42. COMMISSION DES ETOILES DOUBLES PHOTOMETRIQUES

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JOINT WORKING GROUP WITH COMMISSION 30: A. H. Batten, *Chairman;* Abt, Buscombe, Heard, Martynov, Northcott, Popper, Sahade, Thackeray.

INTRODUCTION

For this report, account has been taken of literature and information received up to the middle of September 1966, and of some somewhat later material. Special thanks are due the members of the Organizing Committee who found time in their crowded schedules to compose various sections of the text and compile the relevant tables of references included therein. The work has been very considerably expedited by use of the five issues (numbers 7, 8, 9, 10, 11) of the *Bibliography and Program Notes for Eclipsing Binaries* covering the interval, with the categorizing numbers there assigned to each item listed. We are indebted to the following contributors to the bibliography for their efforts:

Dr Fracastoro, Italy
Dr Hardie, North America
Dr Kitamura, Japan
Mrs Kron, P.A.S.P.
Dr Kwee, Western Europe
Dr Plavec, Eastern Europe
Dr Schneller†, Germany
Dr Sahade, Southern Hemisphere
Dr Shulberg, U.S.S.R.
Dr Sinvhal, India and Indonesia

In accordance with Commission desires, the form of this report is similar to that of previous ones. The total number of references surveyed, which is a rough gauge of the activity in the field, is over fourteen hundred, as compared with about eight hundred for the 1964 issue. Readers should bear in mind that the various sections here set out are by no means mutually exclusive; a given published article will often contain material pertinent to two, or even three, of our sub-fields.

OBSERVATIONAL TECHNIQUES AND NEW PHOTOMETRIC DATA

Fletcher (1) used precise photoelectric measurements of equivalent widths to investigate the variation with phase of the equivalent width of the He I λ4771 line in Algol, and used the observations for a study of the Algol system.

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

Przybylski (2) prepared a computer program for the reduction of photometric observations affected by variable extinction. He assumed a linear change with time for the extinction coefficient, and in this way obtained a considerable increase in the precision of the results. The method, which can be applied generally, was developed to deal with the greatly increased, and varying, extinction caused by the eruption of Mt Agung volcano in March 1963. Przybylski found that the volcanic dust in the atmosphere did not appreciably affect the extinction coefficient of $B - V$ and $U - B$, in other words that the dust acts as a neutral filter.

Bertiau (3) developed a program for the establishment of independent photometric three-color systems. The program, written for the IBM 1620 computer, derives a system of colors and magnitudes for a limited number of standard stars observed during several nights. The observations of all the nights are treated in a single least squares solution. The magnitudes and colors of the standards enter directly as unknown quantities in the fundamental equations. The normal equations permit a unique solution for the colors and magnitudes of the standards. The program was prepared originally to establish standards for O'Connell's observations of ζ Aurigae made with interference filters (4), but it can be applied to any three-color photometric system.

At Flower and Cook Observatory Blitzstein, Mrs Savage, Jurkevich and A. J. Harris have developed computer programs of various sorts for the reduction of the raw observations to light curve data. Blitzstein has completed the Pierce photometer so that it punches cards at the telescope; it is now also suitable for dual operation, simultaneously observing the variable and the comparison star. The completely digitized card-punching photometer, including a digitized clock, constructed by Petty, has been installed at the Mount John Observatory. Also at Mount John, a mounting has been built for four patrol cameras loaned by Strohmeier; a joint photographic program with the Bamberg Observatory is to be initiated.

Shao and Young (5) have studied the Red Leak corrections in ultraviolet photometry, and Young (6) has made further studies of temperature effects in photoelectric photometry generally.

Table 1a is a continuation of the Table on page 691 of *Trans. IAU*, **12A**, and lists both published photoelectric observations and those we have been informed to be in progress. It reflects the steadily increasing activity in the field, containing 217 binaries with 348 references, as compared with 139 stars and 203 references in the previous list. We are especially pleased to note the evidence it contains of the activity in eclipsing binaries at Kodaikanal Observatory, important to us particularly because of the 'longitude gap' which has existed. Table 1b lists visual and photographic estimates of magnitude. Note also that additional series of observations are implied by publication of new light elements as listed in Table 3.

Table 1a. New Photometric Observations

Star	References
RT And	Shao, C. Y. (Harvard) (3 colors).
	Dean, C., Nelson, B. (San Diego) (*UBV*).
	Miner, E. D., *Astrophys. J.*, **144**, 1101, 1966.
	Pohl, E., Kizilirmak, I., *Astr. Nachr.*, **288**, 69, 1965.
AB And	Kalchaev, K., Truttse, Yu., *Perem. Zvezdy*, **15**, 487, 1965.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12**, no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math.-nat. Kl., Abt. 2, 171, 217, 1964.
AD And	Rucinski, S., *Acta. astr.* (in press).
AN And	Schneller, H. (Potsdam) Beginning obs.
BX And	Todoran, I., *Bukarest Studii*, **71**, 1965.
o And	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5**, 286, 1963.
Y Aql	Breinhorst, R., (Bonn Univ. Obs.) 3 color pe obs.

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

Star	References
OO Aql	Bookmyer, B. B., *Astr. J.*, **68,** 741, 1963.
	Pohl, E., Kizilirmak, I., *Astr. Nachr.*, **288,** 69, 1965.
KQ Aql	Cristaldi, S., *Mem. Soc. astr. ital.*, **37,** 205, 1966.
	Filatov, G. S., *Bull. Dushanbe* **35,** 32, 1963.
V337 Aql	Catalano, F., Rodono, M. (Catania) (*V*).
V889 Aql	Semeniuk, I., (*BV*).
RS Ari	Miner, S. D., *Astrophys. J.*, **144,** 1101, 1966.
RX Ari	McCluskey, G. E., *Astr. J.*, **68,** 741, 1963.
SS Aur	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
SX Aur	Fliegel, H. F., *Astr. J.*, **68,** 740, 1963.
AR Aur	Johansen, K., (Brorfelde Obs.) Peaks 3500, 4050, 4730, 5520 Å and Hβ.
	O'Connell, D. J. K., (Spec. Vatic.) *UBV*.
BF Aur	Mannino, G., (Bologna-Loiano) (*UBV*).
β Aur	Johansen, K., (Brorfelde Obs.) Peaks 3500, 4050, 4730, 5520Å and at Hβ.
ϵ Aur	Chen, K. Y., *Astr. J.*, **68,** 740, 1963 (infrared).
	Low, F. J., Mitchell, R. I., *Astrophys. J.*, **141,** 327, 1965.
	Mitchell, R. I., *Astrophys. J.*, **140,** 1607, 1964 (9 colors).
ζAur	Bappu, M. K. V., Doss, A. T., Viswanadham, P., *Observatory*, **85,** 85, 1965.
	Chen, K. Y., *Astr. J.*, **68,** 740, 1963 (infrared).
	Fracastoro, M. G., Catalano, S., *Mem. Soc. astr. ital.*, **36,** 99, 1965; interference filters, 4 colors.
	Hayashi, M., (Kyoto).
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 264, 1963.
	Kondo, Y., Harris, A. J., *Astr. J.*, **69,** 409, 1964.
	Nelson, B., (San Diego) (*UBV*).
	O'Connell, D. J. K., *Ric. astr. Spec. Vatic.*, **6,** 523, 1964 (*UBV* and interference filters).
	Schneller, H., *Mitt. veränd. Sterne*, **2,** 178, 1965. Obs. continuing.
	Shao, C. Y., *Astr. J.*, **69,** 858, 1964.
	van Genderen, A. M., *Bull. astr. Inst. Netherl.*, **17,** 446, 1964.
	Zhang, H.-z., Liu, X-f., *Acta astr. Sinica*, **13,** 102, 1965.
η Aur	Fracastoro, M. G., Catalano, S., *Mem. Soc. astr. ital.*, **36,** 105, 1965. Variation confirmed.
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 264, 1963, finds no var.
θ Aur	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 267, 1963, finds no var.
XY Boo	Wood, R., *Observatory*, **85,** 258, 1965.
ZZ Boo	(Flower and Cook) 2 colors.
AC Boo	Binnendijk, L., *Astr. J.*, **70,** 201, 1965.
	Mauder, H., *Z. Astrophys.*, **60,** 222, 1964.
44 i Boo	Catalano, S., Saitta, T., *Mem. Soc. astr. ital.*, **35,** 43, 1964.
	Chen, K. Y., Rekenthaler, D. A. (Florida) (*BV*).
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math.-nat. Kl. Abt. **2,** 171, 217, 1964.
	Schneller, H., (Potsdam).
Z Cam	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
SV Cam	Nelson, B., *Astr. J.*, **69,** 271, 1964; *Publ. astr. Soc. Pacif.*, **75,** 18, 1965.
TU Cam	Margoni, R., (Asiago).
	West, R., *Publ. astr. Soc. Pacif.*, **76,** 49, 1964; *Medd. Københavns Obs.*, no. 181, 1964.
S Cnc	(Flower and Cook).
TX Cnc	Binnendijk, L., *Astr. J.*, **68,** 740, 1963.
	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
	Kitamura, M., (Mt Dodaira).

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

Star	References
TZ Cnc	Koch, R. H., Lampert, G., *Publ. astr. Soc. Pacif.*, **76,** 254, 1964.
WY Cnc	Chambliss, C. R., *Astr. J.*, **70,** 741, 1965.
R CMa	Kitamura, M., Sato, H., (Mt Dodaira) *UBV* and interference filters.
	Knipe, G. F. G., *Johannesburg Circ.*, no. 122, 21.
29 CMa	Doss, A. T. (Kodaikanal) 2 colors.
XZ CMi	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
	Wilson, R. E., *Astr. J.*, **68,** 740, 1963; **71,** 32, 1966.
RS CVn	Chisari, D., Lacona, G., *Mem. Soc. astr. ital.*, **36,** 463, 1965.
	(Flower and Cook).
	Nelson, B., (San Diego) (*UBV*).
	Catalano, S., Rodono, M., (Catania) (*V*).
TV Car	Devinney, E. J., *Astr. J.*, **68,** 741, 1963.
GV Car	Landolt, A. U., (Cerro Tololo) (*UBV*).
RZ Cas	Burke, E. W., Jr, Henderson, T. C., Boy, W. R., (King College).
	Burke, E. W., Jr, Rolland, W. W., *Astr. J.*, **71,** 38, 1966.
	Plavec, M., *Bull. astr. Inst. Csl.*, **15,** 23, 1964.
	Shao, C. Y., (Harvard) 3 colors.
SX Cas	(Flower and Cook).
	Miner, S. D., *Astrophys. J.*, **144,** 1101, 1966.
	Nelson, B., (San Diego) (*UBV*).
	Shao, C. Y., *Astr. J.*, **70,** 147, 1965.
	Widorn, T., (Univ.-Sternwarte Wien).
TV Cas	Nelson, B., Sievers, J., (San Diego) (*UBV*).
BM Cas	Shao, C. Y., (Harvard) 3 colors.
BY Cas	Malik, G. M., *Astr. J.*, **70,** 94, 1965.
CW Cas	Broglia, P., *Mem. Soc. astr. ital.*, **35,** 23, 1964.
	Hogg, A. R., *Astr. J.*, **71,** 242, 1966.
DO Cas	Winkler, L., *Astr. J.*, **71,** 40, 1966.
RR Cen	Knipe, G. F. G., *Astrophys. J.*, **142,** 1068, 1965.
SV Cen	Irwin, J. B., *Astr. J.*, (in press).
BF Cen	Landolt, A. U., (Cerro Tololo) (*UBV*).
U Cep	Eggen, O. J., *Astr. J.*, **68,** 493, 1963.
	Long, R., Nelson, B., (San Diego) (*UBV*).
	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
VV Cep	Peery, B. F., *Astrophys J.*, **144,** 672, 1966.
VW Cep	Gyldenkerne, K., Jaeger, J. E., Johansen, K. T., *Publ. Københavns Obs.*, 177, 1963.
	Kwee, K. K., *Bull. astr. Inst. Netherl., Suppl.*, **1,** 245, 1966; 265, 1966.
	Rossati, F., *Mem. Soc. astr. ital.*, **36,** 109, 1965.
XX Cep	Angione, R., Nelson, B., (San Diego) (*UBV*).
CQ Cep	Hiltner, W. A., Schild, R. E., *Astrophys. J.*, **143,** 1008, 1966.
	Pyper, D. M., *Astrophys. J.*, **144,** 13, 1966.
CX Cep	Hiltner, W. A., Schild, R. E., *Astrophys. J.*, **143,** 1008, 1966.
	Pyper, D. M., *Astrophys. J.*, **144,** 13, 1966.
EG Cep	Cochran, G., Nelson, B., (San Diego) (*UBV*).
EI Cep	Abrami, A., *Mem. Soc. astr. ital.*, **37,** 369, 1966.
EK Cep	Ebbighausen, E. G., *Astr. J.*, **71,** 642, 1966.
9 Cha	Lagerweij, H. C., Cousins, A. W. J., (Cape Obs.) (*UBV*).
RZ Com	Binnendijk, L., *Astr. J.*, **69,** 154, 1964.
	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
RW CrA	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8,** 25, 1966 (Leiden So. Station of Leiden Obs.).
ϵ CrA	Churms, J., (Cape Obs.).
	Cousins, A. W. J., *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 24, 1964.

