TOWARDS AN IMPROVED MODEL OF THE GALAXY

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We use the Hipparcos survey to derive an improved model of the local galactic structure. The availability of parallaxes for all the stars permits direct determination of stellar distributions, eliminating the basic indeterminacy of classical methods based on star counts. Hipparcos gives for the first time a truly three-dimensional view of the solar vicinity, and a complete, homogeneous and highly accurate set of magnitudes and colours. This means that new techniques can be applied in the treatment of the data which place strong constraints on a model that tries to describe the local Galactic structure. Here we investigate how well a static model of low complexity can describe the Hipparcos observations.

The interpretation of the Hipparcos data is complicated by various observational errors and selection effects that are hard to treat correctly. We do not try to correct the data, but instead use a model and subject this model to the same observational errors and selection effects. A model catalogue is created that can be compared with the observed catalogue directly in the observational domain, thereby eliminating the effects from various biases.

Many features in the HR diagram are for the first time seen in field stars thanks to Hipparcos, such as the slanted red giant clump, previously seen in rich old open clusters such as Berkeley 18. This and other features of the observed HR diagram are well reproduced by the model thanks to the rather detailed modelling of the joint $M_V/B-V$ distribution. Actually, separate distributions were derived for the three different components, disk, thick disk and halo, using the kinematic characteristics of the components to discriminate between them.

For galaxies other than the Milky Way seen edge-on, the vertical distribution of light has a distribution function that has a form between the two ones usually employed: the exponential and the sech^2 (isothermal). We have found the same to be true for our own Galaxy as observed by Hipparcos. From a family of density laws for the vertical mass with with the form: $\rho(Z) = \rho(0)\ \mathrm{sech}^{2/n}(nZ/2Z_e)$, where $\rho(0)$ is the density in the plane and Z_e the exponential scale height at large Z, we find $n = 3$ to give the best representation of the stellar distribution in the Hipparcos catalogue. The limiting cases are the exponential for $(n \to \infty)$ and the isothermal for $(n = 1)$.

Most studies agree that the Sun is not exactly at the plane of the Galaxy, but some distance above it. Before Hipparcos measured values of $Z_\odot$ fell in the interval 10–20 pc (mostly studies of gas, dust and young stars) and 20–40 pc (mostly optical stars counts). Hipparcos finally solves the question in a very convincing way by placing the Sun at $Z_\odot \simeq 8 \pm 4$ pc.

The Hipparcos survey was intended to be a complete sample of some 50 000 stars, limited by apparent magnitude and colour. In reality, the faint part of the survey is incomplete, and the completeness factor is depending on many variables that are hard to reproduce in a model. Therefore only the Hipparcos stars brighter then $V = 7$ were used in the construction of the the model. The much more complete and homogeneous sample offered by the Tycho Catalogue can be used to constrain the model for fainter stars down to about $V = 10$. Here the colour distribution of the stars is still very well represented by the model apart from a narrow region around $B - V = 0.45$ where the model underpredicts the counts and a clear age dependence of the scaleheight seems to be needed in the MS turnoff region.

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