COMMISSION 26 : DOUBLE AND MULTIPLE STARS (ETOILES DOUBLES ET MULTIPLES)

Report of Meetings.

Business Section, Wednesday, November 20, at 4:00 P.M.

The President opened the meeting and welcomed those in attendance : Fracastoro (chairman), Batten, Dommanget, Fredrick*, Heintz, Hidayat, Rakos, J. Russell, Strand, van Dessel.

I Commission President 1985-1988

Commission members unanimously propose to the IAU Executive Committee that prof. K. D. Rakos serve as President of Commission 26 for the 1985-1988 triennium.

II Election of the Vice President

The chairman announces that he has received 13 votes by mail. It is unanimously decided to accept them as valid. Then, votes are expressed by secret ballot from the 10 members attending the session. The final result (13+10) is:
McAlister 11 votes, Heintz 9 votes.
At this point Heintz leaves.

III Organizing Committee

It is unanimously decided to maintain the O.C. at the present number. For the 1985-1988 triennium, Fracastoro, as past president , becomes an ex officio member of the O.C. and Dommanget and Heintz remain for a second term. The terms of Franz, Poveda and Scarfe have just expired; therefore, 3 members must be elected. The chairman announces that 13 members voted by mail. Adding the votes of the 9 members now attending the session, the result is : Harrington 13 votes, Couteau 12 votes Kiseliov 9 votes and Abt 7 votes.

IV New members

It is decided that the following persons can be accepted as members of Commission 26, in view of their scientific activity: Bacchus, Bernacca, Eichhorn, Fletcher, Luyten, Morel, Zukevic, and also Radiman and Zinnecker if they are already IAU members.

V Report for IAU Transactions XIX A

At the proposal of Strand, the report concerning the activity of the commission during the 1982-1984 triennium is unanimously approved.

At 5:30 P.M. the session ends.

Addendum to the Business Meeting.

At 1:05 P.M. on Thursday, November 21, Fracastoro is informed by another Italian delegate (Felli), who shares the same mailbox, that he has some correspondence in the mailbox. Immediately, Fracastoro collects two envelopes, containing votes expressed by two commission members from the USSR. At the IAU Secretariat's office, Fracastoro is advised to inform the commission as soon as possible. This is done before the scientific session of Friday, November 22 begins.

Fracastoro asks first whether or not these votes should be taken into account and added to the previous score. He is strongly in favor of accepting these votes. However, when his proposal is voted on, the majority is against (4 to 1). Consequently, the case comes to an end.

* *Frederick declares to be a member of Commission 26, although he is not listed in the official list received from the IAU Secretariat.*

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2nd and 3rd Session (scientific), Friday November 22. Chairman K. Aa. Strand

K. D. Rakos :

Mass ratio of unresolved third companions associated with the visual binary components.

Three groups of visual binaries have been used to investigate the cosmic scatter in the main sequence. To the first group belong 147 main sequence binaries, the observations being published by Rakos et al. and by Hurly and Warner. The second group is formed by 84 binary systems on the main sequence, selected from the photometry published by Eggen. The third group consists of common proper motion pairs of the same spectral types (stars from the solar neighborhood later than F0). In general the standard deviation of typical B-V and ΔV values for the first and second group does not exceed 0.05 magnitudes. A histogram can be constructed for each group placing all secondaries on the main sequence and considering the difference Δm between the magnitude of primaries and the main sequence.

All three histograms show a local maximum in the distribution of Δm for Δm = 0.2 magnitudes. This maximum can be introduced by the unresolved companions. If we assume that one of the primary components has a close unresolved companion, and the triple structure (AB-C) is responsible for the Δm deviation from the main sequence, we can estimate the luminosity - or mass - distribution of the unseen companion B. As long as the mass ratio $q = M_B/M_A$ is not smaller than 0.5, the distribution is undistinguishable to the van Rhijn luminosity function. For smaller tertiary masses the number of unseen companions decreases rapidly.

From the histograms it can also be seen that the number of hypothetical third companions is larger for the earlier spectral types and twice more frequent for primaries than for secondaries, independent of the spetral type.

The basic formation mechanism for close binaries seems to be the fission or the fragmentation of a gaseous disk. The fragmentation of a rotating protostellar cloud is probably responsible for the formation of binary stars with periods exceeding 100 years. The mass distribution of close companions may be different from van Rhijn's function. According to Lucy, the instability of the 3rd harmonic of an elongated triaxial rotating ellipsoid yields a mass ratio of the components of about 0.7.

In future work, an improvement can be achieved by measuring R-I colors and the precise radial velocities to check the hypothesis of the unresolved companion. Also very extensive photometry of about 400 common proper motion stars is in preparation.

M. Shara, H. McAlister, D. Hutter and O. Franz :

Estimating the percentage of binaries among potential guide stars for Space Telescope (read by J. Russell).