Star	References
ϵ CrA	Hernandez, C., (La Plata).
	(Flower and Cook) 2 colors.
U CrB	Batten, A. H., *Contr. Dom. astrophys. Obs.*, **85,** 1964.
	Catalano, S., Cristaldi, S., Lacona, G., (Catania).
RT CrB	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
VY Cru	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8,** 25, 1966 (Leiden So. Station of Leiden Obs.).
ZZ Cru	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8,** 25, 1966 (Leiden So. Station of Leiden Obs.).
DK Cyg	Binnendijk, L., *Astr. J.*, **69,** 157, 1964.
EM Cyg	Lowell Obs., *Astr. J.*, **68,** 645, 1963.
	Mumford, G. S., *Astr. J.*, **69,** 270, 1964; **71,** 243, 1966.
GO Cyg	Mannino, G., *Mem. Soc. astr. ital.*, **34,** 191, 1963.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
KR Cyg	Vetešník, M., *Bull. astr. Inst. Csl.*, **16,** 326, 1965.
KU Cyg	Popper, D. M., *Astrophys. J.*, **139,** 143, 1964.
MY Cyg	Filatov, G. S., *Bull. Dushanbe*, **35,** 32, 1963.
V380 Cyg	Semeniuk, I., (*V*).
V382 Cyg	Landolt, A. U., *Astr. J.*, **69,** 549, 1964; **71,** 242, 1966; *Astrophys. J.*, **140,** 1494, 1964.
V401 Cyg	Purgathofer, A., *Z. Astrophys.*, **59,** 29, 1964.
V444 Cyg	Demers, S., Fernie, J. D., *Publ. astr. Soc. Pacif.*, **76,** 350, 1964.
	Gusseinzade, A. A., *Perem. Zvezdy*, **15,** 555, 1965.
	Hiltner, W. A., Mook, D. E., *Astrophys. J.*, **143,** 1008, 1966.
	Pyper, D. M., *Astrophys. J.*, **144,** 13, 1966.
	Tcherepashchuk, A. M., *Perem. Zvezdy*, **15,** 549, 1965.
V477 Cyg	Chisari, D., Saitta, T., *Oss. astrofis. Catania Pubbl.*, **54,** 1963.
	O'Connell, D. J. K., (Spec. Vatic.) *UBV*.
	Rodono, M., (Catania) (*V*).
	Semeniuk, I., (*V*).
V478 Cyg	Schneller, H., (Potsdam) l.c. completed.
V548 Cyg	Rodono, M., (Catania) (*V*).
V695 Cyg	Herczeg, T., Schmidt, H., *Z. Astrophys.*, **55,** 162, 1962.
V828 Cyg	Wenzel, W., *Mitt. veränd. Sterne*, **3,** 71, 1965.
V836 Cyg	Harris, A. J., (Flower and Cook).
σ Cyg	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 286, 1963.
31 Cyg	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 283, 1963.
	O'Connell, D. J. K., *Ric. astr. Spec. Vatic.*, **6,** 499, 1964.
32 Cyg	(Flower and Cook).
	Herczeg, T., Schmidt, H., *Z. Astrophys.*, **57,** 254, 1963.
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 283, 1963.
TW Dra	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
TZ Dra	Plavec, M., *Bull. astr. Inst. Csl.*, **15,** 23, 1964.
WW Dra	Koch, R. H., *Astr. J.*, **69,** 269, 1964.
	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
AI Dra	McCluskey, G. E., *Astr. J.*, **68,** 741, 1963.
S Equ	Catalano, S., Rodono, M., (Catania) (*B, V*).
	Plavec, M., *Bull. astr., Inst. Csl.*, **15,** 23, 1964.
RU Eri	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
UX Eri	Binnendijk, L., (Flower and Cook) (*BV*).
YY Eri	Bhattacharyya, J. C., *Kodaikanal Obs. Bull.* (in press).
AS Eri	Filatov, G. S., *Bull. Dushanbe*, **35,** 32, 1963.
U Gem	Bornhurst, L. C., *J. R. astr. Soc. Can.*, **60,** 32, 1966.
	Krzeminski, W., *Astr. J.*, **68,** 639, 1963.

Star	References
U Gem	Krzeminski, W., *Astrophys. J.*, **142,** 1051, 1965.
	Lowell Obs., *Astr. J.*, **68,** 645, 1963.
	Mumford, G. S., *Astr. J.*, **69,** 270, 1964; *Astrophys. J.*, **139,** 476, 1964; *Kitt Peak nat. Obs. Contr.* no. 48.
	Paczyński, B., *Acta. astr.*, **15,** 305, 1965.
RW Gem	Smak, J., *Acta astr.*, **14,** 101, 1964.
AL Gem	Koch, R. H., *Astr. J.*, **68,** 785, 1963.
RU Gru	van Houten, C., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8,** 25, 1966 (Leiden So. Station of Leiden Obs.).
Z Her	(Flower and Cook).
RX Her	Nelson, B., (San Diego) (*UBV*).
UX Her	Gordon, K. C., Kron, G. E., *Astr. J.*, **70,** 100, 1965; *Lick. Obs. Bull.* no. 588.
AK Her	Bertiau, F. C., *Ric. astr. Spec. Vatic.*, **6,** 487, 1963.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math.-nat. Kl., Abt. 2, 171, 217, 1964
DI Her	(Flower and Cook).
	Paczyński, B., (*V*).
	Semeniuk, I., (*BV*).
	Shao, C. Y. (Harvard) (*UBV*).
DQ Her	Bornhurst, L. C., *J. R. astr. Soc. Can.*, **60,** 32, 1966.
	Walker, M. E., *Astr. J.*, **69,** 677, 1964.
HS Her	(Flower and Cook).
NQ Her	Rossati, F., *Mem. Soc. astr. ital.*, **35,** 81, 1964.
	Schneller, H., *Mitt. veränd. Sterne*, **3,** 4, 1965 (not variable).
u Her	Catalano, S., (Catania).
Nova Her 1963	Chincarini, G., Howard, V. S., *I.B.V.S.*, **139,** 1966.
	Mumford, G. S., *Sky Telesc.*, **31,** 214, 338, 1966.
VZ Hya	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
EX Hya	Mumford, G. S., *Publ. astr. Soc. Pacif.*, **76,** 57, 1964; *Kitt Peak nat. Obs. Contr.*, no. 50; *Astr. J.*, **71,** 243, 1966.
SS Lac	Tashpulatov, N., *Perem. Zvezdy*, **15,** 390, 1965.
SV Lac	Paczyński, B. (*UBV*).
SW Lac	Bookmyer, B. B., *Astr. J.*, **70,** 133, 415, 1965.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math-nat. Kl., Abt. 2, 171, 217, 1964.
	(U.S. Naval Obs.) *Astr. J.*, **68,** 676, 1963.
AR Lac	Karle, J. H., *Publ. astr. Soc., Pacif.*, **74,** 244, 1962.
	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
	Nelson, B., (San Diego) (*UBV*).
CO Lac	Semeniuk, I., (*BV*).
	Serkowski, K., (*V*).
EM Lac	Broglia, P., (Merate) (*BV*).
UV Leo	Broglia, P., *J. Observateurs*, **48,** 124, 1965.
	McCluskey, G. E., *Astr. J.*, **68,** 741, 1963.
	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math-nat. Kl., Abt. 2, 171, 217, 1964.
AC Leo	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
	Schneller, H., (Potsdam) (not variable).
RS Lep	Klepczynski, W. J., Wood, F. B., *Astr. J.*, **69,** 92, 1964.
17 Lep	Widing, K. G., *Astrophys. J.*, **143,** 121, 1966.

Star	References
δ Lib	Koch, R. H., *Astr. J.*, **70,** 130, 1962.
RR Lyn	Linnell, A. P., *Astr. J.*, **68,** 620, 1963; **69,** 270, 1964; **70,** 582, 1965; **71,** 458, 1966.
SW Lyn	Gleim, J., *Astr. J.*, **68,** 741, 1963.
FL Lyr	Cristaldi, S., *Mem. Soc. astr. ital.*, **36,** 77, 1965.
	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
NY Lyr	Makarenko, E. N., *Perem. Zvezdy*, **15,** 446, 1965.
β Lyr	Appenzeller, I., *Astrophys. J.*, **141,** 1390, 1965.
	Belton, M. J. S., Woolf, N. J., *Astrophys. J.*, **141,** 145, 1965.
	Chia-Shang, Chang, *Acta astr. Sinica*, **7,** 203.
	Gyldenkerne, K., Jaeger, J. E., *Publ. Københavns Obs.*, 177, 1963.
	Herczeg, T., *Veröff. astr. Inst. Univ. Bonn*, **69,** 1964.
	Serkowski, K., *Astrophys. J.*, **142,** 793, 1965.
ζ Lyr	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 281, 1963.
31 Men	Lagerweij, H. C., Cousins, A. W. J., (Cape Obs.) (*UBV*).
RU Mon	Martynov, D., *Astr. Zu.*, **42,** 1209, 1965.
	Martynov, D., *I.B.V.S.*, **102,** 1965.
RW Mon	Smak, J., *Astr. J.*, **69,** 677, 1964.
IM Mon	Sanyal, A., Sinvhal, S. D., *Observatory*, **84,** 211, 1964.
	Sanyal, A., Mahra, H. S., Sanwal, N. B., *Bull. astr. Inst. Csl.*, **16,** 209, 1965.
U Oph	Koch, R. H., *Astr. J.*, **69,** 650, 1964; **70,** 582, 1965.
	(Flower and Cook).
WZ Oph	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
V502 Oph	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
	Magalashvili, N. L., Kumsishvili, J. I., *Bull. Abastumani*, **30,** 39, 1964.
	Wilson, R. E., *Astr. J.*, **68,** 740, 1963.
V566 Oph	(Flower and Cook).
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss*, Wien, Math-nat. Kl., Abt. 2, 171, 217, 1964.
	Schnell, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** 125, 1965.
V839 Oph	Wilson, R. E., O'Toole, W., *Publ. astr. Soc. Pacif.*, **77,** 58, 1964.
VV Ori	Marasso, R., Nelson, B., (San Diego) (*UBV*).
	Sivaraman, K. R., (Kodaikanal) 4740 Å, 1/2 intensity: 47 Å.
CN Ori	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
FT Ori	Cristaldi, S., *Mem. Soc. astr. ital.*, **37,** 205, 1966.
U Peg	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss*, Wien, Math-nat. Kl., Abt. 2, 171, 217, 1964.
AW Peg	Fresa, A., (Capodimonte) (*B*).
DI Peg	Chou, K. C., *Astr. J.*, **68,** 676, 1963.
EE Peg	Bakos, G. A., *Publ. Dunlap Obs.*, **2,** 431, 1965.
	Catalano, S., Rodono, M., (Catania), (*B, V*).
	Fresa, A., (Capodimonte).
ι Peg	Koch, R. H., *Astr. J.*, **69,** 269, 1964.
RW Per	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
RY Per	Linnell, A. P., *Astr. J.*, **68,** 620, 1963; **69,** 270, 1964; **70,** 582, 1965.
	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
TZ Per	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
AB Per	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
AG Per	Semeniuk, I., (*V*).
DM Per	Catalano, F., Catalano, S., Rodono, M., (Catania) (*BV*).

Star	References
GK Per	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
KP Per	Rossati, F., *Mem. Soc. astr. ital.*, **34,** 349, 1963; *Torino Contr.* no. 37, 1963.
β Per	Chen, K.-Y., Reuning, E. G., *Astr. J.*, **71,** 283, 1966.
	Cristaldi, S., Fracastoro, M. G., Sobieski, S., (Catania and Flower and Cook).
	Herczeg, T., *Veröff. astr. Inst. Univ. Bonn*, **69,** 1964.
ζ Per	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 290, 1963.
o Per	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 290, 1963.
RR Pic	van Houten, C. J., *Bull. astr. Inst. Netherl.*, **18,** 439, 1966.
δ Pic	Cousins, A. W. J., *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 67, 1964; *Mon. Not. R. astr. Soc.*, **131,** 443, 1966.
UU Psc	Schneller, H., (Potsdam) Beginning obs.
VV Pup	Walker, M. E., *Astr. J.*, **69,** 677, 1964; *Lick Obs. Contr.* no. 179; *Mitt. Budapest Obs.*, **57,** 1965.
AU Pup	Chambliss, C. R., (Flower and Cook).
U Sge	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
V Sge	Herbig, G., Preston, G., Smak, J., Paczyński, B., *Astrophys. J.*, **141,** 617, 1965.
WZ Sge	Krzeminski, W., Kraft, R. P., *Astrophys. J.*, **140,** 921, 1964.
Nova W2 Sge	(Lowell), *Astr. J.*, **68,** 645, 1963.
V701 Sco	Leung, K.-c., (Flower and Cook).
ER Sct	O'Connell, D. J. K., (Spec. Vatic.) (*UBV*).
W Ser	Leung, K.-c., (Flower and Cook).
CV Ser	Demers, S., Fernie, J. D., *Publ. astr. Soc. Pacif.*, **76,** 350, 1964.
	Pyper, D. M., *Astrophys. J.*, **144,** 13, 1966.
X Tri	Miner, E. D., *Astrophys. J.*, **144,** 1101, 1966.
	Plavec, M., *Bull. astr. Inst. Csl.*, **15,** 23, 1964.
RS Tri	Plavec, M., *Bull. astr. Inst. Csl.*, **15,** 23, 1964.
W UMa	Binnendijk, L., *Astr. J.*, **71,** 340, 1966.
	Blitzstein, W., Chou, K. C., *Astr. J.*, **69,** 365, 1964.
	Cester, B., (Trieste) (*UBV*).
	Kuhi, L., *Publ. astr. Soc. Pacif.*, **76,** 430, 1964.
SU UMa	Mumford, G. S., *Astr. J.*, **69,** 270, 1964.
UV UMa	Broglia, P., (Merate) (*BV*).
UX UMa	Krzeminski, W., Walker, M. F., *Astrophys. J.*, **138,** 166, 1963.
TY UMa	Broglia, P., (Merate) (*BV*).
VV UMa	Wilson, R. E., *Astr. J.*, **68,** 740, 1963; **70,** 368, 1965; *Georgetown Obs. Repr.*, Ser. II, 22.
W UMi	Devinney, E. J., *Astr. J.*, **68,** 741, 1963.
S Vel	Sisteró, R., (Cordoba) pe obs. at Cerro Tololo Interamerican Obs.
AL Vel	Cousins, A. W. J., (Cape Obs.) (*UBV*).
	Wood, F. B., Richardson, R. R., *Astr. J.*, **69,** 297, 1964.
AO Vel	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8,** 25, 1966 (Leiden So. Station of Leiden Obs.).
γ Vel	Ganesh, K. S., (Kodaikanal).
AG Vir	Fliegal, H. F., *Astr. J.*, **68,** 740, 1963.
	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Purgathofer, A., Widorn, T., *Sber. öst. Akad. Wiss.*, Wien, Math.-nat. Kl., Abt. 2, 171, 217, 1964.
AH Vir	Purgathofer, A., Widorn, T., *Mitt. Univ. Sternw. Wien*, **12,** no. 6, 1964.
	Sievers, J., Nelson, B., (San Diego) (*UBV*).
	Truttse, Yu. L., Kalchaev, K. K., *Perem. Zvezdy*, **15,** 314, 1965.
BH Vir	Koch, R. H., *Astr. J.*, **69,** 650, 1964; **70,** 582, 1965; **71,** 241, 1966.

