Astronomy and astro-physics,

THE SIDEREAL MESSENGER,

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CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory.

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The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO. *Sidereus Nuncius*, 1610.

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THE NEBULÆ.

LEWIS SWIFT.

The neglect with which that branch of astronomy—the nebulæ—has been treated, has been for many years, somewhat painfully apparent to me, though there are many reasons therefor. In the first place but very few persons possess sufficient interest in this subject to arouse any popular enthusiasm, and as telescopes of the largest size are necessary to see them at all, except a few of the brightest, astronomers have, to a very great extent, devoted their time and instruments to the more fascinating and, perhaps, more useful subjects of double-stars, the *Moon*, the *Sun*, etc. During the many years devoted to comet-seeking, I have invariably marked on one of my star-charts the position of every nebula revealed by my comet-seeker, (a 4½-inch refractor). This habit has saved me many hours of anxious watching to detect motion in a nebulous object found, which, at the time of finding, I could not determine whether it were a nebula or a comet. Recourse to my chart with its recorded nebulæ in the position observed, has settled the matter at once.

As soon as the 16-inch refractor of this observatory was mounted, I began the scrutiny of several of the most conspicuous nebulæ for the purpose not only of personal gratification, but also to discover, if possible, some new features overlooked by previous observers as delineated by them in pictorial illustrations. How next to impossible it is to make an accurate drawing of a nebula possessing, as some of them do, many intricate details, is known only to him who has made the attempt! And when to this is added the difficulties surrounding the engraver who, probably, never saw the object he essays to reproduce, it is not surprising that so few of the published illustrations are true to nature. The most difficult nebula for the draftsman is the great nebula in *Orion.* Although every astronomer, from HUYGHENS, its discoverer, (who made the first drawing in 1656), down to our own times, has made the attempt, we as yet have no exact representation of this marvelous object. Its unimagined number of details of exceeding intricacy and delicacy, set at defiance both the pencil of the draftsman and the tools of the engraver. An increase in the size of telescopes affords no relief, for all features seen with the smaller instruments are not only vastly changed in the larger, but new ones are brought out as well. Because the many delineations of this nebula are widely at variance, it is sometimes argued as evidence that a change in its brightness and general configuration is slowly going on. How fallacious this reasoning is, will appear from a consideration of the following curious, and to me unaccountable instances of abnormal seeing, or of discrepant drawing, or of both. On the assembling of our eclipse party at Denver, to observe the total eclipse of 1878, the chief, Prof. COLBERT, located in front of us about fifteen or twenty intelligent ladies and gentlemen, each equipped with a pencil and paper, on which was drawn one or more circles to represent the eclipsed sun. Each, without consultation with any other member of the class, was to make a drawing of the corona as accurate as possible in regard to size, position and general contour. A comparison of these drawings with the utter absence of resemblance to each other or to the object itself, would astonish the gods. No two were alike in any particular, and the picture least resembling the reality was, strange to say, made by a skilled delineator. It appears, therefore, that to obtain a correct illustration of this remarkable nebula, recourse must be had to photography—nature's only artisan.

The great nebula in *Andromeda* has the honor of having been the first discovered, and it is also the brightest and most conspicuous of the five or six visible without a telescope from our latitudes. Down to 1612 this was the only nebula known. Forty-four years later, in 1656, (as before stated) the second—the one of which we have already spoken—the *Orion* nebula was added. In 1714 HALLEY published a list of four new ones, among them being the celebrated cluster, 13 MESSIER, in *Hercules*, which increased the number to six as he supposed, being ignorant that HEVILIUS had already prepared a list of sixteen. In 1755 LACAILLE'S discoveries at the Cape of Good Hope had swelled the list to 64. In 1784, just a century ago, MESSIER'S published catalogues contained 103 clusters and nebulæ whose given places had all the accuracy attainable by the primitive methods at his command. The world knew no more than this about the nebulæ until Sir WILLIAM HERSCHEL took up the subject of their discovery and investigation. In 1802 this mighty Nimrod of astronomy, who, while the world slept, hunted the sky over for these wonderful objects, issued a third catalogue containing an aggregate of 2500 nebulæ never before seen, which were discovered by means of telescopes of his own manufacture, much larger and more powerful than any previously made or thought possible. Since that time his further labors and the studies of Sir JOHN HERSCHEL, DUNLOP, LORD ROSSE, D'ARREST, LASSELL, TEMPEL, STEPHAN and others have brought to our knowledge about 6700, as seen from all latitudes. To this number must be added 197 discovered at this observatory, seven of which were found by my son, a lad of thirteen years of age. Since July 9, 1883, I have made the detection of new nebulæ my special work, with what success will be seen above. The most of those discovered are of the last degree of faintness, or, according to Sir JOHN HERSCHEL'S nomenclature, e. e. e. F. (exceedingly, exceedingly, exceedingly faint.) It is, therefore, not surprising that they should hitherto have been overlooked. I am certain that but for the superior excellence of the eye-piece used, fully one-half of them would never have been seen. It is a periscopic, originally made for my 4½-inch telescope, and, on the 16-inch instrument, gives a power of 132 and a field of 27′. This power is as high as most of the undiscovered nebulæ will bear, even with a telescope of 16 inches aperture. If a much higher power be used and the seeing be poor a few small stars close together will appear nebulous when, in fact, no nebulosity exists.

As before stated, on July 9, 1883, I began a systematic search, selecting for my field of observation the region between the head and third coil of *Draco*, and on that short night found fourteen. The next night's labor was rewarded by the discovery of seven. The seeing on both occasions was exceptionally fine, and superior to any subsequently had, especially since the appearance of the red sunsets, since which some of my faintest nebulæ have become invisible. It may be of interest to state in this connection that nearly three-fourths of the nebulæ discovered at this observatory are in *Draco*, and that the constellation is not yet half explored.

This observatory is situated in the most cloudy section, saving Alaska, in the United States, and since its telescope was mounted the hindrance of work from this cloudiness has been very great. Much time is, of course, also lost by moonlight, and about half the observing weather is given to comet-seeking. But for these drawbacks, added to the fact that during the entire year there are but few nights exquisite enough for such delicate work, my list of nebulæ would, I doubt not, have been much longer.

[*To be continued.*]

WARNER OBSERVATORY, November, 1884.

THE DESIGNATION OF RECENT COMETS.

WILLIAM C. WINLOCK.

In connection with the list of comets which appeared in the September number of the SIDEREAL MESSENGER (vol. 3, p. 201) the following list of *Synonymes* of the more recent comets may be of assistance to any one attempting to collect observations of these objects, scattered with a confusing array of designations through astronomical periodicals of the last five years. And I would here call the attention of astronomers to a real source of annoyance, which a little care would obviate.

The question of the most appropriate method of designating comets has received some attention from time to time, but even in the *Astronomische Nachrichten* no uniform practice has existed. In the general register to the first twenty volumes, the comets are designated by the *year*, with a Roman numeral to indicate the order of discovery; in the register to the twenty-sixth volume, the Roman numeral shows, on the other hand, the order of perihelion passage. Dr. C. A. F. PETERS, the editor, urged in opposition to this plan of designating with Roman numerals according to date of perihelion passage, that a comet could not receive a name until its orbit was computed, and in case a sufficient number of observations was not obtained to determine the orbit, the plan failed entirely; and furthermore that as successive computers modified the elements, the designation of the comet might be changed accordingly. PETERS' proposition to return to the old designation, by order of discovery, brought forth protests from OPPOLZER and LITTROW, (*Astron. Nachr.* vol. 78, p. 319, 363-368) OPPOLZER proposing to introduce in a new manner the date of discovery as a provisional designation.

To avoid the ambiguity which would immediately arise in using the Roman figures with two entirely different significations, PETERS indicated the order of discovery by the small letters *a, b, c,* This etc. was inaugurated with the comets of 1871 in volume 78, and continued to volume 101.

In volume 100 (*Astron. Nachr.* vol. 100, p. 369. Oct. 25, 1881). Dr. KRUEGER, who had become editor, announced that in accordance with a resolution of the *Astronomische Gesellschaft*, the *letters* would be dropped in future volumes of the *Nachrichten* and in the publications of the *Gesellschaft*, and that comets would be designated I, II, III, etc., (with the year) in the order of passing perihelion. Until the time of perihelion was fixed beyond a doubt, the name of the discoverer with the year, or the date of discovery, would be sufficient.

In the table referred to on pages 201-205 of the SIDEREAL MESSENGER, the arrangement is according to the date of discovery. In the following list, the first column contains the arrangement and designation according to KRUEGER'S rule just given, and the second column gives the various additional appellations which the comet has received in our journals. For example: The Pons-Brooks' comet, being the first comet to pass perihelion in 1884, is called "Comet 1884, 1," but as it was the third comet discovered in 1883, it has also been called Comet (*c*) 1883. (The recommendation is that this latter method of designation be dropped, to save the useless duplication of names.) After the regular list for each year, below are given the "suspected" comets, or comets whose orbits could not be definitely settled, designated by the name of the observer or the date of observation. Even where these suspected comets have turned out to be nebulæ I have thought it worth while, in many cases, merely for the sake of convenience in reference, to insert them with a note, since mention may be found of them as comets, before the error was discovered.

Comet 1880 I	= Comet (*a*) 1880.
	= Gould's Comet.
	= The Great Southern Comet of 1880.
Comet 1880 II	= Comet (*b*) 1880.
	= Schæberle's Comet.

Comet 1880 III	= Comet (*d*) 1880. = Hartwig's Comet.
Comet 1880 IV	= Comet (*e*) 1880. = Swift's Comet. = Comet 1869 III (Tempel).
Comet 1880 V	= Comet (*f*) 1880. = Pechule's Comet.
[Comet 1880 Cooper]	= Comet (*g*) 1880. (Observations insufficient for a definite orbit).
Comet 1881 I	= Comet (*c*) 1880. = Faye's Comet.
Comet 1881 II	= Comet (*a*) 1881. = Swift's Comet
Comet 1881 III	= Comet (*b*) 1881. = Tebbutt's Comet. = The Great Comet of 1881 (erroneously referred to as Comet (*c*), 1881. See Mon. Not. R. A. S., vol. XLII, p. 78.)
Comet 1881 IV	= Comet (*c*) 1881. = Schæberle's Comet.
Comet 1881 V	= Comet (*f*) 1881. = Denning's Comet.
Comet 1881 VI	= Comet (*e*) 1881. = Barnard's Comet.
Comet 1881 VII	= Comet (*d*) 1881. = Encke's Comet.
Comet 1881 VIII	= Comet (*g*) 1881. = Swift's Comet.
[Comet 1881 Barnard, May 12.]	Seen again on May 13 but not found afterwards
Comet 1882 I	= Comet (*a*) 1882. = Wells' Comet.
Comet 1882 II	= Comet (*b*) 1882. = Crul's Comet. = Gould's Comet. = Finlay's Comet. = The Great Comet of 1882.

Comet 1882 III	= Comet (*c*) 1882. = Barnard's Comet.
[Comet 1882, May 17]	= The Egyptian Comet. (Seen during the total solar eclipse, May 17, 1882, and shown on the photographs of the corona. No accurate observations of position).
Comet 1883 I	= Comet (*a*) 1883. = Swift-Brooks' Comet.
Comet 1883 II	= Comet (*a*) 1884. = Ross' Comet.

[Comet 1883, Swift, Sept. 11.] (Proved to be a nebula).

Comet 1884 I	= Comet (*b*) 1883. = Pons-Brooks' Comet. = Pons' Comet, 1812. = 1812 Comet.
Comet 1884 II	= Comet (*b*) 1884. = Barnard's Comet.
Comet 1884, (Wolf)	= Comet (*c*) 1884.

[Comet 1884 Spitaler, May 26.] (Possibly a return of Comet 1858 III. Lost after discovery.—No accurate observations obtained).

WASHINGTON, D. C., Nov. 7, 1884.

REPORTS OF EUROPEAN OBSERVATORIES, FOR 1883.

The *V. J. S. der Astronomischen Gesellschaft* for 1884 contains, as usual, reports from the various European Observatories. The following notes are condensed from these reports, and give a connected account of the activity of the various establishments for 1883:

ATHENS.

The *Sun* was observed on 355 days; the *Moon* had 534 points determined in its topography; *Jupiter* was drawn 63 times.

A memoir on the Comet of 1882 is nearly ready for printing. 39400 comparisons of variable stars were made.

BERLIN.

Dr. BECKER has left the observatory to take charge of the Gotha observatory.

The Zone + 20° to + 25° is finished so far as observations are concerned. To determine the influence of the magnitude of the stars on the deduced R. A., the transits of 247 stars were observed on 13 evenings, both with the full objective, and through wire nettings held in front of the objective, so as to reduce their magnitude to a given standard. It was found that faint stars were observed later by $0^s.007$ per magnitude.

It is mentioned in this report that two observers determined the places of 240 stars (using 57 fundamental stars for comparison) in four nights. One observer made the pointings, the other read the microscopes.

VOL. V of the Berlin Observations will shortly be printed

The Computing Bureau has issued the *Berliner Jahrbuch* as usual, as well as the two periodicals, *Circulars* and *Correspondence regarding observations of planets.*

BONN.

The observatory continues to concentrate its efforts on two great works: the *Zone* 40°—50°, and the Southern *Durchmusterung*. In the latter work 114615+1161 stars have been observed. The observation and reductions of this work are now completed and the printing of the catalogue is begun.

BRUSSELS.

The catalogue of E. QUETELET is printed from 0^h to 12^h. The labors of the observatory in Spherical Astronomy, in Physical Astronomy and Celestial Mechanics, as well as in regard to the Transit of Venus 1882, are described in the report.

DRESDEN (private observatory.)

Baron V. ENGELHARDT continues at his private observatory the observations of minor planets, of comets and of nebulæ. 21 planets have been observed 63 times; 3 comets have been observed 43 times; 47 nebulæ have been observed 95 times.

DUSSELDORF.

In 1883, 18 planets have been observed 49 times; since 1847, 144 planets have been observed 1151 times.

Six asteroid orbits are computed yearly.

FRANKFORT (on the Main), (private observatory).

Herr EPPSTEIN has made since 1881, 444 gauges, containing 8332 stars in 113 positions on 23 nights. In all, about 47000 stars in 2426 fields in 774 positions.

Sun-spot observations are also regularly made by Herr EPPSTEIN.

GENEVA.

The 10-inch equatorial has been used for observations of nebulæ, double stars, asteroids and satellites of *Saturn*.

The small equatorial has been used to study the solar prominences.

GOTHA.

Dr. E. BECKER has lately been appointed to the charge of the Gotha observatory. The larger part of the report relates to repairs and to changes which have been made in the instruments.

Dr. BECKER continues the reductions of the Berlin Zone +20° to +25°. The *Moon*, the inferior planets and those MAYER stars not in the *Fundamenta* will be observed on the meridian.

GRIGNON.

The observatory of the Priory of St. John of Grignon, was founded in 1879, and this report relates to its instrumental equipment, and to its observations of Sun-spots, planets and comets.

HERENY, (Hungary.)

Vol. I of its publications has been distributed. The observations relate to the spectra of fixed stars, of variables and of comets; as well as to drawings, etc., of *Jupiter* with meteorological observations.

KALOCSA.

The latitude of the observatory has been accurately determined. The *Sun* is regularly observed. Dr. BRAUN, the director, has contrived a *Trigonometer* with which any spherical triangle can be solved (to about 5′ of arc) with great facility. (22 triangles in 10 minutes.)

KIEL.

Several additions have been made to the instruments; notably a comet-seeker and a star-spectroscope.

The Chronometer observatory has been separated from the Kiel observatory, and constituted a distinct establishment under the charge of Dr. C. F. W. PETERS. The HELSINGFORS–GOTHA Zone is now printing. Kiel has been telegraphically connected with one of the longitude stations of the European *Gradmessung.*

The *Astronomische Nachrichten* is regularly published here.

LEIPZIG.

The changes to the instruments appear to be nearly completed. The observatory has acquired the astro-physical apparatus belonging to the late Professor ZOELLNER.

The work of observation and reduction of the Zone +5° to +10° continues, as well as the reduction of the old Zone +10° to +15°.

LEIPZIG, (private observatory.)

Dr. ENGELMANN made in 1882, 1200 observations of 400 double stars; in 1883, 1600 observations of 540 double stars, as well as other observations.

Victoria and *Sappho* were observed to determine the solar parallax on Dr. GILL'S plan.

LUND.

The Zone observations are finished. DR. DUNER has measured 80 double stars, 563 spectra of red stars and 55 wave lengths in star spectra of the III type. *Victoria* and *Sappho* have also been observed by Dr. ENGSTROM.

MILAN.

The 18-inch equatorial is not yet received.*

*It is understood that the cost of the Dome and Telescope is to be paid from a grant of 250,000 francs ($50,000.) The objective cost 45,000 fr. ($9,000) and is made by MERZ. The mounting (by REPSOLD) cost 65,000 fr. ($13,000.)

The 8-inch equatorial has been employed in making (395) observations of double stars, (64) observations of 3 comets, etc., etc.

The most interesting work of the observatory is the preparation of Baron DEMBOWSKI'S observations for the press. They will be printed in two volumes. The contents of Vol. I is as follows:

I. 2100 measures of 611 stars made at Naples.

II. 2155 measures of 432 stars of OTTO STRUVE'S Catalogue.

III. 663 measures of 199 stars whose distance is between 32″ and 120″.

IV. 1229 measures of 342 doubles discovered by BURNHAM.

V. 476 measures of 134 miscellaneous pairs.

VI. 919 observations of 26 circumpolar pairs.

In all 7542 measures.

Vol. II will contain 13800 measures of W. STRUVE'S Dorpat catalogue.

MUNICH.

The repairs are nearly completed. Among the 37000 stars whose places have been fixed at Munich some 9000 have been only once observed and are in no other catalogue. These are to be each once observed.

The Munich Zones are being completely re-reduced and brought up to 1880.0 with comparisons with LALANDE, BESSEL, SANTINI, RUEMKER, SCHELLERUP, COPELAND and ARGELANDER.

O'GYALLA.

Stars are spectroscopically observed in the Zone 0° to −15°. These observations include stars to 7 magnitude and each star is observed twice. Special star spectra are more carefully investigated. Comet spectra have also been regularly observed. The color of all stars to 4 magnitude inclusive are observed with a ZOELLNER'S colorimeter. The *Sun* was regularly observed (on 203 days.) Many other investigations are also in progress, for an account of which reference must be made to the original report.

PADUA.

The work of the observatory is intimately connected with that of the Italian Geodetic Commission.

PLONSK (private observatory.)

Solar spots are regularly observed, as well as the positions and spectra of comets and the relative situations of double stars.

POTSDAM.

Dr. VOGEL has had the privilege of using the large Vienna refractor during three months of 1883 for the investigation of the spectra of faint stars.

Jupiter and *Mars* have been regularly observed by Dr. LOEHSE.

Sixty-nine nebulæ have been observed for position with the heliometer.

The major planets (except *Uranus*) were photometrically observed each 5 times or more. Many variable stars have been observed. The *Sun* is observed constantly, and a great number of other researches are in hand.

PRAGUE (private observatory.)

Professor SAFARIK has made 1830 determinations of the magnitude of 97 variable stars on 161 nights, besides many other determinations of brightness as of the planets, comets, zodiacal light, etc.

STOCKHOLM.

Dr. GYLDEN'S report relates chiefly to the progress made in his new method of determining the absolute elements of the eight major planets, and can not be summarized here.

The meridian-circle is devoted to the observations of all stars north of +45° which are in the Radcliffe catalogue.

ZURICH.

The *Sun* was observed on 302 days; 2400 single positions of solar spots have been determined. *Jupiter* has been observed on 28 days and observations of comets, etc., have been made.

INTERNATIONAL MERIDIAN CONFERENCE.

The full text of the Final Act of the International Meridian Conference is given below, extracted from the official publications.

The President of the United States of America, in pursuance of a special provision of Congress, having extended to the governments of all nations in diplomatic relations with his own, an invitation to send delegates to meet delegates from the United States, in the city of Washington, on the first of October, 1884, for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the whole world, this International Meridian Conference assembled at the time and place designated; and, after careful and patient discussion, has passed the following resolutions:

1. "That it is the opinion of this congress that it is desirable to adopt a single prime meridian for all nations, in place of the multiplicity of initial meridians which now exist."

2. "That the Conference proposes to the Governments here represented, the adoption of the meridian passing through the centre of the transit instrument at the Observatory of Greenwich, as the initial meridian for longitude."

3. "That from this meridian longitude shall be counted in two directions up to 180 degrees, east longitude being plus, and west longitude minus."

4. "That the Conference proposes the adoption of a universal day for all purposes for which it may be found convenient, and which shall not interfere with the use of local or other standard time, where desirable."

5. "That this universal day is to be a mean solar day; is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian; and is to be counted from zero up to twenty-four hours."

6. "That the conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight."

7. "That the conference expresses the hope that the technical studies designed to regulate and extend the application of the decimal system to the division of angular space and of time, shall be resumed, so as to permit the extension of this application to all cases in which it presents real advantages."

THE LAWS OF FALLING BODIES.

PROFESSOR J. HAGEN, S. J.

Although the laws of falling bodies seem to have no direct bearing on astronomy, and, hence, to find no proper place in an astronomical paper, still the fact that the force of gravitation bears the name of one of the greatest astronomical geniuses, and has ever since engaged the attention of the greatest astronomers, surely entitles the SIDEREAL MESSENGER to open its pages to the following lines.

The writer wishes to communicate to such as are interested in teaching popular astronomy, his own experience in the class-room regarding the laws of falling bodies. Whilst he fully appreciates the experimental proof and even gives it the preference in point of time to any theoretical demonstration, he has found that only the latter, combined with the former, gives the student full satisfaction.

The following table is usually given in text-books as the result of experiment:

Seconds.	Single spaces.	Velocities.	Total Spaces.
1	1	2	1
2	3	4	4
3	5	6	9
t	$2t-1$	$2t$	t^2

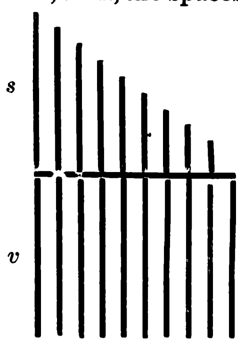
In trying to explain or construct this table *a priori* from the very definition of a constant force, the teacher has to make his students suppose but one fact, viz.: that the *velocity acquired by a falling body at the end of the first second is twice as large as the space fallen during that time.* For from this fact it follows that the spaces fallen during each second increase by two (column 2), as do the successive velocities themselves (column 3), while the total number of spaces fallen are but the result of the addition of the single spaces (column 4). But the student will ask why the velocity acquired after the first second is twice as large as the space fallen. This fact can be made evident to every one who knows that a rectangle is twice as large as a triangle of the same base and altitude.

The unit of time (a second) is mentally separated into an indefinite number of equal parts, which may conveniently, though not quite correctly, be called instants. During each of these instants, the attraction may be supposed momentary, not constant. Now, it is to be remembered,

(1) That the *motion* produced by these single momentary forces is *uniform*, *i. e.*, proportional to time, and,

(2) That the *velocities* acquired by these single forces are *alike*.

If, then, the spaces (s) and velocities (v) produced by these momentary forces are represented by straight lines and placed beside each other (see Fig.) the former will form a triangle, the latter a rectangle of the same altitude, *the more exactly so, the more instants there are in the unit of time*, and hence the law is proved in all rigor.



Though this geometrical demonstration is most simple in itself and may be found by any one, and is perhaps, not even new, the author wished to publish it that other teachers might enjoy that full satisfaction which he himself experienced in his pupils.

College of the Sacred Heart,
Prairie du Chien, Wis.

ASTRONOMICAL JOURNALS.

Besides the transactions of learned societies which have astronomy for one of their objects, we have at present the publications of two societies which are exclusively devoted to astronomy. These are the *Monthly Notices* of the Royal Astronomical Society, and the *Vierteljahrsschrift* of the German Astronomical Society. Besides these there are several journals exclusively devoted to astronomy, of which the *Astronomische Nachrichten* and the *Bulletin Astronomique* are by far the most important.

The *Monthly Notices* are chiefly short papers read at the regular meetings of the society, and abstracts of the larger ones which are finally printed in full in the *Memoirs*. One number per year gives an interesting review of the work of the past twelve months, and a very full account of the proceedings of British observatories. The *Vierteljahrsschrift* devotes one of its four annual numbers to reports from the directors of observatories, chiefly in Germany and America. The other three numbers are largely devoted to reviews of published work. Some of these reviews are of the highest order. To quote only recent ones, we may name SCHOENFELD'S review of DREYER'S paper on the Constant of Precession, and AUWERS' review of GRANT'S Glasgow Catalogue.

The German Astronomical Society is also concerned in the publication of the *Astronomische Nachrichten*, both directly and through its member, Dr. KRUEGER, the editor.

The new impulse is plainly evident in the editing of this journal, which is of the best order, as will be evident to all its readers and contributors. Nothing passes without scrutiny, and, in a way, the editor makes himself responsible for the accuracy of the articles printed.

On the theory of editing which is adopted, nothing could be more satisfactory.

Copernicus, which had reached its third year of publication has lately been discontinued, to the regret of all interested in the maintainance of high class journals. But even before its last number, it found a worthy successor in the *Bulletin Astronomique,* published by M. M. TISSERAND, RADAU, BIGOURDAN, and CALLANDREAU, in Paris. This journal has at once taken a very high rank. It contains observations, usually, such as are made at French observatories, just as the *Astronomische Nachrichten* contains series of observations from all over the world. The *Bulletin* publishes articles on special subjects, but its distinctive feature is monthly abstracts of other scientific journals in which the articles cited are accompanied by very full and complete reviews. In this way the *Bulletin* does for France what the *Nachrichten* and the *Viertel-jahrsschrift* do for Germany, and what the *Monthly Notices* does for England. England has moreover, two special journals—the *Observatory* and the *Astronomical Register*, which cover slightly different fields; Germany has *Sirius*, and France has the new journal of FLAMMARION, *L'Astronomie.* In this country we have had the *Sidereal Messenger* of MITCHELL, the *Astronomical Notices* of BRUENNOW, and the *Astronomical Journal* of GOULD, all of which are now discontinued.

The SIDEREAL MESSENGER published by Carleton College Observatory is our only astronomical journal at this writing.

The Occultation Observed by GILLISS *at Santiago de Chili, on Feb. 29th, 1852. By* JOHN TATLOCK, JR.

In the December number of the SIDEREAL MESSENGER for 1884, Mr. S. C. CHANDLER, Jr., makes mention of an occultation observed by Capt. GILLISS at Santaigo de Chili, and suggests that the star which neither Capt. GILLISS nor Mr. FERGUSON were able to identify subsequently, was *Eta Geminorum.* In accordance with Mr. CHANDLER'S suggestion, I have computed the relative places of the *Moon* and *Eta Geminorum* for the time of the occultation.

The data pertaining to the *Moon's* place, which were kindly furnished me by Prof. NEWCOMB, are taken from the *Nautical Almanac* for 1852, and are as follows:

Feb. 29, 1852.	α			δ			π	
h	h	m	s	°	′	″	′	″
10	6	1	7.18	+22	5	46.4	57	0.7
11		3	27.92		8	27.6		2.9
12		5	48.93		11	1.5		5.2
13		8	10.23		13	27.9		7.5
14	6	10	31.81	+22	15	46.9	57	9.9

The local mean time of the immersion is $7^h\ 40^m\ 48^s.3$, and using the longitude of Santiago, adopted by GILLISS, which is $+4^h\ 42^m\ 33^s.8$, the Greenwich mean time of immersion is $12^h\ 23^m\ 22^s.1$. For this epoch the *Moon's* apparent place from the above data is

$$\alpha' = 6^h\ 6^m\ 36^s.83$$
$$\delta' = +22^\circ\ 59'\ 24''.5$$

The place of *Eta Geminorum*, as given in NEWCOMB'S Standard Stars, is for 1850.0

$$\alpha' = 6^h\ 5^m\ 49^s.39$$
$$\delta' = +22^\circ\ 32'\ 42''.0$$

from which we have the apparent place for Feb. 29th, 1852, as follows:

$$\alpha' = 6^h\ 5^m\ 56^s.67$$
$$\delta' = +22^\circ\ 32'\ 38''.8$$

The relative position of the *Moon* and star is then

$$\Delta\ \alpha = -\ 38^s.16$$
$$\Delta\ \delta = -\ 26'\ 45''.7$$

from which we find that the star, at the epoch given, was distant 12′.2 from the *Moon's* limb in the direction of 198°. A rough computation of the phenomenon on the assumption that *Eta Geminorum* was the occulted star gave substantially the same result.

It is highly probable, although he makes no mention of it, that GILLISS himself may have surmised that *Eta Geminorum* was the star, for only a month before he had witnessed the rare phenomenon of a double occultation of this star, of which he makes mention in the introduction to the third volume of his report in the Expedition to Chili.

Astronomical Observatory,
Beloit College, Beloit, Wisconsin,
Dec. 20th, 1884.

*Report of the Committee on Standards of Stellar Magnitude.**

In selecting a series of stars as standards of stellar magnitude, it would obviously be impossible to choose those which should represent any assigned brightness. Stars could not be found which should have magnitudes of exactly, 1.0, 2.0, 3.0, etc. If the scale was made to conform to the stars, subsequent measures would be sure to show that its divisions were irregular. Moreover, an observer might have difficulty in determining fractions of a magnitude, if the light of all his comparison stars were expressed as integer numbers. A much more precise method seems to be, first, to select suitable stars as standards; secondly, to measure their relative light; and, thirdly, to express these measures in terms of any convenient scale of magnitudes that may be finally adopted. Subsequent measures will then serve to increase the accuracy with which this scale is defined, by determining more precisely the brightness of the comparison stars.

International co-operation is to be desired in order that the system recommended may be adopted by astronomers in all parts of the world. Accordingly, the Royal Astronomical Society and the *Astronomische Gesellschaft* were invited to aid in this work. A committee consisting of Messrs. HIND, KNOBEL, KNOTT, STONE and CHRISTIE was appointed by the Royal Astronomical Society, and Dr. SCHOENFELD was named as its representative by the *Astronomische Gesellschaft.* Unfortunately, the somewhat voluminous correspondence of your committee has been delayed by the great distances to be traversed, and, although the following plans are under consideration by the committees named above, final action has not yet been taken. Stars may be conveniently divided according to their brightness into three classes:—

* Philadelphia meeting of the A. A. A. S.

I. Lucid stars, or those brighter than the sixth magnitude. These stars will form the standards of comparison of the brighter variable stars, and in general for all observations made with the unaided eye or with an opera or field glass. Most of the photometric measures hitherto made relate to these stars.

II. Bright telescopic stars, from the sixth to the tenth magnitude. This class includes most of the catalogue stars, and will furnish the standards for the fainter variables. Meridian observations and those with small telescopes are in general directed towards these objects.

III. Faint telescopic stars, fainter than the tenth magnitude. Large telescopes are required for the convenient study of these stars. They will form convenient standards for the asteriods, for very faint variables, and for the components of clusters, etc.

It is proposed that the first of these classes be assigned to the Royal Astronomical Society, the second to the *Astronomische Gesellschaft* and the third to the American Association. In accordance with this scheme, the following plan is recommended for the fainter stars:

The standard stars to be so selected that they will form twenty-four groups near the equator, and at approximately equal intervals in right ascension. Each group to consist of a series of stars decreasing in brightness by differences of about half a magnitude, from the tenth magnitude to the faintest object visible in the largest telescopes. The groups to be located by bringing a star visible to the naked eye into the field of the telescope, waiting for two minutes, and then forming a chart of the zone ten minutes wide, passing through the centre of the field of the telescope during the next four minutes. This zone will therefore be defined as the region from five minutes north to five minutes south of the bright star, and from two to six minutes following it. The stars to be selected from this zone, which may in some cases have to be extended. Care to be taken that no star is near enough to another to be sensibly affected in apparent brightness by its proximity. The following stars are proposed as leading stars for these groups:—

γ Pegasi, θ' Ceti, α Piscium, α Ceti, γ Eridani, α Tauri, ι Orionis, γ Geminorum, α Canis Minoris, ε Hydræ, α Leonis, θ Leonis, η Virginis, α Virginis, α Bootis, β Libræ, δ Ophiuchi, η Ophiuchi, η Serpentis, δ Aquilæ, θ Aquilæ, β Aquarii, α Aquarii and *α Pegasi.*

Two other groups formed of stars near the poles to be added to these, with which all may be compared, to avoid large systematic errors is different right ascensions.

The advantages of this system are that an observer in any part of the earth and at any season will find comparison stars conveniently situated for observation. Moreover, he will often be able to bring some of the standard stars into the field without moving the dome or reading the finding circles of his instrument. This is a great advantage when working with a large telescope with which alone the smaller stars can be observed. The leading stars will also form convenient standards in observing the others photometrically. For this reason none fainter that the third or fourth magnitude have been selected.

If the above plans are adopted, Dr. C. H. F. PETERS will undertake the preparation of charts of the small zones. By the help of these the standards will be selected and their positions determined. Measures of their light will then, if desired, be undertaken at the Harvard College Observatory. It is greatly to be hoped that similar measures may also be made at some other observatories, and if possible by different methods. The owners of very large telescopes are also invited to examine these regions and locate very faint stars which may be beyond the reach of the other instruments employed in this work.

When the measurements are completed the light of all the standards selected will be expressed in such a scale as may seem best. Any observer may then compare the scale he is accustomed to use with this, by estimating the light of a number of comparison stars. Uniformity may thus be secured where discrepancies amounting to several magnitudes now occur.

Respectfully submitted,

EDWARD C. PICKERING, Chairman.
LEWIS BOSS,
S. W. BURNHAM,
ASAPH HALL,
WILLIAM HARKNESS,
EDWARD S. HOLDEN,
SIMON NEWCOMB,
C. H. F. PETERS,
ORMOND STONE,
C. A. YOUNG,

RIGHT ASCENSION CIRCLE.

During the last year I have had in use a right ascension circle, requiring no clock-work motion or setting during the evening, and making an hour-circle unnecessary and useless.

The right ascension circle moves with the telescope. The index is a complete time circle, graduated to 10 minutes of time, clamped to a fixed bar attached to the stand. The time circle is adjusted for the evening so that an index attached to the bar shall indicate the mean time of the sidereal noon. The right ascension may then be read opposite the mean time upon the time circle. At intermediate times, it is convenient to use for the index the next succeeding 10 minute division, adding the deficit of the time to the right ascension.

To facilitate setting the time circle (this is unnecessary, but, I think, useful), I have a fixed bar capable of being moved through an arc of 10°, with a rocking pawl falling into notches 2° apart. The sidereal noon index is only set on the 10th, 20th and last day of each month; and the remaining adjustment is made by the position of the pawl, which must correspond with the last figure of the day of the month; on the odd days being locked upon the left and on the even days upon the right. With this arrangement the almanac only needs to be referred to at intervals of a month or two, unless there is an interruption in the observations of several weeks at a time.

Brooklyn, N. Y., Dec. 20, 1884. HENRY M. PARKHURST.

EDITORIAL NOTES.

The MESSENGER gratefully acknowledges the prompt renewal of so many subscriptions during the last month.

Considerable matter designed for amateur readers is deferred on on account of much other that deserves prompt attention.

FAINT STARS FOR STANDARDS OF STELLAR MAGNITUDE.

The charts accompaning this circular represent four out of twenty-four regions, from which it is proposed to select certain stars for standards of the magnitude of faint stars. Additional information with regard to the plan is given in the printed reports sent herewith. The regions represented in these four charts are those from 2^m to 6^m following the bright stars γ *Pegasi*, ϵ *Orionis*, η *Virginis*, and η *Serpentis*. Each region extends 5′ north and 5′ south of the declination of the corresponding bright star.

It is desirable that these charts should be made as complete as possible, and it is hoped that astronomers having the use of powerful telescopes, will assist in accomplishing this object. They will confer a favor upon the Observatory of Harvard College by comparing these charts with the regions which they represent, and marking upon them the places of any additional stars which may be visible. Some indications of the comparative brightness of these stars would also be desirable.

Astronomers who may be disposed to take part in this work, are requested to send the chart of any particular region, as soon as possible after its revision, to the address given below.

Harvard College Observatory,
Cambridge, Massachusetts, (U. S.)
Dec. 17th, 1884.

EDWARD C. PICKERING.

We are indebted to Professor YOUNG for the first notice received of the return of Encke's comet. From a private letter under date of Dec. 20, he says:

"I found Encke's Comet here on the evening of the 16th at the Halsted Observatory. It was *extremely* faint,—no nucleus or notable central condensation, and its form seemed, by averted vision, to be considerably irregular; but it was too faint to enable me to make out much more than that it was really there. My assistant in the dome also saw it. It was not distinct enough to allow an accurate determination of place; but by bringing it to the center of the field and reading the circles and clock, I got R. A. = $22^h\ 45^m\ 10^s$, and Decl. $+ 3^\circ\ 41'\ 30''$. The index errors of the instrument were determined by readings on Theta *Piscium* (R. A.=$23^h\ 22^m\ 08^s$; Decl.$+5^\circ\ 44'\ 55''$),

when it came to the same hour angle at which the comet was observed.

"Evidently BACKLUND'S ephemeris is very close: at the time of observation it gives for the comet, R. A. $= 22^h\ 45^m\ 39^s$, and Decl. $+3^\circ\ 41'\ 57''$, and I am not prepared to say that the possible error of my observed position may not amount to as much as the whole discrepancy."

THE RE-APPEARANCE OF RED SUNSETS.

The language generally used to announce that the sunset "glow" has "re-appeared" this fall, is apt to mislead, conveying as it does the idea that the phenomenon, cause and all, had become *non est*, and now re-visits our atmosphere *de novo.*

A few observations and the deductions therefrom are worthy of record at this time, and this branch of the subject merits further examination and proof.

The claim is made in this note that the red glow, morning and evening, has merely been rendered invisible. The reasons for the claim appear below.

The red halo around the *Sun* was seen during the day time, and observed to merge into the red sunsets, before the latter commenced losing their prominence, say in May and June, 1884, thus establishing identity of causation.

This halo has been steadily seen during the whole summer, except on the few days when it was obviously shut out by cloud-forming conditions.

But it only began to be visible some while after sunrise and would disappear before sunset.

Many observations made before and after, both sunrise and sunset, when the heat of summer had passed, compel the conclusion that a little general haziness suffices to veil the whole phenomenon from sight.

On June 16th, 1884, I recorded, "The red halo is seen better when 'the *Sun* is out of lower strata of atmosphere."

On June 24th, 1884, "The halo has been very decided to day—blue 'sky in large patches, between well-defined *cumuli,*—redness is deeper 'than has been seen many times. * * * * When sunset passed 'the whole tint disappeared."

Without multiplying details which would fill pages, may it not be that the mist and haze, and the greater disturbance at sunrise and sunset of the lower air in summer, can account for the shutting out of the color? The "re-appearance" only dates since the fall rains and consequent clearer skies.

Information from two sources would be valuable, *i. e.*

From very elevated regions in the Northern Hemisphere, and from the Southern Hemisphere where winter has prevailed.

One writer speaking of the "intermission," as noticed at the north, under date Sept. 27th, says: "There has been no intermission whatever in the afterglow as observed in our parts of New South Wales, 'for, I think one year. I have observed it myself on nearly every night 'for that space—excepting cloudy days."

The persistence of the halo, though the morning and evening color has faded, seems to warrant the belief that the summer atmosphere near the horizon has to do with the "intermission" of the red sunsets.

A LUNAR RED LIGHT.

It was my good fortune to observe a very interesting and unusual phenomenon on the evening of the 5th of December, 1884. Indeed, so far as I know, it stands unique, viz: a *lunar fore-glow or red light.*

On the date mentioned, about fifteen minutes before moonrise, upon a cloud in the eastern sky at an altitude of about twenty degrees, I noticed a pinkish tint which, in a few minutes, became intensified to a brilliant reddish glow, nearly equalling any display I have witnessed in connection with the *Sun*. The red light extended about thirty degrees in azimuth and was central over the *Moon*, which, although it had not risen, was plainly marked by a peculiar cone-shaped light extending from the horizon to the cloud upon which the red light was displayed. I gave the whole phenomenon a most careful study, and noticed a singular flashing of the red light similar to the aurora. The maximum of intensity was reached the instant before the upper limb of the *Moon* became visible. When the *Moon* was half way up the glow was scarcely visible, and when fully risen all trace of the wonderful light had disappeared. Three intelligent gentlemen of this place independently noticed the display and questioned me as to its probable character on the following day.

Red House Observatory, Dec. 16th, 1884. WILLIAM R. BROOKS.

The large bright nebula to which Professor PORTER calls the attention of astronomers in the December number of SIDEREAL MESSENGER, I have been acquainted with for many years. I began the search for comets in 1857, and very soon after, I think the next year, I ran upon this object, and, finding it was not a comet, I supposed, of course, that an object so conspicuous was well known. The first intimation I had to the contrary, was in a communication from Dr. PETERS, in GOULD'S *Astronomical Journal*, Vol. V, page 16. He gives a list of 7 nebulæ, which he had observed in Naples, which were not in any catalogue, and this same nebula was one of the number. Thinking that so conspicuous a nebula could not have been overlooked, I commenced watching it for variability, and during 25 years no sign of change has been detected, either in size, shape, or brightness.

Warner Observatory, Dec. 19th, 1884. LEWIS SWIFT.

EPHEMERIS OF COMET WOLF, 1884.

This ephemeris has been computed from the elements of Mr. S. C. CHANDLER, Jr., given in SIDEREAL MESSENGER, No. 29, and in *Ast. Nach.*, No. 2625, and may be found useful for the comparison of observations.

Date, Berlin Mean Time.	App. α			App. δ			Log. Δ
	h	m	s	°	′	″	
Sept. 17.5	21	14	20.70	+23	38	8.7	9.912040
18.5		14	39.04	23	13	18.3	9.910882
19 5		14	59.52	22	48	4.5	9.909764
20.5		15	22.95	22	22	22.4	9.908750
21.5		15	48.82	21	56	15.5	9.907813
22.5		16	17.80	21	29	43.3	9.906979
23.5		16	49.23	21	2	50.2	9.906221
24.5		17	23.48	20	35	36 5	9.905548
25.5		18	0.53	20	8	2.2	9.904966
26.5		18	40.19	19	40	10.2	9.904472
27.5		19	22.70	19	12	1.5	9.904067
28.5		20	8.13	18	43	39.0	9.903746
29.5		20	56.45	18	14	3.1	9.903514
Sept. 30.5		21	47.38	17	46	14.3	9.903373
Oct. 1.5		22	41.13	17	17	14.8	9.903325
2.5		23	37.64	16	48	6.7	9.903365
3.5		24	36 72	16	18	51.5	9.903492
4.5		25	38.53	15	49	29.9	9.903705
5.5		26	43.07	15	20	3 6	9.904008
6.5		27	50 24	14	50	34.5	9.904401
7.5		29	0.23	14	21	3.2	9.904896
8.5		30	12.78	13	51	34.4	9.905473
9.5		31	27.89	13	22	2.6	9.906135
10.5		32	45.64	12	52	34.8	9.906891
11.5		34	5.80	12	23	12.0	9.907728
12.5		35	28.56	11	53	54.6	9.908659
13.5		36	53.91	11	24	43.6	9.909673
14.5		38	21.63	10	55	41.0	9.910777
15.5		39	51.85	10	26	48.7	9.911966
16.5		41	44 47	9	58	7.2	9.913239
17.5		42	59.93	9	29	39.3	9.914576
18.5		44	37.14	9	1	23.5	9.916018
19.5		46	16.28	8	33	23.3	9.917536
20.5		47	58.13	8	5	39.3	9.919116
21.5		49	42.20	7	38	12.8	9.920795
22.5		51	28.43	7	11	4.5	9.922541
23.5		53	16.84	6	44	15.7	9.924362
24.5		55	7 20	6	17	46 6	9.926250
25.5		56	59.64	5	51	39.6	9.928209
26.5	21	58	53.96	5	25	55.6	9.930236
27.5	22	0	50.28	5	0	33.5	9.932331
28.5		2	48 44	4	35	35.7	9.934491
29.5		4	48.42	4	11	2.4	9.936716
30.5		6	50.20	3	46	54.3	9.939002
Oct. 31.5		8	53.56	3	23	12.1	9.941343
Nov. 1.5		10	58.64	2	59	56.4	9.943748
2 5		13	5.28	2	37	7.6	9.946206
3.5		15	13.46	2	14	46.2	9.948723
4.5		17	23.14	1	52	52.5	9.951289
5.5		19	34.22	1	31	27.6	9.953907
6.5		21	46 73	1	10	31.6	9.956576
Nov. 7.5	22	24	0.55	10	50	3.7	9.959294

In this connection it may be worth while to notice that in Mr. CHANDLER'S elements as printed in the *Ast. Nach.*, the log. a in the equation of the co-ordinate x should be 9.992051 instead of 9.99905.

JOHN TATLOCK, JR.

ARGELANDER'S DURCHMUSTERUNG.

It appears from Bonn Observations, vol. iii, p. v., that the observations were made with a comet-seeker of 34 lines aperture (3.02 English inches), and a magnifying power of 10 diameters. It does not appear to have been remarked that a magnifying power of 15 would have been necessary to utilize the whole aperture.

EPHEMERIS OF TUTTLE'S PERIODIC COMET, 1885.

Professors ORMOND STONE and P. P. LEAVENWORTH, Leander McCormick Observatory, University of Virginia, have computed an ephemeris of TUTTLE's periodic comet, based on the observations of 1858 and 1871, in which perturbations have received attention. The circular contains the daily ephemerides of the comet from Aug. 10 to Oct. 19, 1885, and will be published in time for early search.

Mr. C. P. JACOBS of Indianapolis, Ind., has taken first steps recently, in organizing a State Astronomical Society, and, among others, such persons as the following are giving favorable attention to this worthy undertaking: Professor D. KIRKWOOD, of the State University; Professor D. E. HUNTER, Washington, Ind.; Professor A. B. CHAFFEE, Franklin College, and Mr. WM. DAWSON, Spiceland, Ind. Of his own work Mr. JACOBS says:

"I have procured a new equatorial mounting for my instrument, which I have just set up and it promises to work admirably. It was designed and constructed by Mr. H. C. WILLIAMS, of this city. The whole of it is solid, and seems to be accurate, and the working parts are nickle plated. The circles are 10 inches in diameter, and are graduated, the declination to 15 minutes, reading to $1^m\ 30^s$ with vernier, the hour-circle to minutes reading to 5 seconds with vernier. My glass, as perhaps you know, was re-made last year by JOHN BYRNE, of New York, has an aperture of 4 inches, and is excellent, both for light and diffinition.

"Mr. WILLIAMS has recently completed and mounted, equatorially, for himself, an 8½-inch Newtonian reflector, and is now grinding a 12-inch for another party. Both of these are silver on glass.

"Mr. PETITDIDIER, whose name appears with mine on the circular, now resides in St. Louis, Mo., being an assistant in the office of the U. S. Engineers in that city. Before leaving here he made and mounted for his own use, an 8½-inch reflector, and has made a smaller one for a party in Cincinnati. The bringing of my telescope here, as you will see, has developed considerable local enthusiasm and scientific enterprise."

Mr. JACOBS' popular addresses, in which are given his theory of the *Sun's* light and heat, are receiving favorable comment. We have already given the substance of this new theory, and, although it is ingenious and possibly true, it is now difficult to prove or disprove it.

I have just received a letter from A. HOHWU, maker of Astronomical clocks, Amsterdam, in which he askes me to make known in America that his price for the very best clock is $360, and that he is now prepared to make a clock which he warrants satisfactory for $300. The latter clock differs from the first only in small details of execution. I take pleasure in complying with his request, as my experience with his clock, No. 32, has been very satisfactory. This clock has been running at the Washburn observatory for nearly four years. When the movement is clean and the clock mounting perfectly firm, I find that its daily change of rate is not more than $0^s.03$.

Washburn Observatory,
University of Wisconsin,
Dec. 4th, 1884.

EDWIN S. HOLDEN.

The printer's miserable failure to correct marked errors in the proof of the elements of BARNARD'S Comet by Dr. MORRISON, in the last number of the MESSENGER makes it simply just to print them in full a second time.

ELLIPTICAL ELEMENTS.

Epoch 1884, Sept. 24.5, Washington mean time.

$M =$	7°	13′	19″.52	Mean Equinox, 1884.0.
$\omega =$	300°	57	44 .43	
$\Omega =$	5	11	23 .56	
$i =$	5	27	18 .94	
$\varphi =$	35°	37	2 .50	
Log. a =	0.4862043			
Log. q =	0.1069968			
Log. μ =	2.8207001			
Period =	1958.4158 days.			

C—O

	$d\lambda \cos.\beta$	$d\beta$
Aug. 12,	+ 6″.52	− 3″.21
Sept. 15,	+ 9″.85	− 8″.09
Oct. 14,	+31″ (?)	+14″.(?)

DR. H. C. VOGEL'S OPINION OF THE OBJECTIVE OF THE GREAT VIENNA REFRACTOR.

(*Publicationen des Astrophysikalischen Observatorium zu Potsdam, Volume IV. page 7.*)

[Translation.]

"In the spring months (1883) when there were several consecutive days of exquisitely clear weather, I got the impression that the objective was rather good, but that the images as regards sharpness were not to be compared with those of middle sized instruments, and on leaving Vienna I had formed the opinion that the difficulty of producing so large objectives had not been quite surmounted, and that the advantage of large objectives principally consisted in the amount of light through which much detail would be revealed (though not with the sharpness of middle sized instruments), which by a smaller amount of light would quite escape the eye of the observer.

"But by my observations in September, this opinion was completely upset. I have acknowledged that the Vienna objective as regards the precision of the images leaves nothing to be desired, and that it was only from want of taking the state of the air into account that I had formed my former opinion. I have with advantage, on splendidly clear evenings in September, used a power of 1000 and even of 1500 and perceived the fine details of planetary disks with admirable sharpness. The images of bright stars were of perfect regularity and the central part of the diffraction disk was so remarkably small, that it may be expected that the instrument would also be very suited for observing double-stars."

PROPER MOTION OF LACAILLE 239.

This star has a proper motion of about $+0^s.050$ in R. A. with no proper motion in Dec. It has been observed since LACAILLE by ARGELANDER, YARNALL, GOULD and STONE. EDWARD S. HOLDEN.

NOTE ON A SOUTHERN NEBULA.

The large nebula mentioned by Professor PORTER on page 314 of the last number of the MESSENGER, has been repeatedly seen in my comet sweeps for the last four years, and it always appears the same. It is large, round, pretty bright,—irregularly bright,—like a flat disk with darkish smear across part of it. E. E. BARNARD.

"GEGENSCHEIN."

This object has been almost constantly visible during the last few months. It is sometimes roundish and at other times elliptical. On Nov. 10, 1884, it was large and elliptical, the axis being as 1:2, the major axis lying approximately east and west. Its center was in a line from *Eta Tauri* (Alcyone) to *Alpha Arietis* at $10^h\ 15^m$.

Vanderbilt University Obs'y. E. E. BARNARD.

The report of Professor G. W. HOUGH, of Dearborn Observatory, Chicago, is received as we go to press. It contains a summary of important work in observation during 1884, on Pons-Brooks' Comet, difficult double-stars, the planet *Jupiter*, the satellites of *Uranus*, and miscellaneous observations. The study of the markings of the surface of *Jupiter* are so instructive that it will be presented fully later.

Of the planet *Saturn*, Professor HOUGH reports as follows:

Near the time of opposition the planet *Saturn* was frequently examined when the seeing was first-class, by Mr. S. W. BURNHAM and myself, in order to detect markings on the rings, if any exist.

All our observations hitherto made on this planet in this respect have been negative. While the two rings have been seen sharply defined, and the boundary of the dusky ring well seen, nothing indicating a division in the outer ring has ever been noticed. We believe any such division subtending an angle of one-half second of arc, would not have been passed over.

It is well known, however, that a division in the outer ring has been alleged to exist, by a number of astronomers using telescopes of much less optical power than our own.

If the phenomenon is real, the most plausible explanation would be to consider it periodic, depending on the rotation of the ring. If such be the case, it is easy to understand how it might escape notice.

The belts on the disc of the planet were at times quite conspicuous and very sharply defined, but we were unable to find any spot or marking by which to observe rotation.

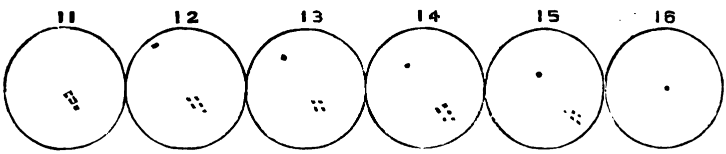
MINIMUM OF ALGOL.

November 9th, the minimum of *Algol* occurred at $7^h\ 23^m$, 75° meridian time. I made observations every few minutes, commencing about 6 o'clock. I compared *Algol* with *Rho*, a star of the fourth magnitude, and *Omega* and *Pi*, stars of the fifth magnitude. This group of stars was in the finder, and was separately distinct in the telescope for comparison, until I noticed a sensible increase in the brightness of *Algol*, which was apparent about eight o'clock. I therefore determined the minimum to be within fifteen minutes of $7^h\ 30^m$ on the day and time before mentioned. G. G.

Professor TODD in his note on the Sun-spot period in the last number of the SIDEREAL MESSENGER, differs so widely from my observations that I can not but refer to it.

It has been my custom for years to take (on all possible occasions) daily observation of the *Sun*, and to note in a circle corresponding to the day of the month what I find on the face of the great luminary. The annexed diagram copied from my observing-book, will fully explain my mode of work.

November, 1884.



It will be observed that there is a regular progression of spots preceding, covering and following the dates given by Professor TODD. Again, October 9th, 1882, I note two spots. At other dates we agree.

G. G.

The following orders and subscriptions have not been previously acknowledged: Miss E. Walter, Mt. Pleasant, Pa.; F. J. Blinn, East Oakland, Cal.; Dr. L. Swift, Rochester, N. Y.; Prof. D. Kirkwood, Bloomington, Ind.; Chicago Public Library, Chicago, Ill.; Library State Normal School, (Vols. I, II and IV,) Ypsilanti, Michigan; Charles P. Jacobs, Indianapolis, Ind.; Library Wellesley College, Wellesley, Mass.; Arthur C. Perry, New York City, N. Y.; Prof. J. Tatlock, Smith Obs'y, Beloit, Wis.; Prof. R. C. Crampton, Jacksonville, Ills.; John W. Osgood, Cincinnatus, N. Y.; George Gildersleeve, Baltimore, Md.; John R. Hooper, Baltimore, Md.; George R. Vickers, Baltimore, Md.: Prof. Winslow, Upton, Brown University, Providence, R. I.; W. H. Numsen, Baltimore, Md.; Prof. C. A. Young, Halsted Obs'y, Princeton, N. J.; Rev. Otis B. Rawson, North Lynn, Ct.; Rev. C. M. Charroppin, St. Louis University, St. Louis, Mo.; J. Wilson Fisher, Philadelphia, Pa.; Library of Cincinnati Obs'y (Vols. I, II, III), Mt. Lookout, Ohio; Professor M. R. Conable, 1126, Girard St., Philadelphia, Pa.; Professor John Haywood, Otterbein University, Westerville, O.

BOOK NOTICE.

Bessey's Botany Briefer Course. Henry Holt & Co., New York.

A copy of this publication has recently come into our hands and has been read with interest.

The publication of the original and larger work was a public expression of a change which had been going on for a long time.

In methods of presenting the natural sciences not yet so old as to be beyond the memory of young men, it was the custom to present such generalizations as are involved in classification without any preliminary demonstration of the facts which give foundation to such arrangements. The fact that botanical classification has been worked out much more thoroughly than that of Zoology and that so admirable a system of determination has been elaborated has contributed to retard the change from classification to structure.

The publication of these volumes of Professor Bessey makes possible to many teachers what they have long desired. Teachers of this branch are not so ignorant of what is desirable as their work would sometimes seem to indicate. The lack of a work treating comprehensively the essential features of Botany has been an impassable barrier.

The Briefer Course is not simply a condensation of the larger work. There is none of that dryness which is the usual result of simple condensation. No essential element of the larger work is lacking in this. There is the same comprehensiveness and the same judicious leading of the student to personal observation.

One commendable feature of the book is the fairness with which all branches of the great vegetable kingdom are treated. Hitherto the student of Botany has been led to think that flowering plants were the only real thing and that the rest, except, perhaps a few of the vascular cryptogams were mythical, or, at least, not to be understood by ordinary mortals.

Of two things Professor Bessey's work is an exponent: of the present state of our knowledge regarding plant life; and of that method of studying the observational sciences which is, or is rapidly coming to be, recognized as the true one. Compact, comprehensive, well written,—with these characteristics the Briefer Course cannot fail to meet with a welcome from many teachers of Botany.

Carleton College. L. W. C., JR.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 2. MARCH, 1885. WHOLE NO. 32.

On the Distribution of the Stars in the Northern Hemisphere. By Prof. H. SEELIGER.

ABSTRACT.

As is well known, the *Durchmusterung* of ARGELANDER contains the position and magnitude of all stars visible in a 3-inch comet-seeker, with a power of 10, from the north pole to —2° declination. Prof. SCHOENFELD has completed a similar *Durchmusterung* from —2° to —23° which is not yet published. The stars of these lists are between the 1.0 and 9.5 magnitudes; (the last approximate only). In 1869, VON LITTROW had the stars of the northern D. M. counted by *magnitudes* and by *declination*. That is, he had the zones of 1° wide in decl. counted, so as to exhibit the number of stars of each tenth of a magnitude. Unfortunately he did not separate the stars so as to exhibit the numbers in right ascension also, as he might easily have done. Prof. SEELIGER, of Munich, has just completed a count of this kind. He was led to do this, he says, because there was no such count in existence, and one was needed. It is clear that a kind of astronomical "clearing-house," where accounts can be adjusted is also needed! A count of the kind exists in *ms.* at the Bonn observatory (see Bonn Obs. Vol. V), but is not accessible. The Washburn observatory prints in its Vol. III, the beginning of a count of this kind (from —2° to +15°), which was stopped on hearing of Prof. SEELIGER'S. Prof. SEELIGER appears also to be unaware that LITTROW'S count has been repeated by Mr. PEIRCE, (Annals H. C. O., Vol. IX)! With this digression, which is not uninstructive, we return to Prof. SEELIGER'S important paper. He has then counted the stars of the D. M. accurately, and by R. A. as well as Dec. and mag. Instead of keeping magnitudes down to the tenths, he has wisely selected the following classes:

1,	containing	stars	from	1.0	to	6.5	mags.	inclusive.
2,	"	"	"	6.6	"	7.0	"	"
3,	"	"	"	7.1	"	7.5	"	"
4,	"	"	"	7.6	"	8.0	"	"
5,	"	"	"	8.1	"	8.5	"	"
6,	"	"	"	8.6	"	9.0	"	"
7,	"	"	"	9.1	"	9.5	"	"

The number of stars for each 20ᵐ of R. A. and each 1° of Dec. was counted. These numbers have been united into sums giving new numbers of stars in areas of 20ᵐ in R. A. by 5° in Dec. The latter tables are to be printed by the Munich observatory.

Prof. SEELIGER'S paper contains the number of stars for each area of 40ᵐ in R. A. by 5° in Dec., the stars of each class 1—7 being enumerated separately. There are, in the northern sky, 4120 objects of class 1; 3887 class 2; 6054 class 3; 11168 class 4; 22898 class 5; 52852 class 6; 213973 class 7; 314952 in all, besides 126 nebulæ, variables, etc. That is 315078 in all, by Prof. SEELIGER'S count. ARGELANDER gives 315089. To deal with this mass of figures, Prof. SEELIGER divides the sky into 8 zones. Zone 1 has its centre at the north pole of the Milky Way, and extends to Galactic Polar Distance 20°; zone 2 extends from G. P. D. 20° to 40°; zone 3, from 40° to 60°; zone 4, from 60° to 80°; zone 5 (containing the Milky Way itself) from 80° to 100°, and so on to G. P. D. 140°.

The number of stars (of each class) per zone is next determined; and next the number of stars (of each class) in each 1° square. We may quote the figures for class 1 and classes 2–7 taken together:

	Class 1.	Classes 2–7.
Zone 1,	0.15	8.51
2,	0.15	8.95
3,	0.17	11.02
4,	0.21	16.77
5,	0.27	24.60
6,	0.25	18.92
7,	0.15	11.59
8,	0.12	10.19

This table shows the influence of the Milky Way most markedly; but if changed so that the number of stars in Zone 5 is always 1.00, it becomes even more interesting.

	Class 1.	Classes 2–7.
Zone 1,	0.55	0.35
2,	0.57	0.36
3,	0.64	0.45
4,	0.79	0.68
5,	1.00	1.00
6,	0.91	0.77
7,	0.57	0.47
8,	0.43	0.41

If we call these last numbers D, and if we form $\frac{7}{1-D}$, these numbers may be called the *gradients* (G), expressing the rapidity of increase of number of stars as we approach the milky way. The values of G are

Class 1,	0.36	Class 5,	0.44
2,	0.48	6,	0.45
3,	0.42	7,	0.45
4,	0.47	8,	0.52

Classes 2–7, 0.50.

It thus appears probable that *G* is greater for the fainter stars. but not so much greater as has been commonly supposed. For stars of the *mags.* 1, 2, 3, and of the *mags.* 4, 5, 6, G results 0.34 and 0.19. These numbers show an important difference between the bright and the faint stars. If we were allowed to assume that stars even fainter than 9.5 would continue to show the constant gradient that these show, it would follow that our stellar system was not to be considered as a flat disc, but rather more or less spherical, with the stars concentrated near its medial plane (the Milky Way).

The author next proceeds to compute the center of gravity of each class of stars, and its position is,

			$\frac{(R)}{r}$
Class 2,	R. A.=23^h 30^m	Dec.+79°.5	0.58
3,	22 32	+81 .5	0.58
4,	23 10	+79 .7	0.56
5,	23 7	+79 .3	0.53
6,	23 9	+78 .3	0.51
7,	24 14	+77 .3	0.51

The last column gives the ratio $\frac{R}{r}$ for each class; where R is the distance of the center of gravity of *all stars* of the class, r that of every star of that class.

The full interpretation of these numbers can only be made when SCHOENFELD'S D. M. is published. Certain further conclusions may also be drawn from the author's figures. This paper is the most important which has appeared on this very interesting question since the publication of Dr. GOULD'S *Uranometria Argentina*. E. S. H.

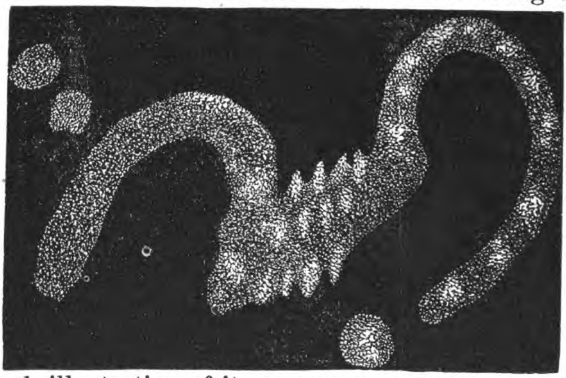
THE NEBULÆ.

[Concluded.]

The question of the absolute distances of the nebulæ and clusters has always excited a high degree of interest among astronomers, but it is impossible, within the limits to which I intend to confine myself, to discuss a subject which, from its very nature, is and must be purely speculative. That they are vastly more distant than the stars is undoubtedly true. In regard to the origin and design of these immense masses of matter, strewn with such lavish abundance in some regions and so sparsely scattered in others, we are also entirely ignorant. In volume they as greatly exceed that of the *Sun* as does the *Sun* that of the minutest microscopic atom. Before the invention of the spectroscope it was a favorite and somewhat plausible theory that all nebulæ were clusters of stars which might be resolved into such were we possessed of telescopes large and powerful enough. A partial success in this direction made the theory very popular. But spectroscopic examination settled at once the vague conjectures of a century. It tells us in language too plain to be misunderstood or doubted, that some are clusters of stars, while others are masses of gas, or nebulous matter, whatever that may be. It would be natural to suppose that inasmuch as these gaseous bodies can be but little acted upon by others, they would, in obedience to the law of gravitation, have ages ago assumed a spherical form, which is quite true of the most of them, though many are as shapeless as the nimbus clouds, and as indeterminate as wreaths of smoke. Of this latter class the great nebula in *Orion* and the *Swan* nebula are notable examples. The most symmetrical of them have no points of reference from which to measure as have the stars and comets with nuclei; nor sharp outline of limb as have the *Sun, Moon* and planets, and consequently the question of distance cannot probably be settled until after the lapse of centuries as it is impossible to obtain with mathematical exactness the position of a nebula that has no starlike nucleus from which to measure.

Under the varying conditions of the atmosphere—its purity, steadiness and other causes—nebulæ with many intricate details will on different nights present very different aspects. A description, therefore, of one of these objects from a single observation will be often misleading and give rise to a suspicion of change when, in reality, no change has taken place. Some of Sir WILLIAM HERSCHEL'S descriptions of his nebulæ as recorded nearly a century ago are widely at variance with their present appearance. Take for example H. 493 III=General Catalogue 493, described by him as "very faint; small; round; bright in the middle; among stars." Almost exactly in its place I have found a nebula described as follows: pretty faint; very elongated; spindle; not a star nearer than 4′. D'ARREST has one near which was easily seen, though not in any respect answering the description of HERSCHEL. Again 741 III=G. C. 4328 is described by HERSCHEL as "very faint; very small; round; stellar;" while my account is, pretty bright; exceedingly elongated. MESSIER'S 76=G. C. 385 R. A. for 1885.0, 1h 34m 52s Dec.+50° 58′ 48″ is recorded in the catalogues as double. Through the 4½-inch telescope it has always appeared square, but seen through the 16-inch instrument it becomes a right-angled parallelogram with size about as 1 to 2 and filled with nebulosity, but having two points of brightness it was called double by Sir WILLIAM HERSCHEL. On one exceptionally good night I observed it as a spiral, and, searching his record of observations, I found that Lord ROSSE had previously seen it as such. For one so small it is a remarkable object.

Another wonder and one which appears entirely unlike the illustrations made by Lord ROSSE, LASSELL, TROUVELOT and others, is the well known *Swan*, or *Omega*, or *Horse-shoe* nebula of the *Milky Way*, a region where very few nebulæ are found. It is No. 4403 of G. C. and 17 of MESSIER, and is in R. A. 18h 14m; Dec. −16° 13′ or, in the constellation of *Sobieskii's Shield*. The following sketch



is a rough illustration of it as seen on many occasions. It is drawn from memory and, of course, not to scale. The singular appendage at the following end has, as far as I know, never before been seen. It was first noticed on July 4, 1883, and entered in my note-book as follows: "Saw a curious appendage from the *f* end of the *Swan* nebula not represented in any known drawing, being an eF. nebulous band irregularly bright, curving gracefully upward (inverted field) then to the right and downward and to the left, curving under the nebula proper and ending near a L. e. e. F. nebula. Cannot trace it clear to the new nebula." "July 5—The above observations are confirmed in every particular with the addition of other *nova* to the left of the neck, one which has, I believe, been previously seen." "July 6—The foregoing phenomena were well seen by Mr. WARNER and Mr. REBASZ. There is much of detail in it, and to accurately represent it requires drawing to scale." Subsequently upon the occasion of their visits to this observatory, it was seen as represented by Dr. COPELAND and Mr. TROUVELOT.

In R. A. $11^h\ 22^m\ 11^s$; Dec. $+59°\ 13'$ is G. C. 24 5=H 247 I, mentioned by all observers as very little elongated. Chancing to run across it with a power of 132, I immediately suspected it to be a close double, which suspicion a power of 200 confirmed. It is probably the closest double nebula known. I shall re-examine it at the first opportunity.

In 1859 while searching in *Eridanus* for comets I ran upon the most conspicuous nebulous star visible from this latitude—a 7th magnitude star nearly in the center of a bright nebulosity. As both were so bright I, of course, supposed they were well known. Not until five years since was I aware that this wonderful object was not in the G. C. In DREYER'S supplement to that catalogue there is, however, a nebula, G. C. 5315, discovered by WINNECKE, and agreeing very well in position, which he describes as "faint; 10′ long"—about as erroneous a description of it as could well be written. Prof. BARNARD, of the Vanderbilt University Observatory, Nashville, Tenn., from his greater southern position has, at my request, made a study of this interesting object, and in a recent letter gave me its position for 1885.0 as follows: R. A. $3^h\ 28^m\ 25^s$; Dec. $-26°\ 15'\ 47''$. Its position for the same epoch as given by WINNECKE is $3^h\ 28^m\ 40^s$; Dec. $26°\ 13'.4$. Being ignorant of the the date of WINNECKE'S observation, I am unable to decide to whom the honor of its discovery belongs.

On the night of April 26, 1884, while engaged in nebula-seeking, there occurred to me the thought that perhaps there are undiscovered nebulæ in close proximity to some of the brighter stars. The telescope was turned upon *Delta Leonis*, and immediately there was seen a nebulous object which proved to be new, and which recorded in the vernacular of my note-book, reads: "C. S.; p. F.; R. f. δ *Leonis*; 4^s; $7'$ —; easily overlooked." This in unabreviated language means, considerably small; pretty faint; round; follows *Delta Leonis*; 4 seconds of time, and is 7 minutes of an arc south of it.

Encouraged by this success, search close to many other bright stars was made but without avail, until Oct. 18, when one was found = to diameter of field (26′) from the variable star *Algol.* At the same time another, also a *nova*, was seen 2° 15′ farther south.

The greater part of HERSCHEL'S class III are bright objects compared with most of those discovered at this observatory. Nearly one-half of the 200 *novæ* can be seen only by averted vision and by the most persistent and long-continued effort. But few nights in a year are suitable for the finding of objects so extremely faint. I have never yet, from a wearied eye, been obliged to desist from comet seeking, though I have many times continued it during the entire night; but am often compelled to abandon nebula-seeking. When, in nebula work, the tired eye fails to equal its best effort, resort is had to the less fatiguing work of comet searching.

Nebulæ are often associated in pairs and sets, and so frequently has this been observed that on the discovery of one, search in its immediate vicinity is invariably made for a mate, and often as the result of chance, one is found apparently connected by physical relations like the binary system of double-stars.

The task of getting their positions quickly and to the desired degree of exactness is a difficult one. The plan adopted may not be the best; in fact I feel quite certain that with more experience and the exercise of greater vigilance, I shall be able to improve my methods. Nearly all of the undiscovered nebulæ are exceedingly faint. Though the reapers who have preceded us were few they labored hard and resolutely, and heeded not the advice of Boaz to let fall some handfuls for the gleaners who were to follow after. The dome-room is absolutely dark while I am sweeping, and the pupil of the eye is greatly expanded (an essential preparation for the observation of such faint bodies.) The gas is lighted only while reading circles and making records, but, as after its extinguishment, I am for a few minutes, nebula-blind, a considerable loss of precious time is involved.

The eye-piece used for this work is a periscopic positive. I have never yet seen a negative eye-piece suitable for comet or nebula seeking, especially the latter. The field of the negative eye-piece is made luminous by the rays from the object-glass impinging upon the field lens, which is not the case with a positive, where the rays come to a focus before reaching it. In front of, and at a proper distance from, the field-lens of the eye-piece used are inserted in a ring, two coarse hairs in the form of a cross, the intersection being exactly in the line of collimation. With little effort and without artificial illumination they can at all times be seen, while never save in presence of moonlight are they obtrusive. When a nebula is found, it is brought roughly to the center of the field, the driving-clock started, the telescope clamped in R. A., the optical center of the nebula bisected with the wires in both coordinates, the telegraph sounder connected with the break circuit sidereal clock started; all without removing my eye from the telescope and without an assistant. After noting its size, shape, brightness and configuration with some of the nearer stars in the field, and if excessively faint, and therefore probably to be re-found with difficulty, the number of seconds as counted from the sounder by which it follows or precedes the nearest bright star. I then descend from the observing-chair read the circles, make the records, both as to position and appearance. As I always, except in special cases, work on or very near the meridian, their positions in R. A. are therefore corrected only for precession, and in Dec., for both precession and refraction. Every nebula thus picked up except those that are bright and therefore presumably not new are noted down in the working-book. The next day every known catalogue of nebulae is examined, and if any in my list are identical with any in the catalogues, record is made in a special ledger. The new ones are carefully reduced and recorded in another ledger ready for publication.

