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ABSTRACTS *

Aller, Lawrence H. Metallic A stars.

Spectra of eleven A-type stars with strong metallic lines, photographed at the Mt. Wilson Observatory by Paul W. Merrill, have been studied in an effort to find the abundance ratio of the metals to hydrogen. The list includes representatives of Morgan's metallic and peculiar A stars. The latter objects show periodic variations of line intensities. The approximate equivalent widths, calibrated roughly in terms of numbers of absorbing atoms by means of the curve of growth suggest ten times as many metallic atoms and ions lie above the photosphere of one of these stars as above the photosphere of a normal A dwarf such as Sirius. The effects of blends, accidental errors accruing from the low dispersion employed, and the uncertainty in the excitation temperature make any comparison of individual elements difficult. In most of the stars, the hydrogen line profiles resemble those of Sirius although they are usually narrower. The number of hydrogen atoms in the second quantum state above the photosphere appears to be the same in these metallic and peculiar A stars as in Sirius, a result in harmony with their Harvard spectral classes, all near A₀. A literal interpretation of the data would suggest a greater abundance of the metals in these A stars than in normal A dwarfs. Although stratification or chromospheric effects may play a role, the profiles of the hydrogen lines in most of the stars do not suggest a shell structure of the atmosphere.

Kirkwood Observatory,
Indiana University,
Bloomington, Ind.

Bidelman, William P. Emission line stars near η and χ Persei.

A plot of the known non-supergiant emission-line stars in the region of the double cluster in

Perseus shows that there is a much more pronounced grouping of these objects about the cluster χ Persei than about the other cluster. In view of the apparent similarity in constitution of the two clusters, this result is of considerable interest.

The average absolute magnitude of these emission-line stars may be estimated at about -3.5 , if it is assumed that they are associated with the double cluster; their spectral types, as far as known, range from B₀ to B₃.

Two previously unrecognized $H\alpha$ emission stars of early type have been found on an objective prism plate of the η and χ Persei region taken with the Schmidt-type reflector of the Warner and Swasey Observatory. This plate was made available to the writer through the kindness of the director of that observatory, Dr. J. J. Nassau. These new Be stars are BD +56°612 and star number 2566 in Oosterhoff's monograph on the double cluster in Perseus.

Yerkes Observatory,
Williams Bay, Wis.

Burns, Kevin. Two stars of low luminosity.

Faint companions having motions parallel to those of the bright stars accompany the following:

	ν And	D'Ag 5533
BD No.	+40°332	+19°4484
α (1900)	1 ^h 30 ^m 9	20 ^h 36 ^m 2
δ (1900)	+40°54'	+19°34'
p	160°	183°
d	55"	125"
π	0".070	0".052
$M - m$	-0.8	-1.4
M	13.7*	11.8

* Suspected variable.

Allegheny Observatory,
Pittsburgh, Pa.

* Of papers presented at the Seventy-fifth Meeting of the American Astronomical Society, Madison, Wisconsin, September 8-11, 1946.

Campbell, Leon. The light curve of Nova (T) Coronae Borealis.

Just eighty years—lacking three months—after the famous nova of 1866 made its appearance, it presented its second observed outburst, confirming the predictions by several authorities that this star is a recurring nova. The assumption that it might be such a nova was based principally on the sharp form of its light curve and the very rapid decline from maximum to minimum, similar to RS Ophiuchi and T Pyxidis in particular.

To date over 700 estimates of brightness of T Coronae Borealis during its present outburst have come to hand, and for the first five months following its maximum of last February, observations have been obtained on all but four nights.

The main purpose of this paper is to indicate the striking similarity in form of variation between the maxima of 1866 and 1946. Although the recent primary maximum appears not to have been as bright as that of 1866, the steepness of the decline and the occurrence of the secondary maximum have, in both instances, been remarkably alike, especially in the phase element.

*Harvard College Observatory,
Cambridge, Mass.*

Clemence, G. M. Application of Brouwer's method for absolute perturbations.

The method described by Brouwer in *A. J.* 51, 37 has been applied to the calculation of those first-order perturbations of Mars by Venus that contain in their arguments the single multiple of the mean anomaly of Venus. The results, comprising some forty coefficients to four decimals of a second of arc, are in entire agreement with those obtained by other independent methods. The method is simple and straightforward in numerical application, considerably surpassing other methods in rectangular coordinates in elegance and efficiency. It deserves the careful consideration of anyone about to undertake the general theory of a planet.

*U. S. Naval Observatory,
Washington, D. C.*

Edmondson, Frank K. Second report on radial velocities of A and K stars fainter than tenth magnitude.

