

## 26. COMMISSION DES ETOILES DOUBLES

PRÉSIDENT: Professor P. van de Kamp, Director of the Sproul Observatory, Swarthmore College, Swarthmore, Pennsylvania, U.S.A.

VICE-PRÉSIDENT: Dr R. v. d. R. Woolley, Astronomer Royal, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

COMITÉ D'ORGANISATION: O. J. Eggen, P. Muller, K. A. Strand, W. H. van den Bos.

MEMBRES: Arend, Baize, Cester, Couteau, Deutsch (A. N.), Dick, Djurković, Dommanget, Finsen, Franz, Guntzel-Lingner, Heintz, Hertzprung, Hopmann, Jeffers, Johnson (M. C.), Jonckheere, Kuiper, Kulikovsky, Lippincott, Luplau Janssen, Luyten, Martin, van Albada, van Biesbroeck, Wierzbinski, Wieth-Knudsen, Zagar.

### I. INTRODUCTION

Several concerns have been expressed and suggested as topics for discussion at the General Assembly; they can be described as follows.

- (a) Need for more measures and more observations of quantities of astrophysical interest, such as photometric measures of  $\Delta m$ , of direct determinations of spectral types and of radial velocities with instruments of sufficiently large aperture.
- (b) Need for a compilation of modern spectral classifications.
- (c) Need for orbit catalogue, say every five years, with annual supplements.  
But one must be aware that the publication of a number of orbits, for any one double star, without residuals or ephemerides should be discouraged.
- (d) Need for support from IAU to help older astronomers obtain grants to attend General Assemblies.
- (e) Need for a discussion of the importance of long-focus instruments for a number of fundamental researches, stressing the simplicity of these instruments.
- (f) Several double star astronomers have also expressed their concern about the lack of impact made by the following sections of the recommendations adopted at IAU Symposium no. 17 (Visual Double Stars):
  - ( $\alpha$ ) IAU Symposium no. 17 (Visual Double Stars), considering the fundamental importance of double-star observations to our science and recognizing the growing scarcity of qualified observers, stresses the necessity of encouraging young astronomers to take up double-star astronomy.  
The Symposium expresses the wish that the IAU facilitate by all means at its disposal the sending of young observers to those observatories where this research is actively pursued.
  - ( $\beta$ ) The Symposium recommends that experienced double-star observers be given increased opportunity to use reflectors of large aperture.
  - ( $\gamma$ ) The Symposium expresses its gratitude to Dr Jeffers and Dr van den Bos for their monumental work in creating the *Catalogue of Observations* and the *Index Catalogue* of double stars.  
To insure the preservation of these catalogues, now available only at the Lick Observatory, the Symposium recommends that copies be deposited at a few selected observatories.

### 2. VISUAL OBSERVATIONS

*Herstmonceux*, 28-inch refractor (van der Riet Woolley, Symms): since 1957, some 3000 observations of nearly 500 pairs. The comparison image micrometer distances show a negative

bias of  $0''.04$  in the mean when compared with published ephemerides, as do other observers using large instruments.

*Johannesburg*, 26½-inch refractor (van den Bos, Knipe, Lategan, Postma): 2892 micrometer measures.

Finsen completed the interferometer survey of all stars between  $+20^\circ$  and  $-75^\circ$  declination to magnitude 6.5, extended to magnitude 7.5 for stars with proper motions exceeding  $0''.05$  in either co-ordinate. The survey is being repeated in part as opportunity offers. To date, 12 262 examinations have been made of 8117 stars, yielding 71 new pairs. The total number of interferometer measures made in the three year period was 1297.

*Lamont-Hussey*, 27-inch refractor (Holden), in service since May 1963: Remeasures, with filar micrometer, of moving pairs from Rossiter's Catalogue.

*Lick*, 36-inch and 12-inch refractors (van den Bos): 12 927 micrometer measures, roughly two thirds with the 36-inch and one third with the 12-inch.

*Lowell*, 24-inch refractor (Holden): 1961, November 15 – 1962, August 15. Measures with filar micrometer, of close pairs.

*Meudon*, (Muller): The 83-cm refractor should be in operation in the near future and will be employed primarily for observations of double stars.