The discovery of nebulæ and the getting of their approximate places is one thing, while the obtaining of their micrometrical positions with mathematical exactness, is another and a very different matter. For the former work (their discovery) one set of appliances only can be used, viz; an eye-piece of low power and a large field for sweeping. For the latter quite another plan must be adopted, and the two cannot be combined. A micrometer eye-piece is as poorly adapted to nebula as to comet seeking. In view of the small number of hours in a year suitable for successful search for such faint objects, but slow progress would be made were the observer compelled to exchange his comet eye-piece for a micrometer and to lose much valuable time in refinding the object—which probably could not be seen at all—selecting his comparison-stars, getting its place and angle of position, determining the direction of its major axis if elliptical, and various other data. To accomplish all this and make his records would require his lamp to be several times lighted, and this, on each occasion, would blot out the nebula, often of unimagined faintness. Then how great his disappointment after all his loss of time to find, as he very probably would, that his presumed new discovery was perhaps a century old.

I see, therefore, no way but to pursue the plan already detailed, viz; to get positions with all the accuracy possible *with the means adopted for their discovery*, leaving to specialists to pick them up without sweeping and to fix their places with such exactness that those who come after us may be able to determine whether they also like the stars, are drifting. It may be that they are no farther distant than the stars, and, consequently, their proper motion may be equally great; and ought, therefore, at least in some cases, to be detected in the course of a century or two.

The faintness of a majority of those in my list of *novæ* is inconceivable except to those who are engaged in similar work. With a luminous field, the largest telescope in the world would not reveal one of them, and it is very doubtful if, even with a dark field and luminous wires, micrometrical measures of position can ever be successfully made.

LEWIS SWIFT.

WARNER OBSERVATORY, Feb. 12, 1885.

Second Report of the Committee on Standards of Stellar Magnitudes.

The first report of this committee (*Proc. Amer. Assoc.* XXX, p. 1) included a plan for the determination of standards for stars fainter than the tenth magnitude. Twenty-four bright equatorial stars were chosen and the standards were to be selected from the regions following them from two to six minutes of time and not differing in declination from the leading stars by more than five minutes of arc. The observations described below have been made at the Harvard College Observatory unless otherwise stated. The light of each of the leading stars has been determined on from seven to eighteen nights with the meridian photometer. Charts have been constructed of all the stars visible with the fifteen-inch telescope, in all but three of the regions from which the standards are to be selected. Most of these charts have been submitted to a careful scrutiny with the fifteen-inch telescope of the Washburn Observatory. An important test of the completeness of the charts is thus afforded.

In the following table three successive columns give the names of the twenty-four leading stars and their approximate right ascensions and declinations for 1880. The next two columns give the number of nights on which they were observed with the meridian photometer, and the resulting magnitude. The details of these measures and a comparison with various other determinations of their light will be found in the *Harv. Observ. Annals*, Vol. XIV. The last columns give the number of stars in each of the charts, and the corresponding number of stars contained in the same portions of the Durchmusterung.

Stars suitable for standards must next be selected by the help of the charts. The light of these stars should then be measured in as many different ways as possible. The committee will be much indebted for aid that may be rendered them in this portion of their work. The early publication of the charts now becomes a matter of importance, as it would permit their immediate use for various purposes.

NAMES.	R. A. 1880.		Dec. 1880.		No. Nights.	Phot. Mag.	Stars on Chart.	D. M. Stars.
	h.	m.						
γ Pegasi	0	7.1	+14°	31′	13	3.04	49	3
θ′ Ceti	1	18.0	− 8	48	12	3.77	27	—
α Piscium	1	55.9	+ 2	11	12	3.99	—	1
α Ceti	2	56.0	+ 3	37	11	2.68	—	2
γ Eridani	3	52.4	−13	51	10	3.05	30	—
α Tauri	4	29.0	+16	16	16	1.00	19	3
ε Orionis	5	30.1	− 1	17	16	1.76	42	6
γ Geminorum	6	30.8	+16	30	17	2.00	150	5
α Canis Minoris	7	33.0	+ 5	32	15	0.46	96	3
ε Hydrae	8	40.4	+ 6	51	7	3.58	64	4
α Leonis	10	2.0	+12	33	15	1.42	39	1
θ Leonis	11	7.9	+16	5	10	3.47	24	3
η Virginis	12	13.8	+ 0	0	10	4.05	23	2
α Virginis	13	18 9	−10	32	13	1.23	30	—
α Bootis	14	10.2	+19	48	13	0.03	25	1
β Libræ	15	10.5	− 8	56	14	2.74	39	—
δ Ophiuchi	16	8.1	− 3	23	11	2.77	48	—
η Ophiuchi	17	3.5	−15	34	10	2.62	100	—
η Serpentis	18	15.1	− 2	56	10	3.35	7	—
δ Aquilæ	19	19.4	+ 2	53	14	3.46	—	3
θ Aquilæ	20	5.1	− 1	11	10	3.39	110	2
β Aquarii	21	25 2	− 6	6	10	3.14	52	—
α Aquarii	21	59.6	− 0	54	10	3.16	48	0
α Pegasi	22	58.8	+14	34	18	2.61	29	3

Respectfully submitted,

EDWARD C. PICKERING, Chairman.

LEWIS BOSS, S. W. BURNHAM,
ASAPH HALL, WILLIAN HARKNESS,
EDWARD S. HOLDEN, SIMON NEWCOMB,
C. H. F. PETERS, ORMOND STONE,
C. A. YOUNG.

Index to the (54) Published Ecliptic Charts of the Paris Observatory.

No.	R. A.					Decl.				
1	0h	0m	to	0h	20m	+ 1°	0′	to	− 4°	15′
1a	0	0		0	20	+ 1	0		+ 6	15
2	0	20		0	40	− 1	45		+ 3	30
2bis	0	20		0	40	+ 3	30		+ 8	45
3	0	40		0	60	+ 6	15		+ 5	30
3a	0	40		1	0	+ 6	30		+10	45
4	1	0		1	20	+ 4	45		+10	0
5	1	20		1	40	+ 7	0		+12	15
6	1	40		2	0	+ 9	0		+14	15
7	2	0		2	20	+10	30		+15	45
8	2	20		2	40	+12	15		+17	30
9	2	40		3	0	+14	0		+19	15
10	3	0		3	20	+15	15		+20	30
10a	3	0		3	20	+10	0		+15	15
13	4	0		4	20	+18	45		+24	0
15	4	40		5	0	+20	0		+25	15
22	7	0		7	20	+20	0		+25	15
26	8	20		8	40	+16	15		+21	30
27	8	40		9	0	+15	0		+20	15
28	9	0		9	20	+13	45		+19	0
29	9	20		9	40	+12	15		+17	30
29	9	20		9	40	+ 7	0		+12	15
30	9	40		10	0	+10	30		+15	45
31	10	0		10	20	+ 8	45		+14	0
32	10	20		10	40	+ 6	45		+12	0
33	10	40		11	0	+ 4	45		+10	0
34	11	0		11	20	+ 2	45		+ 8	0
35	11	20		11	40	+ 0	30		+ 5	45
36	11	40		12	0	− 1	30		+ 3	45
38	12	20		12	40	− 5	45		− 0	30
39	12	40		13	0	+ 8	0		− 2	45
40	13	0		13	20	−10	30		− 5	15
41	13	20		13	40	−12	0		− 6	45
43	14	0		14	20	−15	44		−10	30
43a	14	0		14	20	−10	30		− 5	15
46	15	0		15	20	−20	30		−15	15
48	15	40		16	0	−22	45		−17	30
49	16	0		16	20	−23	45		−18	30
50	16	20		16	40	−24	30		−19	15
51	16	40		17	0	−25	0		−19	45
52	17	0		17	20	−25	30		−20	15
59	19	20		19	40	−24	30		−19	15
60	19	40		20	0	−23	45		−18	30
61	20	0		20	20	−22	45		−17	30
62	20	20		20	40	−21	30		−16	15
63	20	40		21	0	−20	15		−15	0
64	21	0		21	20	−22	0		−16	45
64a	21	0		21	20	−16	45		−11	30
67	22	0		22	20	−14	0		−10	45
68	22	20		22	40	−12	15		− 7	0

No.	R. A.				Decl.			
69	22	40	23	0	−10	0	− 4	45
70	23	0	23	20	− 8	0	− 2	45
71	23	20	23	40	− 5	45	− 0	30
72	23	40	24	0	− 3	45	+ 1	30

E. S. H.

THE LICK OBSERVATORY.

THE EDITOR.

The February number of *Harpers' Monthly* contains an article from the pen of Professor S. NEWCOMB concerning the beginning and growth of the Lick Astronomical Observatory at Mount Hamilton, California. Of the personal character of Mr. LICK, and the charming view of the surrounding country from the mountain summit considerable is said in interesting detail. The pen-picture of the eccentric and wealthy Californian, to which the reader is introduced appears in rough outline, and lively contrast with the other sketch from nature which is grand in its simplicity and beauty.

The outline of the site for an astronomical observatory, in a measure, is assured by the continuous and successful observations of double-stars taken by S. W. BURNHAM, of Chicago, who was at Mount Hamilton for several months in 1879 for the purpose of determining the advantages of that place for astronomical observation. In 1882 Prof. D. P. TODD, of Amherst, made observations and photographs of the transit of *Venus* at the same place, and the photographs are said to be the finest that ever have been taken of a transit of *Venus*.

In 1880 the trustees of the Lick Observatory contracted with Messrs. ALVAN CLARK & Sons to make an object-glass of thirty-six inches clear aperture for the great telescope. The difficulty and hazard of such an undertaking on the part of the makers are poorly realized by our readers if only the fact be stated that such a refracting objective (if it could be made at all) would have a diameter six inches greater than any other ever attempted by any maker. The casting of the two rough disks for so large an objective, that should be perfectly clear and of uniform density, was a task so difficult in itself that scarcely more than one responsible glass foundery in the world would undertake it. FEIL, of Paris, has contracted to furnish these disks and found little trouble in making the flint-glass disk, which has already been in the hands of the optician for about two years, and which is apparently a beautiful specimen of the French art as the writer would say from a casual look at it. The crown-glass disk, which has proved so far too much for the skill of FEILS, is by no means given up. The elder member of the firm has been absent from the works for some time, and it has been thought by some who have had opportunity to know that the nineteen or more failures that have occured in attempting to cast this disk may have been due, in part at least, to the want of his superior skill. Recently the elder FEIL has resumed charge of the foundery and a pair of crown disks have been cast that it is hoped may be successfully annealed. If this step proves successful the grinding of the glass can then go forward; but this part of the work will consume at least two years and more likely twice that time. Then will follow the mounting, which is a problem scarcely less serious or intricate than others already named.

From the pen of Prof. E. S. HOLDEN we have already given in the MESSENGER a very full and interesting account of the fine Meridian Circle recently made by the REPSOLDS, of Hamburg, Germany, under the direction of Professor HOLDEN, who also personally superintended its mounting in the observatory only a few months ago.

Respecting other points of general interest about this great observatory, the *Morning Call* (San Francisco, Cal., Feb. 8) has the following: "The work of constructing the great dome, 75 feet high, to cover the telescope, which will be nearly 60 feet long, goes on. During the winter, the foundation of solid rock, 72 feet in diameter and 6 feet deep, will be excavated. The material of the dome will be of brick and iron, and the construction will probably be commenced in June. Already 400,000 bricks have been hauled to a point within two miles of the observatory. Next to the discovery of a glass founder capable of supplying the necessary lenses for the great telescope, the Lick trustees have met with the greatest difficulty in devising an efficient system of water-works. That trouble has, however, been overcome, and a complete system of water-works is now in operation. Water is obtained at a distance of 400 feet below the observatory and pumped up by steam to a reservoir 50 feet above the observatory, and having a capacity of 100,000 gallons. A supply of rain water at a gap lower down suffices for the stables and other habitations there situated. Seventy thousand gallons were thus obtained during the last heavy rainstorm. According to the rain-gauge at the observatory the rainfall up to February 1st had reached the high figure of 41½ inches. The trustees have expended on the work done so far $280,000, of which $12,000 has been paid on the glass for the great telescope. The entire cost of the glass will be $50,000. The mounting of the telescope will entail an expenditure of $50,000 more, as an instrument so prodigious requires machinery of an unusually complicated quality to operate it. In observations an astronomer sees but a tenth of the apparent size of the planets, and can observe nothing of the other heavenly bodies. The machinery which moves the telescope must, therefore, be of the nicest exactness, as by its movements the astronomer locates the almost endless subdivisions of the sidereal world. When the south dome is finished and the observatory ready to be transferred to the State it will have cost about $425,000. The establishment has already won an enviable reputation by the astronomical work done there during the recent transit of *Venus*. The government sent its astronomers to places only where the entire transit was visible, and the Lick Observatory had to engage some scientific gentlemen for the occasion at its own expense. Professor Todd, one of these gentlemen, succeeded in taking some photographs of the transit which have been universally declared by the scientific world the finest ever seen. The conditions under which the photographs were taken were perfect, the day being such as is rarely seen except in California, and the appliances at the observatory ample. The remarkable success of the first important piece of work attempted by the observatory strengthens the opinion of the scientific that the Mount Hamilton establishment will contribute largely to the astronomical knowledge of the age. One year on the summit of the California mountains affords the opportunities which twelve years of observations in the changeable climates of other states do not furnish. Professor NEWCOMB in his able article admits this fact."

HINTS TO OBSERVERS OF SATURN.

B. J. HOPKINS.

Fifteen years hence is a long time to look forward to, however short a period it may seem to look back upon; and as it will be all those years before the system of rings round the planet *Saturn* are again placed in such a favorable position for observing the markings upon their surface as they are at the present opposition, those astronomers possessing telescopes of adequate power cannot do better than take full advantage of their present opportunity.

As Mr. DENNING points out in the very interesting article on this planet, on page 265, in Vol. XXII, of this journal, we have very "little information as to the changes which probably effect the detailed appearance of the planet in different years;" therefore, good useful work may be done by those astronomers possessing efficient instrumental power making *careful* and accurate drawings, and micrometer measures of the different markings they may observe upon the planet's surface; keeping a good lookout for anything in the shape of spots as they are likely to give the clue to the nature of the planet's surface. The breadth and color of all belts should be carefully noted, together with the shape of any spot that may be observed, as they are probably subject to changes of a more sudden nature than the similar markings on *Jupiter*, though a longer interval intervenes between successive changes on this planet than on the surface of the latter.

With reference to the markings on *Saturn*, the narrow belt described by Mr. RANYARD, in Vol. XLIV., page 441 of the *Monthly Notices*, is worth attention, as it appears to have become more conspicuous than it was at the last opposition.

Another point, too, which deserves much more attention than has hitherto been given to it, is the shadow of the ball on the rings. This shadow is worthy of careful telescopic study, because it does not present at all times those uniform outlines which the laws of perspective teach us should be presented by the shadow of a spheroid projected upon a plane surface; but very frequently this outline is curiously distorted. Observing the planet on the evening of December 5th, 1884, with an 18-inch silver-on-glass reflector and a power of 1,000, the outline of the shadow on the rings was in the form of a truncated cone, as shown in an engraving forming the frontispiece to the *Register*. This distortion of the shadow on the rings is probably due to the unevenness of the surface of the rings, which is sometimes so considerable as to cause the shadows of the rings on the ball to have a notched appearance, as has been observed by LASSELLS, DE LA RUE, JACOB, and others.

Careful watch should be kept for the occultation of any star by the rings, which it is needless to add is a very rare phenomenon, DAWES being the only astronomer who, so far as is known, has had the good fortune to observe a star pass behind the rings. In such a case it should be noted if the star was visible through CASSINI'S division or not; it probably would be, but it is uncertain, as it is possible that CASSINI'S division is filled with a similar material to that of which the dark ring is composed, and a faint star might be so dimmed as to be invisible. As that careful observer, JACOB, once followed the shadow of the ball across this division, the present time would be very favorable for settling the question, as to whether it is absolutely black or not. While some observers have seen it not quite black, the writer has never been able to observe it of any other color; but large apertures are requisite to solve the question. —*Astronomical Register.*

Leyton, Essex.

THE SUN'S CHROMOSPHERE.

S. J. PERRY.

An automatic spectroscope by BROWNING is employed for these daily measures of the chromosphere, and during the year 1884 the same dispersion, viz., 6 prisms of 60°, has been invariably used. The greater part of the year has been very favorable for these observations, and the increase in the results is well marked in the first column of figures. The mean height of the chromosphere, which differed little in 1882 and 1883, and attained its maximum in May, 1883, has fallen away rapidly this year. This is partly due to the continuance of very low readings throughout August and September, but it remained to the end of the year considerably below the average of the three preceding years. There is also a great diminution in the numbers of the prominences and some falling off in their average height. The low reading 6″.41 for the chromosphere on June 30 was the more remarkable, as the prominences were numerous, and the highest recorded for the month was observed that day.

The number of observed displacements of the C line differed but little in the last two years, but the amount of displacement was slight in 1884 compared with that seen in 1883. The distortions recorded during the months of April and May, 1882, were far greater than any observed during the last two years. The line K 654·3 was seen on five different days as a bright line in the chromosphere, C being on each occasion very bright, but short. Both lines were about the same height, but their intensities were as three to ten.

	No. of days of obs. per month.	Mean height of chromosphere excluding prominences.	Mean height of prominences.	Mean extent of prominence arc.	Highest prominences.	No. of days on which lines were observed distorted.
		"	"	° ′ ″	′ ″	
Jan....	1	8·11	21·35	11 13 0	0 40·99	0
Feb....	5	8·37	27.16	44 53 24	1 1·92	3
March.	2	7·69	23·91	29 21 0	1 21·13	1
April..	7	8·36	28·67	43 31 51	1 34·79	2
May...	13	8·44	27·52	48 10 46	1 35·22	4
June ..	14	8·36	23·61	36 48 21	1 19·00	2
July...	4	8·11	22·74	31 14 15	0 52·52	0
Aug...	13	7·10	25·42	34 6 42	1 25·40	4
Sept...	9	7·26	23·87	20 53 40	0 59.78	2
Oct....	6	7·83	29·89	17 26 10	1 3·20	1
Nov ...	7	7·93	28·78	14 31 26	2 2.12	2
Dec ...	7	7·75	25·92	17 1 26	0 55·51	3
1880...	5·3	7·93	23·46	23 21 23	1 7·40	..
1881...	4·3	8·04	24·61	33 18 26	1 11·93	..
1882...	5·8	8·24	24·55	40 56 47	1 14·10	2·8
1883...	6·1	8·27	27·23	41 24 15	1 35·43	1·9
1884...	7·3	7·94	25·74	29 6 0	1 14·30	2·0

Stonyhurst Observatory, Jan. 16, 1885. —*Observatory.*

EDITORIAL NOTES.

Number two of this volume of the MESSENGER is published for March instead of February on account of unexpected and prolonged absence recently from the state.

We should have mentioned before that Dr. B. A. GOULD's astronomical work at Cordova, South America, would be completed some time last month In December last, the General Catalogue of stars was far advanced in copying for the press. It contains approximately 43,000 positions of about 35,000 southern stars. This catalogue completes the work for which Dr. GOULD went to Cordova in 1879. His address at present is Wollaston, Massachusetts.

The Great Nebula of *Orion* was discovered by CYRAT, of Luzene, in 1618, as stated in the "Monograph of the central parts of the nebula of *Orion*" by Professor E. S. HOLDEN, (see page 16 of the appendix to Washington observations, 1878.) H. C. W.

ALGOL.

Minima of *Algol* (β Persei) for February and March, 1885, in 75° mean time, computed from a minimum given in the *Observatory* for January.

February.... 3^d	7^h	35^m
February....17	15	39
February....20	12	28
February....23	9	17
February ..26	6	6
March.......12	14	11
March 15	11	0
March.......18	7	49

ARTHUR C. PERRY.

NEW NEBULÆ IN ERIDANUS.

I have found in my comet sweeps with 5-inch Byrne refractor the following new nebulæ:

$$\left.\begin{array}{l}\alpha = 3^h\ 14^m\ 34^s \\ \delta = -\ 19^\circ\ 32'\ 53''\end{array}\right\}1885.0$$

Faint, not large. From one corrected equatorial pointing.

$$\left.\begin{array}{l}\alpha = 3^h\ 14^m\ 58^s \\ \delta = -\ 26^\circ\ 29'\ 6''\end{array}\right\}1885.0$$

c F; S; R; p s v m b M; 1¼′ *s.f.* 9^m star.

From one corrected equatorial pointing.

I have also found a large, distinct nebula 20″ *s.f.*, the first of the two nebulæ above. From a careful estimation with the finder, made in August, 1882, I deduce the following place of this last object:

$$\left.\begin{array}{l}\alpha = 3^h\ 13.^m9 \\ \delta = -\ 19^\circ\ 53.'3\end{array}\right\}1885.0$$

I have taken this object to be No. 689 of HERSCHEL's General Catalogue. But bringing the place of 689 up from 1860.0, we have:

$$\left.\begin{array}{l}\alpha = 3^h\ 14^m\ 30^s \\ \delta = -\ 20^\circ\ 49'\ 37''\end{array}\right\}1885.0$$

If the object seen by me is 689 the place in General Catalogue is erroneous. It will be noticed that my approximate place with finder makes this object really precede the first nebula in this list, while it actually follows it as stated. A slight error may exist in the pointing on the first nebula, as it was observed with difficulty on account of the sky rapidly clouding. No sky has since offered an opportunity for verification.

Vanderbilt University Observatory,
Nashville, Tenn., Jan. 16, 1885.

E. E. BARNARD.

ENCKE'S COMET.

I picked up ENCKE's comet on the evening of January 4, about 7 o'clock, very near the place indicated by the ephemeris. It was located in the head of *Pisce Occidentalis* just north of the star *Beta*.

It was quite faint, irregular in outline, slightly elongated in a north and south direction and with very small central condensation.

Red House Observatory,
Jan. 20,1885.
WILLIAM R. BROOKS.

CHANGE IN THE ASTRONOMICAL DATE.

After consultation with the principal astronomers throughout the country, it has been decided that this observatory will make no change in the beginning of the astronomical date, the weight of opinion being that it will be better to defer such a change until the ephemerides are constructed in accordance with the recommendation of the recent International Meridian Conference.

U. S. Naval Observatory,
Washington, Dec. 31, 1884.
Very respectfully,
S. R. FRANKLIN,
Commodore, Superintendent.

Facing slightly west of south, early in the evenings of this month, a person unaccustomed to observing the stars cannot fail to see the beautiful constellation, *Orion*, about half-way from the horizon to the zenith. The two brightest stars in *Orion* are *Betelguese*, highest up to the left of a reddish color, and *Rigel*, a white star low down at the right. Midway between these two, are *three* in a line forming *Orion's* belt which point in a northwesterly direction about 22° to *Aldebaran*, the brightest star in *Taurus*, and in the opposite direction about the same distance to *Sirius*, (the Dog-star) the brightest in the heavens.

A line through the stars in the belt measures 3°, forming a good standard of measurment for ascertaining the distance between stars or other heavenly bodies. We can thus see that the *Moon* appears to cover more space in the sky than she really does; as, were she to pass between two of these stars, her diameter would subtend but about one-third the angle separating them.

The three faint stars below the belt, from *Orion's* sword; a person with good eyesight will notice that the middle one of these three has a hazy appearance, caused by the light of the "great nebula of *Orion*." With telescopic aid we see a dark opening in this bright nebula in which this ill-defined star is located. If we point a small telescope at this star, we see instead of one, four stars *very close together*, and, large telescopes reveal six.

There are hundreds of instances in the heavens where powerful telescopes show two stars, when but one appears as seen with the naked eye or a small telescope. Quite a number of these "doubles" are knowm to revolve around their common center of gravity, and are called binary systems, to distinguish them from those not known to be other than optically double. *Sirius* is one of the most remarkable of the binary class, making a revolution in about fifty years; its companion is visible only in the largest telescopes, as it is very faint, and now less than 8″ from *Sirius*; this distance will diminish for several years to come, until but about 2″ will separate them. A. C. P.

PROPER MOTION OF A O e (2) 15647.

This star has proper motions of −0.ˢ021, −0.″45 approximately, or more than 0.″5 in a great circle. E. S. HOLDEN.

SOUTH AMERICAN LONGITUDES.

Measurements of differences of telegraphic longitude in South America have been completed by the parties of the U. S. Hydrographic office, under Captains GREEN and DAVIS. The sum of the errors of longitude in the polygon, Greenwich, Washington, Havana, Panama, Valparaiso, Cordova, Buenos Ayres, Rio, Lisbon, Greenwich is only 0.ˢ18. E. S. H.

ORBITS OF METEORS.

The following orbits I have computed from radiant points deduced by Messrs. W. F. Denning and E. F. Sawyer from their observations of shooting stars. The observations of the former, from which the radiants were taken, will be found in Mon. Nat. R. A. S., Vol. XLII No. 2, page 85, and those of the latter in *American Journal of Science*, Vol. XVII, June number.

Current No.	Catalogue and No.	Longitude of Perihilion.	Longitude of Node.	Inclination.	Perihelion Distance.	Motion.
1	Denning No. 1	265°.9	129.0	77.4	0.865	Direct.
2	" " 4	291 .0	129.0	85.7	0.976	"
3	" " 9	299 .2	123.3	64.2	0.999	Retrograde.
4	" " 11	300 .	126.	34.	0.997	"
5	" " 14	215 .5	128.5	17.5	0.474	"
6	" " 15	308 .5	127.0	49.0	1.000	"
7	" " 16	326 .0	121.4	79.3	0.955	"
8	" " 17	305 .9	126.2	26.4	1.000	"
9	" " 18	22 .0	128.5	81.7	0.642	"
10	" " 19	46 .0	126.2	80.0	0.415	Direct.
11	Sawyer No. 16	140 .5	188.2	16.6	0.163	"
12	" " 17	100 .3	185.7	20.6	0.460	"
13	" " 20	129 .8	206.5	28.1	0.385	"
14	" " 22	115 .9	211.5	7.7	0.549	"
15	" " 27	170 .7	243.1	37.2	0.349	"

The orbit computed from Sawyer radiant No. 22 bears a close resemblance to that of the comet of 1757, and indicates their probable identity.

Harvard College Observatory, Jan. 16, 1885. O. C. WENDELL.

DISTRIBUTION OF THE STARS.

From the pen of Mr. PROCTOR, in late numbers of *Knowledge*, profitable things are given concerning needed star-surveys. The problems of stellar distribution have always been attractive to astronomers from the times of the early masters to the present. Very different methods of study have been pursued by different scholars. Our readers will be interested in what Mr. PROCTOR says of his own. After projecting 324,198 stars—each one in its proper place on an equal surface projection, so that equal spaces in the heavens would occupy equal spaces on the map, he says:

"In the first place, I note a peculiarity in the large chart of 324,198 stars, which attracts attention at once, yet it is manifestly accidental, or due, rather, to the method in which the original series of 40 charts, and the single chart itself, were formed. The peculiarity is a defect, though of little importance,—yet interesting as illustrating the points which have to be attended to in such work. The circular chart seems to show in places multitudes of concentric streaks produced by the aggregation of stars along certain very narrow zones, concentric with the boundary of the map,—that is to say,having the north pole of the heavens as their center. As my friend Professor YOUNG pointed out, there cannot conceivably be any real tendency in the stars to form circular zones around the pole as center, along declination parallels; yet such a tendency seems manifestly suggested by the appearance of the great chart when closely studied. So far as the broad results sought and obtained are concerned, this peculiarity is of no more weight than the direction of the linear streaks by which in an engraving effects of light and shade are produced. Still until, or unless, the peculiarity is explained, it detracts something from the confidence with which those broader results are accepted.

Not really existing in the heavens, how does this peculiarity of star-distribution come to appear in the chart? The answer, though not at a first view obvious, is simple enough. The wonder would be if the peculiarity had not shown itself. ARGELANDER and his assistants, in their survey of the northern heavens, swept the skies in circles round the north pole, after the manner of survey with the equatorial telescope, which works in that sort (its main axis being directed polewards). Now herein is at once a possible cause, circular striation in the resulting charts, from the circumstance that one sweep might be made when the air was exceptionally clear, when moonlight was wanting, and other conditions for showing faint stars favorable (among other causes, difference of observing power among the six who took part in the work must be taken into account), while the next sweep might be made under conditions unfavorable for the work. This, however, is only a possible cause of circular striation, though in so long a series of observations it must inevitably have occurred at times, and so had certainly a share in producing the peculiarity in question. But there was also a sure and certain cause of striation. The field of view of a telescope is a circle, and in sweeping the center of one field runs along a center arc, while the next field is taken a certain distance south of that arc (or north of it, according to the way the observer works). Say the field is half a degree in diameter, and the change north or south for successive sweeps nearly as great of a degree, so that one field only overlaps by a little the field next north or south of it. Then it is clear that the chance of discerning a faint star near the course along which the center of the field sweeps is much greater than the chance of discerning a star where the fields overlap; for in one case a whole diameter of the field is available for search, in the other only part of the arc. In sweeping, the star will not escape in one case if it be seen at any part of the comparatively long time during which that diameter is passing; but in the other case, if it be not caught while the short arc is passing it will not be caught at all. Thus, it is absolutely certain that fewer stars will escape along or near the tracks of the centers of the sweeping fields than midway or nearly midway, between the tracks of the centers. A concentric circular striation must necessarily result. To this must be added the probability that, however carefully I marked in my ninety-two circles there may have been slight departures from their true positions, whereby some of the zones were made slightly wider or slightly narrower than they should have been. This would make the striation more marked in some places and less marked in others than it would otherwise have been, but, on the whole, would help to make it coarser, and therefore more obvious."

The conclusion of Dr. SWIFT's interesting article giving the results of recent study of the nebulæ appears elsewhere in this number. It is due to the writer to say that the cut fails to give the true telescopic appearance of the *Swan* nebula; for example, the nebulous patch just below the extremity of the right hand arch is comparatively too bright. It should have been exceedingly faint, for it is a difficult object in the 16-inch refractor of the Warner Observatory. This was not Dr. SWIFT's fault wholly, for the drawing, though a hurried sketch, was fairly faithful.

"GEGENSCHIEN."

On the night of February 6, between 10^h and 11^h, there was seen a large, hazy "Gegenschien" extended along the Zodiac, on a line between *Jupiter* and *Praesepe*, slightly over one-third of the distance from *Praesepe*.

RING MICROMETER OBSERVATIONS OF COMET WOLF MADE AT THE SAYRE OBSERVATORY OF LEHIGH UNIVERSITY,

1884	Bethlehem Mean Time.	Apparent Geocentric. AR	Apparent Geocentric. δ	No. of Comparisons.	Star.	Star.	Mean AR 1884.	Reduction to Apparent.	Mean δ 1884.	Reduction to Apparent.	Authority.
	h m s	h m s	° ′ ″				h m s	s	° ′ ″	″	
Sept. 25	9 13 36.0	21 18 6.40	20 4 39.2	7	a	a	21 21 17.98	3.38	20 12 43.3	30.1	Weisse, XXI 473.
" 26	10 34 20.1	21 18 48.06	19 35 5.9	7	b	b					*American Ephemeris.*
Oct. 9	7 28 4.2	21 31 32.72	13 20 44.7	7	c	c	21 32 55.46	3.27	13 9 45.1	29.8	Weisse, XXI 751.
" 10	7 58 29.0	21 32 51.54	12 50 19.7	7	d	d	21 35 45.60	3.28	12 53 38.5	29.8	Weisse, XXI 824.
" 13	7 24 48.0	21 36 59.56	11 23 8.7	7	e	e	21 35 34.73	3.24	11 6 55.6	29.5	Weisse, XXI 821.
" 14	7 52 26.0	21 38 28.71	10 53 36.8	5	f	f	21 36 45.27	3.24	10 58 56.9	29.4	Weisse, XXI 856.
" 18	9 9 15.0	21 44 49.91	8 57 57.2	5	g	g	21 40 37.37	3.18	8 48 28.6	28.8	Weisse, XXI 946.
" 19	9 3 0.8	21 46 29.27	8 30 12.2	7	h	h	21 45 59.17	3.20	8 30 0.1	28.8	Weisse, XXI 1052.
" 20	8 13 48.1	21 48 6.26	8 2 55.6	7	i	i	21 48 51.27	3.20	8 14 44.4	28.8	Weisse, XXI 1114.
Nov. 8	7 45 45.8	21 26 23.65	0 27 39.6	7	k	k	22 26 45.52	3.17	0 30 25.1	26.0	Harvard Zones.
" 8	7 45 45.8	21 26 23.65	0 27 43.9	7	l	l	22 27 45.48	3.18	0 35 43.4	26.1	Weisse XXII 546 and Harv. Zones
" 10	7 24 33.3	22 31 17.14	−0 10 11.4	7	m	m	22 29 0.38	3.16	0 0 2.3	25.7	Weisse, XXII 574.
" 12	7 26 9.6	22 35 35.80	−0 46 57.8	7	n	n	22 36 46.24	3.17	− 0 32 6.2	25.3	Weisse, XXII 749.
" 14	6 59 55.7	22 40 15.38	−1 21 2.7	7	o	o	22 39 1.27	3.14	− 1 20 32.9	24.9	Weisse, XXII 793.
" 15	7 52 18.0	22 42 44.12	−1 38 14.6	7	p	p	22 39 51.78	3.13	− 1 32 35.5	24.7	Weisse, XXII 812.

The observations of September 25 and 26 were published in the MESSENGER of November, 1884. The computation has been revised and some small corrections applied which were neglected in the first reduction.

Bethlehem, Pennsylvania.

C. L. DOOLITTLE.

OBSERVATIONS OF COMET WOLF.

Made at the U. S. Naval Observatory, with the 9.6-inch Equatorial by Commander WM. T. SAMPSON and Prof. E. FRISBY. Communicated by the Superintendent, Commodore S. R. FRANKLIN.

Date	Wash. M. T.	* $\Delta\alpha$	* $\Delta\delta$	No. of Com.	α app.	log $(p \times \Delta)$	δ app.	log $(p \times \Delta)$	Obs'r	Com. Star.
1884.0	h m s	m s	′ ″		h m s		° ′ ″			
Sept. 21	9 31 9	−1 14.61	− 0 19.9	20.4	21 15 53.70	8.651	+21 52 33.3	0.410	S	1
" 22	10 44 40	+1 21.84	− 8 18.3	20.4	21 16 21.85	9.311	+21 24 22.0	0.455	F	2
Oct. 4	8 17 34	+0 29.62	− 4 6.5	20.4	21 25 44.36	8.385*n*	+15 46 44.8	0.537	F	3
" 6	10 44 26	−1 38.54	−11 6.8	20.4	21 28 3.58	9.439	+14 44 49.7	0.592	F	4
" 7	9 50 35	+1 42.66	+ 8 4.3	20.4	21 29 9.19	9.259	+14 7 38.5	0.578	F	5
Nov. 5	7 16 38	−0 48.27	+ 5 54.6	20.4	22 19 44.96	8.590	+ 1 29 9.9	0.728	F	6

ADOPTED MEAN POSITIONS OF COMPARISON STARS.

Star.	α 1884.0	δ 1884.0	Authority.
	h m s	° ′ ″	
1	21 17 4.90	+21 51 43.6	Bonn, VI + 21°; 4,531.
2	21 14 57.63	+21 32 10.4	Weisse, (2) 21, 319.
3	21 25 11.45	+15 50 21.3	Weisse, 21, 550.
4	21 29 38.85	+14 55 26 6	Weisse, 21, 699.
5	21 27 23.28	+14 9 4.4	Weisse, 21, 610.
6	22 20 30.07	+ 1 22 44.9	Weisse, 22, 399.

The circumstances of the annular solar eclipse for March are as follows:

		h m	
Eclipse begins........	March 16,	3 17.4,	Washington M. T.
Central eclipse begins		4 39.6,	
Central eclipse ends..		6 51.7,	
Eclipse ends		8 13.9,	

In the northwestern part of the United States the eclipse will appear annular; partial elsewhere.

The partial eclipse of the *Moon*, March 29–30 will be visible at Washington.

MAGNITUDE OF LACAILLE 8802.

The magnitudes of this star from the catalogue at my disposal are are as follows:

Lacaille..........8802,	Mag.	7	(1)	
Taylor...........9913,	"	6.7	(3)	
Aoe2.... 21353,	"	7	(1)	
Lamont.......... 718,	"	6.7	(2)	
Wash. Mu. Z.... 46,	"	6	(1)	
Wash. Mu. Z.... 184,	"	8.9	(1)	
Wash. Mu. Z.... 193,	"	8.7	(1)	
Wash. M. C. Z... 148,	"	5	(1)	
Tacchini.....1867.8316,	"	8	(1)	
Wash.Obs',1868,Sept.19,	"	5.7	(1)	Transit.
Wash.Obs',1868,Sept.21,	"	5.7	(1)	Transit.
Stone, C. G. H...	"	7	(3)	
Holden, 1883, Sept. 30..	"	7		

Although the estimates of magnitude in the Washington Zones are not very trustworthy, the other estimates exhibit an unusual range. The star is not in GOULD's Zones. It is also not in the Uranometria Argentina and is presumably not above 7 Mag. for this reason. My own estimate was carefully made with the large Equatorial.

E. S. HOLDEN.

The following is the programme of work to be pursued at the U. S. Naval Observatory at Washington, D. C., during the year beginning January 1, 1885, as transmitted by Commodore S. R. FRANKLIN, U. S. Navy, superintendent:

The Great Equatorial: First. Observations of a selected list of double-stars will be continued. These stars are such as have rapid orbital motions, or which present some other interesting peculiarity. Second. Conjunctions of the inner satellites of *Saturn* during the opposition of the planet will be observed. There will also be made a complete micrometrical measurment of the dimensions of the ring. Third. There will be made three drawings of *Saturn*—one before one at or near opposition; and one after opposition. Fourth. The observations which have been begun for stellar parallax, and for the temperature co-efficient of the screw o f the micrometer, will be finished.

The Transit Circle: First. Observations of the *Sun* will be made whenever the necessary ephemeris stars can be observed, and the required instrumental corrections determined. Second. The *Moon* will be observed through the whole lunation. Third. The major planets will be observed from fifteen to twenty times, near opposition. Fourth. Each minor planet will be observed at least five times, near opposition. Fifth. Observations of the list of miscellaneous stars will be finished as soon as practicable.

The Transit Instrument: First. Observations will be made as often as practicable for time, for the correction of the standard mean time clock; and computations will be made daily for such correction Second. Observations for the right ascensions of the *Sun*, *Moon* and inner planets to be made as frequently as possible; observations of the major planets, and of the brighter of the minor planets, to be made near opposition. Third. The observations made during 1883 will be prepared for publication; and the computations of those of 1884 continued.

The 9.6-Inch Equatorial: Observations will be made—First. Of all the minor planets whose brightness at opposition is greater than their mean brightness. Second. Of comets, to determine position and physical peculiarities. Third. Of occultations of stars by the *Moon*. When arrangements shall have been made to photograph the *Sun*, any Sun-spots which show any decided peculiarites in the photographs will be examined with the spectroscope.

The Prime Vertical Transit Instrument: Observations of a selected list of stars in conjunction with the Royal Observatory at Lisbon, in pursuance of the plan recommended by the International Geodetic Association, for the determination of variability of latitude.

Time-Service and Chronometers: The time-balls at Washington and New York will be dropped daily at noon of the 75th meridian; and the noon signals will be extended to such other places throughout the country as may be desirable, as rapidly as arrangements may be made. The rating of chronometers will be continued as heretofore. Meteorological observations will be made as usual.

The Mural Circle: Observations will be made of stars down to the 7th magnitude south of ten degrees north declination, the positions of which have not yet been recently determined at some northern observatory; the observing list to be formed of all stars from GOULD'S Uranometria Argentina visible here, and not found in YARNALL'S Catalogue, the Transit Circle list of B. A. C. stars, or the recent Catalogue of the Glasgow Observatory.

THE WARNER ASTRONOMICAL PRIZES, $400.

It is a gratifying fact that very many astronomical discoveries, and those of great importance have been made during the past few years. I think this is due in part to the impetus given by competition for the honors and prizes awarded to discoverers, and in order that this interest may to that extent be continued and sustained, I offer

First. Two hundred dollars for each and every discovery of a new comet made from February 1st, 1885, to February 1st, 1886, subject to the following conditions:

1. It must be discovered in the United States, Canada, Mexico,

West Indies, South America, Great Britain and the Australian Continent and Islands, either by the naked eye or telescope, and it must be unexpected, except as to the comet of 1815 which is expected to reappear this year or next.

2. The discoverer must send a prepaid telegram immediately to Dr. LEWIS SWIFT. director Warner Observatory, Rochester, N. Y., giving the time of the discovery, the position and direction of motion with sufficient exactness, if possible, to enable at least one other observer to find it.

3. This intelligence must not be communicated to any other party or parties, either by letter telegraph or otherwise, until such time as a telegraphic acknowledgement has been received by the discoverer from Dr. SWIFT. Great care should be observed regarding this condition, as it is essential to the proper transmission of the discovery, with the name of the discoverer, to the various parts of the world, which will be immediately made by Dr. SWIFT. Discoverers in Great Britian, the Australian Continent and Islands, West Indies and South America are absolved from the restriction in conditions 2nd and 3d.

Second. I will also give a prize of $200 in gold to any person in the world who will write the best paper containing three thousand words on the cause of the atmospheric effects ("red light," etc.,) accompanying sunset and sunrise during the past sixteen months. It is desired that these papers be as original as possible, both in facts, observations and treatment.

Essays must be exclusively sent prepaid to Dr. LEWIS SWIFT, Director Warner Observatory, Rochester, New York, must be written in English, on one side of paper only, with ink, and must be in the simplest, untechnical phrase. Each competitor must sign a *nom de plume* to his essay, and enclose his real name and address in an envelope, superscribed with his *nom de plume*. The essays must be in Dr. SWIFT's hands by December 1, 1885.

Three disinterested scientists will be selected to determine the result, and also to settle any dispute that may arise regarding comet discoveries. H. H. WARNER.

Rochester, N. Y., Jan. 17, 1885.

Our thanks are due to the large number of subscribers who have promptly renewed their subscriptions to the new volume. If the MESSENGER should fail to visit any, in the future, it will be probably because the publisher thinks it is not longer wanted.

The following list of subscriptions and orders, not previously ac knowledged has been received:

Henry W.Parkhurst, Brooklyn, N. Y.; Prof. E. S. Holden, Madison, Wis.; J. Hagan, S. J., Prairie du Chien, Wis.; George C. Hill, Rosemond, Ill.; C. W. Tallman, Batavia, N. Y.; Geo. B. Merriman, New Brunswick, N. J.; Wm. Strong, Kalamazoo, Mich.; Geo. W. Pritchard, Providence, R. I.; J. P. D. John, De Pauw University, Greencastle, Ind.; Charles H. Rockwell, Tarrytown, N. Y.; John H. Eadie, Bayonne, N. J.; J. H. Devor, Elkhart, Ind.,; "Mechanics Institute," San Francisco, Cal.; Dr. C. H. F. Peters, Litchfield Observatory, Clinton, N. Y.; John D. Elliott, St. Louis, Mo.; Prof. Geo. M. Phillips, West Chester, Pa.; Frank W. Bailey, Erie, Pa.; Jas. S. Lawson, U. S. Coast and Geod. S., San Francisco, Cal.; C. E. Crane, Waseca, Minn.; A. K. Funk, Elkhart, Ind.; G. W. Cheesman, Ansonia, Conn.; S. W. Burnham, Chicago, Ill.; Mrs. J. H. Levengood, Honeybrook P. O., Pa.; M. A. G. Meads, Buffalo, N. Y.; Prof. H A. Howe, Denver Colorado; College Library, Albion, Mich.; S. H. Freeman, Cleveland, Ohio; Prof. R. W. McFarland, Columbus, Ohio; J. Stahn, 34 Ensor street. Baltimore, Md.; J. W. Thompson, Salem, Ohio; C. G. Miller, Fayette. Fulton county, Ohio; University Reading Room, Eugene, Oregon; Sarah F. Whiting, Wellesley College, Wellesley Mass., (Vols. 3 and 4;) Anna Winlock, Harvard College Observatory, Cambridge, Mass.; Mrs. L. S. Burnham, 187 Schermerhorn street, Brooklyn, N. Y.; Chester Guild, 88 Summer street, Boston, Mass.; Miss Mary W. Bronson, Pennsylvania College, Pittsburg, East End, Penna.; Wm. P. Wheeler, Homestead, Louisville, Ky.; Dr. M. S. Dowling, Leslie, Mich.; Cyrus F. Raine, Rochester, N. Y.; F. H. Dickey, 80 La Salle street, Chicago; Wm. B. Phelps, Fargo, Dakota Territory,

QUERIES.

1. Will some readers of the SIDEREAL MESSENGER kindly describe an inexpensive, but effective, method for illuminating micrometer wires? (RIGEL.)

2. What are the comparative merits of drawing and photography in astronomical work? P. W.

3. What is the cause of the black transit of *Jupiter's* satellites? P. W.

4. Will some one give information by which to secure a good but inexpensive star-map for amateur study? S. M.

5. A book giving the correct pronunciation of the names of the stars is desired. S. M.

ASTRONOMICAL PAPERS

The following are the titles of a few important astronomical papers recently published:

Formulas for Computing the position of a Satellite, by Professor ASAPH HALL, Washington, D. C.

Theories Regarding the *Sun's* Corona, by Professor C. A. YOUNG, Princeton, N. J.

Photography—Glass Negatives by the Dry Plate Process, by Professor W. H. PICKERING, Boston, Mass.

The Lick Observatory of California, by Professor S. NEWCOMB, Washington, D. C.

Accurate Measurement of Time, by THEODORE B. WILSON: *Popular Science Monthly*, March, 1885.

The New Astronomy, IV.—The Planets and the *Moon*, by Professor S. P. LANGLEY: *The Century* for March, 1885, fully illustrated.

Needed Star Surveys, by RICHARD A. PROCTOR, in *Knowledge* for February, 1885.

BOOK-NOTICE.

Elements of the Differential and Integral Calculus, by JAMES M. TAYLOR, Boston, GIN, HEATH & Co., 1884; pp. 236.

This concise treatise on the Calculus seems suited to a course of about twenty weeks' study, for an average class. It covers nearly the same range of topics as BOWSER'S or OLNEY'S work on the same subject, though in a different manner. The first twelve chapters (excepting chapters III and V) are devoted to the Differential Calculus. Chapters III, V and XIII-XVI give the elements of the Integral Calculus, together with numerous applications to Geometry and Mechanics, which serve to stimulate the interest to the pupil. The author has employed the method of rates, but coordinated with it, the method of limits, proving many principles by both methods; he avoids the use of the fraction $\frac{0}{0}$. The exercises for solution are abundant and well chosen. H. A. H.

American Journal of Mathematies.—Volume VII, Number 2, of the *American Journal of Mathematics* has just appeared, and contains the following articles:

"A Memoir on the Abelian and Theta Functions," by Professor CAYLEY. This is the continuation of Professor CAYLEY'S great memoir, the first three chapters of which appeared in Volume V of the *Journal.* The present article chapters IV-VII, and treats principally of the case where the "fixed curve" is a quartic both in plane and in space.

"Solution of Solvable Irreducible Quintic Equations without the aid of a Resolvent Sextic, by GEORGE PAXTON, of University College, Toronto. Professor YOUNG assumes JERRARD'S trinomial form for the quintic, finds the criterion of its solvability, and finally solves the equation in all possible cases.

A note on "Maclaurin's Theorem, by M. HERMITE.

The first part of memoir on the "Algebra of Logic, by Mr. C. S. PEIRCE, in which the author studies the philosophy of notation.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 3. APRIL, 1885. WHOLE NO. 33.

*The Limits of Stability of Nebulous Planets, and the Consequences resulting from their Mutual Relations.** By PROF. DANIEL KIRKWOOD.

(*Read before the American Philosophical Society, Nov. 21, 1884.*)

To determine the height of the atmosphere is a problem of no common difficulty. This is evident from the fact that estimates derived from the phenomena of twilight, luminous meteors, and the aurora borealis have been widely various. It cannot extend, however, beyond the limit at which its elasticity is counterbalanced by the force of gravity—a limit probably not less than two hundred miles from the *Earth's* surface. Even the volume and weight of this atmospheric envelope are not absolutely constant, as small quantities of gaseous matter are doubtless brought into it from time to time by meteors and meteoric streams. Nor has this accession of matter from without been the only source of variation; it has been shown by several writers that the extent and density during the cycles of geologic time were in all probability much greater than at present.

But whatever the mass or density of the *Earth's* gaseous

*A preliminary discussion of equation (1) in the following paper was given in the *Analyst* for January, 1881. Those solutions are here revised, and the results for each planet carefully determined.

envelope, an absolute limit—corresponding to the *Earth's* present time of rotation—may be assigned it. "The atmosphere," says LAPLACE, "can only extend itself at the equator to the point where the centrifugal force exactly balances the force of gravity; for it is evident that beyond this limit the fluid would dissipate itself." This limit for the *Earth* is 26,240 miles from the center; for *Saturn* it is within the system of rings; and for the *Sun* it is at the distance of sixteen millions of miles. These distances, however, were obviously greater before the members of the system had contracted to their present dimensions. It is now proposed to find their original or maximum values.

In astronomy, as in other branches of physical science, many well-known facts remain still unexplained. This is true not only in regard to the fixed stars and the nebulæ, but within the narrower limits of the solar system. Recognizing the impossibility of accounting for present relations without considering the causes which operated in the distant past, astronomers have attempted to trace the process of formation from the primal chaos down to the origin of the youngest planet. In the theory of LAPLACE, the planets were formed from nebulous rings successively abandoned in the plane of the solar equator. The present writer, while not rejecting the nebular hypothesis itself, has indicated certain objections to the special form in which it was proposed by its celebrated author.* These difficulties, encountered in the theory of formation from *rings*, are avoided by supposing each planet at its origin to have been separated from a very limited arc of the equatorial protuberance. In either case, however, the dimensions of the primitive planet would be necessarily restricted by the law of gravitation.

It is sufficiently obvious that an original planetary mass in a nebular state could not have retained its continuity of form beyond a certain determinable limit; in other words, that it would have been changed into a ring by the attrac-

*Proceedings of the American Philosophical Society, Vol. XVIII, p. 324, and Vol. XIX, p. 15.

tion of the central body. The main design of the following paper, after finding in several cases the limits of equilibrium, is to trace, if possible, certain unexplained facts to their origin in these primitive relations between the various members of the solar system.

LIMITS OF PLANETARY EQUILIBRIUM.

If two nebulous bodies, M and m, revolve about a common center of gravity, the disturbing force of M on the superficial stratum of m is the difference between the attraction of the former on the nearest point of the surface of the latter and that on its center of gravity. The same is true, *mutatis mutandis*, in regard to the disturbing influence of m on M. If, then,

$a =$ the distance between the centers of M and m and

$x =$ the distance from the center of the former to the limit of the equilibrium of the latter, we shall have

$\frac{M}{a^2} =$ the attraction of M on the center of gravity of m,

$\frac{M}{x^2} =$ that on the nearest point of the surface, and

$\frac{M}{x^2} - \frac{M}{a^2} =$ the accelerating force of M on the portion of the surface of m between the two centers; but as these forces from M and m are in equilibrium, the neutral point, or the limit of m, may be found from the equation

$$\frac{M}{x^2} - \frac{M}{a^2} = \frac{m}{(a-x)^2} - \frac{m}{a^2} \quad (1).$$

Applying this equation to the solar system, x will be the equatorial radius of the solar nebula, and $a-x$ that of a planet at the epoch of its separation. Putting for simplicity $a=1$, aud reducing,

$$x^4 - 2x^3 + \frac{2M}{M-m}x = \frac{M}{M-m} \quad (2).$$

For *Jupiter*, $m=1$ and $M=1048$, hence

$$x^4-2x^3+2.0019102x=1.0009551. \quad (3).$$

therefore
$$x= \quad 0.92501,$$
$$1-x= \quad 0.07499,$$
$$(1-x)\times 480{,}000{,}000=35{,}995{,}200.$$

Solving equation (2) in like manner for each of the principal planets we obtain the distance from the center of each to its limit as given in the following table:

Planet.	Dist. to Limit.
Mercury	152,000 miles.
Venus	700,208 "
Earth	1,082,147 "
Mars	764,650 "
Jupiter	35,995,200 "
Saturn	44,887,000 "
Uranus	48,915,000 "
Neptune	81,000,000 "

In these estimates we neglect the eccentricity of the orbits as well as the centrifugal force due to each planet's rotation. The masses and distances adopted are those given in NEWCOMB'S Popular Astronomy, with the exception that for *Mercury* we have employed a mean between VON ASTEN'S evaluation of the mass ($\frac{1}{7633440}$) and the final value given by LEVERRIER ($\frac{1}{5310000}$). The mean is $\frac{1}{6263800}$. For the *Earth* we have taken the sum of the masses of the *Earth* and the *Moon*.

Applying equation (2) to some of the secondary systems we find the following limits of stability:

For the *Moon*	39,850 miles.
Phobos	6.5 "
First satellite of *Jupiter*	5,250 "
Mimas	1,500(?) "

PRACTICAL APPLICATIONS.

The results obtained may now be employed in the approximate solution of several interesting problems. The limits of stability will be regarded as the primitive radii of the planets and satellites as any exterior matter would have been detached by the influence of the central body. To the primitive relations above developed may we not hope to trace some of the unexplained facts of the solar system? As has been remarked by an eminent writer,* "the plan of the coming universe must have resided in the initial chaos, as certainly as the eagle is in the egg, or the leviathan in its primitive germ."

I. *To find the relative mean densities of the Earth and Moon at the epoch of their separation.*

With the notation used in equation (1) the ratio sought will evidently be

$$\frac{\rho M}{x^3} : \frac{m}{(a-x)^3}$$

where $\rho =$ the ratio of the equatorial to the polar radius of the terrestrial spheroid. The value of this ratio is not known. An approximate value may be found, however, by a tentative process.

We have $a = 240{,}300$ miles, $x = 200{,}450$, $a - x = 39{,}850$, $M = 81$, and $m = 1$. Hence the ratio is $0.636\rho : 1$.

But during the cooling period the ratio of the densities would probably be nearly constant; or, if the *Moon* contracted more rapidly, its solidification would occur earlier and the increase of its density practically cease. The present ratio of the mean densities is 5.67 : 3.57, and assuming this to have been constant we obtain

$$0.636\rho : 1 :: 5.67 : 3.57,$$

or,

$$\rho = 2.498;$$

that is, the ratio of the *Earth's* equatorial to its polar radius at the epoch of the *Moon's* separation was nearly 5 : 2, and this may be regarded with some probability as nearly the ellipticity in other cases at the respective epochs of separation.

II. *To find the relative mean densities of Jupiter and his first satellite at the epoch of the latter's origin.*

Here $a = 260{,}000$ miles, $x = 254{,}750$, $a - x = 5250$; and therefore the ratio is

$$\frac{59240\rho}{(254750)^3} : \frac{1}{(5250)^3} = 0.52\rho : 1,$$

and assuming the constancy of the ratio,

* Prof. PIERCE.

$$0.52\rho : 1 :: 121 : 100; \text{ or, } \rho = 2.33.$$

This value of ρ is nearly equal to that found for the *Earth*; the difference being no greater than might result from the probable error in the elements used.

The present density of *Phobos* is unknown: but with $\rho = 2.5$, the value found for the *Earth*, the ratio of the original densities of *Mars* and *Phobos* was 1.27 : 1. These results seem to indicate that the ratio of the equatorial to the polar radius of the central mass, at the epoch of a planet's or satellite's origin, was about 2.5.* With this value of ρ, and the value of x already obtained for each planet, the ratio of the mean density of the solar mass to that of the planets at the respective epochs of their separation would have been as follows:

For *Neptune*	1.31 : 1
" *Uranus*	1.31 : 1
" *Saturn*	1.39 : 1
" *Jupiter*	1.39 : 1
" *Mars*	1.25 : 1
" *Earth*	1.29 : 1
" *Venus*	1.27 : 1
" *Mercury*	1.22 : 1

From these numbers we infer that central condensation had commenced in the solar nebula before the origin of *Neptune*, and that the ratio of the mean density to the density of the equatorial parts near the surface was approximately the same at the successive epochs of planetary formation.

WERE THE PLANETS FORMED FROM NEBULOUS RINGS?

If the original solar mass, like most nebulæ, was irregular in form, the first matter detached would not probably be a ring, but a nebulous planet. As condensation advanced, the centrifugal force would increase until approximately equal to the central attraction. The disturbing influence of the planet already formed would produce, when in peri-

* It was shown by LAPLACE that a rotating homogenous fluid cannot retain its spheroidal form when ρ is greater than 2.7197. Mec. Cel. III, *iii*, § 20 [1605'], BOWDITCH'S Trans. The ratio would be less in the case of central condensation.

helion, an increasing tidal-wave, resulting in the separation of a second planet. The origin of other planets is accounted for in like manner. If, in the ancient history of the system, nebulous matter, left at first exterior to the orbit of a new planet, should subsequently fall upon the central body, the effect would be not only a shortening of the period, but probably also a lessening of the orbit's eccentricity.

III. *The Peculiar Relations of the Martian System.*— Professor PICKERING estimates the diameter of *Phobos* at seven miles.* Adopting this value, and supposing the ratio between the densities of *Phobos* and *Mars* equal to that between the *Moon* and the *Earth*, we shall find the limit of the satellite's equilibrium to be 6.5 miles from its center, or three miles from its surface. Were the density reduced to that of *Saturn*, the limit would be almost exactly at the surface; or, with a density equal to that of *Mars* when the radius of the latter was that of the satellite's orbit, the limit would be at a considerable distance within the surface. Since, therefore, the satellite could never have existed at its present distance in a nebular state, it must follow, if any form of the nebular hypothesis is to be accepted, that its original distance was greater than the present. Can we assign a probable cause for this ancient disturbance?

Of the eight major planets, *Mars* has the most eccentric orbit, except that of *Mercury*; its perihelion distance being 13,000,000 miles less than its mean distance. This difference, in fact, amounts to 20,000,000 miles when the orbit of *Mars* has its greatest eccentricity. If, therefore, the radius of the *Sun*, or of the solar atmosphere, was somewhat greater than the least distance of *Mars* at the commencement of the latter's separate existence, the planet in perihelion would pass through the outermost equatorial zone of the solar nebula. This resisting medium would not only accelerate the motion of *Mars*, but also, in a much greater

* Annals of the observatory of Harvard college, vol. xi. Professor SETH C. CHANDLER makes the diameter still less. See Sci. Obs. for September, 1877.

degree, that of his extremely small satellites. The solar volumé, meanwhile contracting more rapidly than the orbit of *Mars*, would finally leave the latter moving in an eccentric path, without sensible resistance.*

IV. *The Saturnian System.*—For *Mimas*, the first satellite of *Saturn*, the most probable values of the mass and density give the distance of the limit from the satellite's surface less than the radius of *Mimas*. The rings of *Saturn*, in all probability, could not exist as three satellites, the limits of equilibrium being interior to the surface. This is true at least in the case of the innermost ring. Analysis seems to indicate that PLANETS AND COMETS HAVE NOT BEEN FORMED FROM RINGS, BUT RINGS FROM PLANETS AND COMETS. If, without any loss of mass, the density of a planet were diminished until the radius should exceed the limit of equilibrium, what change would take place in the planetary form? Evidently a portion of the matter nearest the central body would be separated from the rest, and, as the orbital velocity would be less than that corresponding to its distance, it would move in a new ellipse, the aphelion of which would be the point of separation.

V. *Comets.*—The effect of the *Sun's* attraction in the dismemberment of comets is well known to astronomers. The nuclei of the large comets of 1680, 1843, 1880 and 1882 must have had great force of cohesion between their parts, in order to withstand the tendency to disintegration at the times of perihelion passage. Had the nuclei been either liquid or gaseous, or even clusters of solid meteorites, the

* This view was first presented in the *Observatory* for January, 1878. Different explanations of the short period of *Phobos* have been proposed by astronomers, but none, perhaps, entirely free from difficulties. One distinguished writer has suggested that $7^h\ 39^m$, the period of *Phobos*, was the rotation period of *Mars* at the epoch of the satellite's origin, and that the lengthening of the period to $24^h\ 37^m$, has been due to retardation by solar tides. But it is well known that the time of rotation of a planet in the process of condensation varies as the square of its radius. The resulting period of *Mars*, therefore, on reaching its present dimensions, would have been but a small fraction over one hour. This period, it is true, would have been somewhat modified by the counteracting influence of the solar tides; but the hypothesis referred to seems wholly inadequate to meet the objection derived from equation (2).

difference between the *Sun's* attraction on the central and the superficial parts would have pulled the comets asunder, spreading out the fragments into somewhat different orbits, like the meteoric streams of August and November.

This view of the gradual dispersion of comets in perihelion is in striking harmony with the facts of observation. The comets of short period have not only been divested of tails, which in all probability they originally possessed, but they seem to be losing more and more of the cloud-like matter which surrounds their nuclei. HALLEY'S comet has lost much of its ancient splendor, and had its period been no greater than that of ENCKE'S or BIELA'S, it might long since have been reduced to a telescopic magnitude. The separation of BIELA'S comet in 1845, was not the beginning of that body's dismemberment. We have evidence that this process had commenced before 1798, as in that year a meteoric shower, produced by its *debris*, was observed in Europe. A shower derived from the same group was again seen in 1838.* Before 1845, however, the separated fragments were too small to be individually recognized. How far the *Sun's* action alone can explain the facts, it may be impossible to determine.

VI. *The Zodiacal Light.*—Original small planets near the *Sun*, in a nebular or gaseous condition, would probably be transformed either into rings or meteoric clusters, the scattered particles of which, reflecting the *Sun's* rays, would present an appearance like that of the zodiacal light.

VII. *Origin of the Asteroids.*—In the primitive condition of a planet, immediately after its separation from the central mass, not only would the latter cause a considerable elongation of the former in the direction of the line joining their centres, but the planet's also—especially the larger—would produce great tidal elevations on the *Sun's* surface. Now, a comparison of the elements of *Hilda* and *Ismene*, the 153d and 190th asteroids, shows them to be an isolated pair whose periods are very nearly equal, each exceeding the longest in the interior cluster by more than

* HUMBOLDT'S Cosmos, BOHN'S ed., vol. iv., p. 582.

fifteen months. *Jupiter's* limit of equilibrium, when in the nebular form, was immediately beyond the orbits of these minor planets. If the *Sun* once extended to the aphelion distance of *Hilda* (4.632), the central attraction of his mass on a particle of the equatorial surface was but five times that of *Jupiter* at the point to which he was vertical.* The centrifugal force due to the *Sun's* rotation would be greatest at the crest of this tidal wave, produced by *Jupiter*, so that parts might become separated from the solar mass and transformed into asteroids. It is to be further remarked that two periods of *Jupiter* are approximately equal to three of *Hilda* and *Ismene*, that is, to three rotation periods of the *Sun* at the epoch of their separation. The disturbing effect of the "giant planet" on the tides of the central body would therefore be increased at each perihelion passage.† The process would be similar when one period of *Jupiter* was equal to two rotation periods of the central nebula.

VIII. *The Rotations of the Planets.*—It is well known that the analogy between the periods of rotation of the primary planets, as published by the present writer several years since, assigned a much longer period of rotation to *Uranus'* than to *Jupiter* or *Saturn*. But as that of *Uranus* had not been measured, and the observations of the polar compression were by no means accordant, the fact was not then thought incompatible with the proposed law of rotation. Recent measurements, however, leave no room to doubt that the ellipticity is even greater than that of *Jupiter*, and consequently that the planet moves rapidly on its axis. The law connecting the rotation periods must accordingly require an important modification.

In a planet having a constant mass, with a variable volume, the time of rotation varies as the square of the radius. It is easy to show, however, that this law could not have obtained from the origin of the solar system. For instance, in tracing backward the history of the *Earth*, we find that

* *Jupiter's* perihelion distance is 4.95.

† The longitude of *Ismene's* perihelion differs from that of *Hilda's* by 180°.

when the radius was 8,000 miles, its rotation period, according to this law, was 96 hours; when the former was 12,000 miles, the latter was 216 hours; and, finally, if the *Earth* ever extended to the *Moon's* orbit, the time of rotation, by the same law, instead of having been equal to the *Moon's* orbital period, was nearly ten years. So likewise when *Mars* filled the orbit of *Phobos*, his rotation period was seven days and sixteen hours, or 24 times the orbital period of the satellite. We conclude, therefore, that during the earlier stages of its condensation all parts of the mass did not rotate in the same time. It is easy to see, in fact, that tidal retardation must have been much more effective at the surface than in the interior of a large planet in the gaseous state.

In so far as we know, the rotation periods of the smaller planets, *Mercury*, *Venus*, the *Earth* and *Mars*, are nearly two and a half times those of the larger and more remote. What cause can be assigned for this remarkable difference? In other words, why did the process of condensation continue longer in the large and less dense planets exterior to the asteroids than in the small bodies nearer the *Sun*? It may be answered in a general way that in small and dense planets solidification would occur at a comparatively early epoch in their history, and hence the acceleration of their rotary velocity would be, in a large measure, arrested. It seems probable, therefore, that, while the same law of rotation may obtain between the members of each separate group, it cannot apply where one of the planets is in the inner and the other in the outer cluster.

As regards their axial movements, the solar system appears to contain at least three distinct classes of planetary bodies; the obvious characteristics of each being traceable to their relative primitive densities. These are as follows, the primitive density of *Neptune* being taken as unity:

I. *The large planets:*

	Primitive Density.
Neptune	1.0000
Uranus	3.8950
Saturn	32.7073
Jupiter	210.7440

II. *The planets interior to the zone of asteroids:*

Mars	7,446.4
Earth	24,880.5
Venus	70,129.2
Mercury	468,616.0

III. *The secondary planets, of which our Moon and Jupiter's first satellite may be taken as types:*

Jupiter's first satellite	2,600,000
The *Moon*	4,820,000

There is, we may remark, an antecedent probability that the law truly formulated will assign to *Saturn* a period of rotation somewhat less than the period observed; as it is sufficiently obvious that if the ring had remained an integral part of the planet, the resulting time of rotation would have been, in fact, sensibly shorter than the present. It is also to be remembered that the late observations of DENNING and SCHIAPARELLI make *Mercury's* time of rotation nearly 25 hours. In the case of the satellites, the equality between the periods of rotation and revolution was established at an early epoch in their history. No further decrease in the time of rotation was therefore possible.

A comparison of quantities used in equation (1) suggests that a planet's time of rotation is a function of its mass, distance, and primitive density. The form of this function—found by a tentative process—may be expressed as follows:

The square of the number of a planet's days in its year is to that of any other of the same group, as the primitive density of the latter is to that of the former; that is,

$$n^2 : n'^2 :: \Delta' : \Delta \text{; or, } n' = n\left(\frac{\Delta}{\Delta'}\right)^{\frac{1}{2}} \qquad (4),$$

where

$\Delta = \frac{m}{R^3}$ = the primitive density, and

$n = \frac{T}{t} = \frac{\text{orbital period}}{\text{rotation period}}$ = the number of a planet's days in its year.

Equation (4) may be reduced to

$$t^2 : t'^2 :: m\left(\frac{d}{R}\right)^3 : m'\left(\frac{d'}{R'}\right)^3 \quad (5),$$

where d, d' and R, R′ are the respective distances and primitive radii.

THE OUTER OR LESS DENSE GROUP.

In the following table the rotation periods of *Saturn*, *Uranus* and *Neptune* are derived from that of *Jupiter* by formula (4).

PLANET.	m	R	△	T	t	n
Neptune	16.86	81,000,000 m	1.0000	60,126.71 d	$9^h\ 35^m$	150,751.80
Uranus.....	14.46	48,915,000	3.8950	30,686.82	9 33	77,186.00
Saturn	93.84	44,887,000	32.7073	10,759.219	9 43	26,630.00
Jupiter.....	311.80	35,995,200	210.7440	4,332.584	9 55	10,492.64

It will be noticed that the theoretical period of *Saturn* is 31 minutes less than HALL's evaluation.

THE INNER GROUP.

PLANET.	m	R	△	T	t	n
Mars	0.1056	764,650m	7,446.40	586.98 d	$24^h\ 37^m\ 23^s$	669.57
Earth......	1.0000	1,082,147	24,880.5	365.26	23 53 48	366.84
Venus	0.7690	700,208	70,129.2	224.70	24 42 54	218.18
Mercury....	0.0522	152,000	468,616.0	87.97	25 0 46	84.405

Here the rotation periods of the *Earth*, *Venus* and *Mercury* are derived from that of *Mars* by formula (4). The first is two minutes less than the true period; the time of *Venus's* rotation is doubtful; and the theoretical determination of *Mercury's* period agrees with the estimate of Mr. DENNING.

The *Observatory* (March) records the transit of Wolf's comet over two small stars on the evening of Nov. 17, 1884. The first star was occulted at $13^h\ 44^m\ 58^s$ G. M. T.; the second about 50^m + later. Stars not identified.

Changes Observed on the Rings of Saturn by M. E. L. TROUVELOT, *Observatory Mendon, France. Translated from the French by* MISS MARY RIHELDAFFER, *Carleton College Northfield, Minn.*

In the year 1875 I showed* that the variable form of the shadow made by the globe of *Saturn* on the surface of the rings could not be the consequence of changes of level on the surface. I have shown that the nebulous ring had undergone great changes since the observations of BOND, LASSELL and others, and again, that the exterior border of CASSINI'S division was subjected to the changes of form which I have indicated.

My observations of this planet, continued with assiduity since this epoch, have only confirmed that which I published in 1875, and establishing definitely that the rings are not fixed, but very variable. As I am preparing now a plate of *Saturn* which ought to accompany a note more extended and detailed, I will confine myself to giving here a brief account of the important changes recently taking place in *Saturn*.

I will commence first with those occurring on the exterior ring A, and of which M. PERROTIN has lately interested the Academy. It is very plain that great changes are produced on this ring and on the ring B near it. ENCKE'S division does not exist, or if it does, it nearly coincides with CASSINI'S division. It is certain that I see nothing in its place with an eight-inch glass; but on the contrary I see a division larger and clearer than it was and much nearer the division Cassini.

On the 15th of February of this year (1884) I found for the first time that the division Encke had changed place. At the same time I found also that the Zone A, situated between this division and that of Cassini, was whiter and more luminous than I had apparently ever seen it. These changes must have been recent, for the 11th and 12th of

* On some physical observations of the planet *Saturn*. Proceedings of American Academy of Arts and Sciences: Vol. III, p. 171.

February having observed *Saturn*, I took notice that this division of Encke was perfectly visible, and on the drawing that should accompany this note, is in its usual place.

On the evening of the 15th I also discovered these changes on the ring B. We know the ring is divided into three parallel zones. Since I have observed *Saturn* these zones have always appeared pretty nearly the same size. The internal zone, which is near the nebulous ring, is the deepest; and the external one, which forms the internal border of Cassini, is more brilliant. During this evening I found this last zone was narrower than the eastern limb and it size was diminished by less than one-half. It was also brighter, and could be distinguished from the grayish intermediate zone. I observed the same phenomenon the 20th of February, but this time on the western limb; whereas on the opposite limb it was difficult to recognize it.

In 1882 I observed the same changes very apparent on the internal zone of the ring B which touched the nebulous ring and which was so deep it could hardly be distinguished. The nebulous ring showed the same remarkable changes. It was easily seen at the east and with difficulty distinguised at the west. The brilliant and narrow zone which is now on the ring A, between the division of Cassini and the new division of Encke was shown with variations of brightness on the limbs, so much that it was brilliant on the one and hardly seen on the other.

I have shown in the memoir cited above that the shadow of *Saturn* on the ring sometimes changes its form. The shadow did not have the same form to-day which I have seen in preceding years. The 15th of last February, the same day I observed the changes on the exterior ring A, and on the intermediate B, I found also that the shadow of the globe on the ring B, instead of, as formerly, one curve toward the planet, apparently formed two concave curves, united by their interior extremities, and forming a very marked angle, and at the intersection of these two curves this angle was a little nearer the division Cassini than the nebulous ring. Since that day I have always seen the same form of double curves which were again visible to-day.

The beautiful ellipses described by the rings of *Saturn* around the planet appear to us of a symmetrical character, which is so evident that it imposes on us illusions difficult to break.

