COMPARISON OF GLOBAL 21 cm VELOCITY PROFILES WITH Hα ROTATION CURVES

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ABSTRACT. 21 cm profiles are compared with high resolution long slit Hα spectra. Asymmetries in intensity and velocity gradient in the spectra are apparent in the global profiles. When measured at 0.5 of peak intensity, the 21cm profile width and optical rotation curve match best.

High resolution long slit spectra in the Hα region are available for 60 field spiral galaxies of Hubble types Sc, Sb, and Sa (Rubin, Ford and Thonnard, 1980; Rubin et al., 1982, 1983). We also have global 21 cm neutral hydrogen profiles for approximately 3/4 of these galaxies (Thonnard et al., 1983).

Ever since the discovery of the correlation between luminosity and 21 cm profile width, ΔV_{21} (Tully and Fisher, 1977), ΔV_{21} has become an important parameter in characterizing galaxy properties. Unfortunately, observers use various methods to determine ΔV_{21}. Since the global HI profile is a convolution of the HI distribution and the velocity field over the entire galaxy, while the optical rotation curve is derived from a narrow (~1.'5) sample along the major axis, an analysis procedure giving the same dynamical information would be very useful.

Observations of face-on galaxies with very steep profile edges, ones most affected by instrumental resolution, show that for resolutions ranging from 20 to 2.5 km s^{-1}, ΔV_{21} is independent of resolution if measured at the 0.50 to 0.75 peak intensity level. Computer models indicate that gently rising rotation curves (typical of low luminosity galaxies) generate 21 cm profiles whose shape is quite sensitive to the HI distribution, whereas rotation curves that are essentially flat over most of the radius (typical of high luminosity galaxies) generate profiles that are independent of HI distribution. For a wide range of rotation curve shapes, inclinations, resolution (or velocity dispersion) and HI distribution, the measurement level at which the model profile width matches the input maximum rotational velocity ranged between 0.43 and 0.58, except for perfectly flat rotation curves, where the level was 0.8 (which drops to 0.5 with only a 5% positive velocity gradient).

E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 29–30.

The examples shown in Fig. 1 illustrate some of the points mentioned above. NGC 4605, lowest luminosity Sc studied, has a shallow velocity gradient across its disk and a centrally peaked profile. UGC 2885, highest luminosity Sc, having nearly constant rotational velocity over a large radius range, has sharp horns and a deep central minimum in its profile. Note that in both cases, the side in which Hα emission extends to larger radii is the one with more HI. NGC 1087 and 1620 are average luminosity galaxies with similar rotation curves but radically different profiles. A strong central concentration of HI in N 1087 and a lack of central HI in N 1620 could account for this. Also, in N 1087, the steeper velocity gradient seen at large radii on the high velocity side manifests itself as a shallower gradient on the corresponding HI profile edge. NGC 7606 is one of the few galaxies with decreasing rotational velocities in the outer regions. We note the excellent agreement between the maximum optical rotational velocities and velocities at the half power points of the HI profiles in these five extreme cases. For 42 galaxies, the difference in systemic velocity, $V_{opt} - V_{21} = -1.5 \pm 3.9$ km s^{-1} (m.e.).

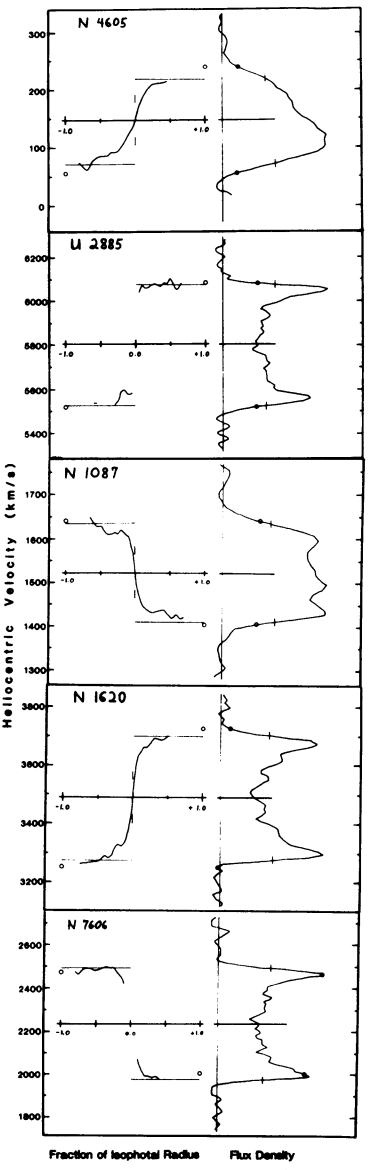

Fig. 1. Comparison of major axis Hα velocities (left) with the HI profile (right). Horizontal lines ranging from -1.0 to 0.0 and 0.0 to +1.0 indicate velocities of the half power points (short vertical lines) on the HI profile. Open circles indicate the extrapolated rotational velocity at R_{25}. The horizontal line going through center of optical and radio data indicates the systemic velocity.

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https://doi.org/10.1017/S0074180900032320 Published online by Cambridge University Press