PART 5

JOINT DISCUSSIONS

A. Stellar Motions and Stellar Dynamics

B. Solar Magnetic Fields

C. The Demands made on Celestial Mechanics by the Preparation of Ephemerides

D. Problems requiring Radio-Astronomical Observations of High Sensitivity and Resolution

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REPORT OF MEETING OF THE INTER-UNION COMMISSION ON SOLAR AND TERRESTRIAL RELATIONSHIPS

A. JOINT DISCUSSION
ON
STELLAR MOTIONS AND STELLAR DYNAMICS

Friday 18 August 1961 at 14^h00^m

ORGANIZING COMMITTEE: A. Blaauw (Chairman), Ch. Fehrenbach, F. P. Scott and K. Aa. Strand.

MEETING CHAIRMEN: A. Blaauw, K. Aa. Strand, B. J. Bok.

RECORDERS: S. Sharpless and O. G. Franz.

Introductory note

The texts of the twelve prepared contributions, often in abbreviated form, are given first; they are followed by a summary of the discussion on all the contributions considered together.

CONTENTS

1. THE STUDY OF THE NEAREST STARS

Wilhelm Gliese

The significance of the study of the nearest stars lies in the fact that only in the immediate neighbourhood of the Sun do we know individual data for a sizeable fraction of all the stars in a space volume. Only among the nearest stars do we know individual space velocities with sufficient accuracy. Trigonometric measures of parallax become unreliable already beyond 25 pc. Spectroscopic measurements are possible to much larger distances, but to date we know spectroscopic data only for some distinct groups of stars.

The compilation of the catalogue of stars nearer than 20 pc (**1**) in 1957 included 915 single and double stars with nearly 1100 components. Space velocities were available for 600 of these stars. No radial velocities were known for the rest. Most of the nearest stars are main-sequence stars from A 0 to the faintest M-dwarfs. Moreover there are a few giants, some sub-giants, sub-dwarfs, and white dwarfs. It is well known that the entirety of these stars form no homogeneous group of stellar motions. But subdividing these stars into several groups, we ask the question: which data will be characteristic for a group of common velocity distribution?

Woolley in his paper 'The Dynamics of Stars in the Neighbourhood of the Sun' (**2**) stresses that the time of relaxation of stellar motions, through stellar encounters, may be about a hundred times greater than the supposed age of the Galaxy. It is for this reason that the present motions of the stars are by no means random motions, but are no doubt still very markedly influenced by initial conditions. Therefore we may suppose that present motions still show a limited number of star streams or extended open clusters. A subdivision into spectral classes alone cannot show us all existing features.

Woolley groups the stars according to the eccentricities of their galactic orbits. This grouping requires the knowledge of individual space velocities, and so it is limited to nearby stars. Comparing the colour-luminosity diagrams for groups of different eccentricities Woolley and Eggen (**3**) show that the array of the group having nearly circular orbits resembles that of the Pleiades, and there is a gradual change of the array to the class with the largest eccentricity. This last array resembles that of the open cluster M 67. In terms of the current evolutionary theory the Pleiades is a new cluster, while M 67 is an old cluster.

A special group seems to be the A-type stars with a strong vertex deviation in their velocity distribution. Another group consists of the M-dwarfs with emission lines, which seem to compose a very young group of low-velocity dispersion.

Among stars with reliable space-velocity data Eggen (**4**) searched for groups of common motions. The colour-luminosity array of such a group shows which stars may really belong together. Among the groups investigated by Eggen are the Hyades, the Sirius group, and the groups of ζ Her, ϵ Ind, 61 Cyg, γ Leo, and Groombridge 1830. Some of these are groups consisting of high-velocity stars.

Obviously the velocity distribution of the stars is correlated with their age. This question was investigated in more detail by v. Hoerner. In the chapter 'Velocity and Spectral Type' of the book 'The Formation of Stars by Condensation of Diffuse Matter' he states: "For the problem of the formation of stars the dispersion of space velocities is of special interest, and further so is the dispersion of the z-components allowing us to conclude about the layer in which we may find stars of this group." He also made use of the data for the nearest stars especially because he needed the estimation and elimination of selection effects caused by favouring stars of large proper motion. The grouping according to the spectral types shows that the velocity dispersion grows from B to G, but remains constant from G to M.

In another paper 'Correlation between Chemical Composition, Age and Velocity Dispersion of the Stars Nearer than 20 pc' (**6**) v. Hoerner subdivides the HR-diagram in some fields for the determination of stellar ages. His results, which are based only on a small number of nearby stars, are

1. The velocity dispersion is a function of age only.
2. The older the stars, the higher the velocities.
3. The slow increase of space velocities of younger stars with age is explained by the Spitzer-Schwarzschild mechanism.
4. The oldest stars show the original galactic turbulence.

These investigations should be continued—but there is an urgent need for additional observational information. Of the data necessary for computing space velocities, normally the parallax measures are the most uncertain. The main problem is the discovery of additional nearby stars.

More than 80% of the known stars nearer than 5 pc have annual proper motions larger than 1″; the smallest value is 0″·49. Within 10 pc 86% of the known stars have proper motions larger than 0″·5, and the smallest proper motion is 0″·17. If we choose the stars for a parallax programme according to their proper motions, the influence of selection effects would be low for distances up to 10 pc. But for distances larger than 10 pc selection effects by proper motions will become noticeable among the faint stars.

Selection effects were avoided by the spectroscopic search for early M-dwarfs carried out by Vyssotsky and his colleagues at the McCormick Observatory. A programme of tracing faint, late M-stars by objective-prism plates separating giants and dwarfs by proper motion measurements has recently been started at Heidelberg by Schaifers. And we should not forget the searches for white dwarfs by Luyten.

Certainly such programmes need considerable time and should be combined with supplementary radial-velocity measurements of the faint nearby stars. But new data will allow new answers to the problems mentioned above.

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4. Eggen, O. J. *M.N.* **118**, 65, 154 and 560, 1958; **119**, 255 and 278, 1959; *Observatory* **78**, 21, 1958; **79**, 88, 135, 143, and 182, 1959.
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