Star	References
Z Vul	Broglia, P., *J. Observateurs*, **47**, 99, 1964.
	Paczyński, B., *J. Observateurs*, **47**, 101, 1964.
RR Vul	Filatov, G. S., *Bull. Dushambe*, **35**, 32, 1963.
BP Vul	Sturch, G., Moorehead, J., *Astr. J.*, **70**, 612, 1965.
DR Vul	Krzeminski, W., (*V*).
	O'Connell, D. J. K., (Spec. Vatic.) (*UBV*).
	Semeniuk, I., (*BV*).
BD +70° 1183	Mannino, G., (Loiano) (*UBV*).
BD +69° 389	Harris, A. J., (Flower and Cook).
=BV 312	Mannino, G., (Loiano) (*BV*).
	Schneller, H., (Potsdam) lc completed.
BD +57° 1546	
=BV 277	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 16, 1965.
BD +54° 49	
=BV 328	Kondo, Y., *Veröff. Remeis-Sternw. Bamberg*, **5**, 18, 1964. Not eclipsing.
BD +45° 1570	
=SVS 1396	Lange, G. A., *Astr. Circ.* (U.S.S.R.), no. 246, 1963.
BD +34° 1051	
=HD 35 652	Mayer, P., *I.B.V.S.*, **49**, 1964; *Publ. astr. Soc. Pacif.*, **77**, 436, 1965.
BD +33° 4252	Kondo, Y., *Astr. J.*, **71**, 54, 1966.
=BV 342	Mannino, G., (Loiano) (*UBV*).
	Rodono, M., (Catania).
	Schneller, H., (Potsdam) lc completed.
BD +30° 2163	Kalish, M. S., *Publ. astr. Soc. Pacif.*, **77**, 36, 1965.
	Kondo, Y., (Flower and Cook).
	Paczyński, B., *Astr. J.*, **69**, 124, 1964.
HD 1372	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8**, 25, 1966 (Leiden S. Station of Leiden Obs.).
HD 128220	Guinan, E., (Flower and Cook).
	Schneller, H., (Potsdam) No ecl. min.
HD 161783	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8**, 25, 1966 (Leiden S. Station of Leiden Obs.).
HD 187418	van Houten, C. J., van Houten-Groeneveld, J., *Inf. Bull. So. Hemisphere*, **8**, 25, 1966 (Leiden S. Station of Leiden Obs.).
HD 200391	Bakos, G. A., Northcott, R., (David Dunlap).
HR 5687	Smith, L. F., *Publ. astr. Soc., Pacif.*, **78**, 168, 1966.
HR 7484	
=HD 185912	Snowden, M. S., *I.B.V.S.*, **127**, 1966.
HR 8164	(Loiano).
ADS 9537 A,B.	Batten, A. H., Hardie, R. H., *Astr. J.*, **70**, 666, 1965.
BV 169	(Flower and Cook).
BV 267	Kondo, Y., *Astr. J.*, **71**, 46, 1966.
	Mannino, G., (Loiano) (*BV*).
BV 332	Harris, A. J., (Flower and Cook).
BV 357	Chambliss, C. R., (Flower and Cook).
BV 382	Bartolini, C., Mammano, A., Mannino, G., Margoni, R., an early type contact system.
	Gleim, J., (Flower and Cook) (*UBV*).
BV 419	Chambliss, C. R., (Flower and Cook) 300 obs., per 15 hrs.
BV 430	Chambliss, C. R., Rogers, M. J. (Flower and Cook) 1200 obs.
BV 513	Leung, K.-c., (Flower and Cook) 2 colors.
BV 516	Chambliss, C. R., (Flower and Cook) 500 obs.
BV 544	Leung, K.-c., (Flower and Cook) 500 obs.

Table 1b. New brightness determinations other than photoelectric

Star	References
S 5043 Aps	Hoffmeister, C., *Veröff. Sternw. Sonneberg*, **6**, 3, 1965.
TT Aur	Karetnikov, V. G., *Perem. Zvezdy*, **14**, 38, 1962.
	Obůrka, O., *Bull. astr. Inst. Csl.*, **15**, 26, 1964.
RZ Cas	Karetnikov, V. G., *Perem. Zvezdy*, **14**, 38, 1962.
AZ Cas	Weber, R., *Bull. Mainterne*, **3**, 1966.
V 364 Cas	Borsdiko, V. I., *Bull. Tadjik Obs.*, **38**, 43, 1965.
AI Cep	Albo, Ch., *Publ. Tartu Obs.*, **34**, 169, 1964.
CQ Cep	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
DK Cep	Albo, Ch., *Publ. Tartu Obs.*, **34**, 169, 1964.
DL Cep	Albo, Ch., *Publ. Tartu Obs.*, **34**, 169, 1964.
Z Cir	van Hoof, A., *I.B.V.S.*, **41**, 1964 (not eclipsing).
Y Crv	Meinunger, L., *Mitt. veränd. Sterne*, **2**, 47, 1964.
RZ Cyg	Ignatieva, L. V., *Perem. Zvezdy*, **14**, 119, 1962.
UZ Cyg	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
DK Cyg	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
DL Cyg	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
MR Cyg	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
V 753 Cyg	Wawriniak, P. F., *Circ. Lwow Obs.*, no. 39–40.
P 5535 Cyg = 173·1935 = CVS 5365	Meinunger, L., *Mitt. veränd. Sterne*, **7**, 14, 1965,
XY Dra	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 15, 1965.
SU For	Omay, G., *Astr. J.*, **70**, 484, 1965.
RT Lac	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
AR Lac	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
AW Lac	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
CM Lac	Ishchenko, I. M., *Trudy Tashkent Obs.*, **9**, 1, 1963.
LZ Per	Ahnert, P., *Mitt. veränd. Sterne*, **3**, 7, 1965.
V Sge	Romano, G., *I.B.V.S.*, **98**, 1965.
SY Vul	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 23, 1965.
BP Vul	Huth, H., *Mitt. veränd. Sterne*, **3**, 36, 1965.
BD +57° 1546 Dra = BV 277	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 16, 1965.
CoD −42° 9876 = S 5001	Strohmeier, W., *Mitt. veränd. Sterne*, **3**, 2, 1965.
BV 36	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 21, 1965.
BV 159, 343, 344	Nikulina, T. C., *Bull. Dushanbe*, **35**, 45, 1963.
СПЗ 1284	Kuročkin, N. E., *I.B.V.S.*, **79**, 1965.
СПЗ 1394	Nikolov, N. S., *Perem. Zvezdy*, **14**, no. 4, 336, 1963.
СПЗ 1399	Popov, M. V., Kazmina, E. I., *Perem. Zvezdy*, **15**, no. 1, 109, 1064.
GR 109 = SVS 548	Romano, G., *Coelum*, **33**, no. 3–4, 1965.
GR 116	Romano, G., *I.B.V.S.*, **106**, 1965.
WR 153	Weber, R.
Zi 1591 = CVS 4506	Meinunger, L., *Mitt. veränd. Sterne*, **3**, 18, 1965.

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Gaposchkin, S., *Kl. Veröff. Remeis-Sternw. Bamberg*, Bd IV, Nr. 40, 1965.
Miller, W. J., Wachmann, A. A., *Ric. astr. Spec. Vatic.*, **6**, 413, 1963; **6**, 497, 1963.
Miller, W. J., *Ric. astr. Spec. Vatic.*, **6**, 591, 1964; **7**, 197, 1965; **7**, 217, 1966.
Plaut, L., *Bull. astr. Inst. Netherl., Suppl.*, **1**, no. 3, 1966.
Szafraniec, R., *Acta astr., Suppl.*, Part 6, 1963. Cracow vis. observations Sct-Vul.

NEW SPECTROGRAPHIC DATA

In Table 2 are listed references to spectroscopic data made available since the previous report. Of the stars showing atmospheric eclipses, there are reports of the 1962 eclipse of 32 Cygni and the 1963–64 eclipse of ζ Aurigae; Peery has published a new orbit and discussion for VV Cephei, and Wright is working up the Victoria results for VV Cephei and 31 Cygni and for the 1965 eclipse of 32 Cygni. Popper continues to improve the orbits for binaries for which accurate masses and dimensions can be determined. The Asiago and Toronto observers report more orbits for Bamberg Variables, and Götz and Wenzel have given spectral types for faint variables. Gyldenkerne has called attention to the possibility of fruitful results from the fall 1966 eclipse of ζ Aurigae.

Among more general papers, Karetnikov, Lavrov and Martynov have published volumes 3 and 4 of their *Bibliography of Spectroscopic Binary Orbits*, Perova has published data on the components in systems with known or suspected variables, MacDonald has listed spectra of 179 eclipsing binary stars, and Koch, Olson and Yoss have discussed the luminosities, spectra and rotation of 19 eclipsing systems. Popper has surveyed the spectra of 38 eclipsing binaries at Mt Stromlo, and also has found (private communication) that the following northern stars have double lines: PW Her, BP Vul, EE Reg, HD 90242 (BV 701), and BD + 47°781 (BV 307). Oke has published observed energy distributions for early-type stars and Aller, Faulkner and Morton have given energy distributions for southern stars. Several papers on Wolf Rayet stars, including eclipsing stars, have appeared: classifications by Hiltner and Schick, energy distributions by Kuhi and colour indices by Popper. Azimov has discussed the sub-dwarf components in close binaries, and Kraft has related novae to U Geminorum stars.

Table 2. Spectroscopic Data on Eclipsing Binary Stars

Star	References	Remarks
V822 Aql	Fitzgerald, P., *Publ. Dom. astrophys. Obs.*, **2**, 417, 1964	Orbit
AE Aqr	Walker, M. F., *Sky Telesc.*, **29**, 23, 1965	
ϵ Aur	Morris, S. C., *Astr. J.*, **70**, 685, 1965	Orbit, dimensions
ζ Aur 1963–64 eclipse	Bardin, C., Prévot, L., *Publ. Hte-Provence*, **7**, no. 32, 1964	
	Faraggiana, R., *Z. Astrophys.*, **62**, 99, 1965	
	Faraggiana, R., Hack, M., *Z. Astrophys.*, **64**, 48, 1966	Comp. 31, 32 Cyg
	Hardop, J., Herczeg, T., Scholz, W., *Z. Astrophys.*, **64**, 97, 1966	
	Kitamura, M.	Okayama observations
	Mammano, A., *et al.*	Asiago observations
	Odgers, G. J., Wright, K. O., *J.R. astr. Soc. Can.*, **59**, 115, 1965	
TU Cam	Margoni, R., (Asiago), Herczeg, T., (Hamburg)	Current program

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Star	References	Remarks
R CMa	Kitamura, M., Sato, H.,	Okayama observations in progress
SX Cas	Fredrick, L. W., (Leander McCormick)	Infra red ob.
YZ Cas	Dombrovsky, V. A., *Publ. Leningrad Obs.*, **21,** 19, 1964	Limb darkening
	Perry, C. L., Stone, S. N., *Publ. astr. Soc. Pacif.*, **78,** 5, 1966	Orbit
AO Cas	Hovhannisian, R. H., *Mitt. Burakan*, **35,** 37, 1964	O.D.
U Cep	Andrews, D. H., Batten, A. H., Plavec, M., *Publ. astr. Soc. Pacif.*, **78,** 68, 1966	No Hα emission
	Batten, A. H.,	Victoria observations
VV Cep	Peery, B. F., Jr., *Astrophys. J.*, **144,** 672, 1966	Orbit, discussion
	Wright, K. O., Trieste Colloq.	D.A.O. observations
EK Cep	Ebbighausen, E.G., *Astr. J.*, **71,** 730, 1966	Orbit, discussion
9 Cha = HD 39780	Jones, D. H. P., (Radcliffe)	Double-lined spectra
ε CrA	Hernandez, C., (LaPlata)	Current observations
S CrB	Abhyankar, A. D., (Dunlap Plates)	New spec. orbit
U CrB	Batten, A. H., (D.A.O.)	Victoria observations
α CrB	Ebbighausen, E. G., (Kitt Peak)	Orb els.
Y Cyg	Petrie, R. M., (D.A.O.)	Victoria observations
KU Cyg	Popper, D. M., *Astrophys. J.*, **141,** 314, 1965	Revision: Dimensions
MY Cyg	Popper, D. M., *Astr. J.*, **69,** 677, 1964	2 comp. will give mass
57 Cyg	Ovenden, M. W., *Mon. Not. R. astr. Soc.*, **126,** 77, 1963	Reflection effect
32 Cyg 1962 ecl.	Faraggiana, R., Gokgoz, A., Hack, M., Kendis, I., *Mem. Soc. astr. ital.*, **36,** 63, 1965	
	Scholz, M., *Z. Astrophys.*, **61,** 179, 1965	
	Wright, K. O., *J. R. astr. Soc. Can.*, **60,** 89, 1966	
S Dor	Thackeray, A. D., *Mon. Not. R. astr. Soc.*, **129,** 169, 1965	Emission (max.) compared with min.
AI Dra	Ebbighausen, E. G., (Kitt Peak)	Orb. els.
CC Eri	Evans, D. S., *Mon. Notes Astr. Soc. Sth. Afr.*,**23,** 67, 1964	
DQ Her	Larsson-Leander, G., *Ann. Astrophys.*, **27,** 587, 1964	High dispersion 1935 Mt Wilson spectra
VZ Hya	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965	Orbit, masses
UV Leo	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965	Orbit, masses
17 Lep	Widing, K., *Astrophys. J.*, **143,** 121, 1966	Main sequence A+, Subgiant M
	Sahade, J., (LaPlata)	Current program
δ Lib	McLaughlin, D. B., *Astrophys. J.*, **138,** 1309, 1963	Rv differences

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Star	References	Remarks
β Lyr	Batten, A. H., (D.A.O.)	
	Hack, M.,	
	Z. Astrophys., **62,** 203, 1065	Composition
	Herczeg, T.	Put at disposal of Dr Svolopoulos (Athens)
	Koch, R. H.,	Scanner; 3rd light source
	Astr. J., **70,** 324, 1965	
31 Men = HD75747	Jones, D. H. P., (Radcliffe)	Current program
WZ Oph	Popper, D. M.,	
	Astrophys. J., **141,** 126, 1965	Orbit, masses
V566 Oph	Heard, J. F.,	
	J. R. astr. Soc. Can., **59,** 258, 1965	Orbit for W UMa system
VV Ori	Sivaraman, K. R., (Kodaikanal)	Current program
DN Ori	Smak, J.	
	Publ. astr. Soc. Pacif., **76,** 210, 1964; *Acta. astr.*, **15,** 327, 1965	Masses: subgiant 10^m overluminous secondary
EE Peg	Bakos, G. A.,	
	Publ. David Dunlap Obs., **2,** 431, 1965	Orbit
IZ Per = BV224 = HD9234	Yavuz, I., (Hamburg)	Orbit
β Per	Fletcher, E. S.,	
	Astr. J., **69,** 357, 1964	Helium cloud model
δ Pic	Thackeray, A. D.	
	Mon. Not. R. astr. Soc., **131,** 435, 1966	Orbit, mass ratio
V Sge	Herbig, G., Preston, G. W., Smak, J., Paczyński, B.,	
	Astrophys. J., **141,** 617, 1965	Nova-like; masses
WZ Sge	Krzeminski, W., Kraft, R. P.,	Stream; W. dwarf pair
	Astrophys. J., **140,** 921, 1964	
XZ Sge	Smak, J.,	
	Acta. astr., **15,** 327, 1965	Inverse M–L relation
V453 Sco	Sahade, J., Frieboes-Condé, H.,	
	Astrophys. J., **141,** 652, 1965	Orbit, model
RW Tau	Makarenko, E. N.,	
	Perem. Zvezdy, **14,** 214, 1962	Orbit
BL Tel	Feast, M. W.,	
	Mon. Notes astr. Soc. Sth. Afr., **25,** 5, 1966; *Mon. Not. R. astr. Soc.*, (in press)	Supergiant; semi-detached dark (?) secondary
TX UMa	Grewing, M., Herczeg, T.,	
	Z. Astrophys., **65,** 1966	Els: apsidal motion
S Vel	Sisteró, R., (Cordoba)	Current program
AL Vel	Wesselink, A. J.,	
	Mon. Not. R. astr. Soc., **127,** 105, 1964	Model: reflection effect
γ Vel	Ganesh, K. S., (Kodaikanal)	Current program, spec. orb.
BH Vir	Abt, H. A.,	
	Publ. astr. Soc. Pacif., **77,** 367, 1965	Orbit
B1985	Cowley, A. P.,	
	Astrophys. J., **142,** 299, 1965	Orbit: atmos. eclipse (?)
B5481 = HR8164	Mammano, A.,	Asiago orbit
GC22276	Makarenko, E. N.,	
	Perem. Zvezdy, **14,** 214, 1962	Revised orbit

