

26. COMMISSION DES ÉTOILES DOUBLES

PRÉSIDENT: M. EJNAR HERTZSPRUNG, *Professor of Astronomy, Leiden University, Holland.*

MEMBRES: MM. Aitken, Armellini, Dawson, Espin, Fox, Giacobini, Innes, Jackson, A. King, Maggini, Olivier, Przybyllok, Rabe, Rossiter, Russell, Salet, Van Biesbroeck, Van den Bos, Voûte.

The most important event of the period elapsed since the last report of this Commission is the completion by R. G. Aitken of the Extension of Burnham's *General Catalogue of Double Stars*. A description of this Extension was given in the report of 4 years ago. The Extension is now published and it is of invaluable help to everyone engaged in double star astronomy. We are all greatly indebted to Dr Aitken for the unselfish way in which he has devoted a large part of his time for the benefit of others.

This Extension covers three-quarters of the sky, viz. from the North Pole to -30° declination. A card catalogue of all observations within this part of the sky is kept up to date at the Lick Observatory and information from it is supplied on request. The same remark holds for the card catalogue kept at the Union Observatory at Johannesburg, covering the region of the Cape Photographic Durchmusterung, viz. from the South Pole to -19° declination. Between the two catalogues there is thus a considerable overlap (-19° to -30° declination), which may, for various reasons, prove to be useful.

The number of discoveries published during the 4 years by W. H. van den Bos and W. S. Finsen in the region of the C.P.D. is 975 and 225 respectively, while it is reported that about treble this number of mostly fainter objects have been found by R. A. Rossiter and his collaborators at the Lamont-Hussey Station at Bloemfontein.

The Johannesburg observers do not confine their activity to discovery but measure also known Southern pairs in need of observation, including new pairs likely to show orbital motion within a few years. These measures should be very valuable.

Espin and Milburn have discovered about 400 new pairs.

During the last 4 years the following numbers of visual observations of double stars have been published:

Observer	Approximate number of visual measures published	Observatory	Approximate number of visual measures published
Van den Bos	10160	Johannesburg	11252
Aitken	2953	Lick	2953
Rabe	1937	Breslau	1937
Olivier	1806*	Flower	5163
Barton	1639	Flower	—
Guillaume	1299	Lyons	2337
Silbernagel	1253	Munich	1253
Bloch	1038	Lyons	—
Finsen	992	Johannesburg	—
Wamer	852	Flower	—
Espin	678	Wolsingham	1279
Mason	660	Flower	—
Furner	651	Greenwich	1106
Milburn	601	Wolsingham	—
Doberck	546	Sutton	546
Fender	529	Flower	—
Fatou	503	Paris	503
All others	2900	All others	2700
Approximately	31000	Approximately	31000

* Of these measures 323 were made with the McCormick refractor.

The relative activity of the different observers in the interval is, of course, not exactly represented by the number of *published* measures, but the discrepancy will be made good in the future reports of the Commission.

The collected measures of Leavenworth (about 7500 in all) and those made by Doberck up to 1927 (about 13,000 in all) have been printed in separate volumes. It is from different points of view an advantage to have the measures of an observer collected in a single volume. If this is to become a general practice, it might be advisable to adhere to a standard form of publication. Reference to the measures and formation of mean values is much easier, when they are all to be found in one volume, than when they are scattered over several publications.

It is recommended that all the measures contained in one publication be arranged according to right ascension with one entry only.

Concerning the photography of double stars a remarkable paper has been published by W. H. van den Bos on the multiple system ξ UMa, using about 4700 exposures made by Potsdam observers with the 50 cm. visual refractor. The accuracy obtained is illustrated by the fact that for the 88 plates used the mean error of a single plate is only $\pm 0''.016$ in each co-ordinate.

Photographic measurement of double stars does not yet in general receive the attention it deserves. Most of the series published since the last report have an occasional or tentative character.

A serious attempt to obtain satisfactory results with a relatively small instrument (scale 1 mm. = $41''.84$) has been made by E. Przybyllok and P. Labitzke. They have published the results from some 700 plates with a total of about 18,000 exposures.

E. S. King has measured 435 pairs on plates taken in the years 1888-1890 with the photographic 13-inch Boyden telescope of the Harvard Observatory (scale 1 mm. = $42''.36$). These measures are of interest because of the early date of the plates, though the accuracy obtained does not exceed that of ordinary visual observations. There were about 4 exposures on each pair.

D. Reuyl has investigated the systematic errors of distance occurring in close pairs, using 2935 exposures of 75 pairs taken with the 26-inch visual refractor of the McCormick Observatory (scale 1 mm. = $20''.75$).

W. M. Smart has published photographic measures of 440 double stars using 2734 exposures taken with the Sheepshanks telescope at Cambridge (scale 1 mm. = $35''.2$).

Smaller series have been measured by Kuiper (790 exposures made by Leiden observers, scale 1 mm. = $39''.38$), by Marriott, Pitman and Onderdonk (764 exposures taken with the 24-inch visual refractor of the Sproul Observatory, scale 1 mm. = $18''.73$), by Olivier (about 670 exposures on McCormick plates, scale 1 mm. = $20''.75$) and by Hoff (364 exposures with the $18\frac{1}{2}$ -inch Dearborn refractor, scale 1 mm. = $29''.26$).

A list of 3092 wider double stars found on *Carte du Ciel* plates in the zone $+ 53^\circ 55'$ to $+ 65^\circ 5'$ has been published by J. Stein.

