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A STUDY OF MOVING GROUPS OF STARS IN OUR GALAXY

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Abstract. Numerous observations over the past decades have confirmed that the distribution of stellar velocities in the solar neighbourhood is not uniform. Certain concentrations of stars in the velocity field mean that there exist groups of stars moving in parallel orbits, with practically the same space velocities, even if the stars are spread all over the sky and appear to be gravitationally unbound. These stellar streams are called moving groups. Their precise nature is still not very well understood.

Many authors have contributed to this field, but it is Olin Eggen who deserves special mention. According to Eggen, about one dozen moving groups can be detected, both in the young and old disk populations. He has noted that moving groups are a result of cluster evaporation. According to this hypothesis, many stars are formed together in a relatively small volume in space, and they initially move together as a gravitationally bound cluster. In time, they evaporate from the cluster spreading along the orbit, but keeping their original velocities in the direction of galactic rotation. This hypothesis has not been generally accepted. It implies that the stars from a moving group will all have the same age, and the same chemical composition, which has not been confirmed by observations. It is also hard to believe that the original stellar velocities could stay preserved over many orbital cycles, which puts the existence of the older moving groups into doubt.

The aim of this thesis is to study the reality of moving groups, by examining the space velocities of over 800 stars mentioned in Eggen's papers. The list of stars was included in the Hipparcos project in order to get precise parallaxes and proper motions, while an extensive ground-based observing programme has been undertaken at the University of Canterbury to collect precise radial velocities for the same stars. By combining the Hipparcos astrometry with the ground-based radial velocities, the total space velocities have been obtained and the corresponding velocity distributions studied. In addition, a numerical model of the galactic potential has been developed, so that the orbits of stars could be examined.

The radial velocities have been obtained in the IAU standard system for more than 400 programme stars. A precision of 20–30 m/s has been achieved for stars with intrinsically constant radial velocities, using the fibre-fed échelle spectrograph on the 1-m telescope at Mt John University Observatory. A precision of about 100 m/s has been obtained for some northern stars observed from the Dominion Astrophysical Observatory, using the coudé spectrograph and the radial velocity spectrometer on the 1.2-m telescope.

The distribution of the programme stars in the galactic UV-plane demonstrates that the grouping is better (i.e. with less dispersion) when the Hipparcos data are used, compared to the ground-based pre-Hipparcos astrometry. However, there are indications that this might only be a result of the improved parallaxes, as they tend to make the overall velocity distribution more compact. A separate analysis using a general sample of about 4600 Hipparcos stars in the solar neighbourhood has revealed a branch-like structure in the velocity plane. The branches are probably generated by the galactic spiral structure itself, or by some other global characteristic of the galactic gravitational field. In such a picture, the moving groups

may be regarded as shorter fragments and concentrations along the branches.

Numerical simulations based on a model including both the axisymmetric and spiral components of the galactic gravitational potential show that certain concentrations and elongated features in the velocity plane might be a result of galactic spiral structure. In that case, a moving group can be composed of stars having different origins. The most commonly accepted membership criterion of constant V was found to be a good first approximation, although both velocity components (U and V) have to be considered in a more realistic approach.

The results presented in this thesis do not discard Eggen's hypothesis, but they open some new possibilities in understanding the origin and nature of moving groups.