It is natural for observers to misrepresent these two limbs and to attribute the peculiarities in one to their mistakes. I, myself, often saw the changes of detail on one limb, but it was impossible to see the same of the opposite side, and supposed the symmetry was fixed, so attributed the irresistibility of these forms as a consequence of defect in the object-glass, or in my own eye, which made me see one side better than the other. To-day I found my error, and I am certain the surface is far from symmetrical. I also find the details of form are very rarely produced exactly the same on the other side. The rings are essentially variable.

These observations show us the rings are not solid masses, since changes are produced which could not be explained by the rotation of one piece.

The hypothesis that they are composed of a number of little satellites, describing independent orbits around the center of gravity of the planet, seems to us more probable, and in this case better explains the observed phenomena. It explains why it was impossible to determine the rotation of the rings.

By the experiences of photometry, well conducted but very delicate, made at opposition and quadrature of the planet, the conclusion is reached that the rings are really formed of little satellites. Indeed, if we know anything about these satellites, they ought to be more luminous toward the opposition, when they present their faces to us, which receive the direct rays of the *Sun*, than toward quadrature, when the face receives less light and is somewhat reduced by a commencement of the phase. It is certain toward the quadratures that the border next the *Sun* appears much darker than that turned toward us.

It ought to be the same with the satellites and this reduction of light would be sensible to our instruments.

THE NEW STAR OF 1572.

THE EDITOR.

There is nothing yet in the history of new or temporary stars that equals the record of the star of 1572. It was observed by TYCHO BRAHE, for the first time, on the evening of November 11th of the year above named, and its strange appearance to his practiced eye interested him so much, that he wrote a large book giving a detailed account of its changes, including also the views of his cotemporaries as to its probable origin.

Its place is in the constellation of *Cassiopeia* and quite near 0^h 19^m; N. 63° 24′ according to ARGELANDER. If the assumed one is really the TYCHO BRAHE star, it will be readily identified by means of a bright ninth magnitude star—8.9 according to ARGELANDER,—which is No. 22 of his Zone 60. It follows this ninth magnitude $29^s.60$ and is south of it 10′ 4″.1 by micrometrical comparisons made at Twickenham observatory.

Those having small telescopes without circles, may find it north of the star *Kappa* of this constellation about one degree and a little west.

The chief things of interest about this star at the time of its discovery were its brilliancy, changes of color, time in view, and its disappearance.

It surpassed in luster the brightest of the fixed stars, was more brilliant than *Jupiter*, although then at his brightest, and even rivalled *Venus*. It was seen to shine through light clouds at night, and was noticed by some persons in daylight. It changed very little, if any, during the month of November, but not long after it began to fade gradually and continued so to do until March, 1574, when it ceased to be visible.

When first seen, its light was white like *Venus*, then yellowish in color, next ruddy like *Mars*, and finally of a leaden hue, appearing quite like the waning of the conflagration of a world, the hottest light first and the coolest last.

TYCHO BRAHE supposed the appearance to be caused by some ethereal substance like that of which the *Milky Way* was then thought to be composed, and that the waning might be accounted for by the action of the *Sun* and stars, or by spontaneous dissolving by some internal cause. As is doubtless well known to our readers, the more modern view is, that the origin of the phenomenon was some vast combustion on the surface of the star, which began in a sudden and tremendous outburst, and gradually sunk away through the succession of cooler colors that were plainly observed. As this took place forty years before the invention of the telescope, it will at once appear that the means of studying such a phenomenon scientifically were limited in the extreme at that time. It was not nntil the spectroscopic observations of a star of similar character in 1866 that anything definite was known as to the cause of these wonderful phenomena. Mr. HUGGINS, of London, was the first to offer the explanation. He saw the spectrum of the star of 1866 continuous and crossed by dark absorption lines, indicating that the star's light had passed through an atmosphere of comparatively cool gas. The meaning of this was, that a sudden and extraordinary outburst of hydrogen gas had taken place on the star, and by its intense heat and light had caused the changes well known in that and other stars. This explanation is fully in keeping with what can be seen, very frequently now, in common solar studies by the aid of the spectroscope, only on a smaller scale. The solar prominences are like these phenomena in character, apparently, and in 1883 there was much in the behavior of our *Sun* to make us think of conflagrations that might take place any time in stars younger in development than our central luminary.

The main thought in calling attention to the star of 1572 now, is not to offer an explanation of its phenomena, but, rather, to remind our readers who are observers, to give it some attention. If it be the same star that appeared nearly in the same place, in 945 and 1264, it may have a period of maximum of about 313 years, and that would bring the next return at about the present time. Foreign observers have had these possibilities in mind, and have been giving attention to this star. The observatories of Pulkowa and Copenhagen have observed stars in this vicinity for the last ten or twelve years. In 1873, Mr. HIND and Mr. PLUMMER made frequent comparisons of the light of star 129 in D'ARREST'S catalogue and noticed fluctuations amounting to about one magnitude. If there should be another maximum of the brightness of this star like that of old, there is no danger that it would pass unnoticed, but it would be useful to science to observe the early states of change as well as the more marked ones.

EDWARD ISRAEL.

PROFESSOR M. W. HARRINGTON.

(*Extract.*)

After having completed his school-course at home with great distinction, he came to the University at Ann Arbor, in the autumn of 1877. He was one of the youngest of his class, but easily stood near or at its head. His predilections were decidedly for mathematical studies, and the writer of this sketch well remembers the difficulty which he seemed to have in understanding which was the hard and which the easy part of his tasks. He read with me WATSON'S Theoretical Astronomy, a work so advanced as to be beyond the range of most college students, and even to offer in places serious difficulties to the professional mathematician or astronomer. Mr. ISRAEL not only read the entire book in a half year, but he seemed entirely unconscious that he was doing anything extraordinary. I was particularly struck by the fact that he never knew that in his usual forty pages he had passed over something especially hard, unless I informed him of the fact. Our daily meetings, (for he made so much more progress than his one or two fellow members of the class that I met him alone,) soon changed from recitation to discussion of topics suggested by what he had read, and these discussions would have been more animated had it not been for his modesty and reserve.

A few weeks before his graduation, there came the opportunity for me to nominate an astronomer for the expedition to Lady Franklin Bay. The nomination was offered to ISRAEL, with some hesitation. This was caused not by any doubt as to his ability to do the work, but by a partial knowledge of his domestic circumstances. He was idolized by a widowed mother to whom even the proposal to have him join a polar expedition would be painful. His circumstances in life were so easy that he could pursue, without anxiety as to income, any line of study which he might select. On consulting with him, the only motive which restrained him from accepting the nomination at once was a knowledge of the pain it would give his mother. With rare self-denial she encouraged him to do what he thought best, and he accepted the nomination, which was soon followed by his appointment. He left Ann Arbor in April of his senior year, and in consideration of his unusual merit, was given his degree in his absence.

As to his relations to the party and the work done by him, we make the following quotations from a letter from Lieut. GREELY to Mrs. ISRAEL, dated August 16, 1884: "It was owing to his careful astronomical observations, made under the most trying circumstances, that the time observations connected with the pendulum work, were successful. The pendulum observations, which, in the case of the English expedition of 1875–76, entirely failed, were in our case successfully made. These observations are said to be of the most valuable character, and your son will be credited therewith. In like manner I put him in charge of the magnetic work for which he will also receive credit."

"Your son, during the past terrible year, occupied the same sleeping-bag with me. He was a great comfort and consolation to me during the long weary winter and spring, until his death. To you, who know his gentle character and amiable disposition, it is hardly needful to state what impression he made on my affections. He was warmly loved by all the men, and I readily believe he spoke the truth when he told me he was certain that he had not an enemy in the world."

Lieut. Greely goes on to relate that at the time of his death, he did not forget those around him nor his friends at home. Having some money on his person, he requested that a small sum should be given to the family of each of the two Esquimaux of the party who had already perished. He also requested that a sufficient sum be reserved with which some survivor might visit his mother. The balance of the money, he desired, should be spent in purchasing delicacies for his surviving comrades while *en route* for home, and that the expenditures should be exceptionally lavish in the case of Corporal Elison, who had lost both hands and both feet. Lieut. Greely adds that he preferred to do this at his own expense, thus fulfilling an unique will, perhaps as remarkable and as admirable a one as the world ever saw for delicacy and thoughtfulness. To understand the character which dictated last wishes of such a nature, we must remember the circumstances under which he was placed, the desolation surrounding him, the natural ferment and souring of men's relations to each other when shut up together away from the rest of the world for year after year, the hardships of death from lack of nourishment and far away from kindred, when it was fairly certain that the survival of a few days would bring relief and life; under all these circumstances nothing but a character, a nobility of mind, and a philosophy which the world rarely sees, could have formed and expressed such last wishes.

Israel died on May 27, only 26 days before the rescue. He met his death with great firmness and resignation, regretting it only on his mother's acount. His death was painless and easy, resulting from water around the heart, caused, of course, by insufficient nutrition. "His remarkable mental powers caused him to live 'till among the last," says Lieut. Greely, "despite the fact that he was physically the weakest man of the party." His remains were received at Kalamazoo with a great popular demonstration, and his funeral was attended by the common council and mayor of his native city in their official capacity.

We will make a single quotation from his letter from St. Johns to his mother, written June 29, 1881, immediately before he sailed for Greenland. He says: "I was greatly surprised to-day on examining our supplies; there is nothing which could possibly be carried of which we have not a great abundance. As far as safety and comfort are concerned, no expedition was ever as well equipped as ours."—*American Meteorological Journal.*

TYCHO BRAHE.

TYCHO, or TYGE, DE BRAHE, sometimes called the "Rectour of Astronomy," was born in 1546, at Knudstorp in Scania, which then belonged to Denmark. He was descended from an ancient princely family, the ruins of whose castle, Wisengsborg, are still to be seen on the shores of the Lake of Wetter. He was the second of ten children, and he, as well as his sister SOPHIA, gave promise of very great intellectual ability. After the death of his father, his maternal uncle, STENO BELLE, sent him to Copenhagen to study philosophy. He had early manifested a taste for astronomy, but his relatives designed him for the legal profession, and accordingly his uncle sent him in 1562 to pursue his studies at Leipsic. But the love of astronomy had become with BRAHE such a ruling passion that he would clandestinely leave the college buildings to make investigations. With only the aid of a small celestial globe and a wooden circle for the measurement of the stars, in 1563 he observed the conjunction of *Saturn* with *Jupiter*. The inheritance of not a small property in 1565, enabled him to follow his darling scheme of prosecuting astronomical experiments, in which he was encouraged by the Danish government. The king, FREDERICK II, recognizing his talents, requested him to give lectures in Copenhagen on mathematics and on comets. His reputation was, if possible, more firmly established by his discovery of a new star in the constellation *Cassiopeia.* The king at once took him under his especial patronage, giving to him a pension of 2,000 crowns and a canonry which yielded 1,000 crowns. He also gave to BRAHE the island of Huen, where in 1580 he had built for him a laboratory and magnificent observatory, which was called Uranienborg. A powerful impetus was there given to astronomical researches. He was visited by many celebrated personages.

BRAHE discovered two new inequalities of the *Moon*, besides other valuable observations, and was, perhaps, the first who had correct ideas about comets. His system, a modification of that of PTOLEMY, was not extensively adopted. But to BRAHE belongs the merit of having laid the foundation of practical astronomy. KEPLER afterwards used his numerous and wonderful observations in his own discoveries. Nearly twenty years his life was spent in assiduously following his astronomical pursuits. But, unfortunately, the king's death put a stop to all his hopes and aspirations. He became an object of persecution, owing to the hostility of WALCHENDORFF and other members of the regency and was driven from Uranienborg. In 1597 he was obliged to leave Denmark forever. The emperor, RUDOLPH II of Germany, invited the expatriated astronomer to a residence in his own chateau near Prague, assigning to him a pension of 3,000 florins. But BRAHE, who could not long survive being exiled from his beloved Uranienborg, died in 1601 and was interred in the Theinkirche. A beautiful marble effigy in Prague perpetuates his memory.

Little is known of his private life beyond the fact that when very young he incurred the displeasure of his relatives by a marriage with a peasant girl. The king tried in vain to effect a reconciliation. He was of a violent and hasty temper, excessively superstitious, always keeping near him a lunatic, whose ravings he regarded as prophetic.

"A Treatise on the New Phenomena of the Heavens" is one of the best of his astronomical works.—WACOOCHEE.

EDITORIAL NOTES.

There are but six copies of Vol. I of the MESSENGER yet remaining. These in plain binding are offered at $5.00 per volume. Volumes two and three, in same binding, can be furnished at $3.00 each.

The partial eclipse of the *Moon* March 29–30 was visible in the western Pacific Ocean, Asia and easterns portions of Europe and Africa. The magnitude of the eclipse, as computed, was 0.886, the *Moon's* diameter being 1.

The report for 1884 of government observatory at Hong Kong, by Dr. W. DOBERCK, the director, has just been received. The greater part of his time and energies since his arrival in Hong Kong, in July, 1883, has been spent in completing the observatory and in the arrangement of the instruments. The attention of the institution is given up mainly to meteorology and to this end it is supplied with a very complete set of self-registering apparatus of the most recent design, made under the supervision of the director, aided by the advice of Kew Committee.

A time-service is also contemplated and the establishment of a time-ball for the use of the shipping in the harbor of Hong Kong, but at the date of the report the horological apparatus had not been received.

In the department of astronomy, besides the instruments for the time-service, the observatory has the Lee equatorial, of 6-inch aperture, loaned to it by the Council of the Royal Astronomical Society. This has been mounted since the report was issued. J. T., JR.

THE UNIVERSAL DAY.

Executive Document No. 78 of the 2d Session 48th Congress deals with the official correspondence relating to the introduction of the Universal Day.

The first document of importance (No. 2) is a circular order of the Superintendent of the Naval Observatory dated Dec. 4, 1884, directing the use of the Universal Day on and after Jan. 1, 1885, in that institution, and

No. 3 informs Prof. NEWCOMB, Superintendent of the American Ephemeris, of this decision.

No. 4 is a long letter from Prof. NEWCOMB, dated Dec. 6, giving reasons why the Universal Day should *not* be adopted.

No. 5 (Dec. 11) is a letter from the superintendent of the observatory in which he gives the reasons that seemed to him "sufficient to justify" the issuance of the order in question.

No. 7 is a circular letter to American astronomers from the super intendent of the observatory asking their views on the general subject and especially on the date at which the new system should be introduced. The replies were as follows:

No. 8. Prof. O. STONE; favors the change on Jan. 1, 1885.

No. 9. Prof. H. A. NEWTON; favors the change; suggests its immediate adoption, retaining the old system also to obviate confusion.

No. 10. Prof. E. C. PICKERING; regards an agreement among astronomers as of more importance than any special mode of reckoning.

No. 11. Prof. M. W. HARRINGTON; favors the change on Jan. 1, 1885.

No. 12. Prof. E. S. HOLDEN; does not favor the change and suggests Jan. 1, 1890 as the earliest date for its introduction.

No. 13. Prof. C. A. YOUNG; favors the change on Jan. 1, 1885.

No. 14. Prof. LEWIS SWIFT; favors the change on Jan 1, 1885.

No. 15. Prof. S. P. LANGLEY; favors the change on Jan. 1, 1885.

No. 16. Prof. C. H. F. PETERS; disapproves the change and suggests 1890 as the earliest date.

No. 17. Prof. J. G. PORTER; favors the change on Jan. 1, 1885.

No. 18. Prof. H. S. PRITCHETT; does not favor the change and suggests a delay of at least one year.

No. 19. Order of the superintendent suspending his former order introducing the Universal Day.

No. 19. Letter of the superintendent to Prof. NEWCOMB stating that of eleven letters received in answer to his circular only two decidedly oppose the change of day on Jan. 1, 1885, but that nevertheless his order is suspended.

No. 20. Circular of the superintendent to astronomers announcing that the "weight of opinion" is against the introduction of the Universal Day at present.

It is well understood that in any astronomical work involving figures, the greatest possible accuracy is needed to give the record value; but in records of experimental tests, or of phenomena merely, there is often an absence of specific detail which is needed to make such records most useful.

To illustrate: In England there is at present a discussion going on concerning certain reported comparisons between reflecting and refracting telescopes. Successive writers ask for important factors which were omitted from the recorded results.

There are also records published claiming the fifth star of the trapezium of *Orion* to be visible to observers with apertures as small as three inches, while one observer cannot see it with a 6-inch aperture. None, however, mention the power of the eye-piece employed, and the "seeing" is supposedly perfect. Under this head comes the statement of the indefatigable observer Mr. BARNARD, on pages 313 and 314 of December number of the SIDEREAL MESSENGER that he could better see his comet with a 5-inch aperature than with a 6-inch. He gives the description of eye-piece used with the 5-inch, but leaves us to infer a much higher power used with the 6-inch, as he speaks of the "contracted field" (p. 313). If this inference is correct, then his conclusion that small apertures will show what larger ones fail in (sometimes) is not a fair one, as a higher power will blot from sight a faint object, readily seen with a low power. J. H. H.

The solar eclipse of March 16th was successfully observed here by Professor WILSON and myself. During the morning the sky was full of flying clouds and the *Sun* only shone at intervals through gaps. A few minutes before the computed time of first contact, the clouds broke away and allowed the *Sun's* limb to be watched uninterruptedly. Owing to the disturbed condition of the atmosphere the definition was very poor.

I observed with the 11-inch equatorial, aperture reduced to three inches and power 90. The probable uncertainty of the times noted would not exceed three seconds.

Professor WILSON observed with the 4-inch equatorial, projecting the *Sun's* image on a screen of white paper; diameter of the projection about five inches.

Local mean times of first contact.

PORTER,	23^h	09^m	$01^s.9$
WILSON,	23	09	04 .1
Computed from American ephemeris,	23	09	03 .0

At the last contact the sky was nearly free from clouds, but the *Sun's* limb was still very unsteady. A few seconds after the *Moon* had passed off, a small cloud obscured the *Sun*.

Local mean times of last contact.

PORTER,	2^h	00^m	$01^s.8$
WILSON,	2	00 .	00 .7
Computed from American ephemeris,	2	00	12 .0

J. G. PORTER,
Cincinnati observatory, March 17, 1885. Astronomer.

OBSERVATIONS OF SOLAR ECLIPSE AT ANN ARBOR, MARCH 15 AND 16, 1885.

The observations were made on the observatory grounds. In column I. are given the local mean times of observations made by myself in the large dome. In column II. those made by Mr. SCHAERBERLE in the small observatory 82 feet east and 80 feet south of the large dome; position, longitude 5^h 34^m $55^s.12$, latitude 42° 16′ 17″.2. The column marked III. contains the observation of Mr. LEVI WINES, teacher of astronomy in the High School, made in the High School observatory, 230 feet west and 66 feet north of the main dome; position, longitude $5^h\ 34^m\ 55^s.39$, latitude 42° 16′ 48″.7. The instruments were: for I., the 12-inch refractor stopped down to 6 inches, negative eye-piece magnifying 150 diameters; for II., the 6-inch refractor, with negative eye-piece magnifying 81 diameters; for III., 4-inch refractor.

The spots are numbered from the side of first contact. No I. is a spot near the edge; II. and III. are parts of an elongated group; IV a small pore following the preceding; and V. a spot with double umbra about as far from IV. as it is from III.

OBJECT OBSERVED.	HOUR AND MINUTE.		SECONDS.		
			I.	II.	III.
	h	m	s	s	
First contact,	23	15	39	45.4	
Ingress of centre of spot I	23	34	0.5	17.5	
" " preceding end, umbra spot II.	23	55	28.5	34.0	
" " following " " " II.	23	56	20.5	9.0	
" " preceding " " " III.	23	57	1	15.7	
" " following " " " III.	23	58	54.5	48.7	
" " spot IV.	0	3	47.5		
" " preceding " " " V.	0	7	24	24.3	
" " following " " " V.	0	7		54.3	
Egress of preceding II. as above	1	16		4.5	
" " following II. " "	1	16		39.4	
" " preceding III." "	1	17		45.0	
" " following III." "	1	19		54.0	
" " spot IV.	1	26		21.8	
" " " V. midway between spots.	1	30		23.2	
Last contact	2	7	2	0.3	1.0

The sky was nearly clear; but not entirely so.

M. W. HARRINGTON.

From Red House observatory, Phelps, N. Y., Professor WILLIAM R. BROOKS writes that good observations were secured of the eclipse of the *Sun* March 16. Although the solar disc was at times partially hidden by light drifting clouds, the sky was fairly clear at the beginning of the eclipse. The definition was fair, although the limb of the *Sun* was unsteady. The first contact was accurately noted at 12h. 6m. 13s. standard time. Last contact lost by clouds.

At Carlaton College observatory some attention was given to photographing the eclipse with improvised apparatus arranged by Prof. PEARSON of the department of Physics. The eye-piece of the 8¼-inch Clark equatorial was removed and an ordinary *camera* was attached. The full aperature of the objective was used and a spring slide, with narrow opening made the exposure on a slow plate, the time being about one-hundredth of a second. The cuts show the size of the focal image of telescope, and will represent the pictures placed in the hand of the engraver. Of the six photographs secured, the four following were taken at the times respectively indicated, Central standard time being used:

Time: 11^h 42^m 15^s A. M.

Time: 11^h 46^m 30^s A. M.

The reader will easily see the relation of the *Sun* and *Moon* in the cuts, and follow the progress of the latter, if he be told that the views are in order, and that lines running through the middle of the cuts parallel to the length of the page would be nearly perpendicular to the Celestial Equator.

Time: 12^h 6^m 30^s P. M.

Time: 12^h 23^m 45^s P. M.

The third cut shows a phase about four minutes after greatest obscuration. The time of first contact was due at this place 10^h 35^m 38^s. The *Sun's* limb was very unsteady, and observation was uncertain by about four seconds. The contact was probably later by that amount.

As elsewhere more fully described, the appearance of the sky and the light at noon were in marked contrast with those of an hour before. The readings of the thermometer showed a fall of four degrees in the space of one and one-half hours.

Dr. T. D. Simonton of St. Paul observed the eclipse with a 3-inch telescope, with the following results as reported by the *Press:*

	Beginning.			End.		
	h.	m.	s.	h.	m.	s.
Predicted,	10	36	18	1	30	50
Observed,	13	35	20	1	30	57

The predictions were made by the careful and experienced computer, Mr. S. J. Corrigan of Nautical Office, Washington, D. C. For so good an observer as Dr. Simonton the errors are large, and throw some doubt on the accuracy of the predictions. Professor J. F. Downey of the University used a telescope of 2¾ inches aperature and observations were said to agree with his previous calculations within a fraction of a second. This is interesting, considering the unavoidable errors of the ephemerides and the tentative methods of computation in common use for solar eclipses.

Winnipeg.—The sky was clear throughout the day. During the eclipse, the thermometer went down from $-11°$ to $-18°$, and during greatest obscuration, which occurred about noon, it was necessary to provide lights for convenience in observation. The first contact took place 11h. 8m. 3s; last contact, 12h. 59m. 4s. standard time. Fifteen-sixteenths of the solar disk was covered. Name of observer unknown. The correspondent of the *Tribune* graphically says:

> The landscape presented a weird appearance and was quite dark at the greatest obscurity. The brute creation was bewildered—dogs barked during the whole time and cattle lowed; fowls sought their roosts and cocks crowed frequently. Some observers report seeing stars with the naked eye in the northern skies. Fifteen-sixteenths of the surface of the *Sun* was obscured at 12 o'clock. The Indians were in terror at its appearance.

Baltimore.—The eclipse was observed with small telescopes, but clouds prevented getting the times of first and last contact.

Washington.—It is reported that heavy clouds obscured the *Sun* the greater part of the afternoon. Some observations and a few photographs, however, were taken. Results of work have not been communicated.

Observations were unsuccessful, as reported, at Pittsburgh, much to the disappointment of Professor Langley.

Observers at San Francisco were also unsuccessful on account of unfavorable sky.

At the Beloit College observatory the first contact was lost on account of clouds. The second contact was successfully observed by

Professor TATLOCK and Mr. R. C. CHAPIN; the former with the 9.5-inch equatorial and the latter with the 3-inch finder of the same. Some occultations of solar spots were also observed.

Letters from Cordoba, South America, written February 7th, state that Dr. GOULD is pushing his work so as to leave as soon as possible. He has sent in his formal resignation and Dr. THOME has been appointed director in his place. Mr. R. H. TUCKER, formerly assistant at the Dudley observatory, who went to Cordoba, in the Spring of 1884, has been promoted to be second assistant. J. T., JR.

Special Circular No. 56, *Science Observer* reports the following discoveries:

A cable message from Dr. KRUEGER, received March 7, announces the discovery of an asteroid by BORELLI.

March 6, $8^h\ 45^m\ 36^s$. Greenwich M. T.

R. A. $11^h\ 6^m\ 13^s.5$. Decl. $+ 7^\circ\ 9'\ 17''$

Daily motion in R. A. $- 48^s$; in Decl. $+ 9'$.

Eleventh magnitude.

A cable message from Dr. KRUEGER, received March 10, announces the probable discovery of POGSON's lost planet, by Dr. PALISA.

March 9, 8h. 28m. 45s. Greenwich M. T.

R. A. 6h. 44m. 41.7s. Decl. $+ 28^\circ\ 10'\ 1''$.

Possible discovery of Comet 1867 (II).—A cable message from Dr. COPELAND, at Dun Echt, received March 14, announces the observation of a suspicious object by Dr. GAUTIER of Geneva, which may be a return of Comet 1867 II. (Tempel.)

A telegram from Professor PICKERING, of Harvard College observatory, received March 18, states that the suspected comet is a nebula.

Professor C. W. PRITCHETT, Morrison Observatory, Glasgow, Mo. at opposition of *Mars* in 1879–80 made micrometer measures of his diameter. This work was repeated at the planet's opposition in 1881–82.

The general mean of his results as given in A. N. No. (2652) is for

$$1879\text{–}80 = 9''.486 \pm 0.033$$
$$1881\text{–}82 = 9\ .484 \pm 0.036$$

A recent number of the Chico *Chronicle* (California) contains an account of the fall of an ærolite. It was attended by a brilliant train of light and fell but a short distance from Chico, Butte Co., Cal. Its length was over thirty feet; diameter, two and its shape pyramidal. The burning rock struck on a lava formation and glanced off plowing a gutter nearly two feet deep for a distance of two hundred feet. Its weight is estimated at several tons.

We gladly give place to the following important communication, not only because of the courtesies frequently extended to the MESSENGER by the Royal Astronomical Society, but also because of the interest that such information may be to American astronomers. We have in our possession a full description of the instrument referred to, which will be cheerfully communicated to any desiring more particular information.

For Sale.—A Heliometer of four inches aperture, by the REPSOLDS of Hamburg, the property of DAVID GILL, H. M. Astronomer at the Cape. The instrument is in perfect working order. Owner parts with it because his work is to be continued with a larger instrument. Particulars may be had on application to the Assistant Secretary, Royal Astronomical Society, London.

QUERIES.

1. Do observers this year notice any difficulty in the study of the details of the planets not seen in previous years?

2. Observing the Moon with a 3½-inch telescope, a small crater inside of *Hercules* is seen to give a dull red light instead of being filled with a black shadow. Why is this?

Knowledge (English), in late numbers, is giving fresh and enjoyable articles on astronomical subjects. In the last before us (No. 176) is found a continued article on "Life in other Worlds," by Mr. PROCTOR. Another by J. R. GREGORY on "Meteoric Stones."

At the February meeting of the Royal Astronomical Society Dr. WILLIAM HUGGINS was awarded the gold medal of the Society for his researches on the motions of stars in line of sight, and on photographic spectra of stars and comets.

Science No. 111 contains a brief article on *Researches in Stellar Parallax*, by Professor DAVID TODD in which reference is made to the principal stars that have been studied recently, in this particular. Dr. BALL, royal astronomer of Ireland, is deservedly complimented for his successful labors in this branch of astronomy.

Mr. C. E. CRANE, of Waseca, Minn., is highly pleased with the work of his 6½-inch Brashear reflector.

Subscribers will please notice that the MESSENGER is numbered consecutively on the first cover page. On the title page the number and volume are also given. The index accompanies the last number of each volume, and will be easily found by this arrangement.

During the year 1884 nine minor planets were discovered. Of these six were found by M. PALISA of Vienna.

The following subscriptions and orders have been received since last acknowledgement:

L'Observatoire de Paris, Paris, France; F. J. Stettler, Slatington, Penna.; J. J. Gilbert, Olympia, W. T.; Prof. Dascom Green, Troy, N. Y.; Cincinnati observatory, Mt. Lookout, Ohio; Prof. W. C. Gurley, Marrietta, Ohio; Fletcher Denell, Carlisle, Pa.; Rector S. S. Chevers, Shamokin, Pa.; J. B. Cummings, New Wilmington, Pa.; E. Crocker, Berea, Ohio; W. Glover, Boston, Mass.; J. Howard Watters, Cooptown, Md.; Prof. Coleman Bancroft, Hiram, Ohio; Prof. R. C. Crompton, Jacksonville, Ill.; William Evans, Philadelphia, Pa.; American News Co., New York City (Vols. I, II and III, bound); Wm. H. Dolbeer, Taylorsville, Ind.

BOOK NOTICE.

Curve Tracing in Cartesian Co-ordinates. By W. W. JOHNSON, Professor of Mathematics in the United States Naval Academy. New York: JOHN WILEY & SONS, 15 Astor Place, 1884; pp. 86.

The object of this little book is the study of the definite problem ascertaining the form of a curve, given by its equation in Cartesian co-ordinates, in such cases as are likely to arise in the applications of analytical geometry. As the book does not discuss the general theory of curves, the calculus is not employed, but algebraic processes only are used. The new and interesting feature is the introduction of the analytical triangle at an early stage as an instrument frequently employed in methods of approximation, as derived from NEWTON'S parallelogram and CRAMERS method of representing possible terms by points.

For so small a book the range is considerable, exercises abundant, and its progressive character satisfactory. The publisher's part is neatly done.

L'Astronomie, Revue mensuelle d'Astronomie populaire, de Meteorologie et de Physique du globe, par M. CAMILLE FLAMMARION. No. de Mars 1885. "Les tremblements de terre," par M. C. FLAMMARION. "Nouvelles observations sur Jupiter," par N. W.-F. DENNING, astronomie a Bristol. "Mouvement propre d'une etoile de 11 e grandeur." Etude oceanographique," par le colonel H. MATHIESEN. "Nouvelles de la Science." "Varietes:" Six trombes marines observees dans l'espace d'une demiheure. Halo et parhelie observes a Orleans. "Observations astronomiques," par M. E. VIMONT. Ce No. continent 19 figures. (GAUTHIER-VILLARS, quai des Augustins, 55, Paris.)

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. No. 4. MAY, 1885. WHOLE No. 34.

THE INSTRUMENTS AND WORK OF ASTRONOMY.*

PROFESSOR ASAPH HALL.

The progress of Astronomy has given us such a knowledge of the earth and of its relative position in space that we can now form a good idea of the conditions in which the astronomer is placed, and of the problems that are presented for his study. We know that our earth, which was formerly thought to be the centre of the universe, is only a secondary body, and is so small that it would require many thousand such bodies to form our central sun. It is from this small body, of an irregular figure, which revolves around the sun, and at the same time rotates rapidly on one of its axes, that the astronomer must study the motions of the other planets, determine his distance from the central sun, and discover the laws that preserve the order and harmony of our solar system. Beyond the planets lies the sidereal system of innumerable stars, which at first must perplex the observer by their number and variety, but which finally become his landmarks and guides. Our earth,

> " That spinning sleeps
> On her soft axle, while she paces even,
> And bears thee soft with the smooth air along."

*An address delivered at the opening of the Leander McCormick Observatory of the University of Virginia, April 13, 1885.

by her motions furnishes us the means of measuring time and space, and enables us to lay our work on sure foundations.

At the beginning of his labor the astronomer had none but the simplest tools, and had to trust wholly to observations with the naked eye, These would be so crude that a long time must elapse before much progress could be made in explaining the complicated motions of the sun, the moon, and the planets. But men so situated are called on to exercise thought and keen judgment, to invent and test theories, and to search carefully for the truth; and these are perhaps the best circumstances under which life can be spent. Hence, although the observations of the ancient astronomers are now of little value, one is tempted to envy them their opportunities, since it is not so much the truth itself, as the struggle for it, that strengthens and ennobles the character. It must have cost many years of patient labor and much ingenuity to obtain the results given by HIPPARCHUS two thousand years ago. The periods of the five planets visible to the naked eye determined by this great astronomer are wonderfully near the truth, and his explanation of the motions of the sun and moon, and his discovery of the precession of the eqinoxes show that he had employed his instruments well, and had arrived at many correct ideas concerning the motions of the heavenly bodies. In fact we may well believe that some of those old astronomers, aided by their primitive instruments, had formed true views of the theory of our solar systsm; but if so, such views were overwhelmed by more popular notions, and were set aside until the time of COPERNICUS.

To accomplish the work of the ancient astronomers many ingenious instruments were invented, most of which have been laid aside and are now nearly forgotten. But means of measuring angles and time were devised which, though rude, enabled the astronomer to begin the foundation of this science. The Greeks were skilled in geometry, and the use of the circle for the measurement of angles must be very old. This method is so simple that its defects would be mechanical rather than theoretical. On the other hand, the ancient instruments for measuring the important element of time were the dial and those that depend on the flow of water or of sand; and, notwithstanding the ingenuity displayed in their construction, even the best of them must have been very unsatisfactory. In striking contrast with these the modern instrument for the measurement of time is remarkable for its simplicity and effectiveness. We owe the invention of the pendulum to GALILEO, and there can hardly be found in the history of science a better illustration of the value of a good theory than in the application of this simple and excellent instrument to measure intervals of time. The pendulum was soon applied by HUYGENS to the control of clocks, and through his labors and those of EULER its theory was made nearly perfect. It needs only a comparison of the theory of the pendulum with those of the ancient instruments to show the value of GALILEO's invention, by means of which we have obtained not only an astronomical instrument of the first importance, but also a valuable instrument of geology.

From the evidence that has come down to us by means of coins and other relics of former times it seems probable that the ancients had a knowledge of lenses, and used them in some of the arts; but they do not appear to have applied them to astronomical instruments. A long interval, nearly fifteen centuries passed away after the epoch of PTOLEMY before this important step was taken, and before any radical improvement was made in the art of making astronomical observations. The results of the old methods of observing are shown at their best in the work of TYCHO BRAHE, whose wealth and skill procured the best instruments of his time, and whose industry accumulated a great mass of observations of nearly all the celestial objects visible to the naked eye. It is well known that these observations were of great value, since, in the hands of KEPLER, they led to the discovery of his famous laws of the motions of the planets around the sun. But for another reason these observations mark one of the most important epochs in the progress of the science. This was the application of the telescope to astronomical observations. The results obtained by TYCHO BRAHE were of the highest excellence of their kind, and some skillful observers refused to use the instrument that GALILEO had applied to astronomy. But the power gained was so great, and the wonders disclosed were so interesting that rapid progress was made. The telescope was first used naturally and simply in the line of discovery. The satellites of *Jupiter*, the spots on the sun, the phases of the planets predicted by Copernicus and the ring of *Saturn* were soon discovered. This marvelous instrument extended our knowledge also to the wonderful stellar systems and nebulæ that are scattered through the celestial spaces and explored regions forever closed to the naked eye. The changes produced in the thoughts and feelings of men by this sudden progress in astronomy were great. Cherished theories were brought into disrepute, and excitement and discussion followed during one or two generations. This enlargement of knowledge and the quickening of thought and investigation that followed form a remarkable epoch in the history of our civilization.

This great advance in descriptive astronomy was soon followed by attempts to improve the methods of measuring angles. The micrometer and microscope were invented, but more than a century elapsed before the real value of this application of the lens was recognized. The old method of measurment by means of sights with the naked eye had been employed by Tycho Brahe, and his observations were made so famous by the work of Kepler that the need of more accurate measurements was not felt. To one who looks back on such a state of things, and who sees the slow and uncertain actions of men, and how improvements are delayed and set aside for trifling reasons, a feeling of impatience is apt to come. Generally an actual need is required to spur us forward. During a great part of the seventeenth and eighteenth centuries practical astronomy had outstripped theory, and waited patient and satisfied. But the discovery of Newton and the labors of his great followers in France and Germany changed this condition. The need of more accurate observations was felt as soon as theoretical astronomy had become extended and refined, and then the full application of the telescope was soon brought about. So completely was this done that in the division of the circle and the measurement of angles hardly any improvement has been made during the last fifty years. During this time observations are nearly comparable in accuracy, and their value depends as much on the astronomer as on his instruments. By this application of the telescope the gain is so great that the ancient observations are now of little value. They served to lay the foundations of the science and were useful in their day; but the refined observations now extend over such an interval of time, and they furnish such accurate data that the astronomer has but little need to refer to the rude work of former times. It is worth while to notice that at the present time the relative positions of practical and theoretical astronomy are nearly the same as they were two centuries ago — that is, theoretical astronomy has fallen behind observation.

Since the invention of the telescope it has received one remarkable improvement which has very much increased its usefulness. The astronomers who first used the telescope employed single lenses of several hundred feet focal length, which made the use of the instrument extremely inconvenient, since it was difficult to give it a steady mounting and to protect it from the wind and weather. The difficulty was overcome by the discovery of the achromatic lens. This invention produced our modern telescope, whose form has not been essentially changed in the last hundred years. During the present century the improvements have been chiefly in the refinement and enlargement of instruments. While the art of dividing circles and of making screws has not perhaps been much advanced in recent years yet many ingenious devices have been made which assist the astronomer, and which tend to increase the accuracy of his measurements. Still it is difficult to believe that any great improvement in the art of observing is to be made by such means. Some more radical change is necessary, and for this we may look hopefully to the present rapid growth in the knowledge of the physical sciences. But should this never come, the astronomer can rely on the other fundamental element, that of time, by the lapse of which his work obtains a sure increase of value.

When the achromatic lens was discovered the knowledge of the manufacture of optical glass was so limited that this lens was at first only a few inches in diameter, and thus the light-power of the telescope was not great. This condition turned attention again to the construction of reflecting telescopes, some of which were made of very great size. These, in the hands of men who understand their construction and who are able to keep them in good order, have done good service in discovery and in the descriptive parts of astronomy. But the standard work of the science has been done by the refracting telescope. About the beginning of this century the inventions and labors of GUINAND and FRAUNHOFER produced lenses of ten to fifteen inches in diameter, and in recent years their followers have been so successful that now it is not easy to set a limit to the size of the future refracting telescope. The chief difficulty is still, however, in the manufacture of the glass; and here is a field for investigation which invites the ingenuity of our countrymen. Already it is something for our country to be permanently proud of that it is chiefly to American genius and skill that we are indebted for the great progress made in the improvement of the refracting telescope within the last thirty years. There can be no doubt that this increase in definition and light-power will give us a substantial gain in scientific knowledge. Of course new difficulties will arise in the use of very large instruments, and more careful investigations will need to be made of the effects of flexure, temperature and other sources of small errors; but these difficulties will be overcome. With the complete knowledge of its errors the increase of light and magnifying power of the large telescope will give us decided advantages in certain kinds of observation. And here it is interesting to notice the difference in the progress of the theories of the two principal instruments of astronomy—the pendulum and the telescope, both of which have now been brought to a high state of efficiency. The complete theory of the pendulum was given by EULER more than a century ago, although this theory depends on the motion of a rigid body, and the investigation requires a complicated mathematical treatment. On the other hand, the theory of lenses depends on comparatively simple mathematical conceptions, but after passing through the hands of the greatest masters of analysis this theory remained imperfect until about fifty years ago, when it was finally placed on a rigorous basis.

In the case of the large telescope we must not, however, commit the common error of expecting too much from the use of such an instrument. Measured by the relative amount of light gathered the gain seems great, but when we pass from a fifteen-inch objective to one of thirty inches in diameter our gain in the visibility of stars is only one and a half magnitudes. It is true that the number of stars brought to view by the larger glass in the shell of our great celestial sphere is very great, but they are of the faintest kind, and the study of these stars is very laborious. It can be only in a distant future that such stars will be brought into catalogues, their positions determined, and their peculiarities learned. But even an approximate enumeration of these stars will be of value by giving us some idea of the number of stars in the different magnitudes, and the law of increase of these numbers, as our vision is extended into the depths of space. There are many stars that present variations and peculiarities of light and color that are well worthy of a careful study with the best telescopes. We have also a great number of double-stars, in the measurement of which a good telescope can be employed advantageously. The study of the motions of the double-stars is hardly begun, and considerable time must necessarily elapse before much knowledge can be gained. This is a field of observation where practice and care add greatly to the value of the results.

Again, there is an extensive class of celestial objects well worthy of a careful study with the great telescopes of the present time. These are the nebulæ — the strange, fantastic objects of the siderial world. As distant as the stars, the nebulæ frequently subtend large angles, and must be of enormous extent. Whether they change in light or position is an interesting question, for the solution of which we need, first of all, good observations. Careful drawings of these objects with respect to the stars near them would furnish the means of judging in the future of their changes of position, and photometric observations would determine their changes of light, if such exist. If photography could be applied to give us exact pictures of the nebulæ, it would be a great gain, but probably this cannot be done yet to any extent, and we must trust to hand-drawings, with all their imperfections.

By means of its light-power the great telescope will doubtless be an important agent in the study of the surfaces of the sun, moon, and planets. Although these interesting objects have been observed since the invention of the telescope, they are still worthy of the most careful attention. The changes that take place on these surfaces are very curious and their causes are a mystery. In this kind of work photography is already rendering great assistance, and improvements in this art may be expected. Also in the stellar spectroscopic investigations of the future the great telescope must play an important part. Should this method of determining the motions of the stars be made certain and accurate we may look in this direction for interesting discoveries in stellar astronomy. There is one general consideration, however, that it is not well to overlook. This is the fact that all the obvious and striking discoveries of astronomy have been made long since. This condition follows from the nature of the case and from the progress of the science. The five bright planets of our system were soon discovered with the naked eye, and it needed but the smallest telescopes to reveal some of their satellites. The same telescopes showed also the sun-spots, the composition of the milky way, the clusters of stars, double-stars, and many of the nebulæ. With the improvement of this admirable instrument the field of discovery has been widened greatly, but the objects that remain to be discovered are, of course, faint and difficult to be seen. The future discoveries in astronomy, therefore, are to be looked for rather as the result of careful and perservering research, and are not to be expected simply from an increase of instrumental means. The astronomer should be provided with the best instruments, but, at the same time, he has a just demand for a kind and considerate judgment of his labors. There are many causes of delay and failure, and, even under the most favorable conditions, it may require years of hard work to bring his undertaking to a successful end. Generally we must remember that, as any science approaches a complete state, its further progress will become slow and difficult. At the present time astronomy needs no poor observations and badly arranged plans, but having become so closely connected with theory, it now needs thoughtful and careful observations and their complete reduction and discussion. The astronomer of to-day may well take his motto from one of our ablest men of science, *Pauca sed matura.* Your new observatory has before it a choice in a wide field of labor; and, from its good position in a fine climate, we feel confident that it will soon take a high rank among its sister institutions.

In considering the changes which the science of astronomy has undergone through the improvement of its instruments we must not forget the changes in the astronomer himself. This would be to overlook the most important factor in the question. During the early days of astronomy a large amount of self-denial and of patience and perseverance must have been required in the astronomer, and doubtless many of the ancient astronomers were men of high character. But this was lost during the middle ages; and for some centuries preceding the revival of science the term "astronomer" was equivalent to "astrologer." KEPLER* himself was for a time a devotee of the black art, and computed horoscopes. Such seems to have been the prevailing idea of an astronomer in the time of SHAKSPEARE. Thus we read:

> "O learned indeed were that astronomer
> That knew the stars, as I his characters,
> He'd lay the future open."

SCHILLER has described in a striking manner the influence of astrology in his picture of the gloomy Wallenstein. By combining in some degree the characters of astronomer and priest the astrologer acquired influence and wealth in the ages of ignorance and superstition. But the great changes wrought in astronomy by KEPLER, and by NEWTON and his followers, put in the background the mythical part of the subject, and gradually compelled the astrologer to become a scientific man. Instead of mysterious predictions of the destiny of man, inferred

* It is an item of history worth preserving that it was by the advice of TYCHO BRAHE, a practical astronomer, that KEPLER abandoned his mystical labors, and undertook to deduce the laws of planetary motion from observed phenomena.

from the stars and planets that culminated at his birth, his work became a study of the motions of the heavenly bodies; and the explanation and prediction of these motions in accordance with the law of gravitation created the science of astronomy.

First, the motions of our solar system and of the comets were shown to be subject to this law of nature, and the telescope has brought to light numberless stellar systems where the same law undoubtedly prevails. A true mechanical theory having been established, this in its turn exerted a wholesome influence on the astronomer. But the change from careless and inaccurate work to correct and exact methods was slowly brought about. If any one wishes to test this statement let him undertake the discussion of some of the observations made in the seventeenth century. Good observations of the objects discovered at that time, such as the satellites of SATURN, would be valuable now for the determination of periodic times and changes in the orbits, but an examination of those observations will show rude and careless methods in fixing positions, and at times something worse. An experience of my own, costly in the time and labor thrown away, has convinced me that the astronomers of those times had the practice of changing, or in technical phrase, of "cooking" observations, to an extent of which the astronomer of to-day gives no example. We find occasionally an astronomer of the present time who will change a little his results, being careful not to alter the mean value, the intention probably being to give an appearance of greater accuracy to his measurements. But even this species of venial dishonesty is not common. This great improvement seems to have been produced by the general advance in the science itself, rather than by any superiority in the morals of the astronomers, who in this respect are of course very much like other men. When, however, observations are so closely connected with theory, and can be subjected to such rigid tests, the observer soon learns the truth of the old saying, that honesty is the best policy, and that tampering with observations is dangerous. Under these conditions, therefore, it is not surprising that astronomical observations have become remarkable for their truthfulness.

It is worth while to notice, in this connection, the importance of a full and orderly record, and also the advantages of a common system of notation. It is a fault with some able observers that their record is carelessly kept, dates being omitted, and the whole matter so disorderly that, after a few days, the observer himself cannot decipher his own writing. In doing a large amount of observing this is a serious fault, and it is one that can be remedied by a little care and patience. The other fault, that of choosing new and uncouth symbols to express common and well-known things, results so much from the personal vanity of able men that it may be beyond control; but, at the same time, this practice introduces into theoretical astronomy much needless confusion. This department of astronomy is now a great field of applied mathematics and rational mechanics, and a common notation would be very useful. At present the symbols are so varied that in complicated investigations, such as the development of the perturbative function, it is almost necessary that each astronomer should repeat the investigation in full, in order to understand the meaning of the symbols.

I have endeavored to give an outline of the past and present condition of astronomy—the oldest and most advanced of the natural sciences. Its theories are now so well established that it lacks the novelty of other sciences, and many of its processes partake of the rigor and dryness of mathematics; yet this science must ever remain an interesting study. As time passes away the observations already accumulated will become more and more valuable. The astronomer of the future will be able to correct the values of his constants, and to increase the accuracy of his predictions. The orbits of the moon, the planets and their satellites, will be more accurately known; and the lapse of time must bring to light also many results of the highest interest, especially in stellar astronomy, which will give a clearer insight into the theory of our science, and which will extend and perfect its domain. The astronomer, therefore, has the satisfaction of feeling that his labors are a contribution to a grand and progressive science, and one that must continue as long as the heavens endure.

The establishment of an astronomical observatory by the oldest university in our country is an event worthy of consideration in respect to the general question of education. The founder of this university was a man who had a better understanding of the tendencies of his time than any other man on this continent. He knew better than any one else the meaning of our Revolutionary War and the French Revolution. He saw that, no matter how the tide of affairs might ebb and flow from year to year, the great current of events tended always toward one end, and that was the abolition of class privileges and a broadening of the rights of man. He had, moreover, the courage of his convictions, and spoke what he thought. That such a man should stir up bitter opposition is unavoidable. One needs but to turn back the pages of our history to the beginning of this century to find him the object of the fiercest denunciation. In fact, those of us whose memories go back fifty years may have personal recollection of such denunciations from some of the pulpits of our land. Happily, such feelings have mostly passed away, and nearly all of us can now see that even the abolition of a church tax may prove a good thing. We may, therefore, be able to judge more justly the actions of the man who was the bold advocate of truths that were sometimes unpleasant. But if JEFFERSON believed in the fullest liberty of man, and in his exercise of all political rights, he believed also that the most ample and complete means of education should be provided. Naturally, therefore, the crowning work of his life was the founding of a great educational institution—a university in which all branches of learning should be taught. The McCormick astronomical observatory is another step toward the completion of his plans.

It is not for me to enter on the vexed question of the relative merits of scientific and classical studies, but it is sufficient to know that in a university both are to be pursued, since it is the purpose of such an institution to apply the various kinds of discipline to promote the development of mind and body. Let me, however, call attention to a characteristic of the study of such a science as astronomy, which is, I think, not often mentioned. The mathematician has for his field of labor the infinity of numbers and of space. He needs no instruments; a pencil and paper are sufficient, and he would scorn to be limited or controlled by such a vulgar thing as an experiment or an observation. He deals wholly with symbols and lives in an ideal world. In that world parallel lines meet and space has dimensions of every order. The pure mathematician is therefore an idealist of the extremest type. The classical studies give power of expression and grace of utterance; but how rarely do we find a man of the liberal professions who can acknowledge himself to be in the wrong. Generally it is the business of his life to plead a cause and to make out a case. Now the purpose of a science such as astronomy is to discover the truth, and when found to acknowledge it. If an astronomer makes a mistake he feels bound to correct it, and not to hide it. It is in this totally different method of looking at matters, and in the practice of bringing all theories to the test of experiment, and in unsparingly rejecting the false, that the scientific method consists. And it is here, I think, that science is destined to improve our methods of instruction, not so much by the new matter it introduces, as by the different method it teaches. Let us take a single example in the subject of political economy, and one that has agitated our country during the past two generations, that is, the question of a protective tariff. Is this a beneficient regulation, which tends to increase the wealth of the country, or is it a cunning scheme of legalized robbery, by means of which a part of the community is enriched at the expense of the other parts? Here is a question of great importance and one that demands solution at the hands of our public men. It has become so inwoven with our system of industry that it is now a complicated matter and requires judicious treatment. But it can never be settled by orations and the pleas of men who present only a part of the evidence. It is a question that should be studied according to the scientific method. Other examples may be found in what is called history, a study the most interesting, and which should be one of the most instructive. But the books on this subject are so distorted by prejudice, that one is continually reminded of the old fable of the picture of the man and the lion, and he feels that it is necessary to hear the lion's side of the story. Shall we ever outgrow such falseness? I think so, but it will be done only by a radical change in the methods of investigation.

We rightly look to our colleges and universities for the men who are to form and direct public opinion; and it is from these institutions we expect those who are to survey the paths and guide the way in our social progress. The university therefore has a right to our earnest support. At the present time the boundaries of the natural sciences are rapidly widening, and I hope the founder of your astronomical observatory may find emulators of his generosity who will furnish you with ample means for the culture of all branches of science. Thus may your University continue to act a noble part in the intellectual development of our country.

THE STAR OF BETHLEHEM.

WM. W. PAYNE.

From recent notices in the newspapers public attention has been called to the supposed re-appearance of a certain star, well known to the Bible student, the "Star of the East," or the "Star of Bethlehem" as some writers have termed it. In some of these accounts, the claim that this notable star has re-appeared this year, is apparently so certain, that its place in the heavens has been pointed out, and the time of day given when it could be seen. In one instance it was urged that persons should seek early opportunity to observe this morning star because it was fast receding from sight. Is it any wonder that many people would take advantage of such advice whether certain of its truth or not, if they might possibly look on the face of a star once divinely chosen to mark the time and place of the birth of JESUS CHRIST in sacred history? Though it be probably true, yet to such it will be disappointing to say that the star referred to was undoubtedly the planet *Venus* as she was recently nearing the *Sun* from the west.

Whether the real Star of Bethlehem has been seen at all or not, since its first memorable appearance it may be profitable to consider briefly the studies of Christian scholars and astronomers in modern time to know something of the evidence on which their views are based.

What was it that the Magi in the East saw according to the account given in the second chapter of Matthew? So far as we know various prominent Biblical scholars in discussing this question have supported one of the following points:

1. It was a miraculous light appearing like a star.
2. A conjunction of the planets *Jupiter* and *Saturn* first, and finally of *Jupiter* and *Mars*.
3. A comet; and
4. A new or temporary star.

In regard to the first point the student of science can have nothing to say as to its truth or falsity, because he knows nothing about it by his methods of study. His opinions are his own and he has a right to them, and if a seeker after truth he will express them with deference and becoming modesty, in view of the opinions of Christian men, which are drawn from premises that may be true, but wholly different in kind.

The other theories would naturally interest astronomers, and they have given attention to them, certainly from the early part of the present century.

In 1826 Professor IDELER, astronomer and linguist at the Berlin University, advanced the idea that the star which the Magi saw was, in fact, a conjunction of the planets *Jupiter* and *Saturn*, which, according to late views, was in the third year before the birth of CHRIST. His imperfect calculations at that time put the two planets about one half degree apart, in nearest approach, a distance equal approximately to the apparent diameter of the *Moon*. To make the two planets appear as one star, when so great a distance apart, IDELER ingeniously supposed that the wise men were near-sighted. In 1831 the distinguished ENCKE repeated the calculations and found that there were three conjunctions of the planets, *Jupiter*, *Saturn* and *Mars* in the year above named, May 29th, September 3rd and December 5th; but that the distance between the two planets was about one whole degree at each of the three conjunctions, so that the two planets could not have been seen as one unless the Magi were miraculously short-sighted, as wittily suggested by Professor PROCTOR in 1882.

It is easy to see how the conjunctions of these great planets within a few years of the birth of CHRIST, in the astronomical sign of *Pisces* of the Zodiac should gain wide attention. The teachings of astrology interpreted the conjunctions of these planets as foreshadowing great national events, and the sign *Pisces* was known to belong to the Jewish nation, hence a conjunction — not only one but three — in *Pisces* was significant of the birth of CHRIST, the expected king. A trace of this view is found in KEPLER'S writings in which he expresses the opinion that the conjunctions of the great planets coincides with the approach of climaxes in human affairs, and names as examples the birth of ENOCH and the Deluge, the births of MOSES and CYRUS, and the births of JESUS CHRIST, CHARLEMAGNE and LUTHER.

The correctness of the views held by ENCKE and others in regard to the time and circumstances of these conjunctions, is, so far as we know, one unquestioned by modern astronomers, including so high an authority as the late Astronomer Royal of England. Although these facts be true, does it follow that these conjunctions could have been called properly a star, which is plainly the meaning of Matthew's account? Astronomers think not, and have generally given up this hypothesis first advanced by one of their own number.

Respecting the theory that the star seen was a comet it need only be said, that no evidence has been found to support such a claim.

In the matter of new or temporary stars the records contain something of interest. By a new or temporary star is meant one that suddenly flashes out where none has been noticed before, and as suddenly dwindles away to a telescopic star, or disappears altogether. Among others that have been spoken of in connection with this theme we will notice only two: TYCHO BRAHE's star and the star of *Coma Berenices.*

There is probably not another new or known variable star that has so wonderful a record as that which bears the name of TYCHO BRAHE. His own words best describe impressions at first sight, as follows: "Raising my eyes as usual, during one of my walks, to the well known vault of heaven, I observed with indescribable astonishment, near the zenith in *Cassiopeia,* a radiant fixed star of a magnitude never before seen. In my amazement I doubted the evidence of my senses. However, to convince myself that it was no illusion, and to have the testimony of others, I summoned my assistants from the laboratory and inquired of them, and of all the country people that passed by, if they also observed the star that had thus suddenly burst forth." Going on with the description TYCHO BRAHE speaks of its brightness as greater than that of *Sirius*, *Vega* or *Jupiter.* For splendor it was only comparable to *Venus* when nearest to the *Earth*, and was seen by some at noonday. After a few weeks it began to decline and in sixteen months became invisible to the naked eye (the telescope being invented thirty-seven years later).

In waning the star passed through changes of color, from white to yellow and red and then to white again. These phenomena interested TYCHO BRAHE so much that he wrote a large book describing the appearance of the star as seen by himself and others, and gave theories to account for those wonderful changes. It has since been thought that this star appeared also in 945 and 1264. If it be a variable star with period of about 314 years, it would make its time of appearance about the beginning of Christian era and also its re-appearance probable, in some slight degree, in 1886. In consequence of this latter supposition astronomers in Europe have been watching its place in *Cassiopeia*, which is now closely marked by a faint star, with special attention, for the last ten years.

In TYCHO BRAHE's time it was claimed by one CARDANUS that this was the star which the Magi saw.

The star of *Coma Berenices* is spoken of as appearing immediately preceeding the birth of CHRIST and was so bright as to be visible by day. HIPPARCHUS and PTOLEMY speak of this star, and IGNATIUS says that it "sparkled in brilliancy above all stars." Chinese records also mention a new, bright star at this time; but none of these statements have we been able to verify from the best authority. In Dr. SEISS's view of the divine origin of the constellations, the theory of this last named temporary star is certainly very suggestive and possibly not too fanciful to be true. So uncertain is all our knowledge of the Star of Bethlehem from records within our reach at the present time.—*Chicago Advance.*

RECENTLY DISCOVERED ASTEROIDS.

PROFESSOR DANIEL KIRKWOOD.

The discoveries in the zone of asteroids since January 1, 1884, are as follows:

Numbers 236 and 237, *Honoria* and *Cœlestina*, were discovered by Dr. PALISA of Vienna; the former on the 26th of April and the latter on the 27th of June. They are of the 12th or 13th magnitude. No 238, *Hypatia* was discovered on July 1 by Dr. KNORRE, of Berlin — the same astronomer who had some years since detected the minor planets, *Coronis* and *Oenone*. *Adrastea*, the next in order of discovery was discovered on the 18th of August by Herr PALISA. It is of the thirteenth magnitude. This discovery placed Dr. PALISA foremost in the list of planet finders; being the forty-third which he had first detected. No. 240, *Vanadis*, of the twelfth magnitude, was found on August 27th, by M. BORELLY, at Marseilles The next, *Germania*, was discovered on September 12th, by Dr. LUTHER, at

Dusseldorf. It is of the eleventh magnitude. Nos. 242, *Kriemhild*, 243, *Ida*, and 244, were discovered by PALISA, at Vienna, on September 22nd, September 29th and October 14th, respectively. The elements of No. 241, *Germania,* very closely resemble those of No. 133, *Cyrene.* No. 244 has not yet been named. Dr. PALISA, desirous of raising funds to defray the expense of his expedition to observe the total eclipse of the sun in August, 1886, will sell the right of naming this asteroid for two hundred and fifty dollars.

The first minor planet of 1885, and the 245th of the cluster was detected by M. BORELLY on the 6th of March. It is of the eleventh magnitude.

Hersilia, the 206th asteroid was discovered by Dr. C. H. F. PETERS, Oct. 13th, 1879. The observations then obtained were not sufficient for the determination of its orbit, and the planet was not re-observed till December 14th, 1884. Its elements are given below with those of the planets recently discovered.

ELEMENTS OF RECENT ASTEROIDS.

Asteroid		Mean Dist.	Period	Eccen	Long. of Perihelion	Long. of Asc. Node	Inclination
			d.		° ′ ″	° ′ ″	° ′
206	*Hersilia*	2.752	1667.7	0.045	95 23 14	145 1 55	3 46
236	*Honoria*	2.933	1835	0.219	328 56	185 34	7 9
237	*Cœlestina*	2.807	1719	0.102	295 46	84 38	9 39
238	*Hypatia*	2.911	1814.2	0.090	29 12	184 29	12 25
239	*Adrastea*	2.978	1873	0.228	26 1	181 34	6 14
240	*Vanadis*	2.654	1579.2	0.194	52 52	115 20	2 7
241	*Germania*	3.047	1943.3	0.089	344 50	272 7	5 33
242	*Kriemhild*	2.972	1871.3	0.257	134 31	208 16	12 53
243	*Ida*	3.001	1878.4	0.303	142 25	329 45	1 15
244	....	2.174	1170.7	0.136	13 57	208 33	2 49
245	....	.....	......	.....	....	....	....
246	....	.....	......	.....	....	....	....

REMARKS.

1. No. 244 is on the inner edge of the zone; its mean distance being the least with the exception of *Medusa.*

2. The orbits of *Hersilia, Hypatia* and *Germania* are nearly circular, and those of *Ida* and *Vanadis* are nearly coincident with the plane of the equator.

3. The number of asteroids discovered in consecutive periods of five years each is seen at one view in the following table:

Discovered previous to 1845	4	asteroids
From 1845 to 1849, inclusive	6	"
1850 to 1854, "	23	"
1855 to 1859, "	24	"
1860 to 1864, "	25	"
1865 to 1869, "	27	"
1870 to 1874, "	32	"
1875 to 1879, "	70	"
1880 to 1884, "	33	"
In 1885	1	
Whole number	245	

The maximum was reached in the five years from 1875 to 1879; a maximum which, when we consider the increasing difficulty of discovery, seems hardly likely to be surpassed.

THE SCHOOL OF PRACTICAL ASTRONOMY AT WILLET'S POINT — NEW YORK HARBOR.

A very interesting report is published by General H. W. ABBOT, of the Corps of Engineers, U. S. Army, on the astronomical work which has been done during 1884 at the engineer post of Willet's Point, New York Harbor. It is to this school of application that young officers of engineers are sent to learn the practical application of their studies at West Point. They are taught the practice of military surveying, mining, torpedo service, etc., and also the application of astronomy to military and boundary surveys. Each year a general order is issued, giving the results of the past year's work in practical astronomy. The order for 1884 may be summarized as follows:

Each officer makes a long series of determinations of the local time, with various instruments, and in various ways. With the portable transit, the time of transit is at first recorded by an assistant, at the word given by the observer; next, the observer records his own time by the relay beat of a chronometer every one second; next by the chronographic method, and lastly by the beat of the chronometer itself (every 0.5 second). Beginners use these methods in succession in the order named.

Personal equation is studied by means of Eastman's machine (see Wash. Ast. Obs., 1875).

The time determinations with the transit are given for each day of observation, with the probable errors.

Time determinations by sextant observations are also given, and by means of the (known) correction of the standard chronometer the error of each observation and observer is determined.

We quote below the errors of the sextant clock corrections so determined. (Usually ten altitudes of an east star and ten of a west were employed:) 3s.0; 3.8; 2.0; 1.2; 6.5; 1.8; 1.9; 0.9; 0.7; 0.1; 0.9; 1.0.

Observations for latitude were made by the sextant and by zenith telescopes. With the sextant the errors in seconds of arc were as follows: 1=101 feet. 1″.0; 4″.3; 2″.2; 7″.4; 1″.7 1.″5; 10″.4.

A table of the separate latitudes obtained by each observer, with each instrument from each pair of stars (Safford's Catalogue) is given in detail, and compared with the results of past years.

The mean of all the observations for latitude made in 1884 is as follows, all pairs and observations having equal weight. Zenith Telescope by Wurdemann (190 observations on 43 pairs) gives 40° 47′ 20″.57. Zenith Telescope by Lingke (333 observations on 54 pairs) gives 40° 47′ 20″.92. Grand mean for Observations of 1884, giving observations and instrnments equal weight is 40° 47′ 20″.75. The results of previous years are added for comparison. 1=101 feet.

Transferred from old observatory....... 40° 47′ 21″.70 ± 0.575
In 1880 (326 observations from 84 pairs).......21.59 ± 0.082
1881 (591 " " 104 ").......21.47
1882 (235 " " 60 ").......21.37
1883 (497 " " 118 ").......21.15
1884 (523 " " 89 ").......20.75

"The grand mean of 2,172 observations made at the new observatory during the past five years is 40° 47′ 21″.23; but it will be noticed that there has been a steady reduction in the yearly means during this entire period, and that the less exact determination at the old observatory indicates a change in the same direction."

Although the nature of the observations and the small absolute value of the quantity in question renders it quite possible to attribute this solely to errors of observation, the fact is nevertheless an extremely interesting one in its relation to the variability of terrestrial latitudes.

The observations of each observer for each pair of stars are given by General ABBOT, and an analysis of the results of the separate years, arranging the results by pairs, by instruments and by observers would probably show whether the very remarkable diminution indicated in the table corresponds to a real phonomenon or whether it is due to the chapter of accidents. The separate observations are not remarkably precise, as they are made by students for practice, but it would seem that their great number would compensate for this in its effect on the general mean.

Longitude was determined by lunar culminations and the errors of each separate result compared with the known (telegraphic) longitude were: 7*s*.5; 36.6; 2.2; 15.1; 3.8; 10.4; 14.6; 5.5.

Longitudes by lunar distances were also determined with errors as below: 16*s*.5; 12.9; 7.3; 6.7; 46.4; 39.7; 23.9; 11.7.

Auroral displays are regularly noted by the sentinels, and an interesting table of the results since 1870 is given.

What has been given as an abstract of one year's work in only one department of this school of application for young engineer officers is sufficient to show that we have at present no better school of practical astronomy in America.

EDWARD S. HOLDEN.

THE RED SPOT ON JUPITER.

PROFESSOR C. A. YOUNG.

The great red spot still remains visible; in position, size and form it has hardly changed at all from what it was four years ago, but it has become so faint as to be seen only with difficulty even in a large telescope; and recently a white cloud has appeared upon it which threatens in a short time to hide it completely. As seen at the Halsted observatory last week (March 23rd, 25th and 26th) with the 23-inch equatorial, the white cloud was almost exactly concentric with the red spot, and of the same form, leaving visible only a faint, narrow, reddish, oval ring about 1½″ or 2″ wide, to mark the outline of what a few years ago was by far the most conspicuous feature of the planet's surface. The outline of the white cloud is for the most part very regular, and the red ring is of almost uniform width; but at the western end of the spot there is a little projection of the cloud, which almost cuts across the ring; and perhaps there may be a very narrow canal connecting the cloud with the white belt outside, which forms the background for the red spot The cloud, in tint and brightness, so closely resembles the belt, that if it were not for the reddish rim around it, it would be quite invisible. On the 26th I was able to make out the red spot and its overlying cloud with the 9½-inch equatorial of the student's observatory, but do not think I shonld have detected them if I had not seen them before with the larger instrument.

There are at present a number of peculiar and interesting markings upon the planet, especially on the equatorial belt; one dark spot in particular on the S. equatorial belt just under the red spot, appeared almost as sharp and definite as a satellite shadow in the smaller telescope.

On the 25th, about an hour and a half before the red spot reached the central meridian, there were visible on the south *polar* belt of the planet (Lat. 50° to 65°) nine brilliant white spots, each about as large, and several of them as round and as well defined, as the discs of satellites. These bright spots were seen again on April 1st, having preserved their configuration sensibly unchanged during the intervening week. The seeing on this occasion was not good enough to permit an entirely satisfactory observation of the central meridian passage, and the rotation time, deduced by a comparison of the observations of March 23rd and April 1st, may therefore easily be erroneous by 3 or 4 tenths of a minute. It comes out $9^h\ 55^m\ 16^s$, which is 22 seconds *less* than that indicated by the red spot. The difference may or may not be significant. The *equatorial* white spots, it will be remembered, rotate in $9^h\ 50^m\ 12^s$.

EDITORIAL NOTES.

The meeting for 1885 of the American Association for the Advancement of Science will be held at Ann Arbor, Michigan, commencing Wednesday, August 26th, and continuing probably one week. Though Ann Arbor is not a large place, the fact that it accommodates nearly two thousand persons belonging to the University of Michigan during the greater part of the year, is proof that the place can afford ample facilities for the large summer meeting of the American Association.

OBSERVATIONS OF THE SOLAR ECLIPSE OF MARCH 16TH AT PRINCETON.

The eclipse was observed here at two stations; at the Halsted Observatory, and at the Observatory of Instruction, the former being about 2″ west and 2″ south of the meridian circle in the latter. The observations at the Halsted Observatory were made by myself with a grating spectroscope upon the 23-inch equatorial. I recorded the first contact at 23*h* 50*m* 33.7*s*, sidereal time, using the clock beats of the standard clock, transmitted telegraphically from the other observatory. This corresponds to 12*h* 11*m* 22.8*s* by Eastern standard time. The observation was made by noting the occultation of the chromosphere by the limb of the moon, the slightly open slit being set tangential at the predicted point of contact. The seeing was bad, and the chromosphere was rather unusually thin at the point observed so that the moon's limb did not become visible more than two seconds before the contact, but notwithstanding this, the observation was easy and satisfactory. I do not think the error can exceed half a second; *late*. if anything.

At the working observatory Mr. MCNEILL observed the contact in the usual manner, using the 9½-inch equatorial (with full aperture), a polarzing helioscope and negative eyepiece magnifying 220 times. He re-

corded contact on the chronograph at 23*h* 50*m* 34.2*s* sidereal, or 12*h* 11*m* 13.3*s* Eastern standard time: he notes the observation as satisfactory. The half-second of difference between his time and mine is more than accounted for by the difference in the position of the two stations, which would make the eclipse begin about one second earlier at the Halsted Observatory than at the other. Several of our students also observed the image of the sun made by a 9 inch reflector upon a suitable screen, but in all cases their observations were obviously late, from a few seconds to more than a minute. The last contact was lost at both stations by clouds.

During the eclipse, as long as the sky was reasonably clear, I studied carefully the B line and other atmospheric lines, putting the slit into all possible positions with reference to the *Moon's* limb, and using a great variety of dispersive and magnifying powers. My results did not corroborate at all those reported by some of the French observers in 1882: I could not find the slightest trace of any lunar atmosphere.

At the other observatory Mr. McNeill made similar observations, and with similar results, except that he records an impression that at one or two places on the *Moon's* limb there might have been a little broadening and fraying out of some of the components of the B group — nothing certain. But the state of the sky was such that our spectroscopic results cannot claim any great weight. C. A. Young.

Princeton, N. J., March 1885.

Under date of April 1, Prof. Young further says: "I find that Mr. McNeill would put his impression of the thickening of the B lines at the *Moon's* limb a little more strongly than I gave it. He is not *confident* about it, but his *suspicion* was a very strong one, he says."

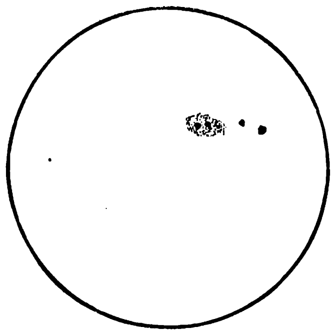
Notes on the Occultation of the Sun, as seen at Hillsdale College, March 16, 1885. By Professor A. E. Haynes.

The sky at this place was cloudless and the atmosphere was very clear and steady. The view as a consequence was surpassingly fine.

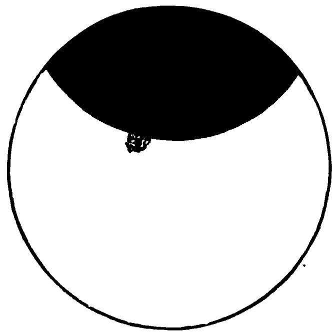
Three interesting points were noted during the time I was using the telescope. First, that the *Moon's* limb or edge where the sunlight passed it, seemed to be *slightly* serrated, or notched, thus showing that the *Moon's* surface is not regular or smooth. Second, that the light of the sun which passed the *Moon's* limb, did not appear to lose any of its intensity; in other words, the part of the sun visible appeared uniformly and equally bright, except where sun spots were seen, up to the very edge of the *Moon's* outline, as it appeared projected upon the *Sun's* face; thus suggesting that the moon has no atmosphere, or perhaps more correctly that it has no atmosphere which obstructs the light. Third, that the central part or umbra as it is called, of a large sun spot appeared nearly as dark as the face of the *Moon.* This was the most interesting observation of the three.

In the early morning I had been watching a large group of sun spots, and two other spots widely separated from this group, forming an irregular line of these spots, apparently extending across nearly a quarter of the *Sun's* disc.

One spot in this group, the largest, and lower one as it appeared in the inverting telescope, was of no little size and appeared very dark.



Sun's Appearance 9h. 0m. A. M.



Sun's Appearance 12h. 49m. P. M.

Later in the day, after the time of the eclipse had partially passed, this group of spots was hidden from view by the *Moon's* passing before it and my line of vision. After a short time, however, by patiently watching, I had the rare pleasure, as the *Moon* changed her position, of seeing this large spot lying apparently close to the *Moon's* limb, thus furnishing an admirable opportunity of comparing the relative brightness of her sable features and that of the spot on the radiant face of the *Sun.*

The last contact took place at Hillsdale (Long. 84° 38½′, Lat. 41° 55¼′) at 1:39 p. m., Central Standard or 90th meridian time.

