In conclusion we should like to point out that the best method for estimating C consists in the use of the same stars for determining both the dispersion in z-velocity and in z-co-ordinates. Otherwise it is difficult to exclude various distortions in the data used. Especially the presence of halo stars may spoil the results by distorting the velocity and co-ordinate dispersions in different amounts.

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18. ON THE LOCAL DYNAMICS OF THE GALAXY

K. F. Ogorodnikov

In the papers presented at this discussion properties of the behaviour of the stars in the local surroundings of the Sun have been discussed and this is a kind of challenge to theoretically minded astronomers to draw up a theory explaining these properties. Unfortunately very little work has been done until now in this respect since in the usual Stellar Dynamics the galaxies are treated as a whole. A few years ago the writer of these lines made an attempt to fill up this gap between the observations on one side and the observations on the other.

He considered the bearing of the so-called Local System of stars within which the Sun is lying. The LS consists of a large number of O and B stars and its existence was first connected by Harlow Shapley with the phenomenon of Gould's Belt. Nowadays, in connection with Ambartsumian's ideas, we may think of the LS as a result of the disintegration of stellar associations which presumably are concentrated along the galactic spiral arms. The newly born OB stars dissipate in the surrounding star field and are lost in it, the more so since within a few million years they drastically change their spectral type. On the whole this phenomenon is stationary in time since the outbound stars are continuously replaced by newly born ones.

From the point of view of Stellar Dynamics this is a cause of a quite unique situation when an observer situated within the LS will always observe within the LS the same kind of 'labelled' stars since the number of outbound stars will be always larger than the number of inbound ones.

This permits us to explain the first of the observed discrepancies between the theory and observation, viz. the deviation of the vertex, since under the above conditions the stars will be subject to Coriolis forces which will rotate the vectors of their residual velocities with an angular velocity twice as large as the local angular velocity of the Galaxy.

Another consequence of the above dynamical situation will be the action of tidal gravitational forces upon the motions of the stars. While the Coriolis forces will cause a rotation of the local velocity ellipsoid, the tidal forces will stretch it in the direction of the galactic radius. The combined action of both factors will result in the velocity ellipsoid becoming an oblate spheroid with its shortest axis perpendicular to the galactic plane. This is exactly what is observed in the case of the velocity ellipsoid of OB stars and what has always puzzled astronomers.

The K-term is also explained from this point of view. When the stars leave the LS the faster ones get ahead of the slower ones and the average velocity is directed outwards and is proportional to the distance from what we may call the centre of the LS. But farther off, beyond the boundaries of the LS, the partial density of the stars which left the LS becomes insignificant with respect to the density of the galactic star field. And then the average velocity of all the stars together will be zero if we assume that the LS is at rest with respect to its galactic surroundings.

Finally, the abnormally low dispersion of velocities of the OB stars may be easily explained if we remember that the faster stars are leaving the LS comparatively rapidly, and this causes a permanent accumulation of slowly moving stars within the latter.

The theory has this practical interest that it permits us to ascribe the observed irregularities of the motions of the OB stars to foreign causes. By composing a self-consistent system of galactic parameters, we can combine the A and B Oort coefficients derived from early-type stars with velocity ellipsoid data derived from stars of later types, which otherwise is unjustified.

19. SUMMARIZING PAPER

Sir R. Woolley

After a discussion of this kind, we may well ask ourselves what sort of information it is that we can expect to extract from a study of stellar motions, especially from the motions of new rather than old objects. We may perhaps try to classify this information in three ways.

1. Information about the potential field in the neighbourhood of the Sun, including perhaps a determination of the distance to the centre of the Galaxy.

2. We inquire whether the motion of newly-formed stars is similar to the motion of the gas clouds from which the stars were presumably formed, as revealed by 21 cm observation and by interstellar lines. Are the motions generally similar or are there newly-formed stars with larger velocities which require special explanation?