Star	References	Remarks
BD +46° 985	Margoni, R., *et al.*, *I.B.V.S.*, **131**, 1966	Asiago orbit
BD +54° 2193	Snowden, M. S., *I.B.V.S.*, **127**, 1966 (Kitt Peak)	Vel. curve
HD 35652	Fletcher, J. M. (D.A.O.)	New spec els.
	Mayer, P. (Prague)	β Lyr binary
HD 200391	Bakos, G. A., Northcott, R., (David Dunlap)	New spec. els.
HD 205372	Batten, A. H.,	Discontinued at D.A.O.
ADS 9537	Batten, A. H., Hardie, R. H., *Astr. J.*, **70**, 666, 1965	2 contact binaries
BV 241, 342, 374	Fitzgerald, P. *Publ. David Dunlap Obs.*, **2**, 417, 1964	Orbits
BV 267	Margoni, R., Mammano, A., Biolchini, R., Bartolini, C. *I.B.V.S.*, **131**, 1966	Prelim. spec. els.
BV 312, 374, 412	Margoni, R., Mammano, A., Stagni, R.,	Asiago Orbits
BV 382	Bartolini, G., Mammano, A., Mannino, G., Margoni, R. *Asiago Contr.*, 168, 1965	Orbits, disc.

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Artiukhina, N. M., *Perem. Zvezdy*, **14**, 225, 1962.
Azimov, S. M., *Nach. Ak. Wiss. Azerbaijan*, no. 4, 109, 1964.
Götz, W., Wenzel, W., *Mitt. veränd. Sterne*, **2**, 85, 1964; *Mitt. veränd. Sterne*, **3**, 133, 1966.
Hiltner, W. A., Schick, R. E., *Astrophys. J.*, **143**, 770, 1966.
Karetnikov, V. C., Lavrov, N. V., Martynov, D. Ya., *Bibliography of Spectroscopic Binary Orbits*, Vols. 3 and 4.
Koch, R. H., Olson, E. C., Yoss, K. M., *Astrophys. J.*, **141**, 955, 1965.
Kuhi, L. V., *Astrophys. J.*, **143**, 753, 1966.
Kraft, R. P., *Astrophys. J.*, **139**, 457, 1964.
MacDonald, D. D., *Publ. Leander McCormick Obs.*, **12**, 51, 1964.
Oke, J. B., *Astrophys. J.*, **140**, 689, 1964.
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TIMES OF MINIMA AND PERIOD VARIATIONS

Table 3 contains the impressive number of over 400 eclipsing binaries whose periods were determined, revised, or discussed in the past triennium. It is to be understood that the entries in this Table represent in fact three rather different categories of observations.

In the first group, we have stars for which the period of eclipses is determined for the first time, usually from estimates on patrol photographic plates. This kind of work is directly connected with the discoveries of new eclipsing binaries. Here the largest number of new systems has again been supplied by the three German observatories: Bamberg (Strohmeier and collaborators), Sonneberg (Hoffmeister, Ahnert, Huth, Meinunger), and Hamburg (Wachmann). The first two recently shifted their surveys to the southern hemisphere, where the harvest will be particularly rich.

In the second category, we have observations of times of minima of eclipsing binaries known for some time. Here the purpose is not only to improve on the first and of necessity preliminary values of the periods, but also to detect whatever variations of period may occur. This field is now dominated by three large amateur groups. One of them, mostly American amateurs, is coordinated by Williams, the reductions are made by Robinson and Ashbrook, and the results are published by Robinson in the *Information Bulletin on Variable Stars* (*IBVS*) in Budapest. The results of German observers have been published by Dueball and Lehmann, and by Pohl and Kizilirmak, in the *Astronomische Nachrichten*. A third group works in Czechoslovakia under the direction of Obůrka, and publishes in the *Bulletin of the Institutes of Czechoslovakia*.

Thanks to these visual observers, many systems are being almost continually surveyed and larger period changes cannot escape detection. However, for some purposes, the precision of photoelectric work is required. Naturally an exact determination of period is a necessary condition for the derivation of photometric and spectrographic elements, but in order to study the period changes we need repeated observations. In the past triennium, systematic work in this field was reported by Fitch (Steward Observatory, Arizona), Purgathofer and Widorn (Vienna), and Plavec (Ondřejov). It is hoped that more observatories will join this program, which is now being coordinated by a special committee under the chairmanship of Plavec consisting of Koch, Kordylewski, Schneller, and Szafraniec. The systems so far chosen for concentrated effort on times of minima are given in the following list:

Stars for Observations of Times of Minima

Star	Max.	A_1	D	P	Reason for inclusion
RT And	$9^m.0$	$1^m.1$	$2^h.9$	$0^d.63$	Short minima. Period constant?
WW Aur	5·7	0·7	6·4	2·53	Check on constancy of period
i Boo	6·6	0·4	W	0·27	Bright W UMa system
RS CVn	8·0	1·3	12·8	4·80	Periodic changes?
R CMa	6·2	0·6	4	1·14	Representative of subclass
RZ Cas	6·4	1·4	4·8	1·20	Easily observable
TV Cas	7·3	1·1	7	1·81	Period constant?
U Cep	6·7	3·1	10	2·49	Large variations
VW Cep	7·8	0·4	2	0·28	Bright W UMa system
U CrB	7·6	1·4	10·6	3·45	Large variations
Y Cyg	7·0	0·6	7	3·00	Apsidal motion
V477 Cyg	8·3	0·9	3·6	2·35	Apsidal motion indicated
W Del	9·4	3·3	12·3	4·81	Apsidal motion? Large changes
TW Dra	7·8	1·7	10	2·81	Large variations
TX Her	8·3	0·7	4·6	2·06	MS system with variable period
AR Lac	7·3	0·9	8·5	1·98	Sudden change of period
β Lyr	3·4	0·9	β	12·93	Secular increase of period?
U Oph	5·8	0·7	7	1·68	MS system with variable period
V451 Oph	7·8	0·6	9·5	2·20	Apsidal motion indicated
β Per	2·2	1·3	9·8	2·87	Longest series of observations
U Sge	6·4	2·7	13	3·38	Suitable for complex studies
RW Tau	8·0	4·3	9	2·77	Gaseous ring
X Tri	8·9	3·1	5	0·97	Accurate timing of minima
TX UMa	6·8	2·1	12	3·06	Periodic changes? Apsidal motion
VV UMa	10·1	0·9	3·4	0·69	Short-period Algol system

The problem of the causes of the period variations remains to a large extent still open. Some astronomers are of the opinion that at least some of the observed variations are independent of the physical nature of the components of the system in question. In particular,

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

the Cracow astronomers K. Kordylewski (**7**), Z. Kordylewski (**8**), and Szafraniec (**9**) expressed the opinion that the variation of period is correlated with the spherical or galactic coordinates. Again, certainly some period changes are due to apsidal motion (see next section), and some to the presence of a third body in the system; the question is, how much can be explained in these ways. Illés-Almár and Almár (**10**) suggested that the presence of a third body might be a good explanation in more cases than believed, and in particular suggested that W Del, Z Dra, TX Her, and RV Lyr may be systems of this kind. Schneller (**11**) opposes this view in each of the above-mentioned cases; he argues that the variations of period are in most cases not periodic but rather cyclic. The same opinion was expressed by Plavec (**12, 13**).

It appears from the work by Schneller and by Plavec that strongest variations of period occur in systems with unstable components. F. B. Wood's idea that these variations are connected with mass transfer or mass loss appears to be much more strongly supported by observational evidence now than it was in 1950. Considerable progress has been achieved recently in the theoretical foundation of this hypothesis. S.-S. Huang (**14**) studied modes of mass ejection and their influence on period variations. A very detailed analysis of the problem of period changes due to mass exchange and mass loss was done by Piotrowski (**15**) and also by Kruszewski (**16**). The whole theory was reviewed by Kruszewski (**17**).

The problem is now how to connect the observed variations with the theory. The formulae derived by the authors just mentioned offer a wide variety of results according to the initial conditions. If we assume that the mass loss is due to ejections from the surface of the unstable component, we have the question of whether the areas of ejection are distributed over the surface at random. If so, we shall need a statistical theory; in this connection, a recent paper by Balasz-Detre and Detre (**18**) is very interesting; they point out the importance of the theory of random walk for the studies of period changes of variable stars in general. On the other hand, many aspects of the problem of period changes of eclipsing binaries appear now to be more directly connected with their dynamics and evolution, and further progress depends much on our understanding why and how the mass transfer goes on.

For Table 3 we have adopted a new form of referencing which we hope will simplify somewhat a rather complicated situation. The first part of the Table, arranged by star, lists the authors and if necessary their (sometimes several) papers a, b, etc.; these papers are then cited by author and letter in the 'Bibliography to Table 3' immediately following that Table.

Table 3. Times of minima, light elements, and discussions of periods of eclipsing binary systems

Star	Authors
RT And	Ahnert (j), Dueball and Lehmann, Obůrka (a, b, c, d), Pohl and Kizilirmak, Robinson, (b, d, e, f), *Sky and Telescope* (a, b)
TW And	Obůrka (a)
XZ And	Dueball and Lehmann, Obůrka (c, d), Pohl and Kizilirmak, Robinson (d, e, f), Sakharov, *Sky and Telescope* (b), Szafraniec (a)
AB And	Dueball and Lehmann, Kalchaev and Truttse, Pohl and Kizilirmak, Purgathofer and Widorn
BO And	Meinunger (C)
BX And	Obůrka (c), Robinson (e)
RY Aqr	Obůrka (d)
CX Aqr	Robinson (d, e), Sakharov, *Sky and Telescope*
V389 Ara	Hoffmeister
77 G Ara (BV420)	Thackeray and Knipe
RX Ari	McCluskey (a)
FK Aql	Szafraniec (a)

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Star	Author
GU Aql	Gessner (a)
KO Aql	Cristaldi (b), Filatov, Pohl and Kizilirmak, Robinson (b)
KP Aql	Dueball and Lehmann, Pohl and Kizilirmak
OO Aql	Dueball and Lehmann, Fitch, Obůrka (c), Pohl and Kizilirmak, Robinson (b, d, e), *Sky and Telescope* (a, b, f)
QS Aql	Knipe (b)
V337 Aql	Catalano and Rodono
V342 Aql	Baldwin and Robinson, Robinson (b)
V343 Aql	Huth (c)
V346 Aql	Cristaldi and Walter, Dueball and Lehmann, Huth (c), Obůrka (c), Pohl and Kizilirmak, Robinson (b, d, e)
V348 Aql	Meinunger (x)
V406 Aql	Gessner (a)
V408 Aql	Gessner (a)
V413 Aql	Gessner (a)
V418 Aql	Gessner (a)
V557 Aql	Meinunger (y)
V589 Aql	Meinunger (y)
V640 Aql	Meinunger (z)
V688 Aql	Huth (c)
V869 Aql	Gessner (a)
RY Aur	Kordylewski, K. (a)
SX Aur	Dueball and Lehmann
TT Aur	Dueball and Lehmann, Obůrka (a, b, c, d)
WW Aur	Dueball and Lehmann, Fitch, Robinson (b, f), *Sky and Telescope* (b, f), Kristenson
AR Aur	Robinson (f)
EQ Aur	Meinunger (d)
ζ Aur	Hardorp, Herczeg and Scholz, Schneller (c)
θ Aur	Jackisch
TY Boo	Szafraniec
TZ Boo	Dueball and Lehmann
XY Boo	Wood, R.
ZZ Boo	Obůrka (c), Pohl and Kizilirmak
AC Boo	Binnendijk, Maunder
i Boo	Catalano and Saitta, Fitch, Karetnikov (c), Pohl and Kizilirmak, Purgathofer and Widorn, Schneller (d, f)
Y Cam	Obůrka (d), Robinson (d, f)
RZ Cam	Pohl and Kizilirmak
SV Cam	Dueball and Lehmann, Obůrka (a, c, d), Pohl and Kizilirmak, Robinson (b, d, e, f), *Sky and Telescope* (b, f)
TU Cam	West
AL Cam	Quester, Braune
S Cnc	Kordylewski, K. (a)
TW Cnc	Model
TX Cnc	Kitamura
UU Cnc	Beyer
WY Cnc	Chambliss, Dueball and Lehmann
RS CVn	Dueball and Lehmann, Rodono (unpubl.)
R CMa	Dueball and Lehmann, Fitch, Knipe (a), Obůrka (b, c), Robinson (b)
RX CMa	Kordylewski, K. (a)
SW CMa	Ziegler
EG CMa	Kordylewski, K. (a)
XZ CMi	Dueball and Lehmann, Wilson (b)