*München*, 28-cm refractor (Heintz); observations are continued. H. A. Schmid has built a photo-electric device for the measurement of angular distance, position angle and brightness of the components of close binaries. A small sharp-edged aluminized prism scans periodically the telescopic image. The modulated light is processed electronically by very low band-width Fourier-analysis.

*Nice*, 38-cm refractor (Couteau): 1423 measures. Experience with this telescope of 7-m focal length over the past decade justifies the planned renovation and operation of the 76-cm refractor of 18-m focal length, which will then be used for all those problems, double stars, parallaxes, perturbations, etc., which require a long-focus refractor.

*Paris*, 38-cm refractor (Baize): 1500 measures over the interval 1960–1963.

*Sternberg Institute*, 20-cm refractor (Kulikovskiy, Kuročkin, Starikova): measurements with polarizing micrometer according to design by Muller.

*Uccle*, 45-cm refractor (Arend, Dommanget); micrometer observations of pairs with separations below  $2''$ , frequently below  $1''$ .

*Vienna*, 68-cm refractor (Hopmann, Jackson): continued measures.

*Yerkes*, 40-inch refractor and *McDonald*, 36-inch reflector (Van Biesbroeck): 1450 measures of close pairs. (Couteau) 605 measures; inspection of 589 stars of large proper motion, large parallax or M type, yielded 27 doubles.

*U.S. Naval Observatory*; stations of *Washington* (26-inch and 12-inch refractors) and *Flagstaff* (40-inch reflector) (Worley).

To date, more than 4000 visual measures have been made with the U.S. Naval Observatory 26-inch and 12-inch refractors, and with the 40-inch reflector of the U.S. Naval Observatory, Flagstaff Station. This latter telescope was found adequate for visual observations after the micrometer had been equipped with an achromatic negative lens to increase the scale.

In September 1962, the micrometer of the 26-inch refractor was equipped with digitizers, with output printed on paper tape. The system has been thoroughly tested, and is now both mechanically and electrically reliable over a wide range of weather conditions. Advantages of the system includes: (1) doubling of the speed of observations, (2) elimination of reading and recording errors, and (3) removal of possible unconscious bias on the part of an observer.

## 3. PHOTOGRAPHIC OBSERVATIONS

*Abastumani*, 40-cm refractor (Salukvadze): measures, also magnitudes and spectra, of 24 multiple trapezium systems.

*Copenhagen*: Wieth-Knudsen has been assisting Hertzsprung in the survey, maintenance and development of his stereotype plate and card catalogue of double star measures.

*Lick*, 36-inch refractor (Hertzsprung, Vasilevskis, Jeffers): some 900 photographic measures.

*Minnesota* (Luyten): photographic proper motions for eighty wide double stars for which spectroscopic observers were anxious to determine whether these were physical or optical pairs, also proper motions for those binaries of which one component is a SS Cygni variable.

*Potsdam*, 50-cm visual refractor (Güntzel-Lingner, Böttger): pairs with separations over 2" (not less than 2", as erroneously reported in 1961), using Hertzsprung's technique.

20-cm astrograph (Böttger): continuation of neglected pairs with separations over 6".

*Pulkovo*, 65-cm refractor, (Deutsch, Kisselev, Plugin, Kanaev): measurements of about 100 double stars. (Bronnikova) wide pairs in the vicinity of star clusters NGC 1513, 1860, 2099 and 6705.

*Sproul*, 24-inch refractor, (van de Kamp, Lippincott): mass ratios and parallaxes for nearby binaries; search for perturbations. Start of program to determine parallax and mass-ratio of Sirius, using objective grating.

*Sternberg Institute*, 38-cm astrograph (Schukstova, Sverdlovsk): measurements from 40 plates taken by Sternberg, Kazansky and 82 plates by Schukstova.

*Urania*, 10-inch refractor (Luplau Janssen): continuation of measures.

*Vienna*, 3.5 m astrograph (Haupt), measures of 200 wide pairs.

*U.S. Naval Observatory, station of Washington*, 26-inch refractor; *Lowell Observatory* 24-inch refractor, (Franz, *et al.*): The photographic double star program, initiated in October 1958 at the U.S. Naval Observatory, was continued. At present approximately 500 objects are under observation. During the period covered by this report (Jan. 1961—Sept. 1963), 994 multiple exposure plates were taken with the 26-inch refractor at Washington. In addition, 490 plates were obtained with the 24-inch refractor of the Lowell Observatory in three observing periods of one month each. Automatic data recording at the measuring engine and the use of electronic data processing equipment made it possible to keep plate measurement and reduction up to date at all times.

