THE ROTATION CURVE FROM A–F SUPERGIANTS

A Progress Report

D. M. PETERSON AND D. SLOWIK
Astronomy Program
State University of New York
Stony Brook, NY 11794 USA

1. Introduction

The Galactic rotation law provides critical information for estimating the distribution of mass in the Galaxy, for tying the distance of the Sun from the Galactic center to local distance scales, and, if determined over large enough distances, for estimating the total mass of the system and the amount of nonluminous matter present. Interior to the Sun velocities are well defined by observations of the ISM, particularly HI. These techniques are not available for points exterior to the Sun and we must rely on observations of velocities of objects whose distances can be estimated. Notable among these are the Cepheids (Pont et al 1994) and the combination of CO velocities and OB cluster distances (Brand & Blitz 1993) where the two are found to coexist. Adding a new class of objects, particularly bright, relatively common objects to this effort is of importance.

Over the past few years we and a number of other investigators (Slowik & Peterson 1993, 1994, and references therein) have been involved in calibrating the strong luminosity dependence of the $\lambda 7774$ triplet of OI in the A and F supergiants. Our calibration rests entirely on members of Galactic clusters, and is comparable to the Cepheid calibration in reliability. Although the primary focus of this effort is extragalactic, these objects being visible to at least 10 Mpc, its usefulness in other contexts is also apparent. We report here on the first application of this approach to determine the Galactic rotation law beyond the Solar circle.

2. The Data

For this initial effort we availed ourselves of the "queue" observing program offered by Kitt Peak National Observatory during the summer of

L. Blitz and P. Teuben (eds.), Unsolved Problems of the Milky Way, 703–706.

1993. While a remarkable opportunity, the program came with constraints, including limitation to the equivalent of two nights of observing. In this case the instrument of choice was the Coudé Feed. As a result, none of the objects in the observing list (obtained with a SIMBAD search) exceeded 10th magnitude, and all but six were brighter than V = 9. In all, 40 objects ultimately satisfied our luminosity and color requirements. In November 1993 we were notified that approximately 100 spectra, at least one for each object in both the λ7770 and λ8600 regions were available by "ftp".

From these spectra we extract the OI equivalent widths to estimate luminosities and CaII indices to estimate reddening (Slowik & Peterson 1993, 1994). From the λ8670–8795 region we were able to derive radial velocities for each object, using a grid of synthetic spectra generated using the Kurucz programs and grid of models (Kurucz 1992). Observations of standards indicated 0.6 km s^{-1} accuracy. However, as a rule these objects all exhibit velocity variability at the few km s^{-1} level. In what follows we have adopted 10 km s^{-1} as the intrinsic uncertainty in each of these measures.

3. Discussion

Figure 1 shows the distribution on the Galactic plane of this group of objects. Although some of the objects are seen quite far from the Sun, reddening and the magnitude limits constrained the distances penetrated toward the anticenter; Galactocentric distances do not exceed 1.4 $R_\odot$. On the other hand, two objects toward l = 60° are measured at distances of 8 kpc, indicating the power of this approach.

Figure 2 shows the deduced circular velocities (assuming $v_\odot = 220$ km s^{-1} and $R_\odot = 8.5$ kpc) as a function of Galactocentric distance. We also show the analytic fit obtained by Brand & Blitz (1993). Clearly evident is the wave structure seen by other investigators (cf Brand & Blitz 1993, Pont et al 1994) with the circular velocity somewhat lower immediately beyond the Sun. Given the limited number of objects and angular coverage, it is premature to pursue an independent solution for the rotation law.

We are in the process of extending this effort. The original SIMBAD search indicated about 150 of these objects in the second quadrant. Rough estimates place several of them at or beyond 2 $R_\odot$, which would substantially contribute to our knowledge of the rotation law at those distances.

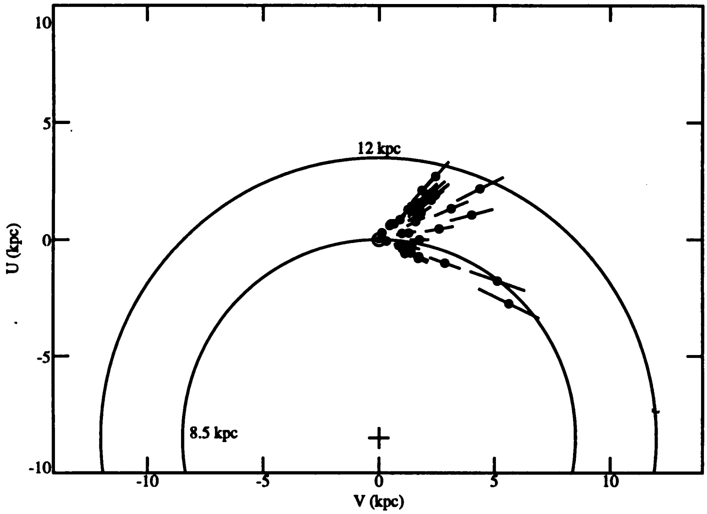

Figure 1. The distribution of the A – F supergiants, projected on the Galactic plane. Distance uncertainties are indicated.

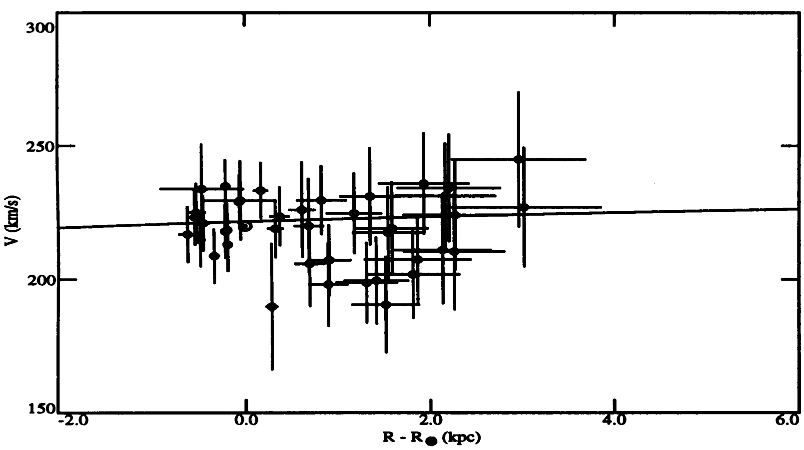

Figure 2. The velocity law defined by the current data. The solid line is from Brand & Blitz 1993.

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References

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