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Star	Author
YY CMi	Dueball and Lehmann
AK CMi	Kordylewski, K. (a), Obůrka (d)
RZ Cas	Burke and Rolland, Chang-chun, Chupilko, Dueball and Lehmann, Karetnikov (a), Kiperman (a, c), Obůrka (a, b, c, d), Plavec, Robinson (a, b, c, d, e, f), *Sky and Telescope* (a, b), Vikhristjuk, Kristenson
TV Cas	Chupilko, Dueball and Lehmann, Karetnikov (b), Kiperman (c), Obůrka (b, c, d), Pohl and Kizilirmak, Robinson (e, f), *Sky and Telescope* (b), Kristenson
TW Cas	Dueball and Lehmann, Obůrka (c, d), Pohl and Kizilirmak
YZ Cas	Dueball and Lehmann
AB Cas	Dueball and Lehmann, Pohl and Kizilirmak, Robinson (e, f)
BM Cas	Beyer
BY Cas	Malik
CW Cas	Broglia (a)
DO Cas	Obůrka (b, c)
EK Cas	Beyer
GR Cas	Gessner (b)
IV Cas	Dueball and Lehmann
RR Cen	Knipe (c)
SV Cen	Irwin (1966, in press)
U Cep	Dueball and Lehmann, Lukatskaya and Lirovchenko, Obůrka (b, c, d), Pankow, Robinson (b, f), Szafraniec
SU Cep	Dueball and Lehmann, Obůrka (c)
VW Cep	Chupilko, Dueball and Lehmann, Kiperman (c), Kwee, Obůrka (c)
WY Cep	Kordylewski, K. (a), Obůrka (c, d)
WZ Cep	Obůrka (c, d)
XX Cep	Dueball and Lehmann, Kordylewski, K. (a), Obůrka (b, c), Pohl and Kizilirmak, Robinson (b, e, f)
XY Cep	Obůrka (d)
XZ Cep	Obůrka (a, c)
ZZ Cep	Obůrka (a, b), Dueball and Lehmann, Robinson (f)
CW Cep	Kiperman (c), Vikhristjuk
EG Cep	Dueball and Lehmann (=200 Dra), Obůrka (c), Pohl and Kizilirmak
RW Cet	Pohl and Kizilirmak
RZ Com	Dueball and Lehmann, Fitch
ϵ CrA	Cousins (a)
U CrB	Fitch (a)
RW CrB	Fitch (a)
Y Crv	Meinunger (c)
Y Cyg	Ahnert (d), Chupilko, Dueball and Lehmann, Obůrka (a, c), Schneller (a)
RR Cyg	Pohl and Kizilirmak
RZ Cyg	Ignatieva
SW Cyg	Todoran (a), Schneller (a)
WZ Cyg	Obůrka (d)
ZZ Cyg	Todoran (b)
BR Cyg	Dueball and Lehmann, Fitch, Obůrka (b, c), Pohl and Kizilirmak
CG Cyg	Obůrka (c, d)
DK Cyg	Obůrka (c)
EE Cyg	Wachmann
EM Cyg	Mumford (b)
FR Cyg	Wachmann
HL Cyg	Wachmann
GO Cyg	Fitch, Obůrka (c), Purgathofer and Widorn
KR Cyg	Fitch

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

Star	Author
MR Cyg	Lavrov (a, c)
MY Cyg	Filatov, Obůrka (c), Pohl and Kizilirmak
V388 Cyg	Obůrka (c)
V401 Cyg	Purgathofer, Wachmann
V445 Cyg	Vam Vjet Chin
V466 Cyg	Pohl and Kizilirmak
V477 Cyg	Ahnert (d), Pohl and Kizilirmak
V548 Cyg	Dueball and Lehmann, Pohl and Kizilirmak
V753 Cyg	Wawriniak
31 Cyg	O'Connell, Wright
W Del	Huth (c), Schneller (b)
RR Del	Huth (c)
TY Del	Dueball and Lehmann, Huth (c), Pohl and Kizilirmak, Robinson (e)
DM Del	Obůrka (c)
BN Del	Meinunger (z)
BO Del	Meinunger (A)
EX Del	Karamish
Z Dra	Obůrka (c, d), Pohl and Kizilirmak, Robinson (b, d, f), Schneller (b), Todoran (a)
RZ Dra	Obůrka (b, c, d)
TW Dra	Kordylewski, K. (a), Obůrka (b, c, d), Robinson (d), Schneller (g)
TZ Dra	Dueball and Lehmann, Plavec, Pohl and Kizilirmak
UZ Dra	Dueball, Dueball and Lehmann, Obůrka (c), Pohl and Kizilirmak
WW Dra	Koch
XY Dra	Meinunger (k)
AI Dra	Dueball and Lehmann, Pohl and Kizilirmak, Robinson (b, d, e), *Sky and Telescope* (e)
S Equ	Dueball and Lehmann, Obůrka (b), Plavec
W Equ	Huth (c, d)
WX Eri	Dueball and Lehmann
YY Eri	Bhattacharyya
AS Eri	Filatov
BC Eri	Fitch (b)
BZ Eri	Meinunger (e)
SU For	Omay
U Gem	Bornhurst, Krzeminski, Mayall
SX Gem	Obůrka (c)
TX Gem	Dueball and Lehmann
YY Gem	Dueball and Lehmann
AL Gem	Dueball and Lehmann
BD Gem	Ahnert (a)
DP Gem	Meinunger (s)
DV Gem	Hildebrandt
EU Gem	Meinunger (t)
FT Gem	Meinunger (s)
Z Her	Fitch (a), Robinson (b)
RX Her	Dueball and Lehmann, Fitch, Obůrka (c), Pohl and Kizilirmak, Vikhristjuk
SZ Her	Obůrka (c, d), Pohl and Kizilirmak, Robinson (b, d, e), *Sky and Telescope* (a, b, f)
TX Her	Dueball and Lehmann, Fitch, Obůrka (c, d), Pohl and Kizilirmak, Schneller (b)
UX Her	Dueball and Lehmann, Fitch, Obůrka (a, b, c, d)

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Star	Author
AK Her	Bertiau, Dueball and Lehmann, Fitch, Obůrka (a, c, d), Pohl and Kizilirmak, Purgathofer and Widorn
BC Her	Fridel
CC Her	Obůrka (c)
DQ Her	Bornhurst
GL Her	Kordylewski, Z.
V342 Her	Kapko
V388 Her	Pohl and Kizilirmak
u Her	Fitch (a), *Sky and Telescope* (d)
RX Hya	Kordylewski, K. (a)
TY Hya	Kordylewski, K. (a)
EU Hya	Kordylewski, K. (a)
EX Hya	Mumford (a)
SS Lac	Tashpulatov
SW Lac	Bookmyer, Dueball and Lehmann, Fitch, Lang and Vetešník, Obůrka (a, b, d), Pohl and Kizilirmak, Purgathofer and Widorn, Robinson (b, d, e, f)
VX Lac	Obůrka (c, d), Szafraniec
AR Lac	Ahnert (e), Dueball and Lehmann, Obůrka (b, c)
BP Lac	Gessner (c)
BS Lac	Gessner (c)
BW Lac	Gessner (c)
CM Lac	Ahnert (e), Dueball and Lehmann, Obůrka (a, b), Pohl and Kizilirmak, Vikhristjuk
Y Leo	Chis and Pal, Dueball and Lehmann, Obůrka (c), *Sky and Telescope* (f), Robinson (f)
UV Leo	Dueball and Lehmann, Obůrka (b, c), Pohl and Kizilirmak, Purgathofer and Widorn, Robinson (d), McCluskey (b)
UX Leo	Kordylewski, K. (b)
XY Leo	Dueball and Lehmann
XZ Leo	Dueball and Lehmann
AM Leo	Dueball and Lehmann, Pohl and Kizilirmak
T LMi	Kordylewski, K. (a)
SS Lib	Fitch, Robinson (b)
δ Lib	Dueball and Lehmann, Fitch, Robinson (b), *Sky and Telescope* (f)
RR Lyn	Dueball and Lehmann, Linnell
RV Lyr	Schneller (b)
TZ Lyr	Obůrka (b, c, d)
UZ Lyr	Dueball and Lehmann, Fitch, Obůrka (b, c, d), Pohl and Kizilirmak
AK Lyr	Wachmann
BV Lyr	Wachmann
EP Lyr	Wachmann
FL Lyr	Dueball and Lehmann, Cristaldi (a), Pohl and Kizilirmak, Robinson (b, d, e)
NV Lyr	Wachmann
NY Lyr	Makarenko
β Lyr	Herczeg (a), Pohl and Kizilirmak, Robinson (e), *Sky and Telescope* (c)
RU Mon	Martynov (a, b)
RW Mon	Ahnert (a)
UY Mon	Ahnert (a)
AT Mon	Meinunger (a)
HK Mon	Meinunger (u)
HY Mon	Meinunger (b)
IM Mon	Sanyal and Mahra and Sanwal

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Star	Author
IS Mon	Olüniak
U Oph	Dueball and Lehmann, Fitch, Obůrka (c), Pohl and Kizilirmak, Robinson (b, e)
RV Oph	Robinson (b), *Sky and Telescope* (b)
V415 Oph	Meinunger (v)
V451 Oph	Fitch (a), Kiperman (c), Obůrka (c), Vikhristjuk
V502 Oph	Fitch (a), Obůrka (c)
V508 Oph	Fitch (a), Karetnikov (a)
V566 Oph	Kiperman (b), Obůrka (b, c), Purgathofer and Widorn, Robinson (c), Vikhristjuk
V575 Oph	Meinunger (v)
V839 Oph	Obůrka (c), Wilson and O'Toole
V916 Oph	Meinunger (w)
Z Ori	Pochkareva
CQ Ori	Ahnert (c), Kordylewski, K. (a)
FF Ori	Ahnert (b), Kordylewski, K. (b)
FI Ori	Dueball and Lehmann, Kordylewski (b)
FT Ori	Cristaldi (b)
V392 Ori	Meinunger (D)
U Peg	Dueball and Lehmann, Obůrka (a, b, c, d), Pohl and Kizilirmak, Purgathofer and Widorn.
TY Peg	Obůrka (b), Huth (f)
UX Peg	Huth (f), Obůrka (a, d), Pohl and Kizilirmak
AQ Peg	Huth (f), Szafraniec
AT Peg	Ahnert (f), Cristaldi and Walter, Obůrka (a, c), Pohl and Kizilirmak
AW Peg	Huth (f)
BB Peg	Huth (f), Strelkova
BG Peg	Huth (f), Szafraniec
DI Peg	Dueball and Lehmann, Huth (f), Pohl and Kizilirmak
DK Peg	Dueball and Lehmann
EE Peg	Bakoś, Dueball and Lehmann, Vikhristjuk
EH Peg	Huth (e)
Z Per	Obůrka (a)
RT Per	Obůrka (b), Robinson (b, e, f), Todoran (a)
RV Per	Kordylewski, K. (a)
RW Per	Kordylewski, K. (a)
RY Per	Kordylewski, K. (a)
ST Per	Ahnert (i), Dueball and Lehmann, Pohl and Kizilirmak, Robinson (f)
XZ Per	Pohl and Kizilirmak
BO Per	Löchel
BP Per	Löchel
DD Per	Obůrka (a)
EN Per	Meinunger (o)
HV Per	Meinunger (k)
LZ Per	Ahnert (i)
β Per	Dueball and Lehmann, Herczeg (a), Pohl and Kizilirmak, Robinson (e, f), *Sky and Telescope* (b)
δ Pic	Cousins (b)
SX Psc	Kordylewski, K. (a)
XZ Pup	Kordylewski, K. (a)
WX Sgr	Fitch (a)
AI Sgr	Kordylewski, K. (a)
V505 Sgr	Cristaldi and Walter, Robinson (b, d), *Sky and Telescope* (b), Vikhristjuk

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Star	Author
U Sge	Dueball and Lehmann, Fitch, Obůrka (c), Pohl and Kizilirmak, Robinson (b)
V Sge	Romano (a, b, c)
SY Sge	Huth (c)
UZ Sge	Huth (c)
RS Sct	Obůrka (c, d)
VZ Sct	Kordylewski, K. (a)
V Ser	Fitch (a)
RW Tau	Dueball and Lehmann, Obůrka (c), Robinson (e, f)
CT Tau	Ahnert (h), Beyer
EN Tau	Meinunger (p)
EO Tau	Meinunger (r)
X Tri	Dueball and Lehmann, Obůrka, Plavec, Pohl and Kizilirmak, Robinson (e, f), Sakharov, *Sky and Telescope* (b)
RS Tri	Plavec
RW Tri	Mandel
W UMa	Blitzstein and Chou, Dueball and Lehmann, Fitch, Joshi, Obůrka (b, c, d), Kristenson
RW UMa	Romano (a)
TX UMa	Dueball and Lehmann, Herczeg (b), Obůrka (a, b, c)
TY UMa	Pohl and Kizilirmak
UX UMa	Dueball and Lehmann, Mandel, Obůrka (c, d), Pohl and Kizilirmak
VV UMa	Wilson (a)
XY UMa	Kordylewski, K. (a)
ZZ UMa	Strohmeier *et al.* (b)
AA UMa	Strohmeier and Ott
W UMi	Dueball and Lehmann
RT UMi	Götz and Wenzel
W Vir	Prikhodko, Tchuprima
AG Vir	Purgathofer and Widorn
AH Vir	Dueball and Lehmann, Fitch, Purgathofer and Widorn, Truttse and Kalchaev
BD Vir	Kordylewski, K. (a)
BH Vir	Dueball and Lehmann
Z Vul	Broglia (b), Ahnert (g), Dueball and Lehmann, Obůrka (b, c, d), Pohl and Kizilirmak
RR Vul	Huth (c)
RS Vul	Fitch (a), Vikhristjuk
SY Vul	Meinunger (u)
XZ Vul	Lavrova, Wachmann
AT Vul	Lavrov (b), Lavrova, Huth (c)
AW Vul	Huth (c)
AX Vul	Huth (c)
AY Vul	Huth (c)
BE Vul	Huth (c)
BO Vul	Huth (c), Obůrka (c)
BP Vul	Huth (a, b)
BS Vul	Huth (c)
BV Vul	Huth (c)
DR Vul	Obůrka (b), Schneller (a)
BV 7 Cep	Meinunger and Wenzel
BV 36 UMa	Meinunger (m)
BV 159	Nikulina
BV 267	Kondo, Margoni *et al.*