Considerable progress has been made since the first report was presented at the Cincinnati meeting.¹ Radial velocities have been completed for 628 stars, 489 K stars and 139 A stars; and unmeasured spectra are on hand for 298 more stars,

168 K stars and 130 A stars. The total number of settings made with the Gaertner machine thus far is 187,559.

The large velocity-dispersion for the K stars that was reported at the Cincinnati meeting, ± 27.7 km/sec, is confirmed by the increased data. The material has been subdivided, with the following results:

Toward galactic center:

$$\sigma_a = \pm 29.5 \pm 1.7 \text{ km/sec.}$$

Toward direction of rotation:

$$\sigma_b = \pm 27.2 \pm 1.6 \text{ km/sec.}$$

Toward galactic pole:

$$\sigma_c = \pm 32.1 \pm 2.2 \text{ km/sec.}$$

In contrast with this, the A stars give a dispersion of only ± 16 km/sec.

No A star has yet been found with a peculiar radial velocity larger than 63 km/sec. Thus far 29, or 6 per cent, of the K stars observed have peculiar radial velocities greater than 63 km/sec. These are all directed toward galactic longitudes between 120° and 0° .

Further conclusions about the percentage of dwarfs (see first report) must await the luminosity classifications. Dr. Vyssotsky is taking charge of this phase of the work.

This program has been carried on since 1941 at the McDonald Observatory with the 82-inch reflector under the terms of the pioneering co-operative agreement between the Universities of Texas, Chicago, and Indiana. Dr. Vyssotsky has been supplying spectral types and apparent magnitudes in advance of publication, as these are the criteria of selection for this program. There have been 1585 spectrograms taken with the 82-inch, as follows: 657 by Edmondson, 410 by Popper, 150 by Hiltner, 123 by Bauer and Münch, 106 by Deutsch, 102 by Elvey and others, 29 by Struve, and 8 by Cesco. S. A. Mitchell took 270 spectra with the Mount Wilson 60-inch in 1941 and 1943.

The K star program will be completed during the coming year. The A star program will require two or three years more to complete. Projects now under consideration include: observations of faint A and K stars from the *Cape Zone Catalogue*, provided that the selection according to motion made by the Cape observers can be allowed for, and additional observations of dwarf stars in order to get accurate space velocities.

1. *A. J.* 51, 19, 1944.

*Kirkwood Observatory,
Indiana University,
Bloomington, Ind.*

Eggen, Olin J. A photoelectric study of the eclipsing variable TX Ursae Majoris.

The eclipsing variable star TX Ursae Majoris has been observed on 40 nights from 1935 to 1942 with the photoelectric photometer on the 15-inch refractor of the Washburn Observatory. A measure of precision of the observations is indicated by the probable error of a single normal magnitude of ± 0.0046 mag.

The light elements of Rügemer were used in the computation of the phases with the exception that the amplitude of the sine term for the variation of the period was reduced to $0^d.015$.

After rectification for small reflection and ellipticity effects, the Algol-type light-curve revealed minima of depths 2.00 mag. and 0.032 mag. for the primary and secondary respectively. Anticipating the darkening coefficients as 0.4 and 0.6 for the B8 and gF2 components, a solution for the elements has been made. Because of the uncertainty of the value of the mass ratio at present available, no attempt has been made to proceed beyond "intermediate elements."

*Washburn Observatory,
Madison, Wis.*

Fath, E. A. The triple variability of 12 Lacertae.

On the basis of 63 maxima from 1917 to 1940 the mean period of variability is $0^d.19308902$ with a mean range of 0.082 mag. Besides this mean period there is a second period of $0^d.164850$ with a range of 0.031 mag. and a third period of about $0^d.1316+$ with a range of 0.017 mag.

*Goodsell Observatory,
Northfield, Minn.*

Gaposchkin, Cecilia Payne. The remarkable variable Y Ceti.

The star named Y Ceti has been recorded on only two plates, taken at the Cape Observatory on 1893 October 7 and 1894 September 26 respectively. Harvard plates taken within ten days of each date do not show the star, and it has never since been seen by any observer.

Through the kindness of the Kapteyn Astronomical Laboratory at Groningen the author has received contact prints of the two discovery plates. Each bore two exposures; one on Cetus, one on a region in Sagittarius; the earlier was a photovisual plate. On comparison with a Harvard photograph of the Sagittarius region it is clear that the two images identified as Y Ceti are in

fact those of two Sagittarius stars. The variable Y Ceti must therefore be regarded as non-existent.

*Harvard College Observatory,
Cambridge, Mass.*

Gaposchkin, Cecilia Payne, Sergei Gaposchkin, and Margaret Mayall. The variations of ρ Cassiopeiae.