The fine guidance sensors for the Space Telescope cannot lock onto guide stars with Δm < 2.0 mag. and separation from 0.02 to 5 arcsec, so knowing the percentage of undiscovered close binaries is essential for planning the operation of the spacecraft. This study involved a list of 683 stars from the Yale Bright Star Catalog, chosen from entries with magnitude between 5.0 and 6.5, declination -20° to +60°, and without regard to previously known duplicity. The stars were observed with speckle interferometry on the CFH telescope at Mauna Kea, Hawaii. The use of bright stars made possible a complete search with Δm < 2.0 mag. and a separation range of 0.15 to 1.2 arcsec. The results include: 62 previously known binaries were resolved (mean separation 0.6 arcsec); 52 new binary systems were discovered (mean separation 0.17 arcsec); 52 of the known and 40 of the new binaries are luminosity class V; 10 of the known and 12 of the new binaries are class III and IV; extrapolating from this discovery rate, there are about 300 class V and about 350 class III doubles still to be discovered in the Bright Star Catalog. Correcting for this percentage of giants among the potential guide stars, for random orientations and for the binaries with separations less than 0.15 arcsec, about 20% of possible guide stars will be binaries and unusable for Space Telescope operation.

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J. Dommanget :

The future of double and multiple star research.

L'astronomie des étoiles doubles et multiples semble atteindre aujourd'hui un point de stagnation particulièrement néfaste au sein de la commission, alors que les étoiles doubles (tout autant celles aux composantes écartées que les couples serrés) apparaissent de plus comme etant les objets les plus fréquents du milieu stellaire.

Les raisons de cette situation se situent sans doute d'abord dans l'intérêt croissant pour l'astrophysique, la radioastronomie, la cosmologie, etc, mais aussi et surtout dans l'attitude des membres de la commission 26. Notre conception de l'astronomie des étoiles doubles est désuète: elle continue à admettre pour piliers fondamentaux des recherches l'observation, le calcul d'orbites, la détermination des masses stellaires, le raffinement de la relation masse-luminosité, parfois aussi l'étude des perturbations des compagnons obscurs et de masses faibles. Bien que ces recherches soient irremplaçables, elles n'en restent pas moins trop restreintes et peu attrayantes pour les jeunes chercheurs, alors que l'astronomie des étoiles doubles et multiples recèle les bases d'immenses domaines à explorer touchant à la photométrie, la spectroscopie, l'évolution stellaire, l'évolution galactique etc.

Curieusement pourtant, il existe chez les collègues des autre commissions un courant sous-jacent favorable aux étoiles doubles, mais qu'ils ne semblent pas pouvoir exprimer par manque de stimulant au sein de la notre. Deux faits importants peuvent être avancés à ce sujet. La proposition d'organiser un colloque sur les composantes écartées d'étoiles doubles et de systèmes multiples a trouvé plus d'échos en dehors de notre commission qu'en dedans. En réponse à l'appel lancé par l'Agence Spatiale Européenne (ESA) pour constituer le catalogue des étoiles à observer par le satellite astrométrique Hipparcos, plus de 200 propositions furent reçues, dont seulement 23 concernant les étoiles doubles de toutes natures. Mais quelques unes seulement sont dues à des membres de la commission 26. On peut se demander ce qu'il en sera des programmes d'observation proposés au Space Telescope.

Aussi, le seul remède à la situation actuelle consiste dans un accroissement sensible de l'éventail des voies de recherche au sein de la commission 26 et dans un recrutement de nouveaux membres intéressés ou déjà impliqués dans leurs développements. Il devrait également comporter une propagande systématique pour ces aspects négligés de l'astronomie des étoiles doubles et multiples.

J. Dommanget :

Wide components in double and multiple systems.

Astrometric observations as well as astrophysical observations of components of medium wide and wide pairs do not favor a particularly great enthusiasm. But we have to decide whether we want to know more about binaries, or if we just want to conduct our activities in small areas, ignoring the characteristics of the whole domain which we are interested in. Actually, wide components and even medium wide ones appear more and more as subjects for discussion concerning the reality of their physical existence, because of their interest for binary and galactic evolutions (see: Lembang-Bamberg IAU Colloquium No. 80 and Bamberg International Conference). Common proper motion stars (mainly discovered by Luyten), moving groups (studied by Schutte and Eggen) and very wide pairs with separations of several parsecs (considered by Upgren and Vandervoort) for instance are different classes of such objects that should lead to increased attention.

The frequency of such objects appears to be much higher than expected: systematic exploration of photographic plates, for instance, reveals that generally half of the pairs with medium wide separations are ignored in the catalogs. Such a situation will lead to further problems as to what kind of systems should be retained for introducing in double star catalogs (index for instance). Other catalog problems have to do with accurate positions and identifications.

