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Hα Velocity Fields of Normal Spiral Disks

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Abstract. We present Hα velocity fields for a sample of nearly face–on spiral galaxies observed with DensePak on the WIYN telescope. We combine kinematic inclinations and position angles measured from these data with photometric inclinations and position angles measured from I-band images to show that spiral disks are intrinsically non-circular.

1. DensePak Hα Velocity Fields

DensePak is a 30×45 arcsec fiber-optic integral-field unit feeding a bench spectrograph on the WIYN 3.5m telescope (Barden et al. 1998). By using multiple pointings of DensePak in echelle mode ($\lambda/\Delta\lambda = 13,000$), we have constructed H$\alpha$ velocity fields for 8 nearby, normal, apparently face–on spiral disks. The velocity fields, typically complete to $\sim$3 disk scale lengths, reach the peak of the rotation curve (Figure 1), and are modeled successfully by a single, inclined disk with a hyperbolic tangent function for V(r) (Figure 2). Residuals from this simple model are small (typically 5 km/s).

Our first discovery was that this sample, while selected to appear photometrically face-on, had projected velocities indicative of significant inclinations (up to 35°). Clearly these disks are not circular.

To quantify this observation, we developed an efficient method to estimate disk elongation of nearly face-on galaxies by combining measurements from Hα velocity fields and I-band images. In the context of a simple geometric model, we interpret differences between kinematic and photometric inclinations and position angles in terms of intrinsic disk ellipticity. Five galaxies in the sample are non-circular at greater than 99% CL; the range of ellipticities estimated within the context of our model is 0.02 to 0.20 (Andersen et al. 2000). Even such modest disk ellipticity can account for much of the scatter in the Tully-Fisher (TF) relation (Franx & de Zeeuw 1992), as discussed by Bershady & Andersen (these proceedings). Support for this research comes from NSF/AST-9970780.

References

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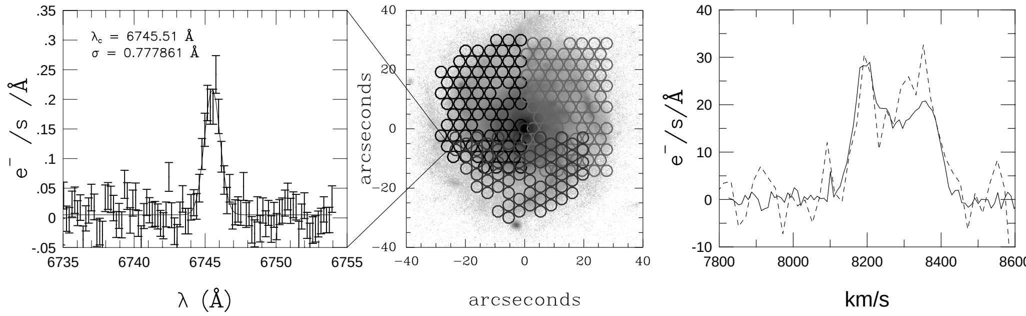

Figure 1. NGC 5123. The left panel is a DensePak echelle spectrum at Hα from the edge of this nearly face-on spiral, with signal-to-noise typical of our data at 2 scale lengths. To provide adequate spatial coverage, we typically use 1 to 3 DensePak pointings to map out the velocity field (middle panel). The right panel overlays Hα (solid line) and HI (dashed line) velocity profiles. The HI profile, from Nançay (NRT), is normalized to the peak of the Hα profile. Measurements of W_{20} from these two profiles agree within errors, indicating we have observed the peak of the optical rotation curve.

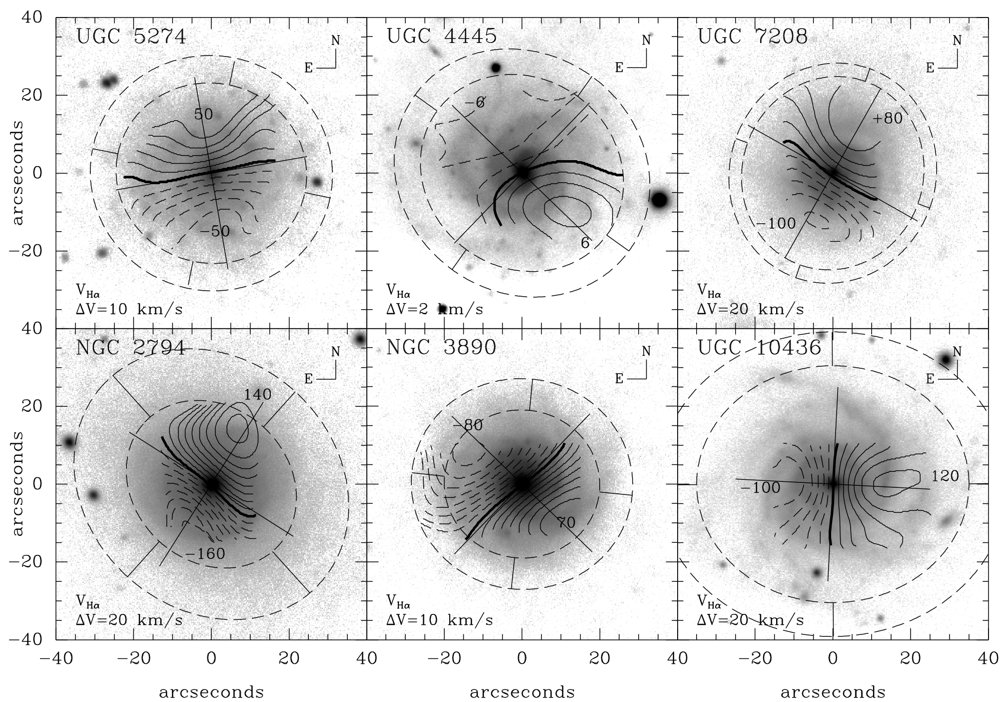

Figure 2. Polynomial surface-fits to the DensePak Hα velocity field for 6 sample galaxies, overlayed on I-band WIYN images (NGC 5123 and UGC 4380 are presented in Bershady & Andersen 2000 and Andersen et al. 2000). Solid, heavy, and dashed lines are positive, zero, and negative velocities, respectively, relative to the model systemic velocity. The dashed annuli represent the radii between which photometric b/a and PA are measured (solid lines in annuli indicate photometric major and minor axes). UGC 4445 is sufficiently face-on ($i < 10^\circ$) that we are unable to determine an accurate kinematic inclination, and therefore we have excluded it from our ellipticity analysis.