proached. Fishes of the high seas intercept many; still more become the food of the large fishes of the banks and coasts, and of such is especially the cod. That voracious fish rises to them and inflicts great slaughter.

The later changes of the larva into a miniature eel are especially remarkable. Instead of growing larger, the little fish grows smaller and smaller, so that an individual that had been over three inches long may shrink to a length of not more than two inches, and the ribbon-like form may dwindle into a thread-like body. Increase is concentrated into growth sideways and with this the diaphanous character is lost. Meanwhile, "pigment is developed, first on the end of the tail, later on the neck, and lastly over the greater part of the dorsal and lateral aspects."

The gradual changes thus indicated have been segregated by Schmidt into six groups or stages, based on specimens obtained by him.

During all the gradual metamorphosis so illustrated, and which takes a full year for completing according to Schmidt, "the larvæ do not take any nourishment." This abstinence from food has been determined by Grassi and Calandruccio and A. C. Johnsen, as well as Schmidt. Johnsen "investigated over thirty specimens from the North Sea and the Danish waters and found the alimentary canal empty in all of them."

The young eels or elvers that in spring commence their ascent of the streams, which become their homes, must be the offspring of old eels which left the streams not during the last autumn, but the one preceding that; consequently, about a year and a half must intervene between the time a parent eel begins a journey to fulfill her procreative duties and that when the offspring is ready to take up its life under similar conditions. This is a history very different from any ordinary fish's, and so far as known unique outside of its genus.

The growth of the eel in fresh water has this year, 1908, been elucidated by Mr. Gemzöe from examination of the scales.[3]

[3] Gemzöe (K. J.), "Age and Rate of Growth of the Eel," Rep. Dan. Biol. St., XIV., p. 10–39, tab. 14, 1908.

The young eel lives and grows for some time without scales. Indeed, "it has lived in [Danish] waters two years, reckoned from the time it arrives as montée (glass-eel, elver) in its early migration"; it is then about 7 inches (18 cm.) long. The scales grow only during the warm months (June to September) and the intervals of arrest of growth differentiate the growth of the respective years. The early years are passed with a yellowish belly. "The females become silver later, scarcely before they are six and a half years old, the majority not before they are seven and a half years, and many indeed only become silver when they have been eight and a half years" in fresh water. If to these figures we now add a year and a half for the time the eggs are being matured and the leptocephalus stage developed, it appears that an eel must be from eight to ten years old before it assumes the livery of maturity and descends into the ocean to reproduce its kind.

Theo. Gill

Smithsonian Institution

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The ninth meeting was held at the Hotel Victory, Put-in-Bay, Ohio, August 25–28, 1908. In addition to the reading of papers, the society appointed two committees: one on luminous meteors, consisting of Messrs. Abbe, Elkin and Peck; the other on comets, consisting of Messrs. Comstock, Pickering, Barnard and Perrine. Officers were elected as follows:

President—E. C. Pickering.

First Vice-president—G. C. Comstock.

Second Vice-president—W. W. Campbell.

Secretary—W. J. Hussey.

Treasurer—C. L. Doolittle.

Councilors for 1908–10—W. J. Humphreys and Frank Schlesinger.

We give below a list of papers presented at the society's sessions, together with brief abstracts:

Formulas used for the Reduction of Satellite Observations: Asaph Hall.

Doolittle's Measures of the Hough Double Stars: G. W. Hough. (Published in *Popular Astronomy.*)

The Standard Clock at the U. S. Naval Observatory: W. S. Eichelberger.

In December, 1906, in an address before the American Association for the Advancement of Science (SCIENCE, March 22, 1907, p. 451), I presented a table showing the daily rates of the standard clock of the U. S. Naval Observatory, Riefler Sidereal Clock No. 70, from February 8 to May 12, 1904.

This clock was enclosed in an air-tight glass case and was mounted in a vault where the temperature was artificially controlled. However, during the period mentioned it was found impossible to prevent air from leaking into the case so that a nearly uniform pressure was maintained by pumping out 1 or 2 mm. a day. The mean difference between the computed and observed daily rates for that period was $0^s.015$.

