SCIENCE

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FRIDAY, FEBRUARY 27, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

THE second winter meeting of this society was held in Washington, D. C., during convocation week, in affiliation with the American Association for the Advancement of Science.

On Monday, December 29, at 4 P.M., over two hundred persons assembled in the lecture room on the first floor of the Law Building of the Columbian University to hear the address of the president of the society, Professor Simon Newcomb. This address has already appeared in SCIENCE.

Three sessions of the society for the reading of papers and transaction of business were held in the Assembly Hall of the Cosmos Club, Tuesday, Wednesday and Thursday afternoons, the average attendance being about seventy-five.

Tuesday evening the annual dinner was given at Maison Raucher. Among the forty-three present were a number of ladies and, as guests, His Excellency, the Im-

perial German Ambassador; Hon. J. T. Morgan, U. S. Senate; the Assistant Secretary of State; and the Superintendent of the Naval Observatory. A most enjoyable evening was spent together, among the good things being addresses by the guests, by Professor Newcomb, and by Professor Hale.

On Wednesday afternoon the session was adjourned shortly before 4 o'clock, to enable the members of the society to attend a reception given them by the Superintendent of the Naval Observatory and Mrs. Chester. After a most pleasant social gathering for an hour or more, all present were invited to spend as much of the evening as they chose inspecting the observatory and its instrumental equipment.

At the final session resolutions were adopted tendering the thanks of the society to Captain Chester, the Superintendent of the Naval Observatory, for his courteous invitation to visit the observatory, and his kind attentions during the meeting of the society; also tendering the thanks of the society to the Cosmos Club, for the use of the club house and of all its facilities so courteously accorded to the society and its members.

During the meeting seventeen new members were elected, and the selection of a time and place for the next meeting was left open for future action by the council.

The officers elected were:

For 1903.

President—Simon Newcomb.

First Vice-President—Geo. E. Hale.

Second Vice-President—W. W. Campbell.

Treasurer—C. L. Doolittle.

For 1903–4.

Councilors, Ormond Stone, W. S. Eichelberger.

For 1903–4–5.

Secretary—Geo. C. Comstock.

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G. C. COMSTOCK: 'The Masses in 85 Pegasi.'

F. W. VERY: 'Form and Structure of the Galaxy.'

S. A. MITCHELL: 'The New Gases, Neon, Krypton and Zenon in the Chromosphere.'

G. C. COMSTOCK: 'Preliminary Account of an Investigation of the Proper Motions of Faint Stars.'

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G. W. HOUGH: 'Improvement in the Mounting of Fixed Meridian Instruments.'

J. A. PARKHURST: 'Photometric and Photographic Observations of Faint Variable Stars.'

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E. E. BARNARD: 'Observations and Light Curves of some of the Small Variable Stars found in the Globular Clusters.'

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A. O. LEUSCHNER: 'A Method of Computing Orbits in Rectangular Coordinates.'

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SIMON NEWCOMB: 'Statement of the Progress made by the Watson Trustees in Computing Tables of the Asteroids discovered by James C. Watson.'

A. S. FLINT: 'Results of Meridian Observations for Stellar Parallax made at the Washburn Observatory.'

L. A. BAUER: 'Preliminary Summary of Magnetic Results obtained during the Recent Eruption in Martinique.'

S. D. TOWNLEY: 'The Light of the Stars.'

ABSTRACTS OF PAPERS.

Comparison of Astronomical Photographic Measures Made with the Réseau and without it: HAROLD JACOBY.

The *réseau* method of measuring stellar photographs, as considered in the present note, is similar to that in use by the observatories participating in the photographic survey of the heavens now in progress. The most important advantage of this method of measurement is that it avoids almost altogether the effects of possible contractions or expansions of the sensitive film during development; and to this advantage has been joined another of a practical character which was perhaps not foreseen by the originators of the *réseau* method. It is found most confusing to measure plates having nothing on their surfaces but stars-images; in fact, in the case of close clusters, it is well-nigh impossible on such plates to make sure that the two coordinates assigned to any star really belong to the same object. All this possibility of confusion disappears, however, with *réseau* plates, as it is easy to keep all measures in order by considering each little square by itself.

As usual, there are compensating disadvantages connected with the *réseau*. It is necessary, for instance, to make certain assumptions, such as the following:

1. That the division errors of the original *réseau* can be determined as accurately as those of a scale.

2. That the photographic copy of the *réseau*, as it appears on the star-plate, really reproduces exactly the division errors of the original.

3. That the bisection of the photographed *réseau* lines on the star-plate can be made with a microscope as accurately as the lines of a scale can be bisected.

It is of course possible to discuss each of these assumptions separately; but in the present note I shall consider one simple experiment only. This consisted in measuring a couple of Pleiades photographs twice, once by the *réseau* method, and once with a metallic scale. A simple comparison ought then to show how far the two methods of measurement differ in their results. Seventy-five stars were observed in each case, and the same stars were used. The first plate was made at Paris, January 14, 1901, and the 'probable discordance' between the two methods of measurement was $\pm$ 0″.11. No corrections were applied for possible division errors of the Paris *réseau*, as none have been published, though the MM. Henry have satisfied themselves that the Paris *réseau* errors are inappreciable. The second plate was made at Helsingfors, December 12, 1900, and gave a probable discordance of $\pm$ 0″.22. In this case, the measures were corrected with Donner's division errors, but these are not large enough to affect the result appreciably. In both cases, measures made with the metallic scale were corrected for the division errors determined at Columbia University. The larger discordance in the case of the Helsingfors plate is probably due to the less well defined character of the photographed *réseau* lines. In many cases it is impossible to bisect these lines under the microscope any-

where except at the corners of the squares, where two lines cross and form a point.

