42. COMMISSION DES ETOILES DOUBLES PHOTOMETRIQUES

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This report will follow the general lines of the previous reports prepared by Professor Kopal, but it will be rather in the nature of a supplement to the very detailed and valuable report presented to the Dublin meeting. I must thank those members of the Commission who have sent me reprints of their papers and who have, in reply to my request of June 1957, sent me information about work completed and in progress. Particular thanks are due to Professor Kopal for much helpful advice and information, to Professor Tsesevich for a full report on the work of Russian astronomers in this field, and to Professor J. E. Merrill for supplying lists of references from the Flower and Cook card catalogue and for his ever-ready assistance, especially with the preparation of this report. The Executive Committee of the I.A.U. has fixed 10 December 1957 as the deadline for sending Draft Reports to the Editor, so that in this report I can deal only with literature and information received before the end of November 1957.

OBSERVATIONAL TECHNIQUES AND NEW PHOTOMETRIC DATA

Recent surveys of the field have been published by Wood [1] and Kron [2]. A detailed treatment of eclipsing systems is contained in an advanced text-book by Binnendijk [3], which will be published shortly.

Photo-electric installations have been described by Kranjc [4] and Strohmeier and Geyer [5]. Plavec is commencing photo-electric observations at Ondrejov with a 60-cm reflector. At Potsdam a 70-cm Cassegrain reflector is being built for photo-electric work (Schneller). At the Vatican Observatory a photo-electric photometer is being constructed for use with the 60-cm Cassegrain reflector. M. K. Vainu Bappu reports the commencement of a full programme of photo-electric observations of eclipsing binaries at the new Indian observatory of Uttar Pradesh, including the use of interference filters to obtain monochromatic light curves. This addition to the observatories engaged in photo-electric work is all the more welcome since it helps to fill a big gap in longitude. The observing conditions at Uttar Pradesh are good and we can look forward to receiving important results from there.

The Pierce photometer, recently completed by Blitzstein at Flower and Cook, carries out certain ideas of both Pierce and Blitzstein. It involves simultaneous observation of comparison and variable star, pulse-counting techniques to permit digital recording, and the automatic recording of time in decimals of a day [6]. Also at Flower and Cook Observatory a photo-electric photometer to work at 16 000 Å will soon be completed and will be used on eclipsing systems. Hardie is already making photo-electric observations of eclipsing binaries in the infra-red (at about 9000 Å) at Dyer Observatory.

Table 1 is a continuation of Table 1 on p. 600 of *Trans. I.A.U.* **9**. Where no reference is given, the observations have not yet been published. This holds also for certain references to observatory reports or abstracts of papers. The table provides sufficient evidence that photo-electric photometry of eclipsing binaries is being actively pursued in many observatories widely separated in longitude. There is plenty of room, however, for much more work of the kind. Sahade in a recent article [7] calls attention to the need for photo-electric observations of close binary systems. W UMa variables are indeed being regularly observed at Babelsberg (by Hinderer since 1954) and at Flower and Cook Observatory (Binnendijk) as well as at the observatories mentioned in the previous report.

Table 1. *New photo-electric observations*

Star	References
RT And	Gordon, *Astr. J.* **60**, 422, 1955; Lenouvel and Fiogère, *J. d. Obs.* **40**, 37, 1957.
BX And	Svolopoulos, *Astr. J.* **62**, 330, 1957.
AB And	Binnendijk (Flower and Cook Obs., two colours).
S Ant	Popper, *Ap. J.* **124**, 208, 1956; *Ap. J. Suppl.* **3**, 107, 1957.
V 822 Aql	Nicolini (Capodimonte).
FU Ara	Lindsay, *M.N.R.A.S.* **117**, 269, 1957.
SX Aur	Lavrov (Engelhardt Obs.).
WW Aur	Piotrowski and Serkowski, *Acta Astr.* **6**, 205, 1956.
β Aur	Uttar Pradesh Obs., two colours.
ϵ Aur	See the section: Co-ordination of photometric and spectrographic observations.
η Aur	Huffer (Washburn Obs., two colours).
ζ Aur	Wood and Blitzstein, *Astr. J.* **62**, 165, 1956; Herczeg, *Budapest Mitt.* **41**, 18, 1956; Fredrick (Flower and Cook Obs., four colours; outside eclipse); Whitford (Washburn Obs., two colours).
44i Boo	Binnendijk, *Astr. J.* **60**, 355, 1955; Schmidt and Schrick, *Z. Ap.* **43**, 165, 1957; Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957; Abrami and Cester, *Publ. Oss. Astr. Trieste*, 270, 1956.
RU Cam	Lenouvel and Fiogère, *J. d. Obs.* **40**, 37, 1957.
SV Cam	Van Woerden, *Sternw. Leiden Ann.* **21**, no. 1, 1957.
RZ Cnc	Linnell, *Astr. J.* **62**, 159, 1956; Lenouvel and Fiogère, *J. d. Obs.* **40**, 37, 1957.
TW Cnc	Linnell, *Astr. J.* **62**, 162, 1956.
TX Cnc	Lenouvel and Daguillon, *J. d. Obs.* **39**, 1, 1956.
RS CVn	Sinvhal (Uttar Pradesh Obs.).
R CMa	Lenouvel and Fiogère, *J. d. Obs.* **40**, 37, 1957; Koch (Steward Obs., Flower and Cook Obs., three colours); Sinvhal (Uttar Pradesh Obs.).
29 CMa	Bappu (Uttar Pradesh Obs., two colours).
δ Cap	Eggen, *P.A.S.P.* **68**, 542, 1956; F. B. Wood (Mt Stromlo Obs.).
GL Car	Van Wijk, Rogerson and Skumanich, *Astr. J.* **60**, 95, 1955.
GM Car	Lindsay (Bloemfontein).
RZ Cas	Lenouvel and Daguillon, *J. d. Obs.* **37**, 137, 1954; **39**, 3, 1956; **40**, 37, 1957; Huffer, *Ap. J.* **121**, 677, 1955.
AO Cas	Koch (Steward Obs., Flower and Cook Obs., three colours).
AR Cas	Huffer (Flagstaff Obs.); Goldberg-Rogosinskaia (Pulkovo); Bappu (Uttar Pradesh Obs.).
AZ Cas	Larsson-Leander (Stockholm Obs., two colours).
BM Cas	Thiessen, *Z.Ap.* **39**, 65, 1956.
DO Cas	Schneller and Daene, *A.N.* **281**, 25, 1952.
U Cep	Lenouvel and Daguillon, *J. d. Obs.* **39**, 3, 1956.
VV Cep	See the section: Co-ordination of photometric and spectrographic observations.
VW Cep	Schmidt and Schrick, *Z. Ap.* **37**, 73, 1955.
XX Cep	Fresa, *Mem. Soc. Astr. Ital.* **27**, 299, 1956; Lavrov, *Astr. Circ. U.S.S.R.* 168, 16, 1956.
AH Cep	Huffer (Washburn Obs.).
CQ Cep	Bappu and Sinvhal (Uttar Pradesh Obs., with interference filters).
RZ Com	Broglia, Fracastoro and Masani, *Mem. Soc. Astr. Ital.* **26**, 65, 1955; Schmidt and Schrick (Hoher List).
21 Com	Bahner and Mawridis, *Z. Ap.* **41**, 254, 1957.
TZ CrA	F. B. Wood (Mount Stromlo).
U CrB	Fresa (Capodimonte).
AI Cru	Ollongren, *B.A.N.* **12**, 313, 1956.
Y Cyg	Magalashvily, Kumsishvily and Razmadze (Abastumani Obs.).
GO Cyg	Popper, *Ap. J. Suppl.* **3**, 107, 1957.
MR Cyg	Hardie (Dyer Obs.); Botsula (Engelhardt Obs.).
V 366 Cyg	Van Houten, *B.A.N.* **13**, 71, 1956.
V 367 Cyg	Wood and Lewis, *P.A.S.P.* **67**, 39, 1955; Fresa (Capodimonte).
V 444 Cyg	Bappu and Sinvhal (Uttar Pradesh Obs., with interference filters).
V 548 Cyg	Fresa, *Mem. Soc. Astr. Ital.* **27**, 51, 1956; Wellmann (Hamburg).

