42. COMMISSION DES ETOILES DOUBLES PHOTOMETRIQUES

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The triennium just past has been one of the most fruitful periods in research of eclipsing binary systems, and increase in understanding of the diverse phenomena exhibited by them. In no previous period were such investigations pursued more extensively, and no previous comparable epoch has seen so many individual contributions to the subject—both observational and theoretical. And yet, as we slowly advance along both lines towards a fuller solution of the individual objects of our inquiries, new problems keep arising on the horizon at a rate which is bound to render this field of study full of fascination and promise of unexpected developments for many years to come. The aim of this Report will, therefore, be twofold: to summarize our accomplishments in the study of eclipsing binary systems in the recent past, and to attempt to trace some trends of future research in this field. Since, moreover, this is the first opportunity for our Commission to make a report of this nature, the present survey will be somewhat more extensive and not strictly limited to the past triennium.

The greatest single factor which contributed most to the rapid outgrowth of the knowledge of our subject in the past three years has undoubtedly been the effective application of photo-electric photometry to the study of eclipsing binary systems. By virtue of the regularity of their light changes, eclipsing variables have for many years been favourite objects for pioneers of accurate photometry of any kind—selenium, photo-electric, or photographic; but it was only in the past few years that the technical advances in vacuum tube construction have brought a sufficient number of eclipsing variables within the means of telescopes of moderate size. Whereas a fairly large telescope was needed to obtain a measurable photo-electric response of a star of the eighth or ninth magnitude twenty years ago, the photometers available at the present time permit us to measure the light of a star which may be too faint to be actually seen through the same telescope, and which may be less than one magnitude above the photographic threshold of long exposures. This far-reaching gain in sensitivity was made possible by the commercial development of electron multiplier tubes as well as of improved means for proper amplification and recording of faint photo-currents.

Astronomical applications of these new techniques have been recently discussed in a number of papers(1-5) whose list is perhaps too long to be quoted here in full, and so would be the list of observatories where such installations are now in active use. Most of these photometers employ the 1P21 RCA photo-multiplier tube and are of the type originally designed by Kron(2):* moreover, some are fitted with facilities for heterochromatic photometry. At least three such photometers are, however, of the pulse-counting type originally designed by Levitt and Blitzstein(4). At the present time, three pulse-counting photometers are already in operation—one at Philadelphia (Cook Observatory), another at Cambridge (England)(5), a third at Leiden, and a fourth is being built at Philadelphia for Princeton. Let it suffice to say that, apart from numerous observatories in the United States and of western Europe which were the original cradles of photo-electric photometry, such photometers are reported in use on eclipsing variables at Kraków (Poland), Budapest (Hungary), Abastumani and Engelhardt Observatories in U.S.S.R., in Tokyo (Japan) as well as at Canberra (Australia). A further increase in numbers of photo-electric photometers operating at these longitudes should be encouraged, and should mitigate the original strong concentration of such installations in the belt of longitudes extending from 1 East to 8 West hours of Greenwich. A more

* Such photometers are, moreover, now also commercially available; cf. Sterling(3).

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even distribution of observing stations in geographic longitude would be desirable, not only for avoiding the possible vagaries of local (or continental) weather, but also for permitting us to obtain complete records of the light changes of short-period eclipsing variables within one cycle, or of other phenomena of short duration (such as the ingress or egress of the eclipses of ζ Aurigae, of which more will be said later on).

The impact of photo-electric methods upon further advance of our knowledge of eclipsing binary systems cannot be overestimated, and there is little room for doubt that such methods will supersede all other techniques used in the past for the study of individual eclipsing variables—except for discovery purposes (or, possibly, for determinations of the times of the minima) where the mass methods of photographic photometry are certain to hold their ground. It is true that, in exceptional cases, photographic light curves can be made equal in accuracy to the photo-electric ones,* but there is also no doubt that such exceptional photographic results call for an expenditure of time and effort much in excess of that needed for obtaining results of comparable accuracy by photo-electric methods. Measures of stellar brightness by these latter methods (or, rather, of the normal points constituting the light curves) can, at the present time, already attain the precision of approximately 0·1 %. It is possible (though by no means certain) that, in the years to come, improved techniques may increase the present accuracy by diminishing the errors of measurement to quantities of the order of 0·01 %, but scarcely more, for beyond this limit, irregular extinction anomalies are likely to impose an impenetrable barrier to any further gain—except possibly at very favourable localities which may be correspondingly rare. A search for such localities may become a matter of real concern for the students of eclipsing variables in the coming decades.

It should, however, be strongly emphasized that the precision already attainable at the present time offers an almost unlimited field of research to the investigator of eclipsing binary systems. A list of stars which have been observed photo-electrically (or are under observation at the present time) in one or more colours has been compiled and is reproduced in the accompanying Table 1, where the individual objects are arranged in order of increasing right ascension. A glance will disclose that it contains but a minor fraction of known eclipsing systems brighter than the 10th magnitude—the Southern Hemisphere being, in particular, an almost virgin field. Many stars listed in Table 1 are in need of re-observation (σ Aql, δ Ori, α Vir), in one or more colours (V 380 Cyg, VV Ori), or of practically continuous observation. Moreover, several well-known eclipsing binaries (such as Y Cyg, V 448 Cyg, S Equ, V 451 and 566 Oph, EE Peg, V 356 Sgr), absent from Table 1, are in desperate need of photo-electric observation, but are (to the writer's knowledge) as yet on no one's observing list. Let us hope that such remaining lacunae in our knowledge of the bright and near-by eclipsing systems will soon be filled!

Moreover, in addition to the work of general survey type, aiming at the determination of reliable elements of the respective eclipsing systems, accurate photometry of suitably chosen systems offers an inviting subject for specialized investigations which are capable of furnishing results of high astrophysical importance that could not be obtained in any other way. Among such investigations we may mention, in the first place, a determination of the *limb darkening* of the components of eclipsing systems of different spectral types, and preferably at more than one effective wave-length. As is well known,† any *totally*-eclipsing system can lend itself to a separate determination of the coefficient of limb darkening of *each* component, provided only that *both* minima have been observed with a sufficient precision. The meagre evidence available at the present time indicates that, for stars of the O and early B type, the total opacity in their atmospheres is due almost predominantly to the scattering on free electrons and, as a result, the coefficient of their limb darkening is in the neighbourhood of 0·5–0·6 and is independent of the wave-length.‡

* For a supreme example of such an arduous piece of work, cf. Wesselink(24).

† Cf., for example, Kopal's *Computation of Elements of Eclipsing Binary Systems*(57), Sec. 3.12.

‡ SZ Cam (B0), according to Kopal's unpublished analysis of Wesselink's photographic light curve(24); V 380 Cyg (B3), according to Kopal's analysis of unpublished photo-electric observations by Kron.

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TABLE I

Photo-electric Light Curves

Star	Source of photo-electric observations
AO Cas	Bennett, *A.J.* **47**, 104, 1939; Wood, *Ap. J.* **108**, 28, 1948; Hiltner, *Ap. J.* **110**, 443, 1949.
TV Cas	Huffer, *Ap. J.* **114**, 297, 1951.
YZ Cas	Huffer, *Washb. Publ.* **15**, 103, 1928. Kron, *Lick Bull.* **19**, 59, 1939 (blue); *Ap. J.* **96**, 173, 1942 (red).
ξ And	Stebbins, *Washb. Publ.* **15**, 29, 1928.
ξ Phe*	Hogg, *M.N.* **111**, 315, 1951.
TW Cet	Bok and Cillié, *A.J* **56**, 35, 1951.
U Cep	Huffer and Nelson (observations completed in two colours, awaiting publication, cf. *A.J.* **56**, 42, 1951).
DM Per	Colacevich, *Mem. Soc. Astr. Ital.* **21**, 73, 1950.
TW Cas	Huffer and Nelson (observations completed in two colours, awaiting publication, cf. *A.J.* **56**, 42, 1951).
RZ Cas	Huffer, *Ap. J* **114**, 297, 1951; Walter, *A.N.* **277**, 158, 1949.
XZ And	Blitzstein (unpublished; cf. *A.J.* **55**, 165, 1950).
β Per	Stebbins, *Ap. J.* **53**, 105, 1921; Smart, *M.N.* **97**, 396, 1937; Hall, *Ap. J.* **90**, 449, 1939 (infra-red); Stebbins (six-colour photometry, unpublished).
λ Tau	Stebbins, *Ap. J.* **51**, 193, 1920; Nikonov, *Abastumani Obs. Bull.* No. 2, p. 29, 1938.
RW Tau	Piotrowski (unpublished).
AG Per	Huffer, *Washb. Publ.* **15**, 192, 1928.
YY Eri	Cillié (in two colours; unpublished).
ε Aur	Huffer, *Ap. J* **76**, 1, 1932; Hall, *Ap. J.* **87**, 209, 1938.
ξ Aur	Many observers.
AR Aur	Huffer and Eggen, *Ap. J.* **106**, 106, 1947.
δ Ori	Stebbins, *Ap. J.* **42**, 133, 1915.
VV Ori	Schneller, *Kl. Veröff. Berl. Bab.* No. 17, 1936; Wood, *Princ. Contr.* No. 21, 1946; Huffer, *Ap. J.* **114**, 297, 1951.
β Aur	Stebbins, *Ap. J* **34**, 112, 1911.
RR Lyn	Huffer, *Washb. Publ.* **15**, 199, 1928.
SV Cam	De Witt and Seyfert, *P.A.S.P.* 62, **241**, 1950.
HD 44701*	Gum, *M.N.* **111**, 634, 1952.
WW Aur	Huffer, *Ap. J.* **114**, 297, 1951.
R CMa	Wood, *Princ. Contr.* No. 21, 1946.
YY Gem	Kron, *Ap. J.* **115**, 301, 1952.
UX Mon	Hiltner, Struve and Jose, *Ap. J* **112**, 504, 1950; Wood observing in two colours (cf. *A.J* **55**, 186, 1950).
V Pup	Hogg, *M.N.* **106**, 292, 1946.
S Cnc	Huffer (observing; cf. *A.J.* **54**, 223, 1949).
S Ant	Hogg, observations completed (cf. *M.N* **110**, 160, 1950).
VV UMa	Donselman (unpublished; cf. *A.J.* **54**, 206, 1949).
W UMa	Huffer, *Ap. J.* **79**, 369, 1934; Calder, *Harv. Bull.* No. 903, 1935.
TX UMa	Wood, *Princ. Contr.* No. 21, 1946; Huffer and Eggen, *Ap. J* **105**, 217, 1947.
GL Car	Bok and van Wijk (unpublished).
AG Vir	Wood, *Princ. Contr.* No. 21, 1946.
AI Cru	Oosterhoff (unpublished).
RS CVn	Keller and Limber, *Ap. J.* **113**, 637, 1951.
α Vir	Stebbins, *Ap. J.* **39**, 475, 1914.
UX UMa	Linnell, *Harv. Cir.* No. 455, 1951; Hiltner and Hardie (ultra-violet) observing (cf. *A.J* **54**, 229, 1949).
δ Lib	Stebbins, *Washb. Publ.* **15**, 33, 1928.
44 i Boo	Shapley and Calder, *Harv. Bull.* No. 907, 1937; Nikonov, *Abastumani Bull.* No. 4, 1940; Eggen, *Ap. J.* **108**, 15, 1948.
α CrB	Stebbins, *Washb. Publ.* **15**, 41, 1928; Kron (observations in the red completed).
ε UMi	Guthnick, *Berl. Abb.*, Math.-Nat. Kl. 1947, No. 7.

* Not previously announced as a variable star.

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TABLE I (*continued*)

Star	Source of photo-electric observations
AK Her	Seyfert and Mason, *A.J.* **56**, 48, 1951.
μ^1 Sco	Rudnick and Elvey, *Ap. J.* **87**, 553, 1938; Stibbs, *M.N* **108**, 398, 1948.
U Oph	Huffer, *Ap. J.* **114**, 297, 1951.
u Her	Baker, *Lick Bull.* **12**, 130, 1926; Shapley and Calder, *Harv. Circ.* No. 398, 1935.
μ Sgr	Morgan and Elvey, *Ap. J* **88**, 110, 1938; Hall, *Ap. J.* **94**, 550, 1941.
RX Her	Wood, *Ap. J* **110**, 465, 1949.
YY Sgr	Keller and Limber, *Ap. J.* **113**, 637, 1951.
β Lyr	Guthnick and Prager, *Berl. Bab. Veröff.* **2**, pt. 3, 1918; Huffer, *Washb. Publ.* **15**, 209, 1931; Smart, *M.N.* **95**, 648, 1935.
U Sge	Irwin (observations in blue and red awaiting publication).
σ Aql	Wylie, *Ap. J.* **56**, 232, 1922.
QS Aql	Guthnick, *A.N.* **241**, 264, 1931; *Sitz. Preuss. Akad. Wiss.*, Phys.-Math. Kl. 1934, Vol. **30**.
V 380 Cyg	Kron, *Ap. J* **82**, 225, 1935; further observations in different colours under way.
V 505 Sgr	Oosterhoff (three colours; observations completed, but not yet published).
V 477 Cyg	Wallenquist, *Uppsala Obs. Medd.* No. 96, 1949.
V 444 Cyg	Kron and Gordon, *Ap. J.* **97**, 311, 1943 (blue); *Ap. J* **111**, 454, 1950 (infra-red); Hiltner, *Ap. J.* **110**, 95, 1949 (ultra-violet).
GO Cyg	Detre (observing in two colours).
VW Cep	Huffer, *Ap. J.* **103**, 1, 1946; McNamara and Stern, *P.A.S.P.* **62**, 112, 1950 (two colours); Detre (observing in two colours).
VV Cep	Huffer, *Publ. A.A.S.* **9**, 44, 1937.
AR Lac	Wood, *Princ. Contr.*, No. 21, 1946; Kron (observations completed, awaiting publication).
CQ Cep	Hiltner, *Ap. J.* **112**, 477, 1950 (three colours).
AH Cep	Huffer and Eggen, *Ap. J.* **106**, 313, 1947.
RT And	Gordon (observations completed, awaiting publication; cf. *A.J.* **53**, 198, 1948).
AN And	Huffer, *Washb. Publ.* **15**, 117, 1928.
AR Cas	Stebbins, *Ap. J* **54**, 81, 1921; Huffer and Kron observing.
U Peg	La Fara, *Ap. J* **115**, 14, 1952 (two colours).

