GALACTIC ROTATION OUTSIDE THE SOLAR CIRCLE

R. Chini
Max-Planck-Institut für Radioastronomie
Bonn, West Germany

New radial velocities and optical distances for partly very distant HII regions give evidence for a rising rotation curve in the outer parts of the Galaxy.

The differential rotation in the outer parts of the Galaxy is a difficult problem of great consequence which has created two competing opinions: The model of a flat rotation curve is represented by Schmidt (1965), whereas recent results by Blitz et al. (1982) propose an increasing rotation curve. The data shown in the present paper contribute to this subject. The results, however, are preliminary in many respects and will be improved by additional observations.

The measurements of the radial velocities were carried out at the 100-m telescope of the MPIfR, Bonn, by observing the H112α recombination line. Radio-continuum maps or cross-scans have been superimposed on optical pictures (POSS) of the HII regions to locate possible candidates for the exciting stars. All stars lying within reasonable limits of the radio contours were investigated by UBVRI photometry at the 2.2-m telescope of the DSAZ, Spain, and at the 1.5-m telescope of the Steward Observatory, Arizona. Those stars which turned out to be of early type by the UBV photometry were studied spectroscopically at the 2.3-m telescope of the Steward Observatory, Kitt Peak. In this way 34 O and early B stars could be identified within 17 HII regions. The BVRI colours served as a check whether the normal interstellar reddening law can be applied to compute the visual extinction (see Chini and Krügel, 1983). It turned out that the normal value of R=3.1 could be used for all regions. The conversion of MK spectral types into absolute visual magnitudes was done by the calibration of Schmidt-Kaler (1981).

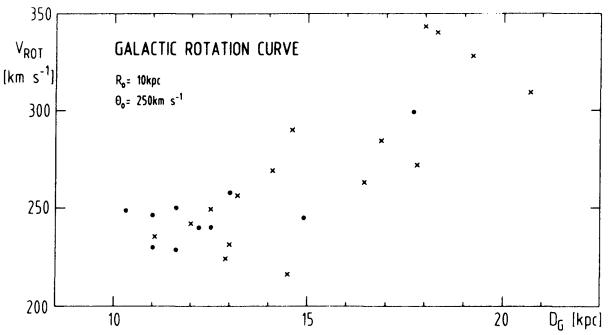
Table 1 gives the observational results. Along with the source name and galactic coordinates the distance d from the sun and the radial velocity v are given. The errors in d are estimated to be better than 20%; the accuracy of v is ± 1 km s^{-1}. For some regions, where data on their exciting stars exist, optical observations have been taken from literature. For reasons of homogeneity their distances have been recomputed by using the luminosity calibration cited above.

H. van Woerden et al. (eds.), The Milky Way Galaxy, 101–104.

Table 1: Observations

Source	l	b	d[kpc]	v[km s^{-1}]
S100	70°3	+1°6	9.0[1]	-23.8
S121	90.2	+1.7	8.5	-55.3
S124	94.6	-1.5	4.0	-37.0
S127	96.3	+2.6	13.7	-96.8
S128	97.6	+3.2	6.9	-75.4
S142	107.1	-0.9	2.5[2]	-39.1
S148	108.3	-1.1	5.0[1]	-54.9
S152	108.7	-0.7	3.5[1]	-50.1
S155	110.2	+2.6	0.8	-7.8
S157	111.3	-0.7	4.7	-47.3
S159	111.6	+0.4	5.4	-67.2
S162	112.2	+0.2	3.8	-44.2
S168	115.8	-1.6	3.8[3]	-47.2
S184	123.1	-6.2	2.5[2]	-28.0
S201	138.5	+1.6	5.5	-34.3
S206	150.6	-0.9	3.3[4]	-25.2
S207	151.2	+2.1	9.8	-38.0
S208	151.3	+2.0	8.9	-30.9
S209	151.6	-0.2	11.3	-47.7
S211	154.6	+2.5	7.3	-35.1
S212	155.4	+2.5	4.8	-42.1
S217	159.2	+3.3	8.3	-21.2
S219	159.3	+2.6	5.1[4]	-30.2
S228	169.2	-0.9	4.2	-11.2
S285	213.9	-0.6	8.5[4]	+45.2
S288	218.7	+1.8	7.5	+56.8

Notes to Table 1: optical data from
1 = Crampton et al. (1978)
2 = Georgelin & Georgelin (1976)
3 = Georgelin et al. (1973)
4 = Moffat et al. (1979)



x = *present work*, • = *optical data from lit.*

Fig. 1: Rotation curve from galactic HII regions.

Figure 1 shows the rotation velocities of the HII regions as a function of the distance from the galactic center. If the observed velocities are due to galactic rotation, then Figure 1 clearly demonstrates that the rotation curve increases beyond 15 kpc from the center. There is no evidence that systematic errors in stellar distances could produce this effect. Non-circular motions, however, and the fact of incomplete galactic cover might be important. Likewise, a change of the rotation constants could produce a flat rotation curve.

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DISCUSSION

P. Pismis: Have you checked whether there is a difference between the rotation curves obtained from the northern and southern regions of the anticentre? In the northern region there is a marked discrepancy between the rotation speeds in the Perseus Arm and the general rotation curve. Have you noted any such discrepancy?

Chini: From our material of observed HII regions we cannot find any difference between northern and southern objects. There are no HII regions in our sample which belong to the Perseus Arm.

L. Blitz: Have you reobserved any of the exciting stars previously observed by, for example, Moffat et al. as an overall check of your distance scale?

Chini: We have reobserved several HII regions. The results concerning the spectral types of the exciting stars agree with those of Moffat et al. Small differences occur in the distances obtained, but these are due to the different calibrations of spectral type vs. absolute magnitude used by Moffat et al. and by myself.

K.S. de Boer: How would your plot look if you had taken a galactocentric distance R_o = 8.5 kpc for the Sun, and a local rotation speed of Θ_o = 220 km/s?

Chini: As shown by Blitz, such a change of the rotation constants would steepen the rotation curve even further.

M.L. Kutner: The scatter in the results is larger than the error budget you outlined.

Chini: The large scatter in the diagram reflects, in my opinion, our poor knowledge of the absolute magnitudes of the earliest spectral types.

F. Bash: Have you assumed circular orbits for your HII regions?

Chini: Yes.

Bash: If, in fact, HII regions do not move on circular orbits, then the rotation curve you get will depend on the distribution of your sample of HII regions in longitude and in distance from the Sun.

B.G. Elmegreen: Would you have noticed a decrease in the ratio of total-to-selective extinction at larger distances from the galactic centre, as might be expected if the grain size is smaller in proportion to the lower metal abundance? You mentioned that the reddening appeared to be normal.

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Chini: If you plot the observed colours of the stars, e.g. V-I vs. B-V, and the extinction law is normal, all stars earlier than about MO (without intrinsic excesses) lie on a straight line. Whenever a star does not follow that line, it might be due to a deviation from the normal extinction law. From our UBVRI observations we could check several colour-excess ratios; we did not find any deviations from the normal extinction law.

P. Pişmiş in discussion with Chini.
Foreground: T.P. de Zeeuw and E.F. van Dishoeck.
Beside Mrs. Pismis: S. Wramdemark, C.C. Lin and K. Begeman.
Behind: J.M. Dickey and H.S. Liszt.
In background: Ch. Terzides and H. van der Laan. CFD

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