The variations of ρ Cassiopeiae have been studied on all available Harvard photographs. Observations are recorded as far back as JD 2409850 (November, 1885) and are fairly continuous for the past 45 years.

The star has varied continuously in brightness, for the most part with small range. Maximum is about 5.5 mag. A well-marked minimum, 6.7 mag., occurred at JD 2416800, and many less prominent ones are recorded. The star is too bright for accurate study with this material, but most of the visual maxima and minima recorded by Hassenstein are shown by the Harvard curves, which strengthens the evidence for their objective existence. During the past year the star has fallen to about the eighth photographic magnitude. No periodicity is evident in the variations, which are executed in an interval of the order of a hundred days.

A number of spectra have been recorded with various instruments. A few were classified by Miss Cannon; these and all others have been independently classified by Mrs. Mayall and Mrs. Gaposchkin. The spectrum of earliest recorded type is supergiant F8p (1885); the latest, M5p (1946). During the intermediate time the spectrum has varied between F8 and K5. In general, the spectrum has been of latest type when the star was faintest; but at JD 2419600 it was K5 when the star was near maximum.

At all times the spectrum is most peculiar; for example in 1946, while displaying titanium oxide bands appropriate to class M5, it shows no corresponding strengthening of the Ca I line 4227. The impression is that the late-type characteristics overlie the G supergiant during times of minimum, producing the overall effect of a later spectrum. Guthnick, in his discussion of the Potsdam spectra, considered that they gave the impression of being complex.

*Harvard College Observatory,
Cambridge, Mass.*

Green, Louis C. Oscillator strengths for the continua of CaII.

A calculation of $df/d\epsilon$ at three or more points in each of five continua of CaII, 4s-p, 4p-s, 4p-d,

3d-p, 3d-f, has been made using Hartree's¹ wave functions for the bound electron and wave functions found by numerical integration using Hartree's field but omitting exchange for the unbound. The 4p-d and 3d-f continua are so large that following the arguments of Bates and Massey² one may have confidence that the inclusion of exchange would not appreciably affect either the magnitude or the variation with ϵ . On the other hand, the three remaining continua are so small that the present work can only be considered as establishing their smallness but neither their magnitude nor their variation. Considerable deviations from hydrogenic character are noted in the total f -values for the continua. A single $df/d\epsilon$ value calculated using wave functions derived from a Kramers field has again been found to lie between the values obtained with the self-consistent field with and without exchange.

1. *Proc. Roy. Soc.* **164** A, p. 167, 1938.

2. *Proc. Roy. Soc.* **177** A, p. 329, 1941.

*Haverford College,
Haverford, Pa.*

Greenstein, Jesse L. Spectra of diffuse nebulae.

A program of observation of the spectra of various galactic nebulae has been started at the McDonald Observatory. This paper reports on spectrophotometric observations of the continuous emission in the Orion nebula. The color temperature of this continuum is found to be near 12,000° on both sides of the Balmer limit. The emission discontinuity is 1.6 mag. If the energy distribution in the Balmer continuum is interpreted as re-combination emission, its electron temperature is about 60,000°. This excessively high value is in contradiction to electron temperatures derived from the forbidden line spectrum, and from the hydrogen emission line intensities near the series limit. If we assume that the nebula is optically thick at wave lengths less than 3646 Å however, an electron temperature near 12,000° can be derived. Suggested observational tests of this hypothesis include the absence of filamentary structure in direct photographs taken in the ultraviolet.

Another very interesting observation is the apparent existence of a "double Balmer jump" in emission. The resolving power of the spectrograph is such that the hydrogen lines blend at about the twentieth series member. The mean intensity of the lines near this point is about one-half the intensity in the continuum at the series limit. This observation can be explained as arising from the departure of the populations of the

various energy levels of hydrogen from the expected values in thermodynamic equilibrium, in accordance with theories developed by Baker and Menzel.

The opacity of the nebula is ascribed to the nearly complete metastability of the 2²S level of hydrogen. The computation of the amount of hydrogen required gives a mass of about 10☉ for the nebula.

*Yerkes Observatory,
Williams Bay, Wis.*

Herget, Paul. The orbits of comet 1925 II (Schwassmann-Wachmann) and comet 1943a (Oterma).

The orbit of Comet 1925 II (Schwassmann-Wachmann) has been determined from 54 observations extending from 1934 to 1944 (p.e. = $\pm 0''.85$ from 12 normal places) and reliable ephemerides can be prepared for years to come.

Approximate perturbations of Comet 1943a (Oterma), based on the elements of *Harvard Announcement Card* 698, were carried backward to see what the effect of the close passage to Jupiter in 1937-38 had been. These indicated that the comet had approached to within less than 0.1 astr. units of Jupiter, and that very accurate starting elements would first be needed to make the computations reliable. Unfortunately, the comet was 1° to the north of the region around Jupiter surveyed by Nicholson in 1938. It is urged that observations be made at opposition and at both quadratures so as to provide the most accurate elements. Another close approach to Jupiter will occur in 1961.