But when we consider that the above discordances involve the errors of both measurements, they do not appear unduly large. Divided by $\sqrt{2}$, they give for the probable error of a measurement by one method only $\pm$ 0″.08 for Paris, and $\pm$ 0″.16 for Helsingfors; and there is no evidence of a systematic arrangement of signs in the differences between the two methods. We may conclude, therefore, that plates measured by the *réseau* method and without it give identical results within a very narrow margin; nor does irregular distortion of the film appear to have affected appreciably the measures made without the *réseau*.

The Spectra of Stars of Secchi's Fourth Type: GEORGE E. HALE, FERDINAND ELLERMAN and J. A. PARKHURST.

In his early surveys of stellar spectra, Secchi divided the red stars into two great classes (his third and fourth types), whose spectra differ very markedly in their general characteristics. Subsequent investigations by Vogel and Dunér confirmed Secchi's conclusion with regard to the presence of carbon bands in the spectra of stars of the fourth type, but in view of the instrumental means employed it was impossible for these investigators to distinguish the individual lines in the spectra. An investigation of these stars was accordingly undertaken with a three-prism spectrograph, used in conjunction with the forty-inch refractor and the two-foot reflector of the Yerkes Observatory. Some 250 photographs, ranging in exposure-time from a few minutes up to twenty-five hours, were made. They include the yellow and green as well as the blue regions of the spectra. A special study has been made of eight stars, in whose spectra the wavelengths of several hundred bright and dark lines have been measured. The presence of bright lines, though suspected by Secchi, was denied by subsequent observers, but has been abundantly confirmed by the present photographs. Hitherto it has not been possible to identify these lines. A large part of the dark lines, however, have been found to be due to iron, titanium and various other substances. By the aid of these lines the radial velocities of the eight stars have been determined. The photographs bring out a marked resemblance between the spectra of the two classes of red stars, so far as the dark lines are concerned. Cyanogen is present in both classes, but carbon, either alone or in combination with oxygen, is absent from stars of Secchi's third type, while very conspicuous in stars of the fourth type. In both classes of stars the relative intensities of the dark lines in the spectrum of a given element seem to differ considerably from the corresponding intensities in the solar spectrum. This led to a comparison of the stellar lines with the widened lines in the spectra of sun-spots. So far as can be judged from the present photographs, there is a marked similarity of these spectra, but this can not be made the basis of any theoretical conclusions before further investigations with higher dispersion have been made. In general, the investigation tends to confirm the opinion of Vogel and Dunér that the two classes of red stars have developed from solar stars. Full details of the work, with tables of wavelengths and reproductions of photographs, will appear soon in the *Publications of the Yerkes Observatory*.

Radial Velocities of Twenty Stars having Spectra of the Orion Type: EDWIN B. FROST and WALTER S. ADAMS.

This paper represents a part of the work done during the past year with the new

Bruce spectrograph of the Yerkes Observatory. Stars with spectra of this interesting type, which seems certainly to characterize an early stage of stellar development, have not hitherto received much attention in respect to motion in the line of sight. These spectra are not adapted to measurements of any such degree of accuracy as is possible for the solar stars, because of the comparative fewness and the generally hazy and ill-defined character of their lines. The results have, however, proved more accordant than was anticipated. The general good adjustment and trustworthiness of the spectrograph are attested by the measures of the moon's radial velocity. The twelve lunar spectra photographed during the year gave a mean difference of 0.2 km. per sec. between the observed and the computed radial velocity, the largest difference being 0.7 km. per sec. The titanium spark was chiefly used for furnishing the comparison spectrum, but the iron and the chromium spark and a helium tube were also employed at times. A perfectly definite amount of self-induction and capacity was always maintained in the secondary circuit.

The lines commonly present and measured in the stellar spectra were those due to one or more of the following elements: helium, oxygen, silicon, nitrogen, hydrogen, magnesium. The observing list included about 150 stars of this type brighter than the sixth magnitude. The present paper included only those of which three or more plates have been obtained and measured. Those found to vary in their radial velocity, six in number, were not included in the discussion. The stars of the *Orion* type are peculiarly distributed in the sky, being for the most part grouped in or near the Milky Way. As many of the twenty are near the apex or anti-apex of the sun's way, the observed velocities clearly show the effect of the solar motion. If a correction were applied for this motion, the resulting absolute radial velocities would be small. The angular proper motions of these stars are also small, and suggest a relatively great distance from our sun, as well as a 'community of interest' of these stars. The radial velocities observed, expressed in kilometers per second, are as follows:

γ *Pegasi*	+ 5	ε *Can. maj.*	+ 27
ζ *Cassiopeiæ*	+ 3	η *Leonis*	+ 4
ε *Cassiopeiæ*	— 6	γ *Corvi*	— 7
ζ *Persei*	+ 22	τ *Herculis*	— 13
β *Orionis*	+ 21	ζ *Draconis*	— 14
γ *Orionis*	+ 18	ι *Herculis*	— 16
ε *Orionis*	+ 26	67 *Ophiuchi*	— 4
ζ *Orionis*	+ 17	102 *Herculis*	— 11
κ *Orionis*	+ 17	η *Lyræ*	— 9
β *Can. maj.*	+ 33	ε *Delphini*	— 26

(Paper will appear in full in the 'Decennial Publications of the University of Chicago.')

