Galaxy Disks and Disk Galaxies
ASP Conference Series, Vol. 3×10^8*, 2000*
J.G. Funes S.J., and E.M. Corsini, eds.

Kinematic Asymmetries in a Broad Galaxy Sample

S. J. Kannappan and D. G. Fabricant

Harvard-Smithsonian CfA, 60 Garden St MS-20, Cambridge, MA 02138

Abstract. We analyze asymmetries in the gas rotation curves of 113 galaxies drawn from the Nearby Field Galaxy Survey, spanning a broad range of luminosities and morphologies. If the origin of the rotation curve is chosen to minimize the asymmetry, then ∼26% of sample galaxies show asymmetry >5% within $1.3r_e$. However, not all gas kinematic asymmetries indicate asymmetries in the underlying potential.

1. Introduction

Roughly 50% of bright spiral galaxies show asymmetry in their global HI profiles (Haynes et al. 1998). Such asymmetries may arise from noncircular motions, lopsided gas distributions, or unresolved companions. By examining resolved optical rotation curves (RC's), we can isolate the kinematic contribution to the asymmetry. Although optical RC's do not extend as far as *resolved* HI data, Courteau (1997) points out that global HI profiles sample primarily the kinematics of the inner disk, and high quality optical data generally perform equally well. We analyze only RC's extending to at least $1.3r_e$, the peak velocity position for a pure exponential disk. We also require that velocity widths reach $2v > 60\ \mathrm{km\,s^{-1}}$, deliberately introducing a bias against the smallest and most face-on galaxies. Although this bias is not in the spirit of the minimum-bias parent survey (the Nearby Field Galaxy Survey, Jansen et al. 2000), our velocity cut serves to focus attention on galaxies with clear bulk motion, while still including a wide range of types, and also luminosities as faint as $\mathrm{M_B} \sim -15$. The final sample comprises 113 galaxies, excluding 2 hard-to-measure cases.

2. Asymmetry Measurements

We adopt a quantitative asymmetry measure akin to the photometric asymmetry index of Abraham et al. (1996). Reflecting the rotation curve about its origin, we compute the asymmetry within $1.3r_e$ as the average absolute deviation between the two sides, $<\mid v - v^{\mathrm{reflected}} \mid>$. (Asymmetries for $r > 1.3r_e$ are more difficult to compare due to the variable spatial extent of the data.) Measured asymmetries depend critically upon the choice of origin, so we shift the origin to numerically minimize the asymmetry. We constrain the spatial coordinate of the origin to remain within the one-sigma error bars of our determination of the continuum peak position, but we allow the velocity coordinate to vary freely. The final asymmetry is expressed as a percentage of the velocity width $2v$.

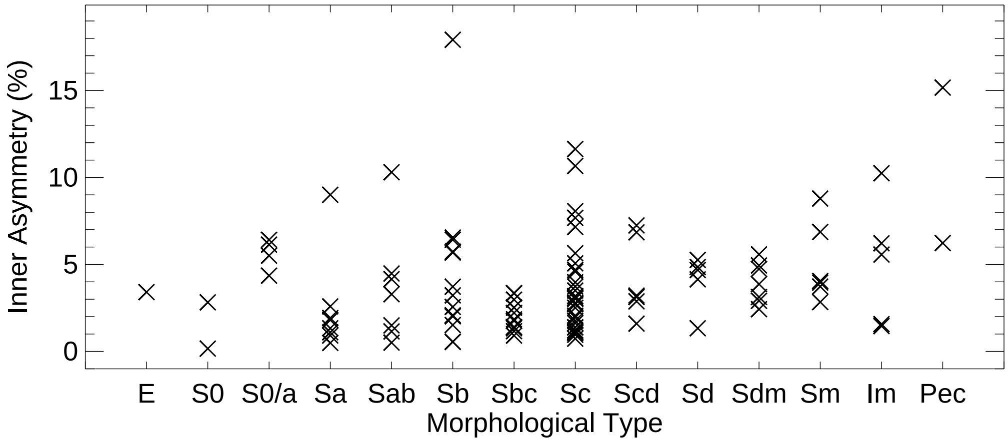

Figure 1. Distribution of Asymmetry Values by Morphology.

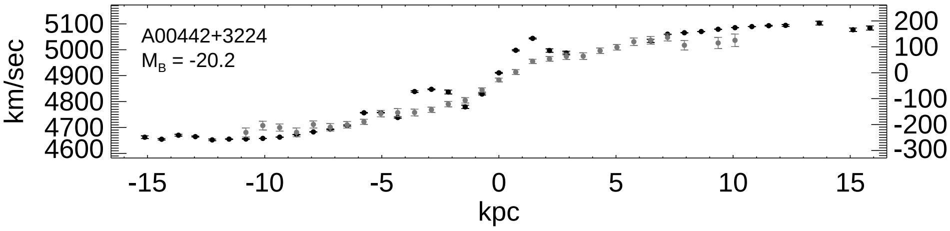

Figure 2. Gas (black) and stellar (grey) RC's for a barred Sb.

Figure 1 shows the distribution of inner asymmetry values by morphology. About 26% of our sample galaxies have asymmetry >5%. This number appears to be smaller than the HI result, consistent with the idea that we are isolating kinematic asymmetries from lopsidedness in the HI distribution, but direct comparison is difficult given the differences in asymmetry measurement technique. Some of the asymmetries we see reflect peculiar gas dynamics with no stellar counterpart, as illustrated in Figure 2, suggesting that the fraction of galaxies with asymmetric gravitational potentials is probably smaller than 26%.

Acknowledgments. We thank R. Jansen for sharing the NFGS photometry. S. J. K. received support from a NASA GSRP Fellowship.

References

Abraham, R. G., Tanvir, N. R., Santiago, B. X., Ellis, R. S., Glazebrook, K., & van den Bergh, S. 1996, MNRAS, 279, L47

Courteau, S. 1997, AJ, 114, 2402

Haynes, M. P., van Zee, L., Hogg, D. E., Roberts, M. S., & Maddalena, R. J. 1998, AJ, 115, 62

Jansen, R. A., Franx, M., Fabricant, D., & Caldwell, N. 2000, ApJS, 126, 271