Table 1. *New photo-electric observations (cont.)*

Star	References
32 Cyg	Botsula, *Astr. Circ. U.S.S.R.* 159, 15, 1955; 173, 18, 1956; Herczeg, *Budapest Mitt.* **41**, 23, 1956.
UX Eri	Kitamura and Nakamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
AS Eri	Lindsay, *M.N.R.A.S.* **117**, 269, 1957; Koch (Steward Obs., Flower and Cook Obs., two colours).
Z Her	Popper, *Ap. J.* **124**, 196, 1956; *Ap. J. Suppl.* **3**, 107, 1957.
TX Her	Botsula, *Per. Zvezd.* **11**, 26, 1956.
UX Her	Gordon and Kron (Lick Obs.).
DQ Her	Walker, *Ap. J.* **123**, 68, 1956.
NQ Her	Fichera (Capodimonte).
u Her	Ruiz, *P.A.S.P.* **69**, 261, 1957.
RT Lac	J. E. Merrill (Flower and Cook Obs., two colours).
SW Lac	Brownlee, *Astr. J.* **61**, 2, 1956; *Ap. J.* **125**, 372, 1957; Schmidt and Schrick (Hoher List).
CM Lac	Hardie (Dyer Obs., three colours); Popper, *Ap. J. Suppl.* **3**, 107, 1957.
UZ Leo	Van Houten, *B.A.N.* **13**, 71, 1956.
XY Leo	Koch (Steward Obs., Flower and Cook Obs., two colours).
RR Lyn	Botsula (Engelhardt Obs.); Magalashvily, Kumsishvily and Razmadze (Abastumani).
β Lyr	Sinvhal (Uttar Pradesh Obs.).
UX Mon	Lynds, *P.A.S.P.* **68**, 339, 1956; *Ap. J.* **126**, 69, 1957; F. B. Wood (Steward Obs., two colours; in press).
V 502 Oph	Kwee (Leiden).
V 566 Oph	Binnendijk (Flower and Cook Obs., two colours).
VV Ori	Hardie and Huffer (Lowell Obs.); Whitford (Washburn Obs.).
ER Ori	Huruhata, Nakamura and Kitamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957; Binnendijk (Flower and Cook Obs., two colours).
δ Ori	Worley, *P.A.S.P.* **67**, 330, 1955; Sinvhal (Uttar Pradesh Obs.).
AR Pav	Wesselink (Radcliffe Obs., three colours).
U Peg	Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
AW Peg	Fresa (Capodimonte).
β Per	Lenouvel and Daguillon, *J. d. Obs.* **39**, 3, 1956.
SZ Psc	Bakos (David Dunlap Obs., two colours).
TY Pup	Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
V 356 Sgr	Popper, *Ap. J. Suppl.* **3**, 107, 1957.
V 505 Sgr	Magalashvily and Razmadze, *Per. Zvezd.* **10**, 313, 1955.
V 499 Sco	Cillié and Lindsay, *M.N.R.A.S.* **117**, 445, 1957.
RT Scl	Lindsay (Bloemfontein, two colours).
SZ Scl	Lindsay (Bloemfontein, two colours).
W Ser	Lynds, *Ap. J.* **126**, 81, 1957; Fresa, *Astr. J.* **62**, 362, 1957; Hardie (Dyer Obs., three colours).
Y Sex	Tanabe and Nakamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
RW Tau	Lenouvel and Daguillon, *J. d. Obs.* **37**, 137, 1954.
λ Tau	Batten (Pic-du-Midi, four colours).
X Tri	Lenouvel and Daguillon, *J. d. Obs.* **37**, 137, 1954; Lenouvel and Fiogère, *J. d. Obs.* **40**, 37, 1957.
RR TrA	Kwee, Oosterhoff and Volders, *B.A.N.* **13**, 328, 1957.
W UMa	Kwee, *B.A.N.* **12**, 330, 1956; Schmidt and Schrick, *Z. Ap.* **41**, 1, 1956.
TX UMa	Koch (Steward Obs., Flower and Cook Obs., three colours).
ϵ UMi	Hinderer, *A.N.* **284**, 1, 1957.
AH Vir	Binnendijk (Flower and Cook Obs., two colours).
Z Vul	Popper, *Ap. J.* **126**, 53, 1957; *Ap. J. Suppl.* **3**, 107, 1957; Wesselink (Radcliffe Obs., two colours).
RS Vul	Goldberg-Rogosinskaia, *Pulkovo Izvest.* **20**, 61, 1956; Popper, *Ap. J. Suppl.* **3**, 107, 1957.
BD +55° 1317	Geyer, *Mitt. Astr. Ges.* 93, 1955.
BD +39° 811	Magalashvily, Kumsishvily and Razmadze, *Astr. Circ. U.S.S.R.* 166, 21, 1956.

Table 1. *New photo-electric observations (cont.)*

Star	References
BD +35° 4496	Schmidt, *Mitt. Astr. Ges.* 54, 1956.
BD +10° 2234 A = Σ 1503	Eggen, *P.A.S.P.* **68**, 452, 1956.
BD −20° 345	Eggen, *P.A.S.P.* **68**, 142, 1956.
HD 16157	Evans, *M.N.R.A.S.* **117**, 267, 1957.
HD 22124	Thomsen, Abt and Kron, *P.A.S.P.* **67**, 412, 1955.
HD 153345	Geyer, *Mitt. Astr. Ges.* 93, 1955.
HD 200391	Bakos (David Dunlap Obs.).
Σ 12 A	Magalashvily and Kumsishvily, *Astr. Circ. U.S.S.R.* 178, 23, 1957.

Hardie and Walker are making U,B,V photo-electric observations of eclipsing binaries with total eclipses, in order to obtain the colours of the components. Following suggestions made some years ago by H. N. Russell and Kopal that eclipsing binaries of very short periods might be found among the white dwarfs, Lenouvel[8] observed twelve, and Broglia, Masani, Pestarino[8a] sixteen, white dwarfs photo-electrically, but found no appreciable variation. J. B. Oke (David Dunlap Observatory) has analysed fifty-five spectroscopic binaries to see if they might be expected to be eclipsing variables. Ten of them may indeed be eclipsing and they are to be observed photo-electrically. Mention should also be made of the new Groningen equipment for discovering variable stars on photographic plates[9], which will doubtless be responsible for a large increase in the number of known eclipsing systems.

I am indebted to Professor Kopal for Tables 2 and 3, containing lists of spectroscopic binaries in need of photo-electric observation. Table 2 lists the eclipsing systems with known two-spectra orbits (and thus furnishing the masses and absolute dimensions of their components) whose photometric orbits are either not available at all, or could be greatly improved if re-observed by photo-electric means. The first reference given for each star is to the source of the spectroscopic data; the second, to the latest light curve, if any.* Table 3 lists the single-spectrum eclipsing systems for which no photometric elements are available at all. The references are to the spectrographic orbits. In both tables the names without references are those of astronomers who are observing the variable photo-electrically.

Table 2. *A list of two-spectra eclipsing systems in need of photo-electric observation*

Star	Period	Amplitude	References
AB And	0^d332	10^m0–10^m9 pg	Struve *et al. Ap. J.* **111**, 658, 1950; Oosterhoff, *B.A.N.* **5**, 151, 1930 (pg); Binnendijk (Flower)
V 599 Aql	1·849	6·5–6·6 pg	Pearce, *Publ. Dom. Astrophys. Obs. Victoria*, **4**, 75, 1927; Gaposchkin, *Bull. Astr. Obs. Harv.* 917, 1943 (pg)
σ Aql	1·950	5·0–5·2 pe	Several orbits; Wylie, *Ap. J.* **56**, 232, 1922 (pe)
SX Aur	1·210	8·2–9·0 pg	Popper, *Ap. J.* **97**, 394, 1943; Oosterhoff, *B.A.N.* **7**, 107, 1933 (pg); Lavrov (Engelhardt)
EO Aur	4·066	7·5–7·8 pg	Pearce, *J.R.A.S. Can.* **40**, 139, 1946; Gaposchkin, *P.A.S.P.* **55**, 193, 1943 (pg)
SS Boo	7·606	10·0–10·5 v	Sanford, *Ap. J.* **103**, 114, 1946; Sitterly, *Pop. Astr.* **30**, 231, 1922 (pg)
ZZ Boo	4·992	6·7–7·5 pg	Shajn, *Crimea Ann.* **5**, 105, 1950; Gaposchkin, *Astr. J.* **59**, 196, 1954 (pg)
SW CMa	10·092	9·1–9·6 v	Struve, *Ap. J.* **102**, 74, 1945; none
CC Cas	3·369	7·2–7·4 pg	Pearce, *D.A.O. Publ.* **4**, 67, 1927; Gaposchkin, *Amer. Astr. Soc. Publ.* **10**, 12, 1939 (pg)
WX Cep	3·378	9·1–9·6 pg	Sahade and Cesco, *Ap. J.* **102**, 128, 1945; Schneller, *Veröff. Sternw. Babelsb.* **8**, Heft 6, 1931 (pg)

* Of course reference-lists for any of these stars (or others considered for observing programmes) should, in general, be obtained from one of the standing Card Catalogues (Flower and Cook, Engelhardt) before proceeding, since the data on any one of them in the Finding List of F. B. Wood are by intention a selected fraction only of that available.