New Spectroscopic Binaries: EDWIN B. FROST and WALTER S. ADAMS.

During the observations described above, six stars of the *Orion* type were found whose radial velocity varied. Preliminary statements have already been published as to three of these (η *Orionis*, o *Persei*, β *Cephei*). The others are δ *Ceti*, ζ *Tauri* and ν *Eridani*. Of δ *Ceti* we have obtained eleven plates since November 1, 1901, which give a range from + 6 to + 16 km. per sec. The period is short, but observations on consecutive nights will be necessary for its establishment.

The plates of ζ *Tauri* available are ten in number (from November 8, 1901, to December 18, 1902), and give a range from + 7 to + 34 km. The period can not yet be given, but may, perhaps, be about fourteen days. The spectrum is rather unique in respect to its very sharp and strong γ and β lines of hydrogen, with the other lines (some of them metallic) very faint.

One plate of ν *Eridani* was obtained in the autumn of 1901, and four a year later. The range of velocity so far observed is from $+3$ to $+26$ km. per sec.

We regard two or three other stars with spectra of the *Orion* type as suspicious of variable radial velocities, but the number of plates so far obtained is insufficient to establish the variation. The proportion of spectroscopic binaries, found by us in this special class of stars, to the number of which we have obtained three plates is about 1:5.

The Orbit of the Spectroscopic Binary η *Orionis:* Walter S. Adams.

The variation in the radial velocity of η *Orionis* was discovered at the Yerkes Observatory in December, 1901, by Professor E. B. Frost and the writer. Since that time twenty-eight spectrograms have been secured, covering an interval of very nearly a year, and in the present paper the star's orbit is computed from them by the method of Lehmann-Filliés. The greatest range found is about 285 km., and is the largest which has hitherto been discovered among binaries which like this have one component dark. The spectrum is of the *Orion* type, but contains several silicon, oxygen and nitrogen lines as well.

The period used in plotting the observations is 7.9896 days, and the following elements are found:

Velocity of system $V = +35.5$ km.
$u_2 = 90° 41'.6$
$w = 42° 16'$
$e = 0.016$
$\mu = 45°.059$
$T = 1901$, December 1.821
$a \sin i = 15{,}901{,}000$ km.

An ephemeris is computed with these elements, and the greatest difference between the observed and computed velocities is found to be less than 3 km.

The Masses in 85 Pegasi: George C. Comstock.

85 *Pegasi* is a sixth magnitude star with an eleventh magnitude companion distant less than a second of arc. Burnham, who discovered the pair in 1878, has published an orbit with a periodic time of 25.7 years. The bright star of the pair has been frequently compared with a neighboring ninth magnitude star, and from a discussion of these measures covering a period of fifty years I find for the masses of the sixth and twelfth magnitude stars the ratio, 2:3, the faint star having the greater mass, although its light is only a hundredth part that of the brighter star.

This result is directly opposed to the common view that regards the fainter component of a binary star as more nearly extinct than its companion, because a smaller mass has caused it to traverse more rapidly the stages of development that lead to extinction.

Stellar Revolutions within the Galaxy: Frank W. Very.

Independent estimates of the parallax of *Nova Persei* give

$$\pi = 0''.052, \text{ and } \pi = 0''.049,$$

whence it is concluded that the distance of this presumably galactic object is about 600,000,000,000,000 km. It is proposed to adopt this distance as a first approximation to the sun's distance from the Milky Way.

The first-type stars, of which the galactic stream is mainly composed, probably have rather small linear velocities, and are the result of agglomerative tendencies; but around the central condensations there is a great sphere of stars, mostly in advanced stages of development, which seems to have been produced by stellar dispersal. These outlying stars may have been thrown off from the central condensations by explosions of great magnitude; and if the ve-

locity of recession is not too great, these stars thenceforth revolve around controlling centers, consisting of densely clustering stars, in periods embracing many millions of years.

The attraction of a spherical mass of stars, equivalent to 10,000,000 such suns as ours, the aggregate extending to ten times the assumed solar distance from the Galaxy, is sufficient to produce the present solar velocity (20 km. per sec.) in moving from rest at the outer limit, and to give an oscillation from one extreme to the opposite boundary in a little over 40,000,000 years. With a central galactic condensation sufficient to turn the movement into an eccentric orbital revolution, if apogalacteum is ten times as far away and perigalacteum one tenth as far from the center of motion as the assumed galactic distance, the period of revolution will be shortened, but can not be less than about 6,000,000 years for a circular orbit around a central cluster. The general stellar sphere controls the movement in an elongated orbit at the greater distances, but the massive central agglomerations exercise directive power at the closer approach.