The first series of measures, complete through the winter observing season of 1962/63, will appear as *Publ. U.S. Naval Obs.* 18, pt. 2 (1964). It will comprise the results obtained from 2307 plates of 488 double and multiple stars.

## 4. ORBITAL STUDIES

Calculations of orbits continue to be made by Bepalov, Hopmann, Muller, Heintz, van den Bos, Finsen, Knipe, Wieth-Knudsen and others. Orbit calculations from very short arcs have been carried out by Bepalov and by Schrutka.

Muller reports the entry on punched cards of the elements of the best available orbits, with the purpose of publishing a revised catalogue of 500 ephemerides (1960–1970). Muller continues the publication of the *Information Circular*. He has calculated true anomalies up to  $M = 20^\circ$  for high eccentricities: *Notes et Informations de l'Observatoire de Paris*, VI, no. 5 (série Astrométrie), 1962.

Arend and Dommanget are preparing a catalogue of ephemerides of radial velocity curves of visual binaries, and are studying the optical criteria, and relative rectilinear motion in double stars.

## 5. MISCELLANEOUS STUDIES

Agekian and Amosova studied the distribution of the configurations of unstable triple systems.

Arend and Dommanget are investigating the evolution of double stars, taking into account mass-loss.

Underhill has published radial velocity observations for eight short-period visual binaries.

Baize has issued a catalogue of double stars with one variable component.

A. N. Deutsch has published an investigation and catalogue of proper motions of double and multiple stars found in 115 Kapteyn Selected Areas. It contains 174 double, 38 triple and 10 quadruple stars. The ratio of triples to doubles is 18%. Among the 38 triple systems, 11 are of the trapezium type.

Eggen has made studies of three-color photometry of wide pairs, the empirical mass luminosity relation and the angular momentum in visual binaries and is preparing a list of all visual binaries with nearby equal components.

Fessenko has published statistical studies involving proper motions, and eccentricities.

Jonckheere is making a general analysis of the distribution of double stars with regard to spectral class, magnitude and separation.

Martin reports on dynamical studies of the two-body problem, including the case of variable mass.

Perova compiled a catalogue of doubles in which one or both components are variable stars.

Rogati has started a search with the 17-inch refractor for faint companions of all variable stars south of the equator and brighter than 11<sup>m</sup>0 at minimum.

Sobolev has published some cosmological conclusions relating to the age of various binaries.

## 6. DOUBLE STAR CATALOGUES

Jeffers reports that the new Index Catalogue of Visual Double Stars has been completed. The necessary financing for the publication was through a grant by the National Science Foundation. The catalogue, in two parts, will have about 750 pages, and will list approximately 64 200 pairs. Publication is scheduled near the middle of December as Volume XXI of the *Publications of the Lick Observatory*.

Strand expresses his concern that copies of the Catalogue of Observations and the Index Catalogue should be deposited at a few selected observatories. Several programs, such as the Yale Catalogue and the Southern Reference Star program, are suffering from not having the double star catalogues available in card form. The Index Catalogue should be made available immediately on IBM cards (see section 1).

Strand also reports that the photographic double star catalogue now in the possession of Hertzprung will be transferred to the U.S. Naval Observatory.

## 7. SYMPOSIA AND COLLOQUIA

The proceedings of *IAU Symposium no. 17 (Visual Double Stars)*, held in Berkeley in 1961, have been published. Copies are available upon request to the Sproul Observatory, Swarthmore College, Swarthmore, Pennsylvania, U.S.A.

A Colloquium *Multiple Stars and Associations*, to be organized by Commissions 26, 33 and 37, is in the planning stage and may be held some time in 1965.

A symposium on the evolution of double stars, involving such problems as the effect of mass-loss on orbital elements, is proposed by Arend and Dommanget. Representatives of different fields: variable stars, spectroscopic binaries, visual binaries, theoretical astromechanicians should participate.

#### 8. ORBIT COMPUTATIONS WITH HIGH SPEED COMPUTERS

High speed electronic computers provide a potential aid for any astronomical calculations, including those of orbits of double stars. They also create the possibility of considerable mischief since a great deal of printed results, unneeded or of doubtful value, can easily be obtained. Orbit computation is already over done; not much good can be expected from high speed computers. We do not need any more unreliable, immature orbits.

