GALACTIC ROTATION AND VELOCITY FIELDS

W.L.H. Shuter and A. Gill
University of British Columbia

Using unpublished 21-cm data from Jackson and Kerr of the entire Galaxy at b = 0°, we have determined the terminal velocities, v_m, to be (Gill & Shuter, 1983)

$$v_m = -173 - 72\sin(\ell) + 88\sin^2(\ell) \quad \text{km/s} \qquad 270° < \ell < 330°$$
$$= 162 - 31\sin(\ell) - 116\sin^2(\ell) \qquad 30° < \ell < 90°.$$

To obtain a rotation curve from the above expression for v_m, we first express the southern-hemisphere equation in equivalent northern-hemisphere terms (ie. change the signs of the first and third terms), and then average. Next we remove a constant offset of 13 km/s (as in Gunn, Knapp, & Tremaine, 1979). Finally, since at the tangent points

$$v_m = v_{rot} - v_\odot \sin(\ell), \quad \text{and } R/R_\odot = \sin(\ell),$$

we find

$$v_{rot} = 154 + (v_\odot - 52)\, R/R_\odot - 102\,(R/R_\odot)^2 \quad \text{km/s} \quad 0.5 < R/R_\odot < 1,$$

where v_{rot} is the circular velocity of rotation.

We can next substitute this equation into the Bottlinger expression for the line-of-sight velocity, v_l,

$$v_l = (v_{rot}(R)\, R_\odot/R - v_\odot)\sin(\ell)$$

to get the VELOCITY FIELD

$$v_l = (-52 + 154\, R_\odot/R - 102\, R/R_\odot)\sin(\ell) \quad \text{km/s} \quad 0.5 < R/R_\odot < 1.$$

This is a very convenient expression to work with in analyzing 21-cm and CO data, as one need not know the values for $v_\odot$ and $R_\odot$ in order to apply the equation.

Two illustrations of the use of this expression for v_l follow.

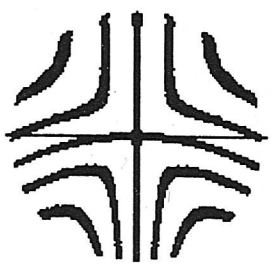
H. van Woerden et al. (eds.), The Milky Way Galaxy, 109–110.

Figure 1(a) shows the velocity field of the previous expression in a circle of radius 0.48 $R/R_\odot$ about the Sun. Figure 1(b) shows the velocity field of 990 B stars (Ovenden, Pryce, & Shuter, 1983) with the same velocity contours for a circle of 4.8 kpc. The reasonable match suggests $R_\odot \sim 10$ kpc.

In Figure 2, we have plotted the concentrations of gaseous material in the galactic disk. In this diagram, the galactic centre is at the centre and the Sun is at the top of the circle of radius $R_\odot$. In the outer Galaxy ($R > R_\odot$), we have used the previously mentioned 21-cm data. In the inner Galaxy ($R < R_\odot$), we have used CO data from the Columbia Survey in the northern hemisphere and the CSIRO survey in the southern hemisphere. No data has been plotted within ± 10° of the centre-anticentre line, for $R < 0.4\ R_\odot$, and in the inner Galaxy for $60° < \ell < 90°$ and $270° < \ell < 300°$. In the inner Galaxy, we have plotted the material at both kinematic distances. Finally, we have corrected for an outward motion of the LSR of 5 km/s.

REFERENCES

Gill, A., & Shuter, W.L.H.: 1983, MNRAS, in press.
Gunn, J.E., Knapp, G.R., & Tremaine, S.D.: 1979, Astron. J., 84, 1181
Ovenden, M.W., Pryce, M.H.L., & Shuter, W.L.H.: 1983 in "Kinematics, Dynamics and Structure of the Milky Way", ed. Shuter, W.L.H., (Dordrecht, Holland : Reidel), p. 67-72.



(a)

(b)

Figure 1

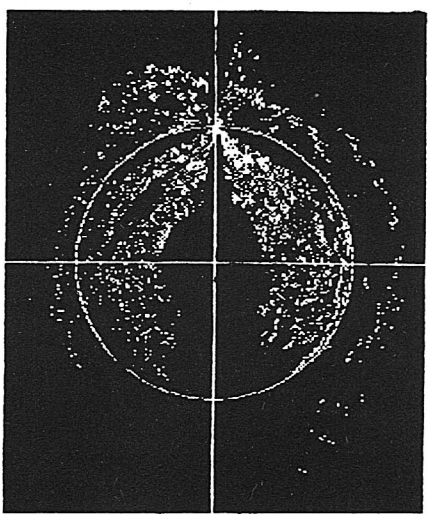


Figure 2

https://doi.org/10.1017/S0074180900242174 Published online by Cambridge University Press