DAILY RATE OF RIEFLER SIDEREAL CLOCK NO. 70

Date	B	Obs. Rate	Comp. Rate	$O-C$
1905	mm.	s.	s.	s.
Feb. 6.6	681	−0.0074	−0.0173	+0.010
10.6	681	−0.0055	−0.0187	+0.013
14.4	681	−0.0386	−0.0199	−0.019
17.5	681	−0.0127	−0.0211	+0.008
20.6	680.5	−0.0317	−0.0163	−0.015
24.5	680.5	−0.0310	−0.0178	−0.013
Mar. 1.7	680	−0.0144	−0.0134	−0.001
6.3	679.5	−0.0038	−0.0089	+0.005
10.5	679	+0.0038	−0.0038	+0.008
13.5	679	+0.0125	−0.0053	+0.018
18.3	678	−0.0048	+0.0050	−0.010
25.5	678	−0.0209	+0.0031	−0.024
28.5	678	+0.0199	+0.0019	+0.018
31.5	678	+0.0113	+0.0010	+0.010
Apr. 2.6	677.5	+0.0062	+0.0060	0.000
7.6	677	+0.0043	+0.0101	−0.006
13.5	677	+0.0098	+0.0084	+0.001
17.5	677	−0.0019	+0.0072	−0.009
20.6	677	+0.0118	+0.0058	+0.006
24.5	677	+0.0173	+0.0046	+0.013
27.5	677	+0.0146	+0.0031	+0.012
May 2.5	676.5	−0.0079	+0.0074	−0.015
7.5	676	+0.0154	+0.0118	+0.004
12.5	676	+0.0074	+0.0103	−0.003
16.4	676	+0.0058	+0.0091	−0.003
19.5	676	−0.0014	+0.0077	−0.009
23.6	676	+0.0072	+0.0067	0.000
25.6	675.5	+0.0082	+0.0113	−0.003
June 1.5	675	+0.0137	+0.0154	−0.002
5.4	675	+0.0235	+0.0139	+0.010
9.5	674.5	+0.0142	+0.0187	−0.004
13.4	673.5	+0.0403	+0.0300	+0.010
16.4	673	+0.0312	+0.0350	−0.004
19.5				
				Mean 0.009

Immediately following the period named, we succeeded in making the glass case air-tight and during the past four years have had practically no trouble from leakage of air. I therefore desire to present to this society a discussion of the daily clock rates of this same clock from February 6 to June 19, 1905.

The following table gives the dates of observations, the mean pressure in the clock case, the observed daily rate, the computed rate and the difference between the last two. The change in the pressure is due to a progressive change in the temperature of the clock vault. The computed rates are obtained from the formula

$$+0^s.00255 - 0^s.01247\ (B - 677^{mm}.5) - 0^s.000366\ (T - \text{April } 14.5)$$

deduced from a least-square solution of the observed daily rates. The mean difference between the computed and observed daily rates is $0^s.009$.

The behavior of the clock can also be shown from the clock corrections during the same period. Each clock correction depending on ten or more time stars has been reduced to April 15.0 by the rate formula given above with the following result:

CORRECTION TO RIEFLER SIDEREAL CLOCK NO. 70, APRIL 15.0

Date of Observation		Clock Correction
1905		s.
February	6.5	−14.33
	10.7	−14.29
	17.5	−14.30
	18.3	−14.29
	20.6	−14.28
	24.5	−14.34
March	10.5	−14.40
	13.5	−14.37
	15.5	−14.33
	25.5	−14.36
	27.5	−14.40
	28.5	−14.44
	29.5	−14.45
	30.5	−14.44
	31.5	−14.38
April	8.5	−14.38
	13.5	−14.40
	14.6	−14.43
	17.5	−14.39
	18.5	−14.40
	19.5	−14.42
	20.5	−14.42
	22.5	−14.40
	24.5	−14.40
	27.5	−14.36
May	2.5	−14.30
	12.4	−14.39
	19.5	−14.41
	22.4	−14.42
	23.5	−14.45
	24.4	−14.44
	25.5	−14.45
June	1.5	−14.44
	2.5	−14.42
	9.5	−14.42
	19.5	−14.44
	Mean	−14.39

The mean of the residuals obtained by subtracting $-14^s.39$ from each of the above clock corrections is $0^s.04$.

Observations were discontinued for some weeks beginning the latter part of June, so that, in order to show how well the clock correction could be predicted a new rate formula was deduced using the observations from February 6 to June 1. Using this rate formula

$$+0^s.00207 - 0^s.01230\ (B - 677^{mm}.5) - 0^s.000373\ (T - \text{April } 14.5)$$

and the clock correction for April 15.0 as $-14^s.39$, the predicted clock corrections for June, 1905, were obtained as given in the accompanying table:

CLOCK CORRECTIONS FOR JUNE, 1905

Date	Sid. Hour	Predicted Correction	Observed Correction	O—C
		s	s	s
June 1.5	16.8	—14.04	—14.06	—0.02
2.5	16.6	14.03	14.01	+0.02
3.5	16.5	14.01	14.04	—0.03
8.5	16.3	13.95	13.91	+0.04
9.5	16.5	13.93	13.90	+0.03
13.4	14.8	13.85	13.85	0.00
14.4	16.1	13.82	13.88	—0.06
18.5	18.6	13.69	13.66	+0.03
19.5	16.9	—13.65	—13.63	+0.02
Mean		—13.886	—13.882	±0.03

Illumination of the Reflex Zenith Tube: C. L. DOOLITTLE.