*Cincinnati Observatory,
Cincinnati, Ohio.*

Huffer, C. M. A photoelectric study of AR Aurigae and RZ Cassiopeiae.

Solutions for these two eclipsing stars have been made from photoelectric observations made at the Washburn Observatory from 1935 to 1942.

The most important results follow:

AR Aurigae. The two components of the system are equal in size ($k = 1$) but are not quite equal in brightness, the difference being 0.15 magnitude, in close agreement with the spectroscopic results. Since the spectral classes are B9, a darkening coefficient, $u = 0.4$, was used for each star. The eclipses are partial. The average residual of a single normal is ± 0.004 magnitude.

RZ Cassiopeiae. The period is variable and the

times of minima can be represented by a close approximation to a formula derived by de Sitter in 1933. The orbit was assumed to be circular. The components are ellipsoids, $z = 0.033$, with ratio of radii, $k = 0.819$. Darkening coefficients, $u = 0.4$ for the brighter star and $u = 0.6$ for the fainter star, were used. More accurate measures will be obtained with the new photoelectric multiplier tube, which will also assist in obtaining a better formula for the variation of the period.

*Washburn Observatory,
Madison, Wis.*

Hynek, J. A. Astrophysical projects in the high altitude rocket program.

The firing of captured German V-2 rockets at the Army test field at White Sands, New Mexico, has provided an opportunity for astrophysicists to send aloft, to altitudes of 100 miles and over, laboratory equipment in the rocket war head, normally used for explosives.

Several groups of physicists and astronomers are cooperating in the scientific part of this program. The main emphasis in the program is given to cosmic ray research, but of primary interest to astronomers is the incorporation in the rockets of spectrographs employing lithium fluoride optics. With these it is hoped to extend the observed solar spectrum to $\lambda 1500$ or below. One of the spectrographs scheduled to be fired is designed to give a dispersion of 50 Å/mm; recording is on film strips affixed to a rotating decagonal cylinder, itself encased in a steel cassette. Observation of sky brightness and the production of artificial meteors at various heights in the atmosphere is also scheduled.

To the time of writing, in only one flight has it proved possible to recover any of the equipment and records. New techniques of recovery, however, promise success in the near future of recovery of the film cassettes if not of the spectrographic and other equipment, which can be considered expendable.

*Perkins Observatory,
Delaware, Ohio.*

Irwin, John B. A photoelectric study of U Sagittae.

U Sagittae is an eclipsing binary system consisting of a B9 component and a larger, much fainter G5 component. The primary minimum is a deep, total eclipse of the B9 component; the secondary minimum is a shallow, annular eclipse of the G5 component. Tidal and rotational forces

distort the G5 star into an approximately tri-axial ellipsoid whose axes are in the ratio 1.00:0.88:0.83. The purpose of the present investigation was to secure photometric data accurate enough to determine (1) the coefficient of limb darkening of the B9 component in two color regions, and (2) the amount of distortion of the G5 component.

The photoelectric observations of U Sagittae at primary minimum, with a blue-sensitive photocell, have been shown to be precise enough to derive an accurate value of the limb darkening coefficient of the B9 component. A least-squares method was extended to include the determination of the mass ratio of the two components. The mass ratio was determined with a precision half that of the spectroscopic method, and was indirectly determined through the effect on the light-curve of the distorted shape of the fainter, eclipsing G5 component. The effect of this distortion is considerable, but it is shown that a combination of fictitious elements would provide a solution that would satisfy all but the most precise observations. The spectroscopic and photometric mass ratios are in agreement within their probable errors.

Observations with a red-sensitive photocell were not precise enough in themselves to derive either an accurate darkening coefficient or an accurate mass ratio. A method of analysis was developed by which it was possible, by a comparison of the observed light-curves in the blue and the red, to determine very accurately the difference in limb darkening between the two color regions. This method, applicable to similar observations of other stars, should yield differential limb darkening coefficients precise enough to afford valuable checks on astrophysical theories of stellar atmospheres.

The time of primary minimum was determined very precisely in both colors and there is no evidence that this time is a function of the wave length of observation. The time of secondary minimum was not precisely enough determined to distinguish between the two hypotheses, (1) a rotating line of apsides or (2) a third component of low mass, necessary to explain the variation of period of U Sagittae.

New methods of rectification, based partly on theory and partly on the observations of the light-curve between minima, were developed and applied. The resulting corrections in the solution of primary minimum are small but not negligible. It is shown that the conventional rectification