For the late B and early A type stars (such as YZ Cas,* α CrB,† U Sge‡), the contribution of the atomic absorption to the total opacity apparently begins already to make itself felt and causes the coefficient of limb darkening, still in the neighbourhood of 0·5–0·6, to increase with diminishing wave-length. Ultimately, for the F and G stars,§ the coefficient of limb darkening seems to be noticeably larger (0·7–0·8) and strongly frequency-dependent. These conclusions are based on the results furnished by less than a dozen eclipsing systems and only partly published so far. It is to be hoped that the underlying observational data will be materially improved—both in quality and quantity—in the near future; for the respective darkening coefficients cannot be empirically obtained in any other way, and are necessarily basic for the determination of the elements of all partially eclipsing systems for which the limb-darkening must only be assumed.

Emphasis should be placed, in this connection, on *monochromatic* observations. It should be of particular interest for the investigations of the hydrogen contents of stellar atmospheres to carry out monochromatic (or nearly monochromatic) observations of selected totally-eclipsing systems (such as YZ Cas, for instance) on either side of the Balmer limit (λ3647), and as close to it as the filter employed and the effective aperture of the telescope would permit. Such observations should enable us to determine the value of the coefficient u of limb darkening on either side of the Balmer discontinuity.

* Kron, *Lick Bull.* **19**, 59, 1939; *Ap. J.* **96**, 73, 1942.

† Kopal, *Proc. Amer. Phil. Soc.* **86**, 342, 1943; Kron (unpublished; private communication).

‡ Irwin (unpublished; private communication).

§ TW And (F0) and AR Lac (G5), according to Kopal and Shapley's unpublished analysis of Dugan's observations of TW And (*Princ. Contr.* No. 14, 1933) and of Wood's observations of AR Lac (*Princ. Contr.* No. 21, 1946).

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According to a recent investigation by Münch and Chandrasekhar (25), the change in u across $\lambda 3647$ should be as large as 0·5 for the early A stars, and about 0·3 for the early F's. Such amounts could be easily detected by the present observational techniques, and a verification of their theoretical predictions could disclose data of considerable importance for the theory of stellar atmospheres. The first astronomer who emphasized such a possibility appears to have been Barbier (22). His joint early work with Chalonge (23) on the determination of a change in u across the Balmer limit for Algol should, however, be repeated with a modern photo-electric equipment and extended to other stars—preferably totally-eclipsing ones! The sensitivity of the present photo-electric photometers might permit the use of interference filters as monochromators, or possibly an application of the spectrophotometric techniques worked out recently by Hiltner (13), to secure a monochromatic light curve of the Wolf-Rayet eclipsing binary CQ Cephei in the light of certain emission bands. Such work, extended to other eclipsing systems exhibiting bright lines, should also yield valuable results.

Lastly, it is to be hoped that the measurements of the *polarization* of the light of U Sge and its variation with the phase, initiated by Miss Janssen at Yerkes (26) and by Dombrovsky at Burakan (see the report of Soviet astronomers), will be continued and extended to other eclipsing systems, in order to ascertain in an independent way the relative contribution of the electron scattering to the total opacity of atmospheres of early-type stars. An establishment of the plane of polarization in the eclipsing binary systems should, incidentally, enable us to determine *the longitude of the ascending node* (and thus the absolute *sign* of the inclination) of their orbital planes—i.e. the data which have so far been available only for visual binaries.

The number of the individual eclipsing systems for which new light curves have been secured in the past few years is too large to enable us to refer to each one individually. The accompanying Table 2 contains a list of the systems whose elements have been deduced or revised on the basis of new observations; while the following Table 3 contains a summary of recent investigations of the period variations of several eclipsing systems.

A few eclipsing variables—such as the well-known Wolf-Rayet binary V 444 Cygni—have continued to attract widespread attention and become the objects of numerous investigations resulting in an extensive literature (6–12), both photometric and spectroscopic, which has considerably enlarged our knowledge of the physical properties of Wolf-Rayet stars. A similar contribution can be expected in the future from CQ Cep—another close eclipsing binary having a Wolf-Rayet star as a component—which was recently studied by Hiltner (13).

Of other well-known eclipsing variables, ζ Aur has been observed photo-electrically in several colours during both the ingress of the 1947–48 minima in December 1947, and the egress in September 1950; the former observations being due mainly to the observers on the Pacific coast (14, 15), the latter (in so far as they have been published) to Beer and Ovenden in Cambridge, England (16). Their results indicate that while the 1947 eclipse occurred approximately half a day earlier than predicted on the basis of Christie's 1939 elements, the eclipse in 1950 took place, if anything, somewhat too late. Such irregularities, which appear to be genuine, may be indicative of small changes in the effective radius of the K5 supergiant occurring from cycle to cycle. New noteworthy spectrophotometric studies of this system have been published by Wilson (17), McLaughlin (18) and Fracastoro (19).

In 1950, the list of eclipsing systems with very long periods, of which ζ Aur can be considered a prototype, was augmented by the addition of 32 Cyg, previously known as a spectroscopic binary, which was recognized as an eclipsing variable with a period of 1141 days by McLaughlin (20). As in the case of ζ Aur, the bodily eclipses of 32 Cyg are preceded and followed by atmospheric extinction phenomena which have been studied spectroscopically by McLaughlin (20) and Wright (21). Of further outstanding recent photometric discoveries in this field, we may mention the observational evidence, obtained by Kron, of the probable existence of 'spots' (or rather 'faculae') in the photospheres of AR Lac (27) and YY Gem (28).

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TABLE 2

Revised Elements of Eclipsing Binary Systems

Star	Source of the Elements
WZ And	Cook, *A.J* **53**, 211, 1948.
SU Aqr	Nekrassova, *Contr. Crimean Astr. Obs.* **3**, 1948.
WW Aur	Huffer and Kopal, *A.J* **55**, 171, 1950 (*Ap. J.* **114**, 297, 1951.)
44i Boo	Eggen, *Ap. J.* **108**, 15, 1948.
RZ Cnc	Gaposchkin, *Harv. Bull.* No. 919, 1949.
TX Cnc	Haffner, *A.N* **276**, 233, 1948.
XZ CMi	Nekrassova, *Contr. Crimean Astr. Obs.* **3**, 1948.
RS CVn	Keller and Limber, *Ap. J.* **113**, 637, 1951.
RZ Cas	Huffer and Kopal, *A.J.* **55**, 171, 1950 (*Ap. J* **114**, 297, 1951); Walter, *A.N* **277**, 158, 1949.
TV Cas	Huffer and Kopal, *A.J.* **55**, 171, 1950 (*Ap. J* **114**, 297, 1951).
AO Cas	Wood, *Ap. J* **108**, 28, 1948.
SV Cen	O'Connell, *Riverview Obs. Publ.* **2**, 69, 1949.
VW Cep	Rybka and Mergentaler, *Publ. Astr. Obs. Kiev*, No. 2, 1948.
CW Cep	Gaposchkin, *Peremennie Zvezdy*, **7**, 34, 1949.
V 477 Cyg	Wallenquist, *Uppsala Obs. Medd.* No. 96, 1949.
RX Her	Wood, *Ap. J* **110**, 465, 1949.
AK Her	Seyfert and Mason, *A.J.* **56**, 48, 1951.
U Oph	Huffer and Kopal, *A.J* **55**, 171, 1950 (*Ap. J.* **114**, 297, 1951).
RV Oph	Bronstein, *Peremennie Zvezdy*, **6**, 246, 1948.
VV Ori	Huffer and Kopal, *A.J* **55**, 171, 1950 (*Ap. J.* **114**, 297, 1951).
DN Ori	Gaposchkin, *Harv. Bull.* No. 919, 1949.
AW Peg	Dobrovolsky, *Peremennie Zvezdy*, **6**, 265, 1949.
RY Per	Gaposchkin, *Harv. Bull.* No. 919, 1949.
β Per	Eggen, *Ap. J.* **108**, 1, 1948.
RS Sgr	Baglow, *M.N.* **108**, 343, 1948.
YY Sgr	Keller and Limber, *Ap. J* **113**, 637, 1951.
V 525 Sgr	O'Connell, *Riverview Obs. Publ.* **2**, 78, 1949.
V 526 Sgr	O'Connell, *M.N.* **108**, 334, 1948.
μ^1 Sco	Stibbs, *M.N* **108**, 398, 1948.
λ Tau	Krat, *Peremennie Zvezdy*, **6**, 143, 1948.
UX UMa	Linnell, *Harv. Circ.* No. 455, 1950.

TABLE 3

Recent Investigations of Period Changes of Eclipsing Variables

Star	Authority
AB And	Oosterhoff, *B.A.N* **11**, 217, 1950.
RX Cas	Martynov, *Engelhardt Obs. Bulletin*, No. 27, 1950.
RZ Cas	Huffer, *A.J.* **54**, 129, 1949.
U Oph	Parenago, *Peremennie Zvezdy*, **7**, 102, 1949.
RT Per	Vasilieva, *Astr. Circ. U.S.S.R. Acad. Sci.* No. 75, 1948.
AG Per*	Ashbrook, *A.J* **55**, 2, 1949.
β Per†	Eggen, *Ap. J* **108**, 1, 1948; Pavel, *A.N.* **278**, 57, 1949.
RS Sgr	O'Connell, *Riverview Obs. Publ.* **2**, 82, 1949.
V 526 Sgr*	O'Connell, *M.N* **108**, 334, 1948.

* The orbit of this star is eccentric and the author discusses also the rate of apsidal advance.

† An extensive investigation of the variation of Algol's orbital period, based on more than 1100 individual minima from the years 1782–1950, is being carried out by Miss E. Reilly at Harvard.

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A number of theoretical investigations dealing with different physical properties of various eclipsing systems have appeared in the past few years. Thus, Krat (29) in two papers has studied the determination of physical elements of eclipsing binaries, while the stability of such systems was the subject of an investigation by Tcherny (30). Mergentaler (31) discussed the periastron effect and asymmetry of light curves of a number of eclipsing systems. Johnson (32) studied the adjustment within shells and asymmetric ejecta in close binaries; Lohmann (33) in his study of RZ Oph made an interesting attempt to utilize the speed of rotation of the gaseous ring around the cF5 component to estimate a lower limit for the mass of this eclipsing system; while Wood (34) invoked the dynamical properties of the Roche model to account for the observed period variations of many eclipsing systems by the proximity of their components to the limiting size of an equipotential capable of containing their mass, or the actual escape of mass from 'oversize' components through the conical end of the critical equipotential. Parenago (35) discussed the masses of single-spectra eclipsing binaries with known radial velocity of the primary component, while Kopal and Treuenfels (36) investigated the effective temperatures of components of eclipsing binary systems on the basis of their known absolute radii and statistical parallaxes derived from both the parallactic and peculiar proper motion and the radial velocities.

In any attempt to attain a deeper understanding of the physical phenomena exhibited by eclipsing binary systems, the results of photometric investigations must be combined with the spectroscopic ones, with which they are in fact inseparably connected. Although a survey of the progress of spectroscopic investigations of close binary systems in recent years is outside of the scope of the present report (as it belongs properly to the domain of the Sub-Commission on Spectroscopic Binaries of the Commission 30 on Radial Velocities), it is impossible not to call attention, in this place, to the publication of Struve's recent book on *Stellar Evolution* (37), which contains a survey of the epoch-making investigations by Struve and his associates in this field in the past decade. We should also welcome the publication by Petrie (38) of an investigation summarizing more than ten years of work at the Dominion Astrophysical Observatory on the spectrophotometric determination of the magnitude differences Δm of components of eighty-two close binary systems. Although only a minority of the binaries observed by Petrie are eclipsing variables, it is well to keep in mind that the spectroscopic Δm's are of decisive importance for a determination of the photometric elements of partially-eclipsing systems, and may enable us to obtain genuine elements even if the eclipses are so shallow that the elements would photometrically border on indeterminacy.* Lastly, we should welcome the publication, from the Lick Observatory, of Moore and Neubauer's *Fifth Catalogue of Orbits of Spectroscopic Binary Stars* (39), which every student of eclipsing variables will find a most useful reference. Since, however, this catalogue contains only the data published before January 1948, the following Table 4 will give a list of eclipsing variables whose spectrographic orbits have been published since that date. A glance at the references in this table discloses eloquently the debt which this branch of research owes to Otto Struve and his collaborators.