As the instrument was originally constructed, the field was illuminated by a small electric lamp placed outside the tube, the light from which fell on a diagonal reflector in the axis of the instrument. The mirror was only eight inches from the micrometer threads. The result was that when the thread was not practically in the axis the reflection back and forth from the under side of the prism and the mercury surface produced a feathery appearance in the threads, making it impossible to obtain a sharp image of the same.

After considerable discussion and some experimenting the following plan was adopted:

The smallest electric lamp obtainable—sometimes called a dental lamp—is placed in the axis of the instrument, six inches above the mercury surface. This is held in place by a thin strip of brass attached to the tube in such a way that it may be readily removed in case repairs or removal of the lamp are called for. The current is furnished by a dry battery, and the brightness controlled by a rheostat. It is all of home construction and gives perfect satisfaction.

On the Constancy of the Period of the Variable Star, M5 (Libræ) No. 33: E. E. BARNARD.

This is one of the Harvard cluster variables and has been under observation with the 40-inch for nearly ten years. The period derived from these observations is

$$12^h 2^m 7^s.3040 \pm 0^s.01781.$$

The period was independently determined from normal observations at intervals of one or two years. The deviations among these values did not exceed $0^s.065$. Though this is approximately progressive with the time, it is not believed to be real.

An observation of the variable at its most rapid light change is subject to a probable error of about ± 1.2 minutes, which, when three or four normals are employed, is reduced to ± 0.5 minute.

The light curve shows that the star, after remaining faint for a large part of its period, rather suddenly begins to brighten and in one hour has reached maximum. It remains but a short time at maximum. The decrease for the first half hour is almost equally as rapid as the rise. It then fades slowly for the next six or eight hours to minimum. The entire light change is about 1.2 magnitudes from $15^m \pm$ to $14^m \pm$.

The Photoheliometer: CHAS. LANE POOR.

By an arrangement with Professor Frost a 25-foot photographic heliometer was mounted upon the tube of the 40-inch Yerkes telescope. The lenses were 2 inches in aperture and were specially made for this work by Brashear. The centers of the lenses were at a fixed distance apart and this distance was so adjusted as to make the photographic images of the sun overlap. The common chord of these overlapping images is a measure of the diameter of the sun, and slight variations in the diameter produce relatively large changes in the length of the chord.

During 1907 a series of photographs were taken by Mr. Fox, but owing to bad weather the number was rather limited. They were sufficient, however, to test the value of the method and to show the general lines upon which an instrument should be built.

A Possible Third Body in the System of Algol: R. H. CURTISS.

Spectroscopic determinations of the center of mass velocity of the eclipsing stars of Algol indicate strongly that three bodies enter into this system about the center of mass of which the eclipsing pair revolve in a nearly circular orbit with a radius of not less than 89,000,000 km., a period of 1.899 years and an epoch of minimum radial velocity at the date, 1901.85.

The variations observed in the eclipse period of this star, as well as those suspected in the eccentricity, are possibly largely due to perturbations arising in such a system.

As a consequence of the orbital motion of the center of mass of the eclipsing pair a variation in the time of light minimum with a range of ten minutes and a period of 1.899 years should be shown by photometric observations.

Achromatic and Apochromatic. Comparative Tests. Preliminary Communication: E. D. ROE, JR.

To test them side by side, two visual telescope objectives, each of the two-lens type, an achromatic and an apochromatic of 2½-inch and 2⅝-inch aperture and 44 inches focal length, were ordered by the writer in March of Mr. Lundin, of the Clark Corporation, and of Steinheil Söhne, of Munich, respectively. Hartmann's Foucault knife-edge test as described in the *Astrophysical Journal* for May was tried by Dr. Saunders and the writer on Mr. Lundin's objective, both visually and photographically. Color screens were used for testing chromatic aberration. Four photographic plates of the objective were secured. The objective showed high excellence under these tests. For the laboratory manipulations and appliances involved the writer is greatly indebted to his colleague, Dr. Saunders. Mounted on a 6½ inch Clark equatorial with clock-work, the writer has tested the objective on double stars with splendid results. As the Steinheil objective was only recently received, the investigation is as yet unfortunately incomplete. Preliminary examination, however, raises the expectation that this objective will accomplish what its maker intended it should.

On a quick Visual Method of redetermining the Focus of a large Visual Refractor when used for Photography with a Color-screen: E. E. BARNARD.

Such a large telescope as the 40-inch refractor of the Yerkes Observatory changes its focus largely from changes of temperature. But the photographic focus of such an instrument, where a color-screen is used, having once been determined, can at any time be redetermined accurately, regardless of temperature changes.