Above are given copies of diagrams made at time of occultation, March 16, 1885.

The address of Professor HALL, the leader of this number, was given at the opening of the Leander McCormick Observatory of the University of Virginia, one of the largest and most important gatherings in the interest of astronomy held in the United States in recent times. This great observatory, with a refracting telescope equal in size to the Washington instrument, has been erected under the supervision of Professor ORMOND STONE, Director during the last two years. Some of the noted gentlemen present at the opening exercises were as follows:

Prof. Asaph Hall, of the United States Naval Observatory; Prof. Simon Newcomb, of the Johns Hopkins University; Prof. G. W. Hill; Prof. H. A. Newton, of Yale College; Dr. Elkin, of the Yale Observatory; W. Roane Ruffin, rector of the University of Virginia; Hon. B. Johnson Barbour, R. G. H. Keane, formerly rectors of the University of Virginia; Charles M. Fry, president of the Bank of New York, George W. Byrd, New York, and Charles M. Blackford, president of the Society of Alumni.

Letters were received from Gov. Stevenson, of Kentucky; Hon. A. H. H. Stuart, Hon. Willis P. Bocock, of Alabama; W. W. Corcorau, of Washington; Prof. Young, of Princeton Observatory; Prof. Hilgard, of United States coast survey, and Prof. Holden, of Wisconsin University Observatory, and other friends.

Observations of the First Contact of the Partial Solar Eclipse of March 15–16, 1885, Made at the U. S. Naval Observatory, Washington.

(Communicated by Rear Admiral S. R. Franklin, U. S. Navy, Superintendent.)

Washington Mean Time.	Observer.	Remarks.
March 15.		
h. m. s. 23 57 6.9	H.	Observation fair, perhaps one or two seconds late. The instrument was the 26-inch equatorial, with aperture reduced to 4 inches and power 383.
23 57 4.7	F.	Observed with 9.6-inch equatorial, with aperture reduced te 4 inches and power 90. Observation satisfactory.
23 57 7.	P.	Aperture 5 inches, magnifying power about 90. Do not think I could have observed it one second earlier with the state of the atmosphere as it was.

No observations of the last contact could be made on account of clouds.

The observers are Prof. A. Hall, Prof. E. Frisby, and Assistant Astronomer H. M. Paul.

The difference of right ascension of the second limbs of the *Moon* and *Sun* was observed by Lieut C. G. Bowman, on 11 wires of the East Transit Instrument, and by Assistant Astronomer W. C. Winlock, on 9 wires of the Transit Circle. The *Moon's* limb was faint at times, owing to flying clouds. The *Sun's* limb was but moderately steady.

RESULTS.

B., Diff. 1*m.* 56.49*s.* ± .028*s.*
W., 1*m.* 56.25*s.* ± .031*s.*

Ninety-nine photographs of the various stages of the eclipse were taken with the photo-heliographic apparatus of the Transit of Venus Commission, by a party consisting of Commander BROWN, Ensigns TAYLOR and WINTERHALTER, and Mr. W. F. GARDNER, the instrument maker of the Observatory. The exposures were made by Ensign WINTERHALTER.

The MESSENGER is favored by the following astronomical notes from E. E. BARNARD, Vanderbilt University, Nashville, Tenn.:

Jupiter's Satellite IV. On the night of February 27th I witnessed a black transit of *Jupiter's* fourth satellite; at the same time the shadow was in transit following it. The satellite was as black as its shadow, and only about one-half as large. The satellite retained its dark cast up to the moment of the beginning of its egress. After emergence it was inferior to the other moons in luster, when a high magnifying power (200) was used; but when a power of 60 diameters was applied, it appeared with the same as I. and II., and was fully as bright as the brightest part of the planet. The only thing remarkable about IV. after it left the planet was, that it seemed to fade more when high powers were applied than the other moons, its light appearing more feeble with the increase of power than that of either I. or II. The III. satellite was large and bright.

"*Gegenschine.*" March 19th at midnight; pretty large, hazy, "Gegenschine" visible 3° northwest of *Gamma Virginis.*

Aurora Borealis. An Aurora was visible on the night of March 15th, from 6*h.* 50*m.* to about 7*h.* 30*m.* At 6*h.* 50*m.* (90th meridian time) streamers were ascending fifteen degrees to east of north; these died out in a few minutes, leaving a large pinkish cloud at an altitude of some ten degrees which remained visible some time. After the cessation of the streamers to the east of north, similar streamers appeared at almost the same distance west of north, and remained visible for a few minutes; presently these died out, leaving a pinkish mass of smoke similar to that observed in the north-east, and after a time vanishing in about the same way. During the entire night there was more or less auroral light in the north horizon.

Nebulæ, New and Old.—In the SIDEREAL MESSENGER, No. 32, I gave approximate places of two new nebulæ. The following are more accurate places of the objects: First nebula,

	R. A.	3*h*	14*m*	0*s.*	1885.0
	Decl.	—19°	30′	43″	
Second nebula.	R. A.	3*h*	14*m*	54*s.*6	1885.0
	Decl.	—26°	28′	43″	

General Catalogue, No. 689.—This nebula, as noticed by me in MESSEN-

GER, No. 32, is erroneously located in Herschel's General Catalogue. Taking the mean of several approximate positions of this object, I get for its place,

R. A.	3*h*	14*m*	30*s*	1885.0
Decl.	—19°	50′.8		

The place given in G. C. for same epoch is

R. A.	3*h*	14*m*	30*s*
Decl.	—20°	49′	37″

Hence the position in G. C. is too far south by about one degree.

New Nebula.—On February 11th, I found with five inch refractor, a faint nebula in

R. A.	9*h*	12*m*	40*s*	1885.0
Decl.	—21°	52′	0″	

This nebula lies close between an 8.8 magnitude and a 9 magnitude star with a 10 magnitude star involved following.

Note on G. C. 1409. Herschel gives the place and description of this object for epoch 1860.0 thus: "AR=6*h* 19*m* 57*s*.6 ;N. P. D.=99°34′ 30″.9. Cl; P; lCM : st, 12..15." Almost in this spot on March 9th, I found a very small and very difficult nebula close north of a 10 magnitude star, between it and a 11 magnitude star. I tried it with six inch equatorial, and could only make out a small indefinite nebulosity, quite hard to see on account of the two stars. I find nothing near this spot that will answer the description in G. C. There is something wrong here.

E. E. Barnard.

A Legal Standard of Time for Wisconsin.

On the recommendation of the R. R. Commissioner of the State, the following bill has been passed by the Legislature of Wisconsin:

"The legal standard of time within the State of Wisconsin shall be the mean solar time of the 90th meridian west from Greenwich, now commonly known as 'Central Time.'"

Although there are sound reasons which could have been brought forward against the new railway time (which so far as I know were not brought forward) *before* its universal adoption, there seems to be no question but that the practical standard of time in Wisconsin is Central Time, and that it will remain so. As there are many advantages in having the practical standard of time also a legal standard, this bill has received the support of the Washburn Observatory.

E. S. Holden.

Observations of the Solar Eclipse of March 16, 1885, at the John P. Williston Observatory, South Hadley, Mass., by Misses E. M. Bardwell *and* I. G. Mack, *Teachers of Mathematics and Astronomy in Mt. Holyoke Seminary.*

(Communicated by Prof. C. A. Young.)

The geographical position of the Observatory is, Lat. 42° 15′ 18.2″, Lon. 18*m.* 05.0*s.* E. from Washington. The observations were made with the 8-inch equatorial (full aperture), and an ordinary diagonal solar eyepiece; power not rated, but probably about 100. The clock error was determined by Transit-instrument observations on the 13th, 14th and 17th. Flying clouds and haze were more or less troublesome during the whole time of the eclipse, but satisfactory observations of both the contacts were obtained by Miss Bardwell.

The first contact was noted at 0*h.* 26*m.* 31.0*s.* local mean time; or 0*h.* 16*m.* 38.2*s.* standard time. The second at 3*h.* 03*m.* 59.7*s.* local mean time; or 2*h.* 54*m.* 06.9*s.* standard time.

During the eclipse the spectrum of the *Moon's* limb was carefully examined with a spectroscope having a grating of 8640 lines to the inch. Nothing decisive was noted, though both observers at times thought that certain lines between 74 and 76 of Kirchoff's scale were perhaps a little thickened and strengthened just at the edge of the *Moon*. Another set of lines between *b* and F seemed also to behave in the same way; but in neither case did the impression amount to anything like a certainty.

Subscriptions and orders received for the Messenger not previously acknowledged are as follows:

Charles P. Howard, Hartford, Conn. St. Mary's Hall, Faribault, Minn. Dr. T. D. Simonton, St. Paul, Minn. George H. Peters, Chicago, Ill. Professor T. C. George, University of the Pacific, San Jose, Cal. Professor H. B. Perkins, Appleton, Wis. The E. Howard Clock and Watch Co., Boston, Mass. O. P. Haines (Vols. III and IV), Baltimore, Maryland. Professor George Davidson, San Francisco, California. Library of the University of Minnesota, Minneapolis, Minn. J. B. Cummings, New Wilmington, Indiana. Professor J. R. French, University, Syracuse, N. Y. J. W. Rall, 118 and 120 Olive Street, St. Louis, Mo. Sec'y H. E. Matthews, James Lick Trust, 120 Sutter St., San Francisco, Cal. Messrs Henry Stevens & Son, 115, St. Martin's Lane, London, W. C., England. (Vols. I, II, III, IV.) Professor C. S. Hastings, Yale College, New Haven Conn. Professor A. E. Engstrom, Cannon Falls, Minn. Capt. C. A. Curtis, Shattuck School, Faribault, Minn. Rev. H. Robinson, Leadville, Colorado. Cleveland Keith, Nautical Almanac Office, Washington, D. C. Rev. James McGolrick, Minneapolis, Minn. Garrett P. Serviss, Office of the *Sun*, New York City. F. E. Seagrave, Seagrave Observatory, Providence, R. I. Professor J. M. Van Vleck, Wesleyan University, Middletown, Conn. Jacob Ennis, 216 Congress St., Houston, Texas. Robert D. Schimpff, Scranton, Pa. Eugene A. Scott, Iowa Hill, California. Jacob Rice (Vols. III and IV) Sulphur Springs, Ohio. Geo. W. Hewitt, Philadelphia, Pa. Rev. J. H. Nason, Fairmont, Minn. Public Library, Boylston St. Boston, Mass. Library Amherst College, Amherst, Mass. Professor George W. Coakley, Hampstead, Long Island, N. Y. Rev. Archibald Brown, Presbyterian Church, Dublin Shore P. O., Lunanburg Co., Nova Scotia. Edgar L. Larkin, Observatory, New Windsor, Ills. A. Krueger, Editor Astronomische. Nachrichten, Kiel, Germany. (Vols. 1, 2, 3, Bound.) George M. Phillips, Northfield, Minn. (Vols. 3 and 4), Professor D. F. Higgins, Wolfville, Kings Co., N. S. Thomas Bassnett, Jacksonville, Florida.

BOOK NOTICES.

Elements of Analytical Geometry, by SIMON NEWCOMB, Professor of Mathematics in Johns Hopkins University. MESSRS. HENRY HOLT & COMPANY, Publishers, New York, 1885, pp. 356, price, $1.50

This book begins with the fundamental concepts of algebra and geometry which are stated and applied, in the first twelve pages, in a way to test the student's ability to undertake analytical geometry profitably.

The body of the text corresponds closely to the usual college course in plane analytical geometry, with some noticeable additions, Under the Straight Line is found a section devoted to the use of abreviated notation, which is both easy and elegant. The subject of Synthetic Geometry of the Circle is added in its proper place, besides other topics of similar interest. Part II is devoted to Geometry of three dimensions, and Part III gives a full introduction to Modern Geometry. This book is clear and concise in statement of principles, and in kind and variety of exercises, is unusually and happily strong. However, in its applications we notice with regret that its distinguished author has omitted altogether the use of the infinitesimal analysis. When a student knows the relations between equations and loci, and can pass from one to the other with facility, the elements of the Calculus render invaluable service in carrying form and analytical investigation, and in deducing in another way many of the most common laws pertaining to plane loci. The writer is convinced, from experience as a teacher, that the larger use of the infinitesimal analysis gives more direct and satisfactory results in developing and applying the principles of the higher mathematics than are obtained by methods more commonly used. And with reason, because the infinitesimal analysis is not at all inherently difficult, and if this be so, why should not its use be early introduced in college study and students be taught to think in, and work with one of the most common, refined and powerful instruments known to modern mathematical research.

Le Contes' Compend of Geology. D. APPLETON & Co., PUBLISHERS.

A copy of this work having come into my possession through the courtesy of the Chicago Agent of the publishers has been reviewed with pleasure.

Not long since at a meeting of the American Association for the Advancement of Science some very sharp criticisms were passed upon American Scientific works, the implication being that we had no books that were up with the times.

Such books as this of Professor LE CONTES', are the best answers to such criticisms. In the matter of text books for general students we believe that America is not only more bountifully, but better provided than the rest of the world.

There have been admirable books upon geology before this one, but to the instructor, looking for a work which should contain the material for instruction in a college class, which could give but a single term to geology, and yet desired a full view of the subject, there were moments of despair.

The great difficulty has been that either the books were overloaded with detail, or else presented the subject in such general outline as to be unsatisfactory. It would be extravagant to say that Professor LE CONTE has produced a perfect book. It is however fair to say that for such class work as indicated it is the only thing we have which meets the requirements.

The completeness with which geological agencies are treated is especially noteworthy. Nothing so furnishes the student to grapple with the detail of Historical Geology as a thorough presentation of the agencies which are and have been concerned.

The manner of presentation has in it that elusive quality which we all call style. The book is good reading aside from its accuracy and scientific value. The illustrations are abundant and typical and for the most part free from that crowding of many figures upon one plate, which is so confusing to the student.

On the whole instructors in geology are to be congratulated upon having such a compend to place in the hands of their classes.

L. W. C. JR.

Carleton College, May, 1885.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. No. 5. JULY, 1885. WHOLE No. 35.

The Change of Latitude in the Observations Made at Willet's Point, New York, by ALICE MAXWELL LAMB, *student in the Washburn Observatory.*

In the SIDEREAL MESSENGER for May, 1885, page 117, the results of observations for the latitude of Willet's Point, N. Y. are given, extracted from the printed orders of the Post.

The results for the various years are —

Transferred from old observatory.........Lat. 40° 47′ 21″.70
In 1880 (326 observations on 84 pairs).....Lat. 40° 47′ 21.″59
In 1881 (591 observations on 104 pairs)...Lat. 40° 47′ 21.″47
In 1882 (235 observations on 60 pairs)....Lat. 40° 47′ 21.″37
In 1883 (497 observations on 118 pairs)....Lat. 40° 47′ 21.″15
In 1884 (523 observations on 89 pairs).....Lat. 40° 47′ 20.″75

On these striking results General ABBOT remarks:

"The grand mean of 2,172 observations made at the new observatory during the past five years is: Latitude 40° 47′ 21.″23; but it will be noticed that there has been a steady reduction in the yearly means during this entire period, and that the less exact determination at the old observatory indicates a change in the same direction. Although the nature of the observations and the small absolute value of the quantity in question, render it quite possible to attribute this solely to errors of observation, the fact is nevertheless suggestive, in view of the favorable report of Messrs. VILLARCEAN, VON BAKHUYZEN, CUTTS, SCHIAPARELLI and CHRISTIE, upon the proposition of Professor FERGOLA (October 16, 1883) to investigate a possible movement of the axis of the earth in its interior, which would cause such a change in latitudes. This report was presented to the International Geodesic Association at its seventh general conference, held at Rome, in October, 1883; and one of the stations proposed for testing the matter was New York City."

At the suggestion of Professor HOLDEN, I have extracted the separate results from the various annual printed results, which were kindly furnished by General ABBOT and arranged them as follows: In the first place all observations with the "Russian Transit" were rejected as this instrument gives poorer results than the Wurdemann and Lingke zenith telescopes. General ABBOT says of it in the printed orders. "The instrument is not so well adapted to reversals and has other defects as a zenith telescope;" and "its precision falls decidedly below that of the Wurdemann pattern."

Secondly, I have retained only those pairs of stars combined thus AA and AA, AA and A, AA and B, A and A or A and B. (The nomenclature is Safford's, and the places are without exception from his last catalogue and therefore good.)

Thirdly, I have rejected the observations of T. A. B. in 1880 and of G. D. F. in 1884, on the evidence of the observations themselves. Their probable errors are in each case about twice as large as those retained.

Fourthly, I have arranged the observations of all well determined pairs taken with the Wurdermann instrument, *by pairs*, and by years. Table I gives the results and 1884 is the only year which stands out from the general mean.

Rejecting 1884, the observations of the years 1880, 1881

1882, 1883 are in fair agreement. In 1884 the results 17.″75 is probably the result of some large error, very possibly an error of 10″ in the reduction, and the last result 20″ depends only upon one observation.

Fifthly, I have arranged all the observations of well determined pairs made with the Lingke Instrument, which was only used in 1881, 1883 and 1884 in Table II. Here I have not given the separate pairs to avoid complicating the table, but the meaning of the horizontal lines is clear.

The various mean results are in good agreement.

Sixthly, I have given in Table III the separate results of all observations of well determined stars with *both* the good iustruments arranged by years and observers, including however only those observers who have worked in two consecutive years. This restriction excludes *all* of the discordant results of the Wurdemann instrument, 1884, and it is a fact worthy of remark that all the observers with this instrument in 1884 were observing for their first year. The results of this table are in fair agreement except perhaps that of 1883.

It would seem that the method of grouping employed in each table is a fair one. If the observations used in each table had been the only ones made, it is tolerably certain that the discordances would have been attributed simply to large accidental errors, which certainly exist. Taking all three tables together there is perhaps strong reason to attribute the systematic change of latitude to such errors alone, as General Abbot himself suggests.

It would seem to be desirable to observe the same pairs with both instruments and to have each observer work in two (or more) consecutive years with the same instrument. And if the Russian Transit could be used in the prime-vertical a valuable check would be afforded.

Washburn Observatory,
University of Wisconsin, Madison.

TABLE I.

Summary of all the observations of well determined stars, with the Wurdemamn instrument, by all observers (excluding T. A. B., 1880) in the years 1880, '81, '82, '83, '84.

WURDEMANN INSTRUMENT.

Star pair	1880	1881	1882	1883	1884
1313 A / 1335 B	21.27 (4)	21.76 (6)	22.60 (5)	22.38 (6)	19.81 [6]
1342 A / 1351 B	20.76 [5]	22.26 [7]	20.70 [7]	20.47 [8]	20.31 [6]
1397 A A / 1406 A	22.09 [1]	20.51 [2]	21.94 [6]	20.62 [7]	20.59 [5]
1416 B / 1431 A	22.85 [2]	21.64 [2]	21.56 [2]	22.29 [8]	17.75 [4]
1493 A / 1499 A	21.25 [2]	21.57 [3]	21.66 [8]	21.16 [5]	20.00 [1]
Mean by weights	21″.37 [14]	21″.77 [20]	21.″64 [28]	21″.37 [34]	19″.76[22]
Grand mean by wts. of all the above results=				21″.29	
Residuals	+0″.08	+0″.48	+0″.35	+0″.08	−1″.53
Grand mean by wts. rejecting 1884=................21″.53					
Residuals	−0.16	+0.24	+0.11	−0.16	....

TABLE II.

Summary of all the observations of well determined stars with the Lingke instrument, by all observers (excluding G. D. F. in 1884) in the years 1881, 1883, 1884.

LINGKE INSTRUMENT.

	1881	1883	1884
Employing same pairs	21″.31 [25]	21″.21 [23]	....
Employing same pairs	....	21.33 [48]	20.99 [65]
Employing all pairs	21.31 [25]	21.29 [71]	20.99 [65]
Grand mean (by wts)=...........		21″.17	
Residuals	+0″.14	+0″.12	−0″.18

No pairs common to all three years, 1881, 1883, 1884.

TABLE III.

Summary of all the observations of well determined stars by both the Wurdemann and Lingke Instruments and by all observers who observed in two consecutive years (excluding T. A. B. and G. D. F.) for the years 1880, 1881, 1882, 1883, 1884.

OBSERVERS WITH WURDEMANN AND LINGKE INSTRUMENTS.

Observers	1880	1881	1882	1883	1884
F. V. A.	21″.24 [29]	21″.00 [47]	....	....	....
G. J. F.	21.06 [23]	21.17 [35]	....	....	....
C. McD.T.	21.49 [11]	21.59 [26]	....	....	....
T. L. C.	21.99 [24]	21.36 [34]	....	....	....
J. B	....	....	21″.23 [35]	21″.36 [24]	....
H. F. H.	....	....	20.93 [28]	21.44 [31]	....
J. G. W.	....	....	20.87 [21]	20.45 [33]	....
E. B.	....	....	....	20.87 [31]	19″.72 [6]
O. T. C.	....	....	....	20.90 [28]	20.13 [14]
E. T. S.	....	....	....	18.24 [33]	21.80 [16]
L. H. B.	....	....	....	19.16 [28]	20.86 [23]
Mean by wts.	21.43 (87)	21.23 (142)	21.04 (84)	20.21 (208)	20.79 (61)
Grand mean (by wts)=.......			20.″91		
Residuals	+0″.52	+0 .32	+0 .13	−0 .70	−0 .12

Photometric Measurements at the Harvard College Observatory of the Faintest Stars in the Charts Constructed by PALISA.

These measurements were made at the request of Professor E. S. HOLDEN, Director of the Washburn Observatory, Madison, Wisconsin, for the purpose of furnishing additional information with regard to the distribution of the stars in space. In such inquiries, the results obtained by different telescopes must be compared together, and hence the magnitude of the faintest stars visible in a given telescope must be determined by some other means than estimates made upon an arbitrary scale. The chart employed as the basis of the investigation here described was kindly furnished by Dr. J. PALISA. It represents all stars within its limits visible at Pola with a telescope, the aperture of which was 6 French inches (16.24 cm.), the magnifying power being 56. This chart was compared with the sky by means of the large equatorial telescope at the Harvard College Observatory, and three groups of stars were selected as examples of the faintest objects visible at Pola. This selection was referred to Professor HOLDEN for his approval, after receiving which, the selected stars were compared with Epsilon *Hydræ* by means of the instrument described in Volume XI of the Annals of the Harvard College Observatory under the name of Photometer I. The resulting magnitudes depend upon that of Epsilon *Hydræ* as determined by the meridian photometer. The difference of magnitude determined by Photometer I may hereafter require corrections derived from other investigations now in progress with the same instrument, but these corrections will probably be small.

Table I contains the results of the separate observations. The stars are designated in the first two columns by the number of the group containing them and by letters of the alphabet. The next two columns give approximate right ascensions and declinations, depending only on the chart, and serving to identify the stars. The next column gives the magnitude of each star as estimated, after adjustment of the scale of the estimates to that of the photometer. Two of these estimates placed in brackets are not adjusted. They relate to comparatively bright stars, inserted in the list only as guides in finding the others. The next column gives the number of observations, each observation consisting of three comparisons. The date of the observations were April 16 and 17, 1885. The observer was Professor SEARLE, who had previously selected the groups to be measured. When one observation only occurs it was made on April 17. The stars which were not measured are retained in the list merely to facilitate the identification of the others. The number of observations is followed by the mean result for magnitude. The next column gives the residuals from this mean of the separate observations, when the star was twice observed. Accordingly, in the case of the first star, the two results appear from this column to have been 13.7 and 13.5. The last column indicates the stars not represented on the chart, or not measured.

TABLE I.

Group	Desig.	R. A. 1855			Decl.. 1855	Est.	No.Obs.	Result	Resid.	Remarks.
I.	*a*	8h	40m	50s	+7° 30′.7	14.0	2	13.6	0.1, +—0.1	
	b		40	56	31.8	14.0	2	14.1	+0.1,—0.1	
	c		40	58	30.8	13.8	2	13.8	+0.1,—0.2	
	d		40	51	32.8	14.1	2	14.4	0.0, +0.1	
	e		40	59	30.5	14.1	2	14.4	+0.1,—0.2	Not on chart.
	f		40	56	31.3	15.2	1	15.7	....	Not on chart.
II.	*a*		43	38	25.4	[9.5]	..	....	....	Not measured.
	b		43	28	26.5	14.0	2	13.7	—0.1, +0.1	
	c		43	32	27.7	13.8	2	13.8	—0.3, +0.2	
	d		43	40	27.5	14.7	2	15.0	—0.2, +0.1	Not on chart.
	e		43	41	27.5	14.7	..	....	....	Not on chart.
	f		43	52	24.5	14.2	2	14.3	—0.3, +0.3	
	g		44	5	24.5	13.8	2	14.0	0.0, +0.1	
	h		44	10	23.0	14.0	2	13.8	—0.2, +0.3	
	i		43	29	27.0	15.0	1	15.0	....	Not on chart.
III	*a*		45	18	15.0	[9.5]	..	....	....	Not measured
	b		45	2	14.0	14.5	2	14.1	0.0, 0.0	
	c		45	12	15.8	14.2	2	14.1	0.0, 0.0	
	d		45	18	18.0	14.0	2	14.0	—0.1, 0.0	
	e		45	12	15.1	14.8	1	14.7	....	Not on chart.
	f		45	1	15.0	15.0	..	....	....	Not on chart

Table II gives a summary of the results contained in Table I. The first column contains the number of the group, and the second the number of stars in the gronp which were represented on the chart and measured with the photometer. The next two columns give the mean results for each group on the two days of observation, and the last column gives the general mean. At the foot of these columns are given the corresponding results for the stars from all three groups taken together.

TABLE II.

		Results for Magnitude.		
Group.	No. of Stars.	April 16.	April 17.	Mean.
I	4	14.0	13.9	14.0
II	5	13.7	14.1	13.9
III	3	14.0	14.1	14.0
All	12	13.9	14.0	14.0

The magnitude of the faintest stars visible with the telescope used at Pola appears, accordingly, to be approximately 14 upon the photometric scale. The accordance of the photometric results indicates a probable error of .14 for a single observation. The average difierence between the adjusted estimates and the measurements is .20.

ON THE SOLAR CORONA.*

BY DR. WILLIAM HUGGINS.

If it were usual to prefix a motto to these evening discourses, I might have selected such words as "Seeing the Invisible," for I have to describe a method of investigation by which what is usually unseeable may become revealed. We live at the bottom of a deep ocean of air, and therefore every object outside the earth can be seen by us only as it looks when viewed through this great depth of air. Professor LANGLEY has shown recently that the air mars, colors, distorts, and therefore misleads and cheats us to an extent much greater than was supposed. LANGLEY considers that the light and heat absorbed and scattered by the air and the particles of matter floating in it amount to no less than 40 per cent. of the light falling upon it. In consequence of this want of transparency and of the presence of finely divided matter always more or less suspended in it, the air, when the sun shines upon it, becomes itself a source of light. This illuminated aerial ocean necessarily conceals from from us by overpowering them any sources of light less brilliant than itself which are in the heavens beyond. From this cause the stars are invisible at midday. This illuminated air also conceals from us certain surroundings and appendages of the sun, which become visible on the very rare occasions when the moon coming between us and the sun cuts off the sun's light from the air where the eclipse is total, and so allows the observer to see the surroundings of the sun through the cone of unilluminated air which is in shadow. It is only when the ærial curtain of light is thus withdrawn that we can become spectators of what is taking place on the stage beyond. The magnificent scene never lasts more than a few minutes, for the moon passes and the curtain of light is again before us. On an average, once in two years this curtain of light is lifted for

*A lecture delivered recently before the Royal Institution of Great Britain.

from three to six minutes. I need not say how difficult it is from these glimpses at long intervals even to guess at the plot of the drama which is being played out about the sun.

The purpose of this discourse is to describe a method by which it is possible to overcome the barrier presented to our view by the bright screen of air, and so watch from day to day the changing scenes taking place behind it in the sun's surroundings.

The object of our quest is to be found in the glory of radiant beams and bright streamers intersected by darker rifts which appears about the sun at a total solar eclipse. The corona possesses a structure of great complexity, which is the more puzzling in its intricate arrangement, because though we seem to have a flat surface before us, it exists really in three dimensions. If we were dwellers in Flatland and the corona were a sort of glorified catherine-wheel, the task of interpretation would seem less difficult. But as we are looking at an object having thickness as well as extension, the forms seen in the corona must appear to us more or less modified by the effect of perspective. This consideration tells us also that the intrinsic brightness of the corona towards the sun's limb is much less than its apparent brightness as seen by us, of which no inconsiderable part must be due to the greater extent of corona in the line of sight as the sun is approached. The corona undergoes great and probably continual change, as the same coronal forms are not present at different eclipses.

The attempts which have been made from time to time to see the corona without an eclipse have been based mainly upon the hope that if the eye were protected from the intense direct light of the sun, and from all light other than that from the sky immediately about the sun, then the eye might become sufficently sensitive to perceive the corona. These attempts have failed because it was not possible to place the artificial screen where the moon comes, outside our atmosphere, and so keep in shadow the part of the air through which the observer looks.

The latest attempts have been made by Professor LANGLEY at Mount Whitney, and Dr. COPELAND, assistant to Lord CRAWFORD, on the Andes. Professor LANGLEY says, "I have tried visual methods under the most favorable circumstances, but with entire non-success." Dr. COPELAND observed at Puno, at a height of 12,040 feet. He says: "It ought to be mentioned that the appearances produced by the illuminated atmosphere were often of the most tantalizing description, giving again and again the impression that my efforts were about to be crowned with success."

There are occasions on which the existence of the brighter part of the corona near the sun's limb can be detected without an eclipse. The brightness of the sky near the sun's limb is due to two distinct factors, the air glare and the corona behind it, which M. JANSSEN considers to be brighter than the full moon. When *Venus* comes between us and the sun it is obvious that the planet as it approaches the sun, comes in before the corona, and shuts off the light which is due to it. To the observer the sky at the place where the planet is appears darker than the adjoining parts, that is to say, the withdrawal of the coronal light from behind has made a sensible diminution in the brightness of the sky. It follows that the part of the sky behind which the corona is situated must be brighter in a small degree than the adjoining parts, and it would perhaps not be too much to say that the corona would always be visible when the sky is clear, if our eyes were more sensitive to small differences of illumination of adjacent areas. My friend, Mr. JOHN BRETT, A. R. A., tells me that he is able to see the corona in a telescope of low power.

The spectroscopic method by which the prominences can be seen fails because a part only of the coronal light is resolved by the prism into bright lines, and of these lines no one is sufficiently bright, and co-extensive with the corona, to enable us to see the corona by its light, as the prominences may be seen by the red, the blue, or the green line of hydrogen.

The corona sends to us. light of three kinds. (1) Light which the prism resolves into bright lines, which has been emitted by luminous gas. (2) Light which gives a continuous spectrum, which has come from incandescent liquid or solid matter. (3) Reflected sunlight, which M. JANSSEN considers to form the fundamental part of the coronal light.

The problem to be solved was how to disentangle the coronal light from the air-glare mixed up with it, or in other words how to give such an advantage to the coronal light that it might hold its owh sufficiently for our eyes to distinguish the corona from the bright sky.

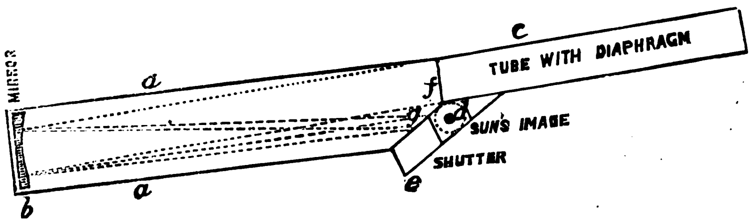
When the report reached the country in the summer of 1882 that photographs of the spectrum of the corona taken during the eclipse in Egypt showed that the coronal light seen from the earth, as a whole is strong in the violet region, it seemed to me probable that if by some method of selective absorption this kind of light were isolated, then when viewed by this kind of light alone the corona might be at a sufficient advantage relatively to the air-glare to become visible. Though this light falls within the range of vision, the eye is less sensitive to small differences of illumination near this limit of its power. This consideration and some others led me to look to photography for aid, for it is possible by certain technical methods to accentuate the extreme sensitiveness of a photographic plate for minute differences of illumination. [A cardboard on which a corona had been painted by so thin a wash of Chinese white that it was invisible to the audience had been photographed. The photograph thrown upon the screen showed the corona plainly.] This cardboard represents the state of things in the sky about the sun. The painted corona is brighter than the cardboard, but our eyes are too dull to see it. In like manner the part of the sky near the sun where there is a background of corona, is brighter than the apjoining parts where there is no corona behind, but not in a degree sufficiently great for our eyes to detect the difference.

A photographic plate possesses another and enormous advantage over the eye, in that it is able to furnish a permanent record of the most complex forms from an instantaneous exposure.

In my earlier experiments the necessary isolation of violet light was obtained by interposing a screen of coloured glass or a cell containing potassic permanganate. The possible coming of false light upon the sensitive plate from the glass sides of the cell, as well as from precipitation due to the decomposition of the potassic permanganate under the sun's light, led me to seek to obtain the necessary light-selection in the film itself. Captain ABNEY had shown that argentic bromide, iodide and chloride, differ greatly in the kind of light to which they are most sensitive. The chloride is most strongly affected by violet light from *h* to a little beyond K. It was found possible by making use of this selective action of argentic chloride to do away with an absorptive medium. To prevent reflected light, the back of the plate was covered with asphaltum varnish, and frequently a small metal disc a little larger than the sun's image was interposed in front of the plate to cut off the sun's direct light.

The next consideration was as to the optical means by which an image of the sun, as free as possible from imperfections of any kind, could be formed upon the plate. For several obvious reasons the use of lenses was given up, and I turned to reflection from a mirror of speculum metal. My first experiments were made with a Newtonian telescope by SHORT. With this instrument, during the summer of 1882, about twenty plates were taken on different days, in all of which coronal forms are to be seen about the sun's image. After a very critical examition of these plates, in which I was greatly helped by the kind assistance of Professor STOKES and Captain ABNEY, there seemed to be good ground to hope that the corona had really been obtained on the plates. [One of these negatives, obtained in August, 1882, was shown upon the screen.]

In the spring of the following year, 1883, the attack upon the corona was carried on with a more suitable apparatus. The Misses LASSELL were kind enough to lend me a seven-foot Newtonian telescope made by Mr. LASSELL, which possesses great perfection of figure and retains still its fine polish. For the purpose of avoiding the disadvantage of a second reflection from the small mirror, and also of reducing the aperture to 3½ inches, which gives a more manageable amount of light, I adopted the arrangement of the instrument which is shown in the following woodcut:



The speculum *b* remains in its place at the end of the tube *a*, *a*, by which the mechanical inconvenience of tilting the speculum within the tube as in the ordinary form of the Herschelian telescope is avoided.

The small plane speculum and the arm carrying it were removed. The open end of the tube is fitted with a mahogany cover. In this cover at one side is a circular hole *f*, 3¼ inches in diameter, for the light to enter; below is a similar hole over which is fitted a framework to receive the "backs" containing the photographic plates, and also to receive a frame with fine-ground glass for putting the apparatus into position. Immediately below, towards the speculum, is fixed a shutter with an opening of adjustable width, which can be made to pass across more or less rapidly by the use of indiarubber bands of different degrees of strength. In the front of the opening *f* is fixed a tube *c*, six feet long, fitted with diaphragms, to restrict as far as possible the light which enters the telescope to that which comes from the sun and the sky immediately around it. The telescope-tube *a*, *a*, is also fitted with diaphragms, which are not shown in the diagram, to keep from the plate all light, except that coming directly from the speculum. It is obvious that, when the sun's light entering the tube at *f* falls upon the central part of the speculum, the image of the sun will be formed in the middle of the second opening at *d*, about two inches from the position it would take if the tube were directed axially to the sun. The exquisite definition of the photographic images of the sun shows, as was to be expected, that this small deviation from the axial direction, two inches in seven feet, does not affect sensibly the performance of the mirror. The whole apparatus is firmly strapped on to the refractor of the equatorial in my observatory, and carried with it by the clock motion.

The performance of the apparatus is very satisfactory. The photographs show the sun's image sharply defined; even small spots are seen. When the sky is free from clouds, but presents a whity appearance from the large amount of scattered light, the sun's image is well defined upon a uniform background of illuminated sky, without any sudden increase of illumination immediately about it. It is only when the sky becomes clear and blue in color that coronal appearances present themselves with more or less distinctness. [Several negatives taken during the summer of 1883 were shown on the screen.] In our climate the increased illumination of the sky where there is a background of coronal light is too small to permit the photographs which show this difference to be otherwise than very faint. A small increase of exposure, or of development, causes it to be lost in the strong photographic action of the air-glare. For this reason, the negatives should be examined under carefully arranged illumination. They are not, therefore, well adapted for projection on a screen. [A negative taken with a whity sky, showed a well defined image of the sun, with a sensibly uniform surrounding of air-glare, but without any indication of the corona. In the case of the other negatives exhibited, which were taken on clearer days, an appearance, very coronal in character, was to be seen about the sun.]

On May 6, the corona was photographed during a total eclipse at Caroline Island by Messrs. LAWRENCE and WOODS. This circumstance furnished a good opportunity of subjecting the new method to a crucial test, namely, by making it possible to compare the photographs taken in England where there was no eclipse, with those taken on Caroline Island of the undoubtedly true corona during the eclipse. On the day of the eclipse the weather was bad in this country, but plates were taken before the eclipse, and others later on. These plates were placed in the hands of Mr. WESLEY, who had had great experience in making drawings from the photographs taken during former eclipses. Mr. WESLEY drew from the plates before he had any information of the results obtained at Caroline Island, and he was therefore wholly without bias in the drawings which he had made from them. [Photographs of Mr. WESLEY's drawings were projected on the screen, and then a copy of the Caroline Island eclipse photograph. The general resemblance was unmistakable, but the identity of the object photographed in England and at Caroline Island was placed beyond doubt by a remarkably formed rift on the east of the north pole of the sun. This rift, slightly modified in form, was to be seen in a plate taken about a solar rotation period before the eclipse, and also on a plate taken about the same time after the eclipse. The general permanence of this great rift certainly extended over some months, but no information is given as to whether the corona rotates with the sun. For from the times at which the plates were taken, one about a rotation period before and the other a rotation period after the eclipse, it is obvious the rift might have gone round with the sun, but there is no positive evidence on this point.*]

As the comparison of the English plates with those taken at Caroline Island possesses great interest, I think it well to put on record here a letter written by Mr. LAWRENCE to Professor STOKES, dated September 14, 1883:—

*See Plates XI and XIA, British Association Report, 1883, p. 348.

"Dr. HUGGINS called upon Mr. WOODS this morning and showed us the drawings Mr. WESLEY had made of his coronas. Ae told us that he particularly did not wish to see our negatives, but that he would like to compare his results with ours. We did so, and found that some of the strongly marked details could be made out on his drawings, a rift near the north pole being especially noticeable; this was in a photograph taken on April 3, in which the detail of the northern hemisphere is best shown, while the detail of our southern hemisphere most resembles the photograph taken on June 6; in fact, our negatives seem to hold an intermediate position. Afterwards I went with Dr. HUGGINS and Mr. WOODS to Burlington House to see the negatives. The outline and distribution of light in the inner corona of April 3rd is very similar to that on our plate which had the shortest exposure; the outer corona is, however, I think, hidden by atmospheric glare. As a result of the comparison, I should say that Dr. HUGGIN'S coronas are certainly genuine as far as 8′ from the limb."

Though the plates which were obtained during the summer of 1883 appeared to be satifsactory to the extent of showing that there could be little doubt remaining but that the corona had been photographed without an eclipse, and therefore of justifying the hope that a successful method for the continuous investigation of the corona had been placed in the hands of astronomers, yet as the photographs were taken under the specially unfavorable conditions of our climate, they failed to show the details of the structure of the corona.

The next step was obviously to have the method carried out of some place of high elevation, where the larger part of the glare which is due to the lower and denser parts of our atmosphere would no longer be present. I ventured to suggest to the Council of the Royal Society that a grant from the fund placed annually by the Government at the disposal of the Royal Society, should be put in the hands of a small committee for this purpose. This suggestion was well received, and a committee was appointed by the Council of the Royal Society. The committee selected the Riffel near Zermatt in Switzerland, a station which has an elevation of 8500 feet, and the further advantages of easy access, and of hotel accomodation. The committee was fortunate in securing the services, as photographer, of Mr. RAY WOODS, who as assistant to Professor SCHUSTER had photographed the corona during the eclipse of 1882 in Egypt, and who in 1883, in conjunction with Mr. LAWRENCE, had photographed the eclipse of that year at Caroline Island.

Mr. WOODS arrived at the Riffel in the beginning of July 1884, with an apparatus, similar to the one shown in the woodcut on a former page, constructed by Mr. GRUBB.

Captain ABNEY who had made observations on the Riffel in former years, had remarked on the splendid blue-black skies which were seen there whenever the lower air was free from clouds or fog. But unfortunately during the last year or so a veil of finely divided matter of some sort has been put about the earth, of which we have heard so much in the accounts from all parts of the earth of gorgeous sunsets and after-glows. This fine matter was so persistently present in the higher regions of the atmosphere during last summer, that Mr. WOODS did not get once a really clear sky. On the contrary, whenever visible cloud was absent, then instead of a blue-black sky there came into view a luminous haze, forming a great aureole about the sun, of a faint red color, which passed into bluish white near the sun. Mr WOODS found the diameter of the aureole to measure about 44°. This appearance about the sun has been seen all over the world during last summer, but with greatest distinctness at places of high elevation.

The relative position of the colors, blue inside and red outside, shows that the aureole is a diffraction phenomenon due to minute particles of matter of some kind. Mr. ELLERY, Captain ABNEY, and some others consider the matter to be water in the form probably of minute ice spicules; others consider it to consist of particles of volcanic dust projected into the air during the eruption at Krakatoa; but whatever it is, and whencesoever it came, it is most certainly matter in the wrong place so far as astronomical observations are concerned, and in a peculiar degree for success in photographing the corona. We are only beginning to learn that whether in our persons or in our works, it is by minimized matter chiefly that we are undone. So injurious was the effect of this aureole that it was not possible to obtain any photographs of the corona at my observatory near London. This great diffraction aureole went far to defeat the object for which Mr. WOODS had gone to the Riffel, but fortunately, the great advantage of being free from the effects of the lower 8000 feet of denser air told so strongly, that notwithstanding ever-present aureole Mr. WOODS was able to obtain a number of plates on which the corona shows itself with more or less distinctness. [Three untouched photographic copies of the plates taken at the Riffel were shown upon the screen.] From the presence of the aureole the negatives show less detail than we have every reason to believe would have been the case if the sky had been as blue and clear as in some former years. This circumstance makes great care necessary in the discussion of these plates, and it would be premature to say what information is to be obtained from them.

[As an illustration of the differences of form which the corona has assumed at different eclipses, photographs taken in 1871, 1878, 1882, and 1883 were projected on the screen. Attention was called to the equatorial extension seen in a photograph taken in 1878, and to the suggestion which had been put forward that this peculiar character was connected with the then comparative state of inactivity of thesun's surface, at a period of minimum sun-spot action, especially as an equatorial extension was observed in 1867.]

It is now time that something should be said of the probable nature of the corona.

Six hypotheses have been suggested:—

1. That the corona consists of a gaseous atmosphere resting upon the sun's surface and carried around with it.

2. That the corona is made up, wholly or in part, of gaseous and finely divided matter which has been ejected from the sun, and is in motion about the sun from the forces of ejection, of the sun's rotation, and of gravity,—and possibly of repulsion of some kind.

3. That the corona resembles the rings of Saturn, and con-

sists of swarms of meteoric particles revolving with sufficient velocity to prevent their falling into the sun.

4 That the corona is the appearance presented to us by the unceasing falling into the sun of meteoric matter and the debris of comets' tails.

5. That the coronal rays and streamers are, at least in part, meteoric streams strongly illuminated by their near approach to the sun, neither revolving about nor falling into the sun, but permanent in position and varying only in richness of meteoric matter, which are parts of eccentric comet orbits. This view has been supporeed by Mr. PROCTOR, on the ground that there must be such streams crowding richly together in the sun's neighborhood.

6. The view of the corona suggested by Sir WILLIAM SIEMENS in his solar theory.

(To be Continued.)

THE ANNULAR ECLIPSE.

BY CHARLES H. ROCKWELL.

I have seen several notices of observation's made at the time of the recent annular eclipse—March 16; but no one seems to have been on the path of the annulus, or even near it. In this respect I was more fortunate than they.

The central line when plotted on a map, struck the coast of California a little south of the mouth of Eel river: running thence north-easterly to the north-east corner of the state: and so on through the centre of Idaho and Montana to the Canadian boundary at 106° long. west from Greenwich. I left home with the intention to see this eclipse from the most favorable location. The difficulty, however, of locating with even tolerable accuracy the geographical position of the towns and rivers, deterred me from taking along any instruments whatever, although I had prepared for transportation a telescope of 2½ inches aperture with equatorial mounting, solar prism, &c. I took therefore an ordinary wedge of colored glass, only. From the best information which I could obtain before leaving New

York, the most promising place seemed to be at or near Delta, the present terminus of the railroad leading towards Oregon. Assuming Lat. 41° 02′, Long. 122° 20′, I obtained as the circumstances of the eclipse local astronomical time March 15th, 19*h* 43*m* 57*s*, 20*h* 59*m* 23*s*, 21*h* 01*m* 22*s*, 22*h* 25*m* 21*s*.

On arriving in San Francisco I soon found that Delta presented more points in its favor than any other locality. By the courtesy of the Central Pacific Railroad I was given the aid and companionship of Mr. W. A. Palmer, Assistant Engineer of the railroad company. Also by the courtesy of the railroad officials, the train was run from Redding to Delta to suit our convenience, so that we arrived at our destination soon after 8 o'clock on the morning of March 15th. This enabled us to receive the noon signals from the Observatory at Washington, which came to us at 9 A. M. 120th meridian time. As it was Sunday, the telegraph line was almost free from local business, and the signals came through *perfectly*. I think I can say we received every beat of the clock at Washington without any break or uncertainty. On Monday the signals were quite unsatisfactory, and it was no easy matter to identify the beats which came through. On the 16th, the atmospheric conditions were all as favorable as anyone could desire. The instrument which Mr. Palmer had brought was an engineer's field transit of the ordinary construction. This required a constant manipulation of the altitude and azimuth screws, in order to keep the *Sun* in the field. Owing in part to this disadvantage, we lost the first contact, as the *Moon* had been on the *Sun's* disc 8 or 10 seconds before it was noted.

I consider the other phases as wholly reliable, viz:

1st contact—Lost.		
2d	"	9*h* 07*m* 09*s*.
3d	"	9*h* 09*m* 06*s*.
4th	"	10*h* 32*m* 43*s*.

Time, 120th meridian. Clock error, 01*m*, 11*s*, slow.

The difference in the apparent diameter of the *Sun* and *Moon* was 1′ of arc, as nearly as may be. This would leave 30″ of the *Sun's* disc exposed when the annulus was perfect. In the opinion of Mr. Palmer, as seen through his instrument, the width of the rim of light was the same on the upper and lower side of the *Moon*. It certainly seemed so to me, as seen through the glass wedge, and a half dozen by-standers using smoked glass agreed as to the uniformity of the two strips of suulight. I conclude therefore we were almost exactly on the central line. The light was so intense that at no time could one look at it with the eye unprotected. I had prepared a lantern to be used if necessary, but I had no difficulty in picking up the time on my watch, a sweep second on a white dial. In some newspaper articles before the eclipse I had seen a discussion as to the possibility of seeing the corona on this occasion. Having distinctly in mind the first appearace of the coronal light as seen in Colorado, July 28, 1878, and again on Caroline Island, May 6, 1883, I did not consider it possible that this phenomenon should present itself, unless the *Sun's* light was wholly obscured, I saw nothing of any indications of the corona as seen at the time of the two eclipses before mentioned. If any of this delicate silvery effect was present, it was wholly absorbed in the shade glasses which it was necessary to use, to look even in the direction of the point of interest in the heavens. We did see, however, a magnificent diffraction halo of some 4° diameter, surrounding the *Sun*, caused doubtless by the *Sun's* rays going obliquely over the disc of the *Moon*. As a matter of scientific importance, I do not attach any value to these notes, but as a magnificent astronomic spectacle, it was eminently well worth seeing. I give below the position of Delta as derived from the U. S. Land Surveys:

Latitude 40° 56′ 16″7,
Longitude 122° 24′ 58″3.

It is doubtless more nearly correct than the position which I assumed, but I should not be willing to accept it as correct to the tenth of a second.—*Argus*.

Tarrytown, N. Y., May, 1885.

No. 2661 *Astronomische Nachrichten* contains a list of 100 new nebulæ discovered at the Marseilles Observatory, France, by M. STEPHAN. The description, right asscension and declination of each are given for 1885.0.

THE CONSTELLATIONS.

THE EDITOR.

A few years ago a book was published in England by FRANCES ROLLESTON, of Keswick, entitled "*Mazzaroth, or The Constellations.*" Soon after a second edition appeared and the work received some attention, and favorable comment in both England and America, although its circulation has been surprisingly small in this country. On this account we venture to call attention again to some of its leading points on topics of general interest to Astronomy.

Most persons know something about the names, and figures that astronomers call the constellations of the Zodiac. When these figures are drawn prominently and in full in the celestial maps or globe, the meaning which they convey, concerning the early history of astronomy is indifferent to many, unattractive to some, and repulsive to others.

So distasteful have they become to the modern astronomer that he has quite abandoned their use as a means of reference in ordinary work, partly, perhaps, on account of the unscientific spirit they seem to foster, and partly, because of late improved methods of reference. This is natural, and, as might be expected, in view of the changed forms and meanings of the figures, representing the constellations since very early times, the introduction of others, incongrnous and absurd, and the evident corruption of names that have suffered in the hands of the heathen mythologist.

The object of the book above referred to is a most laudable one. It is to show by traditions, ancient writers, and the meaning of the ancient names of stars, still extant, that such symbols were chosen to convey the earliest and most important knowledge possessed by the first fathers of mankind. It endeavors to prove that for higher and more important records, those of the only true wisdom of man are contained in the emblems of the constellations. The agreement of the figures with the types used by the prophets of the Bible since the world began, is a strange coincidence, and the fact that in the names the very words in which the prophecies were delivered are frequently to be recognized, is still more strangely suggestive, when it is understood that the primitive roots by which the Assyrian and Babylonish records are now interpreted "exist alike in the names of the stars and the dialects used by the prophets."

We are aware that these names and the ideas conveyed by the figures are found in the mythology of nations, and we know that strange and degrading uses were made of them in heathen imagery, but it now more clearly appears, chiefly by late eminent linguistic research, that their fables were drawn from the constellations, and not the constellations from the fables. If this be true, and it can be shown that the wisdom of the Creator was peculiarly manifested thus, in the beginnings of the history of our noble science, it will certainly give new interest to the student of science in early records and general antiquarian research. There are many questions in astronomy to which no certain answer has been given. Pertaining to its early history such as the following are examples: With whom did astronomy begin? When and where? By whom were the earliest extant emblems and names of the stars chosen? What is their meaning and why were they chosen? Why were these constellations allotted three to each sign? Why were they so figured and thirty-six of them so related?

The discussion of these and other kindred topics is presented in Frances Rolleston's book more clearly and definitely than elsewhere known to the writer. So far as known no answer to this book has been attempted.

There are many occultations of stars by the *Moon* during July, but nearly all are of small magnitude.

Observations of the "Pons-Brooks" Comet, 1883 and 1884, made with the filar micrometer on the 6.4 inch Equatorial of the Davidson Observatory, San Francisco, Cal., Long. 8h. 09m. 42.6s W. of Gr.

Date. 1883.	Observer.	Local Mean Time			Star—Comet Observed difference uncorrected. Star. Δ*a*		Comet. Δ N. P. D.		Comparisons.	Comparison Star. Letter.	Estimated mag.	Name, if Identified.
		h.	m.	s.	m.	s.	′	″				
Dec. 12	D	8	29	42½	—0	45.47	—0	21.5	3	a	8½	Radcliffe 4380.
14	D	8	15	48	—	04.66	+0	04.4	7	b	10½	A. pl. 40°: 3888, 9.1.
		8	37	30	—	10.32	—0	28.2	11	b	10½	do
		8	51	26	—	13.86	—0	46.1	5	b	10½	do
16	D	7	59	46	—	36.60	—3	09.5	12	c	—	Anon.
		8	21	30	+	08.61	—0	44.8	11	d	—	Anon.
18	D	8	25	16	—	39.16	+2	18.4	5	e	11	A. plus 38°: 3954, 9.0.
		8	35	16½	—0	42.04	+1	59.5	5	e	11	do
20	H	7	36	49	—1	24.18	—3	44.3	6	f	—	A. plus 36°: 4065, 8.6.
22	D	7	57	38	+0	04.20	±0	00.0	1	g	10	A. plus 34°: 4117, 8.9.
		8	06	17	+	11.53	+0	18.5	9	h	10½	A. plus 34°: 4119, 9.5.
		8	24	12	—	03.90	—1	05.3	9	g	10	A. plus 34°: 4117, 8.9.
26	D	8	06	19½	—	42.77	—4	00.0	6	i	10	A. plus 30°: 4335, 9.4.
		8	18	00½	—0	46.37	—4	34.1	6	i	10	do
27	H	7	10	56	—2	21.60	—7	44.4	18-6	j	6-7	Yarnall 9281.
	H	7	35	15	—0	08.48	—0	09.6	6	k	—	A. plus 29°: 4362, 9.3.
	D	8	03	08½	—0	16.60	—1	21.1	14	k	—	do
28	H	6	26	10	—2	01.78	—2	58.7	18-6	l	8-9	A. plus 27°: 4049, 8.2.
29	D	7	57	03	—0	14.46	—0	58.7	5	m	9	A. plus 26°: 4186, 9.4.
		8	01	26½	—	16.15	—1	14.2	4	m	9	do
		8	30	50	—	38.00	—1	20.7	6	n	9	A. plus 26°: 4184, 9.4.
		8	43	29	—0	41.72	—1	07.0	4	n	9	do
1884.												
Jan. 3	D	8	08	30	+0	16.02	—1	05.9	5	o	10	Arg. plus 18°: 4394.
		8	13	00		14.44	—1	24.5	5	o	10	do
		8	17	23½		13.46	—1	42.8	5	o	10	do
9	H	7	07	21½		09.08	—1	14.2	5	p	8½	A. plus 7°: 4932.
	H	7	12	04½		08.68	—1	37.0	4	p		do
	D	7	23	26		05.70	—2	32.2	4	p		do
	D	7	28	18		04.27	—2	55.1	7	p		do
	D	7	33	24	+0	02.93	—3	19.4	7	p		do
10	D	8	15	38½	—1	14.30	—1	17.9	4	q	—	A. plus 5°: 5104.
		8	26	21	—1	16.76	+0	27.8	5	q		de
11	D	8	01	58½	—0	22.20	—2	43.4	4	r	—	A. plus 3°: 4812.
24	D	6	20	47	—1	46.71	—0	16.4	21-7	s		Wash. M. C. Zones 206, No. 36.
	D	6	36	02½	—1	49.43	—1	11.4	6-2	s		No. 36.
	D	6	36	02½	—1	25.45	—2	20.9	6-2	t		No. 39.
	H	6	47	45½	—1	51.37	—1	54.9	6-2	s		No. 36.
	H	6	47	45½	+1	23.36	—3	05.0	6-2	t		No. 39.
25	D	6	49	59½	+2	56.07	+1	08.6	15-5	u	7	Wash. M. T. Zones 198. No. 34.

NOTES TO COMPARISON STARS.

(j.) Pos. 1883.0: a=21h. 09m. 10.22s.; N. P. D.=60° 34′56.8″ from A. N. No. 2591.

(l.) Pos. 1883.0: a=21h. 16m. 29.78s.; N. P. D.=61° 55′44.5″ from A. N. No. 2572.

(p.) Pos. 1884.0: a=22h. 43m. 07.57s.; N. P.D.=82° 04′10.0″ from Grant 1870.

(s.) Pos. 1884.0: a=0h. 02m. 37.97s.; N. P. D.=108° 13′16.5″ from A. N. No. 2591.

The * is Lalande No. 47332.

(u.) The * is Lalande No. 257.

Observer: D=George Davidson. H=Chas. B. Hill.

EDITORIAL NOTES.

Continued and unexpected absence from home was the reason for not publishing the MESSENGER for June as usual. It will hereafter appear regularly for each month, during the remainder of the year. A recent change in printers gives the MESSENGER a new dress which speaks plainly for itself. When the Greek fonts and desirable astronomical symbols are secured, our pages will appear beautifully complete through the earnest efforts of a skillful man in charge of the printer's cases.

Volume one of the MESSENGER is out of print. Volumes two and three can be furnished in numbers at the usual price, in plain library binding at $3.00 each. The small sum of $250 would enable the publisher to reprint the exhausted numbers of volume one. Here is an opportunity for some generous friend to assist in a worthy cause. We are unable to fill a number of foreign orders for full sets of this publication which have been recently received.

Professor A. HALL, Naval Observatory, Washington, D. C., in a recent letter, speaks of the spring and summer of this year, as the most unfavorable for observation during the past eleven years. Latterly he has been busy in getting his observations of the satellites of *Uranus* and *Neptune* ready for printing. The reductions for the satellites of *Uranus* are already finished. From all the observations on the two outer satellites, *Oberon* and *Titania*, he finds the mass of

$$Uranus = \frac{1}{22682 \pm 27}$$

This is a slight dimunition of the received value. The oppositions of *Uranus* which Professor HALL observed, from 1881 to 1884, were very well suited to fix accurately the position of the orbit plane of the satellites, because the *Earth* passed through this plane in 1882, and probably the node and inclination are well determined by these observations.

COMET-METEOR RADIANTS.

Below will be found a list of Comet-Meteor Radiants and Distances which I have calculated from the orbit elements of recent comets.

The present list includes the radiants of all the principal comets that have appeared since the first of 1880. The only ones omitted are some three or four faint ones of short period which have already been included in previous lists.

The first column contains the current number; the second gives the designation of the comet by the recent method in the order of perihelion passage of the year; the third, the discoverer; the fourth, the day of the *Earth's* passage through plane of comets' orbit; the fifth designates the nearest node; the sixth, the distance of this node from the *Earth's* orbit in the order R—r, the *Earth's* distance from the *Sun* being taken as unity; the seventh and last column gives the radiant point for the given date.

If, as is generally accepted, comets are formed of meteors, or, at least, have meteors traveling in the same orbits with them, we may be able to identify some past or future showers with some of the comets of the last few years, which has been a period of so much cometary activity.

Allowing for the lateral spreading of meteors in their orbits, we see there are several comets whose meteors we should be liable to encounter, the most noteworthy case being that of Comet 1882.I, where the distance from the *Earth* at node is less than three million miles.

Current Number	Designation of Comet.	Discoverer.	Day of Earth's passage through line of Nodes.	Designation of Node.	Earth's distance from Node.	Comet-Meteor. R. A.	Radiant. Dec.'
1.	1880. I.	Gould.	Mar. 16.	Descending.	+0.98	298.1	— 6.2
2.	1880. II.	Schæberle.	Dec. 9.	Descending.	—1.02	194.6	+28.9
3.	1880. III.	Hartwig.	Nov. 7.	Ascending.	+0.60	142.0	— 8.0
4.	1880. IV.	Swift.	Jan. 17.	Descending.	—0.68	305.6	—12.2
5.	1880. V.	Pechule.	May 31.	Ascending.	+0.33	44.7	—74.6
6.	1881. II.	Swift.	July 30.	Descending.	+0.43	347.3	+69.7
7.	1881. III.	Tebbutt.	June 22.	Ascending.	+0.28	56.4	—58.8
8.	1881. IV.	Schæberle.	June 28.	Descending.	+0.20	14.7	+29.7
9.	1881. V.	Denning.	Nov. 28.	Ascending.	+0.12	274.1	—36.1
10.	1881. VI.	Barnard.	June 26.	Asc nding.	+0.57	19.9	—34.8
11.	1881 VIII	Swift.	Sept. 24.	Descending.	—1.66	116.9	+39.9
12.	1882. I.	Wells.	April 15.	Ascending.	+0.03	356.9	—14.4
13.	1882. II.	Gould.	Marh 16.	Descending.	+0 97	290.9	— 8.1
14.	1882. III.	Barnard.	Dec. 1.	Descending.	—0.51	137.8	+56.9
15.	1883. I.	Brooks.	Dec. 30.	Descending.	—0.14	244.0	+25.6
16.	1883. II.	Ross.	Dec. 16.	Descending.	+0.63	175.8	+42.0
17.	1884. I.	Pons-Brooks	Dec. 6.	Descending.	+0.18	198.9	+67.9
18.	1884. II.	Barnard.	Sept. 28.	Ascending.	—0.69	198.5	—17.2
19.	1884.	Wolf.	Oct. 20.	Descending.	—0.58	275.2	+39.7

Harvard College Observatory, 1885, June 26. O. C. WENDELL.

We greatly regret to record the death, on May 19, of the Rev. T. W. Webb, M. A., in the 79th year of his age. Mr. Webb was a Prebendary of Hereford Cathedral, and Vicar of Hardwick, Herefordshire. He frequently contributed, chiefly on astronomical subjects, to "*Nature*," "*The Astronomical Register*," "*The Intellectual Observer*," "*The Student*," etc., but his principal contribution to astronomical literature was the widely known and highly valued, "Celestial Objects for Common Telescopes," a work by which he will long be rememdered. — *Observatory.*

DARK TRANSIT OF JUPITER'S IV SATELLITE.

The greater portion of this transit was observed here, both with the 10-inch reflector and three-inch Tulley refractor. Definition fair; temperature 54 F.; barometer 30.14.

The satellite for the greater part of the transit appeared black, as it commonly does; but what I should like to call attention to is, that this blackness remained until egress, *instead of disappearing about ten minutes before*—an observation I believe unique, and seen also by Mr. GLEDHILL of Bermerside, as well as others.

Further than his nothing unusual occurred, excepting that for about half an hour, between 11 and 11.30, the satellite became exceedingly faint, appearing to me, at times of good definition, irregularly elongated parallel to the belts, assuming then more of a chocolate color. (Mr. GLEDHILL also noticed the faintness and ill-defined appearance at the same hour.) I was also struck by the faint appearance both before and after transit of this satellite as compared with the others; and, to use an expression once employed by DAWES, "it was far from obvious."

I may add that Satellite III, during a dark transit on May 2 (temperature 46° F., barometer 29.58, definition good until the time of egress, when it became unsteady) was quite different. While dark, it appeared uniformly round, and of a deep steel color, and about ten minutes before egress became invisible, but eventually reappeared on the limb of the planet, perfectly white and defined, during good moments of definition.—*Monthly Notices.*

In a late issue of the "*Evening Bulletin*", Philadelphia, an editorial article appears of some interest, pertaining to the nebulæ. Its concluding paragraph is as follows:—

"It is remarkable that the nebulæ have only lately become known. HALLEY, a great English astronomer, is 1714 published a list of 6. HEVELIUS soon enlarged it to 16. LACAILLE, in 1755, by observations at the Cape of Good Hope, increased the catalogue to 64. MESSIER, in 1784, further enlarged the number to 103. Sir WILLIAM HERSCHEL then took up the subject in real earnest, and in 1802 he published a catalogue of 2,500. A similar number was added by his son, chiefly at the Cape of Good Hope. Other laborers have entered the field, and now about 7,000 nebulæ are known. For many years past the work in nebular astronomy has been nearly stopped. But less than two years ago it was taken up anew by Professor LEWIS SWIFT, of the Warner Observatory, at Rochester, N. Y., and already he has discovered two hundred new ones. He is one of the very best observers in our own day, and it is to be hoped he will persevere in this great undertaking. He has given to the world a a very important paper on the Nebulæ in the January and March numbers of the *Sidereal Messenger*, a monthly magazine on astronomy, published at Northfield, Minn., to which we would refer our readers."

Under date of January, 23rd, 1885, Dr. DOBERCK, the Government Astronomer at Hong Kong, China, published a circular containing twenty-two right ascensisns of the moon observed at Hong Kong, from November 25th, 1884, to January 4th, 1885. The instrument employed was the Troughton and Simm's transit of three inches aperture. The observations were compared with the tabular places of the Nautical Almanac (which contain Newcomb's corrections.) The resulting correction being, in the mean +0s.073. From these observations Dr. DOBERCK deduces a correction to HAMEN'S semi-diameter of −0s.127. Applying this correction to his observations, the resulting mean correction to the Nautical Almanac is +0s.091. J. T., Jr.

The Observatory at Warschau has just been supplied with a meridian circle of 162 millimeters aperture and 2.27 meters focal length, by ERTEL of Munich. The circles are 790 millimeters in diameter. One is capable of being turned upon the axis, and is divided to 3′. The other is intended only for setting purposes and is divided to 10′. On both circles every degee is numbered. There are four microscopes on each side. The microscope bearers are of the same design as those upon the old Repsold circles and are supplied in the some way with spirit levels. The illumination of the field is effected by means of prisms within the cube, the light coming from lamps attached to the outside of the piers. For illuminating the circle a prism is attached to the end of the microscope nearest the circle. J. T., Jr.

In late numbers of the *Observatory* W. F. DENNING has been discussing the comparative merits of reflecting and refracting telescopes. In the course of the discussion he says:

"If Professor YOUNG finds it feasible to examine critically the faint details of *Jupiter* with powers of 950 and 1200, his telescope must be a very remarkable one. Certalnly no small instrument can boast a record anything like this. *Jupiter* is rather a test of definition, and I had no idea there was any telescope in existence that would give us a sharp disc and a steady view of the more delicate features with a power of 600, or only half that mentioned by Professor YOUNG. When, however, your able correspondent states that he has successfully employed 1200 to settle critical matters of detail on the planet, I have only to confess that the Princeton refractor has effected a very fine performance, and one that speaks volumes for its defining capacity, and for the favorable site of the observatory, as regards meteorological conditions. Professor YOUNG's experience with a large telescope is of so exceptional a character that any further information he may afford us will be of deep interest. It now remains for the Princeton refractor to further exhibit its powers by grasping new features of planetary phenomena, for after all we must look to original results as the most safe and enduring proofs of real capacitp."

The MESSENGER would like to know the American meaning of the above English paragraph. We would suggest to Professor YOUNG that he try the defining power of the Princeton equatorial on it in Princeton air. If he be not sure of the details of the compliment by observing in the ordinary way, try a look at it backwards through tho object-glass, and see if the small image will not be more steady, when reduced in such an original way.

By kindness of E. W. MAUNDER, Editor of the *Observatory* (English) we have a copy of his recent paper, "*The motions of stars in the line of sight*," published in parts in late numbers of the *Observatory*. It contains a careful and somewhat full statement of the way in which the motions of the heavenly bodies, in the direction of the visual ray, are studied, the power needed, the practical difficulties in the way of successfully manipulating the spectroscope, and some of the results reached in work at the Royal Observatory recently.

The observations of the star *Sirius* have brought out some singular and unexpected results. In 1868, Dr. HUGGINS found the star to be receding from us at the rate of 29 miles per second. From observations by Mr. MAUNDER during last winter the star appears to be approaching us at a rate of 22 miles per second. Since observations between these dates show a gradual change of motion it has been suggested that the star may be moving in an eliptical orbit, which would fairly accord with the snpposition of Dr. PETERS and others who have claimed that *Sirius* has motion in right ascension and declination at right angles to the line of sight. This paper does not claim to make any comparison between these two kinds of observation, but simply mentions these coincidences as worthy of notice. The difficulty and nicety of this work is better understood by the unexperienced when it is said that the *F* line in the spectrum of *Sirius* changed in position a little more than one twentieth of its total breadth in a period of nine years preceding 1884. That would make the annual change of the line in position less than one hundreth of its breadth. The paper is an instructive one.

Those who read the article in our last issue, entitled "*Recently Discovered Asteroids*," by Professor DANIEL KIRKWOOD, will remember that No. 244 was then the last new minor planet with known elements. Since, the elements of Nos. 245, 246 and 247 have been determined with mean distances respectively 3.0778, 2.7208, and 2.7423. It is interesting to notice that none of these new planets fall in the gapes, which, some time ago, were pointed out in the great asteroid belt by Professor KIRKWOOD and others. We have not yet seen the elements of the new asteroid No. 248.

ERRATUM.—On page 115 (May number) the last word "equator" should be "ecliptic."

A black transit of *Jupiter's* III Satellite was witnessed here on the night of May 9th, at 7*h*. 15*m*. Nashville mean time. The Satellite was seen as a small, round, black spot on the edge of the northern equatorial band. It remained extremely black and well defined—when the unsteady air allowed a fair view—until near the preceding limb. The Satellite passed the center of its apparent path of 8*h*. 0*m*. At 9*h*. 9*m*. III had lost some of its blackness. At 9*h*. 26*m*. still dark, not easy to see; 9*h*. 13*m*. very dim and close to limb; 9*h*. 38*m*. III totally invisible; 9*h*. 40*m*. it was faintly visible and white just on inside of the limb—first contact at emergence. At 9*h*. 43*m*. it was about one-half off disc and as white as any part of *Jupiter's* disc; 9*h*. 55*m*. III was some distance from the limb, not as large or as bright as I (near it preceding). The contact of center of III with *Jupiter's* limb was at 9*h*. 44*m*. Observations were made with the six inch telescope, power 120.

E. E. Barnard.

Vanderbilt University Observatory, Nashville, May 1885.

Face of the Sky.

The evening sky for July will be attractive to the ordinary observer. At ten o'clock, during the first part of the month, *Scorpio* is seen passing the meridian low in the south for latitude 45°. It will be readily recognized by the bright, red star, *Antares*, and the fan-like appearance of the large, loose group of stars to the west and north of it, which constitutes the principal part of the constellation. The handle of the fan, so to speak, points obliquely downward toward the horizon, makes a sudden turn upwards and terminates in two stars, which are easily seen a little way above the horizon. *Antares*, the leading star in the constellation, is a beautiful sight in the telescope. It is fiery red with flashes of crimson and feebler tints of green. This varying color may be due to a seventh magnitude star quite near it, which is green, and independently so, for it has been seen separately when *Antares* was occulted by the *Moon*. About 3½° to the north, and 3° to the west of *Antares* is a brilliant field in the small telescope, in the midst of which is a rich and condensed star-cluster, one of the finest in the northern sky. There are two other clusters near at hand.

To the north of *Anrtares* forty-five degrees, and to the west thirty, is the bright star *Acturus* in the constellation *Bootes*. Astronomers are not agreed which star ranks in brightness, this or *Vega*, which is also seen about as far on the east side of the meridian as that is on the west. *Acturus* is a star of great interest because of a large annual motion of its own among the neighboring stars; yet it is so far away that it has no sensible parallax, and it is only a rough guess that says its light is any certain number of years in reaching the *Earth.* But this we do know, that since the time of HIPPARCHUS, *Arcturus* has changed its place in the sky 2½ times the diameter of the *Moon.* Such a change of place is called proper motion, and is surprisingly great in the case of this star. *Bootes* is rich in double stars, but poor in clusters and nebulæ.

The remaining bright star in the west, which is very near the western horizon is *Jupiter.* He is now so far away, and so unfavorably seen, that telescopic study is given up for a while.

The other star referred to above is the leader of *Lyra.* When *Vega* passes the meridian on clear nights, in this latitude, the telescope does not reveal a richer sight its color being a pale sapphire. By photometric measure, some time ago, at Harvard College observatory, its light was found to be seven times that of *Arcturus,* which seems large, and may possibly be due to its peculiar hue. Its parallax is almost a half second of arc, determined by late studies of Professer A. HALL, of Washington, and therefore its light is almost seven Julian years in coming to our eyes from its distant star-path.

Near *Vega,* about two degrees east and nearly one north, the naked eye observes an interesting star, wnich is seen to double by the aid of the smallest telescope. This is the noted pair often spoken of in elementary text-books, as *Epsilon* one and two. Increase of optical power shows that each component is double, forming a binary system of its own, the first pair revolving in possibly two thousand years, the second in one thousand years, and both systems rotating about a common center of gravity in probably something less than one million of years. The colors of the components of one pair are yellow and ruddy, of the other, both are white. A strange feature of this quadruple group is the excessively faint stars between the double-double, which are sometimes called the debillissima The number of mere points of light is uncercertain.

We can only mention the annular nebula of this constellation, which lies one third of the way between *Beta* and *Gamma,* and is easily found by common telescopes. Though not brilliant it is a most interesting phenomenon under high power.