These data, together with those compiled by Moore and Neubauer, disclose that the number of eclipsing systems with known spectrographic orbits was more than doubled in the last decade. Yet it may perhaps be pertinent to remind our spectroscopic colleagues that, in spite of their magnificent effort in the years just past, the need of their continued co-operation remains as pressing as ever before. The immediate extent of this need is shown on the accompanying Table 5, which lists thirty-one well-known eclipsing systems brighter at maximum than the 10th apparent magnitude, and mostly of Northern Hemisphere, for which no spectrographic orbits are so far available; and a similar survey of the Southern Hemisphere would uncover a much less explored ground. Let us hope that these gaps in our present knowledge will be filled in the forthcoming decade, and the missing data obtained both for the sake of a study of the individual systems, and for

* Cf. reference (57), sec. 3.23.

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TABLE 4

Additional List of Eclipsing Systems with Known Spectrographic Orbits

Star	Authority	Reference
TW And	Hiltner, Smith and Struve	*Ap. J.* **107**, 95, 1949
AB And	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J* **111**, 658, 1950
β Aur	Smith	*Ap. J* **108**, 504, 1948
ϵ Aur	Wright and van Dien	*J.R.A.S.* Canada, **43**, 15, 1949
TZ Boo	Chang	*Ap. J* **107**, 96, 1948
Y Cam	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J.* **111**, 658, 1950
TX Cnc	Popper	*Ap. J.* **108**, 490, 1948
R CMa	Struve and Smith	*Ap. J* **111**, 27, 1950
TW Cas	Struve and Horak	*Ap. J.* **112**, 184, 1950
AO Cas	Struve and Horak	*Ap. J.* **110**, 447, 1949
V 377 Cen	Sahade	*Ap. J.* **110**, 463, 1949
U Cep	Hardie	*Ap. J.* **112**, 542, 1950
VW Cep	Popper	*Ap. J.* **108**, 490, 1948
CQ Cep	Hiltner	*Ap. J.* **112**, 477, 1950
TW Cet	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J.* **111**, 658, 1950
RZ Com	Struve and Gratton	*Ap. J.* **108**, 497, 1948
RV Crv	Struve and Gratton	*Ap. J.* **108**, 497, 1948
V 380 Cyg	Popper	*Ap. J.* **109**, 100, 1949
V 478 Cyg	McDonald	*Publ. D.A.O.* **8**, 135, 1949
TW Dra	Smith	*Ap. J.* **110**, 63, 1949
RY Gem	McKellar	*Publ. D.A.O.* **8**, 235, 1950
YY Gem	Struve, Herbig and Horak	*Ap. J.* **112**, 216, 1950
DI Her	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J.* **111**, 658, 1950
	McKellar	*Publ. D.A.O.* **8**, 235, 1950
SW Lac	Struve	*Ap. J.* **109**, 436, 1949
AR Lac	Sanford	*Ap. J.* **113**, 299, 1951
FL Lyr	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J* **111**, 658, 1950
UX Mon	Sahade	*Ap. J.* **111**, 194, 1950
V 502 Oph	Struve and Gratton	*Ap. J* **108**, 497, 1948
VV Ori	Struve and Luyten	*Ap. J* **110**, 160, 1949
FO Ori	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J* **111**, 658, 1950
δ Ori	Pismis, Haro and Struve	*Ap. J.* **111**, 509, 1950
AR Pav	Sahade	*Ap. J* **109**, 541, 1949
U Peg	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J* **111**, 658, 1950
TY Pup	Struve and Horak	*Ap. J* **112**, 184, 1950
RS Sgr	Sahade	*Ap. J.* **109**, 116, 1949
XZ Sgr	Sahade	*Ap. J* **109**, 439, 1949
V 505 Sgr	Popper	*Ap. J.* **109**, 100, 1949
RW Tau	Hiltner and Hardie	*Ap. J* **110**, 438, 1949
RZ Tau	Struve, Horak, Cavanaggia, Kourganoff and Colacevich	*Ap. J* **111**, 658, 1950
W UMa	Struve and Horak	*Ap. J.* **112**, 178, 1950
UX UMa	Struve	*Ap. J* **108**, 153, 1948
VV UMa	Struve and Horak	*Ap. J* **112**, 184, 1950
AH Vir	Chang	*Ap. J.* **107**, 96, 1948
BF Vir	Struve and Gratton	*Ap. J.* **108**, 497, 1948

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TABLE 5

Eclipsing Systems in need of Spectrographic Orbits

Star	Period	Spectrum	Magn.	Type of eclipse
RV Aqu	1·967	A3	8·8–10·1	Partial
ST Aqu	0·781	F0	9·2– 9·6	?
OO Aql	0·507	G5	9·2–10·1	?
V 337 Aql	2·734	B3	8·8– 9·5	?
V 346 Aql	1·106	A0	9·0–10·4	Partial
BF Aur	1·583	A0	8·5– 9·2	?
SV Cam	0·593	dG5+dG3	9·8–10·5	Partial
S Cnc	9·485	A0+G5	8·0–10·2	Total
RZ Cnc*	21·643	K2+K5	9·4–11·0	?
TU Cnc	5·562	A0	9·5–12·4	Partial
YY CMi	1·094	F5	8·5– 9·1	?
TX Cas	2·927	B4	9·3– 9·8	?
XZ Cep	5·097	B5	8·2– 9·0	Partial
TV Cet	9·103	F0	8·6– 9·1	Partial
KR Cyg	0·845	A0	9·0– 9·7	Total
MY Cyg	2·003	A3	8·9– 9·5	?
V 448 Cyg	6·520	B3	7·9– 8·5	?
SX Dra	5·169	A7	9·8–11·9	Total
S Equ	3·436	A0	8·0–10·2	Total
TT Lyr	5·244	A0	9·2–10·3	Partial
RW Mon	1·906	A0	8·9–11·5	Total
RV Oph	3·687	A0	9·6–11·8	Total
V 451 Oph	1·098	A0	7·9– 8·5	?
V 566 Oph	0·515	F5	7·8– 8·1	?
AT Peg	1·146	A0	8·9– 9·7	Partial
DK Peg	1·632	A5	9·7–10·6	Total
EE Peg	5·256	A0	7·0– 7·5	Total
AY Per	11·777	B9	9·3–10·1	Total
SZ Psc	3·966	G5	8·3– 9·8	Partial
V 356 Sgr	8·897	B9+A1	6·8– 7·9	Total
RS Tri	1·909	A5	9·8–10·6	Total?

* Hiltner (*P.A.S.P.* **58**, 166, 1946) published some spectrophotometric results, but details of the orbit are still lacking.

bolstering the data on which statistical studies of the distribution of different properties of close binary systems—such as the orientation of the semi-major axes of eccentric binaries in space, recently analysed by Ishchenko (40) and Miss Scott (41)—can be based.

As is well known, a combination of the photometric and spectrographic elements of eclipsing binary systems offers a clue for the determination of their absolute dimensions, which is also the only way (apart from interferometric measurements) in which the absolute radii of stars other than the Sun can be directly obtained. The number of systems for which such a combination has been made possible on the basis of new or improved data is indeed almost twice as large as it was ten years ago, and the requisite data (which do not claim to be entirely complete) have been compiled in the accompanying Table 6, which lists the spectra, masses, and radii (in solar units) of 108 components of 54 eclipsing systems, arranged roughly in order of diminishing temperature of their principal components.

The stars listed in the preceding table are (with isolated exceptions) two-spectra binaries for which the mass-ratios could be derived directly from amplitudes of the radial velocity changes of both components. Such a procedure favours heavily the selection of systems in which the masses of the components are more or less equal; for the systems in which the masses (and, therefore, the luminosities) of both components are very

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TABLE 6

Absolute Properties of Eclipsing Binary Systems

Star	Period d.	App. bright m.	Spectrum Sp_1	Sp_2	Radius (in ☉) R_1	R_2	Mass (in ☉) M_1	M_2	Reference
V 444 Cyg	4·212	8·4	O6	WN5	13	—	35	20	Keeping, *D.A.O.* **7**, 349, 1947
AO Cas	3·523	5·8	O8·5	O8·5	16	10	31	29	Wood, *Ap. J.* **108**, 28, 1948
Y Cyg	2·996	7·0	O9	O9	5·9	5·9	17·4	17·2	Dugan, *Princ. Contr.* No. 12, 1931
SZ Cam	2·698	7·0	O9·5	(B2)	12·7	5·6	36	10·3	Kopal (unpublished)
AH Cep	1·775	6·6	B0nk	B0nk	6·1	6·1	16·5	14·2	Huffer and Eggen, *Ap. J.* **106**, 313, 1947
δ Ori	5·733	2·5	B0k	(B2)	17	10	26	10	Luyten-Struve-Morgan, *Yerkes Publ.* **7**, part 4, 1939
V 478 Cyg	2·881	8·9	B0·5	B0·5	7·1	7·1	15·4	15·2	McDonald, *D.A.O.* **8**, 135, 1949
V Pup	1·454	4·5	B1	B3	6·1	5·5	16·6	9·8	Popper, *Ap. J.* **97**, 394, 1943
V 470 Cyg	1·873	8·7	B2	B2	6·0	7·2	13	11	Gaposchkin, *Ap. J.* **53**, 112, 1948
VV Cep	7430	5·1	B3	CM2e	13	1200	33	47	Goedicke, *Michigan Publ.* **8**, no. 1, 1939
TT Aur	1·333	8·1	B3	—	3·8	3·4	6·7	5·3	Joy and Sitterly, *Ap. J.* **73**, 77, 1931
Z Vul	2·455	7·0	B3ns	—	4·6	4·3	5·3	2·4	Baker, *Laws Bull.* **2**, 173, 1916
CW Cep	2·729	7·7	B3	B3	4·0	4·5	9·8	10·0	Gaposchkin, *Peremennie Zvezdy*, **7**, 34, 1949
σ Aql	1·950	5·0	B3	B3	3·6	3·6	6·8	5·4	Wylie, *Ap. J.* **56**, 232, 1922
AG Per	2·029	6·7	B3k	B3k	2·7	2·6	5·0	4·4	Eggen (private communication)
SX Aur	1·210	8·2	B3·5	B3·5	5·1	4·4	10·7	5·6	Popper, *Ap. J.* **97**, 394, 1943
u Her	2·051	4·6	B3	B6	4·4	4·4	6·8	5·4	Baker, *Lick Bull.* **12**, 130, 1926
μ^1 Sco	1·446	3·1	B3p	B6	5·2	5·7	14·0	9·2	Stibbs, *M.N.* **108**, 398, 1949
U Oph	1·677	5·7	B5nk	B5nk	3·4	3·2	5·3	4·6	Huffer and Kopal, *Ap. J.* **114**, 297, 1951
V 599 Aql	1·849	6·5	B5	B8	7·8	4·4	12	6·4	Gaposchkin, *H.B.* No. 917, 1943
U CrB	3·452	7·7	B5	B9	3·4	5·5	6·4	2·4	Shapley, *Princ. Contr.* No. 3, 1915
ξ Aur	972·15	3·9	B6	cK5	2·8	200	10	22	Kopal, *Ap. J.* **103**, 310, 1946
TX UMa	3·063	7·0	B8	gF2	2·1	3·4	2·8	0·9	Huffer and Eggen, *Ap. J.* **105**, 217, 1947
β Per	2·867	2·2	B8	(G)	2·7	2·8	2·3	0·6	Kopal, *Ap. J.* **93**, 92, 1941
U Cep	2·493	6·7	B8	gG2	2·9	4·7	4·7	1·9	Hardie, *Ap. J.* **112**, 542, 1950
AR Aur	4·135	6·1	B9	A0	1·8	1·8	2·6	2·3	Huffer and Eggen, *Ap. J.* **106**, 106, 1947
GO Cyg	0·718	8·2	B9n	A0n	2·0	1·4	1·6	1·3	Pierce, *A.J.* **48**, 113, 1939
β Lyr	12·908	3·4	cB9	—	47	31	52	43	Kopal, *Ap. J.* **93**, 92, 1941
U Sge	3·381	6·5	B9n	gG2	4·5	5·8	6·7	2·0	Joy, *Ap. J.* **71**, 336, 1930
RX Her	1·779	7·2	A0	A0	2·3	1·8	2·1	1·9	Wood, *Ap. J.* **110**, 465, 1949
β Aur	3·960	2·1	A0p	A0p	2·6	2·6	2·4	2·4	Piotrowski, *Ap. J.* **108**, 510, 1948; Smith, *Ap. J.* **108**, 504, 1948
MR Cyg	1·677	8·8	A0	(A0)	3·2	3·6	3·0	2·6	Fracastoro, *Arcetri Publ.* **55**, 37, 1937
TV Cas	1·813	7·3	A0	—	2·4	2·5	1·7	1·0	McDiarmid, *Princ. Contr.* No. 7, 1924
TX Her	2·060	8·3	A2	A2	1·6	1·6	2·0	1·8	Baker, *Laws Bull.* No. 31, 1921
WX Cep	3·378	9·1	A2	(A5)	3	3	1·0	1·0	Sahade and Cesco, *Ap. J.* **102**, 128, 1945
CM Lac	1·605	8·3	A2	A8	1·3	1·7	2·0	1·5	Wachmann, *A.N.* **259**, 323, 1936
AW Peg	10·623	7·2	A2	F0	1·5	2·5	0·4	0·2	Dobrovolsky, *Peremennie Zvezdy*, **6**, 265, 1948
RX Gem	12·208	8·6	A2	K0	2·2	5·5	3·1	0·6	Gaposchkin, *Ap. J.* **104**, 376, 1946
UX Mon	5·905	8·1	A3	gG2	1·8	6·6	3·4	1·5	Struve, *Ap. J.* **106**, 255, 1947
WW Aur	2·525	5·6	A7	A7	1·9	1·9	1·8	1·8	Huffer and Kopal, *Ap. J.* **114**, 297, 1951
S Ant	0·648	6·4	A8	A8	1·4	1·1	1·0	0·9	Joy, *Ap. J.* **64**, 293, 1926
Z Her	3·993	7·2	F2p	gF2p	1·5	3·1	1·5	1·3	Shapley, *Princ. Contr.* No. 3, 1915