There are certainly more than 10,000,000 stars. Hence, either their attractions are largely mutually annulled through symmetrical external position, or else most of the stars have masses very much less than that of the sun, which must be above the average mass.

As the true proper motions of the stars show little preference for particular directions, the dispersals have occurred indiscriminately in all directions.

The diverse regions of space traversed by the sun in its progression from perigalacteum to apogalacteum may have very different meteoric contents whose reception produces secular changes in the planetary atmospheres, and may influence the development of living forms indirectly.

The apex of the sun's way is now about 20° from the axis of the galactic stream. At perigalacteum the apex will recede to the galactic pole, and the direction of motion of the apex in the interim will determine the axis of the solar orbit.

Preliminary Announcement with regard to the Proper Motions of Certain Faint Stars: GEORGE C. COMSTOCK.

The author has measured micrometrically the positions of 45 faint stars (ninth to twelfth magnitudes) referred to brighter neighboring stars whose proper motions were accurately known. From a comparison of these observations with older data of a similar kind, principally the measurements made by the Struves, he has derived proper motions of the faint stars, which in respect of precision are quite comparable with the proper motions of the fainter fundamental stars, *e. g.*, those of the fifth and sixth magnitudes.

These proper motions, although relatively few in number, furnish a determination of the sun's motion in space entirely independent of all previous data, and based upon stars whose average distance from the solar system is much greater than any hitherto employed. The resulting solar motion is in substantial agreement with previous determinations, and when combined with spectroscopic determinations of the velocity of the sun's motion it furnishes as the mean parallax of the stars observed (magnitude 10.5) the value 0″.005 (40,000,000 radii of the earth's orbit) which is in substantial accord with the extrapolated value furnished by Kapteyn's researches upon the brighter stars.

Other results of the present investigation are: (1) That the proper motions of the fainter half of this list of stars do not seem to be materially less than those of the brighter half, *i. e.*, the eleventh and twelfth magnitude stars are not more distant than

those of the ninth and tenth magnitudes; (2) that the average linear velocity with which these faint stars move through space is of the same order of magnitude as that of the brighter stars and about fifty per cent. greater than the velocity of the sun.

An Inquiry into the Cause of the Nebulosity around Nova Persei: FRANK W. VERY.

Lockyer's hypothesis of colliding meteor swarms would require spherical swarms of enormous dimensions, and in other respects it does not fit the facts. Radiation hypotheses do not explain the duplicity, or possible triplicity, of the nebulous ring, nor the double ratio of the radii of the two principal rings; neither is the retardation of the expansion satisfactorily accounted for. Reflection hypotheses are absolutely barred, because they demand an impossible albedo in the nebula.

The supposition that the motion is a real one involves the further hypotheses that it is due to particles of corpuscular dimensions, expelled from great masses of intensely heated gas, surrounding the nova, in moments of powerful electric oscillatory discharges; that these discharges assist to ionize the material and start a series of instantaneous magneto-electric impulses which guide the moving particles along lines of magnetic force; that the material is probably diamagnetic and will finally come to rest in loci of least magnetic potential; that the velocity imparted depends on the masses of the ions which appear to be in the ratio 1:2:4; that the velocity is accelerated out to a radius at which magnetic repulsion and gravitational attraction are equal for particles of the given dimensions, and that at greater distances the velocity is retarded. An estimate of the mass and diameter of the nova indicates that, at the surface of the star, the ratio of magnetic force to gravity may be as great as 100,000 to 1 for these minute particles; and as such a force would be capable of generating in a corpuscle a velocity of 100,000 km. per sec. in one second, if it were possible fully to utilize it for this purpose, the only objection which can be urged against the hypothesis is the difficulty of imagining a process by which this force can be economically applied.

In favor of the hypothesis it can be stated that the theoretical variation in the rate of expansion of the nebula has been observed; that the observed motions of nebulous forms agree well with those to be expected if the phenomenon is a species of magnetic phantom; that there are curved and diverging streamers on the south-southwest side, resembling the sheaves of diverging coronal filaments about the sun's poles; that the absence of a corresponding sheaf on the north-northeast side may be explained on Doppler's principle; that the disappearances of certain forms in the outer of the two principal rings after reaching a radius of 14′ to 16′, and the phenomenal and sudden appearance of bright forms at about the same positions, are to be explained on the same principle; that such appearances and disappearances are demanded on the magnetic hypothesis, and are extraordinary anomalies on any other.

It is concluded, therefore, that the nebula resembles a gigantic corona; that its axis is inclined 40° to the line of sight on the south-southwest side; and that the expansion of the nebula is approaching its limit.

The Mounting of Fixed Meridian Instruments: G. W. HOUGH.

The variation in level and azimuth in fixed meridian instruments is due to the effect of temperature: (1) On the metal outside the piers, (2) on the metal in the piers, (3) on the supporting piers, and (4)

to the motion of the base of the pier. In order to understand how the temperature acts on meridian instruments, we need some physical constants. If we assume the conductivity of iron as one, or unity, mercury is 1/10, stone, brick and wood 1/130 to 1/180. It will be readily understood that the iron outside of the pier will act quickly as a thermometer, the iron inside the pier will act more slowly, and the supporting piers will act very slowly in taking the temperature of the external air.