The following is the method: Find the photographic focus by the usual method of exposure on the stars. Insert in an adapter on the plate-holder a high-power eyepiece with graduated scale on the tube. With the plate-holder set at the scale reading giving the best result, focus carefully with the eyepiece on a star, and record the reading on the scale of the eyepiece. At any other time, disregarding the temperature, etc., the plate-holder is set at the original scale reading for the best focus, the eyepiece is inserted and the visual focus read off. If it is so many millimeters shorter or longer than the original visual reading, the plate-carrier must be moved in or out by that extent. The plate will then be in the best focus for the moment. If a spider line is inserted in the eyepiece and is brought into the focal plane with the star, then any other observer can at any time determine the focus in a minute's time by bringing a star and the wires into focus and making the proper connections.

On the Focal Changes in Nova Persei and on the Focus of some of the Wolf-Rayet Stars: E. E. BARNARD.

In A. N. No. 4232, Dr. J. Hartmann finds that the spectrum of Nova Persei changed to the nebular condition in the fall of 1902. In 1906 it had again changed and was similar to that of the Wolf-Rayet stars. Observations in the rather long interval were lacking to show when the change from the nebular spectrum occurred.

Observations of the focus of this star were made at the Yerkes Observatory with the 40-inch in 1901, 1902 and 1903. They show a change in accordance with Dr. Hartmann's spectroscopic observations.

The focus rather suddenly became nebular about the first of October, 1902, when it was a quarter of an inch longer than for a star. This lasted until the middle of November of the same year, when it slowly returned to the stellar focus, becoming stellar about February, 1903. The last of these focal measures was made September 28, 1903. The result was — 0.03 inch. This value was so small that the sign was not considered real. But for the fact that Dr. Hartmann found the Nova had finally reached a condition similar to that of the Wolf-Rayet stars, it may have a stronger significance than I supposed, for I find that those of the Wolf-Rayet stars I have examined, with the exception of one case, have their focus slightly shorter than for an ordinary star. The focal measures, therefore, verify Dr. Hartmann's results and show, furthermore, just when the change in the spectrum of the star occurred.

Approximate Ephemerides of Fixed Stars: G. C. COMSTOCK.

When only a moderate degree of precision is required, apparent places of the fundamental stars covering a period of many years may be given in very compendious form. Two tables of such places will be published elsewhere, one giving the coordinates of Polaris within a second of arc, for a period of twenty-five years, the other showing the apparent places of fifty equatorial stars for a similar period. The probable error of a right ascension for these clock stars is about two tenths of a second of time.

A New Form of Stellar Photometer: E. C. Pickering.

In this new form of stellar photometer, an artificial star is formed by allowing a small electric light, run by a storage battery, to shine through a minute hole, placed in the focus of a small auxiliary telescope. This telescope is placed at right angles to the main telescope and a piece of plane glass set at an angle of 45° reflects the artificial star into the eyepiece. A piece of opal or ground glass is placed over the hole, and the light of the artificial star is varied by moving the electric light, along the axis of the small telescope, by a known amount. The scale of the instrument accordingly depends on the law of the square of the distances, instead of on the laws of polarized light, or on the empirical law found for wedge photometers.

On the Character of the Light Variations of a Herculis: Frank Schlesinger.

This star has long been thought to be an irregular variable with a period of 35 to 40 days and with rapid fluctuations near minimum. Frost and Adams have shown it to be a spectroscopic binary. In the spring of this year it was placed upon the observing program of the Mellon spectrograph of the Allegheny Observatory and Professor Pickering kindly agreed to have it observed simultaneously at Harvard with the photometer. Our spectrograms were measured and reduced by Mr. Baker, who deduced a period of 2.05 days for the velocity variations, very different from that assigned to the light variations. In discussing these observations with Mr. Baker it occurred to us that the star might be an Algol variable. The character of the spectrum and the form of the orbit (especially the small eccentricity) and most of the observations concerning its light, are in conformity with this idea. Mr. Wendell's observations at Harvard showed that this surmise is correct, and further proved the existence of a secondary minimum, so that the star is more properly of the Beta Lyræ type than of the Algol type. With the help of a diagram it may be shown how all the observed phenomena concerning this star can be explained and how the erroneous conclusions concerning the period and the fluctuations at minimum arose. The case is interesting as showing the intimate connection between photometric and spectrographic observations, the true character of the light variations being first indicated by the latter.

Photographic Light-curve of the Variable Star SU Cassiopeiæ: J. A. Parkhurst.