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TABLE 6 (*continued*)

Star	Period d.	App. bright m.	Spectrum Sp_1	Sp_2	Radius (in ⊙) R_1	R_2	Mass (in ⊙) M_1	M_2	Reference
CVn	4·798	7·9	F4n	dG8	1·6	5·3	1·9	1·7	Sitterly, *Princ. Contr.* No. 11, 1930
Hya	2·904	9·2	F5	F5	1·3	1·0	1·2	1·1	Wood, *Princ. Contr.* No. 21, 1946
UMa	0·334	7·9	F8p	F8p	0·8	0·6	1·0	0·9	Huffer, *Ap. J.* **79**, 369, 1934
Oph	4·183	9·3	G0	G0	1·3	1·2	1·4	1·3	Gaposchkin, *Harv. Bull.* No. 907, 1938
Leo	0·600	8·0	G0	G2	1·1	1·2	1·3	1·2	Gaposchkin, *Ap. J* **104**, 370, 1946
And	0·629	8·9	dG0	dK2	0·8	1·4	1·5	1·0	Payne-Gaposchkin, *Ap. J* **103**, 291, 1946
Mi	39·482	4·4	gG1	A5±	11·8	0·8	13·5	3·4	Guthnick, *Abb. Deuts. Akad. Wiss.* No. 7, 1947
o	0·268	6·0	dG2	dG2	0·7	0·6	1·0	0·5	Eggen, *Ap. J.* **108**, 15, 1948
V Dra	4·630	8·0	gG2	gK2	4·8	8·3	3·5	2·5	Plaut, Diss. Leiden, 1939
Lac	1·983	6·4	G5	K0	1·8	3·0	1·4	1·4	Wood, *Princ. Contr.* No. 21, 1946
Lac	5·074	8·8	gG9	gK1	4·9	4·9	1·0	1·9	Fowler, *Ap. J.* **52**, 261, 1920
Vir	0·408	9·7	K0	K0	1·3	0·8	1·4	0·6	Chang, *Ap. J.* **107**, 96, 1948
Gem	0·814	8·6	dM1e	dM1e	0·6	0·6	1·0	0·9	Kuiper, *Ap. J.* **88**, 456, 1938

unequal are necessarily single-spectrum binaries. Investigations of such systems in the past decade have, in turn, led us to confront two outstanding problems which are as yet unsolved or only partially solved, and which could be termed as the 'Problem of U Cephei' and the 'Problem of R Canis Maioris', according to the prototype stars in which they have been encountered. The first one concerns, in brief, the interpretation of asymmetric velocity-curves, seemingly indicative of large orbital eccentricities, of such eclipsing systems whose light curves exhibit no appreciable displacement of the minima or other photometric indication of orbital eccentricity. The problem first emerged from Carpenter's early work on the single-spectrum orbit of U Cep (42), and was later forcefully reiterated by Struve (43) to whom much of its discussion is due; several other eclipsing systems were found subsequently to exhibit similar anomalies (44). The effects, upon radial velocities, of tidal distortion of the components have been investigated (45, 46), and although the tides were found capable of generating an effect which simulates a small orbital eccentricity, the magnitude of this effect proved utterly inadequate to account for the observed spectroscopic anomaly (46). A recent work by Hardie (47) may, however, have put us at last in sight of a probable solution of this problem: namely, a renewed investigation of U Cep has indicated that the spurious orbital eccentricity of this (and quite possibly of other) eclipsing system is caused by a deformation of the photospheric spectral lines of its principal component by conspicuous gas streams circulating in the system, and that under certain conditions the two effects can be separated with the aid of the observed asymmetry of the resultant spectral lines.

The 'Problem of R CMa' concerns, in turn, a small group of single-spectrum eclipsing binaries whose spectroscopic mass functions prove to be so small as to confront us with the following alternatives: either the masses of the constituent components of such systems are abnormally small for their spectral class, placing them high above the empirical mass-luminosity relation, or their mass-ratio must be so large as to render the secondary component (whose relative radius is known from photometric observations) actually larger than the largest closed equipotential capable of containing its whole mass. This problem, which was first encountered in the case of R CMa by Walter (48) and subsequently, but independently, by Wood (49), is characteristic of a whole group of additional eclipsing variables which have been discussed particularly by Struve (50). The difficulty we are facing in this connection seems very real and deep, and its solution is apparently nowhere yet in sight.

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Concurrently with the observational and theoretical work on the physical properties of eclipsing binary systems, a considerable number of methodical investigations—both original and summarizing—dealing with an analysis of light curves of eclipsing binary systems have been published in the past few years. Of publications of the summarizing nature, we should welcome the appearance of a third volume of the Russian treatise on *Peremennie Zvezdy* (Variable Stars) (51), whose part 2, written by Martynov and Tsesevich, contains the most detailed survey of the methods of analysis of the light curves of eclipsing binary systems which has appeared since the publication of Stein's extensive and elaborate treatise on *Die Veränderlichen Sterne* (52). The present Russian volume is a sequel to an earlier one, by Martynov (53), which described the physical characteristics of eclipsing variables. Although the present book appeared in 1947, its bibliographical references indicate that its writing must have been completed before the outbreak of the second World War; at least very few references beyond 1939 are included.

A great increase in the accuracy of photometric observations in the past ten years has stimulated parallel efforts to put the methods of analysis of accurate photo-electric light curves on a more rigorous basis. Several investigations by different writers concerned with this problem have appeared in the past few years (54-6), notable contributions being due to Piotrowski (54), and a large part of them was subsequently summarized in the writer's treatise on the *Computation of the Elements of Eclipsing Binary Systems* (57), which appeared in 1950 as a sequel to his *Introduction to the Study of Eclipsing Variables* (58) published four years before. The writer understands, moreover, that a Polish treatise on the analysis of light curves is in preparation by Piotrowski with the collaboration of Mergentaler. Attention should also be called to a memoir by Schneller (59) describing a simple method for a determination of the elements of eclipsing binaries, based mainly on the earlier well-known work by Russell and Shapley. Lastly, mention should be made of a recent attempt by Hamid, Huffer, and Kopal (60) to mechanize the routine parts of the analysis of light curves so as to make it amenable to a solution on punched-card computing machines. An application to Huffer's photo-electric light curve of RZ Cas has been carried out as an illustrative example, and details of it should be published in the near future.

Of investigations dealing with special problems encountered in the analysis of the light curves, we should recall a recent work on the idealized models and rectified light curves of eclipsing variables by Russell (61), and one on the detailed effects of limb darkening by Kopal (62). The penumbral part of the reflection effect was investigated by Russell (63), and appears to have been evaluated for the first time at 'full' phase by Matukuma (64)—another important contribution to the study of eclipsing variables which has reached us from Japan after the well-known investigations of the late Prof. Takeda in the middle 'thirties. Ultimately, the reader interested in trends of the research in this field—both past and present—should find it profitable to consult Russell's address on the 'Royal Road of Eclipses'—the first Russell Lecture delivered by the doyen of investigators of eclipsing variables at the Harvard Centennial Symposia in 1946 (65). An address at the same symposia, by the present writer, on the unsolved problems in the theory of eclipsing variables may also be referred to in this connection (66).

It has been recognized for some time that an analysis of light curves for the photometric elements of eclipsing binary systems poses some of the most difficult and delicate problems encountered in double-star astronomy; and that an adequate treatment of such problems would be impossible without appropriate numerical tables of certain special functions. Such tables constituted an essential part of the early semi-graphical methods by Russell and Shapley, and are all the more indispensable for practical application of recent analytical techniques. The existing literature on this subject has likewise been enriched, in recent years, by several important additions. Following the basic set of the p-tables published by Tsesevich (67), Irwin (68) constructed (essentially by a numerical differentiation of Tsesevich's tables) tabulations of the coefficients of differential corrections in the variational equations of our problem. Irwin's tables should make it feasible to resort to a simultaneous least-squares adjustment of all elements of a system whenever the

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observational evidence may warrant such a technique. Tables of the associated alpha-functions, needed for an accurate determination of the elements of close binary systems, were recently published by Kopal (69). Last but not least, we should welcome the long-awaited publication of Merrill's extensive tables (70), giving accurate values of the auxiliary functions used in Russell's method for several intermediate degrees of limb darkening.

A continuously increasing number of known eclipsing variables has correspondingly stimulated the need of a comprehensive summary of the photometric elements of such systems as have been observed accurately enough to yield reliable information of this nature. We should, therefore, welcome a recent Catalogue of the elements of eclipsing binaries brighter than photographic magnitude 8·50 at maximum, by Plaut (71), which can be regarded as a successor in direct line of similar, but more extensive, earlier work by Shapley (72) and Gasposchkin (73). An attractive feature of Plaut's new catalogue is the explicit attention paid to the uncertainty within which the individual elements are defined by the available observational data. Since the observations of no system can be made infinitely numerous or accurate, such an uncertainty should be regarded as an integral and indispensable part of any orbital solution, and it is gratifying to record that this has been respected in Plaut's new catalogue. It should be also mentioned that a more exclusive catalogue of the elements of approximately forty best-observed eclipsing systems has been in preparation by Kopal and Mrs Shapley at Harvard for a considerable time. This work, which has from the beginning enjoyed a generous support on the part of the American Philosophical Society, has been almost complete for some time and its publication has been delayed only by technical reasons.

Another publication of considerable interest to the investigators of eclipsing binary systems has been the well-known Princeton Finding Lists for Observers of Eclipsing Binaries, initiated by the late Prof. R. S. Dugan (74), and after his death in 1940 continued by Prof. N. L. Pierce (75), a keen and devoted student of eclipsing variables, whose sudden and premature passing on August 9, 1950, in the prime of his life, has been a severe loss to the study of our subject and to our Commission.* One of the many serious problems caused by his untimely departure was the disposal of the Princeton Card Catalogue of Eclipsing Binaries. This catalogue, originated by Dugan and since 1940 likewise continued by Pierce, has been available to all astronomers working in this field and its value scarcely requires an elaboration.

It is obviously of vital concern to us that a catalogue of this nature should be kept up to date; and this problem has given rise to some correspondence among the members of our Commission. The concern felt about the continuation of the tasks which were previously carried out by Princeton astronomers was resolved by a circular letter of October 17 by Dr F. B. Wood, Executive Director of the Flower and Cook Observatories, informing his professional colleagues that

With the generous permission of the Princeton University Observatory, the catalogue and the associated Finding List material have been moved to the University of Pennsylvania. It is our intention to keep the catalogue, to add to it as new material becomes available, and to publish, as often as seems practicable, lists of addenda and new editions of the Finding List.

One of the great values of the Card Catalogue lay in the fact that the material in it was made available to all interested astronomers. This practice will be continued, and we will be happy to supply data from the catalogue to any astronomer requesting it. Another feature of great value lay in the fact that so many working astronomers enhanced the usefulness of the catalogue by sending to Dr Pierce or to Dr Dugan their unpublished results and the names of the stars on their observing programmes. This feature can be retained only by the continued co-operation of the astronomers generally, and a sincere plea for this co-operation is hereby made.

* A fitting tribute to Pierce's memory can be found in an obituary, by Spitzer, in *Pop. Astr.* **58**, 425, 1950.

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On the other hand, Piotrowski writing from Kraków recommends that

In the future, the Finding Lists should be issued under the auspices of the Commission 42 of the International Astronomical Union. The material to be incorporated in the Finding Lists should be collected by different observatories, institutes, and persons collaborating with the Commission 42. Such a division of work should greatly add to the completeness of the information contained in the Finding Lists. This information should not be limited to the results already published, but should include also (as it was partly done in previous editions) a mention of the existence of unpublished observations, observations in progress, or intention to observe the star on the part of different astronomers. Circular letters and questionnaires originating from the chairman of the Commission could supply this latter information to the centres assembling the data for the Finding Lists.

The Cracow Observatory could undertake to provide the Finding Lists with systematic information concerning the periods of eclipsing variables. The fact that the Cracow Observatory already maintains a card catalogue of all publications on eclipsing variables, publishes yearly (under the auspices of the I.A.U.) ephemerides of the minima of these variables, and is especially interested and engaged in studies of the variability of periods of eclipsing binaries, seems to predestinate the Cracow Observatory also for the task of continuing the Finding Lists.