Table 2. *A list of two-spectra eclipsing systems in need of photo-electric observation (cont.)*

Star	Period	Amplitude	References
ZZ Cep	2^d142	9^m3–10^m0 pg	Herbig, *Ap. J.* **106**, 112, 1947; none
DH Cep	2·111	8·5–8·6 pg	Pearce, *Astr. J.* **54**, 135, 1947; none
Y Cyg	2·996	7·0–7·6 v	Redman, *D.A.O. Publ.* **4**, 341, 1931; Dugan, *Contr. Princeton Univ. Obs.* **12**, 1931 (v); Magalashvily *et al.* (Abastumani)
V 382 Cyg	1·885	9·0–9·9 pg	Pearce, *P.A.S.P.* **64**, 219, 1952; Petrov, *Per. Zvezd.* **6**, 72, 1948
V 453 Cyg	3·890	8·3–8·6 pg	Pearce, *Amer. Astr. Soc. Publ.* **10**, 233, 1941; Smirnov, *Per. Zvezd.* **6**, 13, 1946
V 470 Cyg	1·873	8·6–8·8 pg	Pearce, *P.A.S.P.* **58**, 247, 1946; Gaposchkin, *Astr. J.* **53**, 112, 1948 (pg)
V 478 Cyg	2·881	9·0–9·4 pg	McDonald, *D.A.O. Publ.* **8**, 135, 1949; Gaposchkin, *Bull. Astr. Obs. Harv.* 919, 1949 (pg)
RT Lac	5·074	8·8–9·6 v	Joy, *Ap. J.* **74**, 101, 1931; Krat and Nekrassova, *Acta Astr.* **2**, 129, 1936 (pg); Merrill (Flower)
CM Lac	1·605	8·3–9·3 pg	Sanford, *Ap. J.* **79**, 95, 1934; Wachmann, *A.N.* **259**, 323, 1936 (pg); Hardie (Dyer)
TU Mon	5·049	9·0–10·9 pg	Deutsch, *Ap. J.* **102**, 433, 1945; Gaposchkin, *Veröff. Sternw. Babelsb.* **9**, Heft 5, 1931 (pg)
AO Mon	1·885	9·2–9·9 v	Struve, *Ap. J.* **102**, 74, 1945; none
WZ Oph	4·183	9·7–10·4 pg	Sanford, *Ap. J.* **86**, 157, 1937; Gaposchkin, *Bull. Astr. Obs. Harv.* 907, 1938 (pg)
V 502 Oph	0·453	8·5–9·0 pg	Struve and Gratton, *Ap. J.* **108**, 497, 1948; Nekrassova, *Astr. Circ. U.S.S.R.* 21, 1943; Kwee (Leiden)
η Ori	7·989	3·2–3·4 pe	Baker, *Publ. Allegheny Obs.* **1**, 136, 1910; Stebbins, *Amer. Astr. Soc. Publ.* **3**, 273, 1916 (pe)
UZ Pup	0·795	9·7–10·6 v	Struve, *Ap. J.* **102**, 74, 1945; none
CV Ser	29·675	8·9–9·1 pg	Hiltner, *Ap. J.* **102**, 492, 1945; none
RW UMa	7·328	9·9–10·9 v	Struve, *Ap. J.* **102**, 74, 1945; Fetlaar, *B.A.N.* **3**, 195, 1926 (v)

(In the above list *D.A.O. Publ.* is sometimes used for *Publ. Dom. Astrophys. Obs. Victoria*)

Table 3. *A list of single-spectrum eclipsing systems for which no photometric orbits are available*

Star	Period	Amplitude	References
KO Aql	2^d864	8^m2–9^m0 pg	Sahade, *Ap. J.* **102**, 470, 1945.
XY Cep	2·775	10·0–10·9 pg	Struve, *Ap. J.* **103**, 76, 1946.
RV Crv	0·747	9·0–10·0 pg	Struve and Gratton, *Ap. J.* **108**, 497, 1948.
SV Gem	4·006	10·2–11·2 v	Struve, *Ap. J.* **102**, 74, 1945.
UX Her	1·549	8·7–9·7 v	Sanford, *Ap. J.* **86**, 153, 1937; Kron (Lick).
TW Lac	3·037	11·5–13·3 v	Struve, *Ap. J.* **104**, 253, 1946.
SS Lib	1·438	10·4–11·3 v	Struve, *Ap. J.* **103**, 76, 1946.
AU Mon	11·113	8·3–9·4 v	Sahade and Cesco, *Ap. J.* **101**, 235, 1945.
EY Ori	16·789	9·5–10·3 v	Struve, *Ap. J.* **102**, 74, 1945.
FO Ori	18·801	9·8–10·8 pg	Struve *et al.*, *Ap. J.* **111**, 658, 1950.
VV UMa	0·687	10·1–11·0 v	Struve, *Ap. J.* **112**, 184, 1950.
UY Vir	1·994	7·8–8·6 v	Herbig, *Ap. J.* **106**, 119, 1947.
BF Vir	0·640	9·5–10·1 v	Struve and Gratton, *Ap. J.* **108**, 497, 1948.

NEW SPECTROGRAPHIC DATA

In Table 4, which is a continuation of Table 2 on p. 605 of *Trans. I.A.U.* **9**, are listed the eclipsing systems for which spectrographic observations have been published since the last report, or are now being carried on. The very large increase in the number of systems observed, as compared with the previous report, is very welcome and shows that much has been done to redress the lack of balance between photometric and spectrographic observations of eclipsing binaries which was deplored by Professor Kopal in his 1955 report.