To the north and a little to the west of the zenith is the constellation of *Ursa Major,* while in the north-east, near the horizon is seen *Cassiopeia,* both of which were spoken of recently. Nearly all the planets are now so unfavorably situated for evening study that we omit special notice of them until later.

The following orders and subscriptions have not been previously acknowledged:

Professor J. S. McGhee. Cape Girardeau, Mo. Professor C. Piazzi Smyth, Royal Observatory of Scotland, Edinburg, Scotland (2 vols.) Willis L. Barnes, Charleston, Clark Co. Indiana. Prof. C. W. McLeod, McGill College, Montreal, Ca.

BOOK NOTICES.

Elements of The Calculus, by J. M. TAYLOR, Professor of Mathematics, Madison University. 252 pp. Mailing price, $1.95. Boston, Messrs. GINN, HEATH & COMPANY, Publishers.

This book starts with the theory of limits as a means of explaining the elements of the calculus. The method of rates, so called, is used to illustrate finite differentials, or increments from which, by the aid of geometrical figures, common to best works, the author passes to the ordinary notation, $\frac{dy}{dx}$

These steps are taken with care and clearness, especially to the minds of those who explain the fundamental principles of the science in this way. While this means of developing the elements has the disadvantage of length, and some difficulty to the untrained mind, it has the advantage of avoiding the indeterminate form of $\frac{0}{0}$

and, easily glides into the uses of the infinitesimal notation.

It is also an advantage to have, as often as practicable, chapters on Integration follow immediately after those on Differentation on the same subjects. There is gain to teacher and pupil by this plan. The teacher of the Calculus will find this work one of the best in matter and arrangement. Its typographical dress is neat and tasteful as we always expect from Messrs. GWIN, HEATH & COMPANY.

The Sun and His Phenomena, by Rev. T. W. WEBB, with numerous illustrations, pp. 80. Neatly bound in cloth, 40 cts. Industrial Publication Company, 294, Broadway, New York.

Every person acquainted with late writers in England on popular astronomy knows something of the work of Rev. Mr. WEBB, entitled "Celestial Objects" by which he has earned wide and deserved fame. The little book whose title is given above is his latest and consists of a familiar description of the *Sun's* phenomena presented in Mr. WEBB's ewn pleasing and attractive style, It briefly notes the progress of solar studies to date and gives the most prominent facts with the care and accuracy of a practical astronomer.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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ASTRONOMICAL CIPHER MESSAGES.

THE EDITOR.

The work of the practical astronomer requires so much care and time, and so many favoring circumstances to assure accurate results, that progress is slow in almost every direction. For example, it is true that the ready computer can know, in a few hours, the rough path of a comet in cases of rapid apparent motion; but the rigorous and exhaustive study of the motions of these erratic visitors, in general, is the task of years, sometimes of centuries. On this account it is necessary to economize time, to make reasonably certain all efforts to transmit useful astronomical data, and to secure concert of action among astronomers in all parts of the world. A good illustration of the vigorous and pains-taking way in which astronomers work, is found in the cipher code for the distribution of important astronomical news, published at Harvard College Observatory in 1881, and now in general use in this and foreign countries.

The key to the code-book is the revised edition of Worcester's Comprehensive Dictionary, and the manner of its use may be shown by explaining a telegram received at Carleton College Observatory, July 13, at 7 o'clock and 35 minutes in the evening, announcing the orbit and ephemerides of BARNARD's new comet, which was discovered July 7, at Nashville, Tennessee. Omitting date and address, the telegram was as follows:

"Customably, digitated, butternut, border, inspection, evenly, cover, jolter, casuist, jaw, cenatory, irresistibly, changeably, invoke, cherub, interrex, fetter. E. C. PICKERING."

For the meaning of these words reference is made to the dictionary before named, and the number of the page and the number of the word on the page to represent facts to be communicated, as will be easily understood in what follows:

ELEMENTS AND EPHEMERIDES OF BARNARD'S COMET, 1885.

		Page.	Word.		
(1)	Customably	136	73	= May 16, 73, 1885	= Time of Perihelion Passage.
(2)	Digitated	150	8	= 150° 8′	= Distance of Perihelion from node.
(3)	Butternut	91	28	= 91° 28′	= Longitude of node.
(4)	Border	84	27	= 84° 27′	= Inclination to ecliptic.
(5)	Inspection	247	40	= 2.4740	= Perihelion distance.
(6)	Evenly	177	40	= (Control word)	= ¼ of sum of one to 5 inclusive.
(7)	Cover	177	40	= { July 13 .87 }	=First date of ephemerides. =Light of comet at discovery being 1
(8)	Jolter	257	42	= 17*h* 11*m*	= First right ascension
(9)	Casuist	98	10	= 98° 10′	= First north polar distance.
(10)	Jaw	256	01	= 17*h* 4*m*	= Second right ascension.
(11)	Cenatory	100	23	= 100° 23′	= Second north polar distance.
(12)	Irresistibly	254	27	= 16*h* 58*m*	= Third right ascension.
(13)	Changeably	102	31	= 102° 31′	= Third north polar distance.
(14)	Invoke	253	03	= 16*h* 52*m*	= Fourth right ascension.
(15)	Cherub	104	32	= 104° 32′	= Fourth north polar distance.
(16)	Interrex	250	32	= { July 25 .72 }	= Last date of Ephemerides. = Light of comet.
(17)	Fetter	188	22.6	= { July 7 2 and 2 or 3 }	=Date of first observation. =Days of interval between obser.

(1). The 136 means the number of the day of the current year found in the Nautical Almanac. The 73 is the fractional part of the day expressed decimally. The next three numbers explain themselves.

(5). The perihelion distance of a body is usually expressed in terms of the *Earth's* mean distance from the *Sun*, and the code requires that the last four figures be regarded as decimal places. Hence the perihelion of this comet's orbit is about two hundred and twenty-two millions of miles from the *Sun*.

(6). The sixth word is added as a check, and represents one fourth of the sum of the preceding five numbers. It is certain unless two of the six words are wrong.

(7). This word gives two facts. The last three figures (0.87) represents the light of the comet on the first day of the ephemerides, in units of the second decimal place, its light on the day of discovery being taken as unity. The remaining digits give the day of the month on which the ephemerides began.

The next eight words are the right ascensions and north polar distances for Washington mean midnight at intervals of four days each, July 13, 17, 21 and 25, and (16, interrex,) is a check on these dates which is the 72nd word on the 250th page. Hence, the last date should be July 25, and the theoretical light of the comet ought to be represented by 0.72, showing that the light of the comet is diminishing.

Two curious things were noticed in translating this message. The sixteenth word, 'interrex,' came in the first telegram 'intervex.' The word meant was supposed to be 'intervene' which made the day of the month all right, and the light of the comet 1.07, which seemed possible though not probable. Looking back to word seven, 'cover,' it was found that that word occurred on successive pages, 130, 87 or 131, 1. If 'intervene' was the word, then 131, 1 would give the light on the 13th, 1.01 which might be true although the comet was receding from the *Sun*. To solve this doubt, occasioned by the uncertainty of the sixteenth word and the ambiguity of the seventh, the local operator at this point kindly offered to have the message repeated from Cambridge. In the course of a few hours a second message made the sixteenth word, 'interrex' and the seventh word would then probably be 130, 87, showing a diminution of the light of the comet since the time of discovery. This was a small thing to reverse the fact intended to be given. Usually the cipher code is accurate and very satisfactory so far as we know. This incident given above is unique, and mentioned only on that account.

Ancient Catalogues in Meridian Photometry. An abstract from Part 2, Vol. XVI of the Annals of Harvard College Observatory.

The earliest attempt to obtain accurate information respecting the fixed stars appears to be found in the second book of PTOLEMY's Almagest. The observations on which this catalogue depends are thought to be due chiefly, if not entirely, to HIPPARCHUS, in which case they were made one hundred and fifty years before the Christian era. It is known that HIPPARCHUS made a catalogue referred to the ecliptic which contained 1080 stars. The epoch of PTOLEMY'S catalogue, which he said depended on his own observations, was A. D. 138. It has an assumed constant of 36″ a year, and contains 1028.

It is a curious fact that the longitudes of this catalogue, with the above constant, agree fairly well with the true places of the stars, when referred to the time of HIPPARCHUS, but not so well when reduced to the epoch of PTOLEMY.

DELAMBRE thinks that the places of this catalogue are simply those of HIPPARCHUS brought forward.

Dr. PETERS suggests that the large systematic errors of the catalogue may be due to the use of the astrolabe in taking observations on reference objects near the horizon, and, later, neglecting the difference for refraction for greater altitudes.

PTOLEMY'S places are now chiefly used to identify stars and assist in the study of magnitudes which were then six in number, as the stars are classified at the present time. Stars that were between the standards in brightness were said to be somewhat fainter than one, or somewhat brighter than another. The most important of these manuscripts is one belonging to the ninth century; it is number 5389 of the collection in the *Bibliotheque Nationale* of Paris.

A valuable revision of the magnitudes by PTOLEMY, or his predecessors, was undertaken in the tenth century by the Persian astronomer, ABDAL-RAHMAN AL-SUFI, whose work is now known through SCHJELLERUP'S translation. SUFI re-observed the stars of PTOLEMY'S catalogue, and also gave the magnitudes of some other stars, the position of which he indicated by description and by estimates of distance. He adopted the expedient of numbering the stars of each constellation to designate those given in PTOLEMY'S catalogue, and he gave much information, useful in identifying them, as well as that which pertained to the astronomical nomenclature of the Arabs. To reduce PTOLEMY'S stars to his own epoch (A. D. 964) his correction was 12° 42′ in longitude, assuming a precession of one degree in sixty-six years. Vol. IX of the *Annals* of the Observatory of Harvard College contains a full discussion of the catalogues of PTOLEMY and SUFI by Mr. C. S. PIERCE, which may be consulted for further details. In Vol. XIII of the Memoirs of the Royal Astronomical Society, BAILY has identified most of PTOLEMY's stars with certainity. SUFI's descriptions of the stars re-observed by him helps to interpret PTOLEMY, and SCHJELLERUP's introduction to the work of the former observer should not be overlooked. When BAILY and SCHJELLERUP differ, the ordinary assumption is, that SUFI's identification of PTOLEMY's stars is correct. There are many cases of this kind which cannot readily be explained.

Other difficulties arise from the different ways in which the same star has been since designated. For northern stars BAILY employs the FLAMSTEED numbers and BAYER's letters. For the southern stars he frequently uses numbers from LACAILLE's *Cœlum Australe Stelliferum*, now a rare work. The Paramatta catalogue, however, has a column for these numbers, and has proved servicable in identifying many stars. The column of magnitudes from the *Uranomatrea Nova*, which SCHJELLERUP gives for comparison with the magnitudes of PTOLEMY and of SUFI is occasionally useful in determining uncertain stars.

Part 2, Vol. XIV of the *Annals* of Harvard College Observatory has a table beginning on page 333 which contains all the stars whose identification is doubtful. The table is fully explained by accompanying remarks.

The catalogue of the Mongol astronomer, OLUG BEG, for the epoch of A. D. 1437 was compiled from original observations of the places of the stars it contains, but the magnitudes are professedly from SUFI's catalogue. Dr. C. H. F. PETERS shows in the *Astronomische Nachrichten*, number 99, that these two catalogues clearly agree. Their differences are given in the *Annals* above referred to.

After the rejection of stars of doubtful places, there are 757 of PTOLEMY's stars and 830 of SUFI's which seemed to be well enough identified, and suitably placed, to be used in determining the scales of magnitude of the ancient catalogues by the meridian photometer at Harvard College Observatory. The first step in this process was to find the mean photometric magnitude of each group of stars to all of which PTOLEMY or SUFI had applied the same designation in the northern, southern and zodiacal constellations. As the work progressed it was soon found that no such systematic differences appeared, in the comparison of the northern, southern and zodiacal stars, as to require a separate determination of the scale of magnitude for each of these classes, nor was it thought best to determine scales for intermediate magnitudes, the six entire consecvtive numbers being deemed sufficient.

The next step in the study of the magnitudes of the stars of these ancient catalogues was to take these entire magnitudes as abscissas, and the corresponding photometric means as ordiinates, and plot a series of points for each catalogue and then draw a smooth curve through them, and the abscissas of points on this curve having photometric means as ordinates were then found, which result was the magnitude sought. It is interesting to notice that the photometric magnitudes of the entire number rarely differ one tenth from those found in the old catalogues.

In a manner altogether similar to that just considered, the study of intermediate magnitudes to tenths has been undertaken, and with the following results in regard to PTOLEMY: It has been found that 1.65 is the equivalent of 1.2; similarly that 2.50 is equivalent to 2.3; 3.23 to 3.4, and 4.49 to 4.5. The mean of the four fractional values, .65, .50, .23 and .49 is .47 but if we give these values weights proportional to the number of stars in each group, the mean becomes .39 which was the value adopted. In plotting the points in this work, the entire magnitudes were used as abscissas of points on the curve already drawn, and the corresponding ordinates were taken as the resulting values of the several sub-divisions of magnitude on the photometric scale.

What has been said indicates the points of interest, shown, in the best of the old star eatalogues, and how they are being used to make the photometric standards of magnitude at Harvard College Observatory. This is a most important work in stellar astronomy, and it is to be hoped that nothing will interfere to retard it until it is speedily completed. Next we will notice the catalogues of Sir WILLIAM and Sir JOHN HERSCHEL, and others later. [EDITOR.]

ON THE SOLAR CORONA.

BY DR. WILLIAM HUGGINS.

(Concluded from last month.)

It has been suggested, even, that the corona is so complex a phenomenon that there may be an element of truth in every one of these hypotheses. Any way this enumeration of hypotheses, more or less mutually destructive, shows how great is the difficulty of explaining the appearances which present themselves at a total solar eclipse, and how little we really know about the corona.

An American philosopher, Professor HASTINGS, has revived a prior and altogether revolutionary question: Has the corona an objective existence? Is it anything more than an optical appearance depending upon diffraction? Professor HASTINGS has based his revival of this long discarded negative theory upon the behaviour of a coronal line which he saw, in his spectroscope, change in length east and west of the sun during the progress of the eclipse at Caroline Island. His view appears to rest on the negative foundation that FRESNEL's theory of diffraction may not apply in the case of a total eclipse, and that at such great distances there is a possibility that the interior of the shadow might not be entirely dark, and so to an observer might cause the appearance of a bright fringe around the moon.*

* Report of the Eclipse Expedition to Caroline Island, May 1883. Memoir of the National Academy of Sciences, Washington.

Not to speak of the recent evidence of the reality of the corona from the photographs which have been taken when there is no intervening moon to produce diffraction, there is the adverse evidence afforded by the peculiar spectra of different parts of the corona and by the complicated and distinctly peculiar structure seen in the photographs taken at eclipses. The crucial test of this theory appears to be, that if it be true, then the corona would be much wider on the side where the sun's limb is least deeply covered, that is to say, the corona would alter in width on the two sides during the progress of the eclipse. Not to refer to former eclipses where photographs taken at different times, and even at different places have been found to agree, the photographs taken during the eclipse at Caroline Island show no such changes. M. JANSSEN says: Les formes de la couronne ont ete absolument fixes pendant toute la duree de la totalite." The photographs taken by Messrs. LAWRENCE and WOODS also go to show that the corona suffered no such alterations in width or form as would be required by Professor HASTING's theory during the passage of the moon.

We have, therefore, I venture to think, a right to believe in an objective reality of some sort about the sun corresponding to the appearance which the corona presents to us. At the same time some very small part of what we see must be due to a scattering of the coronal light itself by our air, but the amount of this scattered light over the corona must be less than what is seen over the dark moon.

That the sun is surrounded by a true gaseous atmosphere of relatively limited extent there can be little doubt, but many considerations forbid us to think of an atmosphere which rises to a height which can afford any explanation of the corona, which streams several hundred thousand miles above the photosphere. For example, a gas at that height, if hundreds or even thousands of times lighter than hydrogen, would have more than metallic density near the sun's surface, a state of things which spectroscopic and other observations show is not the case. The corona does not exhibit the rapid condensation towards the sun's limb which such an atmosphere would present, especially when we take into account the effect of perspective in increasing the apparent brightness of the lower regions of the corona. There is, too, the circumstance that comets have passed through the upper part of the corona without being burnt up, or even sensibly losing velocity.

There can scarcely be doubt that matter is present about the sun wherever the corona extends, and further that this matter is in the form of a fog. But there are fogs and fogs. The air we breathe, when apparently pure, stands revealed as a dense swarming of million of motes if a sunbeam passes through it. Even such a fog is out of the question. If we conceive of a fog so attenuated that there is only one minute liquid or solid particle in every cubic mile, we should still have matter enough, in all probability, to form a corona. That the coronal matter is of the nature of a fog is shown by the three kinds of light which the corona sends to us. Reflected solar light scattered by particles of matter, solid or liquid, and secondly, light giving a continuous spectrum, which tells us that these solid or liquid particles are incandescent, while the third form of spectrum of bright lines, fainter and varying greatly at different parts of the corona and at different eclipses, show the presence also of light-emitting gas. This gas existing between the particles need not necessarily form a true solar atmosphere which the considerations already mentioned make an almost impossible supposition, for we may well regard this thin gas as carried up with the particles, or even to some extent to be furnished by them under the sun's heat.

It will be better to consider first the probable origin of this coronal matter, and by what means it can find itself at such enormous heights above the sun.

There is another celestial phenomenon, very unlike the corona at first sight, which may furnish us possibly with some clue to its true nature. The head of a large comet presents us with luminous streamers and rifts and curved rays, which are not so very unlike, on a small scale, some of the appearances which are peculiarly characteristic of the corona.* We do not know for certain the conditions under which these cometary appearances take place, but the hypothesis which seems on the way to become generally accepted, attributes them to electrical disturbances, and especially to a repulsive force acting from the sun, possibly electrical, which varies as the surface and not like gravity as the mass. A force of this nature in the case of highly attenuated matter can easily master the force of gravity, and as we see in the tails of comets, blow away this thin kind of matter to enormous distances in the very teeth of gravity.

If such a force of repulsion is experienced in comets, it may well be that it is also present in the sun's surroundings. If this force be electrical it can only come into play when the sun and the matter subjected to it have electric potentials of the same kind, otherwise the attraction on one side of a particle would equal the repulsion on the other. On this theory, the coronal matter and the sun's surface must both be in the same electrical state, the repelled matter negative if the sun is negative, positive if the sun is positive.

The grandest terrestrial displays of electrical disturbance, as seen in lightning and the aurora, must be of a small order of magnitude as compared with the electrical changes taking place in connection with the ceaseless and fearful activity of the sun's surface, but we do not know how far these actions, or the majority of them, may be in the same electrical direction, or what other conditions there may be, so as to cause the sun's surface to maintain a high electrical state, whether positive or negative. A permanence of electric potential of the same kind would seem to be required by the phenomena of comets' tails.

If such a state of high electric potential at the photosphere

* See "Comets," Royal Institution Proceedings, vol. x, p. 1.

be granted as is required to give rise to the repulsive force which the phenomena of comets appear to indicate, then considering the gaseous irruptions and fiery storms of more than Titanic proportions which are going on without ceasing at the solar surface, it does not go beyond what might well be, to suppose that portions of matter ejected to great heights above the photosphere and often with velocities not far removed from that which would be necessary to set it free from the sun's attraction, and very probably in the same electric state as the photosphere, might so côme under this assumed electric repulsion as to be blown upwards and to take on forms such as those seen in the corona; the greatest distances to which the coronal streamers have been traced are small as compared with the extent of the tails of comets, but then the force of gravity which the electrical repulsion would have to overcome near the sun would be enormously greater.

It is in harmony with this view of things that the positions of greatest coronal extension usually correspond with the spot zones where the solar activity is most fervent; and also that a careful examination of the structure of the corona suggests strongly that the forces to which this complex and varying structure is due have their seat in the sun. Matter repelled upwards would rise with the smaller rotational velocity of the photosphere, and lagging behind would give rise to curved forms; besides, the forces of irruption and subsequent electrical repulsion might well vary in direction and not be always strictly radial, and under such circumstances a structure of the character which the corona presents might well result. The sub-permanency of any great characteristic coronal forms, as, for example, the great rift seen in the phorographs of the Caroline Island eclipse and also in those taken in England a month before the eclipse and about a month afterwards, must probably be explained by the maintenance for some time of the conditions upon which the forms depend, and not to an unaltered identity of the coronal matter; the permanency belonging to the form only, and not to the matter, as in the case of a cloud over a mountain top, or of a flame over the mouth of a volcano. If the forces to which the corona is due have their seat in the sun, the corona would probably rotate with it; but if the corona is produced by conditions external to the sun, then the corona might not be carried round with the sun.

We have seen that the corona consists probably of a sort of incandescent fog, which at the same time scatters to us the photospheric light. Now we must bear in mind the very different behaviour of a gas, and of liquid or solid particles in the near neighborhood of the sun. A gas need not be greatly heated, even when near the sun, by the radiated energy; heated gas from the photosphere would rapidly lose heat; but on the other hand liquid or solid particles, whether originally carried up as such, or subsequently formed by condensation, would absorb the sun's heat, and at coronal distances would soon rise to a temperature not very greatly inferior to that of the photosphere. The gas which the spectroscope shows to exist along with the incandescent particles of the coronal stuff, may therefore have been carried up as gas, or have been in part distilled from the coronal particles under the enormous radiation to which they are exposed. Such a view would not be out of harmony with the very different heights to which different bright lines may be traced at different parts of the corona and at different eclipses. For obvious reasons, gases of different vapour density would be differently acted upon by a repulsive force which varies as the surface and would to some extent be winnowed from each other; the lighter the gas the more completely would it come under the sway of repulsion, and so would be carried to a greater height than the gas more strongly held down by gravity. The relative proportions, at different heights of the corona, of the gases which the spectroscope shows to exist there (and recently Captain ABNEY and Professor SCHUSTER have shown that in addition to the bright lines already known, the spectrum of the corona of 1882 gave the rythmical group of the ultra-violet lines of hydrogen which are characteristic of the photographic spectra of the white stars, and some other lines also) would vary from time to time, and depend in part upon the varying state of activity of the photosphere, and so probably establish a connection with the spectra of the prominences. This view of the corona would bring it within the charmed circle of inter-action, which seems to obtain among the phenomena of sun-spots and terrestial magnetic disturbances and auroræ.

Many questions remain unconsidered; among others, whether the light emitted by the gaseous part of the corona is due directly to the sun's heat, or to electrical discharges taking place in it of the nature of the aurora. Further, what becomes of the coronal matter on the theory which has been suggested? Is it permanently carried away from the sun, as the matter of the tails of comets is lost to them? Among other considerations it may be mentioned that electric repulsion can maintain its sway only so long as the repelled particle remains in the same electrical state; if through electric discharges it ceases to maintain the electric potential it possessed, the repulsion has no more power over it, and gravity will be no longer mastered. If, when this takes place, the particle is not moving away with a velocity sufficiently great to carry it from the sun, the particle will return to the sun. Of course, if the effect of any electric discharges or other conditions has been to change the potential of the particle from positive to negative, or the reverse, as the case may be, then the repulsion would be changed into an attraction acting in the same direction as gravity. In Mr. WESLEY's drawings of the corona, especially in those of the eclipse of 1871, the longer rays or streamers appear not to end, but to be lost in increasing faintness and diffusion, but certain of the shorter rays are seen to turn round and to descend to the sun.*

* For a history of opinion of the nature of the corona, see Papers by Prof. NORTON, Prof. YOUNG, and Prof. LANGLEY in the '*American Journal of Science*'; also 'The Sun,' by Prof. YOUNG; and 'The Sun, the Ruler of the Planetary System,' and various essays by Mr. R. A. PROCTOR.

It is difficult for us living in dense air to conceive of the state of attenuation probably present in the outer parts of the corona. Mr. JOHNSTONE STONEY has calculated that more than twenty figures are needed to express the number of molecules in a cubic centimetre of ordinary air, and Mr. CROOKES shows us in his tubes that matter, even when reduced to one-millionth part of the density of ordinary air, can become luminous under electrical excitement. [A glass bulb about 4 inches in diameter, kindly lent to me by Mr. CROOKES, was exhibited, in which a metal ball about half an inch in diameter formed the negative pole. Under a suitable condition of the induction current, this ball was seen to be surrounded by a corona of bluish-grey light which was sufficiently bright to be seen from all parts of the theatre.] Yet it is probable that these tubes must be looked upon as crowded cities of molecules as compared with the sparse molecular population of the great coronal wastes.

I forbear to speculate further, as we may expect more information as to the state of things in the corona from the daily photographs which will be shortly commenced at the Cape Good Hope by Mr. RAY WOODS under the direction of Dr. GILL.

Curious, Difficult and Remarkable Nebulæ Discovered at the Warner Observatory, by Dr. LEWIS SWIFT.

I have just sent to the A. N., for publication, the first installment of new nebulæ discovered at this observatory, which, as others already found will soon follow, will be known as Catalogue No. 1. It contains approximate positions with descriptive remarks of 120 new nebulæ. I make a specialty of nebula-work, and, it is not surprising that among the two hundred and fifty *novæ* found, some of them possess characteristics worthy of mention in the SIDEREAL MESSENGER.

When we reflect how thoroughly, during the last hundred years, the sky has been searched over by seekers after comets, nebulæ, double-stars, etc., it would seem that in the heavens, and, more especially, north of 40° south declination, there could be hardly a single undiscovered nebula as bright as HERSCHEL'S Class II, and yet one is often found, visible even with small telescopes, and which is generally picked up by comet-seekers. On the evening of June 23rd, while testing the performance of a new periscopic eye-piece by GUNDLACH for nebula-work, in presence of a nearly full moon, I observed with my 16-inch refractor a nebulous object which I soon found was either a *nova* or a comet. No motion was detected in twenty-four hours and it was thereby shown to be a nebula. To see a nebula in presence of the moon, largely gibbous, and without previous knowledge of its existence, no matter how large a telescope may be used, bespeaks a pretty bright one. Subsequently, consulting BURRITT'S Star Atlas, whereon I had marked the positions of all nebulæ ever seen with my 4½-inch telescope, I found the same object recorded as follows: "Can find no record of it." This was seven years ago. Its approximate position is R. A. 14*h* 33*m* 35*s*; Dec. +52° 3′ 54″. Described as B. ps. R. p DM. +52° 1816 by 31*s*. I have had several such experiences as the above. All of BARNARD'S nebulæ come under this category of unknown nebulæ being found with small telescopes while comet-seeking.

In *Cepheus* is a remarkable object — G. C. 4634=H IV 74. R. A. 21*h* 3*m* 6*s*; Dec. +67° 27′ 16″, a seventh magnitude star exactly in the center of a large, round, evenly bright nebulous atmosphere. These bodies are called nebulous stars. The entire heavens afford but a few specimens of this variety of the neb ulæ as classified by Sir WILLIAM HERSCHEL, and they should form a distinct class from those in which the star is not centrally placed, and presumably are stars that happen to be situated in our line of sight with the nebula, but probably far this side of the nebula itself, and with which it has no physical connection whatever. I have added three to the number of this variety of nebulous stars. One is in R. A. 6*h* 26*m*

36*s*; Dec. +10° 23′ 15″. It follows G. C. 1425 by 28*s* and is 10′ north. Another is in 21*h* 30*m* 45*s*; +12° 15′ 54″. Our *Sun* is supposed by many astronomers to be one of this class of objects, which, seen from a planet belonging to another sun, would exhibit the appearance of a nebulous star surrounded with a luminous atmosphere which we call the Zodiacal Light. The third and last object of this kind, found in my Catalogue, is the most wonderful of all — in fact is the only instance known to me —for instead of the central star being single, it is double. This was discovered last Friday evening (July 10). Soon afterward, in making a second examination of it, I saw, 5′ north, another large nebula having also a double-star in the center, but this belongs to the other class (optically nebulous) and, though extensive, is far less interesting than the one just previously described. The stars in the former are of the eighth magnitude and distant about 20″. Those of the latter are also 20″ apart, but are very unequal as to magnitude.

I have on several occasions studied the great nebulæ which in their conspicuous brightness have frequently been the subjects of the draftman's pencil, viz: the great nebula in *Orion*, in *Andromeda*, the Hunting Dogs, etc., as well as the *Swan* and the trifid nebulæ, and yet only one of them—the great nebula in *Andromeda*,—appears to me to be correctly illustrated. The drawing of this by Bond, is, in every essential detail, exactly as I see it with the great telescope of the Warner observatory. When the difficulties attaching to such illustrations are considered, the indifferent results are not surprising.

A few evenings since on an exceptionally fine night I made an attack on the trifid nebula, R. A. 17*h* 55*m* Dec.—23° 2′ hoping that the telescope would reveal some new features not before observed. I was pleased to find that a new eye-piece, with a power of 132, and the astonishingly large field of 33′, opened up a series of interesting and beautiful appearances which I was not prepared to see. It is quite impossible to give a faithful description of what a 16-inch refractor equipped with a proper eye-piece reveals in an object so bright, so extensive and so full of details as this. It, as its name indicates, is broken into three portions by dark rifts or cracks extending from its center, in which is a triple star, to its circumference. This triple star is, as Sir J. HERSCHEL expresses it, "Where three ways meet." The crack or black yawning canyon between the *s. f.* and *n. p.* triads has, by all observers, always been seen without nebulosity, and thus it has hitherto appeared to me, but on this last occasion I saw a feature which I think is new. It is a bridge across the chasm, a thread of light of the most delicate structure extending from wall to wall, but so faint that a large telescope, a trained and sensitive eye and exquisite seeing are necessary for its revelation. The large nebula close north, discovered by MASON & SMITH, was very conspicuous.

To my extreme surprise I detected still another very large nebula close following the trifid, which, strange to say, is also trifid in character, having a branch or prong extending to, and mingling with, MASON & SMITH's nebula.

Taking all things into account, its internal structure and external surroundings, it seems to me, that the trifid nebula is the most interesting one visible from this latitude.

Warner Observatory, July 16, 1885.

METEOR OBSERVATIONS.

WILLIAM R. BROOKS.

A very fine meteor was observed here on the evening of July 6th, about eleven o'clock. My eye was at the telescope at the time of its first apparition. Removing my eye and looking quickly upwards, I beheld the meteor just southeast of the zenith and moving rapidly towards the northwest. At an altitude of forty degrees it exploded into several balls of different colors, the most notable being green and crimson. The foremost ball was an intense crimson, and just preceding that was a brilliant, sharply defined halo. The light of the meteor brightly illuminated the landscape, and altogether it was a fine spectacle. I listened some time for the report of the explosion, but none was heard. The meteor was witnessed by several persons at this place, also as I heard, the next day, in surrounding towns, including Rochester, 40 miles west of here. It was described there as coming from east to west and brilliantly illuminating the streets of the city.

On the morning of July 8th, about 2 o'clock, another magnificent meteor was seen while resting my eyes from the telescope. This one moved from east to west across the northern heavens below *Polaris*. It left a bright train, visible several minutes, and in the telescope which I turned upon it, was seen to twist and roll in the most curious and interesting manner.

RED HOUSE OBSERVATORY,
July 15th, 1885.

THE SUNSET GLOW.

Very little can be said of the sunset glow, and the concomitant solar halo that would interest any but the few who still watch steadily the faded glories of the first and the persistent uniformity of the second.

The solar halo, as seen during the past six months, is unchanged, except that it appears broader and shades off at the borders more gradually. Though the sky seem clear of haze, may be enough of it to diminish or destroy the visibility of this halo. When the *Sun* is hidden by a cumulus cloud, clear spaces for 20° around, often show a decided salmon color, instead of the dingy red as usual.

From the records of sunsets, it would be difficult to make any general statement. The idea of variability in the phenomenon itself, independent of atmospheric modifications, sometimes seems plausible. On some clear days, when the solar halo was very prominent, the sunset color was entirely absent. Sometimes when we have had a clear, cool air following a finished precipitation, the sunset or sunrise has been deeply red.

Morning or evening the glow disappears quickly, showing ing that if dust be the cause its altitude is not great.

Last year I noticed on several occasions a wider colored space along the horizon southward from the sunset point than was apparent towards the north. In March of this year the same peculiarity was seen, once toward the south, and twice to the north. Last year Mr. EADIE, of Bayonne, N. J., also observed the same thing. These facts should receive attention.

For eighteen months there had been an unusual glare in the field of the telescope while observing bright planets, or first magnitude stars. The cause of this was thought to be the "material" in the atmosphere which has this year quite disappeared. But the difficulty of seeing second and third magnitude stars in day-time still continues. Is this trouble to the observer due to some highly illuminated "material" in the atmosphere, or to some other cause? J. R. H.

COMET BARNARD, 1885

E. E. BARNARD.

While seeking for comets during my regular zone sweeping, on the night of July 7, at about one hour after midnight, I found an object that struck me at once as unfamiliar. It was in the field with, and *n. f.*, the naked-eye star δ *Ophiuchi* which is Yarnall 7244. I knew of a nebula in about the place occupied by the object that I had seen a number of times during my former sweeps. It is G. C. 4301, discovered by WINNECKE in 1860, but from my remembrance of that nebula it was larger and more diffuse than the object now present. I endeavored to get a glimpse of the nebula, but could not be certain of seeing it, the air being full of dew and the field milky, and wet clouds continually forming in the western sky. However, I thought I detected it but could not be certain that it was not diffused light from three or four small stars that preceded the place of the nebula. Even when I turned the 6-inch equatorial on it I was no better off, as the sky was considerably thickened. I followed the suspicious object for fully an hour, it becoming fainter and more indefinite all the time. A comparison with δ *Ophiuchi* gave its place:

R. A. 17*h* 21*m* 24*s*; Decl. 4° 57′ 18″ south, at 14*h* 35*m* 37*s*, Nashville mean time.

While watching for motion, I was positive of a perceptible change in a south-westerly direction. However, not being certain of seeing the nebula at the same time, I concluded it would not be well to announce positively the cometary character of the object, until the following night had confirmed my suspicion of a change.

On the morning of the 8th, I at once notified Professor SWIFT of what I strongly suspected was a comet. The object was rather small and ill-defined, with a tiny brightening or nucleus in the middle. The first glimpse of the eye on the evening of the 8th confirmed the cometary character of the object, it having moved 35′ to the southwest. On the 8th the comet's motion was quite perceptible in a short watch. I secured a number of comparisons with the ring micrometer, but have not yet found the stars used in any catalogue. On this date the nebula G. C. 4301 was easibly visible. It closely follows several small bright stars.

The comet was again observed on the 10th and 13th. On the last date the sky being poor, the comet was difficult to observe on the ring, being very ill-defined and dim.

Professor SWIFT'S observation of this comet on the night of July 8th with the WARNER 16-inch glass showed it to be quite a wonderful object. He describes it as being evenly sprinkled over with from fifty to one hundred bright points, resembling in appearance a resolvable nebula. My own observations have enabled me only to make out a small, indefinite nucleus. No tail has, so far, been observed. At best the comet has a very far-away look about it. The discovery was made with the 5-inch Byrne refractor.

VANDERBILT UNIVERSITY OBSERVATORY,

Nashville, Tenn., July, 1885.

SOLAR ECLIPSE, MARCH 16, 1885.

Under date of July 6, Engineer C. W. IRISH, Iowa City, sent the following observations of the eclipse, absence from home preventing earlier preparation:

"The night preceding and the day of the eclipse were very cold and windy. Clouds began to form in the morning hours and increased during the day, and towards evening, in dense masses, they completely covered the sky, the wind blowing a violent gale from the northwest during the time. Mrs. C. W. IRISH read the time for me from a mean time clock. The point of first contact I had well determined beforehand. At 10*h* 33*m* 55*s* A. M. I saw a very small, sharp notch in the *Sun's* disc at estimated point of contact. It was in shape like a very broad-based, flat saw-tooth. One and one-half seconds later (10*h* 33*m* 56.5*s*), I saw that the circular black and serrated edge of the *Moon* was just to be seen, on the solar disc at the same point. In all my experience in such observations, I never saw the air so enterely clear of haze, nor did I ever see such splendid definition of the minutiæ of the sun-spots and faculæ and all other features of the *Sun* and *Moon* visible on that day. The only draw-backs were the tremulous motion of the air caused by the wind, and the intense cold at the time.

I watched the progress of the eclipse until the clouds began to gather thick and fast, which after the middle phase prevented observation except at intervals. A good view was obtained at 1*h* 27*m* 48*s* as the following limb of the *Moon* left a small notch. The clouds finally made uncertain the last contact, which was estimated at 1*h* 27*m* 03.5*s*. Observations are given in 90th meridian time.

PHOTOGRAPHING THE ECLIPSE.

On Monday, March 16th, the sun was partially eclipsed, the maximum obscuration at this point being about seven-tenths. Profs. HOUGH, BURNHAM and the writer made a number of negatives of the phenomenon by means of the great refractor at the Dearborn observatory, Chicago. Mr. Burnham dried a negative by means of alcohol and made a print from it in a very short time, so that the *Times* was able to illustrate the matter by an excellent cut in the issue of the 17th.

Telescopic lenses are not corrected for photographic purposes, but for vision. The yellow rays form a fine image, but the more active blue and violet rays form an image, or a series of images, further from the object-glass, which, indeed, has been over-corrected. In this case a piece of red glass was inserted in front of the sensitive plate, so as to intercept all but the red rays, which it was hoped would prove sufficiently active, and at the same time form a definite, sharply outlined image. The result fully justified the expectations. The image was as sharp in outline, and the horns of the crescent as finely pointed as if cut with a fine engraver's tool. Two sun-spots were distinctly visible in the negative. It is confidently believed that by this means magnified images can be photographed by means of ordinary refracting telescopes. Experiments in this line will be instituted soon.—*The Practical Photographer.*

It seems at first sight incredible that an occurence of 215 years ago could be reported with but one link between the person who tells you and the actual witness. Such, however, is the fact. The narrator in question was the venerable rector of Bushey (the Rev. W. Falconer) just deceased at the age of eighty-four. He had heard has grandfather (the celebrated Dr. Falconer of Bath) say that he had been told by his grandmother that she could remember being held up to the window to see Halley's comet, which appeared in 1669. She was then six years old. Dr. Falconer, the intervener, was born in 1744, and died in 1824. Assuming him to have been at least six years of age when this story was told him, his grandmother must have been ninety. But the wonder must be increased: for if Dr. Falconer told the story in the last year of his life (1824) to a child of six years it might be passed on to the next century with only one link between the witness and the narrator. After all, we are not so dependent on writing as we sometimes assume ourselves to be.—*Pall Mall Gazette.*

TABLE OF PROPER MOTIONS.

***EXPLANATION.* The numbers in the table are the proper motions of those of Argelander's 250 proper motion stars whose magnitudes are** *between 6.0 and 8.9. The means are taken for the stars of each tenth of a magnitude; and also, at the side, for each whole magnitude, 6.0 to 6.9, 7.0 to 7.9, 8.0 to 8.9. The table shows that the proper motions do not diminish as the numerical magnitude increases.*

Magnitude	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Means
6	0".23=μ	0"65	0".17	2".36	0".21	0".32	0".44	0".11	0".24	0".36	
	.51	.10	.18	.39	0.30	.08	.19	0.69	.26	.20	
	.28	.60	.89	.48		.19	.50	0.97	1.00	.15	
	.24	.24	.99	.30		.20	.85	1.26	.16	0.55	From 6.0 to 7.0
	.15			.74		.19	.64	1.43	.69	7.05	
	.29			0.60		.37	0.14	0.32	.34	0.37	
	.91					.94		.22	.54	0.19	
	.15					.35		.42	.70	1.61	
	0.12					.25		.34	.46	0.36	
						.62		.59	0.28	.39	0"54 [77]
						0.28		.36		.29	
								0.18			
Mean	0".3 (9)	0"54 (4)	0".6 (4)	0".8 (6)	0".3 (2)	0".3 (11)	0".5 (6)	0".5 (12)	0".5 (10)	1".1 (11)	
7	0.47	0.37	0.73	0.82	0.36	0.73	0.29	0.38	0.27	0.62	
	.20	.27	.27	.41	.26	.40	.56	.13	.38	.15	
	.72	.21	.46	.63	.18	.33	.29	.27	.49	.46	
	0.46	.44	.31	.31	0.72	.47	.28	.47	0.44	.49	
	1.31	.32	.28	.28	1.17	.86	.40	.58	1.43	0.60	
	0.34	.55	.84	0.46	0.64	.25	0.40		0.67		From 7.0 to 7.9
	.33	.48	0.43	4.73	.31	.71	1.10		0.39		
	.56	0.62		0.88	.02		0.21				
	0.31			.30	.86		0.54				
				.27	0.37						
				0.28							0".56 [80]
				1.54							
				0.18							
Mean	0.5 [9]	0.4 [8]	0.5 [7]	0.9 [13]	0.5 [10]	0.5 [7]	0.5 [9]	0.4 [5]	0.6 [7]	0.5 [5]	
8	0.44	0.52	2.81	0.68	0.68	0.45	0.47	0.49	1.40	0.16	
	.54	.14	0.64	1.97	0.48	2.24	.97	4.40	0.18	0.31	
	.21	.67	0.24	0.24	.51	0.67	.58	1.38			
	.20	.87	1.38		.27	2.33	.14				From 8.0 to 8.9
	.79	.39	0.47		0.49	0.25	.57				
	.32	.31	0.32			.45	.49				
	.40	.87	0.32			.64	1.20				
	.51	0.44	0.44			0.31					
	.43		1.21								0.71 [58]
	.47										
	0.56										
Mean	0.4 [11]	0.5 [8]	0.9 [9]	1.0 [3]	0.5 [5]	0.9 [8]	0.5 [7]	2.1 [3]	0.8 [2]	0.2 [2]	

EDITORIAL NOTES.

The feature of general interest in astronomical circles during the past month is BARNARD'S new comet. A telegram announcing its discovery by E. E. BARNARD, at Vanderbilt University Observatory, was first received from Dr. L. SWIFT of Warner Observatory, July 9. The discovery was also telegraphed, in cipher, on the following day to Carleton College Observatory by Professor E. C. PICKERING of Harvard College Observatory. The second message was delayed twenty-four hours, because the comet's position in the first message was identical with 4301 of *Herchel's General Catalogue.* Other positions were obtained at Cambridge, on the nights of July 10, 11, 12. The following positions are given in *Science Observer Circular*, No. 56:

OBSERVATIONS.

	d.	h. m. s.		App. R. A. h. m. s.	App. Decl. ° ′ ″	Observer
July	7	21 22 50	Gr. M. T.	17 21 23.53	−4 57 4.0	Barnard.
	9	12 32 47	Camb. M. T.	17 48.29	−6 0 55.6	Pickering.
	10	9 41 20	Camb. M. T.	16 9.25	−6 31 8.0	Searle.
	11	9 20 22	Camb. M. T.	14 19.31	−7 5 0.1	Searle.
	11	9 43 44	Wash. M. T.	14 15	−7 6 18.	
	12	9 27 50	Camb. M. T.	12 28.93	−7 39 29.6	Pickering.
	12	9 44 37	Wash. M. T.	12 26.	−7 40 25.	

Elsewhere in this issue will be found a detailed account of a seventeen word message from Cambridge which gave the orbit and ephemerides of the comet as computed by S. C. Chandler, Jr. from observations of July 7, 9 and 10. The elements of its orbit are as follows:

ELEMENTS.

Time of perihelion passage	= 1885, May 16. 725, G. M. T.
Longitude of perihelion	= 241° 37′
Longitude of pefihelion from node	= 150 8
Longitude of node	= 91 28
Inclination	= 84 26
Perihelion distance	= 2.4740.

C—O.

$$\Delta\lambda \cos\beta = +0'.3$$

$$\Delta\beta = -0.1$$

The above elements show a very singular orbit, in its great perihelion distance, combined with great inclination. Professor SWIFT'S observations make its coma physically interesting.

A full discussion of the theme, "Small *vs.* Large Telescopes," will appear in September issue.

PROPER MOTION OF LALANDE 16616.

(Communicated by Commodore GEO. E. BELKNAP, U. S. N. Superintendent.)

The proper motion of this star has been deduced by comparing observations of LALANDE, ARGELANDER, ROBINSON'S places of 1000 stars observed at Armagh, and Washington Transit Circle observations in the years 1881 and 1882.

The Catalogue places are:

Epoch	R. A.	Decl.
1800.0	8h 17m 16.11s	+51° 17′ 36.″2
1842.0	8 20 22.27	+51 9 21. 8
1870.0	8 22 25.58	+51 2 46. 4
1881.0	8 23 14.38	+51 1 32. 8
1882.0	8 23 18.76	+51 1 21. 85

These observations reduced by precession alone to 1882.0 give

	Date of obs.	Epoch.	R. A.	Decl.
	1800.075	1882.0	8h 23m 19.44s	+51° 1′ 51.″14
	1842.465		19.12	36. 37
	1870.426		18.56	25. 88
	1881.216		18.79	21. 06
	1882.168		18.76	21. 35
Mean	1855.270		8h 23m 18.934s	+51° 1′ 31.″16

Giving these observations equal weight, forming equations by the method of least squares, and denoting by x and y the annual proper motions in right ascension and declination, we obtain $4836.86x = 44.49s$ and $4836.86y = -1750.64''$, whence $x = 0.00920s \pm 0.0013s$, $y = 0.3619'' \pm 0.0048.''$

Applying the values for proper motion and reducing the observations to 1882.0, we have—

	Date of obs.	Epoch	R. A.	Decl.
	1800.075	1882.0	8h 23m 18.69s	+51° 1′ 21.″5
	1842.465	1882.0	18.76	22. 1
	1870.426	1882.0	18.46	21. 8
	1881.216	1882.0	18.79	20. 8
	1882.168	1882.0	18.76	21. 4
Mean			8 23 18.69 ± .0406s	+51 1 21.5 ± .146″

Annual motion in R. A. = −0.00920s ± 0.0013s

Annual motion in Dec. = −0″.3619 ± 0″.0048.

U. S. Naval Observatory
Washington, July 8th, 1885.

EDGAR FRISBY,
Professor of Mathematics, U. S. N.

DARK TRANSIT OF JUPITER'S IV SATELLITE.

At two of the late meetings of the California Academy of Sciences, Professor DAVIDSON, the President, read three papers upon two dark transits of *Jupiter's* IV satellite. The first paper was made up from notes of the observation of May 21st by Mr. CHARLES BURCKHALTER, of Oakland, giving the details of the black image of the IV satellite in transit.

The second paper gives Professor DAVIDSON'S observations of the 7th of June of a similar phenomenon; and the third paper is a mamorandum from Mr. BURCKHALTER'S observation of the same transit. DAVIDSON used his 6.4 equatorial (by CLARK); and BURCKHALTER his 10½-inch reflector (by BRASHEAR). The satellite appeared black to both observers, until it was very close to the limb of *Jupiter* going off, when it rapidly faded, and was lost to sight. It re-appeared as a bright image, protruding from the edge of the planet, but having only one-sixth the brightness of satellite II. From the point where this bright image appeared it would seem that, in all probability, there was a broad dark equatorial belt on the satellite, with white poles, and this is in part sustained by a note in DAVIDSON'S observations wherein he thought the dark image was elongated, but the atmosphere at both stations was very unfavorable to sharp definition.

The phenomenon of the image of the satellite appearing black and white at the same time was observed by DAVIDSON at the transit of January 15, 1884, and illustrated in the "*Mining and Scientific Press*," of San Francisco, of March 15, 1884, after its presentation to the Academy. (And reprinted in the SIDEREAL MESSENGER, May 1884.

In these observations DAVIDSON found a power of 120 diameters, the best under the unfavorable atmospheric conditions, and BURCKHALTER used 215.

Barnard's new comet was readily picked up on the evening of July 10 with the 9-inch reflector, and was afterwards seen with the aperture reduced to four inches. Its approximate place at the time of my observation was R. A. 17 hours 15 minutes; Decl. south 6° 30′. It was faint and rather irregular in outline. The nucleus bright and flashing, and upon the side of the coma towards the *Sun*. It was also observed upon the 11th. On the 12th a faint short tail was detected and curious pulsations of light in the nucleus and coma were noted.

RED HOUSE OBSERVATORY, WILLIAM R. BROOKS.
July 15th, 1885.

The annual report of the Paris Observatory for 1884 is a document of unusual interest generally, but the feature of making star-charts and catalogues by photography is deserving of special notice. The aperture of the glass used in this stellar photography is 13.4 inches, and 11 feet and 3 inches focal length, giving a field of view of over three degrees. The sensitive plates on which the photographs are taken are about 10 inches square which would show a space of over five square degrees. An exposure of one of these plates for an hour showed 2,790 stars varying from the fifth to the fourteenth magnitude. The diameter of the 14th magnitude stars is said to be one thousandth of an inch. This is rapid work in getting magnitudes and star-places. It would require many months to do as much work in the ordinary way as photography promises to do in a single hour. It is gratifying to know that some of the leading observatories in America are giving attention to the study of this means of recording astronomical data, and early favorable results may be expected.

OCCULTATION OF ALPHA TAURI.

The occultation was observed at the Cincinnati observatory with the 4-inch equatorial, power 50.

		Mt. Lookout M. T.
Immersion	July 8	$15^h\ 53^m\ 17^s.9$
Emersion	" "	16 46 46 .6

The disappearance was sudden; at re-appearance the *Sun* was already up and the *Moon's* dark limb could not be seen. On this account the emergence was difficult to observe, and the time noted may perhaps be as much as two or three seconds late. J. G. PORTER.

It is human to repeat some of the kind words that good people utter in the midst of the routine of common duties, especially if sparkling with sallies of wit or fun. We must be pardoned for clipping the following from a late letter from our distinguished friend C. PIAZZI SMYTH, Astronomer Royal of Scotland:—

"I have the pleasure of forwarding a post office order two years more subscription. I regret to say that the post office here is still in perfect ignorance of any other Northfield than one down in Virginia; so I have had to make out the order on St. Paul, Minn., in place of closer at hand to you. *Sic itur ad astra;* your ethereal journal soars upward to heaven, in the admiring gaze of all astronomers—while the bucolic popluations with their downward gaze on earthly things know nothing about it, nor about Carleton College, nor even Northfield City, Minnesota!

But your day of fame—and let us hope popular gratitude—will come."

STARS WITH LARGE PROPER MOTIONS.

In the zone observations which are being carried on at the Cincinnati observatory, working northward from 22° south declination, a number of stars have been found with appreciable proper motions. These will all be determined and discussed when the observations are sufficiently advanced.

The two following stars show such decided motion that it seems worth while to call particular attention to them:

LALANDE 20959. MAGNITUDE 7.5.

	Epoch	R. A.	Computed.	Declination.	Computed.
Lal.	1800	10*h* 47*m* 30.52*s*	30.65*s*	−20° 00′ 10.″7	10″.2
O. Arg.	1850	30.25	29.91	20. 0	21 .1
Brux.	1872	29.49	29.58	(29. 7)	....
Cin.	1885	29.27	29.39	29. 4	28 .7

The R. A. for 1872 is the mean of the Bruxelles' observations in 1869, 1872 and 1874. The declination was observed in 1869 only, and as it is evidently too large it has been rejected in the computation. The Cincinnati position is the mean of four observations. By least square we get

$\triangle\ \alpha = -0s.0148 \qquad \triangle\ \delta = -0''.21.$

The column headed "computed" gives the resulting R. A. and declination for the epoch of observation. ARGELANDER'S R. A. it will be seen, is quite discordant, but as a part of the trouble may lie in *Lalande's.* position, it was thought best to give equal weight to both. The total motion of the star in an arc of a great circle would be 30″.2 in a century.

LALANDE 24423.

	Epoch.	R. A. 1885.	Computed.	Declination 1885.	Computed.
Lal.	1800	13*h* .03*m* 29.52*s*	29.48*s*	−21°33′33″.2	33″.2
Bonn VI	1853	29.80	29.88	33 54 .3	54 .1
Bonn VI, Nachtrag	1867	29.96	29.99	33 57 .8	59 .6
Brux	1870	29.98	30.02	34 02 .6	00 .8
Cincin.	1885	30.24	30.13	34 06 .6	06 .7

The declination was observed at Bruxelles in 1869 and 1870, the R. A. in 1870 only. The Cincinnati position depends on two rather discordant observations. Giving equal weights we get

$\triangle\ \alpha = 0.0077s \quad \triangle\ \delta = 0''.395$ Total motion per century=40″.9.

J. G. PORTER.

By kindness of Secretary MATHEWS of Lick Observatory, six beautiful photographs of the late eclipse were sent us. The images are 1¾ inches with as perfect outline as we have seen. The thin crescent marking probably time of greatest obscuration has singularly perfect cusps. The numbers in a series of 74 taken during the eclipse, which we have received, are 2, 3, 24, 30, 45 and 69. We regret that the time of each photograph was not sent us that they might be published.

SPECTRA AND COLOR OF STARS.

In a report of Harvard College Observatory, recently published, Professor PICKERING speaks of work concerning the spectra and color of stars, as follows:

"Two separate series of investigations with regard to stellar spectra have been undertaken. It has been proposed to examine all stars known to have banded spectra with the object of approximately determining the positions of the bands in each upon a uniform system. This would afford means for a more definite and satisfactory classification than at present exists. The method of measurement consists in comparing the spectrum with a notched bar beside which it is placed in the field of the telescope. The proper position of the spectrum is secured by a previous reference to an image of the star formed by light allowed to pass beside the prism which forms the spectrum.

For the acquisition of more definite knowledge than at present exists with regard to the color of stars, it has also been proposed to observe all stars to the fourth magnitude inclusive, and north of the thirtieth parallel of south declination, with an instrument designed for the purpose. The spectrum of the star to be observed is properly placed in the field by the same means as in the other instrument just described. It is then carried by its diurnal motion behind a series of narrow bars placed at right angles to the spectrum, small portions of which are accordingly visible in the narrow spaces between the bars. The successive extinction of these portions of the spectrum is observed in a wedge of tinted glass. In this manner the relative brightness of definite parts of different spectra may be compared."

At the observatory of Pola, March 15, 16, 17 and 20 four observations of the new minor planet, No. 247 were secured.

Prof. CHARLES A. BORST, of Litchfield Observatory, assistant to Dr. PETERS, writing of Monday night's comet, says:

"At a little after 11 o'clock while standing with Dr. PETERS on the balcony of the dome where he was patiently waiting for the passing of some clouds which were an annoyance to his work, it seemed as if there was a flash of lightning, which made the horizon visible to us both in every direction. It lit up the earth as by a full moon; in an instant there was pessing before us a beautiful meteor, having a bright green light. In size it resembled *Jupiter* when under a power of three hundred diameters. It moued a little above Epsilon Virginis (*Vindematrix*), and apparently toward the north, being visible about five seconds, when it seemed to explode with a most brilliant display, resembling a sky-rocket. Looking by chance at the point in the heavens where it first struck our atmosphere, so intense was the light that it partially blinded the eye and caused the lids to close. The mind hesitated to believe that the green globe of fire was a meteor. The sensation was most peculiar, and can never be forgotten. It was as if the *Moon* were seen dropping into the lap of *Earth*.

But quickly are these fiery monsters checked in their course as the atmosphere catches them and reduces them to ashes, with as much ease as the spider traps and subdues the unsuspecting fly. The astronomer enjoys the beauty of the scene, and his monotony is relieved while humanity sleep on, having in the nature of things little to fear from dangers from which all are so well protected."—*Utica Daily Observer, July 8.*

Mercury and *Jupiter* were seen, at once, in the field of the telescope Juiy 20. 1883. *Venus* and *Jupiter* in the same way July 26, 1883.

The two planets, *Venus* and *Mercury* were seen together in the field of the telescope July 17, 1885, at 5 P. M. 75th medidian time. They were about 22 minutes of arc apart. At 9 o'clock the planets were only 11′ distant, but bad air prevented an observation.

BARNARD'S comet was observed here July 11. It appears faint. I could see, at times, a distinct star-like central point.

July 14, seen again, and is more diffused, central point not seen.

Baltimore, July 14. J. R. H.

Mr. MANSILL, of Illinois, has, at last, relieved astronomers of all doubt about the existence of intra-mercurial planets. A single paragraph from a long article in a popular Canadian paper will show how he does it:

"I think it is unreasonable to expect another planet to exist between the *Sun* and the planet *Mercury*, for the following reasons: As all planets between *Jupiter* and the *Sun* must be large enough to turn by axial rotation a certain amount (much) of their equatorial surface before the *Sun* during a given time at (their) a certain distance from the *Sun*, or they (or any planet) must move through a greater amount of ellipticity in their orbits during the same given time, and on this account a very small planet could not exist between the *Sun* and *Mercury* for the further reasons that its increased density in moving so near the *Sun* would increase its orbital motion—and this would be apt to contract its volume in the same proportion. It therefore could not have so much equatorial surface to turn before the undulating electric action of the *Sun* during the same given time. Hence its path or orbit about the *Sun* would likely be somewhat longer, or lengthened into an elliptical form, or just in the same proportion to the amount of what its axial rotation may have been retarded.—*Advocate.*

O shades of astronomic lore!
From some dark Egyptian shore,
Save us, sure, from any more.

The following orders have not been previously acknowledged:

Professor S. P. Langley, Alleghany Observatory, (Vols. 3 and 4). Library of the University of Rochester, Rochester, N. Y. Samuel A. Boyle' Philadelphia, Pa. Ellen A. Hayes, Wellesley College, Wellesley, Mass. Royal Observatory, Greenwich Kent, England, (Vols. 1, 2, 3, 4). Royal Observatory, Cape of Good Hope, care of Trubner & Co., 57 and 59 Ludgate Hill. London, England, (Vols. 1, 2, 3, 4). Mr. Cruls, Director of Observatory Rio de Janeiro, Brazil, South America. Wm. N. Sage, Rochester, N. Y. D. Appel, Cleveland, Ohio, (Vols. 1, 2, 3, 4).

Professor T. C. GEORGE, University of the Pacific, San Jose, California, in a letter of recent date says:—

"We have just completed an observatory building in connection with our University, consisting of an octagonal room, 16 ft. across, in which is a brick pier 8 ft. square at the base and 22 ft. above the ground, and capped with a stone 3½ ft. square. Dome is 12 ft. in diameter inside, covered with galvinized iron and revolved with windlass, requiring only 15 lbs. to turn it, the track being of steel. On one side is a transit room 10 ft. by 12 ft. and 10 feet high; on the other the reception room, and over this the study."

The instruments are, a CLARK 6-inch equatorial with circles, a driving clock and micrometer, a transit by FAUTH & Co, costing $1000 and a chronometer.

The building and instruments are the gift of Capt. CHAS. GOODALL, of San Francisco, and DANIEL JACKS, of Monterey.

Professor GEORGE is to be congratulated that he has near him men of such spirit and generosity as this very liberal gift indicates.

Mr. JOHN R. HOOPER'S observations of the occultation of *Aldebaran* by the *Moon*, at Baltimore, on the morning of the ninth of July, were as follows:

Immersion was instantaneous at	4*h* 34*m* 17*s*	75° Meridian Time.
Re-appearance, at	5*h* 26*m* 35*s*	
Duration was	52*m* 18*s*	

THE AUGUST PLANETS.

In 90th meridian time,

Mercury sets Aug. 5, 8*h* 29.5*m*, evening.
" " " 15. 7*h* 56.6*m*, "
" " " 25, 7*h* 09.6*m*, "

This planet is in conjunction with *Jupiter* Aug. 4th and 26th; in greatest elongation Aug. 5; in aphelion Aug. 6; in conjunction with *Venus* Aug. 8; with the *Moon* Aug. 11; stationary Aug. 19; is 1*h* 44*m* east of the *Sun* Aug. 1, and 9° 28′ south. It is visible to the naked eye.

Venus sets Aug. 5, 8*h* 40*m*, evening.
" " " 15, 8*h* 25*m*, "
" " " 25, 8*h* 9*m*, "

In conjunction with *Jupiter* Aug. 5; in conjunction with *Mercury* Aug. 8; the *Moom* Aug. 11; and Beta Virginis Aug. 19.

Mars rises Aug. 5, 1*h* 40*m*, morning.
" " " 15, 1*h* 31*m*, "
" " " 25, 1*h* 22*m*, "

The planet is 1° 20′ north of *Saturn* Aug. 6, and in conjunction with the *Moon* on the following morning.

Jupiter sets Aug. 5, 8*h* 40*m*, evening.
" " " 15, 8*h* 5*m*, "
" " " 25, 7*h* 30*m*, "

Except the dark transits of its satellite, *Jupiter's* physical features are uninteresting because far away and low in altitude.

Saturn rises Aug. 5, 1*h* 49*m*, morning.
" " " 15, 1*h* 14*m*, "
" " " 25, 0*h* 38*m*, "

And is in conjunction with the *Moon* Aug. 6.

Uranus sets Aug. 8, 9*h* 11*m*, evening.
" " " 16, 8*h* 40*m*, "
" " " 28, 7*h* 55*m*, "

Conjunction with the *Moon* the planet being 17′ north, Aug. 12, 18*h*, with *Venus* Aug. 23, 21*h*, the latter planet being 13′ north.

Neptune rises Aug. 8, 11*h* 19*m*, evening.
" " " 16, 10*h* 48*m*, "
" " " 28, 10*h* 1*m*, "

Conjunction with the *Moon* Aug. 1 and 31; is stationary Aug. 27.

Minor Planet (248) is the last discovered.

Aldebaran in *Taurus* will be occulted by the *Moon* Aug. 5, 2*h* 47.8*m*.

The new comet (BARNARD'S) is moving south-west and waning.

It is said by apparently good authority, that the best computation of the last contact of the late eclipse in New York differed from several good observations of the same by nearly half a minute of time.

ASTRONOMICAL PAPERS RECEIVED.

On the Right Ascensions of the Cape Catalogues for 1850 and 1880. and

On the Star Places of the Nautical Almanac, by A. M. W. Downing

Formulas for Computing the Position of a Satellite, by Asaph Hall.

The Great Comet of 1811, by Th. Bredichin. (French).

Bulletin of the Philosophical Society of Washington. Vol. VII.

Errata in July number page 152:

Line 16 of the table for −0′.09″.6 read +0′.09″.6.

Line 22 of the table for −1′.−07.″0 read −2′.07.0.

Line 26 of the table for 09.08*s* read 09.98*s*.

Line 31 of the table for −1′.17″.9 read +1′.−17″.9.

Line 36 of the table for −1*m*.25.45*s* read +1*m*.25.45.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 7. SEPTEMBER, 1885. WHOLE NO. 37.

SMALL VS. LARGE TELESCOPES.

S. W. BURNHAM.

Much has been written recently in some of the astronomical journals, and more particularly in the *Observatory* by Mr. DENNING and others, on the comparative value of large and small apertures for showing planetary details and other faint celestial objects; and Mr. DENNING has expressed the opinion that "apertures of from six to eight inches seem able to compete with the most powerful instruments ever constructed." This novel view is based, to some extent at least, upon the failure of the Chicago 18½-inch refractor, in the hands of Prof. HOUGH, to show certain details on the surface of *Jupiter* alleged to have been heretofore seen by various observers with much smaller apertures, and also certain remarkable convulsions or changes on the surface of that planet which have been so frequently described by the possessors of portable telescopes. Prof. HOUGH, it should be noted, has specially studied this planet, and made micrometrical observations with this instrument on every available occasion during the last five years. The evidence of such changes usually consists in the inability to see a a spot or marking on one night which was quite obvious on some immediately preceding or following evening. The argument might have been extended in this direction by also citing numerous instances of double-stars alleged to have been discovered with small telescopes, and these discoveries verified by other observers, but which have persistently remained invisible in the refractor of the Dearborn Observatory and other large telescopes. At the time of the supposed discoveries such instances would have furnished an admirable text for a discourse on the advantage of the smaller instrument, though perhaps it is too late now to turn them to any account in that direction, since it would be difficult to find an astronomer who is not convinced that these observers, like many others since, were too hasty in rushing into print as discoverers, when, by a little patience, they could have satisfied themselves that they had really seen nothing at all. I have spent a good deal of time, first and last, which might have been better employed, in running down these tales of new stars. I had indeed, at the start, but little faith in their existence, partly because as a rule the observers had never discovered any real objects of that class which were difficult, and partly because the character of the instruments employed was such that it was in the highest degree improbable that even an experienced observer could see any companion stars of the magnitude and distance described which would be overlooked by the skilled observers who had traversed that field. In every instance — and there were many of them — I not only failed utterly to see these alleged stars, but satisfied myself by repeated trials under the most favorable conditions that they were purely imaginary. It never occurred to me that I was laboring under any disadvantage in using a larger aperture than those before employed, or that I could be mistaken in asserting positively, after a fair and thorough investigation with the aid of such an instrument, that the supposed stars were simply due to an excess of imagination on the part of the several writers. Perhaps, if I had not used the telescope in question for the discovery of some hundred of difficult pairs, and in the repeated examinations of the severest stellar and other tests known, I might have had less confidence in my own eyes as well as the telescope. The experience I have had with other telescopes by the same makers, nearly as large and larger, leads me to have the same faith in them and their power to show anything which has been really seen elsewhere, that I have had for a long time in that at the Dearborn Observatory. That I have as much reason, perhaps, as any one to appreciate the value of small instruments, will be apparent from the work done with the 6-inch refractor, and for the further reason that the discoveries thus made will all be found to stand the test of future examination.

I have no doubt Mr. DENNING intends to deal with the subject fairly and impartially; but two things are apparent from his communications: First, that his statements are based wholly upon a comparison of small instruments with larger reflectors; and, second, that he has never worked with any first-class refracting telescope. Speaking of large apertures he says: "While possessing an immense superiority of light over smaller telescopes, they are rendered ineffective by inferior definition." This remark would certainly be absurd if intended to be applied to instruments of the quality of those made by ALVAN CLARK & SONS. If it relates to reflectors, as it probably does, most readers will agree with him throughout, and in the conclusion that the best definition is rarely, if ever, found in large reflectors. Personally, I have had no experience in using telescopes of this form, but judging from what has been done by the larger reflectors, and more particularly by what has not been done, in departments of work where the most perfect definition attainable is absolutely essential, the conclusion is irrestible that however well they may answer for work on nebulæ, for instance, where there is nothing to define, and where, from the absence of this quality, the picture and text are rendered all the more pleasing and original, or in any class of work where the result is principally descriptive they are immeasurably inferior to the refractors in work requiring sharp definition. In double-star work, for example, no very close pair has ever been discovered by a large reflector, nor any pair which would be considered a test for the definition of such an aperture. As a matter of fact, practically all the difficult pairs which have any interest as double-stars have been discovered, and the measures of this class of stars made, with refracting telescopes; and this will continue to be the case until some radical improvement is made in the reflecting telescope. It is not enough to say that these observers did not wish to do that kind of work; for no observer, with a perfect instrument of twelve or fifteen inches aperture, and upwards, could fail to find something new among the double-stars, whatever field of work he might be engaged in. It would be almost impossible to avoid it, and most observers would not fail to mention it, even if their principal interest was in another direction. Let the possessor of such a reflector take a little pains to satisfy himself on this point, and spend an hour or two on some good night in the discovery of a *new* double-star with a distance of not more than 0″.3 or 0″.4, if the stars are about equal, or two or three times that distance if there is a difference of at least five magnitudes in the components. If his instrument is approximately equal to a CLARK refractor, it will not take him long to verify and prove it in the manner I have suggested; and such proof would almost necessarily be satisfactory to others as well. For this purpose, observations of known pairs are not satisfactory, for we all know how easy it is for many to fancy a thing is seen when it is known beforehand just how it looks, and where it is; and descriptions of how test doubles appear in the telescope are as unsuitable to enable others to judge of the performance of the instrument as descriptions of planets, and other observations which cannot be positively verified. This is not intended as a reflection on the good faith of any one, but it is not too much to say that the "scientific use of the imagination" is brought into exercise as often in astronomical writings as in any other papers. If some one will point out any hitherto unknown close component of a star, using any reflector, however large, or a telescope of any form under 18½-inches aperture, which we cannot measure, as well as see, at this Observatory, it will be a legitimate and important if not an unanswerable argument in favor of the value and superiority of reflectors and small apertures generally. Until something of this kind is done, the fact that some one with a 4½-inch instrument claims to see a belt on one of the satellites of *Mars*, or a pale lilac streak on *Neptune*, will not be likely to discourage those of us who have only large CLARK refractors to work with, any more than the alleged discovery and repeated verification of a select assortment of companions to *Polaris*, *Vega*, *Sirius*, etc., have done heretofore.

It seems, from the recent articles alluded to, that it is a common practice with those who use reflectors to cut down the aperture under certain atmospheric conditions, for the purpose of improving the performance of the instruments in definition or otherwise. What more convincing proof could be offered of the inferior character of the instruments? Assuming that an object-glass is of the best quality, it would be preposterous to expect to do with part of it what the whole failed to accomplish. I have never had an opportunity of using a telescope where anything could be gained, under any circumstances, by working with less than the full aperture, although the experiment has been tried repeatedly. I can readily see how the definition of an imperfect object-glass would be improved by stopping out the exterior portion, and this may be true of all reflectors on poor or average nights; but it certainly is not true of any object-glass of the best workmanship. Perhaps I should mention in this connection that in all I have said here on the subject of refractors, I refer to the telescopes made by ALVAN CLARK & SONS. I do not intend to disparage the work of other makers, or to make unfavorable comparisons, but my experience has been acquired by the use of a half a dozen or more of Clark telescopes; and I think I know, from the class of observations attempted, what can be done with them. That there are refracting telescopes much inferior to them, no one will deny. That there are at this time any instruments superior to them will, I think, be maintained by few. Every one knows there are nights so unsteady that practically nothing can be done; and, unfortunately, there are many of them. Then, of course, the larger aperture is of but little advantage; but under no conditions will the reduced aperture reveal what the full aperture fails to show. The larger aperture, other things being equal, is as much superior to the smaller for observing planetary markings as for difficult double-star work, and for precisely the same reason. Prof. YOUNG has fully explained (*Observatory* for June) why the character of details, as shown by a small instrument, is frequently modified or changed under the superior separating power of the larger. If Mr. DENNING had ever used the Princeton 23-inch, or a similar telescope, he probably would not have been "surprised at the advantage which he [YOUNG] claims for the larger instrument on all occasions;" and he would not regard this experience of an "exceptional character," even if the Princeton observers should fail to see, as I have no doubt they will, some of the planetary details that have been the subject of so much remark in the last few years. We have several large refractors in this country, and the opinions of the observers at the Naval, Princeton, McCormick, Dearborn, Warner and Washburn Observatories on the subject of the value of contracting the apertures of these several CKARK refractors can be easily obtained, and also the practice of STRUVE with the 30-inch at Pulkowa.

In view of the criticisms alluded to in regard to the performance of telescopes, it is perhaps not surprising that the author should so obviously misunderstand Prof. HALL's letter (*Observatory* for May) concerning the Washington telescope. Prof. HALL says he has seen no remarkable change on the surface of *Saturn* in the past eleven years, (and, so far as his published observations go, he has never recorded any remarkable changes on any of the planets;) he has never seen the notch in the shadow of the ball on the ring, although he says that is "now always given in every good book on popular astronomy, and has been seen by several observers"; and even the "square-shouldered" appearance of that planet which visitors frequently ask for there, as they do here, is always missing, as well as the new stars in the Trapezium of Orion, which have been discovered several times in England and elsewhere. In this connection he candidly admits that his "work will confirm Mr. DENNING'S criticism that the large telescope does not show enough detail."

From all this, Mr. DENNING comes to the conclusion that Prof. HALL gives a "thoroughly discouraging report" of the 26-inch refractor! And because the Washington observer found that "usually a power of 175 gave the best result" on *Mars*, the inference is drawn that the definition of the great telescope is imperfect! If there is a practical observer who would not give that as his own experience in any class of work, however high powers he may use at times and places, I have no idea where to find him. Visitors usually wish to see objects with the highest powers, but the working astronomer finds under ordinary atmospheric conditions that the lowest power which will show a given object is the best for real work. I have repeatedly used, with advantage, a power of 1400 on a CLARK refractor of only 12 inches, but a power of 200 or 300 "usually" gave the best result, and I have no doubt this would be true of any good instrument. It is hardly necessary to say that when a high power can be profitably used on a $0''.2$ pair, there is nothing in the way of observing any planet with it. Such nights, however, are too rare in most latitudes to represent the ordinary working powers.

