THE GALACTIC RADIAL GRADIENT OF VELOCITY DISPERSION

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The kinematical study of the stars in the solar neighbourhood allows, via the equation of the so-called asymmetrical drift, to deduce the sum of the gradients of the density and the velocity dispersions, $\frac{\partial \ln \rho}{\partial \varpi} + \frac{\partial \ln \sigma_u^2}{\partial \varpi}$. In order to deduce the density gradients in the solar neighbourhood, the second term is generally supposed to be zero. This kind of hypothesis, certainly wrong, comes from the old "ellipsoidal theory". A velocity dispersion independent of $\bar{\varpi}$ is not compatible with the Toomre's local stability. On the contrary, if we suppose

$$Q = \frac{\sigma_u(\bar{\varpi})}{\sigma_u(\bar{\varpi})_{min.}} \simeq \text{cte, we estimate } \frac{\partial \ln \sigma_u^2}{\partial \bar{\varpi}} \simeq -0.2, \text{ a non-}$$

negligible value compared with $\partial \ln \rho / \partial \varpi$ (Mayor, 1974). Using Vandervoort's (1975) hydrodynamical approach, Erickson (1975) obtains a similar value for the local velocity-dispersion gradient.

In the following we briefly describe a new method for deducing the local value of $\partial \ln \sigma_u^2 / \partial \varpi$ using also the local distribution of residual velocities.

The galactic potential allows us to transform the observed residual-velocity distribution $f_\odot(U, V, W)$ to a local distribution of the orbital eccentricity e, the mean orbital radius $\bar{\varpi}$ and the velocity perpendicular to the galactic plane W (at z = o), $N_\odot(e, \bar{\varpi}, W)$.

The local distribution $N_\odot(e, \bar{\varpi}, W)$ results from the epicyclic centre distribution $\Sigma(\bar{\varpi})$, from the eccentricity and W distributions at different places in the galactic disk $g_1(e, \bar{\varpi})$, $g_2(W, \bar{\varpi})$ and from the probability to observe the star in the solar neighbourhood $p(\varpi_\odot, e, \bar{\varpi}, W)$.

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$$N_{\odot}(e,\bar{\varpi},W) = cte \cdot \Sigma(\bar{\varpi})\ g_1(e,\bar{\varpi})\ g_2(W,\bar{\varpi})\ p(\bar{\varpi}_{\odot},e,\bar{\varpi},W)$$

Locally $g_1(e,\bar{\varpi}_{\odot}) \propto e \cdot \exp\left(-e^2/e_o^{\,2}(\bar{\varpi}_{\odot})\right)$

and $g_2(W,\bar{\varpi}_{\odot}) \propto \exp\left(\frac{-W^2}{\sigma_W^{\,2}(\bar{\varpi}_{\odot})}\right)$

On one hand we suppose these kinds of distribution valid not too far from $\varpi_{\odot}$ (for example ± 3 kpc) but with varying $e_o(\bar{\varpi})$ and $\sigma_W(\bar{\varpi})$

$$e_o(\bar{\varpi}) = e_{o_{\odot}} + (\bar{\varpi}-\bar{\varpi}_{\odot})\ \alpha_1 + \ldots\ldots.$$

$$\sigma_W(\bar{\varpi}) = \sigma_{W_{\odot}} + (\bar{\varpi}-\bar{\varpi}_{\odot})\ \alpha_2 + \ldots\ldots.$$

On the other hand $\Sigma(\bar{\varpi})$ can be expressed as

$$\Sigma(\bar{\varpi}) \propto \bar{\varpi}^{-n}$$

or $$\Sigma(\bar{\varpi}) \propto \bar{\varpi}\ \exp\cdot(-^{\bar{\varpi}}/\beta).$$

The three free parameters (α_1, α_2 and β) are adjusted to fit at best the locally observed distribution $N_{\odot}(e,\bar{\varpi},W)$.

The α_1 and α_2 parameters can be related to the velocity gradients

$$\frac{\partial \ln\ \sigma^2_u}{\partial \varpi} \text{ and } \frac{\partial \ln\ \sigma^2_W}{\partial \varpi}.$$

In order to avoid possible local perturbations, only regions with e and W not too small can be used in the fitting procedure.

A detailed description for the application of this method to different stellar samples of the solar neighbourhood will be published in Astronomy and Astrophysics.

REFERENCES

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