# GALAXY POPULATION STRUCTURE FROM PROPER MOTIONS

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We are currently engaged in astrometry of Kapteyn Selected Area photographic plates covering the period 1908 to the present day using the GALAXY measuring engine at RGO. Our intention is to use the apparent motions to investigate the stellar velocity structure within a kiloparsec of the Sun. We have completed a preliminary analysis of SA 68 ($\ell$ = 111°, b = 46°), deriving positions and proper motions using the central overlap method on measures of plates spanning the period 1909 to 1980. These include the original (1909) and second epoch (1925) plates taken with the Radcliffe refractor at Oxford, and used in the compilation of the Radcliffe Catalogue (Knox-Shaw and Scott-Barrett, 1934), as well as more recent plates taken using the 26-inch refractor at Herstmonceux. For stars present on all thirteen exposures (including double exposures on the same plate) the internal residuals in positions in each co-ordinate are 0".09 per plate, giving annual motions accurate to ~1 milli-arcsecond over the 71 year baseline. Since our plates have a limiting magnitude of only B ~15, we have used 17 stars in common with Chiu (1980) to transform our relative motions to the absolute frame. Our motions are in very good agreement with those by Chiu, with a scatter of less than 3 milliarcseconds in each co-ordinate and linearity of scale between the two datasets.

From density-law considerations, 95 percent of the stars with colours in the range $0.4 < (B-V) < 0.8$ are expected to be disk dwarfs. Hence we have used photometric parallaxes to determine distance moduli for these stars and convert the observed tangential motions to linear velocities. Since the average distance above the Plane is ~350 parsecs including a reasonable metallicity gradient changes distances by less than 5 percent. We derive mean motions of

$$\bar{V}_\alpha = -29 \text{ km/sec} \qquad \bar{V}_\delta = -26 \text{ km/sec}$$

with dispersions of

$$\sigma_1 = 50.0 \text{ km/sec} \qquad \sigma_2 = 40.9 \text{ km/sec}$$

along the principal axes of the projected velocity ellipsoid.



*H. van Woerden et al. (eds.), The Milky Way Galaxy, 165–166.*

This compares with

$$\bar{V}_\alpha = 17.5 \text{ km/sec} \qquad \bar{V}_\delta = -9.5 \text{ km/sec}$$

$$\sigma_1 = 35 \text{ km/sec} \qquad \sigma_2 = 25 \text{ km/sec}$$

expected from basic solar motion and the velocity ellipsoid of GK dwarfs in the Plane. While the larger dispersions are expected for stars at higher z, the change in the solar motion is not. Since this sample includes 80 stars, the mean motions are particularly well determined - although systematic errors in the conversion to absolute motions cannot be excluded. However, even zero point errors as large as 0.005 arcsec only change the centroid of motion by 12 km/sec. This result will be further investigated using data from other fields.

The most significant result from this preliminary analysis of SA68 is shown in the reduced proper-motion diagram, given by plotting

$$H = M + 5 + 5 \log \mu = M + 5 \log V_t - 3.378 \text{ versus } (B-V).$$

This represents a composite H-R diagram, where the zero point in H for a given population is set by the mean transverse velocity, $V_t$. From our data it is evident that there is a well-populated giant branch extending from (H = 10; (B-V) = 0.8) to (6;1.2). These stars have apparent magnitudes of V ~12-14, and hence are at distances of 2.5 - 7 kpc. The conventional interpretation of these stars as metal-poor (M92, M13) halo giants requires that they have unreasonably high mean tangential motions (650 and 540 km/sec respectively). Alternatively, these stars could be represented as disk-metallicity giants with $V_t$ ~100 km/sec, or as 47 Tucanae-type giants with $V_t \sim$ 180 km/sec. Ratnatunga and Freeman have reported the discovery of substantial numbers of the latter stars in their objective-prism surveys (see Freeman, this conference). This implies the presence of significant numbers of relatively metal-rich stars in the halo population of our Galaxy, and we tentatively identify these stars with the extended stellar component recently discussed by Gilmore and Reid (1983). Spectroscopic observations of these stars are in progress to confirm their luminosity class and metallicity and to determine radial velocities, while we are currently extending our proper-motion survey to cover other selected areas.

A more detailed discussion of these data will be submitted to Monthly Notices of the RAS.

REFERENCES

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