Table 4. *New spectrographic observations*

Star	References
S Ant	Popper, *Ap. J.* **124**, 208, 1956.
DS Aqr	Popper, *P.A.S.P.* **68**, 131, 1956.
V 694 Aql	Popper, *P.A.S.P.* **68**, 131, 1956.
V 805 Aql	Heard and Morton, *Astr. J.* **61**, 179, 1956.
AR Aur	Mädlow, *Mitt. Astr. Ges.* 93, 1956.
ϵ Aur	See the section: Co-ordination of photometric and spectrographic observations.
ζ Aur	Groth, *Z. Ap.* **37**, 261, 1955; *Mitt. Astr. Ges.* 34, 1956; McKellar, *Astr. J.* **61**, 184, 1956; Wempe, *Mitt. Astr. Ges.* 93, 1956; O. C. Wilson, *J.R.A.S. Can.* **51**, 70, 1957.
RZ Cnc	Popper, *Astr. J.* **62**, 29, 1957.
UU Cnc	Popper, *P.A.S.P.* **68**, 131, 1956.
R CMa	Fringant, *C.R.* **242**, 2229, 1956=*Cont. Inst. Astrophys. Paris*, A, 216, 1956.
GL Car	Radcliffe Obs., *M.N.R.A.S.* **117**, 296, 1957.
RX Cas	Sahade and Struve (Mount Wilson Obs.).
RZ Cas	Cayrel and de Strobel, *Mem. Soc. Astr. Ital.* **26**, 267, 1955.
SX Cas	Sahade and Struve (Mount Wilson Obs.).
AO Cas	Struve and Sahade (Mount Wilson Obs.).
AR Cas	D.A.O. Victoria, *M.N.R.A.S.* **116**, 198, 1956.
AZ Cas	Sahade and Struve, *P.A.S.P.* **69**, 79, 1957; Münch and Sahade (Mount Palomar).
BM Cas	Wellmann (David Dunlap Obs.).
GG Cas	Popper, *P.A.S.P.* **68**, 131, 1956.
VV Cep	See the section: Co-ordination of photometric and spectrographic observations.
U CrB	Struve, Sahade and Huang, *P.A.S.P.* **69**, 342, 1957.
Y Cyg	Sahade and Struve (Mount Wilson Obs.).
V 444 Cyg	Sahade, *Liège Symposium on Emission-Line Stars*, 1957.
V 548 Cyg	Heard and Morton, *Astr. J.* **61**, 179, 1956.
31 Cyg	Wright, *Astr. J.* **61**, 194, 1956; *M.N.R.A.S.* **116**, 195, 1956; Wright and Lee, *P.A.S.P.* 17, 1956; Larsson-Leander, *Stockh. Ann.* **19**, no. 8, 1957.
32 Cyg	Larsson-Leander, *Stockholm Meddel.* 87, 1956=*Ark. f. Ast.* **2**, 23, 1956; Wellmann, *Ap. J.* **126**, 30, 1957.
Z Her	Popper, *Ap. J.* **124**, 196, 1956.
AW Her	Popper, *P.A.S.P.* **68**, 131, 1956.
β Lyr	Saidow, *Astr. Circ. U.S.S.R.* 158, 12, 1955; Sahade, Huang, Struve and Zebergs, *Amer. Phil. Soc.* (in press).
RW Mon	Heard (David Dunlap Obs.).
UX Mon	Sahade and Struve (Mount Wilson Obs.).
V 451 Oph	Heard and Morton, *Astr. J.* **61**, 179, 1956.
V 566 Oph	Heard (David Dunlap Obs.).
δ Ori	Underhill, *Publ. Dom. Astrophys. Obs. Victoria*, **10**, 174, 187, 1956.
AR Pav	Thackeray (Radcliffe Obs.).
β Per	Beer and Kopal, *Haute Provence Publ.* **3**, no. 23, 1955; Cayrel and de Strobel, *Mem. Soc. Astr. Ital.* **26**, 267, 1955; Geake, *Observatory*, **76**, 155, 1956; Meltzer, *Astr. J.* **61**, 185, 1956; *Ap. J.* **125**, 359, 1957; Ebbighausen, *Astr. J.* **62**, 14, 1957; Struve and Sahade, *P.A.S.P.* **69**, 41, 1957; **69**, 265, 1957; *Ap. J.* **125**, 689, 1957; Huang, *Ap. J.* **126**, 51, 1957; Sahade, *Liège Symposium on Emission-Line Stars*, 1957.
SZ Psc	Heard (David Dunlap Obs.).
W Ser	Sahade, *Astr. J.* **62**, 31, 1957; Sahade and Struve, *Ap. J.* **126**, 87, 1957.
λ Tau	Ebbighausen and Struve, *Ap. J.* **124**, 507, 1956; Ebbighausen, *Astr. J.* **62**, 14, 1957.
AL Vel	Wesselink (Radcliffe Obs.).
AO Vel	Wesselink (Radcliffe Obs.).
Z Vul	Popper, *Ap. J.* **126**, 53, 1957.
HD 16157	Evans, *M.N.R.A.S.* **117**, 267, 1957.
HD 153345	Wellmann (David Dunlap Obs.).
HD 190967	Petrie (D.A.O. Victoria).
HD 200391	Northcott and Bakos, *Astr. J.* **61**, 188, 1956.
HD 214419	Bappu, *M.N.R.A.S.* **116**, 208, 1956.

ETOILES DOUBLES PHOTOMETRIQUES

CO-ORDINATION OF PHOTOMETRIC AND SPECTROGRAPHIC OBSERVATIONS

In the preceding report a proposal was made for a joint campaign by photo-electric and spectrographic observers to cover the coming eclipses of the super-giant eclipsing systems ϵ Aurigae and VV Cephei. On 28 February 1956, at the request of the President, Professor J. E. Merrill addressed a circular letter in this sense to all members of the Commission and to others who might be interested in taking part in the campaign. It was hoped in this way to co-ordinate photometric and spectrographic observations of the various phases of the eclipses and to ensure that the observers were distributed as widely as possible in longitude. Professor F. B. Wood kindly agreed to act as co-ordinator for this programme [10]. From 4 April 1956, to 26 November 1957, nine bulletins were distributed to those interested, reporting the progress of the campaign. The response has been very satisfactory. In the following tables are listed the astronomers who have been making photo-electric or spectrographic observations of ϵ Aurigae or VV Cephei during the recent eclipses. The observatories where the observations were made are given in brackets. They are arranged according to longitude, from west to east.

ϵ Aurigae

Photo-electric observers	Spectrographic observers
Huffer (Washburn)	Wright (Victoria)
Wood and Fredrick (Flower and Cook)	Struve and Pillans (Berkeley)
Lenouvel (Pic-du-Midi)	McLaughlin (Michigan)
Van Woerden, Kwee, Raimond (Leiden)	Chalonge and Fringant (Haute Provence
De Jager (Utrecht)	and Jungfraujoch)
Thiessen (Hamburg)	Groth and Wellmann (Hamburg)
Gyldenkerne (Brorfelde)	Larsson-Leander (Saltsjøbaden)
Fresa (Capodimonte)	Mustel (Crimea)
Larsson-Leander (Saltsjøbaden)	
Huruhata (Tokyo)	

Accounts of spectroscopic observations of ϵ Aurigae have already been published by Wright [11], Pillans [12], Pillans and Struve [13], Struve and Pillans [14], and a general discussion by Struve [15]. Svechnikov [16] at Burakan Observatory observed the polarization of ϵ Aur during August 1955. He found that the polarization varied without any variation of its plane. The polarization was usually 2%–3%, but on 24 and 26 August it diminished to zero. The simultaneous spectrophotometric observations showed that at this time the ultra-violet gradient was larger than usual. Svechnikov thinks that these phenomena cannot be explained by the hypothesis of the dispersion of light by free electrons contained in the stellar envelope or by the hypothesis of the galactic nature of polarization.

VV Cephei

Photo-electric observers	Spectrographic observers
Huffer (Washburn)	Wright and McKellar (Victoria)
Fredrick (Flower and Cook)	Deutsch (Mount Wilson)
Brück (Dunsink)	McLaughlin (Michigan)
Lenouvel (Pic-du-Midi)	Keenan (Perkins)
Kwee, Raimond, van Woerden (Leiden)	Chalonge and Fringant (Haute Provence
De Jager (Utrecht)	and Jungfraujoch)
Gyldenkerne (Brorfelde)	Groth and Wellmann (Hamburg)
Fresa (Capodimonte)	Mannino (Asiago)
Fracastoro (Catania)	Mädlow (Potsdam)
von Socher (Vienna)	Larsson-Leander (Saltsjøbaden)
Larsson-Leander (Saltsjøbaden)	
Huruhata (Tokyo)	

The results obtained at Victoria from high-dispersion spectrographs of VV Cephei have been published by Wright and McKellar [17]. Larsson-Leander [18] has published a two-colour photo-electric light curve of the ingress phase.

It is hoped to extend the co-operation of photometric and spectroscopic observers to other important eclipsing systems. Some success has been obtained with W Serpentis. Sahade and Struve [19, 20] observed the variable spectrographically at Mount Wilson, while Lynds [21] at Lick, Hardie (Dyer Observatory) and Fresa [22] at Capodimonte made photo-electric observations during the same period.

TIMES OF MINIMA AND PERIOD VARIATIONS

The importance of the accurate and regular determination of the times of minima of eclipsing binaries, particularly in cases where there is any suspicion of a variation of period, was stressed by Kopal in the previous report. It is gratifying to see that so much is being done in this field, where very useful work can be done even with quite modest equipment. The observatories mentioned in the last report as engaged in this work are maintaining their activity, as may be seen from the list of observations in Table 5. In Russia this work is done mainly at the Odessa, Stalinabad and Tashkent observatories. At Flower and Cook Observatory Koch [23] has determined epochs of minima from film-strips (taken at Steward Observatory, University of Arizona), as well as from photo-electric observations. The results of Kwee's photo-electric observations of 16 W Ursae Majoris-type binaries for the determination of accurate epochs of minimum will soon be published. Epochs of minima, from visual and photo-electric observations at Cracow Observatory, are published regularly by Szafraniec and others.

Table 5. *Discussions of periods of eclipsing binary systems*

In the following list: (i) the paper by Whitney has now been published in *Astr. J.* **62**, 371, 1957; (ii) the references to Zessewitch should be to Tsesevich in *Astr. Circ. U.S.S.R.* No. 164, **15**, 1955 (*not* vol. **164**).