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Star	Author
BV 277 Dra	Meinunger (l)
BV 305	Obůrka (c)
BV 312 Tau	Dueball and Lehmann, Robinson (b), *Sky and Telescope* (b)
BV 332	Obůrka (c)
BV 342	Kondo
BV 343	Nikulina
BV 344	Nikulina
BV 374	Strohmeier (d)
BV 375	Strohmeier (d)
BV 376	Strohmeier (d)
BV 382 Cep	Ruiz and Stokes, Bartolini *et al.*
BV 384	Obůrka (d)
BV 412	Schneller (f)
BV 544 Oph	Robinson (e)
BV 623	Strohmeier (c, e)
CVS 134 Cas	Reiche (a)
CVS 160 Cas	Meinunger (e)
CVS 235 Per	Meinunger (i)
CVS 449 Ori	Meinunger (g)
CVS 891 Gem	Meinunger (f)
P 2289 Aqr	Meinunger (A)
S 3948 Gem	Tschäpe
S 3965 Ori	Meinunger (A)
S 4382 Aql	Gessner (a)
S 4417 Aql	Gessner (a)
S 4420 Aql	Gessner (a)
S 4969 Cen	Hoffmeister
S 4997 Cir	Hoffmeister
S 5001 Lup	Hoffmeister
S 5351 TrA	Hoffmeister
S 5375 Ind	Hoffmeister
S 5454 Cam	Meinunger (B)
S 7830 Cyg	Gessner (d)
S 7831 Dra	Gessner (d)
S 7840 Dra	Gessner (d)
S 7847 Cyg	Gessner (d)
S 7849 Dra	Gessner (d)
S 7870 Cyg	Gessner (e)
S 7881 Cyg	Gessner (e)
S 7882 Cyg	Gessner (e)
S 7885 Cyg	Gessner (e)
S 7886 Cyg	Gessner (e)
S 7889 Cyg	Gessner (e)
S 7895 Cyg	Gessner (e)
S 7896 Cyg	Gessner (e)
S 7898 Cyg	Gessner (e)
SVS 645 Del	Kordylewski, Z.
16·1929	Strohmeier (a)
84·1930 Aql	Gessner (a)
107·1930 Aql	Gessner (a)
13·1936 Per	Löchel
35·1936 Aur	Kuhn
166·1940 Cyg	Reiche (b)
76·1942 Lac	Gessner (c)

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Star	Author
77·1942 Lac	Gessner (c)
222·1943 Ori	Ziener
173·1945 Cyg	Meinunger (j)
CPD −67° 3312 = HD 156 545	Deuricks, Briers
HD 161 783	van Houten
HD 187 418	van Houten
HBV 337, 338, 340, 341, 344, 347, 349, 350, 352, 354, 355, 356, 357, 360, 361, 362, 363, 365, 368, 369, 371, 374, 375	Wachmann (a)
HBV 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401	Wachmann (b)

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APSIDAL MOTION

Martynov (**19**) has found that the apsidal motion of RU Mon is faster than had previously been supposed, being 45″ per period of revolution, so that $U/P = 29\,000$. Martynov derives an effective polytropic index of 3·1. Several systems have been examined by Semeniuk (**20**); he derived new values of the apsidal motion period for V 380 Cyg, CO Lac, AG Per and DR Vul. Two further stars, V 889 Aql and DI Her, show slow but detectable apsidal motion. The case of V 477 Cyg is more complicated, because the apsidal motion is apparently distorted by period changes of some other kind. O'Connell is investigating V 477 Cyg, V 526 Sgr, and DR Vul for apsidal motion.

Among the new eclipsing binaries, two systems appear promising for apsidal motion because of large eccentricity: FT Ori (**21**) and AL Cam (**22**).

It would be very important for understanding the internal constitution of the subgiants to detect with certainty apsidal motion in some of the well-known Algol-like systems. However, recent work by Herczeg on Algol and TX UMa, led him to the conclusion that the case is still rather uncertain and that only observations of the secondary minima can decide it.

The problem of apsidal motion, in both its theoretical and its observational aspects, was surveyed by Kopal (**23**). An important chapter in this paper deals with comparison of the results with the theory of stellar constitution.

Table 4. Investigations on apsidal motion

Star	References
V889 Aql	Semeniuk, I., *Acta. astra.* (in press).
Y Cyg	Schneller, H., *Astr. Nachr.*, **287**, 183, 1963.
MR Cyg	Lavrov, M. I., *Trudy Kazan Univ.*, **85**, 1963.
V380 Cyg	Semeniuk, I., *Acta. astr.* (in press).
V477 Cyg	Ahnert, P., *Mitt. veränd. Sterne*, Sonneberg, **2**, 63.
	Semeniuk, I., *Acta. astr.* (in press).
CO Lac	Semeniuk, I., *Acta. astr.* (in press).
DI Her	Semeniuk, I., *Acta astr.* (in press).
AG Per	Semeniuk, I., *Acta. astr.* (in press).
RU Mon	Martynov, D. Ya., *I.B.V.S.*, **102**, 1965; *Astr. Zu.*, **42**, 1209.
β Per	Herczeg, T., *Bonn Veröff.*, 69, 1964.
HV7498 Sgr	Swope, H. H., *Inf. Bull. So. Hemisphere*, **8**, 13, 1966.
TX UMa	Herczeg, T., *Z. Astrophys.* (in press).
DR Vul	Semeniuk, I., *Acta. astr.* (in press).
	Schneller, H., *Astr. Nachr.*, **287**, 183, 1963.

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

CO-ORDINATED OBSERVING PROGRAMS

Results of earlier co-ordinated programs have appeared in the recent literature. Table C lists those publications concerning Epsilon and Zeta Aurigae and 31 and 32 Cygni whether or not these were made as part of the collaborative program. Dr Gyldenkerne, the co-ordinator, reports that observations on all these stars is continuing at Brorfelde with some participants from the 1963–64 campaign joining in.

For newer work, the committee on co-ordinated programs decided at the 1964 meetings to concentrate on only two systems. Dr Koch agreed to serve as co-ordinator for SX Cas. He reports:

'The cooperative program for observing SX Cas attracted considerable initial interest from photoelectrical observers and little response from spectroscopists. From the observations presently in hand several *U*, *B*, *V* light curves can be compiled with suitable phase coverage. The completeness of Hβ light curves is unknown at this time. Spectrographic results may be limited to the valuable series obtained by Joy several years ago. These have been measured but not yet discussed in detail.'

For W Serpentis, Dr Sahade served as co-ordinator and selected the period 17 June–3 July, 1966 as the interval for concentrated work. A number of observers agreed to participate, but the degree of successful coverage is not yet known. Four reports have been received at this writing; they were from Flagstaff, Cerro Tololo, Abastumani and Mount John (New Zealand).

An effort not planned at the meeting was caused by the announcement in *IAU circular* 1954, by Dr George Wallerstein, that spectroscopic data indicated that HD 128220 might be an eclipsing binary with a period of 870 days. Eclipse was predicted for about 6 June, 1966, with an uncertainty of at least ten days. One component of the system is reported as a type O subdwarf. Because of this and because the next opportunity to observe an eclipse will be five years later, it was decided to try to organize a collaborative effort. Dr E. G. Ebbighausen agreed to act as co-ordinator and a number of observers agreed to participate. Most reports are not yet available at the time of writing, but Schneller writes that his observations do not confirm an eclipse minimum.

At the Commission's request, Dr Batten issued an appeal for interested amateurs to assist in a photometric patrol on U Coronae Borealis. The response was disappointing; Dr Batten's own spectrographic work on the system continues as planned, and it would be distressing indeed if a photometric disturbance were missed.

Table C

Star	References
ϵ Aur	Huang, S., *Astrophys. J.*, **141,** 976, 1965.
	Low, F. S., Mitchell, R. I., *Astrophys. J.*, **141,** 327, 1965.
	Mitchell, R. I., *Astrophys. J.*, **140,** 1607, 1964.
ζ Aur	Bappu, M. K. V., Doss, A. T., Viswanadham, P., *Observatory*, **85,** 85, 1965.
	Bardin, C., Prévot, L., *Publ. Obs. Hte-Provence*, **7,** no. 32, 1964.
	Faraggiana, R., *Z. Astrophys.*, **62,** 99, 1965.
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	Fracastoro, M. G., Catalano, S., *Mem. Soc. astr. ital.*, **36,** 4, 1965.
	Hardop, J., Herczeg, T., Scholz, M., *Z. Astrophys.*, **64,** 97, 1966.
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 264, 1963.
	Kondo, Y., Harris, A. J., *Astr. J.*, **69,** 409, 1964.
	O'Connell, D. J. K., *Ric. astr. Spec. Vatic.*, **6,** no. 25, 1964.
	Odgers, G., Wright, K. O., *J. R. astr. Soc. Can.*, **59,** 115, 1965.
	Schneller, H., *Mitt. veränd. Sterne*, **2,** 178, 1965.

Star	References
ζ Aur	Shao, C. Y., *Astr. J.*, **69,** 858, 1965.
	Van Genderen, A. M., *Bull. astr. Inst. Netherl.*, **17,** 446, 1964.
	Zhang, C-y., Liu, X-f., *Acta astr. Sinica*, **13,** 102, 1965.
31 Cyg	Faraggiana, R., Hack, M., *Mem. Soc. astr. ital.*, **34,** 4, 1963.
	Hack, M., *Mem. Soc. astr. ital.*, **33,** 189, 1962.
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 283, 1963.
	O'Connell, D. J. K., *Ric. astr. Spec. Vatic.*, **6,** no. 23, 1964.
	Saito, M., *Publ. astr. Soc.* Japan, **17,** 107, 1965.
32 Cyg	Faraggiana, R., Gokgoz, A., Hack, M., Kendis, I., *Mem. Soc. astr. ital.*, **36,** 63, 1965.
	Kwee, K. K., van Genderen, A. M., *Bull. astr. Inst. Netherl.*, **17,** 53, 1963.
	Jackisch, G., *Veröff. Sternw. Sonneberg*, **5,** 283, 1963.
	Scholz, M., *Z. Astrophys.*, **61,** 179, 1965.
	Wright, K. O., *J. R. astr. Soc. Can.*, **60,** 89, 1966.

DETERMINATION OF PHOTOMETRIC ORBITS

In Table 5 are listed those systems for which photometric orbits have been determined since the previous report, in addition to the systems treated in papers cited in the running references for this section.

One case of 'conventional' solution deserves note. Chen and Reuning (**24**), having observed Algol at 0·60 μ (orange) and in the infrared region from 0·87 to 2·5 μ, deduced relative dimensions in agreement with earlier values. They also discuss the ellipticity, limb-darkening and surface luminosity for the infrared case. These results together with those of the several good earlier investigations, now give a photometric description of this eclipsing binary over the entire spectrum from the ultraviolet to the infrared.

The problem of determination of eclipsing binary elements has been investigated by several persons and some new methods and approaches developed.

Grygar (**25**) considered non-linear distribution of brightness on the disks of O9–A3 stars using Hunger's, Underhill's, Mihalas's and Strom's models of stellar atmospheres. He computed coefficients of limb-darkening for 314 cases of 41 models, and compared the theoretical results with the observed quantities for 9 stars. He found good agreement for Ao stars but the representation for Bo stars not as good. Two explanations for the discrepancy seem possible: either that the Bo stars have cold envelopes or that present theory does not account exactly for the scattering of light by free electrons.

Davis (**26**) computed extensive tables of the function p (x, k, α^{oc}) for cosine darkening and $x = 0{\cdot}1, 0{\cdot}2, \ldots, 0{\cdot}9, 1{\cdot}0$, and similar calculations were made by Linnell (**27**). Jurkevich (**28**) developed explicit expressions for $d\alpha^x/dk$ and $d\alpha^x/dp$ and computed tables for them. Harris (**29**) developed computer programs for generalized linear least squares rectification of light curves using nine Fourier coefficients.

Shulberg and Tabachnik (**30**) developed a method for determination of elements by electronic computers, and applied it to W Del and YZ Cas. Tabachnik has extended the process to the determination of darkening coefficient and has shown that the calculation gives a unique solution.

Minin (**31**) investigated theoretically the reflection effect in close binary systems. Sobieski (**32**) studied the transport of energy through both gray and non-gray stellar atmospheres for determination of the reflection coefficient, and has applied his method to several systems.

Shulberg (**33**), continuing his study of cases of extended atmosphere, applied his method to a photographic light curve of UX Mon. He found that the G component of the system passes through the extended atmosphere of the A component. Tcherepashchuk (**34**) has

developed a new method of solution for light curves of systems which have one component with extended atmosphere. He shows that the solution of a certain integral equation gives enough information for the determination of the geometric parameters of the system and also the darkening function and the absorbing properties of an extended atmosphere. The method yielded satisfactory results on B, V light curves of V444 Cyg.

Kitamura (**35**) published his method of solution based on Fourier transformation of the light curve. He introduced an incomplete Fourier transformation, and computed tables of the special functions involved.

Kříž (**36**) considered a model for semi-detached systems in which one component is spherical and the other may be approximated by a tri-axial ellipsoid. He applied his method to RW Tau. Horak (**37**) extended the method to include solutions for systems having $i \neq 90°$, and investigated UX Her.

Wilson (**38**) offered a quick method for determination of the parameter k from light-curves which show two sufficiently deep minima. Tsesevich has extended Schneller's method for treating β Lyr and W UMa type stars, and computed convenient tables for direct calculations; the paper awaits publication.