I have no wish to attempt to furnish a commentary on Prof. HALL'S communication, for no one writes more plainly and directly on all astronomical subjects. His published work has been singularly free from all padding and fine writing, and he has no wild speculations, or marvellous celestial observations to ventilate. I have had no communication with Prof. HALL on this subject, and do not speak with any authority; but I would suggest the propriety of ascertaining, directly from him, if there is any further doubt as to this question, whether he really took a discouraging, melancholy view of his failure to see so many of the wonders revealed by small telescopes, or whether it was not a delicate form of intimating a wholesale want of faith in the existence of the aforesaid marvels.

CHICAGO, July 15, 1885.

COMMENSURABILITY OF MOTIONS.

BY ASAPH HALL.

It is well known to astronomers that if two planets or satellites, in motion round the same center of attractive force, have their periodic times, or mean motions, nearly commensurable, there will exist in the motions of these bodies certain curious and interesting peculiarities. About two centuries ago it was observed that the motion of *Jupiter* was slowly accelerated, and that of *Saturn* retarded. These irregularities perplexed astronomers for a long time, but at last they were explained by LAPLACE. He pointed out the fact that since twice the period of *Saturn* is nearly equal to five times the period of *Jupiter*, the mutual attraction of these planets produces a large irregularity in their motions; and this irregularity itself has a period of about nine hundred years. Many other similar cases have been found in our solar system, though none where the irregularity is so large. The masses of *Jupiter* and *Saturn* are so great that the mutual perturbations are very large, and the problem of computing them is a difficult one. LAPLACE gave the first investigation, and was followed by PONTECOULANT and others, and especially by HANSEN in his elaborate prize memoir on this subject. Recently, LEVERRIER has investigated this question, but unfortunately his tables of *Saturn* are not much better than the old ones of BOUVARD published in 1821.

But suppose the motions of two bodies should be exactly commensurable, what may we expect under such conditions, and would such a system be stable? This question is not directly answered in the *Mecanique Celeste*, although it is safe, I think to infer the opinion of LAPLACE that there is nothing unstable in such a system.

Still the belief that such a system would be unstable, and would be destroyed by the slightest disturbance, seems to prevail extensively, and even among some astronomers of repute. Thus gaps in the ring of asteroids, and divisions in the ring of *Saturn* have been explained on the theory that it is impossible for bodies to move in such places, since their motions would be commensurable with those of certain planets or satellites. But such conclusions do not rest on any solid foundation, and seem to be drawn from the formulæ and expansions of the *Mecanique Celeste* and their application to an extreme case. All such formulæ, however, are derived under certain assumptions, and we must be cautious how we undertake to limit the phenomena of the universe by our interpretation of them. HANSEN has remarked that in the case of commensurable motions, the common formulæ must be modified to meet the new conditions. An interesting discussion of the case will be found in *Hendrick's Analyst* for April, 1874. This is by Mr. G. W. HILL, and he shows that commensurability of motions has no marked connection with the stability of a system. But since the invention of the telescope we have had an example before our eyes which should have prevented too hasty conclusions in this matter. It is that of the three inner satellites of *Jupiter*. So far as observations show, the motions of these satellites are exactly commensurable, and yet this system shows no sign of instability or decay. The consideration of such a system should have warned us against too general deductions from our formulæ.

It is worth while to notice, in this connection, a curious case brought forward by LAPLACE and which for a time caused much discussion. It had been the custom to teach that the *Moon* was made to give light to the *Earth*. But LAPLACE found a special case of the motion of these bodies which he announced as an improvement in the present arrangement. He says: "If, at the origin, the *Earth* and the *Moon* had been placed on the same right line, at distances from the *Sun* proportional to one and one plus one one-hundredth; if moreover, they had been given velocities parallel and proportional to these distances, the *Moon* would have been continually in opposition to the *Sun*; these two stars would have succeeded each other above the horizon, and as, at that distance, the *Moon* could not be eclipsed, its light during the night would have replaced the light of the *Sun*." This bold improvement of creation, by means of which we should always have a full moon, was startling, and brought out criticism. In a Latin essay, published at Rome in 1825, a writer took the ground that on account of refraction and parallax the conditions proposed by LAPLACE would never exactly occur. But such criticisms are trivial and they produced no effect. It was reserved for the mathematican, LIOUVILLE, to show in 1842 that the system proposed by LAPLACE is essentially unstable, and could never exist in Nature. This point seems to have been overlooked by LAPLACE, since he repeats his assertion in the *Systeme du Monde.*

THE ENDOWMENT OF LITCHFIELD OBSERVATORY.

By the kindness of some uuknown friend a copy of the Utica *Morninq Herald* is in hand containing a sketch of the late EDWIN C. LITCHFIELD, who endowed the Litchfield Observatory, of Hamilton College, Clinton, N. Y.

Mr. LITCHFIELD graduated from Hamilton College in the class of 1832, studied law at Hudson, was admitted to the bar and took up a residence in Brooklyn. By means of fortunate investments in real estate and railroad stocks, he soon became wealthy, at the same time fostering a lively interest in the progress of the arts and sciences.

It is said of him that he was generous with his wealth, public spirited and an ardent lover of pictures and statuary, having of the latter one of the finest collections in this country. His interest in astronomy was shown by his endowment of the professorship of astronomy in Hamilton College. On this account the trustees of the College appropriately gave his name to the Observatory, by which it has been known since the year 1866. The amount of the endowment is $30,000, the income of which is devoted to the payment of the Director's salary and the contingent expenses connected with the Observatory.

Dr. C. H. F. PETERS, who was director of the Observatory at the time of its endowment, was elected the first "Litchfield professor of astronomy" and continues in that position at the present time. When liberal men make large gifts, as in this instance, it is not a common thing that they be on the watch for opportunities to make smaller gifts of money for useful things, and besides, to tender such aid unsolicited. A single instance will illustrate. In 1869 Dr. PETERS desired to fit out an expedition to observe the total eclipse of the *Sun* in August of that year, and he applied to the College for aid, but without success. Mr. LITCHFIELD accidentally hearing of his failure, at once authorized him to organize such an expedition as he knew to be necessary for observing the eclipse. Knowing that a small portable telescope was needed, Mr. LITCHFIELD gave an urgent order for such an instrument, the best of its kind, that STEINHEIL SONS, of Munich, could make, requiring delivery in time for the expedition. It is almost useless to add that the telescope was a complete one, if it be stated that its accessories contained a five-prism direct-vision spectroscope, when the use of such an instrument had scarcely been known, by anybody, a half decade of years. Subsequently, Mr. LITCHFIELD had this small telescope mounted at the Observatory, at his own expense; authorized the printing of five large volumes of the astronomical work which the Observatory had done, and was doing, and furnished a competent assistant, so that work could be reduced and prefaced for the printer while observation was going on.

The work now ready to publish runs through twelve years of observations of solar spots, of planets and comets, and variable stars, etc. The zone star observations, of which over 100,000 have been made, are not included in the plan.

It is generally known to astronomers that the twenty charts already published at Dr. PETERS' own expense cover parts of this work so far completed. In the free distribution of these charts the observatories and leading scientific societies of the world hove become gratified recipients of his personal generosity. In January, 1869, at the alumni meeting of Hamilton College, Dr. PETERS spoke of Litchfield Observatory at length, closing with the following paragraph:

"Not without struggle, however, has been the life of our Observatory. Three years ago it seemed as if it were doomed to lose its character as a scientific institution, to become assimilated to the fashions of observatories in other colleges, and it would have died, had not an alumnus of Hamilton College come forward and saved it. Need I tell you his name? Where is an alumnus who is ignorant of what EDWIN C. LITCHFIELD has done? Nor does it become me to praise him here; to me only the duty belongs, and a pleasant duty it is, to double my efforts, and show to the world by deeds and facts, that his liberal endowment has not been in vain, but bears useful fruit. Let the Oriskany raise its waters above its bed; let the Hill, that beautiful Hill, where we all have tasted the fountain of literature and of knowledge, let the Hill itself, by some geological catastrophe, be swept away, with eveything terrestial upon it—in the heavens written will remain testimonials that will tell the tale of the Litchfield Observatory of Hamilton College."

When the news of the death of Mr. LITCHFIELD, which took place in France, Monday, July 20, reached Hamilton College, Dr. PETERS fittingly signified the sad fact at Litchfield Observatory, in knell and drapery and flag at half-mast.

Of his departed friend "he spoke in terms of deep feeling and kindly eulogy." He said:

"Mr. LITCHFIELD's liberality was as free as it was generous. He was happy in helping to advance the interests of science. His solicitude for this Observatory at no time flagged, and he was proud of the association of his name with it."

A worthy tribute to a worthy man, from one of America's oldest and ablest astronomers.—*Editor.*

ECLIPSES FOR YOUNG STUDENTS.

H. A. HOWE.*

It is customary in many colleges to have the advanced students in astronomy compute an eclipse of the *Sun*. Since few students have any genuine liking for computation, this exercise is regarded by the large majority of them as the climax of their astronomical tribulations.

The object of this article is to show how a class in a high school, or the preparatory department of a college, can be and has been interested in predicting an eclipse. This was accomplished by reducing the mathematical work to be done by the pupil to a small amount of mere arithmetic, trigonometry being excluded. If an eclipse comes during the portion of the school-year allotted to astronomy, the teacher will have little difficulty in interesting his scholars in the prediction of its phases, and they will watch eagerly for the verification of their expectations, on the day of the eclipse.

In March of this year a class ignorant in the main of both geometry and trigonometry computed the solar eclipse of March 16, 1885, in the following manner:

On page 414 of the American Ephemeris, they found the elements of the eclipse given for 3, 4, 5, 6, 7 and 8 hours of Greenwich mean time. From page 45 they took the tabulated values of the *Moon's* right ascension and declination for each of these hours. From page 39 by means of the hourly variations they easily computed the right ascension and declination of the *Sun* for each of the same hours. The teacher had previously computed the parallaxes (in right ascension and declination) for both bodies as seen from Denver, for these hours, and gave the corrections to the class, explaining that the Almanac gave the apparent places as seen from the *Earth's* center, and that by applying the reductions for parallax they obtained the positions of the two bodies as they appeared from Denver. The co-ordinates being thus corrected, the corrected right ascension and declination of the *Moon* at each hour were subtracted from the corresponding values for the *Sun*, and the

* University of Denver, Colorado.

results tabulated. The scholars were provided with paper ruled in squares, which in the present instance were one-fifth of an inch on a side; letting one-fifth of an inch represent 100 seconds of arc, a circle was drawn in the center of the sheet to represent the *Sun*, its semi-diameter (964″) being given in the Almanac on page 414. The differences of right ascension and declination above mentioned were reduced to seconds of arc, the former being multiplied by 15 and also by the cosine of the mean of the declinations of the two bodies, the teacher furnishing the cosines. By means of these differences the position of the *Moon's* centre with reference to that of the *Sun* (which was considered stationary) was located on the paper for each hour, one-fifth of an inch still representing 100″. The *Moon's* center was placed at the right of the *Sun's*, when the *Moon* was east of the *Sun*, and above when it was north. Each position of the *Moon's* center was then connected with the nearest one by a single line, these lines forming a broken one, which was almost straight. The semi-diameter of the *Moon* being found in the Ephemeris, circles were drawn to represent the *Moon* at the different hours. Two other circles were drawn representing it at first and at last contact, their centres being on the broken line. Thus a representation was made of the path of the *Moon* across the *Sun's* disc. It then remained to find the times of contact. The diagram made it evident that the time of first external contact was a few minutes after 4*h*. A measurement of the plot showed that the *Moon's* center at the time of first contact was at a point whose distance from the position of its centre at 4*h* was about 0.18 of the distance between the positions of the center at 4*h* and 5*h*. Hence the time of first contact was 4*h* 18*m* or 4*h* 11*m*, assuming that the *Moon* apparently gained on the *Sun* at a uniform rate. In a similar manner it was found that the time of last contact was 7*h* 4*m*. Denver being just 7*h* west of Greenwich, these times reduced became 9*h* 11*m*, A. M. and 12*h* 4*m*, P. M., respectively. Each of these is a minute and a half in error, according to an accurate computation from the special eclipse-data of the Ephemeris.

The method above sketched may be applied to an eclipse of the *Moon*, the *Earth's* shadow being placed in the middle of the plotting sheet. The radius of the shadow equals the sum of the horizontal parallaxes of the *Sun* and *Moon*, minus the *Sun's* semi-diameter. Instead of the co-ordinates of the *Sun*, those of the center of *Earth's* shadow, which are 12*h* greater, are to be used. No parallax corrections are needed, and the computation is therefore very simple.

The occultations of stars by the *Moon* may be similarly treated, the *Moon's* place being corrected for parallax, as above.

Since the *Sun* and *Moon* are both spherical, eclipses of the former and occultations of stars by the latter readily lend themselves to simple though rigorous trigonometric treatment along the lines already pointed out. Remembering that in the case of a solar eclipse, at the times of external and internal contact, the distances between the centers of the *Sun* and *Moon* are equal to the sum or to the difference of their semi-diameters, the times of the phases can be found by the inverse of interpolation. In this process a quadratic equation presents itself for solution. But an elaboration of the method just hinted at would take us beyond the scope of this article.

Some Account of a Set of Tables, Prepared by Professor GEORGE W. COAKLEY, *for Computing Eclipses and Occultations.*

These tables are based upon the following formulæ, most of which are readily demonstrated by the principles of spherical trigonometry:

If the *Moon's* center be not far from a fixed star, or from the *Sun's* center and $\Delta =$ the apparent distance of those centers as seen from any place on the *Earth*, whose longitude west of Greenwich is λ, and its geocentric latitude φ', then the following exact formula may be demonstrated:

$$\sin^2 \Delta \cdot (1-2 \sin P_1 \cos z_1+\sin^2 P_1)=(x-\xi)^2+(y-\eta)^2 \quad (1).$$

in which

$$\left.\begin{aligned} x&=\sin(\alpha_1-\alpha_2)\cos\delta_1 \\ y&=\sin(\delta_1-\delta_2)+2\sin\delta_1\cos\delta_2\sin^2\frac{1}{2}(\alpha_1-\alpha_2) \\ \xi&=\sin P_1\cos\varphi_1\ (\mu-\alpha_2) \\ \eta&=\sin P_1\sin(\varphi^1+\delta_2)\sin^2\frac{1}{2}(\mu-\alpha_2) \\ &\quad+\sin P_1\sin(\varphi^1-\delta_2)\cos^2\frac{1}{2}(\mu-\alpha_2) \end{aligned}\right\} \quad (2)$$

α_1 and δ_1 are the geocentric right ascension and declination of the *Moon*, α_2 and δ_2 of the *Sun* or star, z_1 and z_2 their geocentric zenith-distances. $P_1 = \rho\ (\pi_1 - \pi_2)$, or the *Moon's* local relative horizontal parallax, and μ is the sidereal time at the place (φ^1, λ), corresponding to the Greenwich mean time, T, at which the data are taken from the Nautical Almanac.

If the members of equations (1) and (2) be divided, the first by $\sin^2 P_1$, the others each by $\sin P_1$, they will then correspond exactly to the fundamental equations of eclipses and occultations given by Professor CHAUVENET in his Spherical and Practical Astronomy. These are also the equations employed in the American Nautical Almanac for computing eclipses and occultations. But for the purpose of constructing my tables, I have found it more convenient to divide the members of (1) by $\sin^2 1'$, and those of the other equations by $\sin 1'$, and thus express all the quantities to be used in the computation as *minutes of arc*. The equations then become, in minutes of arc,

$$\Delta^2 \cdot (1 - 2 \sin P_1 \cos z_1 + \sin^2 P_1) = (x-\xi)^2 + (y-\eta)^2 \qquad (3).$$

$$\left.\begin{aligned} x &= (\alpha_1 - \alpha_2) \cos \delta \\ y &= \delta_1 - \delta_2 + (\alpha_1 - \alpha_2)^2 \cdot \sin 2\delta_2 \cdot \frac{\sin 1'}{4} \\ \xi &= P_1 \cos \varphi' \sin (\mu - \alpha_2) \\ \eta &= P_1 \cdot \sin (\varphi' + \delta_2) \sin^2 \frac{1}{2} (\mu - \alpha_2) \\ &\quad + P_1 \cdot \sin (\varphi' - \delta_2) \cos^2 \frac{1}{2} (\mu - \alpha_2) \end{aligned}\right\} (4)$$

In the second small term of y, δ_2 has been substituted for δ_1, as they are nearly equal, and as this term is multiplied by the small factor $\frac{\sin 1'}{4}$. CHAUVENET represents this term by E, and I shall do the same, making

$$E = (\alpha_1 - \alpha_2)^2 \cdot \sin 2\delta_2 \cdot \frac{\sin 1'}{4} \quad (5)$$

and $y = \delta_1 - \delta_2 + E$, E being positive or negative according to the algebraic sign of δ_2.

If now we let x' = the hourly variation or increment of x, y' that of y, ξ' that of ξ, η' that of η, and make one hour the unit of time, we shall readily obtain the following expressions:

$$\left.\begin{aligned}
x' &= \cos\delta_1 \cdot \frac{d(a_1-a_2)}{dt}, \text{rejecting terms that are too small;} \\
y' &= \frac{d(\delta_1-\delta_2)}{dt} \\
\xi' &= P_1 \cos\varphi' \cos(\mu-a_2) \cdot \frac{d(\mu-a_2)}{dt} \\
\eta' &= \frac{1}{2} P_1 \sin(\varphi'+\delta_2) \sin(\mu-a_2) \,.\, \frac{d(\mu-a_2)}{dt} \\
&\quad - \frac{1}{2} P_1 \sin(\varphi'-\delta_2) \sin(\mu-a_2) \cdot \frac{d(\mu-a_2)}{dt}
\end{aligned}\right\} (6)$$

$\frac{d(a_1-a_2)}{dt} = \frac{da_1}{dt} - \frac{da_2}{dt}$, is the difference of the hourly increments of right ascensions of the moon and sun, derived directly from the Nautical Almanac; and $\frac{d(\delta_1-\delta_2)}{dt} = \frac{d\delta_1}{dt} - \frac{d\delta_2}{dt}$, is the difference of the hourly increments of declination. For a star, $\frac{da_2}{dt}=0$, and $\frac{d\delta_2}{dt}=0$. For a star we may write logrithmically, $\frac{d(\mu-a_2)}{dt}=$ [9.419156]. The method of reducing to the case of an eclipse will be given subsequently.

It will be convenient to write $\eta=\upsilon_1+\upsilon_2$, and $\eta'=\upsilon_1'-\upsilon_2'$

where
$$\left.\begin{aligned}
\upsilon_1 &= P_1 \sin(\varphi'+\delta_2) \cdot \sin^2 \tfrac{1}{2}(\mu-a_2) \\
\upsilon_2 &= P_1 \sin(\varphi'-\delta_2) \cdot \cos^2 \tfrac{1}{2}(\mu-a_2)
\end{aligned}\right\} (7)$$

$$\left.\begin{aligned}
\upsilon_1' &= P_1 \cdot \sin(\varphi'+\delta_2) \cdot \sin(\mu-a_2) \cdot [9.118126] \\
\upsilon_2' &= P_1 \cdot \sin(\varphi'-\delta_2) \cdot \sin(\mu-a_2) \cdot [9.118126]
\end{aligned}\right\} (8)$$

If all these values have been computed, or taken from the the Tables, for the Greenwich mean time, T, it is not probable that the values of x, y, ξ, η, will satisfy equation (3). But if a small correction, t, be added to T, the values $x+t \cdot x'$, $y+t \cdot y'$, $\xi+t \cdot \xi'$, $\eta+t \cdot \eta'$, ought to satisfy the equation (3) at the time, $T+t$.

At the moments of external contact, moreover, we ought to to have $\Delta = s_1'+s_2$, when s_1'=the *Moon's* augmented semi-diameter, and s_2=the *Sun's* semi-diameter. Hence (3) will become $(s_1'+s_2) \cdot \sqrt{(1-2\sin P_1 \cos z_1+\sin^2 P_1)}=$

$$\sqrt{([x-\xi+t \cdot (x'-\xi')]^2+[y-\eta+t \cdot (y'-\eta')]^2)}.$$

But $s_1' \cdot \sqrt{(1-2 \sin P_1 \cos z_1+\sin^2 P_1)}=s_1$, and we may write $\sqrt{(1-2 \sin P_1 \cos z_1+\sin^2 P_1)}=1-\sin P_1 \cos z_2$, replacing z_1 by z_2 in the small term of the first order, and rejecting the other small terms.

Hence $(s_1'+s_2) \cdot \sqrt{(1-2 \sin P_1 \cos z_1+\sin P_1)}=$
$s_1+s_2-s_2 \sin P_1 \cos z_2$.

Let $s_2'=s_2-s_2 \sin P_1 \cos z_2$, where $\cos z_2=$
$\sin \varphi' \sin \delta_2+\cos \varphi' \cos \delta_2 \cos (\mu-a_2)$.

Then s_2' may be called the *Sun's reduced* semi-diameter. In the case of occultations, $s_2=0$, hence $s_2'=0$, and we have strictly $\Delta^2=s_1{}^2=[x-\xi+t \cdot (x'-\xi')]^2+[y-\eta+t \cdot (y'-\eta')]^2$

As usual, we put

$$x-\xi=m \sin M$$
$$y-\eta=m \cos M$$
$$x'-\xi'=n \sin N$$
$$y'-\eta'= n \cos N$$

$$\therefore t_1=-m \cdot \frac{1}{n} \cos (M-N) \cdot \sin \psi=\frac{1}{\Delta} \cdot m \sin (M-N)$$

$$t_2=\frac{1}{n} \cdot \Delta \cos \psi$$

$T+t_1$=Gr. M. Time of nearest approach.
$T+t_1-t_2$=Gr. M. T. of 1st contact.
$T+t_1+t_2$= " " " " last contact.

Of the eight constants, x, y, x', y', ξ, ξ', η, η', the first four are the simplest, most readily computed, and are the chief ones given in the American Nautical Almanac. The computations of the last four are by far the most laborious. But all of them are given with very little trouble in the set of seven tables now considered.

The constants depending upon the parallax, P_1, cannot be tabulated readily for all values of P_1. Hence they are tabulated for a *mean parallax* of 57′. If we denote the value of for this parallax by writing it in parenthesis, we shall have $(\xi)=57' \cdot \cos \varphi' \sin (\mu-a_2)$ and $\xi=P_1 \cdot \cos \varphi \sin (\mu-a_2)$. Hence $\frac{\xi}{(\xi)}=\frac{P_1}{57'}$; or $\frac{\xi-(\xi)}{(\xi)}=\frac{P_1-57'}{57'}=f$, f being a small factor, easily tabulated. Hence $\xi=(\xi)+f \cdot (\xi)$. Thus the value of ξ is readily derived by simple contracted multiplication from the tabulated value (ξ), for 57′. In like manner $\eta=(\eta)+f \cdot (\eta)$, and ξ' and η' are derived in the same manner, by the same factor, f, which is tabulated in Table I, for every unit of the third decimal place.

Table II contains the values of E, for every two degrees of δ_2 to 30°, and for every *minute* of *time* of $a_1—a_2$ up to $6m$. But the value of E may usually be neglected.

Table III gives the values of x, and of x', for every degree of δ_1 to 30°, and for every *second of time* of $a_1—a_2$, from $1s$ to $10s$, and then for $20s$, $30s$, $40s$, $50s$, $1m$, $2m$, $3m$, etc., up to $9m$. It will thus serve for solar and lunar eclipses as well as for occultations.

Table IV gives the values of (ξ), for every degree of φ', up to 90°, and for every $10m$ of $\mu—a_2$ up to $6h$, and thence in reverse order to $12h$. These are all given in minutes of arc, and two decimal places below the unit.

Table V gives (η), by giving (υ_1) and (υ_2), for every degree of $\varphi'+\delta_2$ and $\varphi'—\delta_2$ up to 90° and for every $20m$ of $\mu—a_2$ up to $12h$. Hence $(\eta)=(\upsilon_1)+(\upsilon_2)$, and thence $\eta=(\eta)+f\cdot(\eta)$. These values are also given to hundredths of minutes of arc.

Table VI gives the values of (ξ') *for occultations*, for every degree of φ', to 90°, and for every $10m$ of $\mu—a_2$ to $6h$, after which they simply change their algebraic sign, and answer for $12h—(\mu—a_2)$.

If $\frac{3}{1000}$ of these values be subtracted from them, the remainders will serve for solar eclipses.

Table VII gives the values of $(\eta')=(\upsilon_1')—(\upsilon_2')$, by giving those of (υ_1') and (υ_2') for all values of $\varphi'+\delta_2$, and $\varphi'—\delta_2$, for each degree up to 90°, and for all values of $\mu—a_2$ up to $6h$, by intervals of $10m$. The same reduction is made from occultations to eclipses, by diminishing the values by $\frac{3}{1000}$ of the same.

The tables are so arranged that the data, for determining x, x', y, y', ξ, ξ', η, η', may be taken from the Nautical Almanac with the least possible change. For example, the right ascensions of the *Moon* and *Sun*, or star, and the sidereal time need not be changed from hours, minutes and seconds of time, to degrees, minutes and seconds of arc. The differences, $a_1 - a_2$, $\mu - a_2$ in hours, minutes and seconds of time, are used directly as the arguments for finding the constants x, y, etc., in minutes of arc. The difference of declination, etc., may be expressed as minutes of arc, and the seconds of arc may readily be written at sight from the Ephemeris as tenths and hundredths of minutes of arc. Thus the data from the Ephemeris are obtained with the least possible loss of time. A little familiarity with the tables and with the mode of computing will lead to a very rapid use of them, saving a great deal, both of time and labor, especially in their application to the computation of occultations. They serve also for computing lunar eclipses, occultations of planets, and transits of *Mercury* and *Venus* over the *Sun*, with sufficient accuracy for observing these phenomena.

UNIVERSITY of THE CITY of NEW YORK.

REPORTS OF EUROPEAN OBSERVATORIES.

From the V. J. S. *der Astron. Gesell.* the following account of the work at various European Observatories for the year 1884 is condensed.

Berlin:—The large meridian circle has been dismounted and has received important mechanical improvements.

The observations on the southern half of the Berlin Zone were temporarily stopped during the year. Dr. KUESTNER has begun a series of observations with the object of determining the Constant of Aberration by measures of the difference of zenith distances of pairs of stars in the same R. A. and equal and opposite Z. D. The work is to be finished in 1885.

Dr. KNORRE has made a large number of observations with the 9.6 equatorial for the positions of asteroids, comets and faint stars. The planet *Hypatia* was found by him July 1, 1884.

Dr. BATTERMANN is regularly observing occultations, both immersions and emersions.

Dr. MARCUSE has charge of the heliometer and has made thirty-three determinations of the solar diameter, etc.

Vol. V of the Berlin observations has been published during the year.

Berlin:—German Transit of Venus Commission. Report of Dr. AUWERS on the work of the computing bureau. This report of Dr. AUWERS relates first, to the *observations.* These are of three kinds: 1st. Observations before the expeditions for practice and for the investigation of special points; 2nd. Observations at the stations, and 3rd. Observations made after the return of the parties.

A list of the heliometer measures of each observer comprised in these classes is given separately and a summary, from which it appears that the total number of complete measures with the four heliometers was,

Before and after the expeditions	1769
At the stations themselves	1074
In all for thirteen observers	2843

Four of the observers made more than 320 apiece. The reductions are fully described in the report of eighteen octavo pages, to which reference must be made. It is already a summary and can not be abridged with advantage. A reference to it will show, in a very instructive way, how thorough is the co-operation of observatories and astronomers in Germany and outside of it.

Bonn:—2881 zone stars (400 fundamental stars) were determined in the A. G. Zone. The southern *Durchmusterung* has required the examination of some 750 places in the sky to solve doubts. In December 1883 the charting of the stars on the maps was again begun and finally completed in March 1885. The catalogue will contain 133,658 stars between —2° and —23°, 692 more are given north of these limits and 479 south.

Brussels:—The transit and mural are used to observe moon culminating stars. A general catalogue of the stars observed at Brussels in the years 1857—1878, reduced to 1865, will be printed during 1885.

Dresden:—(Private observatory of Baron ENGELHARDT.) 242 observations of the positions of comets, planets and nebulæ (198) have been made with the 12-inch equatorial, besides minor observations.

Dusseldorff:—Professor LUTHER discovered planet 241, *Germania*, during the year on his Berlin chart for 0 hours. Since 1847 150 planets have been observed 1233 times at Dusseldorf with the 6-inch telescope.

Frankfort-on-the-Main:—(Private observatory of Herr EPPSTEIN.) The star guages were continued on sixty-two nights, in 682 places, 2714 fields containing 25,875 stars.

Sun-spots are also regularly observed here.

Geneva:—The large equatorial has been provided with a spectroscope. Besides the regular observations relating to meteorology and to chronometers, observations of comets and of the satellites of *Saturn* have been made.

Gotha:—The computations of the Zone 20°—25° of the A. G. have been prosecuted, The meridian circle is used to observe moon culminating stars and others of MAYER's Catalogue; the equatorial for planet and comet observations.

Grignon:—has made various observations on solar-spots, comets, meteors, lunar eclipses, spots on *Venus* and *Mars*, etc., for which observations and the conclusions drawn from them, reference must be made to the original report.

Helsingfors:—Dr. ANDERS DONNER was appointed director to succeed Professor KRUEGER, in 1883. The meridian instrument has been used to re-observe some 500 stars of the Helsingfors Zone +55° to +65°, *Victoria* and *Sappho*, the *Moon* and moon-culminating stars, etc.

Hereny:—Vol. II will be published in 1885. Spectrum observations of β *Lyræ* have confirmed the variability of the spectrum of this star. Many other spectroscopic observations of stars, planets and comets have been made.

Karlsruhe:—The principal work of the observatory is the determination of the positions of southern stars to 8 magnitude, inclusive. In the Zone 0° to —4°, 5000 observations have made and the Zone —4° to —7° has been commenced. The single positions have probable errors of $\pm 0s.028$ and $\pm 0''.39$. The 6-inch refractor has been remounted.

Kiel:—The equatorial has been used among other things to observe Σ 2164 for parallax by Dr. LAMP. New comets were regularly observed.

The meridian circle is used to determine the positions of stars between 79° and 82° north.

The Zone catalogue (55° to 65°) is in preparation.

Leipzig:—A six-inch heliometer by REPSOLD is in process of construction and will be delivered at the end of 1886. A universal instrument has been ordered with which a long series for latitude will be commenced. 10,541 observations (123 zones) of Zone stars have been made in the new Zone (+5° to +10°) and the reductions for the old Zone (+10° to +15°) are in progress.

Leipzig:—(Private observatory of Dr. ENGELMANN.) 2600 observations of 430 double-stars have been made, mostly of STRUVE'S doubles. An investigation of the constant errors is in progress. It appears that the *difference* in magnitude of the components influenced the *constant* errors in a marked degree. OTTO STRUVE'S list of double-stars for comparison have been observed; about 500 measures have been obtained.

Lund:—Dr. DUNER continues his observations of the spectra of stars, measures of double-stars and positions of comets. No account is given of the Lund Zone, nor of Dr. DUNER'S spectroscopic *Durchmusterung.*

Milan:—The 8-inch refractor has been used to measure 255 double-stars, and for observations of comets. The measures of the ellipticity of *Uranus* "can not yet be considered to be free from all objections."

The observations on *Mars* seem to confirm previous results as to the duplication of canals, etc.

The large dome for the 18-inch refractor is nearly completed and the instrument may be mounted towards the end of 1885.

Munich:—The 10-inch equatorial is now remounted and the REPSOLD micrometer has been studied. It will be principally used to determine the parallaxes of Ll. 28298, 26 *Draconis*, Gr. 2875, Br. 3077.

The Munich zones contain 34,000 stars, of which 9,800 require re-observation. This will be accomplished in zones 6° broad.

The old Munich zones are re-computed and a catalogue (for 1880) is in preparation.

O'Gyalla:—1610 observations for the spectroscopic *Durchmusterung* of the southern sky have been made. Color observations with the Zœllner photometer are also continued as well as various other photometric and spectroscopic series.

Potsdam:—Researches are in progress on a new determination of the wave lengths of a large number (300) of the Fraunhofer lines; on the influence of temperature on the refraction and dispersion indices of fixed substances; on the reflective power of various substances; on the absorption-spectra of such substances as are used in photography, etc.

Jupiter and *Mars* were regularly observed and the nebulæ observations are concluded.

The photometric measures embraced long series of determitions of the brightness of the major planets and of seven of the asteroids. Many variable and red stars were also measured. Determinations of the brightness of stars by photography have also been made, and a number of photographs of clusters have been taken.

Prague:—(Private observatory of Professor SAFARIK.) 1482 observatians of ninety-two stars were made in 121 observing nights.

Taschkent:—The main object of the observatory is to co-operate in the surveys and explorations of Turkestan. Four latitudes and longitudes were determined in 1884. Comets, asteroids and solar-spots have been observed also.

Upsala:—The unpublished observations of nebulæ and clusters up to 1880 are now prepared for the press. With the Zœllner photometer it is proposed to determine the magnitudes of the comparison stars used by ARGELANDER, SCHOENFELD and OUDEMANNS for variables.

Zurich:—The sun-spots are assiduously observed here. The maximum occurred in December 1883 to January 1884.

EDITORIAL NOTES.

Though BARNARD'S comet was faint when the announcement of its discovery was made, it has been seen, and positions recorded at the larger observatories in all parts of the world.

Dr. HOLETSCHEK, of Wien, Austria, publishes for the new comet the following,

ELEMENTS.

Perihelion passage,	1885.16 Berlin M. T.
Perihelion from node	198° 43′
Longitude of node	93 30
Inclination	75 53
Perihelion distance	2.2903

These elements depend on observations of July 9, Cambridge; July 11, Arcetri, Wein, Straasburg, and July 13, Wien.

VANDERBILT UNIVERSITY OBSERVATORY.

On July 15, 10*h* 35*m* 30*s*, Nashville mean time, the position of BARNARD'S Comet was as follows:

R. A.	17*h* 7*m* 0.17*s*
Decl.	9° 24′ 10″.9

The above was the mean of twelve observations both rings of the micrometer being used, and corrections for refraction being applied.

E. E. BARNARD.

BARNARD'S COMET.

According to Prof. CHANDLER'S elements this comet had already passed its perihelion at the time of discovery and is, consequently growing fainter. This supposition accords with my observations as I am certain that it is now less bright than on July 8th when I could easily see it with my 4½-inch comet seeker. No tail was noticed even with the great telescope, but on the evening of the 11th (my next observation) a tail 2′ long was seen with the 15-inch refractor which still continues visible though now very faint. There appears to have been, besides the real nucleus, several points of light, seen, only during moments of fine definition. Some were, no doubt, imaginary like the excessively minute stars one sees, or thinks he sees, with high powers and intensely strained vision in the Ring Nebula in *Lyra*, but which instantly vanish as soon as the attention is turned to them.

The most interesting feature of this comet is its great perihelion distance, surpassing in this respect every known comet save that of 1729.

No prior claim to discovery has been filed with me, and Mr. BARNARD is therefore clearly entitled to the Warner Prize of $200. This is his fourth reception of this prize, making an aggregate of $800, received from Mr. H. H. WARNER.

LEWIS SWIFT.

A REMARKABLE METEOR.

A meteor of almost unexampled size and brilliancy was seen from this locality and was witnessed, in fact, from the entire state, at about 10 minutes past 9 o'clock, on the evening of July 17th. From personal observation I can give no data regarding it as I was inside the observatory and saw only its blinding flash through a north-east window, but from two intelligent persons who saw it through nearly all of its visible path, and who were able to mark it by the stars adjacent, I am able to locate its path with some approximate accuracy. Mr. REBASZ, one of my reliable informants first saw it in the center of the right angled triangle formed by the stars Alpha, Gamma and Delta *Cygui.* He thinks, it burst upon his vision so suddenly, that it must have made its first appearance near Delta. It passed between Alpha and Gamma—one quarter the distance between from Alpha—and near Xi *Cygni,* and continued on in a north-easterly direction to within about 30° of the horizon, when it burst into many fragments of three different colors and disappeared. We estimated the time of visibility at three seconds. My other informant agrees with Mr. REBASZ, and, by aid of the stars, pointed out to me its path. He shows that after leaving the cross of *Cygnus,* it passed midway between Alpha *Cassiopeiæ* and Beta *Pegasi* and exploded. These are reliable facts which set at naught the random stories of the public prints that it moved from S. E. to N. W., and, indeed, in every direction but the true one. Its motion, therefore, was direct and not retrograde.

With the last witness were three others, and all aver that they heard after the explosion a report. Each, to himself, marked the elapsing time, as follows: *2m, 2¼m, 2¾m,* and *3m.*

Popular statements concerning the size, brightness, height, direction of path, length of train, etc., of bright meteors are sometimes very amusing. They say, a certain number of rods above the *Earth*; "had a tail six feet long, and four inches in diameter," and many other things equally ludicrous.

After the very fine meteor of July 3rd, 1884, which was seen over nearly all of the northern states, and regarding which I was quite anxious to collect data for determining its size and height, in response to a published request I received about two hundred descriptive letters, but the statements given were so discordant as to render the attempt futile. However, I traced its visible path from Buzzard's Bay, Mass., to Marion, Ohio, and yet one man testified that he saw it fall into Seneca Lake, while another declared that it struck the ground about ten rods from where he stood. One correspondent kindly informed me that its size was just equal to that of a samp-bowl. A woman in Canada assured me (no doubt she thought the information all that was necessary for the computation of its orbit) that it passed exactly over her garden.

WARNER OBSERVATORY, July 20, 1885. LEWIS SWIFT.

CINCINNATI OBSERVATORY.

The observation of Comet Barnard (1885) at the Cincinnati Observatory, made July 17, 9*h* 53*m* 32*s*, Mount Lookout mean time was as follows:

Apparent R. A.	17*h* 03*m* 40.26*s*.
Log. $p \times \Delta$	8.789
Apparent Decl.	$-10° 29' 55''.8$
Log. $p \times \Delta$	0 826.

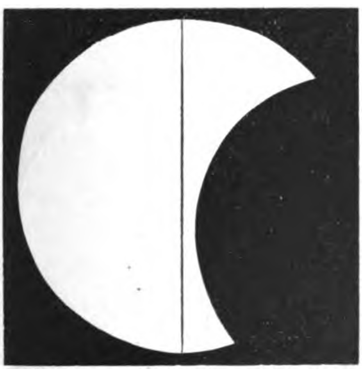
POSITIONS OF COMPARISON STARS.

R. A. 1885.0	Red. to app.	Decl. 1885.0	Red. to app.
17*h* .03*m* 27.40*s*	+2.955*s*	$-10° 22' 15''.8$	$+7''.8$

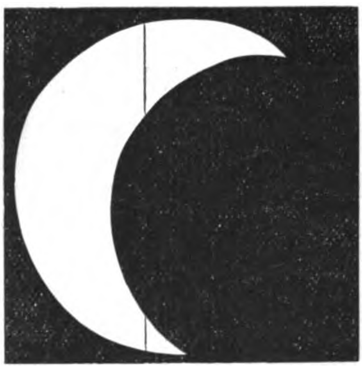
Authority, WEISSE, RADCLIFFE, *Astr. Nach.* 608, LEMONT.

J. C. PORTER,
Astronomer.

Secretary H. E. MATHEWS, of Lick Observatory, gave under date of July 22, interesting data respecting the partial eclipse of March last, He says; "The seventy-four negatives taken during the eclipse were all carefully timed, and a record kept in the same manner as photographic work was recorded during the transit of *Venus* in 1882. 'Dry plates' were



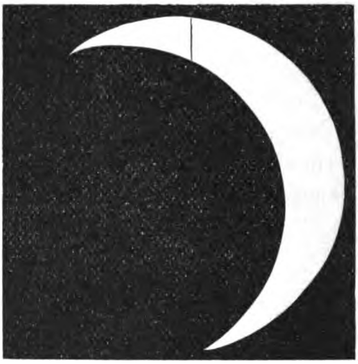
Negative No. 2, at 20 h 14 m 10 s.



Negative No. 13, at 20 h 33 m 57 s.

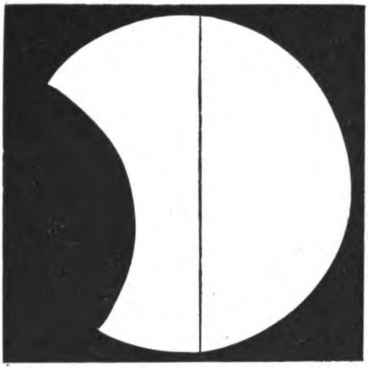
used with excellent success, the faint lines of the reticule plate being plainly visible in all the seventy-four negatives, and indistinctly visible on only four. To Mr. MATHEW's surprise the few that are less distinct are those showing the least of the surface of the *Sun's* disc, and the cause of indistinctness proved to be too much light, as the plates developed too readily. At the time of greatest obscuration the *Sun's* light acted more powerfully, as though concentrated in the narrow rim of light in view and exactly the same features appeared at the cusps, which uniformly showed a more rapid development of the plates at these points. The opening in the slide used most of the time was one-twentieth of an inch in width, but the time of the passage of the slit before the sensitive plate is not given.

Negative No. 24, at 21 h 0 m 51 s.

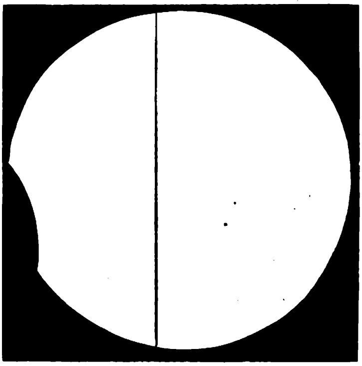


Negative No. 30, at 21 h 10 m 2 s.

One dozen of these negatives have been sent to Washington, but probably the remainder will be measured at the Lick Observatory by the aid of the new measuring apparatus just received, which belongs to the Observatory.



Negative No. 45, at 21 h 51 m 49 s



Negative No. 69, at 22 h 17 m 45 s.

The time given in connection with each photograph from which the above cuts are made, is for the astronomical date of March 15, 1885, and was the mean time at Lick Observatory, probably within one second, the transit observations for time not having been carefully reduced at the time of writing.

The last report of the Observatory in Yale College shows active work in various ways, chiefly in the horological bureau, the thermometric bureau and with the heliometer. Dr. LEONARD WALDO is in charge of the horological bureau. He has received fifty-eight time-pieces for rating, during the year; is still at work on new clocks of precession for a watch-rating standard; has a new mercury-cup relay for securing the transmission of time-signals, in which it is claimed, that the break of the electric circuit can be adjusted to any degree of nicety desired. Time observations have been made on one hundred and forty-two nights during the year, ranging from six to twenty observations in each month.

Mr. ORRAY T. SHERMAN, astronomer in charge of the bureau of thermometers has examined 5,696 instruments and reported on the same. The thermometers were chiefly for chemical and meteorological uses and physical standards. He reprints a brief, though useful, study of thermometers intended to measure temperatures from 100° to 300° C. from the July *American Journal of Science and Arts.* The case of thermometers in rapid change is also considered and some light given on the question, whether it is possible to derive from the disturbed reading the temperature of the glass, the temperature of the mercury and the effect of friction, things important to know in delicate standards.

Since October last Mr. ELY has taken magnetic observations on 17 different days for declination, horizontal force and dip. It is known that neighboring rocks disturbed the observations, but how much is not known.

In measuring the diameter of *Venus* with a GRUBB filar micrometer attached to equatorials of 8, 6 and 4 inches aperture respectively, results were found to differ considerably. The 8-inch made the diameter greater than the 6-inch by 0".22, and greater than the 4-inch by 0".27. The average error of observation does not exceed 0".05.

The principal object of research by Dr. W. L. ELKIN, astronomer, in charge of the heliometer, has been the triangulation of the *Pleiades* The present plan includes 69 stars ranging downward to 9.2 magnitude whose distances and position-angles from *Alcyone* are to be determined. The relation of the stars of BESSEL'S list to the four stars that form a large quadrilateral, enclosing the major portion of the group, has been determined in a fairly complete manner. Work in this direction may be continued also.

The heliometer has been used in getting 88 independent positions of the *Moon* on 36 nights; in determining the places of three craters and the diameter of the *Moon* in 36 directions; 102 measures on the diameter of *Saturn's* outer ring, besides other short series of observations on *Venus* and *Titan*.

The publication of this work will be awaited with interest.

Observations of Comet Barnard (1885). Made at the U. S. Naval Observatory with the 9.6-inch equatorial.

(Communicated by Commodore GEO. E, BELKNAP, Superintendent.)

Date	Wash. M. T.	Δ α	Δ δ	Comp.	App. α	log. Δ p	App. δ	log. Δ p	Star	Obs.
	h m s	m s	′ ″		h m s	s	° ′ ″	″		
July 11	9 43 44	−1 10.53	− 7 56.5	20.4	17 14 15.37	8.298n	−7 6 18.0	0.802	a	F
12	9 44 57	+1 13.51	+ 4 2.5	15.3	17 12 25.60	7.761n	−7 40 24.6	0.806	b	F
14	10 7 24	+3 28.58	− 8 54.2	20.4	17 8 49.57	8.799	−8 48 59.9	0.728	c	F
15	9 40 39	−0 16.05	−13 29.7	15.3	17 7 6.45	8.349	−9 22 7.0	0.722	d	F
16	9 15 28	+0 8.96	− 8 36.8	20.4	17 5 24.08	8.292n	−9 55 35.1	0.726	e	F
17	10 32 14	+0 8.88	− 8 1.5	20.4	17 3 38.42	9.166	-10 30 9.5	0.744	f	F

COMPARISON STARS.

Star	α 1885.0	δ 1885.0	Reduction	Authority.		
	h m s	° ′ ″	s ″			
a	17 15 22.96	−6 58 30.5	+2.94 +9.0	Schiel		6193
b	17 11 9.14	−7 44 35.8	+2.95 +8.7	Weisse	XVII,	151
c	17 5 18.04	−8 40 13.9	+2.95 +8.1	Weisse	XVII,	39
d	17 7 19.54	−8 8 45.5	+2.96 +8.2	Schjel		6146
e	17 5 12.17	−9 47 6.0	+2.95 +7.7	Weisse	XVII,.	37
f	17 3 38.42	-10 22 15.8	+2.95 +7.8	Weisse	XVII.	3

E. FRISBY.

NAVAL OBSERVATORY, WASHINGTON, July 21, 1885.

ASTRONOMICAL NOTES.

Comet Barnard. The comet has been regularly observed here since the night of discovery upon every favorable occasion. The last observation of the object being on the night of August 13th, when it appeared very faint. Since the withdrawal of the *Moon* in the last of July, the comet has generally been quite faint, though it could doubtless have been followed for a couple of weeks longer had it not been for increasing moonlight. *A fine mean time clock and a chronograph* have been ordered from the E. HOWARD Watch & Clock Co., of Boston, and from WARNER & SWAZEY, of Cleveland, Ohio, respectively. The clock has arrived and is being put into working order, and the chronograph will doubtless soon arrive. These are two things the observatory badly needed. The clock has an electric signalling device for the distribution of time-signals, so that should it become necessary we can supply the city and surrounding towns with accurate time.

The August Meteors were much more frequent this year than last, and quite a number of fine ones were seen; other work prevented any accurate observations being made. Unfortunately, the nights of August 10 and 11th (also the 12th) were cloudy, But the 7th, 8th and 9th showed a gradual increase. On the night of the 9th before eleven o'clock many fine ones were seen traversing the southern sky from the direction of *Cassiopeiæ* and *Perseus*, each of these left trains, permanent to the eye for a second, but never remained long enough to be caught with the telescope.

The nebulæ run upon lately with the 5-inch, were G. C. 5957 (supplement) and G. C. 4599. The first is small and somewhat faint; it is *close* preceding a small 9-magnitude star, and is gradually pretty much brighter in the middle. There is an irregular figure of four or five small bright stars a short distance *s.f.* this nebula. G. C. 4573 at this observation was not seen. The second nebula (G. C. 4599) was very difficult with 5-inch. It is *close f.* three or four small bright stars. The light from these stars makes it difficult to see the nebula, which is small pretty suddenly much brighter in the middle to a flickering, ill-defined nucleus. I can not see why it should be called bright in G. C., probably in the southern hemisphere it is much brighter.

Large Nebula not in G. C. On the night of July 7th, I swept up a large nebula close to the southern horizon. Two equatorial pointings gave its place:

$$\left.\begin{array}{l} \text{A. R.} = 17h\ 16m\ 43s \\ \text{Decl.} = -48^\circ\ 21'.3 \end{array}\right\} 1885.0$$

Neither G. C., nor supplement, contains this large nebula. Professor SWIFT informs me it is one of DUNLOP'S. It must be quite a bright object to be seen from this latitude. It is in field with and about ½° *n. p.* a 6 mag. or 7 mag. star.

VANDERBILT UNIVERSITY OBSERVATORY. E. E. BARNARD.

THE SEPTEMBER PLANETS.

The time used is that of the 90th meridian in astronomical reckoning.

Mercury rises	September	5	17*h*	16*m*.
"	"	15	16	22.
"	"	25	16	41.

The planet is in inferior conjunction Sept. 1, 23*h*; in conjunction with the *Moon*, Sept. 7th, and 37′ south; in greatest elongation W. 17° 52′ September 15th 3*h*; in perihelion September 19 13*h*, and in conjunction with *Jupiter* September 26, 15*h*, *Mercury* being 52′ north.

Venus sets	September	5	7*h*	52*m*.
"	"	15	7	37.
"	"	25	7	23.

It is in conjunction with the *Moon* September 10, 15*h* 36*m*; and September 12 enters the descending node.

Mars rises	September	5	13*h*	13*m*.
"	"	15	13	5.
"	"	25	12	57.

Is in *Præsepe* September 24.

Jupiter sets.	September	5	6*h*	52*m*.
"	"	16	6	14.
"	"	26	5	39.

Is in opposition with the *Moon* September 8, 4*h* 4*m*. Conjunction with the *Sun* September 8th, 4*h* 7*m*.

Saturn rises	September	5	12*h*	0*m*.
"	"	15	11	24.
"	"	25	10	47.

and is in quadrature with the *Sun* September 30, 18*h* 18*m*.

Uranus sets	September	5	7*h*	24*m*.
"	"	17	6	39.
"	"	26	6	5.

and is in conjunction with the *Moon* September 9, 6*h* 34*m*, being only 4′ north of it.

Neptune rises	September	5	9*h*	30*m*.
"	"	17	8	42.
"	"	25	8	11.

and is in conjunction with the *Sun*, September 27 14*h* 16*m*. The *Sun* is totally eclipsed September 8th, its path of totality being almost wholly in the South Pacific Ocean, between Australia and South America and ending 75° south latitude. Its path touches land only at New Zealand.

There will be a partial eclipse of the *Moon*, September 23rd, visible at Washington, also on the Atlantic Ocean, North and South America and the Pacific Ocean.

The phases for Washington mean time are:

Moon enters penumbra	September	23	11*h*	52.3*m*
" " shadow	"	23	13	6.4
Middle of eclipse	"	23	14	40.
Moon leaves shadow	"	23	16	13.7
" " penumbra	"	23	17	27.7

First contact of shadow with *Moon's* limb 37° from the north point toward the east when the *Moon* is in the zenith in longitude 95° 45′ west of Greenwich and in latitude 0° 13′ south.

Last contact of shadow with *Moon's* limb 73° from the north point towards the east when the *Moon* is in the zenith, in longitude 141° 37′ west of Greenwich, and in latitude 0° 18′ north.

Magnitude of the Eclipse=0.790 (*Moon's* diameter=1).

September 1 *Aldebaran* is occulted by the *Moon* at 8*h* 29.5*s*.

Mercury is also occulted by the *Moon*, September 7, 9*h* 19.8*s*.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. No. 8. OCTOBER, 1885. WHOLE NO. 38.

THE COMET OF 1866 AND THE METEORS OF NOVEMBER 14.*

DANIEL KIRKWOOD.

The probable recognition of several ancient returns of the first comet of 1866, together with the identification of an additional number of star-showers related historically to this comet as their source; the further confirmation of the existence of three distinct meteoric clusters all moving in the orbit of TEMPEL'S comet; and the data thus afforded for studying the structure and history of this interesting part of the solar system, afford sufficient reason for the following re-discussion of the facts now known in regard to the origin and history of the November meteors.

TEMPEL'S COMET OF 1866.

On the 19th of December, 1865, a small comet was discovered by M. TEMPEL, of Marseilles. It was generally observed till the following February; and, although an inconspicuous object, its relations to the *Earth* and *Uranus* have given it an importance equaled by few comets recorded in history. Its orbit was computed by Dr. OPPOLZER, of Vienna, who found the time of revolution to be 33.176 years. Later researches, however give 33.28 years as the more probable period. The comet

* Read before the American Philosophical Society, July 17, 1885.

seemed much smaller in 1865–6 than at any previously observed return — a fact indicative of its gradual dissolution. Its apparent magnitude, however, at any apparition, would evidently depend on the time of year at which it passed its perihelion. Comets are recorded in the years 1733, 1699, and 1399, corresponding to dates at which TEMPEL'S comet was due; but these returns are to be regarded as doubtful. In 1866 Professor H. A. Newton suggested that the comet of that year was a return of one discovered in China, August 26, 1366, and which passed its perihelion October 13th. This identity is now very generally admitted. The interval between the perihelion passages of 1366 and 1866 is 499.3 years; or fifteen periods of 33.28 years. The comet of 1266 may have been a return of the same body; the comet seen in China, September 29, 1133, was in all probability TEMPEL'S; the interval between the apparitions of 1133 and 1366 corresponding to seven periods of 33.28 years.

The comet seen in January, 868, both in China and Europe, has been regarded by HIND and others as an early appearance of TEMPEL'S comet. "In 868," Mr. HIND remarks, "at the end of January, a comet was observed under the tail of *Ursa Minor*, which moved in seventeen days almost to the constellation *Triangulum*. In China it was seen in the first moon (February) with the same right ascension as stars in *Aries* and *Musca*. I find by calculation that when TEMPEL'S comet arrives at perihelion at the end of March or early in April, it must follow this path in the heavens, being first situated at the end of January in the constellation *Camelopardus*, where, for want of conspicuous stars of reference, it might be said to be below the tail of *Ursa Minor*; afterwards moving to *Triangulum* and *Aries*." * Neglecting the apparitions of 1133 and 1266 as perhaps more doubtful, the interval between 868 and 1366 is equal to fifteen periods of 33.24 years.

"Sometime between April and December, A. D. 69, a comet appeared." † The interval between this date and 868 is equal

* Monthly Notices, Vol. xxxiii, p. 49.

† See Chambers' Catalogue, No. ii.

to twenty-four periods of 33.28 years. Seven periods of the same length take us back to B. C. 165; nine more to B. C. 465; and two additional, to B. C. 581; at each of which epochs a comet is recorded. 465 B. C. is also the date at which the celebrated meteoric stone, called the "Mother of the Gods," was said to have fallen from the skies. The entire history includes 2396 years, or seventy-two periods of 33.28 years.

The orbit of TEMPEL'S comet approximately intersects that of the *Earth* near perihelion and that of *Uranus* near aphelion. The discovery that it is intimately related to the meteors of November 14, and the fact that one of the minor clusters of these Leonids is soon to return, give interest to a new study of the recorded phenomena.

THE METEORS OF NOVEMBER 14TH.

Professor H. A. NEWTON traced back the great showers of 1866 and 1833 to A. D. 902.* He showed that the period must be 180 days, 185 days, 355 days, 377 days, or 33.25 years, and even suggested the method of determining which of the five is the true period. This important problem was first solved, however, by Professor J. C. ADAMS, of England, who found the periodic time to be about 33.25 years.

The comet's perihelion passage occurred January 11, 1866. The meteoric shower derived from the principal group, A, was observed in Europe, November 14, 1866, and the display was repeated with diminishing brilliancy in 1867, 1868 and 1869. The most dense part of the cluster passed the descending node of its orbit about November 13, 1833, and hence also early in 1867, or about a year after the comet passed the same point.

The conclusion that TEMPEL'S comet and the great meteoric cluster of 1833 move in the same orbit, and that the latter was in fact derived from the former, was reached almost simultaneously by PETERS, LEVERRIER and SCHIAPARELLI. In 1875 the present writer called attention to the fact that the dates of sev-

* American Journal of Science, May and July, 1864.

eral meteoric showers given by HUMBOLDT and QUETELET as belonging to the November stream, indicated the existence of a second cluster B, moving in very nearly the same orbit. These, with the writer's observations in 1852, are as follows:

A. D. 288, 28 September, apparition in China.
855, } 21 October each year. For particulars, see QUETELET's Physique du Globe.
856, }
1787, "On the night between the 9th and 10th of November, many falling stars were observed at Manheim by HEMMER."
1818, } 12 and 13 of November.
1820, } 12 November.
1822, } 12 November.
1823, } 12 and 13 November.
1852, 13 November. Nature, 3 June, 1875.

The best observed seem to have been those of 288 and 1787. The interval, 1499 years, is equal to forty-five periods of 33.31 years. Seventeen of these periods bring us to A. D. 855. One period from 1787.86 brings us to 1821, the middle of the series 1818–1823. Another period would give 1854 as the time for the next display, the beginning of which was seen by the writer in 1852, when seventy-five meteors were counted between two and three o'clock. The next shower from this cluster will be due about November 13–15, 1887; the display, perhaps, commencing in 1886, or even in 1885.

The third cluster, C, has been less observed and is probably less extensive as well as less dense. The dates at which the shower has been observed are as follows:

A.D. 1582, November 7. QUETELET's Catalogue.
1813, November 8. COSMOS, iv, p. 582.
1846, } November 13. Ib., p. 578.
1847, } November 13. QUETELET.
1849, } November 13. "
1879, } November 14. Observatory, Dec., 1879, p. 248, and January, 1880, p. 274.
1880, } Nov. 14. Pop. Sci. Monthly, Feb. 1881, p. 542.

These phenomena may be thus represented:

From 1582 to 1813....231 y = 7 periods of 33.00 years.
1813 to 1847....33.19 = 1 period of 33.19 "
1847 to 1880....33.19 = 1 " " 33.19 "

The respective periods of the comet and the three meteoric groups are as follows:

Tempel's comet	33.28 years.
Group A (NEWTON)	33.25 years.
Group B	33.31 years.
Group C	33.11 years.

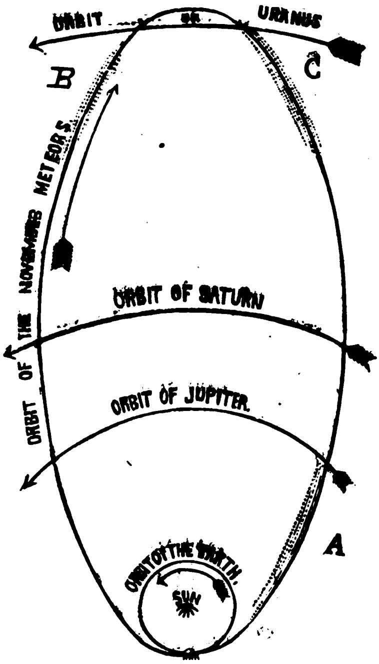
During the last five hundred years the period of Group A seems to have been rather more than 33.25 years. The meteoric display of 1366 was contemporaneous, or nearly so, with the apparition of the comet, and the complete separation of this cluster from the original mass may have then occurred. "The comet of 1866 was invisible to the naked eye; that of 1366, seen under similar circumstances, was a conspicuous object. The statement of the Chinese historian that 'it appeared nearly as large as a tow measure,' though somewhat indefinite, certainly justifies the conclusion that its magnitude has greatly diminished during the last 500 years." * Is the less apparent magnitude a consequence of separation at that epoch?

The following table affords the means of comparing the elements of the comet and those of the principal meteoric group:

	Nov. Meteors.	TEMPEL'S Comet.
Perihelion passage	Nov. 10, 1866.	Jan 11, 1866.
Longitude of perihelion	56° 26′	60° 28′
Longitude of ascending node	231° 28′	231° 26′
Inclination	17° 44′	17° 18′
Perihelion distance	0.9878	0.9765
Eccentricity	0.9046	0.9054
Semi-major axis	10.3400	10.3240
Period	33.2500 y.	33.1760 y.
Motion	Retrograde.	Retrograde.
Computer	SCHIAPARELLI.	OPPOLZER.

The orbit of TEMPEL'S comet and of the meteors associated with it is represented in the following figure, where the relative positions of the meteoric clusters correspond to the epoch of the comet's perihelion passage in 1866:

*Comets and Meteors, p. 52.



The next returns of the several bodies may be expected at the times indicated below:

TEMPEL's comet	1899
Group A	1899 to 1901
Group B	1886 to 1889
Group C	1912 to 1915

This cometary and meteoric orbit is a connecting link between the orbits of the *Earth* and *Uranus*; the perihelion being immediately within the former, and the aphelion just exterior to the latter. All matter moving in it is liable to considerable perturbation by *Uranus* and the *Earth*, but each of the meteoric clusters is now too extensive to be much disturbed as a whole. The present writer has elsewhere noticed that about 547 B. C., just before the first recorded (probable) appearance of TEMPEL's comet, this body and *Uranus* were comparatively near each other. *

* Comets and Meteors, p. 80.

LONGITUDE BY MOON CULMINATIONS.*

The right ascension of the *Moon* may be determined by means of a transit instrument, mounted at the place whose longitude is required, and the local time of observation compared with the Greenwich time corresponding to this right ascension, either by taking this time from the ephemeris of the *Moon*, or by means of similar observations made at Greenwich, or some place whose longitude from Greenwich is known.

COMPARISON BY MEANS OF THE EPHEMERIS.

The transit instrument having been adjusted as accurately as may be, the transit of the *Moon's* bright limb is observed, together with a number of stars suitable for determining the errors of the instrument and the clock correction. The corrections necessary to give the *Moon's* right ascension, from the observed time of transit of the limb, are then applied according to formulæ, as follows:

$$\delta' = \delta - \pi\, \rho \sin(\varphi' - \delta);$$
$$A_1 = 1 - \rho \sin \pi \cos(\varphi' - \delta);$$
$$B_1 = \frac{1}{1-\lambda};$$
$$F = A_1\, B_1 \sec \delta;$$
$$a = T + \Delta T + iF + \left\{ a\,\frac{\sin(\varphi - \delta')}{\cos \delta'} + b\,\frac{\cos(\varphi - \delta)}{\cos \delta'} + \frac{c'}{\cos \delta'} \right\} F \cos \delta' \frac{S}{16\,(1-\lambda)\cos \delta'}$$

The last term of the formula may be taken from the table of moon culminations where it is given under the heading "Sidereal time of semi-diameter passing meridian."

To insure greater accuracy, the *Moon's* right ascension may be derived by comparing the observed time of transit with that of about four stars differing but little from the *Moon* in declination, two culminating before the *Moon* and two after. A list of stars suitable for this purpose was formerly given in the

* From Doolittle's Practical Astronomy as applied to Geodesy and Navigation.

ephemeris, under the heading "Moon-culminating stars," but it has been discontinued since 1882. It is an easy matter for the observer to select suitable stars from the general list of the ephemeris.

Let A_0=the right ascension of the *Moon's* bright limb at the instant of culmination;

A=the right ascension of the *Moon's* center;

Θ=clock time of observed transit of limb, corrected for all known instrumental errors and for rate;

α, θ=right ascension and time of transit respectively of a star, the time being corrected for instrumental errors and rate of clock;

S_1=sidereal time of semi-diameter passing the meridian, taken from ephemeris.

Then
$$\left.\begin{aligned} A_0-\alpha&=\Theta-\theta; \\ A_0&=\alpha+(\Theta-\theta); \\ A&=A_0\pm S_1. \end{aligned}\right\} \quad (1)$$

This quantity A is then the local sidereal time of transit of the *Moon's* centre.

We have now to take from the ephemeris of the *Moon* the Greenwich mean time T corresponding to this value A of the *Moon's* right ascension; the mean time T must then be converted into the corresponding Greenwich sidereal time θ_0. Then λ being the difference of longitude, we have

$$\lambda=\theta_0-A. \quad (2)$$

The time T may be interpolated to second differences from the ephemeris, as follows:

Let A_1=the ephemeris value nearest to A;
T_1=the corresponding time.

Then T_1+t=the required time corresponding to A.

$$A_1=f\,(T_1);$$

$$A=f(T_1+t)=A_1+\frac{dA_1}{dT}t+\frac{d^2A_1}{dT^2}\frac{t^2}{2}.$$

Let ΔA = the difference of right ascension for 1 minute, taken from the ephemeris;

δA = difference between two consecutive values of ΔA. δA then equals the change in ΔA in one hour. Then if t is supposed expressed in seconds, we shall have to second differences inclusive,

$$\frac{dA}{dT}=\frac{\Delta A}{60}; \qquad \frac{d^2A}{dT^2}=\frac{\delta A}{3600};$$

$$A=A_1+\frac{t}{60}\left\{\Delta A+\delta A\cdot\frac{1}{2}\cdot\frac{t}{3600}\right\}.$$

From which $$t=\frac{60\,[A-A_1]}{\Delta A+\delta A\dfrac{t}{7200}};$$

and with sufficient accuracy,

$$t=\frac{60\,[A-A_1]}{\Delta A}\left\{1-\frac{t}{7200}\frac{\delta A}{\Delta A}\right\} \quad - - - \quad (3)$$

Writing $x=\dfrac{60\,[A-A_1]}{\Delta A}$, $x''=-\dfrac{x^3}{7200}\dfrac{\delta A}{\Delta A}$,

then (3) becomes $t=x+x''$ - - - - - - - (4)

Example. Among the observations of the *Moon* made at Washington I find the following:

1877, May 23d. Observed right ascension of the *Moon's* centre, $A = 13h\ 28m\ 5.02s$

From ephemeris of the *Moon*, $T_1=14h$, $A_1 = 13\ \ 27\ \ 3.91$

$\Delta A=2.0996$ $\qquad A-A_1 = \quad 1\ \ 1.11$

$\delta A=+.0029$ $\qquad 60\,(A-A_1)=3666.6$ $\qquad$ log. $=3.56426$

log. $\Delta A=\ .32213$

$x=29m\ 6.4s$ $\qquad$ log. $x=3.24213$

$x''=\quad -.6$ $\qquad$ log. $x^2=6.48426$

$t=29\quad 5.8$ $\qquad$ log. $(-\delta A)=7.46240_n$

ac log. $\Delta A=9.67787$

ac log. $7200=6.14267$

$T_1+t=14h\ 29m\ 5.8s$

log. $x''=9.76720_n$

This is now the Greenwich mean time corresponding to the Washington sidereal time A. In order to compare the two T_1+t must be converted into sidereal time.

$T_1+t=$	14h	29m	5.8s
Table III, Appendix N. A.,		2	22.77
Sidereal time Greenwich M. N.=	4	4	48.56
Greenwich Sidereal time $\theta_0=$	18	36	17.1

$$\lambda=\theta_0-A=5h\ 8m\ 12.1s,$$

the required difference of longitude.

If the ephemeris were perfect, very little could be done further in the way of perfecting this method. The errors of the ephemeris, however, are not inconsiderable, and in consequence it cannot be used directly as above, except when an approximate value of the longitude is sufficient. For the year 1877 the average correction to the right ascensions of the ephemeris, as derived from 66 observations at Washington, was —.31*s*, which would have produced an error of 8*s* in the longitude if the observations had been used for that purpose.

Either of two different methods may be used for eliminating from the result these errors of the ephemeris.

First Correction of the Ephemeris. This method is due to Prof. Peirce.* The ephemeris is compared with all available observations of the *Moon* made at Greenwich, Washington, and other fixed observatories during the lunation, and in this way a series of corrections to the ephemeris obtained which, as they depend on all available data, are much more reliable than simply the place of the *Moon* observed at any one observatory.

Peirce found that for each semi-lunation the corrections to the right ascension of the ephemeris could be represented by the formula

$$X=A+Bt+Ct^2; \quad - - - - - - - - \quad (5)$$

X being the correction required, t the time reckoned from any assumed epoch (which should be chosen near the middle of the

*Report of U. S. Coast Survey 1854, p. 115 of Appendix.

period under consideration for greater convenience), and A, B and C being constants determined from the observations made at Washington, Greenwich, etc The ephemeris when so corrected is used as already explained.

Second. Corresponding observations. The difference in the longitude of any two points may be found by comparing the values of the right ascension of the *Moon* observed on the same night at both places.

The times of transit of the *Moon's* bright limb and of the comparison stars are observed at both places and the corrections applied as already explained to find the right ascension of the centre at the instant of transit. It will be a little better if the same comparison stars are used at both stations.

Let L_1 and L_2=the assumed longitudes of the two stations;*

λ=the true difference of longitude;

A_1 and A_2=right ascensions of *Moon's* centre from observations at L_1 and L_2;

H=variation of right ascension for one hour of longitude, while passing from meridian of L_1 to that of L_2.

Then $A_2 - A_1 = \lambda H$;

$$\lambda = \frac{A_2 - A_1}{H} \quad - - - - - - - \quad (6)$$

H is taken from the table of moon culminations, where it is given for the instant of transit of the *Moon's* centre over the meridian of Washington. When used as in (6) its value must be interpolated for a longitude midway between L_1 and L_2.

PHOTOGRAPHING THE SOLAR CORONA BY A NEW METHOD.

In photographing an object of such intense brilliancy as the *Sun*, a formidable drawback to some researches is found in the diffuse reflection from scratches or dust on the speculum or object-glass employed. When photographing Sun-spots or

*Reckoned from Washington or Greenwich according as we use the ephemeris computed for Washington or Greenwich. One of the longitudes, L_1 or L_2 must be known with some accuracy.

other well-defined markings a little false detail is not of very much consequence; but when our object is to separate the corona from the atmospheric glare, false detail cannot be permitted at all. I believe an efficient remedy for this evil is to use "nature's own camera—a minute hole in a screen.

I have this method under trial, and will shortly commence daily photographs of the corona. These will be of interest in connection with those about to be made at the Cape of Good Hope by Mr. C. RAY WOODS. T. S. H. SHEARMEN.

August *Observatory*.

Observation on the Aurora Borealis. Made at Beloit, Wisconsin by JOHN TALLOCK, Jr.

The times given are expressed in the mean time of the 90th meridian. (Central Standard Time.)

SEPTEMBER 13, 1884.

9*h*	0*m*.	Brilliant aurora. Bright arch extending at its highest point to an altitude of about 12°. Dark cloud beneath arch.
10	30	No aurora visible
11	0	Faint light in north.
12	0	More as it was at 9*h*.

SEPTEMBER 17, 1884.

7	30	Brilliant aurora. Arch about 12° in altitude. Dark cloud beneath.
10	5	The arch is lower, more brilliant, and in the western extremity there are streamers flashing up to an altitude of 35° or 40°.
11	10	The arch is fainter.
11	20	There are more streamers, directly in the north, and there is a belt of auroral light extending across the sky. It touches the western horizon and reaches to within 40° of the eastern. Passes about 5° south of the zenith and is about a degree wide.
11	30	The belt of light reaches clear across the sky and now touches the horizon in the east.

NOVEMBER 17, 1884.

9 15 Auroral light on north horizon. Low, seen through clouds.

FFBRUARY 5, 1885.

7 0 Bright auroral light on north horizon. Seen through clouds.

FEBRUARY 11, 1885.

10 0 Very bright aurora. Band of light along north horizon about 10° high. Western end partially obscured by clouds. At eastern end there is a streamer stretching up about 25°.

12 15 Aurora is still visible and apparently of about the same degree of intensity, but the clouds are thicker and cover more of the sky.

13 35 The light has entirely disappeared. Sky perfectly free from clouds.

MARCH 14, 1885.

12 0 Line of auroral light above north horizon. No arch or streamers. Dark cloud beneath.

MARCH 15, 1885.

8 35 Very bright aurora. Cannot make out full extent on account of clouds, but light reaches to an altitude of certainly 30° and extends farther than usual towards the east and west points.

9 18 There is a rift in the clouds at an altitude of 15°—20°, and I think that the light is decreasing.

10 12 Sky entirely overcast.

MARCH 20, 1885.

10 18 Faint diffused auroral lights on north horizon.

MAY 11, 1885.

10 48 Same appearance as on March 20th.

13 15 Lighter, still visible, same as seen at first.

HOOSAC FALLS, N. Y., August 10th, 1885.

SUN SPOTS FOR JULY 1885.

R. HENRY FERGUSON.

The *Sun* has been observed throughout July each day except on the 1st 14th, and 30th, when clouds obscured the disc.