A lantern-slide was shown of the mean light-curve of this star derived from 86 extra-focal images taken with the Zeiss 6-inch doublet between October 19, 1906, and April 5, 1908. The plates were measured with a Hartmann "Mikrophotometer" and reduced with the writer's "absolute scale." The observations were best represented by a period of $1^d.9498$, giving a correction of $-0^d.0008$ to Müller and Kempf's period.

The range in magnitude found was 0.47, from 6.52 to 6.99. Compared with Müller and Kempf's range of 0.33 (5.93 to 6.26), this gives a color-intensity of 0.59 magnitude at maximum and 0.73 at minimum; the difference being similar to that found for other variables of short period. The star's spectrum is *F* 3 *G* on the Harvard classification. The radial velocity, as determined from 9 one-prism plates taken with the Bruce spectrograph and 40-inch refractor, is about —7 km., with but slight variation between the different plates.

This star has about the smallest range of any well-attested variable, but presents no difficulties to the extra-focal method.

(To be published in the *Astrophysical Journal.*)

On the Irregularity of the Proper Motion of the Star Krueger 60: E. E. Barnard.

From observations with the 40-inch refractor of the Yerkes Observatory, the parallax of *Krueger 60* was determined. The resulting value was $\pi = +0''.247 \pm 0''.010$. This agrees closely with the values determined by Dr. Schlesinger and also with that by Dr. Russell, the three values being:

Barnard	$+0''.247$	$\pm 0''.010$
Schlesinger	$+0''.248$	$\mp 0''.009$
Russell	$+0''.258$	$\mp 0''.013$

One of the components of *Krueger 60* is a rather wide double star, found by Professor Burnham in 1890, of the magnitude 9.3–11.0. The distance between the components is about 3¼", and they are in rapid orbital motion. During the investigation for parallax, it was found that the proper motion of the larger star, as determined from comparison with other stars, was slowly changing its direction, having in the past six or seven years changed about 8° or 9°, from 239° to 247°. This is undoubtedly due to the orbital motion of the two stars. It shows that the small star must have a rather large relative mass. The masses of these two stars can be accurately determined by measuring the position of *A*, with reference to near-by stars.

The Cœlostat Telescope of the Dominion Observatory: J. S. PLASKETT.

This paper contains a description illustrated by lantern slides of a new installation for solar research at Ottawa. A cœlostat and secondary mirror, each of 20 inches aperture, feed a concave of 18 inches aperture and 80 feet focus. Owing to local conditions the beam from the concave has to pass under the secondary mirror to a focus in the basement of the observatory. Notwithstanding the different and less advantageous conditions the solar definition is in general very good, much better than obtained with the refractor more suitably situated. The cœlostat is covered by a house, moving back on rails and the beam passes through a shed and short tunnel to the focus. Both house and shed are thoroughly louvered. A grating spectroscope of the Littrow form, with Brashear 6-inch objective of 23 feet focus, and Michelson plane grating ruled surface, $4\frac{1}{4} \times 4\frac{3}{4}$ inches, arranged to rotate around its optical axis, will be used with this telescope for spectroscopic investigation of the solar rotation, sun spots, etc.

Camera Objectives for Spectrographs: J. S. PLASKETT.

This paper contains an account of tests for definition and flatness of field performed on a number of different types of lenses used in and especially made for spectrographic work. The advantages of some new forms by Brashear and Zeiss over those previously used is illustrated diagrammatically. For work with a single prism a new objective by Brashear with widely separated elements, both of the same material, light crown, gives the best field, while for three-prism work another single material by Zeiss, in this case of the prism material, performs most satisfactorily. Neither of these forms can be used with larger angular aperture than $f/10$. For shorter focus lenses the Zeiss Tessar seems to be most suitable. A description of the effect upon the definition and flatness of field of changing the separation of the elements will be given.

The Distribution of Eruptive Prominences on the Solar Disk: PHILIP FOX.

This communication reviews a paper presented to the American Association for the Advancement of Science at the Chicago meeting on "The Detection of Eruptive Prominences on the Solar Disk" and summarizes the observations on their distribution as follows:

Spot birth is always accompanied by and generally preceded by eruptions. While the spot continues active the prominences will be present, generally following it at the edge of the penumbra. Spots beginning to decline are also accompanied with eruptions which will be seen at the ends of the bridges. In the case of complex spots where we have a large leader spot and another at the tail of the stream the eruptions follow the preceding spot and precede the following spot and are seen among the smaller spots of the stream. Eruptions are rarely seen preceding the leader spot and as seldom found following the trailer.

The eruptions about the spot groups are probably due in part to the interference of the whirls about the spots. Judging from the direction of motion indicated by the whirls of calcium and of hydrogen shown on the spectroheliograms, and from motion in some of the prominences, I find the direction of the whirls in the northern hemisphere as counter-clockwise and clockwise in the southern.