H. Groot has picked out 2953 pairs whose separation is less than $30''$ on Greenwich Astrographic plates. A list of those found in the zone $+ 64^\circ$ to $+ 72^\circ$ (of which 449 have a separation less than $10''$) has been published.

S. G. Barton has collected 603 pairs, whose separation is less than $5''$, from various Astrographic Catalogues.

The photographic measures are limited to the wider pairs but can be made more accurate than the visual measures. These two facts practically compensate each

other, if the observations are made for the detection of the first traces of orbital motion (dynamical parallaxes), which motion, *ceteris paribus*, is inversely proportional to the square root of the separation.

At present the observatories at Potsdam, Lembang and Johannesburg are equipped with refractors of proper size for the photography of double stars and are provided with the auxiliary instruments (coarse objective gratings, etc.) necessary for the application of the method to its full advantage. The scales are for Potsdam 1 mm. = 16".4, Lembang 19".2 and Johannesburg 18".9.

At the two last-named southern observatories the photography of double stars forms a permanent part of the programme. At Johannesburg about 7000 exposures have so far been obtained and are now waiting for measurement.

The double-star work with the 40-inch Yerkes telescope has been limited to visual work on close pairs and photographic observations of a small number of systems offering favourable conditions for the determination of the mass-ratios.

An extended investigation of this latter kind is under way at the McCormick Observatory.

Visual measures of double stars form a considerable part of the work now done at the Bosscha Observatory at Lembang, Java, there being about two or three thousand observations to hand.

At the Paris Observatory M. Giacobini has about 6000 visual measures unpublished.

The reversing prism of Salet is now used by many observers and it is hoped that it will soon be generally adopted.

Information has been obtained that M. Maggini at Collurania continues his measures of double stars with the interferometer attached to the 15½-inch Cooke refractor. About 400 close pairs have been observed in this way in the years 1927-1930.

An interferometer for use on the 12-inch Brashear telescope at the Yerkes Observatory is under construction. It would be most desirable if several observatories would test the interferometer method with instruments of moderate size on double stars that have been measured directly with larger instruments.

F. J. Hargreaves has recently published a short series of measures made with a comparison image micrometer of his own design, which appears to deserve further attention.

The number of observations of double stars, which can be obtained annually, is naturally limited. The question consequently arises, which pairs should take precedence. This question is difficult to answer. It is hard to say at the present time which of our observations will be most valuable in the future. The only thing, that we can be sure of, is that our successors will want accuracy. Deliberately neglected pairs often prove later to be of particular interest. In this connection it should be remembered that fixed double stars are specially suitable for giving information about systematic differences between individual observers.

Usually the formula $\log \rho = \text{const.} - .2m$ is adopted for the corresponding limits of ρ and m , below which a pair is considered as a double star. This formula simply means that a pair, which is at the limit at a particular distance from us, will be on that same limit at all distances. The formula is therefore very different from that which would be required, if the expected amount of orbital motion within a given time should fix the limits of ρ and m . In that case the formula would be $\log \rho = \text{const.} - .6m$. For stars belonging to the main series ("dwarfs")—nearly all faint stars

whiter than those of spectrum G—the formula can be much improved by taking the colour of the star into consideration. We then have approximately

$$\log \rho = \text{const.} - .6m_{\text{vis}} + 3.1 (m_{\text{pg}} - m_{\text{vis}}).$$

Another good indicator of expected orbital motion is the common proper motion, μ , of the components. The corresponding formula is empirically found to be $\log \rho = \text{const.} - .2m + 2 \log \mu$. On the average the orbital motion is, *ceteris paribus*, proportional to the proper motion.

When the current double star surveys have been completed and our knowledge of the proper motions of faint stars has been extended to the whole sky, the time will have come for a systematic examination of faint proper motion stars for duplicity. A start could already be made now for the most interesting objects of this kind. A plan on this line is in preparation at the Yerkes Observatory.

Measures on triple or multiple stars in which one or more components are of short period are valuable for determining the mass-ratio and in studies of the problem of three bodies.

Other stars, specially deserving examination for duplicity, are:

1. Variable stars. If a variable is found to be double, it indicates a difference between the observed and the real range, which may considerably affect the elements calculated from the form of the light curve. Furthermore, dynamical parallaxes of double stars with one variable component are of particular interest.

2. Physical members of star clusters such as the Hyades, Pleiades and Praesepe.

3. Stars used as standards in stellar photometry (e.g. the North Polar Sequence).

It is evident that double stars should be rejected for this purpose.

The important problem of accurate determination of the difference in magnitude between the components of double stars has been attacked in different ways by Kuiper at Leiden, using coarse gratings placed in front of the objective, and by Maggini estimating the visibility of the fringes produced by the interferometer.

An important contribution to the theoretical treatment of observations of double stars is contained in the list of *Dynamical Parallaxes of 1777 Double Stars* by H. N. Russell and Charlotte E. Moore. The authors are to be congratulated on the fact that they have not been deterred from doing this useful work by the realization that such a catalogue will naturally soon need additions and alterations. That the catalogue contains many pairs, where the orbital motion is still insensible, and thus may be said to be more than complete, adds to its value, as in special cases it indicates whether or not a trustworthy dynamical parallax can as yet be derived.

Barbier has investigated the distribution of eccentricities of the orbits of wide binaries and further the influence of selection on the computed dynamical parallaxes.

Many orbits have been derived during the past 4 years. A very thorough discussion of the system of Procyon has been given by H. Spencer Jones.

The above report does not claim to be complete. It contains a selection out of the investigations, which have come to my knowledge.

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President of the Commission

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