The piers acting as a thermometer may lag one month or more, and this is the explanation of the phenomenon observed at Edinburgh. Hence we conclude that variation of level and azimuth during a night of observation is almost entirely due to the effect of temperature on the metal parts of the instrument. The covering of piers with cloth and wood is of no use.

Many instruments in use change their level and azimuth by jumps, and not in any regular manner. If the expansion of iron is taken as unity, brass is 2, sandstone and granite 0.8 to 0.9, and bricks from 0.3 to 0.5. It is readily seen that the difference of expansion between brick and iron is so great that the instrument will always be loose on the piers. Hence it is free to jump in both level and azimuth.

In the Pistor & Martin's meridian circle the brass cylinder for holding the Y should be replaced with iron.

The modern Repsold is defective in its mechanical construction, for the reason that the Y-piece and the counterpoise weight are all supported on one frame, and when the instrument is reversed it is liable to be disturbed in level and azimuth. The Dearborn Observatory old pattern Repsold meridian circle is mounted on sandstone piers, and the lugs for holding the Y-pieces are set in with lead. The instrument is absolutely stable in level and in azimuth. The computed monthly level for two years, when corrected for temperature and the motion of the pier, agrees with the observed level within a fraction of a second of arc.

The Probable Value of the Constant of Aberration: S. C. CHANDLER.

The number of determinations of this constant is now so considerable that even wide differences of judgment as to the weights to be assigned them can have but little influence on the mean result. Forty-three determinations are combined with the following weights:

Talcott's method	20.523	Weight, 151
Meridian declinations	.514	22
Prime vertical transits	.525	24
Right ascensions	.53	6
Prismatic apparatus	.48	5
Mean	20.521	208

The Constant of Aberration from Observations with the Zenith Telescope, 1901–1902: C. L. DOOLITTLE.

A preliminary reduction of the series of zenith telescope observations covering the period from October 1, 1901, to October 1, 1902, gives for this constant the value 20″.510.

This is preliminary in the sense that some of the work of reduction has not been fully verified and that it is proposed to include in deriving the final result some additional data, viz., about four hundred observations between October 1, 1902, and January 1, 1903.

The values derived from the different series of observations at the Sayre and Flower Observatories are as follows:

(1)	1889–1890	20″.448 ± 014	Weight ½
(2)	1892–1893	20.551 ± 009	1
(3)	1894–1895	20.537 ± 014	1
(4)	1896–1898	20.580 ± 008	½
(5)	1898–1899	20.540 ± 010	1
(6)	1900–1901	20.561 ± 008	1
(7)	1901–1902	20.510	1
Weighted mean		20″.539	
Unweighted mean		20 .532	

I have elsewhere given reasons for suspecting the genuineness of result (1). There are also reasons for the small weight assigned to result (4) aside from the somewhat larger value given.

It is proposed to continue this series for another year. It will then be terminated unless means can be had for giving the investigation a wider scope. For a number of years I have been hoping that I might be able to set up an instrument of different construction and have a second series of observations carried on simultaneously with my own for a period of at least two or three years. At present the necessary means are not available, but I have not entirely abandoned this project.

Micrometrical Measures of Individual Stars in the Great Globular Clusters: E. E. BARNARD.

The great power of the forty-inch refractor of the Yerkes Observatory has been utilized in a systematic micrometrical survey of between 600 and 700 small stars in the globular clusters *M* 3, *M* 5, *M* 13 and *M* 92.

The paper deals mainly with the measures of stars in *M* 13 *Herculis* and a comparison of these with measures made by Dr. Schriner, of Potsdam, in 1891, of photographs of the cluster. This comparison shows a generally close agreement between the photographic and visual measures. There are a few discordances amounting to one or more seconds of arc. There does not seem to be any proof that these are due to motion in these stars, but rather due to the difficulty of making the photographic measures. In the ten years' interval there does not appear to be any certain proof of motion in any of the stars under observation. In the work with the large telescope the stars are referred to a standard star in each cluster. This star is accurately measured with reference to known stars, and its absolute position given, from which the exact place of any one of the small stars observed can be easily deduced. The measures were made by the method of position angle and double distances, though the relative position of the stars to the standard stars are given in the order of $\Delta\alpha$ and $\Delta\delta$.

On Some of the Variable Stars in the Cluster M 5, *Librœ:* E. E. BARNARD.

These are observations of some of the variable stars discovered in this cluster by Professor S. I. Bailey.

The smaller stars all have periods of nearly half a day, but there are three bright stars—the brightest in the cluster—which have relatively long periods. These periods are:

Star No.	Period, Days.	Light Range.
42	25.7739	1¾ m.
84	26.5760	1¾ m.
50	106.17	1 m.

The first two rise rapidly to maximum and decline slowly to minimum. No. 50, which seems to have the longest period in the cluster, differs markedly from the other two in that its rise and decline are both slow and uniform. All three are slightly yellowish at maximum.

Several of the small, quick-period variables were under observation. The best observed of these was No. 33, whose period is $0^d\ 12^h\ 2^m\ 7^s.6$, and whose light range is about one magnitude ($1^m.1$). The light curve for this star is rather remarkable.