The Work of the Nautical Almanac Office: M. UPDEGRAFF.

The *American Ephemeris and Nautical Almanac* is one of five similar publications, and was first issued for the year 1855 at Cambridge, Mass., under the direction of Lieutenant (afterward Rear-Admiral) Chas. H. Davis, U.S.N. The American Nautical Almanac Office was established in the year 1849, was removed from Cambridge, Mass., to Washington, D. C., in 1866, and after occupying from time to time various quarters in the Navy Department and elsewhere in the city of Washington, was located in the main building of the new Naval Observatory in 1893. During the first forty-eight years the *Almanac* had four superintendents, and during the remaining eleven years six directors, the title of superintendent having been changed to director in 1893.

Professor Simon Newcomb, U.S.N., was superintendent and director for twenty years, 1877 to 1897, and during that time there were published under his direction eight volumes of the "Astronomical Papers" of the *American Ephemeris* as well as the yearly volumes of the *Ephemeris* during that time. During the past eleven years the accuracy of the computations for the *Ephemeris* has been improved, a catalogue of zodiacal stars published, and orbits and ephemerides of certain new satellites of the planets computed. The next volume to be issued is that for the year 1912. It is intended hereafter to leave out the lunar distance tables, to insert the ephemerides of about 300 additional fixed stars, and to substitute for the Struve-Peters constants the constants adopted at the conference of directors of national ephemerides held in Paris in May, 1896. Among minor changes which are under consideration may be mentioned:

(*a*) Moon culminations given for lower as well as for upper culmination.

(*b*) A more convenient arrangement of ephemerides of satellites of the planets.

(*c*) Ephemerides of the brightness of the planets in terms of stellar magnitudes.

(*d*) Ephemerides for physical observations of the sun, moon and planets.

The second edition of the American *Nautical Almanac* for 1909 will contain a star list and map for the use of navigators, and it is hoped later on to add certain tables and ephemerides for the convenience of surveyors and engineers.

Definite suggestions as to possible improvements in the *American Ephemeris and Nautical Almanac* from astronomers, navigators and others who make practical use of that publication, are desired, will be carefully considered and should be addressed to "The Director, Nautical Almanac, U. S. Naval Observatory, Washington, D. C."

The American Nautical Almanac Office cooperates with the British Nautical Almanac Office in certain lines of work, and is also at present cooperating with Professor Simon Newcomb, U.S.N. (retired), in his lunar researches and in a revision of the orbit of Mars. The present superintendent of the Naval Observatory, Admiral Wm. J. Barnette, is disposed to promote the cooperation of the Department of Astronomical Observations of the Naval Observatory with the Nautical Almanac Office, especially as regards the meridian work of the observatory and the places of the fixed stars given in the *American Ephemeris*.

The distributing list for the *American Ephemeris and Nautical Almanac* has recently been enlarged by more than 50 per cent., and that for the "Astronomical Papers" has been more than doubled. The former publication is sent to libraries, though not, as a rule, to individuals, while the "Astronomical Papers" are widely distributed to scientific men and institutions throughout the world.

A considerable number of sets of the "Astronomical Papers," eight quarto volumes bound in cloth, are now available for free distribution, as also are a number of volumes and parts of volumes for the completion of sets, carriage free within the limits of the United States. There are also several hundred copies bound in cloth of an interesting and valuable book on "Astronomical Constants," a supplement to the *American Ephemeris* for 1897, which will be mailed free to those who apply for it.

The publications of the Nautical Almanac Office are no longer sold by the office. On October 1, 1906, the sale of these publications was transferred to the superintendent of documents, Government Printing Office, Washington, D. C.

On an Infinite Universe: G. W. HOUGH. (Published in *Popular Astronomy.*)

The Luminosity of the Brighter Lucid Stars: GEORGE C. COMSTOCK.

Parallaxes have been determined for about three fourths of all stars brighter than magnitude 2.5. These are here utilized to determine the intrinsic brightness of each such star and to derive from these a curve showing the relative frequency of occurrence of the several degrees of luminosity among the stars in question. A theoretical distribution curve for these luminosities, derived from the hypotheses with regard to stellar distribution that are commonly made, is shown to be widely divergent from the curve above found. The cause of this divergence is sought in the hypotheses upon which the theoretical curve is based and it is shown that the theoretical and observed distributions may be brought into agreement by either of the following suppositions:

(*a*) The intrinsically brightest stars are not widely distributed through space, but manifest a distinct tendency to cluster about the sun.

(*b*) There is a sensible absorption of light in its transmission through space, of such average amount that a star having a parallax of a tenth of a second appears one magnitude fainter than it would appear in the absence of absorption.

