

# THE STELLAR DISTRIBUTION IN THE GALACTIC SPHEROID

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Our Galaxy is the only galaxy in which the 3-dimensional distribution of visible mass, chemical abundances and the stellar velocity field are all directly measurable. A project to determine these properties is currently underway, utilising direct photographic plates from the UK Schmidt telescope and the Las Campanas du Pont reflector, and the COSMOS and APM automated measuring machines. These provide reliable number-magnitude-colour distributions for complete samples of stars to  $V = 19$  in 20 square degrees, and  $V = 22$  in 1 square degree, in each of eight directions. These data may then be directly interpreted to determine the density profile, shape and luminosity function of the Galactic spheroid.

The chosen fields lie near  $(l, b) = (0^\circ, -90^\circ); (0^\circ, -45^\circ); (90^\circ, -45^\circ); (180^\circ, -45^\circ); (270^\circ, -45^\circ); (0^\circ, -30^\circ); (0^\circ, -60^\circ); (40^\circ, -50^\circ)$  and photometric results for the first and last of these fields are now available.

The complete sample of stars with photometrically determined absolute magnitudes  $M_V > 14$  has been identified from the visual photometry, and every such star has been observed in the infrared (JHK). This provides both independent confirmation of the absolute magnitude, and a luminosity classification from the J-H/H-K diagram. These data have also been used to derive a revised effective-temperature scale for M dwarfs, which confirms that all known very late M dwarfs lie on the hydrogen-burning main-sequence. No "brown dwarfs" have yet been discovered. This same sample provides the first determination of the stellar main-sequence luminosity function which is complete to the minimum mass for hydrogen burning near  $M_V = 19$ . Integration of this function determines the total mass density in main-sequence stars in the solar neighbourhood to be  $0.04 M_\odot \text{pc}^{-3}$ , and the total mass to light ratio, in solar visual units, to be  $\sim 1.2$ .

The available number-magnitude-colour data from the first two fields for  $12 < V < 18$  are well fit by a three-component model with a disk, a "thick disk" and a spheroid, but are in poor agreement with the model published by Bahcall and Soneira (1981). The old disk follows an ex-

potential perpendicular to the plane with scale height  $\sim 100$  pc for  $M_V < 4$  and  $\sim 300$  pc for  $M_V > 4$ . The luminosity function follows that of Wielen, with a dip for  $6 < M_V < 9$ , a broad maximum near  $M_V = 12$ , and a slow decrease to  $M_V = 19$ . The "thick disk" is modelled with the luminosity function and colour-magnitude diagram of 47 Tuc, and the spheroid with the luminosity function and colour-magnitude relation for M92. The density law of the "thick disk" for  $1 \leq z \leq 5$  kpc is equally well described by an exponential in  $z$  distance with a scale height near 1.5 kpc, and by a flattened  $r^{1/4}$  spheroid with axial ratio near 1:4. In both cases approximately 2% of all stars in the solar neighbourhood belong to this population.

These results are in excellent agreement with recent studies of several edge-on spiral galaxies, thought to be similar to the Galaxy, which show pronounced "thick disk" structure perpendicular to their disks (e.g. van der Kruit and Searle, 1981), with scale heights and mass fractions relative to their thin disks very similar to those derived here.

Complete subsamples of stars from several fields are currently also being observed to determine the metallicity distribution and the velocity structure as a function of position in the spheroid, and to redetermine the local  $K_z$  force law and mass density.

Further details are available in Gilmore and Reid (1983) and references therein, and several forthcoming papers.

#### REFERENCES

- Bahcall, J., and Soneira, R.: 1981, *Ap. J. Suppl.* **47**, 357.  
 Gilmore, G., and Reid, N.: 1983, *M.N.R.A.S.* **202**, 1025.  
 van der Kruit, P., and Searle, L.: 1981, *Astron. Astrophys.* **95**, 105.

#### DISCUSSION

**B. Strömgren:** It will be extremely interesting to follow this work up through four-colour photometry and radial-velocity work, to determine the composition and kinematical properties of the stars that form the "thick disk". The suggestion that it represents 2% of the local population, and that its velocity dispersion is about 60 km/s, does not check with Intermediate Population II (IP2) as a whole, but it might represent just the lower-metal-content fringe of IP2 and the higher-metal-content fringe (the 47-Tucanae stars) of the halo-population II as generally defined. I think that further work will soon clear up this point.