Moreover, from a report reaching us from the Soviet astronomers, and prepared by Martynov, it transpires that

Since 1932, the Engelhardt Observatory (Kazan) has been keeping up-to-date a bibliographical card-index of eclipsing variable stars, which at present includes 2756 stars, both certain and suspected, with 21,157 abstracts of the literature on them. In view of the close connection between eclipsing variables and spectroscopic binaries, a detailed bibliography of the spectroscopic binaries has also been maintained (2056 stars and 14,995 abstracts). In addition, N. I. Chudovichev has compiled a catalogue of the photometric and spectroscopic elements of eclipsing binaries, which is in print. The Engelhardt Observatory, having a modern and complete card-index of eclipsing variables, is fully able to resume the compilation of a reference-book of eclipsing variables and recommendation lists for observers—work which was carried out at the Princeton Observatory by the late Prof. R. S. Dugan and the prematurely deceased Dr N. L. Pierce.

The Soviet astronomers submit, therefore, a recommendation for our Commission

To request the Engelhardt Observatory to prepare once in three or four years a list for recommended observations of eclipsing variables, containing elements of the variations of brightness and bibliographical references. To ask observatories to send to the Engelhardt Observatory systematic informations on their observations of eclipsing variables.

From the foregoing correspondence it appears that we are really in a very fortunate position of having *three* independent card catalogues of the literature concerning eclipsing variables, maintained and kept up-to-date at the same time at Kazan, Kraków and Philadelphia. The Chairman cannot but second the plea of these observatories for the co-operation of all astronomers working in this field, and, conversely, it is to be hoped that the information stored in these centres will be made accessible to all astronomers who may request it.

With respect to the Finding Lists, the opinion of the members of our Commission seemed unanimous that their continuation should likewise be encouraged; but since this problem is not pressing at the present time, its discussion may perhaps be deferred until the meeting of our Commission during the next General Assembly. Hogg, Irwin and Wesselink, however, have advanced already a recommendation with which most astronomers will probably be in sympathy: namely, that future editions of the Finding Lists should be extended to include the stars of *both* hemispheres, instead of stopping,

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as in the past, on the parallel of $-30°$ southern declination. Hogg had explained his reasons in the following cogent terms:

Perhaps as one of the isolated members of the Commission, I should like to point out what I feel to be a real difficulty: namely, that of feeling reasonably certain that one is making the best use of observational time and is not unnecessarily repeating work that is going on elsewhere, or perhaps has already been done. The Finding List by N. L. Pierce is most useful, and Stibbs has prepared a card index for binaries south of $-30°$ Whilst this is valuable, it is not necessarily exhaustive, nor can it give the latest information. Any scheme to get over this would be helpful. It could perhaps take the form of an amplification of the existing progress reports into lists of stars being currently observed; it might also include stars suggested for observation.

In the last two years, photo-electric observations have been carried out at Mount Stromlo on various southern spectroscopic binary systems, observers being Hogg, Gottlieb, Gum, Simonow and Bowe. Light curves have been obtained for nine stars. These include curves for zeta Phoenicis (a totally eclipsing system) and HD 44701 (partial eclipse), neither of which was listed as a light variable. Orbits for both these stars as well as for S Antliae were determined. The spectroscopic binaries 19 Eri, 66 Eri, Boss 2473, θ^2 Cru and γ Cen show no appreciable light variation.

Dr Sahade of Cordoba, another colleague of ours from the South, is much in sympathy with Hogg's views.

I should like [writes Sahade] to emphasize the convenience of continuing the publication of progress reports of those astronomers engaged either in photometric or spectrographic studies of close binary systems. If short information of the results could be obtained in advance of publication of detailed papers, a desirable co-ordination of efforts between the photometric and spectrographic observers could be maintained, particularly in the cases of systems showing some peculiarities. Perhaps such progress reports could be issued in separate sheets, or published in any of the regular astronomical journals.

Of his own unpublished work, Sahade reports to have completed observations of the eclipsing variables R Ara and S Vel and the results should appear in the near future. Furthermore, the following eclipsing stars are now under observation at Bosque Allegre: X Car, GG Car, GL Car, RR Cen, V 346 Cen, W Cru, TT Hya, TU Mus, V 393 Sco, V 449 Sco, and V 453 Sco.

From Dr Oosterhoff (Leiden) the following recent communication reaches us:

While in South Africa, I spent most of the observing time on the colours of the stars, but I made photo-electric observations of the eclipsing binaries AI Crucis and V 505 Sagittarii. AI Crucis has been observed in white light, whereas V 505 Sagittarii was observed in the blue, white, and yellow.

The pulse counter has been now in use at the telescope in Leiden for quite some time, and it works very well indeed.. We hope that a description of various electronic instruments constructed here (i.e. at Leiden) will be published before the Rome meeting in the Bulletin of the Astronomical Institutes of the Netherlands.

Dr Eggen (Lick) sent in a communication disclosing that

Some unpublished work on the Praesepe cluster shows that at least one W Ursae Maioris variable, TX Cancri, falls 0·75 of a magnitude above the Main Sequence, indicating that the equality of depths of the eclipses actually does mean equality of brightness of the two components. Observations of several binaries of the W UMa type persist in showing no colour change throughout the period of variation, except for a slight reddening at *both* eclipses. The erratic light variations between minima, found in 44i Bootis, appear to be characteristic of the whole class. Some clue to the equality of brightness, but inequality in mass, of these stars may be derived from the fact that their colour places most of such stars right at the intersection of the dwarf and subdwarf sequences.

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Dr Joy (Mount Wilson) reports that

I have a few spectrograms of RV Librae, which were originally taken with the impression that it was a Cepheid variable. This did not prove to be the case, and only recently I have found a light curve by Shapley in an obscure publication* showing that it is a Beta Lyrae star with a period of 10·7 days. The spectrum is G6, with a tendency toward double lines at elongation. The velocity range is 120 km./sec. Since eclipsing stars of this type are rare, it might be good to have further photometric observations. Dr Sergei Gaposchkin writes me that it is on the Harvard programme.

Dr Irwin (Bloomington) emphasizes some methodological tasks and desiderata confronting the analysis of light curves at the present time:

Despite the recent appearance of Merrill's Tables, considerable work in this field remains still to be done. For example—since most coefficients of limb-darkening u of real stars at realistic wave-lengths are apt to be between 0·4 and 0·6, the respective tables for $u=0·5$ would be very useful. Furthermore, the basic tables of α (k, p) for both occultation and transit eclipses of completely darkened stars should be republished. They are at present available only in an out-of-print publication,† and yet are useful (and, in fact, necessary) to photo-electric interpreters using non-standard values of the limb-darkening. Third, simplified tables of photometric perturbations due to the distortion, gravity-darkening, and reflection, as functions of k and p (and whatever other parameter or parameters seem desirable) would be useful. Because of the necessary assumptions involved in the choice of some parameters, and because of our lack of more complete astrophysical knowledge, such tables at first could be published only to two significant figures, and for some intermediate degrees of limb darkening.

Photo-electric work in two colours on eclipsing binaries is continuing at the Goethe Link Observatory on a somewhat limited basis at present.

In the past several years, studies of eclipsing binary systems have been pursued vigorously by different astronomers of the Soviet Union and their efforts have resulted in many important contributions. The following summary of their work in the years 1948–50 has been prepared by Prof. Martynov, and communicated to us through the Secretary of the Astronomical Section of the U.S.S.R. Academy of Sciences:

The theoretical work of Soviet investigators was directed to the study of the effects on the light curves of eclipsing variable stars, of the dissimilarity in form of the components and their relative position. These phenomena are to be expected in view of the viscosity of stellar matter, and may exert a great influence upon the evolution of binary star systems. The photometric effects are discussed in the paper of V A. Krat (*Bull. Variable Stars*, **6**, no. 6, 1949), in papers (in the Press) by A. V Sofronitsky and A. N. Dadaev (Pulkovo)‡ and N. I. Chudovichev (Engelhardt Observatory). The method developed by A. S. Gainullin for determining the tidal lag has been applied by A. O. Bronstein to the system of RV Oph (*Var. Stars*, **6**, no. 5, 1949). It follows from Chudovichev's analysis that a definite solution of the problem can be obtained only for systems the components of which differ markedly in colour, and only on the basis of highly accurate photo-electric light curves.

D. J. Martynov (*Eng. Obs. Izvestia*, No. 25, 1948) has investigated the evolutionary effect of the tidal lag taking into consideration the loss of the rotational moment of the star through its radiation and corpuscular ejection of matter. V A. Dombrovsky (Leningrad) has considered the effect of reflection in close binary systems with different periods of revolution and axial rotation, and has explained several discrepancies between the theory and observations.

B. I. Kaminsky (Pulkovo, unpublished paper) and D. J Martynov (*Eng. Obs. Izvestia*, No. 25) have studied the motion of the components of close binary systems in the presence of a near-by third body. The former generalized Brown's method for the case of large inclina-

* See 'Sidereal Explorations' (*Rice Inst. Pamph.* **18**, no. 2, 1931), *Harv. Reprint*, No. 68 (ZK).

† Tsesevich, Reference (67) in the Bibliography.

‡ Since published in *Poulkovo Obs. Bulletin*, No. 147, 1951.

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tions, while the latter applied Laplace's lunar theory for the stellar case in algebraic form, deducing a formula for the epochs of minimum brightness.

At the Ninth Conference of investigators of variable stars held in Kiev, D. J. Martynov proposed a list of eight subjects of utmost importance for the theoretical study of eclipsing variables (*Var Stars*, Vol. **7**, no. 4).

Investigations of Individual Variable Stars. Of the numerous series of investigations of eclipsing variable stars carried out by Soviet observers, I shall mention only those which stand out for either accuracy or completeness. The following photo-electric observations have been secured at Abastumani—Y Aql in two wave-lengths (*Astr. Circ. U.S.S.R.* No. 84; no eclipses observed), RX Her (*Astr. Circ.* No. 93; a detailed article will appear in the *Abastumani Bulletin*), RS Vul (observations incomplete); at the Engelhardt Observatory, U Cep (N. I. Chudovichev's excellent light curve can be found in *Astr. Circ.* No. 100), VW Cep (*Astr Circ.* Nos. 96–7), TX Her, AR Cas (unpublished), CC Cas, RR Lyn (incomplete). In addition, starting from 1950, photo-electric observations of a number of spectroscopic binaries have been started at the Abastumani Observatory, with the purpose of discovering the effects of possible eclipses.

N. M. Goldberg (Pulkovo) has made an extremely thorough and complete spectrophotometric investigation of the system u Her and given a theoretical interpretation of her results (in the Press).* Spectro-photometric investigations of various other eclipsing variables have been started at the Pulkovo Observatory with a 10″ cata-dioptric Slusarev camera and a direct-vision prism. D. J. Martynov's thorough investigation of the system RX Cas over a period of many years has also been published (*Engelhardt Bull.* No. 27). V A. Dombrovsky of the Burakan Observatory investigated the effect of the polarization of light on the limb in the system of U Sge. B. N. Kadomsky (Engelhardt Obs.) investigated RS Vul in blue and red light. The unpublished observations of the variable were carried out with the aid of G. A. Tikhov's spectrograph, and accurate light curves obtained; the effect of reflection was found to be smaller than shown by Dugan's observations. I. M. Ishchenko of the Tashkent Observatory carried out a special series of photographic observations of the variables YX, CS Lac, BO And AE Cyg (*Tashkent Bull.* No. 10, p. 20, 1948) of UZ Cyg, SY Sge (unpublished) and RT, CM Lac (incomplete). At the Crimean Astrophysical Observatory S. V Nekrasova obtained accurate light curves and photometric elements of the systems XZ, CMa and SU Aqr. V P. Tsesevich has finished the reductions of his visual observations of many eclipsing variables (in the Press).

P. P. Parenago has found (*Var. Stars*, **7**, no. 2) a periodic term in the epochs of minima of U Oph; D. Y Martynov has found the same for RX Cas. A. A. Vasilieva cleared up some points on the motion of the system RT Per about a third body (*Astr. Circ.* No. 75, 1948). P. P. Parenago has also made an interesting attempt to calculate the true elements of the system UX UMa (*Var. Stars*, **7**, no. 4, 1950).

The foregoing reports received from our members indicate the extent of work in this field which is currently in progress at their observatories; but the need of a mutual exchange of information in the periods between the meetings of I.A.U. remains as urgent as ever. With the rapid increase of the number of active photo-electric photometers all over the world, and with a relatively limited number of bright eclipsing variables in the Northern Hemisphere and the equatorial belt, the danger of unnecessary duplication of effort might become serious in the near future if no organized steps were taken to minimize it; and the same may soon be true of spectroscopic observations as well. In the early days of the American Panel on Orbits of Eclipsing Variables, of which our Commission is a successor, occasional notes and progress reports were circulated in informal mimeographed Bulletins, six of which were issued from Harvard Observatory in 1946 and 1947. When the need of co-operation between observers in different latitudes and longitudes called for an organization on a broader than national basis, and our Commission thus came into being at the Seventh General Assembly of the I.A.U. at Zürich in August 1948, the former American panel became an integral part of the Commission,

* See *Poulkovo Bull.* No. 147, 1951.