Photographic Determinations of Stellar Parallax with the Yerkes Refractor: FRANK SCHLESINGER.

This paper is an informal report on work done with the 40-inch Yerkes telescope under the auspices of the Carnegie Institution, from 1903 to 1905. The methods and precautions adopted for making the photographs and for measuring and reducing them were described in some detail and the results exhibited for twenty-three stars. This paper is to be published in the *Astrophysical Journal*.

Measurement of Starlight with a Selenium Photometer: JOEL STEBBINS.

This paper presents the results of experiments on the use of selenium in stellar photometry. It is well known that the crystalline form of selenium decreases its electrical resistance when exposed to light. The method is to cast an extra-focal image of a star upon a selenium surface, and note the effect by means of a galvanometer. Using a 12-inch telescope, it has been possible to measure first and second magnitude stars with about the same accuracy that is obtained in visual methods. Tests with brighter artificial lights give a probable error of less than one per cent. for a single measurement.

In the course of a year the sensibility of the apparatus has been increased one hundredfold, and it is hoped that further improvements in the elimination of disturbing factors will produce extremely accurate results.

Spectrographic Observations: E. B. FROST.

A favorable report may be made upon the result of re-annealing by the original maker, M. Parra-Mantois, of Paris, of the three large flint prisms first made for the Bruce spectrograph and discarded on account of lack of homogeneity.

The star 46 (Upsilon) *Sagittarii*, which has been qualitatively studied by Miss Cannon at Harvard, and was found to be a spectroscopic binary by Campbell some years ago, has recently been observed, and a number of plates have been measured by Dr. D. V. Guthrie. He finds a range of velocity from + 55 km. to — 25 km. The bright lines are not conspicuous on our plates, and can be seen with certainty only on the thirteenth plate.

Observations of the fainter component of ζ *Ursæ Majoris* (*Mizar*) have been continued for several months, the measures being made by Mr. Lee. A careful study by the writer has failed to bring out a regular periodicity in the radial velocity, and the indications are that more than two bodies are involved.

Mention was made of certain new spectroscopic binaries:

φ *Sagittarii* ($18^h\,39^m$, $-27°\,6'$), of Orion type, which shows a large range of velocity.

β *Trianguli* ($2^h\,4^m$, $+34°\,31'$), Ia2, which was suspected from preliminary examination here, and established by measures of the same plates at Columbia University by Professor S. A. Mitchell.

55 *Ursæ Majoris* ($11^h\,14^m$, $+38°\,44'$), Ia2, found by Mr. Lee; range thus far: 40 km.

ι *Andromedæ* ($23^h\,33^m$, $+42°\,43'$), of Orion type, found by Mr. Barrett, probably of rather long period.

The Figure of the Sun and Possible Variations in its Size and Shape: CHAS. LANE POOR.

The first part of this paper contains a résumé of the more important investigations of von Lindenau, Secchi, Auwers, Newcomb and Ambronn. In practically every case the original reductions showed periodic variations in the diameter of the sun. Auwers discussed an immense mass of meridian circle and heliometer observations and reached the conclusion that the sun is sensibly a sphere and that the observed variations are due to personal and instrumental causes. This conclusion, however, was reached only by attributing variable personal equations to the different observers.

The second part contains a retabulation and rediscussion of the heliometer observations used by Auwers and of those made by Schur and Ambronn. It is here shown that these observations indicate a periodic variation in the shape of the sun, the period being the same as that of the sun-spot cycle. The observations of Schur and Ambronn were also investigated for short period vibrations by means of the method of "Time Correlation" as developed by Newcomb. These observations indicate a semi-permanent fluctuation in the shape of the sun having a period of about 28 days.

Results of Photometric Investigations: E. H. SEARES.

Light-curves were shown for RS *Draconis*, VY *Cygni*, RV *Tauri*, SU *Andromedæ*, RS *Bootis*, 52.1907 *Ophiuchi* and 43.1907 *Draconis*. All are interesting and unusual types of variation. The last four are of the so-called Antalgol type with periods ranging from ten to sixteen hours.

In addition, there was presented a simple and general method of determining the circular elements and relative dimensions of a binary system on the basis of an observed light variation of the Algol type. The arrangement of the method is such that the light-curve corresponding to the first approximation for the elements and dimensions must be tangent to the observed curve at two points. Differential formulæ can then be used for improving the agreement of the calculated and observed curves. The application of the method to a considerable number of cases can be facilitated by the use of tables.

The Temperature Gradients of the Atmosphere and an Attempt to Account for the Upper Inversion: W. J. Humphreys.