3. We may attempt as Strömgren has done in his very interesting paper to find the actual locations in which stars were formed. If this can be done we may find some areas in which stars did get formed in the past, and other areas in which there were none. This sort of investigation leads to experimental evidence which will check theories of star formation. If we can find where the stars were formed, we may find out how they were formed, for example, in what densities of gas. This is, of course, an examination of the near past, whereas Herbig deals with the present.

It is not possible to discuss the merits of different determinations of the local density at short notice. I should like to correspond with Dr Ogorodnikov about the precise reasons for the difference between the results he describes and those which give rather higher values (Leiden and Herstmonceux).

We have not heard today about new determinations of A and of R_0, but they have been detailed at other Commissions. I should like to call attention to a new determination by Feast: $A = 14{\cdot}3$ km s^{-1} kpc^{-1}, $R_0 = 9{\cdot}9$ kpc; also to a method presenting a novel feature which has been used by Murray and Clube at Herstmonceux which gives a distance of $R_0 = 10$ kpc. This was described by Murray yesterday in another Commission.

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There has been a group of papers about the present space distribution of the stars, especially in relation to spiral arms. As Dr Schmidt-Kaler aptly said, if you make a composite diagram from the work of all the different observers, the result looks like an example of contemporary art. I had supposed from earlier accounts that I have heard, especially of the work of Dr Beer which was not described today, that there was a real difficulty in reconciling the stellar with the 21 cm observations, but it is possible that much more work must be done before this point can be resolved. As far as I could see, it was not resolved by today's discussion. Regarding Dr McCuskey's results for the rather older stars, I do not feel that any surprise should be felt when the present space distributions are quite different from those of earlier types. Here I think we must agree with Dr Eggen that the distribution in velocity (u, v plane) is much more significant than the present distribution in x, y space.

Now to turn to the papers which dealt with star formation and the connections between stellar motions and star formation. Dr Herbig presented a very convincing picture of stellar formation going on at this moment and being strongly associated with the presence of dust. Indeed this connection with dust seems so strong that I wonder whether it is not necessary for Dr Maarten Schmidt to make some explicit reference to it, despite his elegant method of connecting one parameter with another by making them both functions of t.

Dr Eggen's very interesting papers should be of great interest to those of us who attended the recent conference on orbits in Greece. The 'dispersion rings' which he described are in some way similar to Dr Contopoulos's boxes of orbits. As he said, the result that V is restricted but U is much freer follows from what I like to call the V theorem, but I am afraid there is no time to call the attention of theorists to this now.

Very interesting results were mentioned by Van Woerden about the presence of gas clumps with masses as high as 400 $M_{\odot}$. These might be expected to perturb galactic orbits very considerably, and I would call the attention of all those who attended the Thessaloniki conference on stellar orbits to them. The perturbations might be expected to break up the V theorem, i.e. break up the Eggen group, but for the fact that this effect is strictly differential. You are not riding round and round a circular track with permanent obstructions. It is more like an obstacle race in which attendants obligingly carry the obstacles round with you.

But the effect should certainly be examined. I believe that Ogorodnikov has already investigated the effect on stellar relaxation and finds that it tends towards promoting equipartition.

If one may speculate for a moment on future developments in this subject one should no doubt turn one's attention to the 'enigmas' described in the address given last Monday by Prof. Oort, which we all admired so much. One particular enigma which affects a great deal of our reasoning is the behaviour of interstellar gas with respect to the circular velocity. We are accustomed to supposing that the gas in the galactic disk is found to move with the circular velocity and we make use of this concept to calculate the distance of hydrogen as revealed by the 21 cm observations, and still further to calculate the attracting force in the plane of the Galaxy from the assumed circular motion, as discussed by Kerr. However, observations in the centre reveal very strong radial motions of this gas, and the enigma is, what has happened to the circular velocity? This question, whether the radial motion is only sporadic or a permanent or at least a frequent feature of galactic behaviour must affect our views about the ages of stars with eccentric orbits, but the behaviour of old stars is a subject rather far removed from the topics of today's discussion. However, it should be clear that Prof. Oort's enigmas must be studied very carefully if we are to make further progress in interpreting the local structure and motions in the Galaxy.

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