Star	References
AB And	Binnendijk, *J.R.A.S. Can.* **51**, 85, 1957.
AD And	Whitney, *Astr. J.* (in press).
AM Aur	Whitney, *Astr. J.* (in press).
44 i Boo	Schmidt and Schrick, *Z. Ap.* **43**, 165, 1957; Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957; Abrami and Cester, *Publ. Oss. Astr. Trieste*, 270, 1956.
Y Cam	Szczepanowska, *Acta Astr.* (b) **2**, 134, 1955.
SV Cam	Sommer, *A.N.* **283**, 155, 1956; van Woerden, *Ann. Sternw. Leiden*, **21**, no. 1, 1957.
RW Cap	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955; Whitney, *Astr. J.* (in press).
GL Car	van Wijk, Rogerson and Skumanich, *Astr. J.* **60**, 95, 1955.
RZ Cas	Svechnikov, *Per. Zvezd.* **10**, 262, 1955.
ZZ Cas	Whitney, *Astr. J.* (in press).
AB Cas	Whitney, *Astr. J.* (in press).
BM Cas	Beyer, *A.N.* **280**, 267, 1951.
GU Cas	Whitney, *Astr. J.* (in press).
IT Cas	Whitney, *Astr. J.* (in press).
IV Cas	Whitney, *Astr. J.* (in press).
U Cep	Svechnikov, *Per. Zvezd.* **10**, 262, 1955.
RS Cep	Whitney, *Astr. J.* (in press).
VW Cep	Schmidt and Schrick, *Z. Ap.* **37**, 73, 1955; Binnendijk, *J.R.A.S. Can.* **51**, 84, 1957.
WW Cyg	Whitney, *Astr. J.* (in press).
ZZ Cyg	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
MR Cyg	Ishchenko, *Per. Zvezd.* **10**, 302, 1955.
W Del	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955; Whitney, *Astr. J.* (in press).
TT Del	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
YY Del	Whitney, *Astr. J.* (in press).
Z Dra	Lange, *Astr. Circ. U.S.S.R.* **167**, 19, 1956.
RR Dra	Whitney, *Astr. J.* (in press).
TW Dra	Gadomski, *Acta Astr.* **6**, 111, 1956.
S Equ	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.

Table 5. *Discussions of periods of eclipsing binary systems (cont.)*

Star	References
UX Eri	Kitamura and Nakamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
SZ Her	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
TT Her	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
TU Her	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955; Whitney, *Astr. J.* (in press).
TX Her	Botsula, *Per. Zvezd.* **11**, 26, 1956.
AK Her	Binnendijk, *J.R.A.S. Can.* **51**, 84, 1957.
CC Her	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
CT Her	Whitney, *Astr. J.* (in press).
SW Lac	Binnendijk, *J.R.A.S. Can.* **51**, 84, 1957.
TW Lac	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955; Whitney, *Astr. J.* (in press).
VX Lac	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
AR Lac	Svechnikov, *Per. Zvezd.* **10**, 262, 1955.
Y Leo	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
RR Lyn	Botsula (Engelhardt Obs., Kazan).
RV Lyr	Whitney, *Astr. J.* (in press).
β Lyr	S. Gaposchkin, *Astr. J.* **61**, 397, 1956.
UX Mon	Whitney, *P.A.S.P.* **68**, 253, 1956.
SW Oph	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
EQ Ori	Whitney, *Astr. J.* (in press).
ER Ori	Binnendijk, *J.R.A.S. Can.* **51**, 84, 1957.
ET Ori	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
FH Ori	Szczepanowska, *Acta Astr.* (b) **2**, 134, 1955.
U Peg	Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957. Binnendijk, *J.R.A.S. Can.* **51**, 84, 1957.
TY Peg	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
UX Peg	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
AQ Peg	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955; Whitney, *Astr. J.* (in press).
Z Per	Szczepanowska, *Acta Astr.* (b) **2**, 134, 1955.
RT Per	Lange, *Astr. Circ. U.S.S.R.* **167**, 19, 1956.
ST Per	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
XZ Per	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
β Per	Kopal and Kurth, *Z. Ap.* **42**, 97, 1957.
Y Psc	Zessewitsch, *Astr. Circ. U.S.S.R.* **164**, 15, 1955.
TY Pup	Huruhata, Kitamura, Nakamura and Tanabe, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
U Sge	Svechnikov, *Per. Zvezd.* **10**, 262, 1955.
V 523 Sgr	de Kort, *Vistas in Astronomy*, **2**, 1191, London, 1956 = *Misc. Astr. Roma*, **3**, no. 108, 1956.
W Ser	Sahade and Struve, *Ap. J.* **126**, 87, 1957; Fresa, *Astr. J.* **63**, 362, 1957.
λ Tau	Kopal and Kurth, *Z. Ap.* **42**, 98, 1957.
X Tri	Lange, *Astr. Circ. U.S.S.R.* **173**, 19, 1956.
W UMa	Binnendijk, *J.R.A.S. Can.* **51**, 85, 1957.

In Table 5 are listed the eclipsing systems whose variations of period have been discussed since the last report. The very large number of binaries in this list, sixty-seven, is an indication of the amount of information that has been accumulated by the patient and persistent observation of times of minima. Particularly noteworthy are papers by Tsesevich [24], who studied the changes of period of twenty eclipsing binaries, using mainly his own observations over a period of thirty years, and by Whitney [25], who has completed a study of thirty-three eclipsing binaries, nineteen of which have variable periods. Tsesevich finds that the changes of period, as a rule, have the character of a jump, citing as the best example of the kind Y Leonis. He found that the period of TU Her has shortened over the past half-century proportionally to the time. At Odessa Observatory Miss A. E. Prikhodko has investigated the periods of 53 Algol-type variables and finds that for ten of these the periods change in a cyclic manner, for ten the changes are abrupt, and for three irregular. She has studied also the correlation between log P and ΔP and finds that the systems with longer periods have the larger jumps ΔP.

Svechnikov [26] at Leningrad University has studied the changes of period of RZ Cas, U Cep, AR Lac and U Sge, all of which systems are close to Roche's limit of dynamical stability, and has attempted to explain the variations in period by the outflow of matter from one of the components. Lange (Odessa Observatory) has examined the changes in the periods of Z Dra [27], RT Per [27], X Tri [28] and XZ And and has showed that the observed variations cannot be explained by the hypothesis of orbital motion about a third body. V. A. Krat (Pulkovo) has discussed the problem of the effect of dissipation of matter on the period of a binary (unpublished) and R. D. Bonkadze (Pulkovo) has obtained the absolute dimensions of two eclipsing systems, taking into account this effect (unpublished).

Kopal and Kurth [29] have investigated the exact mathematical relationship between the times of maxima or minima of a variable star and its period. They point out that since the relations customarily used are rigorously true only when the period under consideration is constant, it will sometimes be necessary, especially if the period is changing rapidly, to use the more general expressions developed in their paper.

Apsidal motion

The apsidal motion in the systems of GL Car, VW Cep, U Peg and V 523 Sgr is discussed by the authors referred to in Table 5. J. de Kort [30] finds that the eclipsing binary HD 163708 has a highly eccentric orbit ($e \sim 0{\cdot}42$); it would seem worth while to observe this system photometrically for a possible variation of the period. The same author has published a convenient graphical method of finding the period of apsidal revolution of an eclipsing binary [31].

DETERMINATION OF PHOTOMETRIC ORBITS

A very important event is the publication of Professor Kopal and Mrs Shapley's 'Catalogue of the Elements of Eclipsing Binary Systems' [32]. This critical discussion of the elements of eighty-three eclipsing systems is the most complete and homogeneous that has yet appeared, and all workers in this field will be grateful to the authors for the ten years' patient labour of which it is the fruit.

Table 6 is a continuation of Table 6 on p. 621 of *Trans. I.A.U.* **9** and lists those systems for which orbit determinations from photometric curves have been published in the meantime, excluding, however, all those which have already been discussed by Kopal and Mrs Shapley.

Table 6. *New solutions of photometric curves*

Star	References
44 i Boo	Binnendijk, *Astr. J.* **60**, 355, 1955; Abrami and Cester, *Publ. Oss. Astr. Trieste*, 270, 1956.
SV Cam	van Woerden, *Ann. Sternw. Leiden*, **21**, no. 1, 1957.
GW Car	O'Connell, *Ric. Astr.* **3**, 317, 1956.
HI Car	O'Connell, *Ric. Astr.* **3**, 326, 1956.
KU Car	O'Connell, *Ric. Astr.* **3**, 332, 1956.
DO Cas	Schneller and Daene, *A.N.* **281**, 25, 1952.
V 350 Cen	O'Connell, *Ric. Astr.* **3**, 338, 1956.
V 377 Cen	O'Connell, *Ric. Astr.* **3**, 344, 1956.
V 646 Cen	O'Connell, *Ric. Astr.* **3**, 351, 1956.
XX Cep	Fresa, *Mem. Soc. Astr. Ital.* **27**, 299, 1956; Lavrov, *Astr. Circ. U.S.S.R.* 168, 16, 1956.
RW CrB	Kalchaev, *Pulkovo Izvest.* **20**, no. 2, 74, 1956.
AE Cru	O'Connell, *Ric. Astr.* **3**, 359, 1956.
AI Cru	Ollongren, *B.A.N.* **12**, 313, 1956.
VW Cyg	Losowskaja, *Publ. Polytech. Inst. Novotscherkask*, **28**, 27, 1955.
V 548 Cyg	Fresa, *Mem. Soc. Astr. Ital.* **27**, 51, 1956; Wellmann, *Mitt. Astr. Ges.* 79, 1956.
RZ Eri	Gadomski, *Acta Astr.* **7**, 83, 1957.
UX Eri	Kitamura and Nikamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.