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and the publication of the *Bulletins* had ceased. This loss was more than made up by Shapley's decision to make the *Harvard Circulars* available to our Commission for promoting the interest of research in this field. Under this arrangement, eight issues of the *Circulars* (Nos. 450–7, totalling 135 pages) have appeared since 1947, and their copies have been distributed (apart from the regular recipients of Harvard publications) to all members of our Commission. A more formal character of the *Circulars* (and the fact that very few members sent in pertinent information) has made, however, this new channel perhaps less effective than the earlier *Bulletins* were in this respect. At any rate, a continued dissemination of information regarding concurrent observing programmes at different observatories constitutes a need keenly felt by many investigators, and poses a technical problem which will have to be discussed at our next meeting.

In conclusion, no report on recent activities in the study of eclipsing binary systems would be complete without recording our debt of obligation to the Kraków University Observatory for their yearly ephemerides of eclipsing variables (76). These ephemerides, which have been published by Banachiewicz from Kraków under the auspices of the Commission 27 (Variable Stars) of the I.A.U. for many years, have reappeared in 1947 after a lapse of eight years caused by the war, and have been of invaluable assistance to many investigators since that time. It is our hope that the Kraków Observatory may be in a position to continue this meritorious work also in the future.

ZDENĚK KOPAL
President of the Commission

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SUPPLEMENTARY DRAFT REPORT

The text of the Draft Report preceding the reports on the sessions of the Commission in Rome was completed some eighteen months before the Rome meetings; and it is the purpose of the following supplement to bring the information contained in the Draft Report up to date as to September 1952.

One of the most gratifying features of the period just past has been an extraordinarily rapid increase of observational evidence bearing on the subject of our study—both photometric and spectroscopic. It is encouraging to note that, of the systems singled out as especially deserving notice in the introductory paragraphs of the Draft Report eighteen months ago, three have already been investigated—V 451 Oph, V 566 Oph by Colacevich and Fresa (see Report on the third session of the Commission), and EE Peg by Wellmann—while the remaining ones are being placed on observing programmes of other observatories. As we learned from Dr Petrie at the second meeting of the Commission, the Victoria astronomers may observe Y Cyg, V 448 Cyg, and S Equ photo-electrically, and BF Aur and S Cnc spectrographically. Prof. Colacevich (Naples) intends to place the systems WW Aur, XX Cep, CW Cep, V 367 Cyg, V 548 Cyg, and DM Per on the photo-electric programme of the Observatory di Capodimonte (private communication), while Dr Wellmann intends to embark on photo-electric observations of EE Peg at Hamburg-Bergedorf. Moreover, in the *Mitteilungen der Astronomischen Gesellschaft für* 1950 the Hamburg-Bergedorf Observatory reports spectrographic observations of ζ Aur and RW Tau (p. 46); while Potsdam reports spectrophotometric observations of ζ Aur (during August–September 1950) and of YZ Cas (op. cit. p. 58).

Hellerich (Münster) reports (op. cit. p. 56) an extensive programme of photographic observations of eclipsing variables (including RX, RZ, SX, TW Cas, U Cep, TW, WW Dra, β Lyr, U Sge) for the purpose of determining the epochs and light curves; and the *Mitteilungen für* 1951 (p. 61) adds to the previous programme TV Cas, U CrB, RX Her, and V 451 Oph (Günther).

This intense activity at various observatories in different parts of the world does not, however, diminish significantly the scope of our subject of study; for the number of stars recognized as eclipsing variables is increasing rapidly all the time—and not only among faint stars; for the photo-electric observers still keep discovering eclipsing systems with

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shallow minima among naked-eye stars, particularly in the southern hemisphere. And how much remains yet to be learned about some time-honoured objects! It is really remarkable how little we know of the light changes of such systems as σ Aql, β Aur, δ Ori, or α Vir, which have been known as eclipsing variables for several decades, and which are accessible to photo-electric observation even with telescopes of very modest light-gathering power.

A list of additional stars which have been observed photo-electrically in recent years has been compiled in the form of the following extension of Table I of the original Draft Report. Although it is true that the original table and its present extension partly overlap in time, the intensity of current research in our field can be gathered from the fact that the number of systems now under photo-electric observation appears to be comparable with the total number of systems observed photo-electrically throughout the past thirty years.

A glance at the bibliographical references of Table 1 reveals another noteworthy feature: namely, that whereas prior to 1948 a large majority of photo-electric observations of eclipsing binaries have been carried out in America, since 1950 a significant readjustment of balance has taken place, and, at present, most eclipsing systems now under photo-electric observation are being followed in Europe. Will the European climate enable its astronomers to compete with their American colleagues not only in quantity, but also in quality and precision of their observations? Anyone who has seen the accurate light curve of X Trianguli which M. Lenouvel (Observatoire Astrophysique de Haute Provence) exhibited during the second session of our Commission will be tempted to answer in the affirmative; and there is little doubt that southern Europe possesses certain localities of which climatic conditions for photo-electric work are as good as those encountered along the American Pacific coast.

The following Tables 2, 3 and 4 contain additional material intended to bring the respective tables (under the same headings) of the Draft Report up to date. Table 6 should be likewise augmented by the addition of the absolute dimensions of at least two new eclipsing systems—V 382 Cyg and V 477 Cyg—which have since been published by Pearce (*P.A.S.P* **64**, 219, 1952; and *A.J* **57**, 22, 1952, respectively).

TABLE 1 (Addenda)

Star	Reference to photo-electric observations
YZ Cas	McNamara (Berkeley, two colours; unpublished).
U Cep	Walter, *A.N.* **276**, 225, 1948. Tchudovitchev, *U.S.S.R. Astr. Circ.* No. 100, 1950. Miczaika (Heidelberg-Königstuhl; unpublished; three colours).
X Tri	Lenouvel (Observatoire Astrophysique de Haute Provence; unpublished).
AB Cas	Lenouvel (unpublished; cf. *Rocznyk Astronomiczny Kraków*, No. 23, p. 81, 1952).
DO Cas	Schneller and Daene, *A.N.* **281**, 25, 1952.
TW Cas	Bartlett (unpublished; cf. *A.J.* **56**, 150, 1951).
RZ Cas	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 20, p. 81, 1949; No. 21, p. 80, 1950; No. 22, p. 82, 1951). Piotrowski (op. cit. No. 23, p. 83, 1952).
ST Per	Lenouvel (unpublished; cf. *Roczn. Astr.* No. 23, p. 88, 1952).
β Per	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 20, p. 83, 1949; No. 21, p. 82, 1950; No. 22, p. 87, 1951). Piotrowski (op. cit. No. 23, p. 88, 1952).
CC Cas	Tchudovitchef (Engelhardt Observatory; unpublished).
RT Per	Lenouvel (unpublished; cf. *Roczn. Astr.* No. 23, p. 88, 1952).
RW Tau	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 20, p. 84, 1949). Lenouvel (*Journ. des Obs.* **34**, 13, 1951).
BF Aur	Schneller and Daene (unpublished; cf. *Mitteilungen der Astronomischen Gesellschaft für 1951*, p. 63).
SX Aur	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 80, 1950; No. 22, p. 81, 1951).
CD Tau	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 22, p. 88, 1951).
VV Ori	Huffer (additional unpublished observations in two colours).

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TABLE 1 (*continued*)

Star	Reference to photo-electric observations
RR Lyn	Tchudovitchev (Engelhardt Observatory; unpublished).
SV Cam	Nelson (unpublished; cf. *A.J.* **56**, 136, 1951).
WW Aur	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 20, p. 81, 1949; No. 22, p. 80, 1951 (two colours)); Piotrowski (op. cit. No. 23, p. 82, 1952).
S Ant	Hogg and Bowe, *M.N* **110**, 373, 1951.
W UMa	Schneller and Daene (unpublished; cf. *Mitt. Astr. Gesell. für 1951*, p. 63).
UV Leo	Perek, *Publ. Astr. Inst. Masaryk Univ. Brno*, **1**, No. 10, 1952; Nason and Moore, *A.J* **56**, 182, 1951; Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 81, 1950; No. 22, p. 85, 1951); Wallenquist (unpublished).
Z Dra	Lenouvel (*Journ. des Obs.* **34**, 13, 1951).
α CrB	Pilowski, *A.N.* **279**, 191, 1951.
TW Dra	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952.
ϵ UMi	Hinderer (unpublished; cf. *Mitt. Astr. Gesell. für 1951*, p. 33).
AK Her	Piotrowski (unpublished; cf. *Roczn. Astr.* No. 23, p. 85, 1952).
U Oph	Magalashvili, *Abastumani Obs. Bull.* No. 10, 1949. Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 22, p. 86, 1951, two colours). Piotrowski (unpublished; cf. op. cit. No. 23, p. 86, 1952).
TX Her	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 81, 1950). Tchudovitchev (Engelhardt Observatory; unpublished).
V 566 Oph	Fresa (Capodimonte Obs., Naples; unpublished).
Z Her	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952.
V 451 Oph	Colacevich (Capodimonte Obs., Naples; unpublished).
RX Her	Magalashvili, *Variable Stars*, **7**, 240, 1950.
V 805 Aql	Fresa (Capodimonte Obs., Naples; unpublished).
RS Vul	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952. Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 82, 1950). Piotrowski (unpublished; cf. op. cit. No. 23, p. 89, 1952). Magalashvili (Abastumani Obs., unpublished).
Z Vul	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 82, 1950).
BD $+40°$ 4220	Miczaika (Heidelberg-Königstuhl; unpublished).
GO Cyg	Piotrowski and Strzalkowski (unpublished; cf. *Roczn. Astr.* No. 21, p. 81, 1950; No. 22, p. 84, 1951). Schneller and Daene (unpublished; cf. *Mitt. Astr. Gesell. für 1951*, p. 63).
VW Cep	Kostilev, *U.S.S.R. Astr. Circ.* No. 96, p. 97, 1950.
RT And	Lenouvel (*Journ. des Obs.* **34**, 13, 1951).
AR Cas	Tchudovitchev (Engelhardt Observ.; unpublished).

TABLE 2 (Addendum)

Revised Elements of Eclipsing Binary Systems

Star	Source of the elements
RX Cas	Martynov, *Engelhardt Obs. Bull.* No. 27, 1950.
DO Cas	Schneller and Daene, *A.N* **281**, 25, 1952.
VW Cyg	Fatkina, *Variable Stars*, **7**, 252, 1950.
WZ Cyg	Kurzemniece, *Publ. Inst. Phys. Latvian Acad. Sci.* No. 2, p. 123, 1950.
LN Cyg	Taffara and Mannino, *Padova (Asiago) Contr.* No. 17, 1950.
V 371 Cyg	Kukarkin and Sicheva, *Variable Stars*, **7**, 265, 1950.
V 546 Cyg	de Kort, *Vatican Ricerche*, **2**, 355, 1952.
TW Dra	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952.
RZ Eri	Gaposchkin, *A.J.* **56**, 125, 1951.
Z Her	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952.
RX Her	Magalashvili, *Variable Stars*, **7**, 240, 1950.
UX Her	Kurzemniece, *Publ. Inst. Phys. Latvian Acad. Sci.* No. 3, p. 73, 1952.
AK Her	Fresa, *Mem. Soc. Astr. Ital.* **21**, No. 4, 1950.
u Her	Goldberg, *Poulkovo Bull.* No. 147, 1951.
UV Leo	Perek, *Publ. Astr. Inst. Masaryk Univ. Brno*, **1**, No. 10, 1952.
RS Vul	Baglow, *David Dunlap Obs. Publ.* **2**, No. 1, 1952.
CD Vul	Guman, *Budapest Mitteilungen*, No. 24, 1951.

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TABLE 3

Additional Recent Investigations of Period Changes of Eclipsing Variables

Star	Authority
AB And	Woodward, *A.J* **56**, 77, 1951.
SV Cen	Gaposchkin, *P.A.S.P.* **63**, 148, 1951.
VW Cep	Woodward, *A.J* **56**, 77, 1951.
U CrB	Bartlett (unpublished; cf. *A.J.* **56**, 150, 1951).
SZ Her	Bartlett (unpublished; cf. *A.J* **56**, 150, 1951).
TU Her	Ustinov, *Variable Stars*, **7**, 254, 1950.
UX Her	Kurzemniece, *Publ. Inst. Phys. Latvian Acad. Sci.* No. 3, p. 73, 1952.
SW Lac	Woodward, *A.J.* **56**, 77, 1951.
V 477 Cyg*	Gaposchkin, *P.A.S.P.* **63**, 149, 1951.

* The orbit of this system is eccentric and the author discusses also the possibility of apsidal advance.

TABLE 4

Additional List of Eclipsing Systems with Known Spectrographic Orbits

R Ara	Sahade	*Ap. J* **116**, 35, 1952.
X Car	Sahade	*Ap. J.* **115**, 134, 1952.
RZ Cas	Horak	*Ap. J.* **115**, 61, 1952.
BM Cas	Wellmann	Unpublished (cf. *Mitt. Astr. Gesell. für 1950*, p. 46).
V 448 Cyg	Petrie	Unpublished.
	Wachmann	Unpublished (cf. *Mitt. Astr. Gesell. für 1951*, p. 50).
V 453 Cyg	Wachmann	Unpublished (cf. *Mitt. Astr. Gesell. für 1951*, p. 50).
AR Lac	Sanford	*Ap. J.* **113**, 299, 1951.
U Peg	Struve	*Ap. J* **112**, 216, 1950.
EE Peg	Wellmann	*Nachrichtenblatt Astr. Zentralstelle*, **5**, 38, 1951.
U Sge	McNamara	*Ap. J* **114**, 513, 1951.
W Ser	Beer	Unpublished.
ϵ UMi	Climenhaga, McKellar and Petrie	*A.J.* **56**, 36, 1951.
S Vel	Sahade	*Ap. J.* **116**, 35, 1952.
HD 44701*	Pearce	*A.J* **56**, 137, 1951.
HD 126648†	Shajn	*Annals Crimean Astr. Obs.* **5**, 105, 1950.
CPD $-60°$ 3278‡	Sahade	Unpublished.
BD$+40°$ 4220§	Wilson and Abt	*Ap. J* **114**, 477, 1951.