The normal condition is faint at about 14½ mag. At about one hour before maximum it begins to rise. Its light increases rapidly, and the duration of maximum is very short. The star then declines about as rapidly as it rose, for about forty minutes. It then seems to halt in the decline, and from this on sinks very slowly to minimum, not reaching its faintest or normal condition until seven or eight hours after maximum.

Notes on the Short Method of Determining Orbits from Three Observations: A. O. LEUSCHNER.

In order further to simplify the computation of preliminary orbits, the author proposes several modifications in the application of his 'Short Method, etc.' (*Publications L. O.*, Vol. VII., part 1):

1. The accuracy of ρ_0 is increased by eliminating the parallax from the second observation through simple corrections applied to the corresponding solar coordinates in group I.

2. When the parallax factors for the three observations differ materially, the accuracy of the geocentric velocities is increased by applying the parallax corresponding to the unit of distance to all three observations in the formulæ of group II.

3. No correction for parallax is to be applied to the middle observation on the basis of the successive approximations for ρ_0 (cf. groups V., VII.), but instead the parallax is to be eliminated once for all by correcting the rectangular equatorial solar coordinates for the normal date as follows:

$$\Delta X = (p_\alpha \rho_0) \sin \alpha_0 \cos \delta_0 + (p_\delta \rho_0) \cos \alpha_0 \sin \delta_0,$$
$$\Delta Y = -(p_\alpha \rho_0) \cos \alpha_0 \cos \delta_0 + (p_\delta \rho_0) \sin \alpha_0 \sin \delta_0,$$
$$\Delta Z = -(p_\delta \rho_0) \cos \delta_0.$$

4. By replacing the A and B by

$$A' = A + \cos \delta \, p_\alpha / \rho^2, \qquad B' = B + p_\delta / \rho^2.$$

respectively, in the differential formulæ (group VII.), terms depending on the parallax factors are introduced which will minimize the effect, on the residuals, of changes in parallax, and the convergence is increased.

5. The sufficiency of the differential formulæ should be tested by checking the new residuals obtained in group VII. by means of the corresponding formulæ of group VI.

6. Simple formulæ involving the squares of the corrections have been derived for those rare cases in which the linear relations are found to be insufficient.

7. The new values of x_0, y_0, z_0 (group VII.) may be found rigidly in *all* cases by changing the former values by

$$\partial x_0 = \cos \alpha_0 \cos \delta_0 \partial \rho_0, \quad \partial y_0 = \sin \alpha_0 \cos \delta_0 \partial \rho_0,$$
$$\partial z_0 = \sin \delta_0 \partial \rho_0.$$

8. The method may be applied to longer arcs by using closed expressions in place of the series in group VI.

A Method of Computing Orbits in Rectangular Coordinates: A. O. LEUSCHNER.

From

$$\omega_\alpha = f_\alpha \omega_0 + g_\alpha \omega_0 \quad (\omega = x, y, z)$$

(*Publications L. O.*, Vol. VII., part 1) the author derives the three fundamental equations:

$$\omega_0 = \frac{g_{111}}{f_1 g_{111} - f_{111} g_1} \omega_1 - \frac{g_1}{f_1 g_{111} - f_{111} g_1} \omega_{111}.$$

Introducing

$$\rho \cos \alpha \cos \delta = x + (X)$$

in the first of these three equations, it becomes

$$\frac{g_{111}}{f_1 g_{111} - f_{111} g_1} \rho_1 \cos \alpha_1 \cos \delta_1$$
$$- \frac{g_1}{f_1 g_{111} - f_{111} g_1} \rho_{111} \cos \alpha_{111} \cos \delta_{111} - \rho_0 \cos \alpha_0 \cos \delta_0$$
$$+ (X)_0 - g_{111}(X)_1 + g_1 (X)_{111} = 0$$

where the (X) (similarly the (Y) and (Z) in the remaining two equations) are the solar coordinates, corrected, to eliminate parallax, by the formulæ given in 3 of the foregoing 'Notes.' These coordinates are referred to the beginning of the year and apply to the actually observed dates.

The solution of the fundamental equations gives at once

$$\rho_0 = \frac{c_x D' + c_y D'' + c_z D'''}{D}$$

where the D are simple functions of the uncorrected observations, and

$$c_x = (X)_0 - \frac{g_{111}}{f_1 g_{111} - f_{111} g_1}(X)_1 + \frac{g_1}{f_1 g_{111} - f_{111} g_1}(X)_{111}$$

or otherwise

$$c_x = (X)_0 - \frac{[r_{11} r_{111}]}{[r_1 r_{111}]}(X)_1 - \frac{[r_1 r_{11}]}{[r_1 r_{111}]}(X)_{111}$$

and where c_y, c_z are given by similar expressions. If not previously available, a first approximation to the triangular ratios may be obtained by the 'Short Method, etc.' Next ρ_1, ρ_{111}, x_0', y_0' and z_0' are obtained by simple expressions. The accuracy of the initial values of the ratios of the triangles is now tested by recomputing them from closed expressions or by the series. Any disagreement between the initial and final values is removed by means of differential formulæ. The elements are computed by formulæ VIII. of the 'Short Method.' The use of rectangular coordinates as outlined in the paper presents many advantages and is applicable to long arcs.

The Solution of an Orbit, Irrespective of Parallax and Aberration: A. O. LEUSCHNER.

