

DEVIATIONS FROM CIRCULAR MOTION AND THE IMPORTANCE OF SOUTHERN HEMISPHERE 21-CM. OBSERVATIONS

F. K. EDMONDSON

Goethe Link Observatory, Indiana University, Bloomington, Indiana, U.S.A.

(1) The suggestion of systematic deviations from circular motion by an angle ϕ , constant throughout the Galaxy, was first presented (Edmondson, 1955) [1] as an *ad hoc* way to recompute distances so as to make the long circular arm discovered by the Leiden observers (van de Hulst, Muller and Oort, 1954) [2] spiral in. The logarithmic spiral motions postulated in this model are not necessarily along the spiral arms, in contrast to the assumption made by Mrs Rubin (1955) [3].

(2) The value $\phi = 4^\circ$ was based on the discrepancy between the longitude of the centre derived from differential motions and from direct determinations (Oort, 1952) [4], but this is highly uncertain. This value of ϕ implies motion along the arms if the Perseus arm and the Sagittarius arm are portions of the same arm.

(3) It was shown later (Edmondson, 1955) [5] that the apparent kink in the anti-centre direction is straightened out when distances are computed with $\phi = 4^\circ$ in place of the assumption of circular motions. Diagrams illustrating this have been published elsewhere (Edmondson, 1955) [6], and will not be reproduced here.

(4) There is very little difference between the predicted radial velocities toward the galactic centre from the circular orbit and spiral orbit models for distances less than that to the centre. This is illustrated in Figs. 1 *a* and 1 *b* which have been computed using the rotational velocities from *B.A.N.* no. 458. At and beyond the centre the spiral model predicts negative velocities, in contrast to the zero velocities expected if the orbits are circular. McClain's observations (1957) [7] of the galactic centre source (I.A.U. 17S2A) show a small, but well defined, secondary maximum at -40 km./sec. A similar maximum is less clearly shown on the Leiden profile (Kwee, Muller, and Westerhout, 1954) [8] at $l = 328^\circ.3$, $b = -1^\circ.4$. McClain (1955) [9] has pointed out: (*a*) that this corresponds to the

maxima at -80 , -70 , and -60 km./sec. shown on the Leiden diagrams for longitudes $321^{\circ}1$, $323^{\circ}6$ and $325^{\circ}8$; and (b) that at $l=330^{\circ}8$ it merges with the more intense low velocity part of the profile but still shows up as a slight asymmetry. These figures are consistent with $\phi=5^{\circ}$ if we are observing a spiral arm about 3 kiloparsecs beyond the centre.

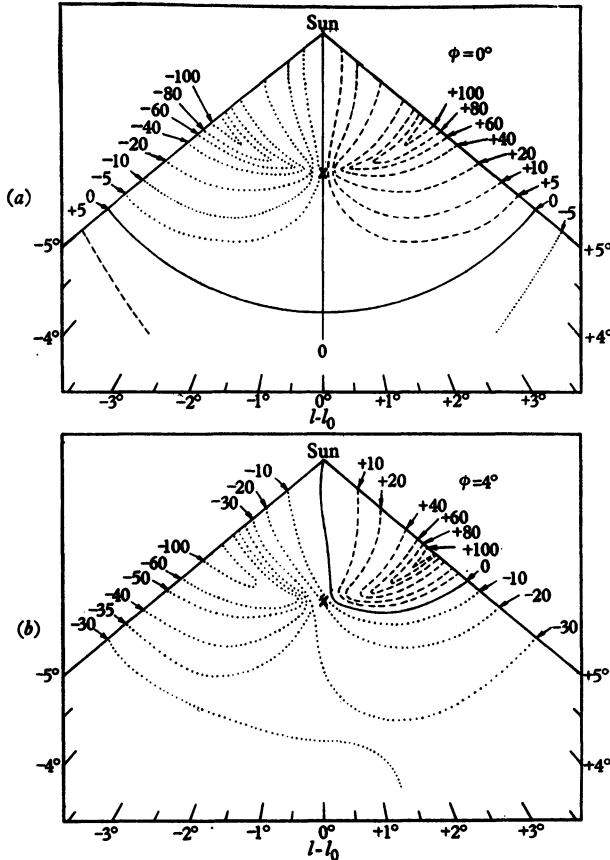


Fig. 1. Contours of equal radial velocity in the galactic plane computed from the rotational velocities in *B.A.N.* no. 458. \times marks the position of the galactic centre; (a) circular orbits, $\phi=0^{\circ}$; (b) spiral orbits, $\phi=4^{\circ}$.

These four points are suggestive, but are not conclusive evidence that the proposed deviation from circular motion exists. Such evidence could be provided by a detailed comparison of values of V_{\max} , as defined by the Leiden observers, in the northern and southern hemispheres. If $\phi=4^{\circ}$ the southern hemisphere V_{\max} should be systematically larger by

$$30 \cos (l - l_0) \text{ km./sec.},$$

disregarding signs. The difference will be reduced at those longitudes where the southern hemisphere V_{\max} are observed too small because there is no hydrogen in the line of sight at the distance corresponding to V_{\max} . It will be increased where the northern hemisphere velocities are observed too small. Hence, comparison of profiles at a single longitude is not a sufficient basis for any firm conclusions regarding the presence or absence of this effect.

The Australian profile for $l = 311^\circ 2$ (Martha S. Carpenter, 1957) [10], while in general appearance similar to the two Leiden profiles ($l = 343^\circ 4$ and $345^\circ 9$) with signs reversed, has a cut-off velocity slightly larger than the Leiden cut-off velocity for the same value of $|l - l_0|$, and the difference corresponds to $\phi \sim 1^\circ$. Unfortunately, the longitude chosen for this comparison is too close to the galactic centre to give a reliable determination, even if the previously mentioned effects were absent. It is quite important that many more such comparisons should be made over a wide range of longitude, and V_{\max} should be computed from the southern profiles following the method of *B.A.N.* no. 458. If there is a systematic difference, it will give an accurate determination of the amount of deviation from circular motion.

It should also be possible, in principle, to use radial velocities of distant supergiants to check whether the relationship between radial velocity and distance from the sun follows the circular orbit model or the spiral orbit model. Unfortunately, the accuracy with which distance determinations can be made at the present time is not quite sufficient for this problem. The southern hemisphere 21-cm. observations can give a quicker and more certain answer.

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