* Photometric observations made at the Commonwealth Observatory at Canberra detected shallow eclipses of this dwarf binary system (cf. Gum, *M.N* **111**, 634, 1952).

† Gaposchkin (*Astr. News Letter*, No. 56, June 1951) reported this star to be an eclipsing system with two well-defined minima.

‡ This star was announced as probably an eclipsing variable by Father O'Connell.

§ This system was discovered photo-electrically by Miczaika to be an eclipsing variable with two well-defined minima (unpublished; private communication).

We should welcome the appearance of D. Y Martynov's summarizing investigations. *An Investigation of Periodic Inequalities in the Epochs of the Minima of Eclipsing Variables* appeared in the Publications (Izvestia) of the Engelhardt Observatory. No. 25, 1948. This is a valuable technical monograph of over 200 pages, completed in 1942 and published six years later, but distributed only recently outside the U.S.S.R. The same seems, moreover, true of V A. Krat's treatise on the *Figures of Equilibrium of Celestial Bodies*, published by the Government Publishing House for Technical and Theoretical Literature in Moscow and Leningrad in 1950. This latter work appears, moreover, to be already out of print two years after its publication. The non-Russian reader can gather at least to some extent the wealth of the material included in these treatises from

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their English summaries prepared by Vyssotsky and Struve (see *Astronomical News Letter*, Nos. 58 and 62). The existence of these new books, together with that of the earlier treatise on *Variable Stars* by Martynov and Tsesevich (51), will place any astronomers unacquainted with the Russian language at a distinct disadvantage; for it is a fact that our Russian colleagues have written and published in recent years more technical monographs, of high quality, on eclipsing binary systems than there are available in all non-Russian languages combined. Will also this inequality be rectified before the next meeting of the I.A.U. in 1955?

ZDENĚK KOPAL
President of the Commission

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Report of meetings

First meeting. Friday, 5 September 1952

President: Prof. Zdeněk Kopal

Secretary: Prof. Charles M. Huffer.

The meeting was called to order at 9.30 a.m., and opened with a discussion of the several propositions submitted by members of the Commission and published in the *Draft Reports*. After a considerable discussion the following resolutions have been passed by a unanimous vote and referred to the Finance Committee:

(1) The investigators of eclipsing binary systems are requested to send in reprints of all papers and publications (as well as all such unpublished information as can be communicated in advance) dealing with all aspects of our subject to the Observatories at Kazan (Engelhardt Observatory, U.S.S.R.), Kraków (University Observatory, Poland) and Philadelphia (Flower and Cook Observatories, U.S.A.). These observatories intend to maintain, and keep up to date, card catalogues of all eclipsing stars observed, and will be glad to communicate any or all data relevant to particular stars to any astronomer who may request them.

(2) The Commission welcomes the continued publication of the Finding Lists by Dr F. B. Wood from the Flower and Cook Observatories, as well as the intention of Prof. D. Y Martynov of the Engelhardt Observatory to embark upon the publication of a new list of eclipsing variables of special interest. The Engelhardt Observatory is understood to be in no need of outside support to carry on this work; but it is recommended that the International Astronomical Union grant the Flower and Cook Observatories a subsidy of one thousand dollars to defray a part of the cost of publication of the new edition of the *Finding List* (which is estimated to amount to approximately $6000).

It was agreed that the next edition of the *Philadelphia Finding List* should be extended to include eclipsing stars of both hemispheres and contain more complete bibliographical references.

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Prof. Martynov informed the members of the Commission that the Engelhardt Observatory at Kazan under his direction intends to embark on the publication of semi-periodic lists summarizing the most important information on photometric and spectroscopic elements of eclipsing variables and paying especial attention to the neglected stars. The first such list, by N. I. Tchudovitchev,* entitled *Catalogue of the Photometric and Spectroscopic Elements of Eclipsing Variable Stars*, had already appeared as *Engelhardt Observatory Bulletin* No. 28 (1952) and was circulated among the members present at the session.

Dr Plaut (Groningen) urged the need of concentrating on the observations of all eclipsing variables brighter at maximum than a certain limiting magnitude—say 8·5—for the sake of completeness of statistical investigations before giving more attention to fainter stars.

After one hour's session the first meeting adjourned at 10.30 a.m.

Second meeting. (Joint Sessions of Commissions 27 and 42.)

PRESIDENTS: Prof. A. DANJON and Prof. Z. KOPAL.

SECRETARY: Prof. C. M. HUFFER.

The meeting was called to order at 9.45 a.m. Prof. Danjon presented a resolution on behalf of Commission 27 (cf. *Draft Reports*, Vol. II, p. 21). The resolution was translated into English by Dr van Hoof and passed by a unanimous vote.

Prof. Kopal moved next that a telegram be sent on behalf of both Commissions 27 and 42 to Prof. H. N. Russell, who was unable to attend the meeting for health reasons, and Prof. Huffer moved that a similar telegram be sent to Prof. Joel Stebbins. Both motions were unanimously adopted.

The agenda then turned to a survey of current work in the field of eclipsing binary systems, which is now in progress at different observatories.

Dr R. M. Petrie (Dominion Astrophysical Observatory) reported that a photo-electric photometer is under construction at Victoria and is expected to be in operation this year. It may be possible to study one or two eclipsing binaries with it in the near future. Possibilities are S Equulei, V 448 Cygni, and Y Cygni. He stressed the desirability of observing AR Cas with high precision. This star was originally observed by Stebbins with the selenium cell. The light and velocity curves agree in the orbital eccentricity $e=0{\cdot}25$, but disagree in the longitude of the periastron ω. An advance in ω is established by several spectroscopic orbits, and work is being continued. The crucial point is to determine the phase of the secondary minimum. The spectrographic orbit of the star V 448 Cygni is being completed by Petrie; the spectrum of the secondary component turned out to be anomalous.

Dr Otto Struve (Leuschner Observatory) gave a brief account of his recent spectrographic investigations of the system of Capella, and Dr Lenouvel (Observatoire de Haute Provence, Saint Michel) described and passed around an excellent photo-electric light curve of X Trianguli secured with the aid of a photometer of his design attached to the 120 cm. reflector at Saint Michel.

Dr Petrie read also a prepared statement by Dr J. A. Pearce concerning a catalogue of spectroscopic binary systems and Prof. Martynov opened up the same subject; but its discussion was eventually referred to the Sub-committee on spectroscopic binaries of Commission 30.

The meeting was adjourned at 10.30 a.m.

* It has since become our sad duty to deplore the passing of this young and talented investigator of eclipsing variables in the prime of his life. For his obituary see: Martynov, *Variable Stars*, **8**, 318, 1952.

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Third meeting. Monday, 8 September 1952

PRESIDENT: Prof. Z. KOPAL.

SECRETARY: Prof. C. M. HUFFER.

The meeting was called to order at 5.30 p.m. The Secretary took the Chair and read the text of the telegrams sent to Prof. Russell and Prof. Stebbins, and requested the approval of the members.

He also moved a surprise resolution:

that members of Commission 42 express their thanks to the President of the Commission for a comprehensive report prepared for the *Draft Reports*, and appreciation of the many hours of labour devoted to its preparation.

The resolution was adopted by acclamation.

Prof. Banachiewicz (Kraków), who arrived at Rome too late to attend the previous meetings of the Commission, requested its members to endorse his application for financial aid to enable the Kraków Observatory to purchase a 20-place electric calculator needed for the preparation of the data published in the well-known Kraków Ephemerides. After a discussion in which Drs Martynov, Plaut and Wood took part, the following motion was adopted by a unanimous vote and referred to the Finance Committee:

The Kraków Observatory publishes every year the ephemerides of the minima of eclipsing stars. These ephemerides were supported for many years by grants from the Union, but for technical reasons the grants could not be secured after the war. Now the Kraków Observatory is greatly needing an electric calculator with 20 decimals for computing these minima. The Commission recommends that the I.A.U. should give all necessary support for the acquisition of a machine, needed for preparation of the Kraków Eclipsing Binaries Ephemerides, and should assist financially the publication of these ephemerides.

After this remaining item of business the members returned to a survey of their current work in the field of interest of the Commission and to their plans for the future.

Dr Wood of the University of Pennsylvania informed the members that in the future he expected to continue the programme of photo-electric observation of eclipsing binaries at the Flower and Cook Observatories of the University of Pennsylvania. He stated that he planned to concentrate their observations largely, although not exclusively, on two classes of stars. The first one will comprise those systems which have known or suspected apsidal motion, and for which the degree of central condensation has not yet been determined. He was especially interested in systems in which the spectral type of the fainter component is later than G0. The second one will consist of the ζ Aurigae type in which one component is a late-type supergiant. In these systems, it is usually necessary to combine the results of many observers in order to obtain a complete light curve of the partial phases. He emphasized the importance of exchange of advance information among such observers, especially concerning the choice of comparison stars, and expressed his willingness to co-operate in any way possible with others interested in these systems.

Profs. A. Colacevich and M. G. Fracastoro presented a communication dealing with the provisional results of their recent spectrophotometric observations of 32 Cygni. Slit spectra of this star were taken by Kuiper, Bidelman and Colacevich during the egress phase of the eclipse in 1949 at the McDonald Observatory with the aid of the quartz spectrograph (dispersion 55 A./mm. at H_γ).

Provisional elements of this system have been established. If we assume (for the sake of simplicity) that the absolute radii of the late-type components of 32 Cygni and ζ Aurigae are the same, the ratio k of radii of the components of 32 Cygni is approximately 1/120 if the spectrum of the smaller star is assumed to be A0, or k is equal to 1/140 if this spectrum is B8. The inclination i of the orbit is approximately equal to 75° and the semi-major axis of the orbit is about 10^9 km.

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Relative intensities of spectral lines referring to the continuum of the star have been measured, ϵ Geminorum being used as a comparison star. Measurements of single lines have been arranged according to the multiplets, and their behaviour was studied by plotting the mean intensity of the multiplets against the date of observation or the height of the early-type star above the limb of the late-type star.

Some Fe I lines around 4090 A. attained their final intensity as early as 15 November 1949 (third contact having taken place on November $10^{d}\cdot0$ = phase + $6^{d}\cdot4$ days). Fe I lines belonging to the multiplets (4), (20), (5) and (21)* show a slow diminution of their intensities up to 23 December. No observations after that date were available. The

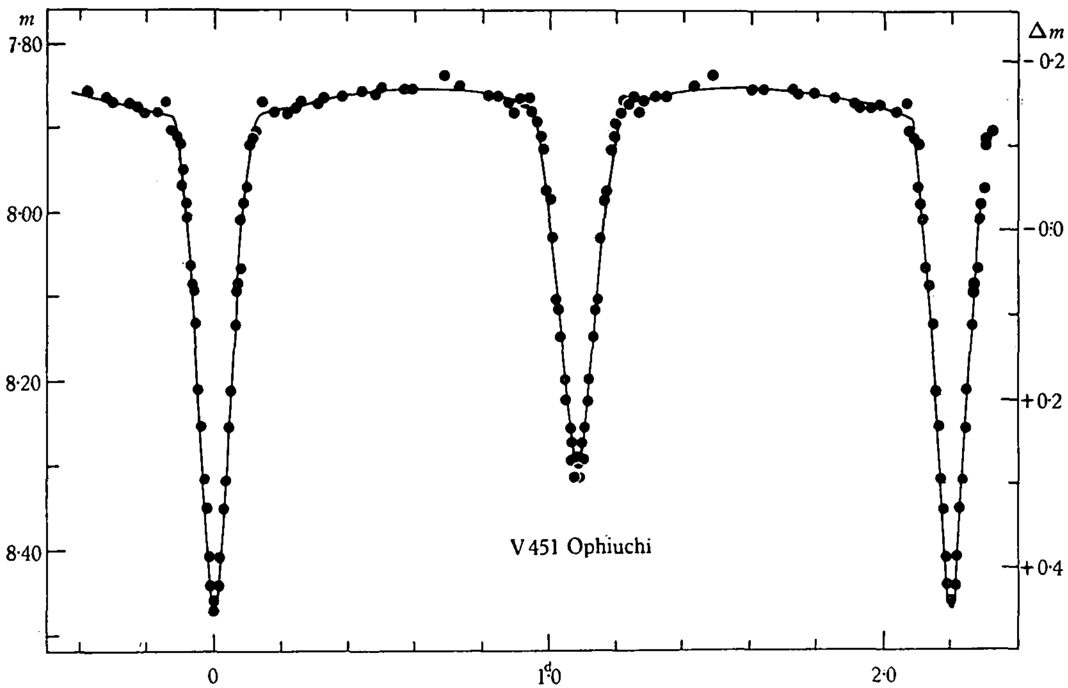

Fig. 1.

curves relative to the ionized metals such as Ti II [(13), (14)] and Ca II [(1)] exhibited quite a different behaviour. The intensities of these lines increase rather than diminish after 11 November and the slope of their curve was still strongly negative on 23 December. Therefore the system was not yet spectroscopically 'normal' on that date, even for neutral lines. Full details of this investigation should appear in a paper by Colacevich and Fracastoro to be published in *Memorie della Societa Astronomica Italiana*, **23**, 55, 1952.