In the 'Method of Computing Orbits in Rectangular Coordinates' the effects of parallax and aberration are fully eliminated, except in the expressions for the ratios of the triangles, in which the θ's are affected by the difference of planetary aberration (*e. g.*, $\theta_{11} = k(t_{111} - t_1)$). In certain rare cases, particularly for very short intervals, the c_x, c_y, c_z become so small that the solution will become indeterminate unless the accurate differences in planetary aberration can be introduced at the start. In a first orbit, therefore, recourse is had to eliminating the first powers of the differences in aberration, by segregating the first powers of the θ's as factors from c_x, c_y, c_z and then replacing them by expressions involving the differences of aberration, *e. g.*,

$$\theta_1 = \theta_1^0 - k\alpha(\rho_{111} - \rho_1).$$

The fundamental equations then take the form

$$a\rho_1 + b\rho_0 + c\rho_{111} + d + k\alpha e\rho_{111}\rho_1 + k\alpha f\rho_{111}\rho_0 + k\alpha g\rho_0\rho_1 = 0,$$

where α is the aberration factor.

The solution of these equations is reduced to the solution of two equations of the form

$$\rho_0 = f(\rho_{111} - \rho_1) \quad \text{and} \quad \rho_{111} - \rho_1 = \phi(\rho_0)$$

from which $(\rho_{111} - \rho_1)$ and ρ_0 are obtained.

The Orbit of Comet 1902 a: A. O. LEUSCHNER.

The paper contains a preliminary report on the investigation of the orbit of comet 1902 *a*. A preliminary orbit based on three observations, of which the third represented a single micrometric measure in α and δ was published shortly after the appearance of the comet. The elements, which were computed by the 'Short Method,' indicated an unusually short period. A comparison of the sum of the squares of the residuals from the elliptic with those from a parabolic orbit computed at Kiel gave the following results for the first nine observations;

[vv] parabolic orbit	2985
[vv] elliptic orbit	711

For further investigation the observations were grouped into six places, three of which represent single observations, one was based on two, one on three, and one on five observations. The best three of these were selected for the improvement of both the parabolic and elliptic orbits. The final parabolic orbit is completed and does not represent the

observations so well as the preliminary elliptic orbit. In determining the final elliptic orbit many difficulties were encountered which led to the theoretical results given in the foregoing papers. The calculation of an orbit irrespective of parallax and aberration has just been undertaken. A preliminary improvement of the orbit gave evidence that the first results concerning a very short period will be substantiated. The following students and assistants have taken part in the computations: Dr. R. T. Crawford; Messrs. H. K. Palmer, Joel Stebbins, Ralph Curtiss, C. A. G. Weymouth, Fellows in the Lick Observatory; and Miss A. M. Hobe.

The Photoheliograph of the U. S. Naval Observatory; Its Use and Defects in Solar Photography: G. H. PETERS.

This paper dealt with the changes made in the instrument during the past four years. A considerable variation of focal length has been found, amounting to about one half inch, between the temperature of summer and winter. In a proposed new and larger instrument, some defects due to the attached building are to be avoided.

The use of Jena glass No. 0.2164 combined with No. 0.2001, with an alternative of No. 0.164, is suggested for this lens, to reduce the secondary spectrum to a minimum.

Attention was called to the necessity of a study of the thermo-focal changes in long focus lenses, to be used in eclipse work.

Results of Meridian Observations for Stellar Parallax made at the Washburn Observatory, University of Wisconsin: ALBERT S. FLINT.

Results were presented for a list of ninety-six stars whose distances from the solar system were to be determined. This list consists mainly of stars whose proper motion, or drift across the heavens, is comparatively large; and these results show that, on the average, the larger this apparent motion, the nearer the star. These observations were forwarded to Professor Kapteyn, of Groningen, Holland, who made use of them in an important investigation of the structure of the heavens.

Preliminary Statement of the Magnetic Disturbances Coincident with the Recent Eruption in Martinique: L. A. BAUER.

The disturbances of the magnetic needle coincident with the volcanic eruption of May 8 and 20 were felt practically simultaneously at the four Coast and Geodetic Survey magnetic observatories situated respectively at Cheltenham (Maryland), Baldwin (Kansas), Sitka (Alaska) and Honolulu (Hawaiian Islands).

In response to a circular sent by the Superintendent of the Coast and Geodetic Survey records have been received from the principal foreign observatories. A cursory examination of these records shows the disturbances and that they occurred practically simultaneously at all of the observatories thus far heard from. An examination of the records indicates that apparently there were premonitory symptoms a month before the actual outbreak. The records will be subjected to a critical discussion, with the view of settling definitely whether the cause of these remarkable disturbances had its source within or outside of the earth's crust.

A comparison of these effects was made with that which had revealed itself during the total solar eclipse of May 28, 1900, and also the more recent one of May 18, 1901. It was shown that the eclipse effect is not in any sense to be classed as a magnetic disturbance, but that it is of the periodic variation kind and is precisely similar in character to the solar diurnal variation.

Preliminary Note on the Total Light of the Stars: Sidney D. Townley.

While engaged in photometric work at the Lick Observatory during the past summer a few experiments were made to determine the amount of light received from the sky at night when the moon is not shining. This work was undertaken at the request of Director Campbell, to whom the problem was suggested by Professor Newcomb.