Table 5. New solutions of photometric curves

Star	References
AD And	Rucinski, S., (in press in *Acta. astr.*).
BX And	Todoran, J., *Publ. Obs. Astr. Cluj*, no. 44, 1965 (pg).
Y Aql	Breinhorst, R., (Bonn Univ. Obs.).
V346 Aql	Cristaldi, S., Walter, K., *Astr. Nachr.*, **287,** 207, 1963.
RX Ari	McCluskey, Jr, G. E., *Astr. J.*, **71,** 527, 1966.
IU Aur = HD35 652	Mayer, P., *Publ. astr. Soc. Pacif.*, **77,** 436, 1965 (*UBV*).
AC Boo	Binnendijk, L., *Astr. J.*, **70,** 201, 1965 (yellow, blue). Maunder, H., *Z. Astrophys.*, **60,** 222, 1964 (*B, V*).
44i Boo	Catalano, S., Saitta, T., *Mem. Soc. astr. ital.*, **35,** 43, 1964 (red).
S Cnc	Irwin, J. B., *Astrophys. J.*, **138,** 1104, 1963 (differential coefficient of darkening).
TX Cnc	Kitamura, M., (unpublished).
WY Cnc	Chambliss, C. R., *Astr. J.*, **70,** 741, 1965 (two colors).
CW Cas	Broglia, P., *Mem. Soc. astr. ital.*, **35,** 23, 1964; *Milano-Merate Contr.* no. 226, 1964 (pe obs.).
DO Cas	Winkler, L., *Astr. J.*, **71,** 40, 1966.
RR Cen	Knipe, G. F. G., *Astrophys. J.*, **142,** 1068, 1965.
RZ Com	Binnendijk, L., *Astr. J.*, **69,** 154, 1964.
DK Cyg	Binnendijk, L., *Astr. J.*, **69,** 157, 1964.
KR Cyg	Vetešnik, M., *Bull. astr. Inst. Csl.*, **16,** 326, 1965.
V382 Cyg	Landolt, A. U., *Astrophys. J.*, **140,** 1494, 1964 (*UBV*).
V444 Cyg	Tcherepashchuk, A. M., *Astr. Zu.*, **43,** 517, 1966.
V386 Cyg	Harris, A. J. (unpublished).
EK Cep	Ebbighausen, E. G., *Astr. J.*, **71,** 642, 1966.
CC Eri	Evans, D. S., *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 67, 1964.
YY Eri	Binnendijk, L., *Astr. J.*, **70,** 209, 1965 (yellow, blue).
U Gem	Krzeminski, W., *Astrophys. J.*, **142,** 1051, 1065. Mumford, G. S., *Astrophys. J.*, **139,** 476, 1964 = *Kitt Peak nat. Obs. Contr.*, **48.**
UX Her	Horak, T., *Bull. astr. Inst. Csl.*, **17,** 27, 1966. Gordon, K. C., Kron, G. E., *Astr. J.*, **70,** 100, 1965 (two colors).
DI Her	Khivrenko, A. P., *Perem. Zvezdy*, **15,** 84, 1964.
EX Hya	Mumford, G. S., *Astrophys. J.*, **139,** 476, 1964 = *Kitt Peak nat. Obs. Contr.*, **50.**

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Star	References
SW Lac	Bookmyer, B. B., *Astr. J.*, **70**, 415, 1965 (two colors).
CO Lac	Semeniuk, J., (unpublished).
Y Leo	Chis, G., Pal, A., *Studii Cerc. Astr. Seism.*, **9**, 14, 1964.
UV Leo	McCluskey, Jr, G. E., *Astr. J.*, **71**, 536, 1966.
	Popper, D. M., *Astrophys. J.*, **141**, 126, 1965.
RS Lep	Klepczynski, W. J., Wood, F. B., *Astr. J.*, **69**, 92, 1964.
RR Lyn	Linnell, A. P., *Astr. J.*, **71**, 458, 1966.
FL Lyr	Cristaldi, S., *Mem. Soc. astr. ital.*, **36**, 77, 1965.
RU Mon	Martynov, D. J., *Astr. Zu.*, **42**, 1209, 1965 (phe).
WZ Oph	Popper, D. M., *Astrophys. J.*, **141**, 126, 1965 (yellow).
V566 Oph	Binnendijk, L., *Astr. J.*, **70**, 209, 1965 (yellow, blue).
Z Ori	Bochkareva, L. G., *Perem. Zvezdy*, **15**, 437, 1965 (pgr).
DI Peg	Rucinski, S., (Warsaw Obs.).
EE Peg	Bakos, G. A., *Publ. David Dunlap Obs.*, **2**, 431, 1965.
RT Scl	Bookmyer, B. B., (in press *Astr. J.*).
V499 Sco	Bookmyer, B. B., (in press *Astr. J.*).
RW Tau	Kříž, S., *Bull. astr. Inst. Csl.*, **16**, 118, 1965.
V Tri	Ureche, V., *Publ. Astr. Obs. Cluj*, no. 40, 1964 (pgr).
W UMa	Binnendijk, L., *Astr. J.*, **71**, 340, 1966 (two colors).
VV UMa	Wilson, R. E., *Astr. J.*, **70**, 368, 1965.
AL Vel	Wesselink, A. J., *Mon. Not. R. astr. Soc.*, **127**, 107, 1964.
BV267	Kondo, Y., *Astr. J.*, **71**, 46, 1966.
BV332	Harris, A. J. (unpublished).
BV342	Kondo, Y., *Astr. J.*, **71**, 54, 1966.
BV412	Harris, A. J. (unpublished).

ABSOLUTE DIMENSIONS OF ECLIPSING SYSTEMS

In Table 6 we list most of the determinations of absolute dimensions published since the previous report; some also occur in the papers cited in this section. To the continuing study of normal and of specially selected systems is now added some little emphasis on U Gem stars and old novae.

Krzeminski found in 1961 that U Gem is an eclipsing variable. The star has been further studied recently by Krzeminski (**39**), by Mumford (**40**), and by Paczyński (**41**). It appears well established that U Gem is a system which consists of a flare star and a white dwarf with a gaseous ring.

The following old novae have been investigated: WZ Sge by Krzeminski and Kraft (**42**), and EX Hya by Mumford (**43**). In an investigation of the physical parameters for novae Paczynski (**44**) has given a critical discussion of their masses.

Herbig, Preston, Smak and Paczynski (**45**) discovered that the irregular variable star V Sge is an eclipsing binary. From a detailed study of it they find the system parameters significantly variable.

Popper (**46**) continues his important study of special eclipsing systems with new determinations of absolute dimensions for WZ Oph, UV Leo and VZ Hya. New photoelectric observations of VZ Hya are needed.

Using 268 Michigan spectrograms Peery (**47**) has computed the absolute orbit of VV Cep. His discussion of the structure of the atmosphere and envelope of the M giant has shown that the density decreases with height more slowly than in the case of 31 Cyg. From analysis of his interference-wedge light curves of V444 Cyg at $\lambda\lambda$ 4686, 4795, 4440 and 4260Å, Tcherepashchuk (**48**) has constructed a model of the system and observed the variations of

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intensity of lines caused by physical changes in the system. Smak (**49**) finds that both components of RW Gem have colors which are abnormal for their radii and masses.

Bookmyer's careful study (**50**) of the light curve of SW Lac and of its variations opens up by implication a field of considerable potential value in the investigation of W UMa type systems. She finds that these variations are consequences of irregular changes in the system which are traceable in the system parameters computed at selected epochs. Her proposal that there be organized a program of simultaneous detailed photometric and spectroscopic observations of SW Lac will be discussed at the Prague sessions.

Finally, Binnendijk (**51**) finds that the increase of period observed in W UMa is a 'consequence' of the flare observed by Kuhi.

Table 6. New determinations of absolute dimensions of eclipsing binaries

Star	References
KO Aql	Roxburgh, J. W., *Astr. J.*, **70,** 690, 1965.
QS Aql	Chincarini, G., Margoni, R., Taffara, S., (unpublished).
V603 Aql	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
V822 Aql	Fitzgerald, P., *Publ. David Dunlap Obs.*, **2,** 417, 1964.
T Aur	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
	Walker, M., *Astrophys. J.*, **138,** 313, 1963.
TT Aur	Lavrov, M. I., *Publ. Kazan Univ.* for 1963, p. 188, 1964.
VV Cep	Peery, B. F., *Astrophys. J.*, **144,** 672, 1966.
EK Cep	Ebbighausen, E. G., *Astr. J.*, **71,** 642, 1966.
RZ Com	Binnendijk, L., *Astr. J.*, **69,** 154, 1964.
T CrB	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
MR Cyg	Lavrov, M. I., *Bull. Engelhardt Obs.* (Kazan), no. 38, 3–26.
V382 Cyg	Landolt, A. U., *Astrophys. J.*, **140,** 1494, 1964.
WW Dra	Kříž, S., *Bull astr. Inst. Csl.*, **16,** 306, 1965.
YY Eri	Binnendijk, L., *Astr. J.*, **70,** 209, 1965.
U Gem	Paczyński, B., *Acta astr.*, **15,** 305, 1965.
RW Gem	Smak, J., *Acta astr.*, **14,** 101, 1964.
UX Her	Gordon, K. C., Kron, G. E., *Astr. J.*, **70,** 100, 1965.
DQ Her	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
VZ Hya	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
SW Lac	Bookmyer, B. B., *Astr. J.*, **70,** 415, 1965.
Y Leo	Chis, G., Pal, A., *Studii Cerc. Astr. Seism.*, **9,** no. 1, 14, 1964.
UV Leo	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
FL Lyr	Cristaldi, S., *Mem. Soc. astr. ital.*, **36,** 77, 1965.
RU Mon	Martynov, D. J., *Astr. Zu.*, **42,** 1209, 1965.
WZ Oph	Popper, D. M., *Astrophys. J.*, **141,** 126, 1965.
V566 Oph	Heard, J. F., *J. R. astr. Soc. Can.*, **59,** 258, 1965.
DN Ori	Smak, J., *Astr. J.*, **69,** 677, 1964; *Publ astr. Soc. Pacif.*, **76,** 210, 1964; *Acta astr.*, **15,** 327, 1965.
EE Peg	Bakos, G. A., *Publ. David Dunlap Obs.*, **2,** 431, 1965.
GK Per	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
IZ Per	Yavuz, I., (unpublished).
δ Pic	Thackeray, A. D., *Mon. Not. R. astr. Soc.*, **131,** 435, 1966.
V Sge	Herbig, G., Preston, G. W., Smak, J., Paczyński, B., *Astrophys. J.*, **141,** 617, 1965.
WZ Sge	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
	Krzeminski, W., Kraft, R. P., *Astrophys. J.*, **140,** 921, 1965.
XZ Sgr	Smak, J., *Acta astr.*, **15,** 327, 1965.
V1017 Sgr	Kraft, R. P., *Astrophys. J.*, **139,** 457, 1964.
V453 Sco	Sahade, J., *Astrophys. J.*, **141,** 652, 1965.
AL Vel	Wesselink, A. J., *Mon. Not. R. astr. Soc.*, **127,** 107, 1964.

Star	References
BH Vir	Abt, H. A., *Publ. astr. Soc. Pacif.*, **77**, 367, 1965.
BV 241	Fitzgerald, P., *Publ. David Dunlap Obs.*, **2**, no. 14, 1964.
BV 342	Kondo, Y., *Astr. J.*, **71**, 54, 1966.
BV 344	Yavuz, I., (unpublished).
BV 374	Fitzgerald, P., *Publ. David Dunlap Obs.*, **2**, no. 14, 1964.
BV 382 Cep = GK Cep	Bartolini, C., Mammano, A., Mannino, G., Margoni, R., *Contr. Asiago*, 168, 1965; *I.B.V.S.*, **85**, 1965.

ASTROPHYSICAL AND DYNAMICAL INVESTIGATIONS

The fission theory of the origin of binary stars was revived by Roxburgh (**52**). He investigated the pre-main-sequence evolution of rotating non-magnetic stars, formed from interstellar clouds. After the end of the Hayashi track, each element of the growing radiative core conserves its angular momentum. For masses $> 0{\cdot}8\,M_\odot$ rotational instability in the core is likely to occur, and this is probably leading to a splitting of the star into two components. Assuming conservation of angular momentum on fission, it is shown that stars with mass $< 4\,M_\odot$ can form a contact binary (of the W UMa type), whereas more massive stars will produce separate binaries.

This new version of the fission theory is largely based on recent studies of rapidly rotating masses of gas. Polytropic models in solid-body rotation were treated by Hurley and Roberts (**53**), as a sequel to previous work by Roberts. James (**54**) studied the polytropic case as well as the white-dwarf case. For the study of rapidly rotating polytropes, Monaghan and Roxburgh (**55**) developed an approximation technique, which is well suited for investigating rotating stellar models. This technique was used by Roxburgh, Griffith and Sweet (**56**) to derive models for rapidly rotating main-sequence stars, and by Roxburgh (**57**) for models of rotating white dwarfs. Polytropic models with fast, non-uniform rotation were studied by Stoeckly (**58**); he found that instability may develop and that non-uniform rotation could be a factor in double-star formation. Chandrasekhar has completed (**59**) the extensive and important series of investigations he initiated in 1960 on the ellipsoidal figures of equilibrium of homogeneous masses. Lebowitz (**60**) has specified the circumstances under which Riemann's energy criterion for stability breaks down.

At the 1966 Liège symposium on 'Gravitational instability and the formation of stars and galactic structures' three papers were given which deal with the origin of binary stars. Roxburgh (**61**) discussed the influence of rotation and magnetic fields on the formation of single and multiple stars. Mestel (**62**) outlined a mechanism by which a close binary might be formed from a pair of proto-stars. Such a system is during the Hayashi phase subject to very efficient tidal friction, assuring close synchronism of orbital and rotatory motion. A small amount of mass loss can yield a large loss of angular momentum, if the emitted mass is magnetically coupled to the proto-stars. Provided the magnetic braking more than offsets the increase of spin due to contraction, the loss of rotatory angular momentum is made up at the expense of orbital angular momentum, and the two stars will steadily approach each other. Van Albada (**63**) described numerical integrations of the N-body problem which show that a random initial structure alters into a hierarchial one with a close binary in the center. The escape process is strongly connected with the formation of binaries, due to the tendency to redistribute the binding energy among fewer and fewer stars. It was suggested that this phenomenon may have been operating after the fragmentation of a dense cloud into proto-stars. In this way it may also account for the formation of wide binaries.

A general and rather detailed review article on the evolution of close binaries was written by Hack (**64**). At the Herstmonceux 1962 colloquium on 'Clusters and stellar evolution' McCrea (**65**) and others discussed the status of the stars forming the blue extension of the

main sequence beyond the turn-off point in certain old clusters. The consensus was that they probably represent close binaries, the evolution of which have been halted because of considerable mass transfer, a hypothesis further elaborated by McCrea (**66**). According to McCrea the components that have suffered great mass loss would show high helium abundance. Hill (**67**) found that several helium stars, with no detectable hydrogen, show no signs of duplicity, while some helium-rich stars are in fact binaries. Smak (**68**) made a prediction of the number of semi-detached systems to be expected in the blue extensions and reached satisfactory agreement with the observed numbers. Only a few of these binary stars should, however, be eclipsing variables. Williams (**69**) advanced the theory that the blue-extension stars are single objects, which have accreted material ejected from super-giants in the clusters. Coudé spectrograms of blue 'stragglers' in the old clusters M 67 and NGC 752, taken recently by Deutsch (**70**), indicate that the lines are highly broadened by rotation. Deutsch supposes that the stars represent metamorphs of late F-dwarfs, i.e. F-dwarfs that in the red-giant phase have shed a substantial part of their masses, including the slowly rotating outer parts, and returned to the neighborhood of the main sequence as chemically homogeneous objects. That would imply that at least some late-type stars have rapidly rotating interiors. Jaschek and Jaschek (**71**) studied the evolution of close binary systems using the limiting equipotential surface. It was shown that if the limiting sizes for the components are taken into account, it is understandable why the proportion of spectroscopic binaries is decreasing towards the later spectral types. Paczyński and Ziolkowski report that they are engaged in stellar model computations, in an attempt to follow the evolution of close binary components. We note that Zeldovich and Guseynov (**72**) pointed out the exciting possibility that invisible massive components of some binaries may be collapsed stars, which manifest themselves only by gravitational fields.

Eclipsing binaries of the W UMa type have recently been discovered in the old clusters M 67 and M 188 (**73, 74**). Kuročkin and Kukarkin (**75**) discussed the implication of this for some problems of stellar evolution, and concluded, inter alia, that the W UMa-type systems must be very stable.