Table 6. *New solutions of photometric curves (cont.)*

Star	References
TX Her	Botsula, *Per. Zvezd.* **11**, 26, 1956.
AK Her	Wellmann, *Mitt. Astr. Ges.* 79, 1956; Kalchaev, *Pulkovo Izvest.* **20**, no. 2, 74, 1956.
DQ Her	Walker, *Ap. J.* **123**, 68, 1956.
SW Lac	Brownlee, *Ap. J.* **125**, 372, 1957.
UX Mon	Lynds, *P.A.S.P.* **68**, 339, 1956.
V 451 Oph	Nekrasova, *Crimea Izvest.* **6**, 130, 1951.
ER Ori	Huruhata, Nakamura and Kitamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
β Per	Arakely, *Burakan Publ.* **21**, 1957; Meltzer, *Ap. J.* **123**, 359, 1957.
V 505 Sgr	Magalashvily and Razmadze, *Per. Zvezd.* **10**, 313, 1955.
Y Sex	Tanabe and Nakamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
RR TrA	Kwee, Oosterhoff and Volders, *B.A.N.* **13**, 328, 1957.
ϵ U Mi	Hinderer, *A.N.* **284**, 1, 1957.
CV Vel	S. Gaposchkin, *M.N.R.A.S.* **115**, 391, 1955.
Z Vul	Popper, *Ap. J.* **126**, 53, 1957.
RS Vul	Goldberg-Rogosinskaia, *Pulkovo Izvest.* **20**, no. 2, 61, 1956.
W UMa	Kwee, *B.A.N.* **12**, 330, 1956.
UX UMa	Kalchaev, *Pulkovo Izvest.* **20**, no. 2, 74, 1956.
AG Vir	Kalchaev, *Pulkovo Izvest.* **20**, no. 2, 74, 1956.
HD 193345	Wellmann, *Mitt. Astr. Ges.* 79, 1956.

New methods or tables to facilitate the analysis of light curves for the determination of orbital elements have been developed by Dadaev: 'Tables for the computation of elements of eclipsing systems with different ellipticities of components' [33]; Hosokawa: 'Auxiliary tables for the analysis of eclipsing binary light curves' [34]; Ferrari d'Occhieppo: 'Beitrag zur Bestimmung des Radienverhältnisses bei Bedeckungsveränderlichen' [35]; Linnell: 'Light-loss tables for atmospheric eclipses' [36]; Miss Gianuzzi: 'Un nuovo metodo per la determinazione dell'orbita fotometrica delle stelle variabili ad eclisse' [37]. Schneller has completed the preparation of several tables which will appear in the Publications of Potsdam Observatory during 1958: (1) Tables of the function $q(k, \bar{\alpha})$ (defined in *Sonneberg Veröff.* **2**, no. 4) for values of the darkening coefficient $x = 0{\cdot}0$, $0{\cdot}2$, $0{\cdot}4$, $0{\cdot}6$, $0{\cdot}8$, $1{\cdot}0$ and for both *oc* and *tr* eclipses; (2) Tables of the function $\delta = \delta(k, \alpha)$ for the same values of x and for *oc* and *tr* eclipses; (3) Tables for $\sin\theta$, $\cos\theta$, $\cos^2\theta$; and (4) Tables for $\sin^2\Theta = \sin^2\theta/(1 - z\cos^2\theta)$. Tables 3 and 4 have as argument the phase in decimals of the period instead of phase in degrees, and in Table 4 the second argument is the 'geometric ellipticity' (z) of the components.

J. E. Merrill [38] has surveyed recently the present state of, and future prospects for, the interpretation of light curves and hopes to provide some new auxiliary tables—of the correction to α regarded as a function of ψ (or vice versa) resulting from the assumption of limb darkening varying with $\cos^2\gamma$, for use near the tangencies.

Heard and MacRae [39] have described the use of an electronic computer (FERUT) for the calculation of orbital elements of spectrographic binaries. Wellmann [40] has developed a method of determining photometric orbits on the same computer, whereby rectification for 'periastron effect', sine-terms, ellipticity and reflexion, and computation of intermediary elements, can be performed very quickly; he has computed in this way orbits for V 548 Cyg, AK Her and HD 193345.

Hosokawa [41] computed the coefficient of darkening x_λ for various wave-lengths for different spectral types. In a later paper [42] he studied the question further and prepared new tables of x_λ and of the gravity-darkening coefficient y_λ. He then computed the photometric ellipticities for eighteen eclipsing systems for which there are accurate light curves and well-determined mass-ratios. He finds that, in systems with primary components earlier than B 8, the computed constants are considerably larger than the observed values; this discrepancy is reduced when constant coefficients for the integrated radiation are used, instead of the computed values.

Huffer and Kopal [43] have discussed the darkening to the limb in the case of AR Cas. Miss N. N. Semenova (Pulkovo Observatory) has investigated the darkening to the limb in different colours for YZ Cas, as well as for β Lyr and β Per, and has reached conclusions as to the temperature distribution on the surfaces of the primary components of these systems (unpublished).

ABSOLUTE DIMENSIONS OF ECLIPSING SYSTEMS

A critical examination of the absolute dimensions of eclipsing binaries is contained in Kopal and Shapley's 'Catalogue' [32]. In Table 7 are listed such recent determinations as have not been discussed in this catalogue. The critical study of the absolute dimensions of eclipsing stars was discussed by Popper [44] at the very valuable Victoria Conference on Binary Stars (frequently referred to in this report).

Table 7. *New determinations of absolute dimensions of eclipsing binaries*

Star	References
44i Boo	Binnendijk, *Astr. J.* **60**, 355, 1955.
SV Cam	van Woerden, *Ann. Sternw. Leiden*, **21**, no. 1, 1957.
RZ Cnc	Popper, *Astr. J.* **62**, 29, 1957.
32 Cyg	Wellmann, *Ap. J.* **126**, 30, 1957.
RZ Eri	Gadomski, *Acta Astr.* **7**, 83, 1957.
DQ Her	Walker, *Ap. J.* **123**, 68, 1956.
SW Lac	Brownlee, *Ap. J.* **125**, 372, 1957.
β Lyr	S. Gaposchkin, *Z. Ap.* **39**, 133, 1956.
UX Mon	Lynds, *P.A.S.P.* **68**, 339, 1956.
ER Ori	Huruhata, Nakamura and Kitamura, *Ann. Obs. Astr. Tokyo*, (2), **5**, no. 1, 1957.
β Per	Meltzer, *Ap. J.* **125**, 359, 1957.
ϵ UMi	Hinderer, *A.N.* **284**, 1, 1957.
CV Vel	S. Gaposchkin, *M.N.R.A.S.* **115**, 391, 1955.
Z Vul	Popper, *Ap. J.* **126**, 53, 1957.

THEORETICAL AND DYNAMICAL INVESTIGATIONS

Much attention has been devoted to the problems presented by close eclipsing binaries; their classification has been discussed by Kopal [45], and their evolution by Kopal [46], Struve [47] and Huang [48, 49]; Struve and Sahade [50] have discussed the rate of evolution of β Lyrae, and a general treatment of close binaries has been published by Struve and Huang [51]. Other papers bearing on this subject are by M. Johnson [52] on the electromagnetic effects of eruption from ringed stars and Wolf-Rayet binaries; and by Kuiper and J. R. Johnson [53] on the dimensions of contact surfaces in close binaries.

At the I.A.U. Symposium on Non-stable Stars, in Dublin, papers dealing with close binaries from this standpoint were presented by Kopal [60], Krat [61], Martynov [62], Struve [63], F. B. Wood [64].