Number of days on which the *Sun* was observed	28
Total number of groups of spots......................	82
" " " spots...............................	339
Probable number of groups	90
i. e. iucluding those probably on the *Sun* the three cloudy days.	
Probable number of spots............	371
Largest number of spots any one day (20th, 21st, 22nd)..	24
Smallest " " " " " " (24th, 25th, 26th)..	4

Largest spot on *Sun* from the 18th to 30th having a diameter of about 34″, or about sixteen thousand miles.

The spots this month showed about the same interesting facts as those of any previous month when an equal number of spots was visible. Among these worthy of note are the very rapid and extensive changes in both position and contour of the spots in three of the groups observed July 2nd and following days. When first seen they formed three distinct, irregular groups. On the third they had drawn nearer together. On the 5th they were arranged in three parallel lines extending north and south, having respectively two, three and four spots, with several very minute spots between the pairs forming the line of four, the most southerly. On the 6th these spots were so near together as to form only one group with only four medium sized spots, one at each angle of a square enclosing many smaller spots into which the other spots had been resolved, most of them lying between the two largest spots, the two southerly ones. On the 9th they formed one very irregular group, one large spot preceding and one medium following, attended by several small and very small spots. The 11th brought another change, for the group was then on the western limb, and exhibited two very interesting phenomena, confirming the "saucer shape" of the spots and otherwise aiding the cyclonic theory. On the 11th at $1h$ $30m$ the large spot of this group was exactly on the western limb and a very marked indenture of the limb was visible where the spot had disappeared, while the spot next in size was very near the limb and gave a more marked concave appearance than I ever before observed. The penumbra on the western side was very marked, that on the northern and southern sides was compressed into a mere line and that on the eastern side was wholly invisible, the edge of the bright portion of the *Sun* being in strong contrast with the umbra.

The large spot which appeared on the eastern limb of the *Sun* about sunrise of the 18th showed also this phenomenon of perspective. The penumbra of this spot was very clearly defined on the sides nearest the limb when entering and disappearing was waning on the opposite side and at the intervening positions was very regular in width and with the spot underwent no appreciable change during its twelve days' stay, except on the 24th, when a crescent of flake white about 10″ in length, and three in breadth, appeared on the southerly side between the penumbra and umbra, and having a triangular horn or tongue of about 4″ length, projecting into the umbra.

On the 25th at $4h$ $32m$ this phenomenon of the white crescent had disappeared.

The 31st brought two new groups of spots quite irregular and poorly defined, completely defying any good observation. With all powers they appeared as spots out of focus and to-day are still visible, presenting the same indistinct outline. All the spots visible this month appeared in groups, except the large one mentioned above (18th–30th); no attendant spot being detected, although carefully sought. Very brilliant faculæ were seen on the limbs between the 15th and 19th.

It is here impossible to enter into any more minute description of the above spots, or even to consider the sun-spot theories in general which the observations of these spots for July would suggest, and in answer to many questions as to what are sun-spots reference may be made for brief descriptions to the work of Dr. YOUNG, entitled "The *Sun*," also to the shorter works of Rev. T. W. WEBB, "The *Sun* and His Phenomena," and the article "The Spots on the *Sun*," Art. 1, of the New Astronomy by Prof. LANGLEY in *The Century* for September, 1884.

Those who wish to know in a word what the astronomical world consider sun-spots will find it in the following words by Prof. LANGLEY: "We must conclude that the question as to the cyclonic hypothosis cannot yet be decided, though the probabilities fron telescopic evidence at present seem to me on the whole to favor M. FAYE's remarkable theory." (i. e., that on account of the varying depth of the stratum from which the gases forming the bright surface or photosphere ascends equatorial currents are formed, eddies, cyclones, or "whirls" result, resembling whirlpools in the ocean or "whirl"-winds in our atmosphere and the funnel-shaped vortices thus formed are the spots, the centre being the umbra and the descending sides the penumbra as noted above) which has the great additional attraction to the student that it unites and explains numerous other quite disconnected facts.—*Roxbury Advocate.*

THE NEW STAR IN THE NEBULA OF ANDROMEDA.

E. E. BARNARD.

A telegram from Prof. PICKERING was rceeived here on the evening of September 1st, announcing the discovery of a star-like nucleus in the great Nebula of Andromeda by HARTWIG. That evening, though cloudy, allowed frequent observation of the nebula through breaks in the clouds. The first glimpse through the telescope showed at once the bright stranger beaming forth in the midst of the nebula. It was a bright eighth magnitude star — perfectly stellar — of a slight yellowish cast. The light from this object was quite intense and very steady. Upon the application of high powers it retained its star-like form as distinctly as did the neighboring stars. The object illuminated the nebulosity surrounding it like a star shining through fog. With the higher powers I noticed that the nebulosity close following and slightly south was brighter; there appeared at that point a stronger condensation of the nebula light. The star was perfectly central. [I imagined it slightly south of the middle.] On September 2nd it was suspected to be slightly brighter, though from the interference of clouds on the 1st, preventing a fair observation, any slight change could not have been certainly distinguished. On this last date a sketch of the stars in the neighborhood of the new object was begun for reference in detecting changes of its brightness. On September 3rd it was certainly not brighter; but its light was whiter. On the 4th no decided change was noticeable. So far the light of this object has presented a steady radiance with

NEBULA OF ANDROMEDA.

a is the position of the new star.
b, less bright than new star } New star midway between brightness of them Sept. 3.
c, brighter than new star }
d, as bright as new star Sept. 3.5. Many bright and small stars omitted.

no rapid fluctuations. On the 3rd for a space of a few seconds the star appeared considerably brighter, then resumed its original appearance. I think that this was deceptive and place no confidence in it though it may not be improper to state the observation so that it may be confirmed. This supposed change occurred at about midnight.

I enclose the foregoing quite incomplete sketch which will be finished at the first favorable opportunity. It will aid in tracing any changes of light in the new star that will likely occur.

It may not be out of place to state that I have always seen this nebula differently from that which other observers have delineated.

If your engraver will faithfully produce the sketch I will call attention to the main objects wherein my view differs from what I have seen sketched elsewhere. This nebula does not have the pointed ends so commonly shown in drawings of it. At both the *p.* and *f.* ends there is a brushing out or diffusion of the nebulosity toward the south, extending nearly a half degree from the main axis.

I have also detected a small, faint, but perfectly distinct nebula involved in the preceding end of the large nebula as shown in the sketch. I have seen this latter object many times, both with 5 and 6-inch aperture, and can find no record of it elsewhere.

There is a long faintish ray passing parallel to the north side of the nebula, but distinctly separate; this is one of the objects detected by BOND, I presume. There are several other features that will be shown in a drawing I am preparing to make of this very wonderful object. The northern side of the nebula is the best defined, the south side differing very much, especially at the ends.

In reference to the new star in this great nebula, I wish to put forward the claim for a gentleman in Texas who saw this star-like object on the night of August 30th at 9*h*.

On the evening of September 3rd I received a letter [postmark Aug. 31] from Mr. H. S. MOORE, of McKinney, Texas, dated Aug. 31st, 1885, in which he says, " * * * * Last night was the first good night and after failing to find the comet [*a* 1885] I turned my tube [3 5-16-inch refractor] to the N. E. on the great oval nebula of *Andromeda* and was much surprised to see at 9*h* a 6½ or 7 magnitude star nearly central in this nebula." My impression is that HARTWIG's observation was on Aug. 31st, if so, Mr. MOORE saw it first. Mr. MOORE's observation is of great interest for if he has correctly estimated the magnitude of the new star on Aug. 30th, it was then brighter by a magnitude or a magnitude and a half than at present.

Speculations on the new star at present would be quite premature, but from my observations it seems quite clear that the star is *in* the nebula or on the other side of it, certainly not on this side, inasmuch as it illuminates the nebulosity by the transmission of its rays through it. I am aware that the star is shining in the brightest part of the nebula, but from my recollection of the original appearance, the nebula was not so bright at this point previously.

VANDERBILT UNIVERSITY OBSERVATORY, Sept. 5, 1885, Nashville, Tennessee.

THE VISIBLE SHADOW OF THE EARTH.

JOHN HAYWOOD.

We say we see the shadow of an object when the object intercepts the light of a luminary from a part of a surface, so that the surface is in part illuminated, and the eye notes the contrast between the light and dark parts. In this way we see the shadow of the *Earth* on the *Moon* when the latter is partly immersed in the shadow of the former.

We can also under favorable circumstances see the shadow of the *Earth* projected into the illuminated atmosphere, that is upon the sky. But to get sufficient depth to the shadow, and a sufficiently well-defined boundary between the shadow and the bright sky to be seen distinctly, the eye must be in or near the surface of the shadow; so as to see the shadow in its greatest intensity, and also see the unobscured bright sky.

To analyze the subject somewhat mathematically: The portion of the surface of the *Earth's* shadow within the atmosphere, and at the same time within the range of sight of the observer is to be considered sensibly a plane. This plane is tangent to the *Earth*, and as it contains the eye of the observer is a great circle of the visible sphere, and coincides with the horizon. In this case, the shadow is below the horizon, and of course invisible; and the *Sun* is in the horizon, that is, is just rising or setting. But if it is below the horizon not more than about two or three degrees and the eye directed to the opposite side of the horizon, the line of sight makes a small angle with the shadow surface; but if the air is very clear, and the horizon is not too much obstructed by hills or forests, the shadow may be very distinctly seen. We will still consider the plane of the surface of the shadow a great circle though it passes a little above the center of the sphere, that is, the eye of the observer. Therefore as it now does not coincide with the horizon, the two great circles include between them a lune of the sphere, the breadth or angle of the lune being equal to the distance of the lune below the horizon. This lune is a visible part of the shadow of the *Earth.* When seen under favorable circumstances, it presents the appearance of a low dense cloud lying along the horizon opposite to the *Sun.* Let us suppose the time to be morning, a few minutes before sunrise, and the air to be very clear, and the western horizon to be unobstructed. We look in that direction and see a low black cloud lying along the horizon, extending well toward the north and south; and perhaps being nearly a complete lune. The shadow is identified by the evenness of its upper edge, and by its extent. Its character is proved still further, as we watch it, by its becoming narrower and more intense; the definition becoming more distinct as the shadow plane comes down nearer to the eye; thus approaching coincidence with the horizon. And then it disappears as the *Sun* begins to illuminate the western horizon, and we see there is no cloud then.

The same appearances in reverse order present themselves in the evening under like conditions. First after the *Sun* has set, there is an appearance like a dark cloud seen along the eastern horizon, having a moderately well-defined upper edge, being a narrow lune. The cloud rises as the *Sun* sinks lower; but we notice that the sharpness of the definition diminishes rapidly as the lune increases in the width; in other words, the shadow seems to be shaded into twilight, and pretty soon we find we have lost the boundary between the shadow and the illuminated sky. Next twilight ends, and we are in the shadow of the *Earth;* but we do not now see the shadow. I have followed the shadow in the evening to a height of eight or ten degrees, but in such cases the border is very ill-defined.

I think this phenomenon should be more striking at sea, provided the atmosphere is clear enough; as the visible shadow would be, with a perfect horizon, a perfect lune. Also if seen from the summit of a high elevation, as a mountain top, from which the dip of the horizon is great enough to be sensible; the phenomenon should be still more striking; as the dip would, by so much augment the breadth of the shadow lune, as it is seen from sea level. It is interesting in this connection to notice more particularly the disturbing effect of clouds and mist and smoke in the air. At first one might think that the more opaque air would show the shadow better. But in fact it totally destroys the definition. It arises from this; that in this case there is a lack of suitable illumination of the air; there is not the bright sky to contrast with the shadowed sky. Clouds destroy the visibility of the shadow by covering and confounding the shadow, and by obscuring the bright sky.

I have wondered if this phenomenon has not been noticed by scientific observers, and been mentioned by them. Likely it has; but it has been my fortune to find a description of it nowhere except in WILLIAM BLACK's "Green Pastures and Piccadilly." His party are journeying across our western plains by railroad, when he notices the phenomenon and explains it correctly. But why has he not observed the same in England, and more especially on the Atlantic during his voyage? I am not sure I can give a correct answer to this question, as I have never been in England, nor on the sea. But I conjecture that the phenomenon, even if visible, can easily be overlooked in a hilly country on account of the obstructed horizon. And on the ocean clouds and mists may have obstructed the view, Prof. MENDENHALL once told me that he had seen an account of observations by some one on the ocean, who had noticed the shadow and had explained it.

I always call the attention of my classes in astronomy to this subject; and some of them have afterwards reported to me some specially favorable views they have had of it.

EDITORIAL NOTES.

The new star, or star-like nucleus, which has recently appeared in the great nebula of *Andromeda* is a wonderful celestial phenomenon. It was first seen, in this country, so far as we know, by J. C. McClure, an amateur observer of Red Wing, Minnesota.

In a private letter bearing date August 31st, Mr. McClure says: "Please look at the nebula of *Andromeda*. The star in the center I never saw until last Saturday night." The date of his first observation was then August 29th.

Dr. Hartwig's observation of the same object at Straasburg was reported, by telegraph, in America Sept. 1st. On the same day its spectrum was observed at Princeton and reported to be continuous. W. H. Numsen, of Baltimore, also saw it Sept. 1st. One day later Professor Pickering, of Cambridge, secured a series of spectroscopic and photographic results, which have not yet been published.

The place of this new object was reported by an observer to be 13″ west of the old nucleus. We are not aware that this measure has been verified by any other astronomer. It was early reported, as about the 7th magnitude in brightness. September 15th it was nearly as bright as the 6th magnitude, for it was seen by two observers without optical aid. Later observations seem to indicate a decline in luster.

Observation does not yet decide whether the phenomenon is a newly developed nucleus belonging to the nebula, or a new or temporary star less distant than the nebula and in the same line of sight. Whatever the object is. it will be studied with deep interest.

Comet Brooks.

The new comet discovered by me in *Canes Venatici* on the evening of August 31st has been observed almost nightly with the 9-inch reflector. No very marked change has taken place in the appearance of the comet, except that it has grown somewhat fainter. It is nearly circular in form, with very slight central condensation. The entire coma is very flashing at times. On September 10th the comet was observed to pass almost centrally over an 8th magnitude star one and one half degrees north of Gamma in *Bootes*. The light of the star was not dimmed.

WILLIAM R. BROOKS.

Red House Observatory, Phelps, N. Y., September 14, 1885.

New Star in Andromeda.

I obtained an observation of this wonderful object on the evening of September 2nd. It appeared to me then almost of the 6th magnitude and was distinctly seen by the naked eye. All powers of the telescope gave a hard, well-defined nucleus. In later observations it has seemed to me somewhat fainter than at first. I notice that most observers with refractors call the star reddish. To me with the silvered-glass reflector it has always seemed of a pale greenish tint. WILLIAM R BROOKS.

RED HOUSE OBSERVATORY, September 14, 1885.

THE NEW STAR IN ANDROMEDA NEBULA.

In reference to this wonderful object I have written to Mr. H. S. MOORE, of McKinney, Texas, and he has forwarded to me his original observations of August 30th, 1885. In answer to inquiry as to his familiarity with star magnitudes, he says:

"I answer that I am not well posted on magnitudes of stars, and that on the second observation I felt sure I had overstated the magnitude in my letter to you * * *. I remember that my finder, about ⅞ in., had never shown the star. * * * * On last night (7th Sept.) 50 required more careful focusing to show the star than on previous nights. One hundred has shown it plainly all the time. * * * The star seems much larger than the companion to Sigma *Scorpionis* and is an easier object and has been at every observation since the 30th [August]."

The original observations of Mr. MOORE, which he has kindly sent me without alteration or correction, state: "August 30th 9 p. m. Saw 6½ or 7 magnitude star in *Andromeda* nebula. Believe it to be new in this place. Nearly central in nebula. Aug. 31st. Saw it again, no change. Sept. 1st, 2nd and 3rd. No change. Cloudy interval. * * * Sept. 7th * * observed star again, not a good night, but I feel sure it is diminishing. * * *"

From these observations we may justly infer that the star was not sensibly brighter on August 30th, 1885, than on the few succeeding evenings. E. E. BARNARD.

SMALL NEBULA INVOLVED IN PRECEDING END OF GREAT ANDROMEDA NEBULA.

I have found a small pretty faint nebula in

$$\left.\begin{array}{l} \text{R. A.} = \ \ 0^h\ 34^m\ 16^s \\ \text{Decl.} = +40^\circ\ \ 5'\ \ 59'' \end{array}\right\} 1885.0$$

It is involved in the extreme *p* end of the great nebula of *Amdromeda*. It lies a little south of three small stars that form a triangle.

This nebula has been seen frequently with the 5-inch telescope during the last two years, but I could never be certain of its being a distinct separate nebula until lately examining the object with the 6-inch, when it was seen to be a well-defined but faint nebula. I find no record of this having been seen by any one else. E. E. BARNARD.

August 5th at 5 p. m *Jupiter* and *Venus* were both seen at once in the field of the telescope, the two planets being about 35′ apart. J. R. H.

The Secretary of the Treasury is said to have sketched out a plan to further eliminate, as far as possible, opportunities for irregularities such as have been discovered in the coast survey and are believed to exist in some of the scientific bureaus, which is to ask congrsss to authorize the creation of an executive committee or advisory board in each scientific bureau, which board or committee shall have charge of all details, such as appointments outside the scientific staff, designation of duties of employes other than those of said staff, apportionment of salaries, and supervision of the accounts of disbursing officers. Such legislation will leave the heads of these bureaus, free to spend their whole time in advancing science. It is also a part of his plan to ask that power be given the president to appoint annually a board of independent experts in science, who shall examine the scientific workings of the department or bureau and approve the same before the estimates for the work for the ensuing fiscal year shall be incorporated into the book of estimates.—*Chicago Tribune.*

BARNARD'S COMET.

My last observation of BARNARD'S Comet was on the evening of Sept. 2nd. I consider it the faintest object ever seen at this observatory though some of my new nebulæ are about equal to it in faintness. I set my telescope according to Prof. EGBERT'S ephemeris, being quite sure I had it somewhere in the field. It required 20 minutes of intense looking before I could positively assert that I saw anything at all. It was almost in the center of the field. I had no time to get its position very exactly as I wished to verify BROOK'S discovery of a comet, not knowing how long it might take. I made the positlon of BARNARD'S comet as follows: R. A. $16h\ 27m\ 0s$. Dec. $-30°\ 30'\ 45''$. Not corrected for refraction in declination. LEWIS SWIFT.

WARNER OBSERVATORY, Sept. 8, 1885.

NOTES ON THE NEBULA OF ANDROMEDA.

Sept. 1: Central nucleus exceedingly distinct and equals about 5½ magnitude.

Sept. 2: Star the same, and a portion of the nebulous matter around the star seems brighter than formerly, as if illuminated additionally to the star's light.

Sept. 3: No change.

Sept. 9: Star less brilliant, having a dull cast.

Sept. 11: Star is fainter than when first seen; equals a 7½ magnitude.

Sept. 14: Star decidedly fainter, below 8 magnitude, is a small point, showing more of the apparent disk as heretofore.

Sept. 15: Apparently about 9 magnitude. J. R. H.

THE TITLES OF CONTRIBUTIONS TO ASTRONOMICAL PERIODICALS.

A whole volume might be written on the *mechanics* of literature in general or of astronomical literature in particular. One of the most important chapters might be devoted to the rules which should be followed in giving the title to a particular book or paper. As examples of bad titles we might quote two famous books, one by HAUSEN.

"Ausseinander setzungeiner zweck massigen Methode zur Berechnung der absoluten Storungen der Kleinen Planet en," and the other by ALBERS — "Abhaudlung neber die leichteste und bexuemshe Methode die Bahnlines Cometen zu benechen."

Each of these titles sins against brevity and attacks human life, and other worse ones might easily be found and the chapter written at fever heat. But the object of this note is to enter a protest against a worse style of title than this, even.

These titles are definite enough when you get through with them, and exactly express the intention of the essays, although not in the best and briefest manner. At the worst you can invent a kind of technical name and speak of "HANSEN's Anseinander setzung," just as one says "CRELLE" for CRELLE's tables. But for many years there has been a kind of nebulous title floating about, especially in the *Astronomische Nachrichten* which may be described in the language of the elder HERSCHEL as

e e e diffused and difficult nucl ? ? ?

This is Auszug aus ein Schreiben von Herrn Professor Dr. ***** au deu Herausgeber."

What we wish of a title is that it shoud be

S. C. B. S. M. B. M,

and we respectfully ask that the above nebulosity should be attached to some solid mass as "betreffeud sigma 1494, sigma 1801, partielle Sonneufinsterniss von Marz 16, 1885 etc." to quote the most recent example.

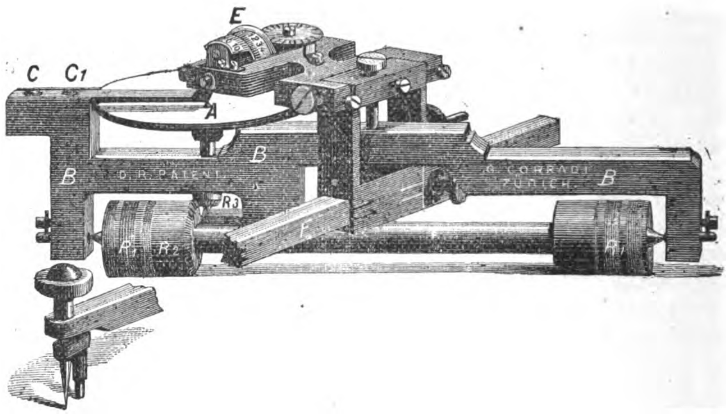
Any one who has tried to index any portion of the *Nachrichten* will appreciate the force of this request, and the Editor is humbly asked to consider this one improvement to his journal. There are not many others left to make. X. Y. Z.

ROLLER PLANIMETER.

This instrument has been very much perfected of late, and especial attention is asked to it as the most accurate one now in use. It is more exact than all other similar instruments. The roller does not run directly on the paper, but on a perfectly flat disc, and, consequently, the results of the instrument are in no wise affected by the nature of the paper. The rotation of the roller is ten to twenty times smaller than that of the Amsler Planimeter with equal length of tracing-arm.

This new Planimeter has been described in all the leading engineering papers in Europe, and we have no doubt but that it will be welcomed by every engineer in this country who desires a really first-class instrument.

By consulting Messrs. FAUTH & Co.'s Catalogue of Astronomical and Engineering Instruments a full description of this new and useful instrument may be found.



RECENT DISCOVERIES.

New minor planet No. (249) was discovered, August 17, by Dr. C. H. F. PETERS, Clinton, N. Y., Aug. 16.608, Wash. M. T.

R. A. 21*h* 58*m* 40*s*;

Decl. −15° 51′. 12 magnitude.

Star like nucleus in the nebula of *Andromeda*. Seen August 29 by J. C. McCLURE of Red Wing, Minn. Aug. 31 by Dr. HARTWIG, of Dorfset, Russia.

Comet (BROOKS) discovered Sept. 1 by W. R. BROOKS, Phelps, N. Y.

R. A. 13*h* 20*m*; } Rough position.
Decl. +37°. }

Ninth magnitude. Circular nebulosity of 2′ in diameter. Some central condensation and no tail.

New minor planet No. (250) was discovered by PALISA of Vienna, September 3. At 9*h* and 53*m* of the same day, Gr. M. T., its position was,

R. A. 23*h* 34*m* 40*s*;

Decl. −16° 9′ 35″. Eleventh magnitude.

MEROPE NEBULA.

On the morning of August 17 last, while waiting for TUTTLE's comet to get above the horizon, the sky being very dark, I examined the *Pleiades*, and could see the faint light in the region about the star *Merope*. The general outlines can be made out by slowly moving the telescope about; when the contrast with the surrounding darker sky becomes very evident.

The failure to see this very interesting object might be attributable to a sky not transparent enough, though seemingly so.

I used a 5-inch Clark refractor, power 45, with which I once before saw the nebula, and have failed to see it on other occasions. J. R. H.

R CORONÆ.

This star which is very irregular in its fluctuations, and sometimes for years remaining nearly constant in light, is at present quite faint, and is evidently undergoing one of its rare downward fluctuations. It is at present about 7.0 magnitude and should be closely followed by variable star observers. Position for 1870 is

R. A. 15*h* 43*m* 13*s*.
Decl. +28° 33.5′.

It changes from 6 magnitude to 13 magnitude. E. F. SAWYER.

I entirely agree with Mr. BURNHAM's remarks on the question of "Small *vs.* Large Telescopes" in the SIDEREAL MESSENGER for September, 1885. EDWARD S. HOLDEN.

The *Science Observer* announces the observation at Nice, of TUTTLE's comet, giving the following position, August 9.6124 Gr. M, T.

R. A. 7*h* 23*m* 43.1*s*
Decl. +28° 1′ 24″.

Professor LEWIS SWIFT first saw TUTTLE's comet August 18th, unfavorable weather preventing an earlier search. It is fairly bright on a dark sky, and shows a strong condensation at the center.

Answers to interesting queries from a friend in Exeter, N. H., are deferred for want of space.

Much of interest concerning the new star must be dropped this month for want of space.

BROOK'S COMET.

The circumstances attending the discovery of this comet resembled in one respect that of BARNARD'S. The position of the latter at discovery was so close to a nebula as to raise a suspicion that it might be the nebula itself which caused a delay of a day in cabling to Europe in order that its cometary character might be certainly established. BROOK'S comet, however, instead of being near one nebula was near to five and in my telegraphic dispatch to PICKERING announcing his discovery, I thought best to say "verify."

It may not be known to all of your readers that the discoverer of a comet must, in order to claim the WARNER $200 comet prize, telegraph its discovery to me and to me only. Being then untrammelled by a single doubt as to what announcements the discoverer had made, immediate notification by telegraph is made to Prof. PICKERING, and, according to an arrangement between us, I am to say "Cable" if after a thorough examination of all the circumstances, it is considered almost certain that the object seen is a comet. If some doubt arises I am to say "verify". If neither word is used it indicates that the cometary character of the object is considered doubtful, but desire Prof. PICKERING to share with me the responsibility of withholding it for confirmation. The scheme thus far has worked well, and renders a false alarm less probable At most the delay would amount to but a day, as the discovery could be verified at some one of the many observatories in the United States.

It is important that discoverers in their telegrams to me should use one of the three following terms expressive of motion, viz: motion suspected; motion strongly suspected; motion certain. LEWIS SWIFT.

WARNER OBSERVATORY, September 8, 1885.

COMET A 1885 [BARNARD.]

The following observations have been made with the 6-inch Cook equatorial of this observatory. The first observation was obtained by three differences of right ascension and two estimations for difference of declination, the comet being too faint to be seen on the ring.

The rest have been obtained with ring micrometer. The comet has also been observed on July 30th, 31st, and August 3rd, 4th, 5th, 8th, 12th, and probably on 13th, but the comparison stars have not yet been found in the catalogue. I wish to acknowledge the kindness of Messrs. S. C. CHANDLER Jr. and H. V. EGBERT, of Harvard and Dudley observatories, in supplying the places of work of the comparison stars used in these observations. The star *h*, was observed specially by Mr. EGBERT.

E. E. BARNARD.

VANDERBILT UNIVERSITY OBSERVATORY, Nashville Tennessee.

Longitude $+39^m$ 0.68^s from Washington.

Latitude $+36^\circ$ $8.5'$ $8.25''$

OBSERVATIONS OF COMET A 1885 [BARNARD] MADE WITH THE 6-INCH EQUATORIAL OF VANDERBILT UNIVERSITY OBSERVATORY.

Nashville mean time 1885.	$\Delta\alpha$ c—s	$\Delta\delta$ c—s	No. of comps.	Apparent α	Apparent δ	Stars.	Remarks.
d h m s	m s	′ ″		h m s	° ′ ″		
July 7 14 35 37	+0 48.70	−1 50.0	3	17 21 23.53	−4 57 4.0	a	Wet clouds forming in west. Comet faint, could not observe on ring.
" 8 12 16 7	−0 21.99	−8 52.5	7	17 19 40.56	−5 27 39.6	b	Small and dim with very small ill-defined nucleus. No tail.
" 8 12 16 7	−2 56.74	+4 53.3	7	17 19 40.60	−5 27 36.9	c	Both stars used at same observation of comet.
" 10 11 31 4	−3 54.41	−6 47.8	7	17 15 56.91	−6 35 27.2	d	There is an ill-defined brightening in the middle to a tiny nucleus.
" 15 10 35 30	−0 22.04	−15 43.0	12	17 7 0.46	−9 24 18.7	e	Dim and hazy. There seems to be considerable but indefinite condensation.
" 29 8 51 14	−3 5.41	−10 29.7	8	16 46 20.74	−16 47 45.6	f	Occasionally indefinite brightening near center. Comet very faint. Moon near rising.

COMPARISON STARS.

Star	Mean α 1885	Reduction to apparent place	Mean δ 1885	Reduction to apparent place	Authority.
	h m s	s	° ′ ″	″	
a	17 20 31.90	+2.93	− 4 59 3.6	+9.5	Yarnall 7244
b	17 19 59.63	+2.92	− 5 18 56.5	+9.4	H. V. Egbert, Dudley Observatory.
c	17 22 34.12	+2.92	− 5 32 39.6	+9.4	Weisse's Bessel. The star is west 47*h* 365.
d	17 19 48.38	+2.94	− 6 28 47.6	+8.2	5816 of Rumker's Catalogue of 12,000 stars.
e	17 7 19.55	+2.95	− 9 8 43.9	+8.2	Schj. 6146. This star is taken from A. N. 2674.
f	16 49 23.23	+2 92	−16 37 21.3	+5.4	⅓ (Yarnall 7008 + Rumker 5585 + Stone [?])

Professor JOHN, of De Pauw University has in place in the new McKINN observatory a 9½-inch equatorial. The mounting of the telescope and the dome of the observatory which is 17 feet in diameter were made by Messrs. WARNER & SWASEY, Cleveland, Ohio, whose excellent work is attracting wide and favorable attention. Professor JOHN will soon give us a full description of this new observatory.

The following orders and subscriptions have not been previously acknowledged:

Levi K. Fuller, Brattleboro, Vermont. F. M. Bookwalter, Springfield, Ohio, (Vols. 3 and 4). Maryland Institute, Baltimore, Maryland. Isaac P. Guildenschuk, 14 Achilles St., Rochester, New York. R. Rother, 238 Randolph Street, Detroit, Michigan. Charles A. Hiller, Salina, Kansas. Wm. A. Haren, 1400 Hickory Street, St. Louis, Missouri. Lawrence Oberliss, Rochester, New York. Rev. S. G. McFarland, Bangkok, Siam, Asia (via San Francisco). Lewis H. Roberts, Clinton, Iowa. Simeon G. Cole, Romeo, Michigan. Professor M. B. Snyder, Central High School observatory, Philadelphia, Pennsylvania. M. A. Newell, Principal State Normal School, Baltimore, Maryland. John Goldie, Galt, Ontario, Canada. State Normal School, Winona, Minnesota. A Bassett, Bannock City, Montana. Reading Room, State Normal School, Winona, Minnesota. Samuel B. Eason, Wooster, Ohio. Professor M. A. Newell, State Normal School, Baltimore, Md. State Normal University, Normal, Illinois. N. H. Campbell, Pine State Normal School, Johnson, Vt. R. C. Wilkins, Northfield, Minn. G. W. McGinnis, State Normal School, Kirkville, Mo. (Vols. 3 and 4). Frank Drummond, Lamori, Iowa. W C. Pond, Hartford, Conn. Library, Harvard College, Cambridge, Mass. W. H. Klingfelter, Woodbridge,California. Rev. Dr. Williamson,Queen's University, Kingston, Canada. Israel Brundage, Pastor of First Presbyterian Church, Rochelle, Ill. J. C. McClure, Red Wing, Minn. Abraham Cooper, Zanesville Ohio. Bert Luty, Alleghany City, Pa. Rev. Thomas Thomas, Trenton, Oneida Co., N. Y. Professor Frank H. Bigelow, Racine College, Racine, Wis. Reading Room of West Virginia University, Morgantown, West Va. Professor C. S. Howe, Buchtel College, Akron, Ohio. Library of Mechanics Institute, San Francisco, Cal. Dr. J. H. Wythe, Oakland, Cal. C. H. Stegman, Oakland, Cal. L. D. Hampton, Hampton College, Louisville, Ky. Normal Reading Room, State Normal School, Warrensburg, Mo. John M. Black, No. 1334, Chestnut Street, Philadelphia, Pa. A. S. Moore, McKinney, Texas.

THE OCTOBER PLANETS.

[Central Standard Time.]

Mercury	rises	October	5th,	17*h*	33*m*;
"	"	"	15th,	18*h*	26*m*;
"	"	"	24th,	19*h*	14*m*.
Venus	sets	October	5th,	7*h*	14*m*;
"	"	"	15th,	7*h*	7*m*;
"	"	"	25th,	7*h*	6*m*.
Mars	rises	October	5th,	15*h*	29*m*;
"	"	"	15th,	12*h*	40*m*;
"	"	"	25th,	12*h*	29*m*.
Jupiter	rises	October	5th,	16*h*	25*m*;
"	"	"	15th,	15*h*	57*m*;
"	"	"	25th,	15*h*	27*m*.
Saturn	rises	October	5th,	10*h*	9*m*;
"	"	"	15th,	16*h*	51*m*;
"	"	"	27th.	16*h*	8*m*.
Uranus	rises	October	7th,	17*h*	19*m*;
"	"	"	15th,	16*h*	51*m*;
"	"	"	27th,	16*h*	8*m*.
Neptune	rises	October	7th	7*h*	23*m*;
"	"	"	15th	6*h*	51*m*;
"	"	"	27th	6*h*	3*m*.

BOOK NOTICE.

A Treatise on Practical Astronomy as applied to Geodesy and Navigation. By C. L. DOOLITTLE, Professor of Mathematics and Astronomy, Lehigh University, New York. Messrs. JOHN WILEY & SONS, Publishers, 1885, pp. 642.

The author has aimed to prepare a text book for colleges and technical schools, which may also be used as a manual for the field astronomer, in Geodesy and Navigation.

The subjects of Least Squares and Interpolation are first considered, and deserved prominence given to them as themes introductory to the part designated as Practical Astronomy. Those students who have not read very much mathematics will find the discussion of Least Squares not at all tedious, as usual, but rather gratifying in the author's ready application of the theoretical side of the theme to common practical ends and to the best use of astronomical observations in particular lines of work.

Under the head of Practical Astronomy the first chapter treats of the celestial sphere and the transformation of co-ordinates, and the ordinary problems related thereto; the second discusses prallax, refraction, and the dip of the horizon; the third is devoted to time; the fourth, angular measurements, the sextant, the chronometer and the clock; the next to the determination of time and latitude, and methods adapted to the use of the sextant; the sixth gives a full study of the transit instrument; seven, determinations of longitude; eight, the zenith telescope; nine, determination of azimuth; and ten, precession, nutation, aberration and proper motion.

This book lays no claim to new or original methods, but presents, in systematic form, the most approved ones in actual use at the present time. For the range of work the author has chosen, the treatment of topics is always clear and concise, formulæ and mathematical work neatly in order, and the applications, instructive and general. The book makes no show of learning for its own sake in the treatment of its topics. It is not a treatise on Astronomy or Geodesy or Navigation as such, but it is a useful work in the study of the applications of Mathematics and Astronomy to the two important branches of scientific labor named in its title.

The publishers, as usual, have done their part neatly and well.

Books Received.

Memoirs of the Royal Astronomical Society, Vol. 48, Parts I and II, 1884.

Maderia Spectroscope, C. Piazzi Smyth, Edinburg, Scotland. 1881—2.

The fixed Idea of Astronomical Theory, by August Tischner, Leipsic

Observations upon the Topography and Climate of Crownborough Hill, Sussex, England.

Publications of the Washburn Observatory, Vol. III, Madison, Wis.

Report of Observations of the Total Eclipse of the *Sun*, August 7, 1869. Prof. J. H. C. Coffin, U. S. A.

Papers.

The orbits of *Oberon* and *Titania*, the outer satellites of *Mars* by Prof. A. Hall.

The orbit of the satellite of *Neptune* by Professor A. Hall.

Tornado Studies for 1884 by John P. Finley.

Heights of the stations of the Davidson Quadrilaterals from Trigonometrical Determinations by George Davidson, U. S. C. and G. Survey.

The Run of the Micrometer, also by Professor Davidson.

Papers read before the American Astronomical Society. (No. 1.)

Possibility of Errors in Scientific Researches due to Thought Transference, by Professor E. C. Pickering,

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 9. NOVEMBER, 1885. WHOLE NO. 39.

COMMENSURABILITY OF MOTIONS.

BY DANIEL KIRKWOOD.

(For the Messenger.)

With respect to the proposed explanation of the observed intervals in the ring of *Saturn* and the zone of minor planets, Professor HALL remarks:*

" Gaps in the ring of asteroids, and divisions in the ring of *Saturn* have been explained on the theory that it is impossible for bodies to move in such places, since their motions would be commensurable with those of certain planets or satellites."

In assigning a physical cause for the gaps in *Saturn's* ring I have never considered the question of stability independently of collisions. I have simply shown [1] that the matter which originally moved where the intervals are now observed was liable to extraordinary perturbation; and [2] that as the rings have considerable density the disturbed portions would be brought in collision with either the exterior or interior parts of the ring, thus eliminating the primitive matter from the belts of greatest disturbances. A body revolving as a satellite in any part of the greater interval would be brought in contact with

* Sidereal Messenger, Sept., 1885, p. 201.

the outer ring before its eccentricity could become equal to 0.012. This is less than the observed eccentricity of some of the satellites.

The same reasoning is applicable to the zone of asteroids; but the small comparative density of the latter would render collisions relatively less frequent.* In this case, however, a cause somewhat different is equally apparent. The disturbed orbits of the minor planets would attain considerable eccentricity so that the matter moving in them would, in perihelion, be brought in contact with the equatorial parts of the solar mass, and thus become reunited with it. The origin of gaps, therefore, is not referred to the commensurability of periods as the simple or only cause. The fact, however, that such chasms occur precisely where the periods have such relations is too obvious to pass for an accident. The gap, for example, where an asteroid's period would be half that of *Jupiter* is 0.1393 in breadth. The number of asteroids, as has been elsewhere shown, in the belt of equal extent immediately interior is 37. The probability that this fact should be due to a chance distribution is as 1 to 137,438,953,472.

The writer's explanation of these remarkable gaps, proposed nearly twenty years since and frequently re-stated, does not necessarily require that the chasms in question should be absolutely void. Some portions of the primitive matter might, under peculiar circumstances, escape precipitation. It is to be observed, moreover, that orders of commensurability higher than the third could hardly be expected to produce well-defined intervals.† Adopting this limit, we have only the distances, 2.50 2.82, 3.27, 3.58, 3.70 and 3.80; at all of which chasms are very distinctly marked. The distance 2.70, where three periods of

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* Monthly Notices, Vol. XXIX, p. 101

† The order of commensurability depends upon the difference between the numerator and denominator of the fraction expressing the ratio: Thus ½ or ⅔ is the first order, ⅓ or 3-5 is the second, ⅜ is the fifth, etc. The frequency of conjunctions during the number of Jupiter's revolutions contained in the numerator is indicated by the order of commensurability.

Jupiter are equal to eight of an asteroid, is of the *fifth* order, and consequently the conjunctions would occur at five different points around the ecliptic. The fact that the mean distances of several minor planets differ but little from 2.70 has been thought unfavorable to the view that the chasms are produced by *Jupiter's* action. The facts are as follows: The average of seventy-nine adjacent intervals [between 2.6 and 2.8] is 0.002,113. The interval 0.011020, between *Hera* and *Olympia* where an asteroid's period is three-eights of *Jupiter's*, is not only greater than any of this number, but is more than five times the average.

The mode in which gaps were produced by disturbing causes has been here indicated, I trust, with sufficient clearness. The statement that *Jupiter's* action, alone, independently of collisions, may have changed the mean distances of certain asteroids* is unnecessary as well as doubtful. It was made without investigation on the authority of HUMBOLDT. Among the chief elements of stability this eminent writer includes the fact "that the periods of the planetary revolutions have among each other no common measure."† From this view Mr. PROCTOR at once dissented, while admitting the correctness of my principal explanation.‡

* Monthly Notices, vol. XXIX, p. 100.
† Cosmos, Vol. IV, Bohn's Ed., p. 600.
‡ Intellectual Observer, Vol. IV, p. 23.

SMALL VS. LARGE TELESCOPES.

W. F. DENNING.

(For the Messenger.)

With reference to the letters on this subject, recently published in the *Observatory* and Mr. BURNHAM'S comments thereon in the SIDEREAL MESSENGER for September, I wish to say that your correspondent has quite misunderstood the point at issue. The basis of the discussion [see *Observatory* for March,

p. 79] was the relative value of small and large telescopes in showing detail on a bright planet. Mr. BURNHAM says the discussion has been "on the comparative value of large and small apertures for showing planetary details and other faint celestial objects "[! !] and proceeds to argue the point in relation to double-star observations. This is quite irrelevant to the special question in hand, and I may add that his denunciation of reflectors is equally unnecessary. No one has questioned the superiority of large apertures for double-star work, but with bright planets the conditions are very different.

I have pointed this out in a communication to the *Observatory* and there seems little need for one to discuss the matter further on the new basis introduced by Mr. BURNHAM. But I am sorry to find the *intention* of my remarks has been misconstrued. From the tone of certain criticisms it would appear that I had specially attacked the large refractors of ALVAN CLARK & SONS. I am sure that anything I might say in disparagement of these justly celebrated instruments would carry very little weight. My statements have applied to large telescopes generally, and I incidentally referred to the large refractors at Washington, Princeton and Chicago because they have been actively employed on planetary work, and the published results afforded the means of gauging their capacity in this respect. I did not speak of the large English refractors as they are only heard of indirectly about once in ten years! COOKE's 25-inch mounted at Galeshead has been found practically useless, the climate being so bad, and Mr. BUCKINGHAM's 21¼-inch at London has not been mentioned since January, 1870! In initiating the recent controversy in the *Observatory* I had no thought of deprecating American instruments or work. Every man who has any regard for astronomy and has watched its progress of late years must feel a sincere and undisguised admiration for what has been accomplished in the United States.

In concluding I may add that Mr. BURNHAM is not justified in twisting Prof. HALL's perfectly candid expression of opinion to suit his own views. Let any one read Prof. HALL's letter in the *Observatory* for May, p. 174, and see if it will bear the construction put upon it by Mr. BURNHAM. Nothing could be more intelligible and concise than the words of the eminent astronomer of the Naval Observatory. As to Mr. BURNHAM's sneer at the planetary detail observed in small telescopes, it is evident he is far from entertaining a fair opinion on the subject. Should he ever be led to study the bright planets by means of one of WITH's or CALVER's silvered mirrors he will be rather astonished to see with such distinctness many of the features which are described as very difficult objects in much larger instruments, and possibly his keen and practiced eye may reach a marking, which, though of absolute existence is obliterated in the glare from very large object glasses and specula. If he is so successful he must clearly understand it is a mere deception arising from small aperture.

BRISTOL, ENGLAND, September 16, 1885.

SUN-SPOTS FOR SEPTEMBER.

R. HENRY FERGUSON.

(For the Messenger.)

The *Sun* has been observed throughout September each day except seven when clouds, or necessary absence from the city prevented observation.

Total number of days on which *Sun* was observed	23
" " " groups of spots	61
" " " spots	113
Probable total number of spots; i. e. calculated to include days when the *Sun* was not observed	70
Probable total number of spots	125
Largest number of groups, on the 3d, 4th, 5th, 26th	5
" " " spots on the 3d	13

On the 20th no spot was visible on the *Sun*; bright faculæ on the eastern limb was observed.

Nothing of especial interest was noted this month in connection with the sun spots except the proper motion and division of the spots appearing on the 8th and 21st, respectively. The former of these which was the largest spot visible during the month showed, when first seen on the 9th, a very marked, but minute triangular tongue projecting from the penumbra into the black spot. The tongue was very white, while the penumbra at point of contact with it was quite dark, perhaps due partly to contrast. On the 10th the tongue had extended itself and could be traced across the spot as a bridge exceedingly narrow at the end just formed. On the 11th the bridge had widened, and the division was complete.

During these three days the penumbra also underwent most rapid changes. When first seen it was nearly circular (elliptical on account of foreshortening) but it soon became irregular and sent out a branch from its southern side, resembling in shape the continent of South America. On the 10th this was broken into two horns, or perhaps better, chains of penumbral patches, one horn from the southern side and one from the western, and curving near their extremities toward each other. Soon after these portions of penumbra became detached and on the 14th were invisible, the bridge at the time being very wide and paler so that the black spots were clearly two, although enclosed by one penumbra.

On the 15th the two spots had separated much wider apart, the penumbra of each still being connected though only very slightly. Observation on the 16th revealed the penumbra and spots wholly distinct, each with a nearly circular penumbra and they continued to separate rapidly until they disappeared around the limb. It will also be noticed that these spots had also a decidedly rapid proper motion westward, traversing the disk from limb to limb in less than eleven days. This spot, which was at a latitude of nearly 20° should have taken nearly

12*d* 21*h* in crossing if it had the average motion of spots at that latitude.

The spots which appeared on the 21st exhibited on the 25th and succeeding days much the same phenomenon. On this latter date a white tongue appeared, and on the 28th the bridge was complete although the penumbra shows as yet no signs of division.

A peculiar phenomenon was noticed in connection with the spot first seen on the 3rd. On the 4th there appeared a very black, wedge-shaped tongue connected at its base with the umbra, extending eastward, dividing the penumbra, and for several seconds projecting into the bright surface of the *Sun*. On this latter portion no penumbra could be detected, the dividing line between the dark and bright being very sharp and abrupt.

THE ECLIPSE OF SEPTEMBER 24TH.

The eclipse which began here in contact with the penumbra at 23*d* 12*h* 05*m* "standard time" was observed and several features noticed. The brownish red border to the shadow was not seen, although carefully sought, the penumbra being very dark and clearly seen ten minutes after the time for first contact. The umbra was of an ashy blackness and wholly obscured all lunar configuration which it covered, and at the point nearest central shadow the limb of the *Moon* was so obscured that its outline could only be traced in imagination by continuation of the eastern and western limbs slightly visible. In the eclipse of the autumn of 1883 the writer could observe with ease all the more prominent markings of the *Moon*, although immersed in the brownish red shadows. On the 23rd, however, even Petavius and Tycho were much obscured by the penumbra. The night was remarkably clear. Observation was discontinued at 3 A. M. just after middle eclipse.

A BRIGHT METEOR.

Sept. 28th at 6*h* 45*m*, while returning from the post-office a very bright meteor, surpassing *Sirius* in brilliancy, darted slowly from *Aquila* and became extinguished near *β Herculis*. It appeared suddenly, though not with its full brightness, which it soon gained and retained until it went out instantly. No train of light could be seen. It looked like a white hot ball, not like ordinary meteors as a hard substance being consumed.

Yesterday I received the following communication from St. Johns, Newfoundland:

"On September 24th appeared an unusual phenomenon in the north-west. A huge red meteoric body rose over Conception Bay, and within seven minutes traversed an arc of between thirty and forty degrees."

NEWTON CENTER, MASS.

GALLE'S CATALOGUE OF COMETS FROM 1860 TO 1884.

[The following catalogue of more recent comets is from Dr. J G. GALLE'S "Uebersicht ueber die Bahn-Elemente der seit dem Jahre 1860 erschienenen Cometen, sowie ueber neu berechnete oder verbesserte Bahnen von Cometen der frueheren Zeit," contained in Nos. 2665 and 2666 of the *Astronomische Nachrichten* (vol. 112, 1—26), omitting his list of newly-computed orbits of comets earlier than 1860. The signification of the symbols, T, π, ☊, etc., has been inserted for convenience, and in the references to journals the volume (in Arabic numerals) and page, separated by a colon are generally given. W. C. W.]

The list of comets given in the third edition of "Olbers' Methode zur Berechnung der Cometenbahnen" ends with the year 1863, and for several years I have desired to bring together the additions which have accumulated since that time, together with the list of 1847 and the supplement of 1864,—into one newly-arranged catalogue: I have not thus far, however, been able to carry out my scheme as planned. In the meantime, on account of the great number of new comets, there has appeared to be a real need of such a list, and a wish expressed by the editor of this journal [*Astron. Nachr.*] has induced me to compile, as a temporary substitute, a brief synopsis of the newly added comet orbits, following in its tabular form the list of 1864.

Our limited space allows for each comet merely the approximate data from a single (if possible, the latest) orbit, and the remarks are restricted to the reference for this orbit, the date of discovery, the duration of visibility, and a few other notes, principally brief remarks on the orbit given.

The headings, T, π, Ω, i, $\log q$, e, in the table are those commonly used, and correspond exactly with the list of 1864, except that the column "mean motion," as it is called, has been omitted.

T=Paris mean time of perihelion passage.
π=Longitude of the perihelion.
Ω=Longitude of the ascending node.
i=Inclination of the plane of the orbit to that of the ecliptic.
$\log q$=Log. perihelion distance.
e=eccentricity.

The distinction between direct and retrograde motion (*D* and *R*) is, also, for the present retained. In retrograde orbits we readily change from one system of reckoning, π, i, to the other, π', i', by means of the relations

$$\pi+\pi'=2\Omega$$
$$i+i'=180^\circ$$

and it is only necessary to remember that the distance, ω, of the perihelion from the node in the retrograde reckoning is not $\pi=\Omega+\omega$, but $\pi=\Omega-\omega$.

The comets are arranged strictly in the order of their perihelion passage. This is a long established and very natural system and one possessing numerous advantages: furthermore, it has lately been made the rule of the *Astronomische Gesellschaft*, so that it will require no further discussion here. The uncertainty sometimes existing in the designation of particular comets during the year of discovery can always be easily removed, for the time being, by the addition of the name of the discoverer. Moreover a strict adherence to this system of numbering comets in each year has become necessary of late, partly on account of the greater number of comets discovered, and partly on account of the considerable increase of the known periodic comets, during the last forty years; for the actually observed returns of these comets must be arranged with the other comets. Since in many cases the periodicity has first been established at the second apparition, and in a few cases at the third, the exclusion of periodic comets from the list of apparitions of each year would frequently cause annoying changes in the designations of earlier years, and it would give rise to all sorts of ambiguity. In the publications of the past ten years, the periodic comets, particularly, have led to a great many differences in the designation of comets, an evil which is not merely of a theoretical nature, but, for those who often have occasion to refer to the literature of comets, is one which carries with it very real and practical inconveniences, frequently necessitating much troublesome comparison of observations, or of ephemerides, to decide what comet really is referred to. Especially in years in which a great many comets are seen, if the names of the discoverers are not given, there is not only loss of time, but besides this mistakes easily occur.

In the list published in 1864 this arrangement of the observed apparitions of comets in the order of perihelion passage is closely followed out to the end of the year 1863. The present supplement, however, on account of further discussion of data belonging to the years immediately preceding, I have begun with the year 1860, so that it contains the orbits of all computed comets (ninety-four in number) for the twenty-five years from 1860 to 1884.

The numbering in the first column of the table follows that of the table published in 1864. Although these numbers have no special signification here; and, as numerous insertions have been made, they ought really to be increased, still, on account of their connection with the earlier list, they have been retained. Interpolations between the earlier numbers are marked with the letters *a*, *b*, *c*, etc. The current numbers of the present list are therefore to be increased by 6+6+4=16, so that at the end of the year 1884 the number of different comets of which orbits have been computed, is 302. The number of apparitions of comets, including the present recorded returns of periodic comets, is considerably greater:

D'ARREST'S	Comet	has	been	observed	4	times.
BIELA'S	"	"	"	"	6	"
BRORSEN'S	"	"	"	"	5	"
ENCKE'S	"	"	"	"	23	"
FAYE'S	"	"	"	"	6	"
HALLEY'S	"	"	"	"	7	"
PONS'	"	"	"	"	2	"
TEMPEL'S$_1$	"	"	"	"	3	"
TEMPEL'S$_2$	"	"	"	"	2	"
TEMPEL'S$_3$	"	"	"	"	2	"
TUTTLE'S	"	"	"	"	3	"
WINNECKE'S	"	"	"	"	4	"

Accordingly 67−12=55 repeated apparitions are to be added, bringing up to 357 the total of the observed appearances of comets. In this summary, of course, no allowance is made for the great uncertainty of many of the older orbits, or for the fact that in some cases it is doubtful whether the *same* periodic comet has been seen.

In the table for the period since 1860 it appeared desirable to show at a glance the returns of the periodic comets in their chronological order, and to be able to find them among the comets arranged for each year strictly according to perihelion passage, without further reference. There are accordingly added to the numbers in the first column (which always refer to the first appearance of the comet) the initial letter of the name commonly in use for the comet:

D'A=D'ARREST'S comet B=BIELA, Br=BRORSEN, E=ENCKE, F=FAYE, H=HALLEY, P=PONS 1812, T_1, T_2, T_3=TEMPEL'S three comets, 1867 II, 1873 II, 1869 III, Tu=TUTTLE, W=WINNECKE. As no fixed rule for designating periodic comets has been established—and indeed none can be established without great difficulty—I have retained the designation which seemed to me to be most generally used. If other names should be preferred, the designation can easily be changed, without disturbing the numbering of the comets according to perihelion passage—the only point considered essential. TEMPEL'S three comets I have distinguished according to their periods as finally fixed by the observed returns; T_2 being the last discovered of these three comets.

It is readily seen that some rule of this sort must be used in such cases, in order that subsequent changes may be avoided.

There are since 1864 quite a number of comets which have been incompletely observed, or, at all events, for which only uncertain data are at hand, so that no orbit could be deduced. In some instances, the observations are so imperfect that no great value can be attached to the computed orbit. All such comets are found (as in the catalogue of 1864) with necessary references, among the notes for the different years.

Finally, it is to be mentioned that for the equinox to which the elements are referred, the mean equinox of the beginning of the year in question is, generally, to be understood. This plan for facilitating the comparison of comet orbits was proposed by OLBERS, and it will be recognized by astronomers as the commonly accepted rule. In the elements of some of the periodic comets where perturbations have been taken into account, the equinox of the beginning of the decade has lately been used to some extent, and in these cases, in the present table (which gives only minutes; and for all more accurate computations, reference must be made to the sources which are quoted) I have reduced the longitudes to the beginning of the year of the observed return.

The following abbreviations are used for journals frequently referred to:

A. N. *Astronomische Nachrichten.*

M. N. = *Monthly Notices of the Royal Astronomicul Society.*

C. R. = *Comptes rendus hebdomadaires de l'academie des sciences de Paris.*

A. V. S. = *Vierteljahrs-Schrift der Astronomische Gesellschaft.*

Wien. Ak. S. B. = *Sitzungsberichte der k. Akad. d. Wiss. in Wien, math. phys. Classe.*

[The reference is usually to the volume and page (or column in A. N.) which are separated by a colon. Further abbreviations will explain themselves.]

216 A. N. 72: 236. Discovèred by LIAIS at Olinda, Brasil, Feb.

26, and observed by him till March 13, on seven days. Not observed except by the discoverer. The second certainly known example of a double comet. PECHULE has computed the orbits of the two nuclei separately.

217. Bull. de St. Petersb. 6: 363. From all the observations formed into six normal places, which are well represented. Discovered by G. RUMKER at Hamburg, April 17. The observations of this faint comet extend over a little more than a month, a single observation of BOND's on June 11, excepted.

218. Schriften der Berl. Akad. 1867. Bright comet visible to the naked eye at various places in Europe from June 18, to about the middle of July; observed at Santiago to September 12, and at the Cape to October 18. The most probable orbit, deduced by AUWERS from a very careful discussion of the observations, showed no deviation from a parabola; similar result by FISCHER, A. N.: 67: 291.

219. A. N. 75: 165. Discovered October 23 by TEMPEL at Marseilles and observed there on the day following, and, also, October 25, at Paris. The above orbit rests on a new reduction of TEMPEL's observations, and agrees veiy closely with a provisional computation by v.OPPOLZER (A. N. 73: 189). The orbits by VALZ, widely differing from these, are to be rejected, and an identity with an object observed on November 14 seems inadmissible.

220. A. N. 62: 187. First discovered April 4 by THATCHER at New York. Seen in Europe on April 30 with the naked eye by BAEKER at Nauen. Before perihelion, observed in the northern hemisphere (at Washington and Athens) to May 25; after perihelion by MOESTA at Santiago, July 30 to August 15; by MANN at the Cape, August 18 to September 6. The definitive orbit by v. OPPOLZER is deduced from seven normal places (April to September) and gives a period of 415.43 years. The orbit comes very close to the *Earth's* orbit—evidently connected with the periodic meteors of April 20.

221. Diss. inaug. Bonn. 1880, p. 146. This great comet at its ascending node was almost directly between the *Earth* and the *Sun*, and as the plane of its orbit is almost perpendicular to the ecliptic, it appeared very suddenly in the northern hemi-

sphere, June 29—30, in its full splendor. In the southern hemisphere it had already been discovered, May 13, by TEBBUTT at Windsor. It remained visible for a long time in the northern hemisphere—far north in declination—and could be followed (at Pulkowa) even to May 1, 1862. The definitive orbit which was computed by KREUTZ, taking into account the perturbations of *Venus*, the *Earth*, *Jupiter* and *Saturn*, required no less than 1156 observations. These were brought together in thirty-one normal places. The period is 409.4 ± 0.367 years.

222. A. N. 69: 106. Discovered 1861, December 28, by TUTTLE at Cambridge, U. S., and 1862, January 8, by WINNECKE in Pulkowa. On account of its rapid decrease in brightness it could be observed for but a short time; last observed February 2 by TIETJEN at Berlin. NOETHER has divided the few observations into sixteen normal places, and the elements agree remarkably well with those by V. FUSS (Bulletin de St. Petersb. 8) from four normals.

(96) E. Mem. de l'acad. de St. Petersb. 26 No. 2 (1878). ENCKE'S comet. Found October 4 by FOERSTER at Berlin; more generally observed in November, December and January. The observations at the Cape by MACLEAR extend from December 23, 1861, to March 12, 1862.

223. A. N. 58: 141. Discovered on July 2 by SCHMIDT at Athens, and an hour later by TEMPEL at Marseilles, and also on July 3 by BOND at Cambridge, and by SIMONS at Albany. The comet, owing to its nearness to the *Earth*, looked, at first like a great nebula, even visible to the naked eye, but it soon decreased in brightness, and was observed only to July 30 (at Athens, Cambridge, U. S. and Clinton). The orbit above is from July 2, 10 and 23.

224. A. N. 59: 87. Probably first seen July 15, at Marathon, U. S., by SWIFT, who mistook it for the preceding comet [223]; more definitely located July 18 by TUTTLE at Cambridge; July 25 by P. ROSA at Rome; July 26 by SCHJELLERUP at Copenhagen. In August the comet was visible to the naked eye, moderately bright. It was observed at Athens by SCHMIDT up to September 26, and in the southern hemisphere by MANN at the Cape to October 27. From the observations

formed into six normal places, v. OPPOLZER, taking account of the perturbations of the *Earth* and *Jupiter*, found the above orbit with a period equal to 121.502 years. Closely associated with this comet is SCHIAPARELLI's discovery, in 1866, of the connection with the meteors of August 10.

225. A. N. 65: 61. Discovered November 27 by RESPIGHI of Bologna, and December 1 by BRUHNS at Leipzig. The observations before perihelion go only to December 17 (the last at Florence). After perihelion the comet was observed only twice, and with considerable difficulty, by BRUHNS. The above orbit is the most probable from all the observations divided into five normals.

226. A. N. 60: 149. Discovered by BRUHNS at Leipzig, November 30, one day before he found the preceding comet. At first, very faint; at the time of perihelion, brighter; observed by BRUHNS till March 12. Above orbit by ENGELMANN is a parabola computed from five normal places. The deviation from this curve is inappreciable.

227. Wien. Akad. S. B. 1864, A. N. 62: 343. Discovered April 11 by KLINKERFUES at Gottingen, and April 14 by DONATI at Florence. In May, visible to the naked eye; last observed November 14, at Pulkowa. FRISCHAUF has collected all the observations into eight normals, which are accurately represented by this orbit.

228. A. N. 60: 112. Discovered April 12 by RESPIGHI at Bologna, April 13 by BAEKER at Nauen, April 16 by WINNECKE at Pulkowa and TEMPEL at Marseilles, April 18 by KARLINSKI at Cracow. Last observed June 1, at Leyton, by ROMBERG. The orbit, by FRISCHAUF, is deduced from three normal places, April 18, May 7 and 18.

229. A. N. 61: 248. Discovered by TEMPEL at Marseilles, November 4, and eight days later by SCHMIDT at Athens; observed at Leipzig by BRUHNS till February 9, 1864. The elements are derived from three normal and two single places (to December 20) which are very well satisfied by the parabola.

230. Diss. inaug. Berol. 1869. Discovered December 28 by RESPIGHI at Bologna, and 1864, January 1, by BAEKER at Nauen; also January 9 by KARLINSKI at Cracow and by WATSON at Ann

Arbor. Observed at Leyton by ROMBERG to March 1. In deriving the above elements the available observations were collected into nine normal places, and they agree very closely with the parabola computed by WEISS (A. N. 61: 349) from six normal places, January 3—23.

231. A. N. 68: 158. Discovered before either of the preceding comets, October 9 by BAEKER at Nauen, and October 13 by TEMPEL at Marseilles, (Annuaire 1884). Last observed at Leipzig by ENGELMANN, April 13. The above orbit is the most probable parabola, from all the observations. A similar computation has been made by JULIUS, (A. N. 69: 6) and it gives a complete agreement with the above.

232. A. N. 73: 84. Discovered by DONATI at Florence, September 9; but few observations obtained. Last observed October 10 by ENGELMANN at Leipzig. The elements are from fourteen observations divided into three normal places.

233. A. N. 75: 164. Discovered July 4 by TEMPEL at Marseilles, July 5 by RESPIGHI at Bologna, July 11 by KARLINSKI at Cracow; last observed in the northern hemisphere at Athens Sept. 22 by SCHMIDT. In the southern hemisphere the comet was first seen August 10 at Windsor, and August 11 at Santiago by MOESTA. It was observed at Windsor by TEBBUTT till September 25, and was seen as late as September 27; also seen September 26 at the Cape, but extremely faint. The elements are derived from seven normal places.

234. A. N. 66: 123. Discovered July 23 by DONATI and TOUSSAINT at Florence; observed in the northern hemisphere till the middle of August (at Leipzig by ENGELMANN to August 13) and then in the southern hemisphere, from November 2 to December 23 by MOESTA at Santiago. On its return to the northern hemisphere it was found again by SCHMIDT at Athens, January 19, 1865, and observed to January 30; last observed February 24 by PETERS at Clinton. The elements are deduced from six normal places, and take account of the perturbations of *Jupiter*.

235. A. N. 73: 90. Discovered by BAEKER at Nauen December 15; also by CHARCORNAC at Marseilles December 19, and by RESPIGHI at Bologna December 29 (Ann. 1884); last observed

by STRASSER at Kremsmunster. Most probable orbit from seven normal places.

236. A. N. 68: 119. Discovered December 30 at Leipzig by BRUHNS; last observed January 29, 1865, by BRUHNS and ENGELMANN. The elements give the best possible agreement with the whole collection of observations.

(To be Continued.)

STELLAR PHOTOMETRY.

BY HENRY M. PARKHURST.

Early in my endeavors to devise means for the accurate determination of the relative brightness of stars, certainly as early as 1859 I was confronted with the disturbing effect of the illumination even of a darksky, which increased in the moonlight and in the twilight. With the same aperture, and therefore with the same amount of light from a given star, its apparent brightness is much increased by increasing the magnifying power; and fainter stars become visible. From an examination of my star-maps I ascertained, in 1860, that reducing the magnifying power from 96 to 27 made a difference of about a magnitude in the visibility of stars. From a series of observations in 1875, I ascertained that magnifying power of itself does not affect the apparent brightness of stars, and does not tend to bring to view fainter stars; but that the observed effect is solely due to the darkening of the field by spreading its light over a larger surface. I ascertained this by the following means:

I mounted my six-inch object-glass outside of the telescope tube, and also a holder for eye-pieces. It was then easy, in looking at stars through that, or any smaller aperture, to admit light from around the object-glass sufficient to make the illumination of the field the same, whatever magnifying power was employed. When that was done with a series of eight eye-pieces, there was no difference in the visibility of faint stars which could be attributed to magnifying power.

A little reflection showed that the bringing to view of fainter stars being due solely to the darkening of the field, the diminution of the aperture tends to bring to view relatively fainter stars; for instance, if the aperture is diminished one half in area, a star must be twice as bright intrinsically to give as much light at the focus of the telescope; but the field being darkened by the diminution of the aperture, stars less than twice as bright will be visible. The amount of this effect can be approximately ascertained from the determination in 1860 already referred to. Raising the magnifying power from 27 to 96 corresponds in the illumination of the field, with the reduction of the aperture in that ratio. To the effect of this reduction, which would be 2.7 magnitudes, is to be added the difference of about one magnitude from the difference of illumination, which will be required to extinguish the star, making the measured difference 3.7 magnitudes; in other words, the scale is extended, between these limits, about one-third.

This was not varied by extinguishing the pencil of rays near the eye-piece; for although a large part of the field would remain bright, there would be a darkening of the field on the side where the stars were extinguished, and the background upon which the star is last seen is precisely as much darkened as if the pencil of rays had been reduced in the same proportion by diminishing the aperture of the object-glass.

The same principle is evidently applicable to the use of the wedge for extinguishing the star. As the star passes the transit wire, it is seen projected upon a field of a certain brightness. It passes behind the wedge, and is constantly passing into a darker and darker field. The star's light must be reduced by four magnitudes (using for convenience this rough approximation) to reduce its visibility by three magnitudes. But we have no means of determining directly how much the star's light is diminished by the wedge; we can only determine how much its visibility, as affected by illumination, is reduced. So that if we have a correct standard of comparison, and neglect for the present second differences, the varying illumination will not introduce any error into our results, provided the illumination is the same when we make our observations as it was when the scale was determined.

But suppose that we determine the scale by comparisons with a dark sky, and that we subsequently make observations with full moonlight, or a brief twilight; how will that affect the results? That depends upon the law of extinction from illumination, upon the investigation of which I have spent a great deal of time, and made many thousands of observations, without reaching satisfactory results. But I will assume certain numbers for convenience in illustrating the principle: and it will be seen that they can be varied exceedingly without affecting the argument.

Suppose we start with an illumination barely sufficient to affect the retina perceptibly, extinguishing .01 magnitude; so that a star appears .01 magnitude fainter in consequence of that illumination than it would if there were absolutely no illumination.

First, let us diminish the illumination. We reduce it 5 magnitudes, or one hundred fold. This can only reduce the extinction by .01 magnitude; and if we were to reduce the illumination 5000 magnitudes we could not reduce the extinction any more.

Next let us increase the illumination one hundred fold, or 5 magnitudes. Starting with .01 magnitude extinction, one hundred times the illumination, while it will not produce one hundred times the extinction, may produce ten times, or .1 magnitude. Increasing the illumination again one hundred fold, it will be pretty safe to say that the extinction will have increased to a whole magnitude.

Now suppose a 12th magnitude star is just visible through the thin edge of the wedge while *Polaris*, a 2nd magnitude star, is visible at the thick edge. The apparent light must be reduced 10,000 times by the wedge between these two points.

The light of the sky must be reduced in the same proportion. If at the thin edge the light of the sky is only sufficient to reduce the star by .01 magnitude, there will be no appreciable difference between the extinction of the two ends of the wedge: it cannot exceed .01 magnitude.

But, on the other hand, suppose that in consequence of a bright moon or twilight, the light of the sky is sufficient, even at the back end of the wedge, to produce an extinguishing effect of .01 magnitude. In that case it is evident that at the thin edge, where the illumination is 10,000 times greater, the effect must be very considerable; perhaps exceeding the amount suggested above 1.0 magnitude. The scale of the wedge having been determined with the dark sky first assumed, there will evidently be introduced a very appreciable difference of scale with the bright sky last assumed.

I understand Prof. PICKERING to believe that in the observations of Prof. PRITCHARD with the wedge, there are to be found evidences of such a change of scale from varying illumination. The amount of the variation is not yet important; but its existence, for I understand Prof. PRITCHARD to claim that the constancy of his observations of *Polaris* proves that if there is any error at all, it is inappreciable.

I regret that he did not group his observations of *Polaris* in a more satisfactory way. With the light of the full moon taken as unity, the average light of the second and third quadrants is about .373, while the average light of the first and fourth quadrants is about .026; but if he had divided the circle into four parts, so as to bring the full moon into the center of one of the parts, the average light of the full moon period would have been .599, of the first and third quarters .096, and of the new moon period only .007. Such a grouping would have shown much more plainly any effect of the moon's illumination.

But taking the figures as he gives them, and admitting that the difference is not greater than the ordinary errors of observation; what does that prove? Simply that the effect of the moonlight in the thick part of the wedge, where the light of a 2nd magnitude star is reduced to invisibility, is inappreciable. That is just where we should expect the effect to be the least; it is where the effect of the moonlight is reduced 100 times less than its effect in observing a 7th magnitude star through a thinner part of the wedge.

I have recently made some observations directly bearing upon this point. In a certain group of stars, I found two of such relative brightness, that in observing with a dark sky, the brighter through a shade and the fainter without it, the magnitudes were almost precisely equal, measured photometrically. Several days before full moon, when its light was .25, the brighter star seemed about as before, but the other had become too faint to measure. I then compared the brighter, seen through the shade, with a third star seen without it; and the result was, allowing for the known difference in the magnitudes of these two comparison stars, that the fainter star was extinguished 1.2 magnitudes more than the star seen through the shade. The observations of the brighter star through the shade, corresponded with an observation through the thicker part of a wedge, while the observations of the fainter stars corresponded with observations at the commencement of the wedge; the difference of 1.2 magnitudes caused by the moonlight corresponding with the error which would be produced by the same amount of moonlight in comparing the same stars with the wedge, the scale having been determined in a dark sky.

These considerations and observations suggest two precautions in the use of the wedge: 1st, that there shall be no moonlight or twilight sufficient to cause an error appreciably increasing the error of observation; and 2nd, that the scale shall be determined with the same magnifying power used in the observations.

It has been suggested that the three observations upon which so many of the determinations in the Harvard Photometry are based, are insufficient to give a result as accurate as is desirable. Admitted: yet it may be better to have observed 4000 stars with three observations each, than 2000 with six observations each. In the latter case each individual star would be better determined; but in most cases the object will be to compare some new star with *Polaris*. If it is compared by three observations with each of four of the H. P. stars, it is nearly equivalent to twelve observations with *Polaris*; and six observations each, of two stars previously determined by six observations each, would give no better result. We have then in the Harvard Photometry, the means of multiplying *ad libitum* our comparisons with *Polaris*, by the aid of stars in the same part of the heavens as the star we wish to measure.

All methods of stellar photometry founded upon extinction by diminished aperture, involve the question of diffraction; which opens a field broad enough to be reserved for another article.

VARIATION IN THE NEBULA OF ANDROMEDA.

W. H. NUMSEN.

The remarkable variation in the great nebula in *Andromeda* was duly observed immediately upon receipt of the news. On Sept. 1st it was watched at intervals for about three hours, from 8*h* 30*m* to 11*h* 15*m* (75th meridian time) in company with several others at the observatory of another. Its brightness, during the interval, I estimated at about the 5th magnitude by a rough comparison with ν *Andromedæ* (4½), but on the next night, at my own observatory, I came to the conclusion that this was an overestimate, for a careful comparison with D. M. +39°,158, convinced me that it was no brighter than 7th magnitude. The nucleus, however, was very sharp and distinct, standing out clear from the surrounding bright nebulosity, and while, in this sense, it was stellar, yet there was something about it that did not impress itself upon me as a real star point. This, however, may have been due to its being seen through the nebula. The intrinsic brightness did not seem to equal that of a star, and it rather resembled the appearance of the stellar nucleus that formed so suddenly in the Pons-Brooks comet, and which was seen by me on the night of January 13th, 1884. The observations below were made with my 4-inch Cooke equatorial.

The comparison stars were identified after each observation by means of the Durchmusterung maps, a diagram being made at the telescope at the time. The magnitudes appended are those found in the "Bonner Sternverzeichness—Zweite Section." At the end of each observation, is given the approximate magnitude, as estimated by me from the comparisons with the D. M. stars.