Zahn (**76**) considered the influence of tides on the angular momentum of close binaries, his conclusion being that due to this mechanism alone, rotation and orbital motion cannot remain synchronized. Dziembowski is at present working on the problem of tidal friction. Peraiah (**77**) obtained a new expression for the angular velocity of the components of close binaries, which shows that synchronism may not hold in most cases. For the W UMa systems Smak (**78**) found that the rotational momentum is more than 100 times smaller than the orbital momentum. In an investigation of the mass-luminosity relationship for components of W UMa stars Osaki (**79**) obtained equality between luminosity ratio and mass ratio. To explain this mass-luminosity behaviour the internal structure was discussed. The magneto-gravitational stability of close binary systems was studied by Santarelli (**80**), using the method of small oscillations. An expression was derived, from which follows that an assumed degree of asynchronism between rotation and orbital motion is related to a minimum value of the magnetic field, and vice versa. Under certain assumptions the component in contact with the limiting equipotential surface was found unstable for perturbations having wave-lengths exceeding a critical value. Numerical examples are given for ER Ori and RZ Cas, a contact and a semi-detached system, respectively. Equations for the internal constitution of components in close binaries were deduced by Dziembowski (**81**). The importance of the binaries in the study of perturbations of spherical equilibrium stars was stressed by Schwarzschild (**82**) in his concluding remarks to the Joint Discussion C at the Hamburg General Assembly.

The theory of apsidal motion and its relation to stellar structure was given a general and detailed treatment by Kopal (**83**). Mean $\bar{k}$ of the constants of internal structure of both components in a large number of systems were derived, using a statistical relation between

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rotational and angular velocities. From apsidal motion data for RU Mon Martynov (**84**) obtained an effective polytropic index of 3·1 for both components. Peraiah (**85**) deduced expressions for the apsidal motion, assuming that the components rotate faster than is demanded by synchronism. Effective polytropic indices, computed for a number of binaries, give larger central condensation than in the case of synchronism.

Problems of mass transfer have during the last few years been treated by a number of authors. Reference to the paper by Plavec, Sehnal and Mikulas (**86**) on trajectories of particles ejected from L_1 in RW Tau was given already in the previous report of this Commission. Plavec and Kříž (**87**) have made supplementary calculations for RW Tau, as well as calculations for models resembling U Sge and U Cep. The pattern of trajectories is the same, although the mass ratio varies between 0·2 and 0·5. If ejections take place over the whole surface of the secondary, the following phenomena are predicted: (1) a variable extended atmosphere around the secondary, (2) a broad and dense stream flowing to the primary from the adjacent face of the secondary, (3) under favorable circumstances a transient or semi-permanent ring, formed by particles ejected at fairly high speeds into certain directions, (4) a certain amount of particles escaping from the system, if the ejection velocities are high enough.

Particle ejection due to non-synchronism between rotation and orbital motion was investigated by Kruszewski (**88**). The ejecting star was supposed to fill the limiting equipotential surface, ejection taking place at L_1. Numerical calculations of trajectories were made for various values of the non-synchronism parameter and for a variety of mass ratios. In addition to a particle stream ending on the smaller component, there is also a stream returning to the ejecting component. This latter stream always exists in the case of non-synchronism. It is suggested that the impact area, which is asymmetrically situated with respect to the line connecting the centers of the two stars, should be locally heated. Koch (**89**) postulated the asymmetrical shape of the secondary minimum of many close binaries to be evidence that the heated impact area is eclipsed in a number of systems. From the aspect of the asymmetry it was possible to discern the sense of rotation of the spectroscopically invisible component, and sometimes to set limits to its angular velocity.

Huang (**90**) studied several problems in connection with the gaseous flow in close binary systems, and derived a set of differential equations, which take into account the collision of particles but not the pressure. These equations thus form an intermediate between the particle and hydrodynamic treatment of mass motion. The solution of the equations gave results similar to those obtained previously by Prendergast from the hydrodynamic equations.

At the Joint Discussion C in Hamburg 1964 mass transfer was discussed by Plavec (**91**) and others. The restricted problem of three bodies, basic to most of the investigations quoted above, was extended by Lebrun and Robe (**92**) to the case when the finite masses are ellipsoids revolving in circular orbits.

Limber (**93**) studied surface forms and properties relating to mass loss in the general case of non-synchronous rotation. Roche models were used, and the deviation from uniform rotation was neglected in a first approximation of the surface forms. The nature and magnitude of the deviations from this approximation were then considered.

The effects of isotropic mass loss upon the orbital elements were treated by Chiara (**94**), Hadjidemetriou (**95**), Martin (**96**), and Omarov (**97**), assuming various laws for the mass loss. Huang (**98**) studied the transfer of angular momentum between ejected particles and the binary system. Recently, Huang (**99**) advanced the idea that observed axial rotation in excess of synchronism is only a superficial phenomenon, caused by impact of particles carrying a large amount of angular momentum. He also states that an unpublished study shows that no equilibrium surface exists for a component rotating non-synchronously. Kruszewski (**100**) studied period changes caused by the exchange of matter according to his computations of

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trajectories. The ejection of material, its fall on the other component and perturbations during flight were considered. In close connection with this work, Piotrowski (**101**) gave a detailed discussion of the effects of mass transfer with special attention to changes in period and eccentricity. An exhaustive review article by Kruszewski (**102**) on exchange of matter and period changes has recently appeared. Observed period changes of Y Leo were discussed by Chiş and Pál (**103**) and interpreted in terms of mass ejection from the secondary component. Similar interpretations were made by Schneller for i Boo (**104**), TW Dra (**105**) and, in as yet unpublished papers, for β Lyr and V 401 Cyg.

Porfiryev and Kalenichenko (**106**) made a theoretical study of radial velocity curves for various rotation laws and axial orientations. Shakhovski (**107**) discussed results of polarization measurements for 17 eclipsing binaries, including 5 stars with variable polarization. Mechanisms responsible for the polarization are photospheric scattering, the reflection effect, and, most important, scattering in a gaseous envelope. Orbital orientations and total masses of the envelopes were derived for RY Per and β Lyr. A new effect, a pronounced ultra-violet excess, was found by Popper and Walker (**108**) in some eclipsing variables.

A review paper on the problem of β Lyr, with the inclusion of new results, was given by Sahade (**109**). Reuning and Springer (**110**) gave a distorted-polytrope representation of the components. Woolf (**111**) found that the primary is slightly less distorted than the Roche model. He supports Huang's suggestion that the secondary is a star imbedded in a disk, and states that at least half the mass of the secondary is in the disk. The masses for primary and secondary component are found as 2·05 and 11·74 $M_\odot$, respectively. A model was worked out also by Sahade and Hernandez (**112**).

For ϵ Aur Huang (**113**) proposed a new model analogous to that of β Lyr; the secondary is supposed to be a rotating gaseous disk, which appears opaque when viewed edge-on. Roxburgh (**114**) found that KO Aql has an undersize sub-giant secondary in pre-main-sequence contraction. Smak (**115**) reported evidence of low surface gravity for both components of RW Gem. Various problems of the Algol systems were reviewed by Fracastoro (**116**).

The ultra-short period binaries from the class of cataclysmic and related variables have been the subject of a large number of theoretical investigations. Kraft (**117**) published a comprehensive review on our knowledge of this topic about 1962, and gave a shorter account in Hamburg at the Joint Discussion C (**118**). In this latter paper Kraft especially considered period changes due to mass ejection from the red component. Mumford (**119**) wrote a series of popular papers on these stars, dealing also with the theoretical side. Paczyński (**120**) developed a theory for the outbursts, as caused by mass transfer from the red to the blue component. Kraft (**121**), in a paper on observations of 10 old novae, discussed models, the period-luminosity relation for cataclysmic variables, causes of outbursts, and population membership. Kraft and Luyten (**122**), from data on proper motions and radial velocities, determined the mean absolute magnitude of the U Gem stars as 7·5. From this and from kinematical and other data for W UMa stars Kraft (**123**) concluded that the U Gem stars are probably descendants of W UMa systems. Gorbatzky (**124**) investigated the effect on stellar spectra of the disk-like envelopes, using SS Cyg as an example. Krzeminski (**125**) gave an interpretation of U Gem, and a detailed model for the nova-like variable V Sge was derived by Herbig, Preston, Smak and Paczyński (**126**). Another nova-like variable, 17 Lep, was treated by Widing (**127**).

Turning to new developments in the field of element computation, we note that Wilson (**128**) outlined a quick solution method in the case of complete eclipses. Tcherepaschuk (**129**) described a method of solution of light curves when one of the components has an extended atmosphere. Kitamura (**130**) published an exhaustive account of the element determination by means of Fourier transforms of the light curves, together with examples of practical analysis. Tables of the characteristic function of the eclipse and the related delta-functions, to be used in this method, have also been computed by Kitamura (**131**). Tabachnik and

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Schulberg (**132**) published a computer program for the case of total and annular eclipses of spherical components with circular orbits.

Members of the Flower and Cook group have developed computer programs for solutions under the Russell Model, with each program representing a single step of the sequence and so re-runnable at need. The aim is not to substitute the computer for the astronomer, but to enable calculations of all kinds to be made rapidly and then presented to the astronomer for his judgment. These stage-wise programs have not been published in detail, as this seems inefficient, but are available on request.

Linnell (**133**) wrote a group of computer programs for ${}^{0}\alpha$, ${}^{10}\alpha^{oc}$, ${}^{10}\alpha^{tr}$, ${}^{10}\alpha^{ann}$, ${}^{x}\alpha^{tr}$, and ${}^{x}\alpha^{oc}$. Each program calculates a value of that function for arbitrary permissible values of the parameters x, p, k. Programs were also made for the inverse functions ${}^{x}\varphi^{oc}$, ${}^{x}\varphi^{tr}$, ${}^{x}\chi^{oc}$, and ${}^{x}\chi^{tr}$. Samples of calculated tables have been published (**134**). Jurkevich (**135**) developed explicit expressions for the derivatives of ${}^{x}\alpha$ in terms of k and p, and tabulated these quantities. Tables for calculating the light equation due to the orbital motion of the Earth, were published by Schneller (**136**).

A new method for determining the limb-darkening from light-curves was developed by Wilson (**137**). Hosokawa (**138**) considered the coefficient of limb-darkening for bright main-sequence stars. Non-linear limb-darkening laws were computed by Grygar (**139**) for 41 model atmospheres (range O5–A3) constructed by Hunger, Mihales, Saito, Strom and Underhill. Gingerich (**140**) computed limb-darkening tables for a series of his model atmospheres (range $T_{\text{eff}} = 10\,000°\text{K}$ to $7000°\text{K}$). Kříž (**141**) made a new approach to the limb-darkening of RW Tau.

Minin (**142**) treated the theory of the reflection effect. Sobieski (**143**) obtained detailed numerical solutions of the radiative transfer problem for selected systems of close binaries in order to study the wave-length dependence of the phase law and to compute values of the net reflection coefficient A_1.

Ebbighausen and Gange (**144**) made a spectrographic investigation of the motion of Algol AB in the triple system. The mass ratio m_{AB}/m_C was found to be $3{\cdot}57 \pm 0{\cdot}16$. On the theoretical side Brazhnikova and Babinchuk (**145**) have investigated aspects of the recurrent problem of photometric spectroscopic anomalies due to 'periastron effects'.

Finally, still another paper in the lengthening series of studies of the *UBV* photometric system, has been published by Karyagina and Kharitonov (**146**).

STATISTICAL AND THEORETICAL INVESTIGATIONS

A number of interesting papers have appeared relating to the statistics of binary systems. Abt (**147**) has discussed the proportion of binaries among normal A-type stars and, with others, (**148**) has found 5 binaries among 47 Pleiades studied. The Jascheks (**149**) related the lower proportion of binaries in late-type stars to their evolution, while Sahade (**150**) has called attention to several systems (HD 698, HD 47 129, AO Cas, V 453 Sco, V 448 Cyg and β Lyr) all having underluminous, massive components and therefore perhaps a significant group evolutionwise. Szafraniec (**151**) has studied the dependence of period on galactic latitude and Cester (**152**) has found that the mass-luminosity relation for binary stars requires different segments for bright and for faint stars. Plavec (**153**) has suggested a two-dimensional system of classification for close binary systems based on Kopal's criterion of size relative to the Roche surface and Sahade's criterion of their position on the HR diagram.

Peraiah (**154**) has found that the velocity of rotation of binary components is frequently greater than suggested by the period. Porfiryev (**155**) has given formulae for line profiles computed for various velocities in systems with various orientations. Koch (**156**) has noted that the sense of rotation in a binary system can be determined from the asymmetry of the

https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press

light curve during eclipse and Mumford (**157**) has discussed the orientation of binary orbits. Huang (**158**) has shown that the origin of the angular momentum in binary systems is not from galactic rotation, but must have arisen from random motions in the pre-stellar medium.

There have been several papers discussing the relation between W UMa stars, U Gem stars and main sequence stars. Kuročkin (**159**) finds that the ages of W UMa stars are the same as main sequence stars; Artiukhina (**160**) finds that their solar motions and absolute magnitudes agree; and Smak (**161**) has compared W UMa stars with other stars of the same mass. Kraft (**162**) finds that the kinematics of W UMa stars and U Gem stars are nearly the same, but Popov (**163**) finds that their space distribution in the z-component is different. Kraft and Luyten (**164**) found a statistical parallax for U Gem stars which gave a mean absolute magnitude $M_v = 7{\cdot}6$ for stars with a period of $5^h\,32^m$.

The *Sixth Catalogue of the Orbital Elements of Spectroscopic Binaries* is being prepared for press at the time of writing and should be distributed soon after the Prague Assembly. The Catalogue will appear in the Publications of the Dominion Astrophysical Observatory. It will contain orbital elements for nearly 740 spectroscopic binary systems—an increase of 50% over the Fifth Catalogue of Moore and Neubauer—as well as references to about 60 other systems for which orbital elements are not yet well enough known to be included in the Catalogue.

Schneller writes that work is going forward well on the third edition of his 'Geschichte und Literatur der veränderlichen Sterne' and that the first volume is expected to appear early in 1967. F. B. Wood states that the Flower and Cook Card Catalog on Eclipsing Binaries is expanding at a rapid rate, and reminds all workers in the field that its thousands of entries are at their disposal.

The Third Colloquium on Variable Stars (**165**) held at Bamberg in 1965, on 'The Position of Variable Stars in the Hertzsprung-Russell Diagram' resulted in review papers by Binnendijk, Eggen, Kopal, Plavec and Grygar, Mayall, and Herczeg concerned mainly with summarizing in a new and rather productive fashion material on close binaries already published in conventional form.

Finally, Batten (**166**) has summarized the state of our statistics on all double stars in a way that both shows the high degree of observational selection present and suggests some courses of action for closing the gaps between the number of systems known, the number studied, and the aspects of study needing emphasis.

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https://doi.org/10.1017/S0251107X00030686 Published online by Cambridge University Press