Huang and Struve [54] in a paper on the radii, masses and evolution of eclipsing binaries, have shown that, in all systems with emission lines, one component touches the inner contact surface (or the Roche limiting surface). Plavec [55] has worked out a generalization of the Roche model for a binary system. Miss V. Hewison [56], using the electronic computer at Manchester University, has calculated ejection trajectories of mass-particles from the conical point of contact of secondary components. Crawford and Kraft [57], in their study of AE Aquarii find that the K star of the system ejects material to the blue companion. Sahade [58] suggests that in Wolf-Rayet binary systems matter is streaming out from the W-R component towards the O-star of the system. For W Serpentis Sahade and Struve [19] deduce a more complicated system of streaming: they suggest that an under-massive late A-type star ejects matter at high velocities, that the gaseous mass forms an expanding envelope around this star, that the whole system is surrounded by a very extended atmosphere, not completely transparent, and finally that there is also a gaseous stream from the secondary star towards the following hemisphere of the primary.

Ovenden [59] has discussed the asymmetries observed in the light curves of close eclipsing binaries and concluded that they are due to absorption by gaseous envelopes. He also concluded that the radiation from the secondary star originates effectively over only a limited region of the secondary star, close to the primary component (Ph.D. thesis, University of London, 1954, unpublished).

An important new book by Kopal on close binary systems [65] is due to appear in 1958, containing an exhaustive treatment of the dynamics of close binaries, as well as a detailed theory of their light- and radial velocity-changes. Among the topics treated will be: (*a*) the variation of period of close binaries caused by perturbations in the systems; (*b*) the light- and velocity-changes due to precession of the rotational axes of both components (and giving rise to asymmetry of the light curves between, as well as within, minima); (*c*) the effects of non-linear darkening to the limb on both the light- and velocity-curves of close binary systems, and its determination from the observations; (*d*) determination of the elements of contact binary systems. Professor Kopal writes that he has worked out a complete theory of the second-order effects of rotation and (equilibrium) tides on the light- and velocity-curves of close binary systems and that he will be glad to communicate his results, in advance of publication, to any colleagues who may need them.

Theoretical topics relating to eclipsing binaries in general are discussed in papers by Kreiken [66] on the period-density relation for spectroscopic binaries and eclipsing binaries; by Serkowski [67] on the density distribution and the ellipticity of the components of CO Lacertae; by Odgers and Stewart [68] on the origin of binary systems.

STATISTICAL AND SPECTROPHOTOMETRIC INVESTIGATIONS

Statistical studies of eclipsing binaries have been published by Lavrov [69], Alksnis [70] and Rigal [71]. Miss Roman [72] determined the spectral types of the components of sixty-three eclipsing systems; more general catalogues of spectral types by Bidelman [73] and Miss Woods [74] also list many eclipsing binaries. The absolute magnitudes of the components of eclipsing systems are discussed by Petrie and Moyls [75]; and those of W UMa variables by Huruhata and Kitamura [76], who find the components of these systems less luminous for their spectral class than stars on the main sequence.

Strand [77] contributed a paper on stellar masses and the mass-luminosity relation to the Victoria Conference on Binary Stars, and Pearce [78] one on the masses of O- and B-type spectroscopic binaries, while Eggen [79] discussed the masses of the subgiants.

In a series of papers on the Algol system Struve and Sahade [80–3] announce the discovery of emission lines at quadratures. They explain certain features that appear in the spectrum during primary eclipse as arising from a blend of the lines of components A and C; they estimated that C is about two magnitudes fainter than A. Huang [84] has found a difference in magnitude of 1^m8 between A and C.

The chromosphere of ζ Aurigae was studied by O. C. Wilson [85], and the spectra of ζ Aurigae-like stars by McKellar and Wright [86]. The spectrum of 31 Cygni is the subject of papers by Wright [87], Wright and Lee [88], Larsson-Leander [89] and McKellar and Petrie [90]; and that of 32 Cygni by Larsson-Leander [91] and Wellmann [92].

At Odessa Observatory Saidov, studying the spectrum of β Lyrae, finds that the spectrophotometric gradient is variable; the intensity of the yellow helium line remains nearly constant, whereas the blue helium line becomes very bright at primary minimum and disappears at other phases, so that there seems to be a 'transparent window' for the blue helium line in the outer envelope of the system. V. M. Grigorevsky, also of Odessa Observatory, has measured the polarization of the light of β Lyrae, using the instruments of the Abastumani Observatory, and found variations similar to those found by Svechnikov for ϵ Aurigae [16].

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President of the Commission

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Report of Meetings. 15 and 18 August 1958

ACTING PRESIDENT: V. P. Tsesevich.

SECRETARY: J. E. Merrill.

At the request of Dr O'Connell, who was unable to be present, the Executive Committee of the Union appointed Dr Tsesevich as Acting President for the sessions of Commission 42 at Moscow. During the course of the congress, three one-hour sessions of Commission 42 and one one-hour joint session of Commissions 27 and 42, were held. For convenience, by agreement of the two chairmen involved, the report on the joint session is incorporated herein, with that of Commission 42.

Dr Kopal, in a memorial on the passing of Dr Henry Norris Russell, summarized briefly, but eloquently, the rich contribution to astronomy and in particular to the field of eclipsing variables, made by Dr Russell in a half century of active leadership in our field. On motion by Dr Kopal, participants in the session stood for a minute of silence in tribute to the memory of our departed member.

On motion by Dr Kopal, seconded by Dr Wood, it was voted unanimously that the *Draft Report* be approved for publication.

Concerning the co-operative program on 12 Lac in the fall of 1956, Dr de Jager reported that fifteen observatories (seven in Europe, seven in North America and one in Asia) undertook to obtain during a prescribed fourteen days a continuous record of the star's brightness and color. This goal was not completely attained because the number of Asiatic observatories involved was insufficient, but valuable scientific results as well as important insights on conducting future co-operative programs were obtained. For example, the 1956 observations showed that the amplitude in the secondary period was considerably less then than it had been in 1951–2. Dr de Jager believes that further such programs should be undertaken and feels that the following three points are of importance: (1) There should be five observatories co-operating on each of three continents; (2) more attention should be paid to the effective wave-lengths actually used; (3) there should be closer co-operation with the spectrographic observers.

Dr Wood reported as follows on the co-operative programs on ϵ Aurigae and VV Cephei. About thirty astronomers fairly well distributed in longitude, undertaking observation of one or both of these systems at their respective recent eclipses, systematically exchanged information on their photo-electric and/or spectroscopic observations. The Flower and Cook Observatory acted as intermediary by collating the information sent to it and mailing the material to all concerned in a series of bulletins. The spectrographic observers were thus kept informed of the changes in light, and the photometric observers could compare their observations with work done elsewhere. In conclusion, Dr Wood called attention to light-curves on display derived from observations made at several different observatories.

In reply to a question from Dr Popper, Dr Wood reported that the Princeton-Flower Card Catalogue continues to list all published and much unpublished information about eclipsing variables, and that information concerning any system is gladly supplied on request. Decision on an approximate date for publication of a revised edition of the 'Finding List for Observers of Eclipsing Variables' will depend largely on how strongly the need for a new edition is felt by other astronomers, and comments on this point would be welcomed at any time.

With tacit agreement obvious as to the value of such programs, discussion on possible future co-operative programs ensued. To the five eclipsing binaries listed in the agenda (namely β Lyr, AR Cas, U CrB, ζ Aur, W UMa) there were added VW Cep, AH Vir, SW Lac, AO Cas, AR Lac, W Ser, DQ Her and AW Peg as deserving consideration; definitive choice among these thirteen possibilities was informally deferred to the last session of Commission 42 during the congress.

Dr Ahnert reported that photo-electric measures on DQ Her on about seventy plates taken between November 1930 and November 1934 show a light variation consonant with eclipses: the period (0·1932084 days) in 1930–4 is shorter than after the nova outburst,and if the semi-axis of the binary system has not been changed by the outburst, the loss of mass for the system comes out as 0·43%. Professor Tsesevich stated that he felt that AW Peg should be investigated as soon as possible because photometrically he has found the primary eclipse total but the duration of eclipse appreciably shorter in the red than in the blue, while spectroscopically he finds it three times as long. Dr Fresa reported that his photo-electric observations of early August 1958 on AW Peg seem to indicate partial eclipse rather than total. Dr Batten stated that he is now studying Huffer's three-color observations of AR Cas obtained in 1954 and 1956, and that the high coefficient of limb-darkening (0·85) found for the 1954 yellow series is not confirmed in the 1956 one. He stated also that the 1954–6 photometric observations do not appear to be in agreement with the spectroscopic material available, on the matter of the rotation of the line of apsides.

Several resolutions, duly placed before the sessions and discussed, were adopted by voice vote. They are recorded here in an order slightly different from that of their discussion and passage, in order to bring related ones closer together.