Both visual and photographic methods are applicable to the solution of this problem, and Professor Newcomb has already employed some of the visual methods, the results of which were printed in the *Astrophysical Journal,* December, 1901. My efforts were directed almost exclusively to perfecting a photographic method. The results thus far obtained are meager, but it is believed that a reliable method has been found.

The method adopted is, indeed, very simple. Both lenses were removed from the Crocker photographic telescope and a cardboard cap of three centimeters diameter attached to the end of the telescope tube. An exposure of one hour was made upon a bright star and the result was, of course, an impression on the plate of the size and shape of the aperture. Exposures were then made upon the sky by means of four camera boxes, consisting simply of aperture and plate, attached to a polar axis made of a piece of 4 x 4. The angular apertures used varied from five to ten degrees. The five plates were developed at the same time in a large tray, and their relative intensities measured by means of a Lummer-Brodhun photometer.

In the very limited length of time which I had to devote to this work it was possible to obtain only a few sets of plates. Two of these sets give reliable results. In each Vega was the comparison star used. In the one the camera boxes were directed to the sky about half way between γ *Pegasi* and β *Ceti,* in the other to the Milky Way nearest Vega.

The results are, from the first, that the light of Vega is equivalent in actinic intensity to the light received from an area of rather vacant non-galactic sky 7° 16′.4 in diameter, from the second, that the light of Vega is equivalent to the light received from an area of galactic sky 5° 19′.8 in diameter. This gives galactic sky to be 1.9 times brighter than non-galactic sky. If we take the magnitude of Vega to be 0.2, then from the first result we find that the light received from an area of non-galactic sky one degree in diameter is equal to the light of a 4.5 magnitude star, which is not far from the result obtained by Professor Newcomb, namely, that the light received from an area of non-galactic sky one degree in diameter is equal to 0.9 the light of 5.0 magnitude star.

Photometric and Photographic Observations of Faint Variable Stars: J. A. Parkhurst.

In the course of this work at the Yerkes Observatory several stars have been found whose brightness at minimum is at or below the limit of the 40-inch refractor. To illustrate three specimen fields, lantern slides were prepared from negatives taken with the 24-inch reflector, covering a field of 30′ around the variable, corresponding to the inner square of Hagen's charts.

7220 S Cygni.—Plate taken November 24, 1902, exposure 61 minutes. The variable is about 11th magnitude; its greatest range of variation is from the 8th to the 16th magnitude, being approximately equal at maximum to the star 1′ north, and at minimum to the star 0′.5 preceding.

7458 V Delphini.—Plate taken September 7, 1902, exposure 68 minutes. This star has perhaps the greatest range of any

known variable. At the maximum of 1899 it reached nearly the 7th magnitude, at minimum it is about the 17th magnitude. As shown on the slide it is 10th magnitude, at its faintest it is equal to the small star 0'.2 south.

7582 X Cephei.—Plate taken March 13, 1902, when the variable was photographically fainter than 17th magnitude, and visually below the limit of the 40-inch when using the eyepiece of the photometer, power 237. The magnitude at maximum is 9.7, equal to the star 4' south, 1' following.

The work in progress includes determination of the photometric magnitudes of comparison stars for 25 faint variables, using the equalizing wedge photometer devised by Professor E. C. Pickering, in connection with telescopes of 6, 12 and 40 inches aperture; connecting the comparison stars with Harvard and Potsdam standards in the neighborhood; also visual comparisons by Argelander's method, and photographs of the fields for the purpose of certain identification of the comparison stars, and for determining the brightness of the variable when below the visual limit of the telescopes used.

W. S. EICHELBERGER,
For the Council.

THE ASSOCIATION OF AMERICAN ANATOMISTS.

THE sixteenth session of the Association of American Anatomists, meeting in conjunction with the American Society of Naturalists and other affiliated societies, was held in Washington, D. C., December 30 and 31, 1902. The association met in the Columbian University Medical School.

The association gave consideration, at its general business session, to the following recommendations made by the executive committee:

1. They accepted the invitation tendered by the American Association for the Advancement of Science, to form an affiliation with this association, agreeing to elect a delegate to the council of the American Association for the Advancement of Science. Such affiliation impairs in no degree the integrity of the Association of American Anatomists and does not bind this association to meet with the American Association for the Advancement of Science, unless it deems it expedient.

2. In view of the fact that the regular annual meeting of this association was held this year in Washington, it was deemed inadvisable to arrange for a second meeting at this place in May of the present year, in conjunction with the other American associations and societies participating in the Congress of American Physicians and Surgeons. This association, therefore, moved that the meeting in connection with the Congress of American Physicians and Surgeons in May, 1903, be omitted.

3. It was moved to omit from the program the abstracts of papers presented at the meetings.

4. The following addition was made to the by-laws of the association: 'Newly elected members must qualify by payment of dues for one year within thirty days after election.'

5. It was voted that any change in the constitution of this association must be presented in writing at one meeting in order to receive consideration and be acted upon at the next meeting; due notice of the proposed change to be sent to each member at least one month in advance of the meeting at which such action is to be taken.

6. The following amendment to Article V. of the constitution was proposed at this meeting and will receive consideration at the next annual meeting:

"Candidates for membership must be persons engaged in the investigation of