Sept. 2nd.—8*h* to 9*h* 15*m*. Clear, 60. Stellar nucleus about the same as last night. Certainly not as bright as HEIS 85 = 32 Flamsteed, 5½ magnitude according to the " H. P. " (This star was identified afterwards by means of HEIS' Atlas. It was also seen to be brighter than nucleus last night, but not having my maps at hand, its name and magnitude were not known. Nucleus about equal to *a*, brighter than *b*. Perfectly stellar and sharp again. 7th.

Nova and Companion Stars.

Cloudy weather and illness prevented any further observations until the 9th, except on 8th, when it was observed with an opera-glass from my window. It was then seen to be fainter than HEIS 85, and thought to be more easily seen than D. M. +39°. 158.

Sept. 9th:—11*h* 45*m* to 13*h* 15*m*. Cleared up and bright—p. 60. Undoubtedly fainter since last seen with telescope. Seems brighter than *b*, and fully equal to *c*, and perhaps slightly brighter. Appears dull though still very distinct from balance of nebula. 9th.

Sept. 12th:—7*h* 20*m* to 9*h* 40*m*. Clear, crescent *Moon* for awhile. Not certain about seeing it with finder, but with p. 25 and 60 it is still plain and distinct. Appears fully as bright as *b* or *c*, intrinsic brightness seems also about equal to those stars. At times think nucleus slightly brighter, perhaps, but it is certainly as bright. 9th.

Sept. 14th:—7*h* 30*m* to 8*h* 20*m*. Clear, *Moon* near first quarter. Not always evident with p. 25, sometimes blurred, better with p. 60. When steadily seen generally appears perfectly stellar. Sometimes think almost equal to *b* and *c*, but generally not as bright. *Much* brighter than *x* and *y*, and more nearly equal to *d*. 9¼.

Sept. 15:—7*h* 40*m*. Seen for only five minutes or so between clouds. Quick comparisons with *d* seemed to make it about same as last night, possibly very slightly fainter, though not enough time to satisfy myself upon this.

(To be Continued.)

EDITORIAL NOTES.

The new variable star in the great nebula of *Andromeda* still continues to be a celestial object of great interest to every astronomer at home or abroad. For more than two hundred and seventy years this nebula has been observed by the telescope, and yet very little progress has been made in learning its physical constitution. "Its spectrum is continuous without transversal dark lines, and consequently the substances which compose it remain unknown. The highest powers have shown 1500 stars in it, but it is not certain that these stars belong to it; they may be simply before it. Its shape alters strangely according to the power employed."

As stated last month, the first intelligence of the existence of this new star came to us from Mr. J. C. McClure, of Red Wing, Minn., who observed it on the evening of August 27. Mr. H. S. Moore, of Texas, saw it September 30th. Dr. HARTWIG, of Dorpat, observed it August 31st and immediately reported the observation by telegraph to astronomers everywhere, so that on the first days of September it was very generally observed.

The exact date at which the outburst took place, (if sudden, or comparatively so) is not known. The record of observation, however, is nearly continuous for the month of August. On the 18th day of that month, as reported by the *Observatory*, a Mr. SLIOOCK observed the nebula and was sure that the star was not then seen. At 11 o'clock P. M., August 19th, ISAAC W. WARD reports a new star distinctly visible. On August 22nd this observation was confirmed by others made in Russia It is very probable then, that this wonderful change took place either on the 18th or 19th day of August, and that the star was brightest a b o u ugust 31st, or Sept. 1st, at which time English observers claim that its magnitude was 6.5. Sept. 2nd and 3rd it was 7.3, with little change in magnitude. From this time the star declined rather unsteadily, alternately rising and falling, until Sept. 18th its magnitude was 9.2 and at the end of the month it was certainly below an eleventh magnitu de.

The star is of an orange yellow tint.

It is difficult to determine its spectrum because of its unfavorable surroundings and its faintness. Reports that have been received are so conflicting that little confidence is felt in conclusions based on the observations of the spectroscope.

The most that can be said is that the spectrum is continuous, which of course gives no knowledge of present physical conditions of the *nova*. The following points, gathered from American observers of experience may be of interest to our readers:

1. The star does not in any way affect the structure or brightness of the surrounding nebula.

2. It stands apparently only in accidental relation to the nucleus of the nebula. It is not *in* the nucleus, but about 15″ one side.

3. It has not changed its position since its appearance.

4. Its spectrum was on Sept. 1st and 2nd as nearly continuous as that of any star known to our most experienced American observers.

OBSERVATIONS OF THE NEW STAR IN THE NEBULA OF ANDROMEDA.

News of the outburst was received at Princeton in the afternoon of Sept. 1, by telegram from Cambridge, and observations were made the same night.

The star, as seen in the 23-inch equatorial with the 'comet eye-piece' (power 110) was of a brilliant orange color, and much brighter than anything else in the field of view, which is about 28′ in diameter. It was adjudged about half a magnitude fainter than the star Argelander 39° 158, which is given as 7th magnitude; but no photometer readings were taken. It was easily visible in the 2-inch finder. In the 5-inch finder it was of course conspicuous, and by close attention, the old nucleus of the nebula could be seen, just to the east of the new star, but nearly overpowered by it.

With a power of 360 on the great telescope, the nebula was seen to retain its familar form and appearance, unchanged, except so far, of course, as the introduction of a fiery spark into such a luminous haze would necessarily modify it subjectively. The contrast between the ruddy, sharply-defined star, and the indefinite, hazy, yellowish-green glow of the nucleus was very beautiful.

A set of micrometer measures was made, to determine the distance of the new star from the little 11th magnitude star which follows the nucleus about 11s, nearly on the parallel. They gave, position angle 262° 34′, distance 109.3″. Another set on Sept. 2nd gave, 262° 36′ and 109.6″ (No correction for differential refraction yet applied.)

The distance from the star to the brightest part of the nucleus is about 14.5″—but no accurate measure was attempted, because it is impossible to set the wire with much precision on the nucleus, which loses its definiteness under any adequate magnifying power.

Most of the time on September 1st was spent in trying to make out the spectrum of the star. Various forms of instrument were used, and all agreed in showing simply a continuous spectrum in which we could make out no lines or bands of any kind; but it was abnormally weak in the blue portion. I do not mean to say that there were no lines or bands present; only that if they existed at all, they must have been very faint and hard to see, for we expected to find them, and looked for them carefully. The dark lines in the spectrum of the 7th magnitude star, before mentioned, came out well with the same apparatus.

With a power of 1100 the star was still a star, as sharp as any of the neighboring stars, while the nebula nucleus had become a mere diffuse glow of light.

Subsequent observations have added very little. The star has maintained its position unchanged, but has grown gradually fainter, though not without fluctuations, and sometimes slight increase of brightness. Since Sept. 12th we have made photometric comparisons on seven nights with the 9th magnitude stars, Argelander 39,145 and 149, using a wedge photometer. At the last observation the new star was at least half a magnitude fainter than either of them.

On September 18th the new star was nearly a quarter of a magnitude *brighter* than on the 17th or 25th, the next preceding and following observations.

On September 7th, when the new star was about 8.2 magnitude, we, for a while, thought that the small round nebula, M. 32, just south of the great nebula, was sympathizing in the excitement. Both in the 5-inch finder, and with powers up to 300 in the great telescope, its nucleus looked exactly like a star of the ninth magnitude; with powers exceeding 500, however, the stellar appearance was lost, and we concluded that probably the imagined change was imaginary only.

Princeton, N. J., Oct. 5, 1885. PROF. C. A. YOUNG.

Astronomers have watched with interest the work of Dr. WILLIAM HUGGINS, of London, and other English physicists who have been studying the solar corona by photography, during the last two years, without the favoring circumstances of a total eclipse. From results obtained it seems evident that real progress has been made in the solution of this, one of the most difficult and delicate problems known to solar physics.

During the early part of this year, however, Professor W. H. PICKERING of Boston made some attempts to photograph the corona of the *Sun* under similar circumstances which were unsuccessful.

He said in *Science* (August 14, 1885): "The result of my researches, seems to indicate 1st, that without a total eclipse it ought to be impossible to photograph the solar corona; 2nd, having tried, I have failed to photograph the corona, but have obtained the result which theory indicated."

To the paper containing the result of Prof. PICKERING's work, Dr. HUGGINS replies, the following being a letter addressed to *Science* and THE MESSENGER, October 2, 1885.

"Mr. W. H. PICKERING having courteously sent me a copy of *Science* (August 14) containing a letter entitled "An Attempt to Photograph the Solar Corona without an Eclipse" may I ask you to insert the few lines which follow, in the next number of your journal?

Passing by all those points which are covered directly or indirectly by my reply to Mr. PICKERING's first letter (*Science* April 3) I find only two matters which I consider it necessary to notice.

1. Mr. PICKERING says: "The inferiority of the best gelatine plates to the human eye in this respect (small differences of light) is very readily shown by an attempt to photograph distant mountains." He then goes on to say: "Another illustration of the same thing is the impossibility of photographing the *Moon* in the daytime when the *Sun* is high above the horizon. Although the *Moon* may be perfectly distinct to the eye, the negative shows no trace of it."

To your scientific readers the reasons will readily suggest themselves why in the case of the *Moon* in the daytime at some angular distance from the *Sun* the eye has an advantage over the plate, while in the case of the corona the plate has a great advantage over the eye. Next, from any such considerations, as a matter-of-fact, *there is no difficulty in photographing the Moon at noonday.* Yesterday I took with the apparatus used on the corona four negatives on bromide plates (EDWARD'S) between 11:30 a. m. and noon in full sunshine. On all the plates the *Moon* is very distinct and well defined. The *Moon* at noonday, unless too near the *Sun* is an easier object to photograph than the corona. It is obvious, therefore, that photographic methods which are not delicate enough for the *Moon* must utterly fail if applied to an object still more difficult, as the corona undoubtedly is at ordinary elevations.

If Mr. PICKERING'S statement of the "impossibility" of photographing the *Moon* under the conditions already named rests upon his own experiments, some light may come upon a point which has occasioned me surprise, namely that Mr. PICKERING does not appear to get upon his plates, the effects of his own apparatus; for example those of the position of his shutter, and those of his spectacle lens. In some experiments I made with a shutter, similarly placed, very strong diffraction effects appeared on the plates; effects stronger than any photographic action which could be supposed to be due to the corona.

2. With regard to Mr. PICKERING'S experiments, I would point out that the conclusion to which they lead him, namely:—"It therefore seems that even in the clearest weather the reflected light of the atmosphere is 300 too strong to obtain the faintest visible image of the true coronal rays;" appears to me to be irreconcilable with the direct observations of Prof. LANGLEY and others, of the planets *Mercury* and *Venus* as black disks before they reach the *Sun*. Prof. YOUNG says: "Of course this implies behind the planet a background (of corona) of sensible brightness in comparison with the illumination of our atmosphere.—[*The Sun p. 229.*]

I trust that Mr. PICKERING will not think me wanting in courtesy, if I should prefer not to take notice of any further communications he may make on this subject. The Bakerian lecture, read recently before the Royal Society, in which I have discussed some of the points more fully will be in print in a few weeks. The photographic method is now being tried at the Cape of Good Hope under the scientific conditions I have pointed out as essential by Mr. RAY WOODS under the able superintendence of Dr. GILL, F. R. S."

PARALLAX OF 61 CYGNI.

In Dunsink observations (V) Prof. BALL gives a history of researches on the *parallax* of this star. In 1837—38 BESSEL found a parallax of 0.314″, using two comparison stars, D. M. 37°, 4173 (8.8 mag.) and D. M. +37°, 4179 (8.6 mag.) In 1853 O. STRUVE found the parallax to be 0.509″ using D. M. +37°, 4345 (9.4 mag.) Dr. LAMP has re-reduced this and finds −0.5063″ ±0.0234″. In Moscow observations, VII, p. 79 is a series of measures by SCHWEIZER with the latter comparison star extending over the years 1863—1866. These have been reduced by SOCOLOFF, who finds parallax=0.4330″ ±0.0291″. Dr. LAMP has re-computed this and finds 0.4396″ ± 0.0223″. Dr. BALL made a series employing D. M. +37°, 4351 (9.5 mag.) and 61 A *Cygni*. The resulting parallax was 0.4654″ ± 0.0497″ (Dunsink, III p. 16). Dr. BALL made another series in 1878—79, using 61 B and D. M. 4351. The resulting parallax is 0.4676″ ± 0.0321″. Prof. HALL (Wash. Ast. Obs. 1879) has used the same comparison star as STRUVE (D. M. 4345) and finds the parallax of 61 B *Cygni* to be 0.4783″ ± 0.0138″.

C. A. F. PETERS from absolute I. D. gives (1846)—0.359″.

Dr. AUWERS (Abh. d. Acad. Berlin 1868) has re-discussed BESSEL's and SCHLUTER's results. The following Table is taken from Dr. AUWERS and SCHLUTER:

BESSEL: first 14 months	0.357″
" last 3 months and SCHLUTER	0.536
JOHNSON: first 3 months	0.526
" last 1 month	0.192
STRUVE:	0.511
AUWERS	0.564

ON THE BRIGHTNESS OF THE NEW VARIABLE STAR IN ANDROMEDA.

The method followed in the observations of this star was that proposed by Prof. PICKERING in his "Plan of securing Observations of the Variable Stars," p. 12. It consists in estimating the brightness of the variable in tenths of the interval between two comparison stars, one slightly brighter, the other slightly fainter than the star to be measured. The number of tenths estimated is written between the letters of the comparison stars, that of the brighter standing on the left side, and smaller numbers indicating greater brightness.

The instrument employed is a 3-inch telescope by MERZ. The observations were made by two observers: H=HAGEN and Z=ZAISER, the latter being assistant at the observatory.

In order to facilitate the comparision of our observations with those of others, the following Table I exhibits the places and magnitudes of the four comparison stars, *A*, *B*, *C*, *D*, to which are added the three comparison stars, *b*, *c*, *d*, employed by Mr. E. E. BARNARD, as represented in his sketch, page 241 of the MESSENGER. His observation of September 3 is a valuable addition to the following series of magnitudes, and is given below in Table II, under the letter *B*.

TABLE I.

Comparison Stars; position and magnitude taken from the D. M. (1855).

A	0*h* 38*m* 6.7*s*	+40° 0.8′	magnitude 7.5
B	37 45.2	23.5	9.0
C	36 54.2	30.8	9.0
D=*b*	36 9.7	40 46.9	8.9
c	34 9.5	39 53.6	7.0
d	36 11 3	38.0	8.0

TABLE II.

Date	Central Time	Observations	Remarks	Obs.	Reductions.	Mags.
Sept. 3.5		*c* 5 *b*, *c* 10 *d*		B.	8.0	8.0
9	9*h* 16*m*	*A* 8 *B*	Sky clear	H.	8.7	
10	8 10	*A* 7 *B*, *A* 8 *D*	Very clear	H.	8.6	8.6
13	8 7	*A* 8 *B*, *A* 9 *D*	" "	H.	8.7	8.8
14	9 50	*A* 9 *B*, *A* 10 *D*	" "	H. Z.	8.9	8.9
15	9 28	*A* 9 *B*, *A* 9½ *D*	Moonshine	H. Z.	8.9	8.8
16	9 0	*A* 8 *B*, *A* 9 *D*	"	H.	8.7	8.8
		A 8½ *B*, *A* 9 *D*		Z.	8.8	8.8
17	9 33	*D* 1 *B*	Clear	H.	8.9	
	9 43	*A* 9 *D*		Z.	8.8	
18	9 27	*D* 1 *B*	Cloudy	H.	8.9	
19	8 35	*D* 1 *B*		H.	8.9	
		D 2 *B*		Z.	8.9	
20	8 46	*D* 10 *B*	Moon very bright	H.	9.0	
		D 9 *B*	" " "	Z.	9.0	
21		*D* 10 *B*	" " "	H. Z.	9.0	
22	8 36	*B* 10 *C*, *D* 10 *C*	" " "	H.	9.0	

On September 23, 24, 25, 26, the star was observed less than C, i. e. less than 9.0 mag. From October 1, it was entirely invisible with power 30, i. e. less than 9.5 mag. Each observation is reduced separately for the sake of comparison. The reductions, however, being based on the magnitude of the Durchmusterung, are only preliminary, and may easily be transferred to the photometric scale of Harvard College Observatory, as soon as the comparison stars have been subjected to a new determination with the photometer. J. G. HAGEN, S. J.

College of the Sacred Heart, Prairie du Chien, Wisconsin.

Occultation ot the Hyades, Observed at Williamstown, Mass., on September 28th, 1885.

The following observations of occultations of stars in the *Hyades* group were made at the Hopkins Observatory of Williams College:

Star	Phase	Williamstown M. T.		
D. M.+15,621	Emersion	9*h*	54*m*	47.0*s*
Theta[1] *Tauri*	Immersion	10	13	51.7
Theta[2] *Tauri*	"	10	21	8.3
Theta[2] *Tauri*	Emersion	11	1	56.3
Theta[1] *Tauri*	"	11	8	40.0
D. M.+15,633	"	11	25	57.8
B. A. C. 1391	"	12	12	10.7
D. M.+15,640	"	12	17	10.9
Alpha *Tauri*	Immersion	13	57	13.0
" "	Emersion	15	15	5.4

These observations were made with the Clark equatorial of 7½-inches aperture, using a power of 120 for the immersions and a power of 77 for the emersions. The times were noted by a mean time chronometer, beating half seconds, whose error was determined by careful comparison with the sidereal clock at the Field Memorial Observatory, both before and after the observations. Prof. T. H. SAFFORD determined the error of the sidereal clock by observation with the Wanschaff transit, the resulting correction being reduced to the meridian of the Hopkins Observatory, which is 1.52*s* east of the Field Observatory.

The atmosphere on this night was remarkably steady, and, so far as I could judge, the disappearance and re-appearance of the stars were absolutely instantaneous. The immersion took place at the bright limb.

I must here express my acknowledgements to Prof. SAFFORD for his courtesy and kindness in placing the facilities of the observatory at my disposal, and thus enabling me to make these interesting observations.

The working list was formed by plotting the *Moon's* apparent path and the places of the neighboring stars, and deducing from the plot the times of immersion and emersion, and the position angles for each phase.

HOOSAC FALLS, N. Y., 5th Oct., 1885. JOHN TATLOCK, JR.

NEW STAR IN ANDROMEDA NEBULA.

"While engaged in making some miscellaneous observations this evening my attention was particularly directed to the great nebula in *Andromeda*, the central part of which, always bright, seemed very much brighter than ever before.

In fact the center of the great nebula seems now to be occupied by a well-defined star which I estimated to be of the 6th or 7th magnitude.

The fainter portions of the nebula are not nearly so well-defined as as if the light of the nebula were overpowered by that of the star.

The object thus seen is surely a star, inasmuch as with powers of 40, 80, 135, 200 and 300 the star like disk was clearly and sharply defined The star-like character was also plainly indicated in the finder. Can it be that we have here a solution of the mystery of this nebula as indicated by the spectrum observations of Dr. HUGGINS who found a continuous spectrum cut off at the red end. It has long been a mooted question whether the nebula of *Andromeda* was stellar or gaseous.

Should the object seen by me prove to be in fact a star will it be classed among the "variables" or take permanent rank as another nebulous star, or will it fade into star mist like the new star in *Cygnus* in 1876? At all events it deserves to be carefully watched."

HENRY A. PAVEY.

[NOTE: —The above recorded observation was made by me on Sunday night, August 30th, 1885, from 9 o'clock p. m. to 11 o'clock p. m. at Hillsborough, Ohio.]

Letter to the Editor from Professor EDWARD S. HOLDEN, *relating to the Lick Observatory and to the Washburn Obeervatory.*

MY DEAR SIR:—

The Lick Observatory is a gift from Mr. JAMES LICK to the State of California. t is to be built and completely equipped under the direction of the Board of Lick Trustees, of which Captain RICHARD S. FLOYD is President. The Observatory, when completed, and the unexpended balance of the original fund of $700,000 are then to be turned over to the Regents of the State University of California as the Astronomical Department of the University. I have beeen elected President of the University of California and Director of the Lick Observatory and I shall assume these new duties about January 1st, 1886.

May I ask, through your columns, that letters and parcels destined for me personally should be directed to me at Berkly, California, (the seat of the University), while parcels for the Observatory should be addressed:

Library of the Lick Observatory,
San Jose, Santa Clara County,
California.

I desire to thank the many astronomers and societies who have generously added to the library of the Washburn Observatory by their gifts, and to ask of them a similar generosity to the Lick Observatory, where a large library is forming.

Real astronomical work at the Lick Observatory will begin as soon as it is possible. Under the provisions of the Trust, no salaries can be paid to observers until after the completion of the Observatory; and this date depends upon the time at which the large telescope is finished by the firm of A. CLARK & SONS. Everything else is practically complete.

I have hopes that some arrangement may be made by which the meridian circle and the 12-inch CLARK refractor may soon be put to use. The Washburn Observatory will shortly print its Volume IV, containing as many of the observations of the 303 fundamental stars as I have been able to make since May, 1884, when this work was begun.

I am, my dear Sir, very faithfully yours.

EDWARD S. HOLDEN.

WASHBURN OBSERVATORY, University of Wisconsin, Madison, October 20th, 1885.

WEIGHT OF LARGE OBJECT-GLASSES.

The glass in the cell for the 30-inch Pulkowa refractor weighs 428 pounds. If the weight of the 36-inch objective for the Lick Observatory increases proportionally, its weight will be 740 pounds. These are heavy weights to handle.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 10. DECEMBER, 1885. WHOLE NO. 40.

THE GREAT RED SPOT ON JUPITER.

PROF. G. W. HOUGH, DIRECTOR OF DEARBORN OBSERVATORY.

The earlier observers of the planet *Jupiter* inferred that its visible surface was subject to rapid and extraordinary changes, occurring in a few days, or even a few hours.

"On the 13th of December, 1690, Cassini perceived five belts on the planet, two in the northern hemisphere, and three in the southern. An hour afterward there appeared only the two belts nearest the center, and a feeble trace of the remaining northern belt. The same astronomer frequently witnessed the formation of new belts on the planet in the course of one or two hours."—*Grant's History of Physical Astronomy.*

Without multiplying examples of alleged extraordinary changes, it may be added that the tradition has come down to us that there is no permanency with regard to the markings on the disc, and this doctrine appears to have been adopted by modern observers. I entirely dissent from this view of the subject.

I think it is more rational to believe that such extraordinary phenomena as the formation or destruction of belts, in an hour or two, was due to the condition of the seeing, rather than to physical change on the surface of the planet.

Soon after the discovery of the great red spot on the southern hemisphere of the planet Jupiter, in 1878, it was alleged, by various astronomers, that it was subject to marked fluctuations in its length. Similar statements have been made from time to time during the past seven years.

The following micrometer measurements, from Sept. 11th 1879, to June 27th, 1885, of the length, breadth and latitude of this object, may help us to decide whether such statements were warranted.

The micrometer observations for length usually consisted of five single distances, the time being noted. The measures, preferably, were made when the center of the spot was near the central meridian of the planet, but occasionally they could only be secured at 25 or 30 degrees distance.

The measures for breadth were made in the same manner.

The latitude, or distance from the equator, was determined by three measures from each pole.

In the table, the first column is the date; second, the length; third, the difference in length from the "mean" of all the observations; fourth, breadth; fifth, latitude.

Date.	Length.	Dif. Mean.	Breadth.	Latitude.
1879.	"	"	"	°
Sept. 11	11.12	—0.54	3.26	....
Sept. 18	....	....	....	—7.12
Sept. 25	10.82	—0.84	....	—6.44
Oct. 5	13.27	+1.61	2.38	—7.56
Oct. 10	11.80	+0.14	3.05	—7.11
Oct. 14	13.03	+1.37	3.61	....
Oct. 15	13.21	+1.55	....	—7.00
Oct. 20	12.24	+0.58	....	—7.14
Oct. 22	....	....	3.52	....
Oct. 29	11.90	+0.24	3.57	—7.25
1880.				
Feb. 10	12.78	+1.12	....	—6.00
June 9	10.67	—0.99	....	....
June 16	12.53	+1.87	3.79	—6.79
July 3	11.30	—0.36	....	—7.01
July 5	11.28	—0.38	3.72	—6.95
July 8	11.66	—0.00	3.28	....

Date.		Length.	Dif. Mean.	Breadth.	Latitude.
1880.		″	″	″	″
July	20	12.10	+0.44	...	...
July	22	11.38	—0.28	...	—7.09
July	27	11.94	+0.28	3.32	...
July	29	...	...	...	—7.50
Aug.	3	11.37	—0.29	...	...
Aug.	5	11.98	+0.32	3.41	...
Aug.	6	...	...	...	—7.42
Aug.	11	...	...	...	—7.46
Sept.	4	10.90	—0.76	3.41	—7.32
Sept.	6	11.95	+0.29	...	...
Sept.	9	12.03	+0.37	3.87	—6.81
Sept.	21	11.47	—0.19	...	...
Oct.	13	11.55	—0.11	3.39	—7.04
Nov.	26	10.73	—0.93	3.63	—7.00
Dec.	10	10.94	—0.72	...	...
Dec.	12	11.51	—0.15	...	...
1881.					
Jan.	17	12.28	+0.62	3.65	—7.23
June	20	...	...	...	—7.44
June	22	11.93	+0.27	...	...
July	28	11.51	—0.15	...	—7.28
Aug.	2	11.64	—0.02	...	...
Aug.	4	...	...	...	—7.23
Aug.	24	11.36	—0.30	3.54	...
Sept.	21	11.05	—0.61	...	...
Oct.	7	...	...	...	—7.50
Oct.	24	...	...	...	—8.15
Oct.	26	11.34	—0.32	3.41	—6.95
Nov.	21	11.50	—0.16	3.52	...
Nov.	22	11.57	—0.09	...	—7.33
Dec.	28	10.56	—1.10	...	...
1882.					
Jan.	9	10.65	—1.01	...	—7.27
Feb.	4	11.04	—0.62	4.17	—7.26
Feb.	14	11.45	—0.21	...	...
Mar.	22	11.25	—0.41	...	—7.57
July	13	11.90	+0.24	...	...
July	25	...	...	...	—8.09
Aug.	18	...	...	...	—7.69
Sept.	25	11.93	+0.27	3.66	...
Oct.	3	11.76	+0.10	...	...
Nov.	1	11.20	—0.46	...	...
Dec.	29	11.03	—0.63	3.64	—7.34
Dec.	31	12.16	+0.50	...	—7.58
1883.					
Jan.	3	12.54	+0.88	...	...
Feb.	20	11.79	+0.13	...	—7.33
Feb.	27	11.32	—0.34	...	—7.17
Mar.	9	12.04	+0.38	...	...
Mar.	21	12.34	+0.68	...	—7.25
Mar.	23	11.95	+0.29	...	...

Date.	Length.	Dif. Mean.	Breadth.	Latitude.
1883.	″	″	″	″
Apr. 9	....	....	....	—7.70
Sept. 10	....	....	....	—6.37
Sept. 17	13.09	+1.43	....	—6.99
Nov. 6	12.23	+0.57	....	—5.67
Nov. 24	11.79	+0.13	....	—6.81
1884.				
Feb. 9	....	....	....	—5.79
Feb. 22	11.90	+0.24	....	—6.33
Mar. 9	12.84	+1.18	....	....
Apr. 2	11.93	+0.27	....	....
Apr. 4	....	....	....	—6.71
Apr. 16	....	....	....	—6.31
Apr. 26	....	....	....	—5.82
May 13	....	....	....	—6.14
Nov. 7	11.61	—0.05	....	—6.60
1885.				
Feb. 2	....	....	....	—6.73
Feb. 27	10.32	—1.34	....	—6.69
Mar. 9	....	....	....	—6.41
Mar. 11	9.83	—1.83	4.60	....
Mar. 23	10.02	—1.64	4.00	—6.20
Apr. 4	10.92	—0.74	4.01	....
Apr. 9	....	....	....	—6.78
May 3	11.17	—0.51	....	....
May 10	11.10	—0.56	4.59	....
May 15	12.73	+1.07	....	—6.11
June 8	....	....	....	—6.63
June 27	12.77	+1.11	....	—6.09
Mean.	11.66	.... 68 obs.	3.61 26 obs.	—6.96 57 obs.

The mean length from 68 observations is 11″.66 or 37°.9 of Jovian longitude. (Mr. Denning, in the *Observatory* for October, has inadvertently given 34°.3 as equal to 11″.65.)

The mean breadth from 26 observations was 3″.61, and the mean distance from the equator of the center of the spot, from 57 observations, was −6″.96.

Assuming that the length of the spot remained constant, the mean error of a single measure was + 0″.59 or 2 degrees.

The observations made during the opposition of 1880, when the conditions for measurement were most favorable, gave a mean error of +0″.43. These errors are not excessive.

An examination of the residuals in the third column leads us to infer that the fluctuations, if any, in the length of the great red spot, between Sept. 1879 and June 1885, were inappreciable to the eye of the observer.

The apparent length, as measured, was undoubtedly affected by the conditions of the seeing. Under very favorable conditions of the atmosphere the ends of the spot appeared as a sharp V, but when the definition was not so good, they were blunt and rounded. A difference of one second of arc, on either end, due to this cause, would not be an improbable quantity.

During the period covered by these measures, there was probably a slight oscillation in the length, as shown by the residuals in the third column.

The following synopsis will show at a glance the possible fluctuation in length, breadth and latitude.

The numbers show the deviation during each opposition from the general "mean."

Opposition.	Length.	Breadth.	Latitude.
	"	"	"
1879	+0.59	+0.15	—0.01
1880	—0.11	—0.07	—0.18
1881-2	—0.36	+0.05	—0.44
1882-3	+0.17	+0.04	—0.56
1883-4	+0.63	....	+0.61
1884-5	—0.50	+0.69	+0.46

The breadth appears to have been pretty constant until 1884, when it was apparently 0″.7 greater than the mean. The latitude also varied slightly from year to year.

The eye estimates of the length of the spot, from the observed transit of the two ends over the central meridian of the planet, are subject to personal error, as well as large accidental error. However carefully the observations may be made, only an approximate result can be secured by this method.

In the *Observatory* for October Mr. Denning has compiled the mean values observed in 1879-82 for a number of observers. The deduced length varies between 29°.3 and 37°.8, or more than twenty per cent.

I think it will be found that small telescopes and insufficient magnifying power make the spot too short, since the extreme end will not be seen.

The red spot was observed for longitude on the 23d and 25th of October, and from its appearance then I judge it will be a conspicuous object during the coming opposition.

THE HABITABILITY OF OTHER WORLDS.

H. A. HOWE.

[For the Messenger.]

It is difficult to treat in a small space of a subject on which so much has been written, unless, indeed, one is confined to a mere statement of known facts. Unfortunately, the amount of theorizing in the present case is entirely disproportionate to the amount of knowledge, and it is not always easy to separate the known from the unknown, so thoroughly are they interwoven by the writers.

As the ancients peopled even the trees of the forest with spirits, and the Arabians made the enchanted air teem with *genii*, so it has been a wide-spread opinion of men in all ages, that the shining spheres about us shelter beings whose intellectual life is in some degree akin to our own. When at the dead of night, while nature is hushed in repose, one looks out upon the over-arching sky, inlaid with "patines of bright gold," and, perchance, plying his telescope, is carried in imagination from cluster to cluster, from universe to universe, the thought that there is no intelligent being in those unfathomable depths of space, gives an oppressive sense of the loneliness of man. Can it be that the eyes and reason of man alone are feasted by this transcendent spectacle, and that even he is chained by an inexorable law to a bit of rock which we call *Earth*, and forever kept from a full view of these glories? Has the all-wise Creator fashioned them in vain? Recoiling from such thoughts, men have given loose reign to imagination, and made the glowing orbs about us instinct with intelligence.

They have even sought to clothe these intelligences with human forms, and no less a personage than the elder HERSCHEL once thought that there might be a heavy layer of clouds beneath the glowing exterior of our *Sun*, to protect the inhabitants within from its heat. All analogies lead to the belief that the stars in the heavens are attended by troops of planets, as our *Sun* is. If one choose to think that these planets are the abode of sentient beings, or even that the race of mankind is scattered over the universe, and that some day myriads of them, freed from the bondage of their present bodily form, may be gathered home on some star-cluster of inconceivable grandeur, we may call the theory extravagant, but not impossible. If it be asserted that the shining stars are peopled by orders of intelligent beings, whose organisms are suited to their environment, the possibility that the assertion is true cannot be denied. But if, on the other hand, we are told that the inhabitants of *Earth* are so magnificent in their mental and spiritual endowments that, when they escape from their present chrysalis forms, the entire visible universe wlll be none too vast or wonderful for the exercise of their powers, we may be disposed to side with this view of the matter.

Special interest is felt in the planets of our own system, and many think that some of them are inhabited by man. Accepting both the Nebular Hypothesis, and that part of the Theory of Evolution which concerns the adaptability of species to a slowly changing environment, it is easy to conclude that each of the planets either may have been in the past the abode of the man-like creatures, or may be in the future. Let us, however, restrict our inquiry to the following plain question: Are the present physical conditions of the planets compatible with the existence of man on them?

Mercury is subject to great variations of heat on account of the eccentricity of its orbit. At its perihelion the solar rays beat ten times as fiercely upon it as upon us, while at aphelion the ratio is reduced to 4.6. Such heat would prove fatal to mankind, were there no protecting atmosphere. ZOLLNER, by photometric methods, has come to the conclusion that *Mercury* has no appreciable atmosphere, but to VOGEL'S eye the spectroscope gives some evidence of an absorptive envelope. The waters of the seas (if there are any), rapidly raised by the *Sun*, would become condensed at no great height, because of the rarity of the atmosphere, and being precipitated again, might furnish a continual rain-storm, which would mitigate the heat. But, on account of the low barometric pressure (the intensity of gravity being less than half that on the surface of the *Earth*), the planet would be uninhabitable for us.

Venus receives heat of twice the intensity of ours, but it is positively known that its atmosphere is quite dense. The aureole of light seen at the times of transit demonstrates its refractive power, and VOGEL has found that the same rays of light are absorbed by it as by our own atmosphere, Though human eyes have probably never pierced the cloud-mantle which envelopes the planet, the seeming quiescence of that envelope shows that there is no great amount of internal heat; we therefore think that there is a solid crust. TACCHINI has detected aqueous vapor in the cloud-mantle, and our present knowledge indicates that the conditions of life on *Venus* are not very dissimilar to what they would be here, if we were robbed of our sunny skies, and accustomed to perpetual rain and snow. The inclination of its axis to the plane of its orbit being unknown, nothing can be predicted with reference to its seasons.

The telescopic appearance of *Mars* has led to a general belief that it is quite like the *Earth*, and maps have been constructed, showing supposed continents and seas. The phenomena of the polar ice-caps, which are said to increase and decrease as the seasons change, and the occasional cloud-like objects which are sometimes thought to obscure the outlines of the promontories, all lend color to the hypothesis that the processes of evaporation and condensation of water go on there as here. But *Mars* has a much sunnier sky than ours, and there is abundant evidence that its atmosphere is quite tenuous. Thus the solar rays, though reaching the planetary surface easily, are not stored up in it, but are radiated away rapidly, so that the temperatures of day and night differ widely. The height of the barometric column is estimated by WINCHELL to be in the neighborhood of four inches. Men who would enjoy respiration up in a balloon, ten miles above the surface of the *Earth*, may be recommended to try their lungs on *Mars*.

Our telescopes show that *Jupiter* is in a state of ferment, and there is evidence that a solid crust has not been formed. It is a huge, seething caldron; the heated vapors rising from the interior, being cooled on reaching the outer surface, descend again, and keep up a ceaseless round of motion. *Jupiter* may well be surrendered to salamanders, if Shakespeare's opinion about those animals is correct.

The visible surface of *Saturn* is much more placid than that of its giant neighbor, and HUGGINS's spectroscope has shown that the planet's nucleus is buried deep in an atmospheric ocean. No crust is supposed to exist, but if it has been formed, there may be sufficient *internal* heat, (as indicated by the presence of aqueous vapor in the atmospheric envelope), to keep mushroom-like men alive for awhile, cultivating the warm, muddy soil, and breathing the muggy air.

Uranus and Neptune, at their enormous distances, cannot elude the spectroscope, which shows very dark bands in their spectra, caused by the absorption of dense atmospheres. The telescope reveals no changing aspect. The solar rays, wearied by the long journey, are entirely unable to send a thrill of life through these passive orbs, and we may readily believe that the blood of a warm human heart would be congealed in a moment in their frigid depths. But if one prefer to think that they have solid crusts warmed by internal heat, no astronomical observations can be cited against the theory. Such homes must be dark, clammy prisons into whose depths no distinct cheering ray of starlight, moonlight or sunlight ever penetrates.

The *Moon* and the asteroids have no atmospheres sufficient to sustain human life.

If all other conditions were favorable it would be impossible for man to exist on any planet, unless the composition of its atmosphere was closely allied to that of our own.

On the whole, it may be said that there is but slight probability that men dwell upon any planet of our system except the *Earth*. Prof. ALEXANDER WINCHELL affirms as the result of his researches, which are based on the Nebular Hypothesis, that "within the vast limits of the solar system, there is but one happy niche where corporeal organizations according to our standard can enter into material relations with the physical environment."

UNIVERSITY OF DENVER, Colorado.

NEBULA OF ANDROMEDA.

BY JOHN H. EADIE.

[For the Messenger.]

Allow me to draw attention to the following quotation from Professor SIMON NEWCOMB'S "Popular Astronomy," fifth edition, in regard to the great nebula in *Andromeda*:

"It was first described by Marius, in 1614, who compared its light to that of a candle shining through horn. This gives a very good idea of the singular impression it produces, which is that of an object not self-luminous, but translucent, and illuminated by a very brilliant light behind it. With a small telescope, it is easy to imagine it to be solid, like horn; but with a large one, the effect is much more that of a great mass of matter, like fog or mist, which scatters and reflects the light of a brilliant body in its midst. That this impression can be correct, it would be hazardous to assert; but the result of a spectrum analysis of the light of the nebula certainly seems to favor it. Unlike most of the nebulæ, its spectrum is a continuous one, similar to the ordinary spectra from heated bodies, thus indicating that the light emanates, not from a glowing gas, but from matter in a solid or liquid state. This would suggest the idea that the object is really an immense star-cluster, so distant that the most powerful telescopes cannot resolve it. Though we cannot positively deny the possibility of this, yet in the most powerful telescopes the light fades away so softly and gradually that no such thing as a resolution into stars seems possible. Indeed, it looks less resolvable and more like a gas in the largest telescopes than in those of moderate size. If it is really a gas, and if the spectrum is continuous throughout the whole extent of the nebula, it would indicate either that it shone by reflected light, or that the gas was subjected to a great pressure, almost to its outer limit, which hardly seems possible. But, granting that the light is reflected, we cannot say whether it originates in a single bright star or in a number of small ones scattered about through the nebula."

In view of the recent blazing out of a star apparently at or near the center of this nebula, his remarks are certainly very suggestive. Particularly so when it is remembered that the spectrum of *Messier 80*, in *Scorpio*, is also continuous, and its nature therefore similar, in the midst of which a new star suddenly shone out in May, 1859.

RECENT SHOWERS OF METEORS.

BY W. F. DENNING.

[For the Messenger.]

During the four months from July to October, 1885, I observed about 670 meteors, during observations extending in the aggregate over 70 hours. The paths of all such meteors as were noted accurately, were registered, and their peculiarities of appearance recorded, for the purpose of determining their radiant points. In all, about 55 distinct radiant points were found, and I have selected some of the most noteworthy of these in the following table. They represent the most active meteor streams seen here during the period mentioned, and I believe the positions may be relied on, every possible care having been taken to assure accuracy:—

Epoch of shower.	Night of Max.	Radiant Point. RA.	Dec.	No. of Meteors.	Appearance.
1885.		°	°		
July 8 -13........	8th	245	+52	7	Meteors very slow.
July 9 -14........	13th	271	+21	8	Slow, faint.
July 9 -14........	12th	329	+36	8	Swift, streaks.
July 9 -13........	9th	280	−14	7	Slow, long paths.
Aug. 16-20........	17th	345	± 0	7	Medium speed.
Aug. 8 -20........	17th	345	+53	10	Very swift.
Aug. 16-20........	20th	5	+12	7	Medium speed.
Sept. 1 -8	4th	346	± 0	9	Slow, bright.
Sept. 1 -15........	3rd	354	+38	19	Very swift.
Sept. 3 -5	3rd	253	+54	7	Slow, yellow.
Sept. 3 -17........	8th	62	+36	16	Very swift, streaks.
Sept. 4 - 9........	9th	335	+71	7	Medium speed.
Sept. 5 -17........	15th	76	+57	7	Very swift, streaks.
Sept. 8 -18........	8th	335	+28	8	Slow, faint.
Sept. 12-17........	15th	5	+12	8	Slow.
Sept. 15........	15th	13	+ 6	7	Swift.
Oct. 6 -12........	12th	103	+33	8	Very swift, streaks.
Oct. 6 -16........	8th	42	+55	13	Slow.
Oct. 6 -16........	16th	143	+49	6	Swift, streaks.
Oct. 7 -8	7th	31	+18	10	Slow, bright.

In addition to these there were a considerable number of minor showers, whose radiants I regard as established with nearly equal certainty. It seemed desirable, however, at present, not to extend the list beyond the more marked displays.

Possibly Mr. O. C. Wendell might undertake to compute the orbits of some of these recently determined showers, or Mr. E. F. Sawyer (well known for his accurate meteoric work in the years 1877 to 1880) may redetect them during future observations.

A comprehensive catalogue of all the meteor streams hitherto observed has long been felt as a great want by those engaged in this department of astronomy. When a radiant point of a new comet has been computed, or a fresh meteor shower observed, it becomes necessary to search through more than a dozen different catalogues of radiants for comparisons. This entails much labor, and, moreover, there are very few persons who possess all the results hitherto published. In order to facilitate reference and to obviate the difficulties mentioned, I have just completed a general catalogue of all the known meteor showers, and arranged the radiant points according to Right

Ascension, instead of according to epoch, as in pre-existing catalogues. I believe the method adopted will be found thoroughly efficient when practically tested, and it is my aim to get the catalogue published as quickly as possible, so that observers may have it in their hands early next year. It contains some 2,500 radiant points, and will include observations to the end of 1885.

BRISTOL, October 25, 1885.

VARIATION IN THE NEBULA OF ANDROMEDA.

BY W. H. NUMSEN.

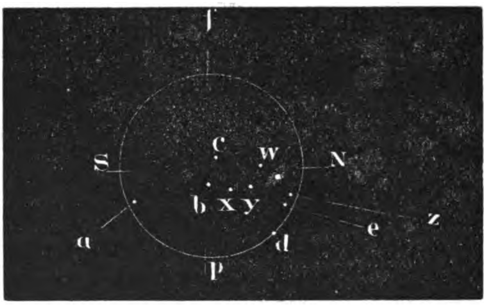
[*Concluded from page 280.*]

Sept. 16th:—7*h* 35*m* to 8*h* 25*m*. Very clear and beautiful during the whole time, moonlight—p. 25. Definition very bad. Nucleus plainly visible, except at times blurred and diffuse, but at such times the stars indistinct also. Comparisons made between intervals when definition moderately sharp. Fully equal to *b* and *c*, sometimes think slightly brighter. Certainly brighter than *d*, and much brighter than *e*. Plainly not as bright as *a*, *f* also brighter. About equal to *g*, that star probably very slightly brighter. 9th.

Sept. 17th:—9*h* 15*m* to 9*h* 55*m*. Very clear and beautiful again, moonlight, stars sharp to naked eye—p. 25. Definition simply execrable again. Nucleus not always visible, most of the time blurred; compared at intervals of moderate definition. Appears just about equal to *b* and *c*, certainly not as bright as *f*, and *h* also brighter. Certainly brighter than *d* and *e*. Much brighter than *x*, undecided about *g*, as definition so bad most of the time. Stars *x* and *y* both plainly visible with p. 25. 9th.

Sept. 18th:—8*h* 35*m* to 9*h* 40*m*. Clear and beautiful, bright *Moon*—p. 25. Definition poor again, although at times the stellar nature of the nucleus is plainly evident. Just about equal to *b* and *c*, sometimes think it very slightly brighter, and again very slightly fainter. Still certainly brighter than *d*, and much brighter than *x* and *y*. Plainly much fainter than *f* and *h*, generally somewhat fainter than *g*, although at times when nucleus is steadily seen, there does not appear to be much difference in favor of that star. 9th.

Sept. 19th:—*7h* 10*m* to *7h* 45*m*. Strong moonlight—p. 25. Nucleus very uncertain, owing to bad atmosphere; for considerable intervals not visible at all, at others pretty distinctly stellar. Magnitude difficult on this account. Some haze and cirrus occasionally. Think it somewhere between *b* or *c* and *d*,



Nova and Companion Stars.

certainly brighter than *e*, and think somewhat brighter than *d*. Generally appears when steadily visible about equal to *b* and *c*, although sometimes think it fainter, and once or twice very slightly brighter. Certainly much fainter than *h* and *f*. 9¼.

Sept. 22nd:—*8h* 30*m* to 9*h*. Passing clouds, fairly clear for only half an hour, then clouded up, with rain—p. 25. Not as bright as *b* and *c*, both always easier than nucleus. Still much brighter than *x* and *y*, not positive about seeing *x*, and *y* certainly invisible. Certainly brighter than *e*, if *e* is seen, and brighter than *d*, which is seen. *l* and *m* pretty sure are brighter, and *k* also, I think. Nucleus always plainer than *n*, which is not readily seen, and was not noticed for some time. 9¼.

Sept. 23d:—*7h* 45*m* to *8h* 30*m*. Superbly clear, full *Moon*—

p. 25 and 60. Definition bad, not seen steadily, magnitude difficult. *b* and *c* always seen much easier, *k*, *l* and *m* also certainly brighter, *n* also is apparently somewhat brighter. Generally brighter than *e*, and perhaps about equal to *d*, though at times thought slightly brighter. Probable brightness somewhere between *d* and *e*. Certainly brighter than *x*, *y* and *o*. 9½.

Sept. 24th:—*7h* 10*m* to *7h* 40*m*. Some haze, bright *Moon*, definition bad—p. 25. No material change since last night. Not equal to *b* and *c*, and certainly not equal to *l* and *m*; pretty sure *n* is also brighter. Certainly brighter than *e*, and generally equal to *d*, sometimes, perhaps, very slightly brighter. 9½.

Sept. 25th:—*7h* 40*m* to 8*h* 30*m*. Pretty clear, bright *Moon*—p. 25. Apparently about the same as last night, certainly no brighter. *b* and *c* easily brighter; uncertain at times about *d*, but generally about as bright as that star. Certainly brighter than *e*. Comparisons difficult, stars hard to see at times. 9½.

Sept. 26th:—*7h* 30*m* to *7h* 50*m*. Pretty clear, some haze; *Moon* rising through haze—p. 25 and 60. A very perceptible difference since last seen. Only seen at short intervals, and then no comparison to *b* and *c*, *d* plainly much brighter. When visible the longest and steadiest, do not think it more than equal to *e*, certainly never any brighter. Does not seem much brighter, if any, than *x*, but brighter than *y* when best seen. Nucleus so small, difficult to separate it from bright condensation in the estimates. 10th.

Sept. 27th:—9*h* 30*m* to 9*h* 45*m*. *Moon* up, cirrus troublesome—p. 60. Seen only at intervals. When at its best and steadily seen, not equal to *d*, but brighter than *x*. Just about equal to *e*, much brighter than *y*. Impression formed is that it may be very slightly brighter than last night. (This may have been due, however, to its being seen at a higher altitude.) 9¾.

Sept. 28th:—9*h* 35*m* to 11*h* 5*m*. Light cirrus, *Moon* in haze and clouds. After 10*h* clear around the nebula, and p. 120 then used. Nucleus generally pretty distinct, only at times not seen. When seen steadily, certainly brighter than *y* and generally thought to be slightly brighter than *x*. Not as bright as *d*, but appears just about equal to *e*. Much brighter than *z*. 10th.

Sept. 29th:—6*h* 55*m* to 7*h* 25*m*. Somewhat misty—p. 60. Certainly not as bright as *d*, not near as bright. Still plainly brighter than *y*. Generally think it slightly brighter than *x*, but not brighter, if any, than *e*. Probably between *e* and *x*. 10¼.

Sept. 30:—10*h* 55*m* to 11*h* 50*m*. Clear, *Moon* near last quarter—p. 60. Apparently no material change. Certainly brighter than *y*, and much brighter than *z*. Hardly think it as bright as *d*, but probably somewhere near *e*. 10¼.

Oct. 3d:—7*h* to 8*h*. Interrupted for considerable intervals by cirro-cumuli. Clear between clouds—p. 60. Seen generally pretty steadily, definition good. No more comparison with *d*; *e* also, I am sure, is easily brighter. Pretty sure *x* also slightly brighter. Probably just about equal to *y* and *z*, both those very nearly same magnitude. Much brighter than *w*. Somehow or other, have an impression that the condensation is not as bright as formerly. 10½.

Oct. 4th:—9*h* 45*m* to 10*h* 10*m*. Very clear and sharp—p. 60 and 120. About same as last night. Just about equal to *y* and *z*, though at times think nucleus somewhat brighter, size for size. Still much brighter than *w*. 10½.

Oct. 6th:—6*h* 55*m* to 7*h* 15*m*. Clear at first, stopped by clouds—p. 60. Think somewhat fainter than when last seen. *x* much brighter, *y* also certainly easier than nucleus. Think *z* may also be slightly brighter. Still much brighter than *w*. 10¾.

The above comparisons are the final results obtained from the series of observations made on the different nights. Numerous comparisons with the different stars were made on each night, and until a pretty satisfactory result was obtained. Comparisons became more difficult after the nucleus had sunk to the ninth magnitude and under, owing to the bright condensation in which it was situated.

Baltimore, Oct. 6, 1885.

COMPARISON STARS.

a	D. M. +39° 158 7.0 magnitude.		*n*	D. M. +40° 146 8.8 magnitude.	
b	D. M. +40° 145 9.0	"	*o*	D. M. +40° 150 9.5	"
c	D. M. +40° 149 9.1	"	*x*	Not in D. M., estimated magnitude slightly under 10th.	
d	D. M. +40° 143 9.5	"	*y*	Not in D. M., estimated magnitude about 10½ nearly.	
e	D. M. +40° 144 9.5	"	*z*	Not in D. M., estimated magnitude about 10¼.	
f	D. M. +39° 167 7.1	"	*w*	Not in D. M., estimated magnitude about 11 to 11½.	
g	D. M. +39° 166 8.5	"			
h	D. M. +40° 158 7.5	"			
k	D. M. +40° 156 9.0	"			
l	D. M. +40° 154 9.0	"			
m	D. M. +40° 151 8.9	"			

McKIM OBSERVATORY.

W. V. BROWN.

(For the Messenger.)

The McKim Observatory was opened in September as a department of De Pauw University. It is located in the suburbs of the University town of Greencastle, Ind., in west longitude from Greenwich 86°37½′, north latitude 39°37′. The building and the full instrumental equipment which it is designed to have are the gift of Mr. ROBERT McKIM, of Madison, Ind. This gentleman, who has so signally evinced his interest in astronomy, has for a number of years had a 6-inch glass, mounted in a handsome dome of his own manufacture near his residence, so that the observatory he has just presented to De Pauw University might almost be called the second McKim Observatory.

Dr. J. P. D. JOHN was given the directorship in addition to his duties as Professor of Mathematics, and the planning and construction of the building proceeded under his immediate supervision. For the very first step, Mr. McKIM and Dr. JOHN visited nearly every prominent Observatory in this country, noting in each the features to be adopted or avoided; and this preliminary outlay of time and trouble has brought its reward in giving to the University an Observatory which is a model of beauty and convenience.

The University, at about this time, purchased a large tract of land, which included a low hill, the highest ground, however, in a radius of several miles. Here the Observatory was located, six hundred feet from the nearest road, and half a mile from the nearest railroad track. It enjoys an unusual freedom from the dust and the jar of teams or trains.

The limestone formation, which prevails so largely over Indiana, at this point makes an unbroken bed rock only twelve feet below the surface; and, after much reflection, it was decided that the pier for the equatorial should not go down to the solid rock, but an elastic layer of clay of a thickness of four feet was left between the rock and the base of the pier. The efficiency of this clay in acting as a cushion was recently tested by carefully watching a sun-spot while workmen who were digging a cistern two hundred and fifty feet away exploded two blasts, and not the slightest tremor could be detected.

The dome and telescope are from WARNER & SWASEY, of Cleveland. The dome is seventeen feet in diameter, made wholly of iron, and is modeled after the dome of the McCormick Observatory, but with a few variations in detail. It also differs from the McCormick dome in being unlined.

The way in which WARNER & SWASEY triumphed over friction in the case of the great McCormick dome is well known, and their peculiar system of friction rollers has been described at the meeting of the American Association. It only remains for me to say that the McKim dome is to the observer a continual source of satisfaction and comfort. There is no gear-wheel, no crank, no windlass, no grinding at the dome or shutter until the muscular exertion has unfitted one for accurate work. A simple straight arm comes down along the wall, and a pull which would register twelve pounds on a spring balance will move the dome rapidly.

The shutter, although made in one piece, moves with a pull of only eight pounds, so that the wind is readily able to blow it open or to close it; and, when open, the impact of the wind against the shutter can revolve the dome.

The telescope has a Clark glass of 9.53 inches clear aperture, and WARNER & SWASEY have fitted it up with many conveniences, such as a focusing handle on each side of the telescope tube; clamps and slow motion rods brought down to the eye-piece, and working independently in R. A. and Decl.; spoked wheels for moving the instrument in R. A. or Decl. and placed by the position circles; and a right ascension indicator.

The driving clock is also of a new design by WARNER & SWASEY. It is placed in a little apartment in the iron pier, and being enclosed by glass doors, is in itself an ornament.

I do not know but that its construction has already been described in these pages, so I will simply say that its performance does not leave anything to be desired. The regulation of it is simplicity itself, and a power of seven hundred diameters on the telescope fails to show any irregularity or lack of smoothness in running.

For observations in R. A., or declination, latitude, longitude, or for clock errors, it is decided to purchase an Almucantar, rather than a Meridian Circle. We are thoroughly convinced that the McKim Observatory will but head the long list of the observatories that in the future will regularly depend upon Almucantars for time and star places.

Our mean time clock is by the HOWARD Co., of Boston, and is already mounted, but the sidereal clock is yet to be obtained.

The aim throughout has been to put up an observatory which should at once be fitted for a working observatory, and also be adapted to the instruction of students in astronomy.

Thus far, the building and instruments have cost $8,000, and about $2,000 more are to be expended.

How well the two diverse purposes have been combined is for the future to disclose.

ERRATA.

Page 222, after July 16, for $9h\ 15m\ 28s$ read $9h\ 34m\ 26s$.
Under log. Δp, same line, for $8.292n$ read 8.063.
Page 248, last line but one, for *more* read *none*.

NOVA ANDROMEDÆ.

E. E. BARNARD.

[For the Messenger.]

The new star in the great nebula of *Andromeda* has been observed here on every favorable occasion with the 6-inch equatorial.

Comparisons of the light of the *Nova* with that of other stars in the field have been made at each observation, and some remarkable and rapid fluctuations in its light noticed. I must say, however, that I regard these quick changes with much suspicion, though it seems highly probable that the radiance of the star is subject to certain variations. Since the star has diminished to a small point its light seems to come and go every few minutes. I have at almost every observation lately been struck with this apparent ebb and flow of light. For a few seconds the star will almost totally disappear; strain your eyes as best you may, you cannot see it clearly; but presently it will become quite bright and distinct; remaining thus a short time, it will again fade away, even while other stars in the field are fairly steady. These changes are so rapid that I would far rather seek some other explanation of the phenomenon than to suppose it due to actual alterations in the star itself.

It will be well to notice that there is now comparatively little difference between the brightness of the nebula and the star; a very slight disturbance in the atmosphere—not enough to disturb the light of the neighboring stars—might be sufficient to blend together the light of the star and nebula, and thus cause an apparent fading of the stellar point.

I think this explanation of these rapid fluctuations all the more probable from my experience with certain of the nebulæ which have a small nucleus, or stellar center. There are several such nebulæ that I have encountered in my comet-seeking. As an example I would give G. C. No. 4514.

I have been struck, when looking at this nebula, with the wonderful changes that apparently go on in an ordinary night. There seems to be an almost constant battle going forward between the nebula and the bright stellar nucleus; for a moment the nucleus will be overcome, and its light blending with that of the nebulosity, it will seem to have faded out; but presently you will see it flash forth brightly and steadily and perfectly stellar in form; a few moments thus and it is gone again. Now, I never thought of attributing this to real changes in the star-like center.

The fluctuations of the light of the *Nova* are precisely similar to those in the nebula referred to. While the *Nova* was bright there was great contrast between it and the nebulous background, therefore slight disturbances in the air would not so sensibly affect the star; but bring the light of the star and the nebulosity to near an equality, and the equilibrium is easily destroyed by a feeble disturbance that might not sensibly affect another star in the same field. Of course, the only way to decide as to whether these changes are real or not, will be to have simultaneous observations made at stations remote from each other. If in such cases the observations invariably indicate change at the same absolute instant of time, why then the proof is clear; otherwise, I think we should be very careful in the interpretation of these apparently wonderful changes.

VANDERBILT UNIVERSITY, October 20th, 1885.

EDITORIAL NOTES.

This number completes the fourth volume of the MESSENGER, and with it a large number of subscriptions expire. Our friends are requested to inform us promptly whether or not its continuance is desired, so that mailing lists may be revised during the month of December.

Amateur observers are requested to watch the *Merope* nebula. November 10 it was plainly seen by one observer, but on the 13th following it was very faint.

The twenty-eighth volume of the Washington astronomical and meteorological observations, for the year 1881, has been distributed. We are aware of the causes that make it necessary to delay these publications three or four years before they can be printed, and so become of general use. It is not the fault of those in charge of the work at the Naval Observatory, but is chargeable to higher authority. It is a source of painful

regret that these things continue so year after year. There is no real need of it. If the scientific men of this nation shall unitedly say this irregularity shall continue so no longer, it will speedily end. Then why not say so?

Besides star and planet observations by the transit circle, those of the 26-inch equatorial on the satellites of *Saturn*, *Uranus* and *Neptune* are noticeably important. This volume also contains two carefully prepared papers by Professor HALL; one on the orbits of *Oberon* and *Titania*, the outer satellites of *Uranus*, and the other on the satellite of *Neptune*. The mass of each of the planets *Uranus and Neptune*, as determined by late studies of their satellites, has already been published in this journal. It is gratifying to notice the attention that these papers has received at the hands of foreign distinguished astronomers.

In 1884, Oct. 17, Professor LANGLEY read a paper before the National Academy of Sciences at Washington, "On the Temperature of the Surface of the *Moon*." The points made at that time were:—

1. Concerning the direct measurement of lunar heat as compared with solar. No ratio was then found. A presumption was raised by the observations "that the earth's atmosphere is diathermanous to heat of lower wave-length than has been heretofore supposed, and lower wave-length than appears to reach us from the *Sun*."

2. Comparison of *Moon's* heat with that of Leslie Cube. Inference from this class of observations was that the sunlit surface of the *Moon* is not far from the freezing temperature, but not so far below as might be expected of an absolutely airless planet.

3. Transmission of lunar heat by the *Earth's* atmosphere.

4. Comparative transmission of glass for lunar and solar heat.

5. Observations during a lunar eclipse.

6. Formation of a lunar heat spectrum.

Each of these methods showed abundance of heat from the *Moon*, but its character could not be determined from any of them.

Since the above paper was read Professor LANGLEY has succeeded in obtaining measures, with rock-salt prisms and lenses, in the lunar heat spectrum. This delicate work is by no means yet complete, still, it may be said, in a general way, that the heat curve seems to have two maxima, one corresponding to the solar curve maximum, and the other indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature. The inference is that the temperature of the lunar soil is certainly below boiling water, and in an indefinite degree.

Color of the Eclipsed Moon.

As the color of the eclipsed *Moon* has recently been under discussion in some of the astronomical journals, the following observations made at the Allegheny Observatory during the partial lunar eclipse of Sept. 23, of this year, may be of interest.

The principal work done at this observatory consisted of heat measurements made at different phases of the eclipse, and these were successfully carried out. Up to the time of the passing off of the penumbra the sky was beautifully clear. At 2 o'clock A. M., about half an hour before the time of greatest obscuration (0.79), I turned the 13-inch equatorial, armed with a low power eye-piece having a field of over half a degree, upon the *Moon*, and remarked particularly the uniform silvery gray illumination of the eclipsed part. This feature was quite independently noted by Mr. F. W. Very, who was observing with me, and who compared the intensity of the illumination with that of the dark part of the *Moon* in the first quarter. There was no trace of the ruddy or coppery color generally seen under these circumstances. On returning to the telescope half an hour or so later, however, I found the ruddy glow quite perceptible, particularly on the most deeply immersed portion of the *Moon*, when it was so strong that it could not possibly have been overlooked, if it had existed at the time of the previous observation. Toward the edge of the shadow it was less noticeable.

It is well known that the appearance of the darkened body of the *Moon* is greatly different in different eclipses, but perhaps, it is not often that the change has been noticed during the progress of any one eclipse. Such changes as that described may be due to changes in the atmospheric conditions at the points on the *Earth's* surface to which the *Sun's* rays are tangent; or, what is more probable, to similar changes brought about by the rotation of the *Earth* during the time of the eclipse. J. E. KEELER.

Merope Nebula.

On the morning of August 17th last, while waiting for Tuttle's Comet to get above the horizon, the sky being very dark, I examined the *Pleiades*, and could see the faint light in the region about the star *Merope*. The general outlines can be made out by slowly moving the telescope about, when the contrast with the surrounding darker sky becomes very evident.

The failure to see this very interesting object might be attributable to a sky not transparent enough, though seemingly so.

I used a 5-inch Clark refractor, power 45, with which I once before saw the nebula, and have failed to see it on other occasions. J. R. H.

The New Star.

At the meeting of the American Astronomical Society in Brooklyn, on October 5th, the new star in *Andromeda* was the special subject of discussion.

Mr. Henry M. Parkhurst, of Brooklyn, said that he had been observing the star with his 9-inch equatorial every night since its discovery was made known. Mr. Parkhurst has for years been engaged in the special study of variable stars, and he saw at once that the new star was a variable one. He found that it had sunk in brightness about one magnitude in a week after his observations began. When he first saw it, on Sept. 7th, it was of the 8.5 magnitude. Its magnitude has since decreased to 11.7, but its rise and fall have not been uniform. Mr. Parkhurst exhibited a drawing showing the erratic variations in the magnitude of the star. He said that four different observers, Mr. Barnard at Nashville, Mr. Denning in England, John H. Eadie at Bayonne, N. J., and himself had independently observed sudden variations in the brightness of the star resembling the flickering of a fire. In this respect the new star differed from all ordinary variables.

Mr. Eadie and Mr. Parkhurst frequently compared their observations, and one evening they found that a clearly perceptible increase in the star's brightness had occurred in the course of some two hours. Mr. Parkhurst found the star to be a little different in position from the old nucleus of the nebula. This nucleus was visible all the time unchanged, and this fact had led him to change his views as to the location of the star. At first he had thought it was in the nebula, but when he found that the nucleus of the nebula was entirely undisturbed the opposite conclusion was clearly suggested, namely that the star was not connected with the nebula.

Mr. Eadie corroborated Mr. Parkhurst's statement that one evening within the course of some two hours the star had increased between one half and a whole magnitude in brightness. The new star occasionally exhibited a curious shimmering which was very easily seen.

Professor Geo. W. Coakley suggested that the shimmering or flickering of the star's light might be due to floating vapors in our atmosphere, or to variations of atmospheric density.

Mr. Eadie replied that other stars in the same field of view at the same time had not exhibited any such phenomenon, and Mr. Parkhurst agreed in this statement. The fluctuations of light were almost instantaneous, and these observations were not the result of carelessness or inexperience.

Mr. S. V. White, the President, thought the chances were very largely in favor of the view that the new star had no connection with the nebula, but was a variable which had always existed between us and the nebula, and had heretofore escaped observation because few observers were carefully watching that particular point, and few were perfectly familiar with the exact location and appearance of the stars seen in or against the nebula. He felt confident that future observers would again see this star suddenly brightening, and that it would be found to be simply a variable star lying in the line of sight of the *Andromeda* nebula.

The discussion will be continued at the November meeting.

GARRETT P. SERVISS.

Gratifying news arrives from Rome regarding the progress of astronomy. A new observatory is being built under the direction of Father FERRARI, S. J., formerly assistant, and successor, of Father SECCHI, in the observatory of the Roman College. Not long after the death of Father SECCHI the Italian government spoliated the Roman College, a private institution belonging to the Jesuits, of the observatory, and drove Father FERRARI and assistants, by police force, out of its walls. The college, which, by its world-wide reputation, had deserved the support of the new government, rather than the spoliation of its most valuable department, survived the usurpation, and has now erected a small dome with a four-inch equatorial by MERZ, equipped with helioscope, spectroscope, thread-micrometer, etc., and nearly completed a larger one, which is to be furnished with a 10-inch equatorial by the same maker. Thus it is expected that the valuable work of Father SECCHI in the interest of astronomy will in its whole extent be continued by his brethren at Rome.

J. H.

THE GREAT NEBULA IN MONOCEROS.

The SIDEREAL MESSENGER for March, 1884, No. 22, contains an article by Dr. Swift on a great nebula that he had discovered in the constellation *Monoceros*. I have lately examined this object carefully and obtained its position with the 6-inch equatorial. The place is, from four equatorial pointings,

$$\left.\begin{aligned}\alpha &= 6h\ 24m\ 48s \\ \delta &= +5^\circ\ 7'.5\end{aligned}\right\}1886.0.$$

On the night of January 29th, 1883, I ran upon this object while seeking comets with 5-inch refractor, and never having heard of it, thought it might be a comet, and watched it a large part of the night for motion. Writing to Prof. Swift about it, he notified me that he had found it some years previous. My note for that time says: "Found a large nebulous object, close *n. p.*, a scattering cluster of bright stars; it is elongated southwest and northeast. Larger than the field of view.''

I have frequently swept up the nebula since without at the moment thinking of it, showing that it must be quite conspicuous.

My notes of this object made on the night of Oct. 30th, 1885, with 6-inch refractor and comet eye-piece of about 1° diameter of field, are:—

"The great nebula in *Monoceros* is quite conspicuous. It close precedes the coarse cluster, and is very large and very much extended. There is no condensation that I can see. It strongly resembles that very diffused part of the great *Andromeda* nebula that extends *p.* G. C. 106. It is simply a great diffused nebulosity, without any apparent condensation, though I suspect a slightly denser part away from the middle, in the direction of the cluster."

I again observed this nebula on November 3rd, when the sky was clearer and the object at a greater altitude:—

"The great nebula in *Monoceros* examined to-night (after midnight). It is quite conspicuous and is extended very much in a direction *s. p.* There is a decided but ill-defined spot of light in the nebula *just* opposite the cluster (some 10′ to the north of the cluster.) I also suspect another nebulous spot in the nebula a little *s. p.* the one just mentioned. There is a large dark spot in the *p.* end of the big nebula. I have not previous for certain seen the two faint condensations and the dark spot."

With a low power and any aperture of consequence, no one will have the least trouble in seeing this quite remarkable object.

It is probable that the condensations I have described are the same seen by Prof. Swift, and described in the article I have referred to.

E. E. BARNARD.

Vanderbilt University Observatory, Nov. 8, 1885.

In answer to the queries of a friend from Exeter, N. H., it may be said, we know certainly nothing about the habitability of the planets. Judging from analogy and from a very imperfect knowledge of the physical conditions of even our nearest neighbor, *Mars*, it is very doubtful if beings like ourselves could live there. Much more improbable is it that a suitable abode for man would be found on any other planet. It is possible, to be sure, that some form of life may exist on any, or all, of the planets. But if different from that of the *Earth* we could scarcely make an intelligent guess concerning it.

MITCHEL'S "Planetary and Steller Worlds," PROCTOR'S "Other Worlds

Than Ours," and many other popular works speak of this and kindred themes, but none are devoted to it exclusively because known facts are too few.

Answers to other queries will be readily inferred.

Chronograph Pens.

Everyone who has worked with a chronograph is familiar with the endless small troubles which come from poor pens and unsuitable ink. I have tried nearly everything, from glass pens of the usual form at $3.60 a dozen, to stylographic and fountain pens at $3.00 apiece. I have never been satisfied till about a year ago, when we began manufacturing glass pens here for our own use. These I consider perfectly satisfactory, the only drawback being that they require filling about every twenty minutes. This has never been an inconvenience in my work, but it may prove so to others. The pens should not have more than 1 inch or 1.5 inches of their length filled. The ink can be renewed with a stylographic pen filler. The ink *must* be William A. Davis' Treasury Green Ink for the best results. This gives a chronograph sheet which is very easy to read. After using, the ink may be left in the pen. One pen lasts us a month to three months.

Such pens will be furnished at $1.10 per dozen by Mr. G. W. Brown, Washburn Observatory, Madison, Wisconsin. They will be sent registered. I believe they will give perfect satisfaction.

EDWARD S. HOLDEN.

The Great Nebula of Andromeda.

In the October number of the Sidereal Messenger I called attention to a small nebula involved in the preceding end of the Great Nebula of *Andromeda*.

Through the kindness of Professor Ormond Stone and Dr. Lewis Swift, (both of these gentlemen having examined it), I am enabled to give some further information concerning the object. At my request Prof. Stone very kindly looked the object up and says of it: "It is very plainly visible in the 26-inch with a low power * * * . It is much elongated and might very properly be described as a condensation in the nebula of *Andromeda*."

Dr. Swift's remarks are about to the same effect, and he further adds that he found several others much fainter and further west of the Great Nebula.

I have for some time suspected another nebula, this one being in the *f.* end of the Great Nebula. Last night being very clear I verified its existence and can find no record of it anywhere. This object lies 17.1′ north of, and follows by 29*s*, the star *b* of my diagram in MESSENGER for October. I take that star to be W. B. 0*h* 952. Hence the place of the nebula is

$$\left.\begin{array}{l}\text{R. A.} = 0h\ 38m\ 15s; \\ \text{Decl.} = +41^\circ\ 13.6'\end{array}\right\} 1885.5$$

This object is extremely faint, but by averted vision it flashes out quite distinctly. It is just free of the north following end of Great Nebula. To find it: "If a line be passed through the star *b* of my diagram and the *nova* and extended north-easterly to a distance equal to that between *nova* and *b* the nebula will be found several minutes north of the *f.* end of the line. It is close *s. f.*, a small star.

E. E. BARNARD.

VANDERBILT UNIVERSITY OBSERVATORY, Nashville, Tenn., Oct. 9, 1885.

Professor PORTER permits me to communicate the following observations of the new star in the *Andromeda* nebula:

The star has been observed at Mt. Lookout on the nights of Sept. 2, 3, 11 and 21 with the 11-inch equatorial, and on several nights with the 4-inch. It seems to be growing fainter. The following are independent estimates of magnitude:

	Porter.	*Wilson.*	*Mean.*	
Sept. 2	8.0 or brighter.	8.0	8.0	
Sept. 3	Same.	Same.	8.0	
Sept. 11...........	9.0	9.0	9.0	
Sept. 21..........	9.0 or fainter.	9.5	9.3	(Bright moonlight.)

On the 2nd and 3rd the star was supposed to be coincident with the nucleus of the nebula, but on the 11th and 21st the nucleus was seen independent of the star. According to the notes of both observers, the star precedes and is a little north of the nucleus. It is certainly not 5″ south of the nucleus, as stated in the Dun Echt circular, No. 98.

H. C. WILSON,
Assistant.

Mt. Lookout, O., Sept. 22, 1885.

BOOK NOTICE.

H. N: Siebenstellige Logarithmen der trigonometrischen functionem fur jede Zeitsekunde. Leipzig. B. G. TEUBNER. 1885. (Price $1.50.)

Each minute of time occupies a page of 60 lines; the type is large and clear and old style. Proportional parts are given for every tabular difference in one third of the table, but in the remaining two-thirds, the logarithmic tangents vary so rapidly that the proportional parts for for some differences have to be omitted. After the printing was completed, a comparison of the table with the seven-place tables of TAYLOR and SHORTREDE resulted in the discovery of thirteen errors, which are noted in the preface.

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NOTE.—The numbers following the titles of articles are the pages of Volume IV. Those in parenthesis are the numbers of the minor planets.

ILLUSTRATIONS.