Experienced double star observers and computers have stressed over and over again that the prime need in the field of visual double stars is more and better observations. At present these are mainly provided by perhaps half a dozen observers. Some of our veteran observers are hard pressed to obtain time at large instruments which are as valuable in this field as in others. At the same time, long before the advent of high speed computers, there have been too many non-observing astronomers, willing and able—some not too able—to calculate double star orbits.

It is an understatement that the present need for calculation of double star orbits is easily filled by the few experienced double star observers who are able to judge the relative accuracy and systematic errors of observations obtained by different telescopes, methods and observers. Now, there is a potential danger for computer-happy inexperienced people, to derive premature 'orbits' which serve only to clutter up an already overburdened literature; later they may have to be exposed by qualified workers in the field.

An article on 'automatic' orbit computation published in 1962 proved to be the straw that broke the camel's back. That paper, when carefully reviewed by one of our leading double star observers, proves to have conclusions which can not be believed or understood.

A number of double star observers feel that a stop should be put to this kind of publication. It is not the use of electronic computers for orbit work to which objection is raised. Judgment and experience of a double star observer can not be replaced by an electronic calculator, which is, after all, only a clever idiot. Double star observers should reiterate their stand that any orbit, no matter how computed, should be published with a list of measures and residuals (weighted means, if necessary) and with an adequate ephemeris. Without this information the double star orbit should be disregarded and editors of journals advised to refuse publication.

A letter outlining the above concerns was sent by the president to members of the Commission and some other astronomers. Basically the replies confirmed the stand presented in the letter. It was generally felt that leading astronomical journals and periodicals should be requested that no double star orbits be published unless accompanied by an ephemeris and residuals. Obviously, the editors of journals and their referees will have to continue to be vigilant to ensure a satisfactory quality of the published orbits. A recommendation by the Commission was felt to be in order.

#### 9. PUBLICATIONS

It is almost impossible to compile a bibliography on double stars in view of the great number of papers, ephemerides, observation notes, etc. Measures, orbital determination and the results of various investigations are issued in many journals and publications, the list of which can be established as follows, for a very large majority of the papers in consideration.

- Abastumanskaja astrofisičeskaja Observatorija Gora Kanobili. Bjulleten.*  
*Annales de l'Observatoire Royal de Belgique* (Bruxelles).  
*Astronomical Journal.*  
*Astronomičeskij Zurnal* (Moskva).  
*Astrophysical Journal.*  
*Astrophysical Journal. Supplement series.*  
*Bulletin Astronomique* (Paris).  
*Communications de l'Observatoire Royal de Belgique* (Bruxelles).  
*Izvestija glavnoj astronomičeskoj Observatorii v Pulkove* (Leningrad).  
*Journal des Observateurs.*  
*Lick Observatory Bulletin.*  
*Mitteilungen der Universitäts-Sternwarte Wien.*  
*Mitteilungen der Sternwarte München.*  
*Monthly Notes of the Astronomical Society of South Africa.*  
*Osservatorio Astronomico di Trieste. Pubblicazioni.*  
*Publications of the Astronomical Society of the Pacific.*  
*Publications of the Dominion Astrophysical Observatory* (Victoria).  
*Publications of the U.S. Naval Observatory* (Washington).  
*Publikationen des Astrophysikalischen Observatoriums zu Potsdam.*  
*Pulkovo Bulletin.*  
*Republic Observatory Johannesburg. Circulars.*  
*Royal Observatory Bulletin* (Greenwich).  
*Soobščeniya gosudarstvennogo astronomičeskogo Instituta im. P. K. Sternberga.*  
*Stars and Stellar Systems. Vol. 2 and 3.* (University of Chicago Press, 1962, 1963).  
*Trudy glavnoj astronomičeskoj Observatorii v Pulkove* (Leningrad).  
*Trudy gosudarstvennogo astronomičeskogo Instituta im. P. K. Sternberga.*  
*UAI Commission 26. Circulaires d'Information* (P. Muller).  
*Union Observatory. Circulars* (changed in 1962 to *Republic Observatory Johannesburg. Circulars*).
- Veröffentlichungen der Sternwarte in München.*  
*Vestnik Leningradskogo Universiteta. Serija mat., mekh. i astr.*