GALACTIC ROTATION FROM YOUNG OPEN STAR CLUSTERS

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The rotation of the Galaxy can best be studied with the aid of tracers for which distance and velocity can be obtained simultaneously, accurately and unambiguously out to large distances. Clearly, the best objects are the very young clusters. The *local* gradient of the angular velocity is contained in Oort's constant

$$A = -(R_o/2)\delta\omega/\delta R|_{R_o}$$

and, due e.g. to perturbations from spiral features, may not reflect the smoothly varying, underlying global component of rotation. Thus, it is necessary to reach out as far as possible in order to allow a smoothing of the rotation curve.

The presently adopted value, $A = 15 \pm 3$ km $s^{-1}kpc^{-1}$, is based mainly on a study by Johnson and Svolopoulos (1961) of 36 open clusters without age restriction. Of these, 29 are O-B2 and are unevenly distributed in the four galactic quadrants (7-14-6-2). This situation has been considerably improved mainly through our own studies of southern clusters; the quadrant distribution of O-B2 clusters with well-determined distances and radial velocities is now 12-26-26-23.

Using the standard solar motion to obtain

$\omega - \omega_o = V_{rad}(LSR)/(R_o \sin l \cos b)$ we fit

$$\omega - \omega_o = \text{const} - 2A/R_o \cdot (R-R_o) - \text{const}\,(R-R_o)^2$$

with weighting factor $\sin^2 l$.
We obtain as formal, local value $A = 18.4 \pm 0.6$ with rms deviation 11 km s^{-1} of the observed velocities from the curve, much like individual population I stars but significantly superior to the

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interstellar clouds from which clusters likely form. The expected standard errors due to uncertainty in observed radial velocity and distance are ~ 3 km s^{-1} and < 2 km s^{-1}, respectively.

From a study of stellar groups in HII regions, which reach out to greater distances, Jackson, FitzGerald and Moffat (1979) find evidence that the above local value for A is high due to undulation of the rotation curve in the solar vicinity, and that the underlying rotation curve is nearly flat from R $\sim$ 7 to 17 kpc with $\Theta \approx 250$ km s^{-1}, assuming R_o = 10 kpc. This leads to a global value of A = 12.5. With more updated values, R_o = 8.7 kpc, Θ = 220 km s^{-1}, we obtain A = 12.6 km s^{-1} kpc^{-1}.

If systematic metallicity gradients exist in the disk, their effect would be to shrink our picture of the Galaxy and increase the global value of A.

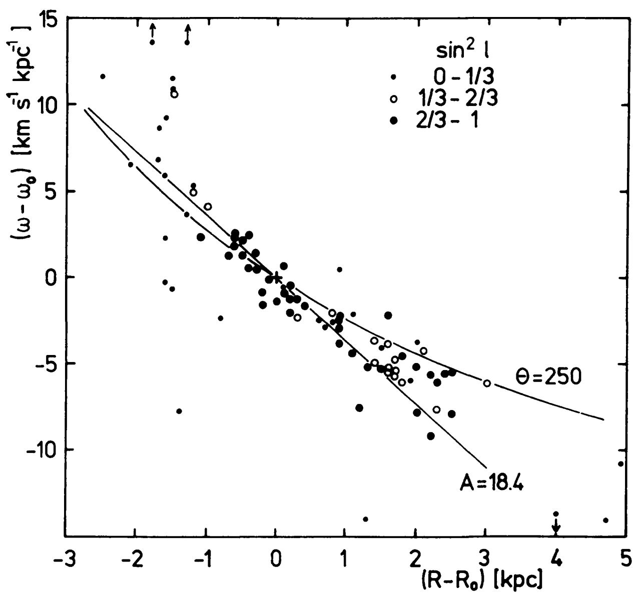

Figure 1. $(\omega - \omega_o)$ vs $(R - R_o)$ diagram.

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DISCUSSION

BOK: Wouldn't you be better off to use R_o as 8.2 or 8.5 only, and leave the 10 out? The 10 is only an IAU value, that's all, and everybody knows it's wrong.

MOFFAT: As you saw, the final result does not really depend sensitively on the choice of R_o.

BOK: No, but then you change the value of Θ_o simultaneously with R_o. That makes little sense; I would use R_o as 8.5, or something like it, and Θ_o = 220 km/sec, and say the heck with it.

BROSCHE: I think your weighting is wrong; how much do your results depend on that?

MOFFAT: I haven't done the calculations, personally; but I cannot imagine that the results depend very strongly on it.

FEAST: I wonder if you couldn't reduce your value of σ somewhat by correction for the uncertainty introduced by uncertainties in the distances of the clusters?

MOFFAT: Yes, that may play a role. [Later calculations, included in the present text, show these to be virtually negligible].

LYNGA: That might bring it down nearer to the interstellar clouds.

SCHMIDT-KALER: That's a very small amount.

BLAAUW: Shouldn't one take in this analysis the clusters that are close to the potential dips of the spiral structure?

MOFFAT: No; in fact we were originally looking for these dips.

BLAAUW: No; but then what is the meaning of A in that context? Shouldn't one have a separate A for the area between the spiral arms and sort of a local A near the spiral arms? It was my impression that here you have sort of a mixture of both.

MOFFAT: We gave two values: (1) the higher local one which depends on perturbations of the general rotation curve; and (2) the lower global one after smoothing out the rotation curve. The latter is more interesting in the context of mass determination of galaxies.

BOK: Have you given any thought to B? Because if you have a flat curve and A and -B must be the same, isn't that right?

MOFFAT: Definitely.

BOK: But then you'll get some very peculiar things in the equations of motion.