THE GALACTIC CIRCULAR VELOCITY NEAR THE SUN

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The conventional value of the galactic circular velocity near the Sun is V_o = 250 km s^{-1} (Schmidt 1965). Recently both lower (Mathewson et al., 1974; Einasto et al., 1976) and higher (Lynden-Bell and Lin, 1977) values have been suggested. The following summarizes our dynamical determinations of V_o. Altogether six independent methods have been used.

Recently Illingworth (1977) has measured the rotation velocities of a number of elliptical galaxies. Rotation velocities are considerably smaller than expected. This result is confirmed by the radial velocities of the globular clusters of M31 determined by van den Bergh (1969). Using these data, we adopt the rotation velocity of extreme halo population objects as 40 km s^{-1}. The heliocentric centroid velocity of these objects near the Sun, corrected for the solar motion in terms of the circular velocity, is 172 km s^{-1}. Thus from these data V_o = 212 km s^{-1} has been obtained.

Using the data on centroid velocities and density gradients of disk population objects, one can determine the solar motion which brings centroid velocities and density gradients into mutual agreement. The result is V_o = 230 km s^{-1}.

The solar velocity can be determined by a trial-and-error procedure, demanding that apogalactic distances derived for objects moving with tangential velocity $V_o + \Delta$($\Delta \sim$ 65 km s^{-1} is the Oort limiting velocity) should coincide with the boundary of the Galaxy. This method gives the value of V_o = 225 km s^{-1} for the circular velocity.

The dynamics of the nearby companions of the Galaxy (galactocentric distances between 30 and 250 kpc (open circles in Fig. 1) yields V_o = 220 km s^{-1}. More distant galaxies (R between 500 and 1500 kpc; dots in Fig. 1) give $V_o + V_{gal}$ = 380 km s^{-1}. Radial velocities have been taken from Yahil, Tammann, and Sandage (1977) and from Hartwick and Sargent (1978).

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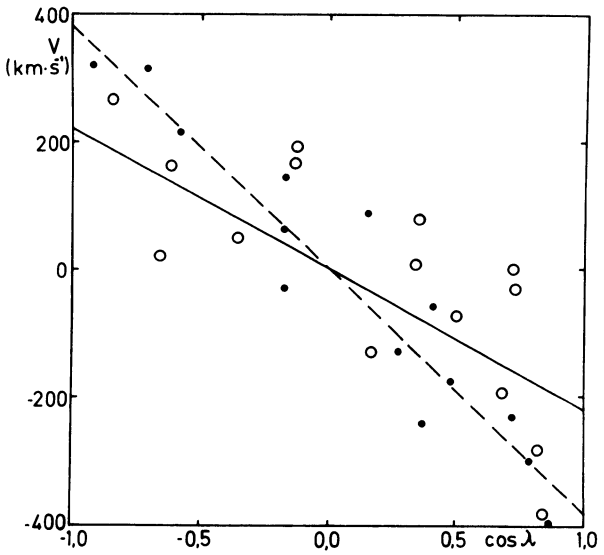

For five galaxies (NGC 224, 1068, 3031, 4594, and 5194) both maximum rotation velocities and velocity dispersions in the center (and in the halo in case of NGC 224) have been measured. The ratio V_{max}/σ depends slightly on the morphological type of the galaxy; for Sb (supposed type of the Galaxy) we adopt $V_{max}/\sigma=2$. The velocity dispersion of galactic halo objects is $\sigma=115$ km s^{-1}, which yields V_{max} = 230 and V_o = 225 km s^{-1}.

Finally, the circular velocity can be determined from the system of galactic constants. Adopting for the galactic constants and their rms errors the values given by Einasto (1978), one obtains $V_o = 217 \pm 10$ kms.

Adopting for all determinations, excluding the last one, an rms error of 20 km s^{-1}, we found the weighted mean circular velocity to be $V_o = 220 \pm 7$ km s^{-1}, in good agreement with the scatter of individual estimates.

REFERENCES

Einasto, J.: 1978, IAU Symp. 84, invited report.
Einasto, J., Jôeveer, M., and Kaasik, A.: 1976, Tartu Astron. Obs. Teated, No. 54, 3.
Hartwick, F. D. A., and Sargent, W. L. W.: 1978, Astrophys. J. 221, 512.
Illingworth, G.: 1977, Astrophys. J. Lett., 218, L43.
Lynden-Bell, D., and Lin, D. N. C.: 1977, Monthly Notices Roy. Astr. Soc. 181, 37.
Mathewson, D. S., Cleary, M. N., and Murray, J. D.: 1974, Astrophys. J. 190, 291.
Schmidt, M.: 1965, Stars and Stellar Systems 5, Univ. Chicago Press, p. 513.
van den Bergh, S.: 1969, Astrophys. J. Suppl. 19, 145.
Yahil, A., Tammann, G. A., and Sandage, A.: 1977, Astrophys. J. 217, 903.