Resolution on Engelhardt Catalogue. Commission 42 recommends that the bibliography of spectroscopic binaries compiled in 1945–7 by Dr Martynov and Dr Korytnikov at Engelhardt Observatory, be published, that an extension to the present time be compiled and published, and that the project be continued in the future, with publication of new compilations at reasonable intervals (see Resolution no. 5).

Resolutions on bibliography, number 1. The Commission recommends that a running bibliography of articles dealing with eclipsing binaries be inaugurated, on the following lines:

(*a*) The bibliography to be circulated semi-annually by the Secretary to all members of Commission 42 and other persons interested and concerned.

(*b*) The references to be assembled by three volunteers, approved by the President of the Commission, dividing the responsibilities among them as seems best to them and the President.

(*c*) Abstracts and/or summaries to be included when given in the articles, but otherwise not to be obligatory.

Resolutions on bibliography, number 2. The Commission instructs its President to request, through notes in the principal journals, that as soon as the manuscript of an article dealing with eclipsing binaries is accepted for publication, the author inform the President of Commission 42 of the fact and simultaneously, if feasible, transmit to him a copy of the manuscript.

Resolution on Cracow work on light elements. Commission 42 appreciates the continued effort of Cracow astronomers in maintaining an observational check on the light elements of eclipsing binaries. The Commission records here its appreciation of the work of the Cracow Observatory in the publication of the ephemerides of eclipsing binaries, and expresses its hope that the facilities of the Observatory will continue to be used to this end.

Resolution requesting Cracow Observatory to undertake a collating service. The Commission requests the Center for Eclipsing Variables at Cracow to act as receiving center for visual estimates and photometric measures (including photo-electric) newly obtained on eclipsing variables. The Commission requests that the Cracow Observatory undertake to transmit to the observatories and individual persons interested, at least once every three months, lists of observations and of the observed times of minima derived therefrom, from the communications sent to Cracow by the observers.

Resolution on special grant. Commission 42 recommends that the Union provide a special grant of $650 to the Cracow Observatory to help meet the direct outlay for reporting forms, envelopes, circulars, postage, etc., connected with the collating service requested in the previous resolution (see Resolution no. 66).

Resolutions on compilation of published times of minima. Whereas published material on observed times of minima of eclipsing variables is scattered through many volumes of many journals (including some no longer active and some not widely available in astronomical libraries), and whereas collection of all this scattered material into one place would be a service of great value to present and future workers in the field, and whereas the Odessa Observatory has informed this Commission that such a collating is now about 70% completed at that Observatory, Commission 42 recommends that the Observatory complete this valuable work and publish the resulting lists of observed times of minima in a single volume.

During discussion of the foregoing resolutions on observations and observed times of minima, Dr Wood reported that Steward Observatory has several dozen film-strips, each containing successive exposures on an eclipsing variable as it passed through minimum light. Any astronomer interested in borrowing some of these for derivation of times of minimum should write to Dr Carpenter.

Resolution on co-operation in binary star investigations. The increase in the number of students of double stars, and the development of highly specialized methods of observation, have created a danger that effective contact may be lost between the several divisions. Progress in solving problems of binary stars is likely to be most rapid if studies made with micrometers, photometers, and spectroscopes, are correlated, and combined attacks made when necessary. Commission 42 urges, therefore, that every effort be made to insure the rapid exchange of information, and to encourage frequent discussion, between the separate Commissions concerned with double star investigations.

After the adoption of this resolution, Dr Petrie, Acting President of Commission 30, transmitted to Commission 42 the following request: 'At the meeting of Commission 30 it was agreed to request that Commission 42 prepare a list of eclipsing binaries most urgently in need of spectroscopic observations and transmit such a list to Sub-Commission 30*b*. The list should be revised frequently so as to be up-to-date. Sub-Commission 30*b*, for its part, will endeavour to interest radial-velocity observers in obtaining velocity curves for the required stars.' It was agreed that Commission 42 welcomed this opportunity for closer co-operation and that it would gladly undertake the preparation of such a list.

Resolution on proposed observatory in New Zealand. The Commission emphasizes the need for increased numbers of photo-electric observations of eclipsing stars, especially in the southern hemisphere. In particular, the Commission welcomes the plans of Mr F. M. Bateson for the establishment in New Zealand of an observatory devoted primarily to systematic and precise observation of variable stars.

Resolution on spectral types from Dr Vyssotsky's plates. In view of the lack of spectral types for eclipsing stars Commission 42 expressed interest in the spectra of such stars obtained by Dr Vyssotsky and hopes that this valuable material may be classified in order to advance studies of eclipsing variables.

Resolution on standards for photo-electric observations. Commission 42 recommends that observers of eclipsing variables employing photo-electric equipment use 2- or 3-wavelength filter-photocell equipment approximating in spectral response as closely as possible that of a well-established photometric system. The Commission recommends that each photo-electric observer publish his *original* observations, together with either the reductions to a standard system or information which will permit the observations to be reduced to a standard system.

Resolution on need of theoretical work. In recent times the interest of students of eclipsing variables in extension and improvement of methods of orbit-determination has decreased. There remain, however, many questions of theory and of practical computation to be solved, especially for the precise determination of such effects as distortion of figure, reflexion and limb-darkening; the problem of atmospheric eclipse has been insufficiently

investigated. Commission 42 recommends that more attention be given to theoretical work in these directions.

Resolution on co-operative programs. Commission 42 approves inclusion of the following four eclipsing systems in co-ordinated world-wide programs, and requests that the astronomers whose names are given in parentheses act as co-ordinators of the programs for the respective cases:

ζ Aurigae (K. Gyldenkerne)	VW Cephei (K. K. Kwee)
AR Cassiopeiae (C. M. Huffer)	β Lyrae (F. B. Wood)

Resolution of greetings to the President of the Commission. Presented by Dr Tsesevich from the chair. The members of Commission 42 and the many other persons who have participated in its sessions, send cordial greetings to Dr O'Connell and warm thanks for his work during the past three years in the interest of the field. They look forward to his leadership during the coming triennium and to his presence and presidency at the sessions in 1961.

By acclamation the Commission expressed its thanks to Dr Tsesevich for his work as Acting President.

HENRY NORRIS RUSSELL—IN MEMORIAM

It has become a tradition in the short history of our Commission to commemorate, at our first session of each General Assembly, the names of those colleagues who could no longer come to join our counsels in this world; and this year it has thus become our sad duty to pay homage to the memory of our senior and most distinguished member, Professor Henry Norris Russell, who departed from this life on 18 February 1957, a few weeks before his eightieth birthday.

Russell's contributions to astronomy over more than half a century of active and prominent professional life range far and wide across many fields of astronomical research. Yet it is eminently appropriate that we commemorate him primarily in our own midst; for eclipsing variables have probably been Russell's principal scientific interest (and, some of us would say, his *grande passion*) all his life. His first paper, published while Russell was still a graduate student at Princeton (*Ap. J.* **10**, 315, 1899) characteristically dealt with the problem of mean densities of the components of eclipsing binary systems (deriving formulae still in use to this end today); and his last paper, devoted to a study of eclipsing variables in the Magellanic Clouds, appeared posthumously on pp. 1177–86 of the second volume of *Vistas in Astronomy*, published in London last year.

In the fifty-eight years that lay in between, Russell's contributions to astronomy were on a massive scale. The highlight of his activities in the field of our Commission coincided no doubt with the triennium of 1912–15 when he developed, in collaboration with his (then) student Harlow Shapley, the well-known semi-graphical methods for the computation of the elements of eclipsing binary systems, which are still frequently used today. I do not wish to dwell too much on this subject at this time, not perhaps because it became my lot in later years to supersede such methods by more adequate analytical machinery, but rather because we are fortunate to have in our midst Dr and Mrs Shapley, who both took such prominent part in this glorious episode in the history of our subject, and who could tell us much more about it than anybody else in this room.

In the years subsequent to 1915, Russell's interest in our field of research subsided perhaps somewhat; but it was fully renewed in the 1940's to last to the end of his days; all of Russell's papers in the last ten years of his life deal again with his *première amour*. In 1946, he became chairman of the newly organized Panel on Orbits of Eclipsing Variables in the United States; and it was only his impending retirement and failing health which caused the first chair of our Commission to devolve on another individual.

In our past two sessions at Rome and Dublin it has been my privilege to move that we send Professor Russell a telegram of good wishes. Today we can, alas, no longer do so; for, in the meantime, Russell departed from us to realms where no telegram could reach him any more; and those of us left behind, who are meeting at Moscow today, can only rise from our seats in tribute to the memory of a great predecessor and master. Z. KOPAL