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The recognition on the sky and the final census of all binary and multiple systems are of the highest interest for correct statistics; for instance, in the case of establishment of the distribution diagrams of various physical parameters (e.g. magnitudes, spectra and also true separation of their components). All these diagrams are of fundamental importance for a better understanding of the formation and the evolution of the binary and multiple systems, and indirectly for stellar and galactic origin and evolution, as succintly reported by Dommanget in a paper given at the Lembang-Bamberg IAU Colloquium No. 80. An IAU colloquium on "Wide components in double and multiple systems" has been proposed and officially supported by Commission 26 during the XIX General Assembly in New Delhi.

The main aim of this colloquium would be restricted more to practical problems than to theoretical ones. It should make possible a better evaluation of the subject at a time where it is urgently needed.

A. H. Batten :

Parallax and masses for 70 Ophiuchi.

Batten reports about his continuing high-dispersion spectroscopic observations of both components of 70 Ophiuchi. It was recently possible to publish values for the parallax of the system and the masses of the components, derived from these spectroscopic observations, and they agree well with the corresponding values derived from the astrometric observations, thus strengthening the credibility of very small paralaxes obtained spectroscopically for similar systems. The masses of the components of 70 Oph must now be among the best determined. In 20 years, no residuals from the velocity curve as large as 1 km/s have been found and most are much smaller. Thus it has been possible to eliminate the 3 rd body postulated for this system, just as Strand had shown earlier, that supposed perturbations in the plane of the sky were not real. The radial velocity of the primary component is now increasing again. Similar observations of other systems show that the components of many visual binaries are not main-sequence stars, and they are very valuable for testing theories of stellar evolution.

R. Pannunzio, G. Massone, V. Zappalà and R. Morbidelli :

Statistical analysis of the errors of visual double stars observations (read by V. Zappalà).

A selected sample of well-known binary orbits and 3141 observations of visual binaries, obtained by 12 observers of the old generation, have been analyzed, comparing the average residuals in separation ρ and position angle θ to the actual and the apparent ρ, allowing to evidence systematic and accidental errors. A systematic positive increase of the residuals in ρ for decreasing ρ's has been detected inside the resolving power of the used telescopes. Moreover, a negative and a positive systematic displacement appear for large separations in the $(O-C)_\rho$ and $(O-C)_\theta$ plots respectively, for which no physical explanation seems to be plausible. The analysis of the standard deviations allows to show a different behavior for the accidental errors inside and outside the resolving power. In the inner zone they slightly increase with decreasing separations, and depend on the apparent separation between the components, as seen in the eye-piece. In the outer zone, the accidental errors increase with increasing separations and strongly depend on the actual separation. In general, the single plots relative to each observer of our sample do not differ sensibly from the general plot obtained by averaging all the 3141 observations. The contribution of the "resolving power effect" on the orbit determination has been qualitatively investigated, pointing out some possible tests for its quantification. Similar studies on modern observers and on observations obtained by interferometric and photographic techniques are in progress. Furthermore, taking into account the results obtained by the present statistical study, a systems of weights, depending on the separations of the binaries and on the telescopes size, is given.

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M. G. Fracastoro recalls a paper published in "Atti della Accademia Nazionale dei Lincei (vol. LXXIII, p. 226, December 1982), in which the Yale Catalog of Bright Stars, by D. Hoffleit, and the Catalog of Nearby Stars, by Gliese, have been analysed in order to determine the frequency of couples, in view of the mission of the astrometric satellite Hipparcos. In particular, the observed number of these pairs N_{obs} is higher than that theoretically foreseen by the Poisson formula N_{exp}, up to separations of 10 arcsec, namely well beyond the resolving power of any telescope, as shown by the following table, where the ratio log N_{obs}/N_{exp} is given, in terms of magnitude of the secondary and of separation.

m_2	4:5	5:6	6:7	7:8	8:9	9:10	10:11	11:12	12:13
s"									
0.1-0.9	5.7	5.7	5.2	4.7	3.7	2.9	2.2	1.4	-
1.0-1.9	4.6	4.6	4.3	3.9	3.3	2.8	2.2	1.7	1.2
2.0-3.9	3.8	3.8	3.6	3.2	2.8	2.2	1.8	1.3	0.8
4.0-7.9	3.0	3.1	2.8	2.6	2.2	1.7	1.2	0.7	0.4
8.0-16	2.7	2.6	2.3	2.0	1.5	1.1	0.7	0.3	-0.2
16 - 32	2.1	1.7	1.5	1.3	0.9	0.5	0.1	-0.2	-0.5
32 - 64	1.0	1.2	0.8	0.7	0.4	0.1	-0.4	-0.9	-1.4
64 -128	0.3	0.1	0.1	-0.2	-0.4	-0.9	-1.3	-1.8	-2.4
128-256	-0.4	-0.4	-0.7	-1.1	-1.5	-1.7	-2.2	-2.6	-3.7

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