Prof. Fracastoro presented also a communication on photometric observations of ζ Aurigae during its 1950 eclipse. Monochromatic amplitudes at wave-lengths of 4090, 3950 and 3786 A. have been measured, yielding amplitudes of $0^{m}\cdot99$, $1^{m}\cdot52$ and $1^{m}\cdot52$, respectively; the second value being increased by the wings of the H and K lines of Ca II. Central intensities of several strong lines have been measured during the egress and the totality, and their behaviour has been compared with the preceding eclipse.

Fracastoro emphasizes the importance of measuring the monochromatic amplitudes of ζ Aurigae through 'windows' of the continuum. Pettit's period $P = 972\cdot07$ days is

* Numbers refer to Moore's Table.

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not confirmed by his observations which fit more satisfactorily with Christie's value $P \doteq 972{\cdot}24$. The discrepancy may possibly be due to the fact that atmospheric extinction phenomena take place before the onset of the geometrical eclipse (see M. G. Fracastoro, *Memorie della Societa Astronomica Italiana*, **21**, 195, 1950; **23**, 39, 1952).

Dr A. Fresa reported on photo-electric observations of some eclipsing variables made at the Capodimonte Observatory in Naples. Visual photometric observations have been conducted at the Capodimonte Observatory under the direction of the late Prof. A. Bemporad for more than twenty years. They are now being taken up again with the aid of a photo-electric photometer designed by the new director, Prof. A. Colacevich. This photometer is attached to the 7-inch Fraunhofer refractor of 10 feet focal length. The photo-cell employed is of the type RCA 1P21. The anode current amplified by an amplifier of the Kron type is recorded by a milliampermeter of the CGS of Monza, Italy. The Naples sky is characterized by long periods of good weather, with good transparency and steadiness of vision.

In order to test the performance of this photometer, the Neapolitan astronomers have observed the light curves of the variables V 451 Oph, V 566 Oph, and V 805 Aql, a plot of these light curves accompanies this report. The two former were requested for observation in the Draft Report of the Commission. Observations of V 450 Oph were secured by A. Colacevich; those of V 566 Oph and V 805 Aql were made by A. Fresa. The probable error of a single observation is in the neighbourhood of $\pm 0{\cdot}01$ magnitude for variable stars of approximately eighth magnitude. V 451 Oph and V 805 Aql are variables of the Algol type with deep secondary minima, and with periods which are twice as long as those previously given. V 566 Oph is a variable of the W Ursae Majoris type. Its period turned out to be four-fifths of that previously given. The photometric elements of these systems are being computed at Naples.

V 451 *Ophiuchi* (see fig. 1). 241 observations of this star have been made. Provisional light curve elements are:

$$\text{Max.} = 7^{\text{m}}{\cdot}85,\ \text{min. I} = 8^{\text{m}}{\cdot}47,\ \text{min. II} = 8^{\text{m}}{\cdot}31.$$
$$\text{T.U. helioc.} = \text{J.D. } 2434165{\cdot}497 + 2^{\text{d}}{\cdot}1965956\ \text{E}$$
$$\pm{\cdot}001$$

The secondary minimum takes place 25 minutes before half the revolution. The first elements were determined by C. Hoffmeister,* who discovered this variable. He gave a period of 1·09 days, because the difference between the two minima was not noticed. V 451 Oph is of spectral type A0 as is the comparison HD 170673.

V 566 *Ophiuchi* (see fig. 2). 280 observations of this star were secured.

Provisional light curve elements are:

$$\text{Max. I} = 7^{\text{m}}{\cdot}58,\ \text{max. II} = 7^{\text{m}}{\cdot}59;\ \text{min. I} = 8^{\text{m}}{\cdot}07,\ \text{min. II} = 8^{\text{m}}{\cdot}02.$$
$$\text{T U. helioc.} = \text{J.D. } 2434226{\cdot}351 + 0^{\text{d}}{\cdot}409658\ \text{E}$$
$$\pm{\cdot}001$$

The variable is of spectral type F5; it has been compared with HD 163592 of spectral type B9. For this star a magnitude of 8·01 has been adopted through comparison with other stars.

The period as given by the discoverer, Hoffmeister,† was $0^{\text{d}}{\cdot}51518$ and was subsequently corrected by Tsesevich to $0^{\text{d}}{\cdot}515194$.‡

V 805 *Aquilae* (see fig. 3). 666 observations of this star were made.

Provisional elements of the light curve are:

$$\text{Max.} = 7^{\text{m}}{\cdot}81,\ \text{min. I} = 8^{\text{m}}{\cdot}47;\ \text{min. II} = 8^{\text{m}}{\cdot}10.$$
$$\text{T.U. helioc.} = \text{J.D. } 2434225{\cdot}372 + 2{\cdot}408230\ \text{E}$$
$$\pm{\cdot}001$$

* *A.N.* **255**, 413, 1935. † *Kl. Veröff. Berlin Bab.* no. 28 (1943).
‡ *Astr. Circ. U.S.S.R.* No. 100 (1950).

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The secondary minimum occurs exactly halfway between the primary ones. The period $P = 1{\cdot}20409$ given previously by Bakos is half of that given here.

Prof. C. M. Huffer next discussed briefly some of the photometric peculiarities of U Cephei which he has been following for some years (see Table 1 of the Draft Report). In commenting on his communication, Dr G. R. Miczaika (Heidelberg-Königstuhl) stated that during the year 1952 U Cephei was being observed photo-electrically also at Heidelberg in three separate spectral ranges. The form of the light curve between minima depends strongly on the wave-length. In addition to the well-known asymmetry of the primary

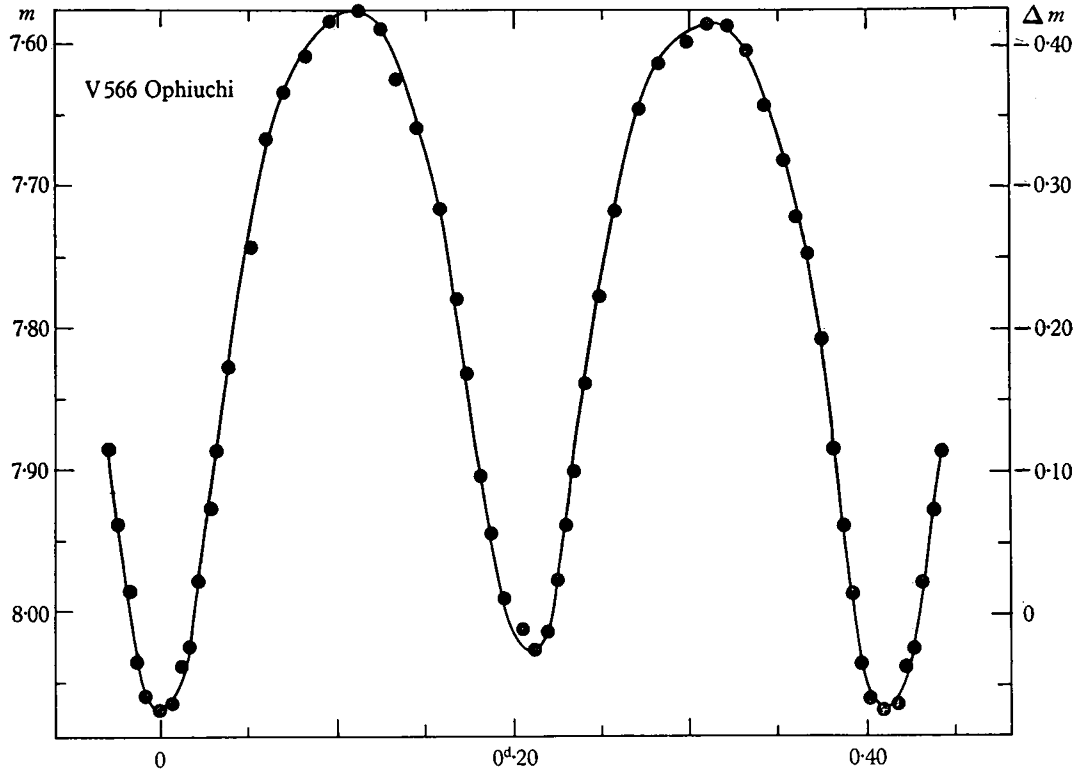

Fig. 2.

minimum the two branches of the light curve between the secondary and primary minimum, and the one between the secondary and next primary minimum are also asymmetric. The portion of the light curve in full light following a primary minimum shows moreover secondary fluctuations which are more pronounced in the blue than in the yellow light. In contrast to previous observations the brightness of the system at the bottom of the primary minimum, that is, the brightness of the secondary component, is proving to be nearly constant. On the other hand, the shape of the whole light curve does not seem to be exactly the same from cycle to cycle.

In reference to the previous communications, Prof. A. van Hoof (of Louvain) stated that the well-known variable YZ Cas reveals also peculiar features when observed in light of different colours. Already in 1948 Dr van Hoof drew attention to the fact that Kron's accurate red and blue light curves (for references see Table 1 of the Draft Reports) could not be accounted for by the same set of geometrical elements. Van Hoof interpreted this anomaly as being due to the presence of a semi-transparent envelope surrounding at least one of the components. This spring Dr McNamara of Berkeley has

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produced new monochromatic light curves separated by a wider baseline of wave-lengths and fully confirmed the inconsistency just pointed out.

Dr van Hoof also called attention to the asymmetric light curves of stars like U Cep or RS CVn. He believes that this asymmetry which was previously described by Huffer and Miczaika represents nothing but a lagging phase-effect due to a difference between the periods of axial rotation of the secondary component and the revolution of the system. Provisional computations based on this assumption led to results which are in

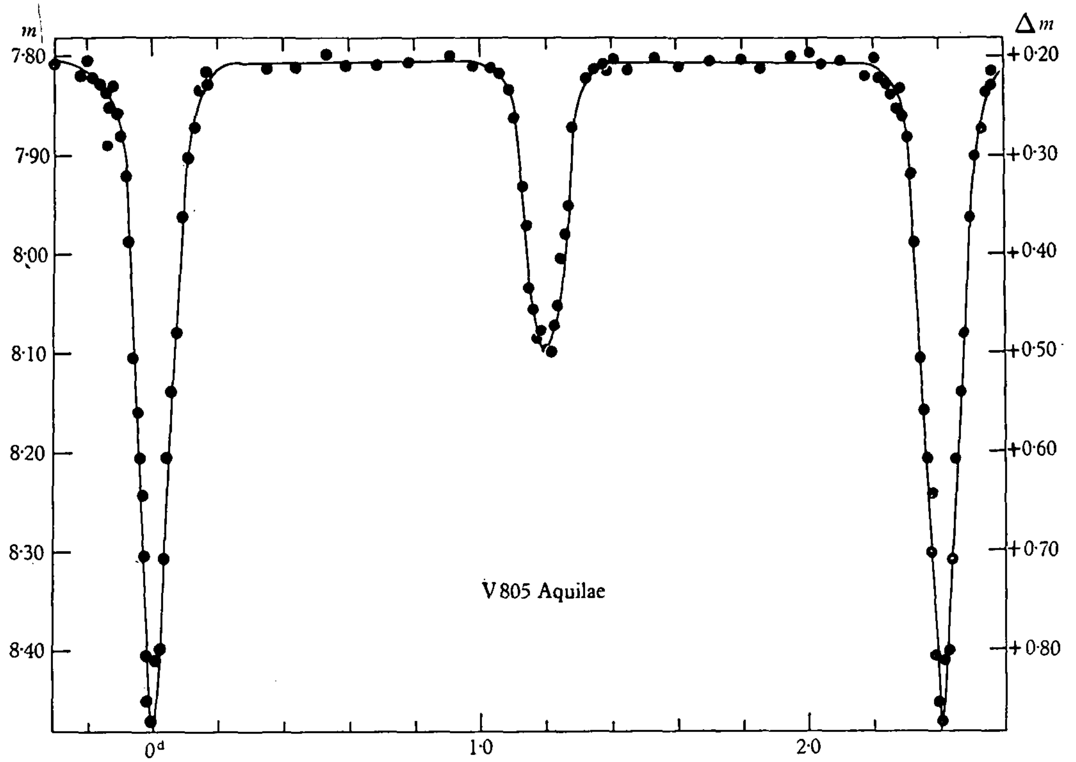

Fig. 3.

fair agreement with the observed facts. Details of these computations are approaching completion at Louvain.

Owing to the lateness of the hour, the meeting was adjourned *sine die*. In closing the session, the Chairman commented on the fact—amply borne out by the preceding discussion—that while observers are doing a thorough job all round, the theoreticians have but little reason to feel very proud of themselves—a feeling which becomes intense when one confronts the beautiful observational evidence bearing on such stars as U Cephei and others, exhibiting phenomena which have so far defied a rational explanation. Will this situation change before the next meeting of the Commission in 1955?

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