During the past few years many sounding balloons, equipped with registering apparatus, have been sent up from different places and under different conditions to altitudes ranging from twelve to twenty kilometers, and observations have been secured indicating a division of the explored atmosphere into the following three regions:

1. A layer some 3,000 meters thick next the surface, in which the change of temperature with elevation is irregular and often locally reversed.
2. A region of fairly uniform and rapid temperature decreases with elevation extending from the top of the first layer to the high cirrus clouds.
3. The upper inversion, or the region above the cirrus clouds, when the temperature slowly increases with elevation.

The upper inversion is due primarily, but not wholly, to long wave radiation from the earth as a planet, and to which water vapor is a black body. When the temperature of the high atmosphere is 218° C. absolute, it can be shown that the temperature of the effective radiating surface is about 260° C. absolute.

Effect of Increasing the Slit Width on the Accuracy of Radial Velocity Determinations: J. S. Plaskett.

Experiments at Ottawa have shown that exposure time is almost proportionally decreased with increase in slit width to about 0.075 mm. Six spectra of β Orionis were made for each of four slit widths—0.025, 0.038, 0.050 and 0.075 mm. —at three different dispersions. The accidental errors of setting, as measured by the probable errors of the velocity from a single line obtained from the six plates in each series, are only slightly increased, scarcely at all in the higher dispersion, by increase in slit width to 0.075 mm. A further discussion shows that the increase of systematic error, so far as it may be determined from the limited number of plates, is also small with high dispersion, although quite marked for a slit 0.075 mm. wide with low dispersion. These somewhat unexpected results show that for stars with single lines the slit may be much widened without much loss of accuracy and with a considerable saving in exposure time.

The Algol System, RT Persei: R. S. Dugan.

With a Pickering polarizing photometer with sliding achromatic prisms, a series of 14,048 settings on RT *Persei* was completed in February, 1908. Most of the observations were made without a recorder.

The period is obtained from nineteen more or less thoroughly observed minima.

The mean curve shows a primary minimum of 1.33 magnitudes' range and a secondary of 0.16, each lasting about four and one quarter hours.

The curve between minima is not a straight line. After recovering from primary minimum the curve rises steadily until it reaches the point midway between the minima, and from that point decreases very little until secondary minimum begins.

The residuals show a constant correction for the night, depending on the average hour angle at which the observations were made.

The eccentricity and inclination are small, the two stars are nearly of the same size, one has six times the intrinsic luminosity of the other, and the radius of the orbit is three times the radius of the stars.

Observations of the Total Solar Eclipse of January 3, 1908: W. W. Campbell.

The paper summarized the more interesting results of the work of the Crocker Expedition from the Lick Observatory, with lantern-slide illustrations copied from the original negatives.

The corona was rather remarkable for the great number of long, straight and slender streamers extending in all directions. There was a conspicuous conical pencil of radiating streamers, near position angle 75°, whose vortex, if on the sun's surface, would lie within the largest sunspot group visible on January 3.

By far the greater part of the coronal light came from the areas lying within two inches of the sun's edge.

Polarigraphic negatives showed the existence of strong polarization in the coronal light, even up to the very edge of the sun.

A spectrogram with continuously moving plate recorded the changing spectrum of the sun's edge as the edge was gradually uncovered by the moon.

The spectrum of the corona was essentially free from absorption lines. Several new coronal bright lines were discovered. The maximum of continuous spectrum of the corona was displaced toward the red from that of the solar spectrum, indicating a lower temperature in the corona than in the photosphere.

The plates for the intra-mercurial planet search recorded more than 300 stars, including some of the ninth magnitude. All were identified as well-known stars. It is felt that the Lick Observatory observations of 1901, 1905 and 1908 bring definitely to a conclusion the observational side of this problem, famous for half a century. It is not contended that no planets exist in the intra-mercurial region, but it is believed that undiscovered planets do not exist in sufficient numbers to provide the mass necessary to explain the anomalies in the motion of Mercury and the other minor planets.

Value of the Solar Parallax from Photographs of Eros taken in 1900 with the Crosley Reflector: C. D. PERRINE.

The following determination of the values of the solar parallax is based on 823 images of Eros and the images of surrounding groups of stars contained on 281 photographs. These photographs were secured on eighteen nights from October 6 to December 24 inclusive.

The value of the solar parallax obtained is

$$8''.8054 \pm 0''.0025.$$

The measurements and reductions were made under a grant from the Carnegie Institution by Mrs. Moore and Miss Hobe.

The general results will be published in a Lick Observatory Bulletin, and a full account of the work by the Carnegie Institution.

HAROLD JACOBY
F. H. SEARS

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908.

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-president, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. H. Howell, Johns Hopkins University; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Professor John Dewey, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 31. President, Professor D. P. Penhallow, McGill University; secretary, Dr. H. McE. Knower, The Johns Hopkins Medical School, Baltimore, Md. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December