The I–Band Tully–Fisher Relation at Intermediate Redshifts

Daniel A. Dale[1], Riccardo Giovanelli[1], Martha P. Haynes[1], Marco Scodeggio[1], Luis Campusano[3], and Eduardo Hardy[4]

[1] Astronomy Department, Cornell University, Ithaca, NY 14853, USA
[2] Observatory of Cerro Calán, Universidad de Chile, Casilla 36-D, Santiago, Chile
[3] Department of Physics, Laval University, Ste–Foy, P.Q., Canada G1K 7P4

Abstract. We present first results of all all–sky observing program designed to 1) improve the quality of the I band Tully-Fisher (TF) template and 2) obtain a bulk flow dipole solution for a volume of radius 18,000 km s^{-1}. We are obtaining between 5 and 15 TF measurements per cluster on a sample of $\sim$ 50 clusters at intermediate redshifts ($0.02 \lesssim z \lesssim 0.06$) which should determine the offset in the I–band TF template to within $\sim$ 0.02 mags, or bulk flows of this sample to within $\simeq$ 150 km s^{-1}.

1 Introduction

Claims of large amplitude, coherent flows on scales up to $100h^{-1}$ Mpc (Lauer & Postman 1994: LP; Courteau et al. 1993) present a scenario difficult to accomodate with current cosmological scenarios (Bahcall & Oh 1996). These claims have been challenged by the SN Ia work of Riess et al. (1995) and by the TF work of Giovanelli et al. (1996), both of which use methods independent from the Brightest Cluster Galaxy technique used by LP. Unfortunately, the challenges originate from data samples that are either too sparse or too shallow to adequately verify the amplitude and extent of any bulk flow. The Giovanelli et al. sample derives a TF template relation based on 555 galaxies in 24 clusters to $cz \simeq 9000$ km s^{-1} (Giovanelli et al. 1997a,b: G97a,b). We are extending this work by measuring the redshift–independent distances of some 50 Abell clusters with radial velocities $6000 \lesssim cz \lesssim 18{,}000$ km s^{-1}. Not only will this enlarge the volume over which bulk flows can be measured, but it will also significantly increase the accuracy to which bulk flows can be measured; we predict we will be able to determine the amplitude of any bulk flow for our sample to within $\simeq$150 km s^{-1}.

2 The Sample

We are obtaining TF measurements for 5 to 15 galaxies per cluster for a total of $\sim$ 50 clusters. Figure 1 shows the distribution of the 36 clusters observed thus far. An attempt to sample the sky uniformly has been made, though regions near the Galactic disk are avoided due to the large foreground extinction present there.

Table 1 lists the main parameters of the first set of completed clusters. Standard names are listed in column 1. Adopted coordinates of the cluster center

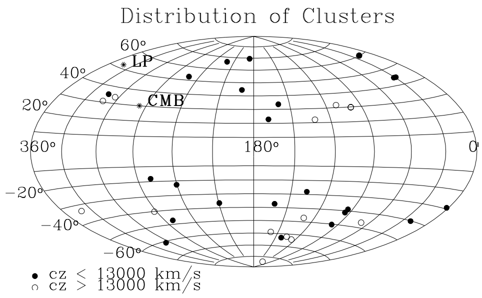

Fig. 1. The distribution of the Abell clusters selected thus far. We have avoided clusters with $|b| \lesssim 20°$ where Galactic extinction is significant. The apices of the CMB and the LP dipole motions have been plotted for reference.

are listed in columns 2 and 3, for the epoch 1950; they are in general obtained from Abell et al. (1989). An exception is a cluster slightly offset from Abell 1983 in both RA–Dec and redshift. We designate this cluster "A1983b." For all the clusters we have compiled our own systemic velocities (column 4 with errors parenthesized) using n_z redshifts (column 5).

Table 1. Cluster Coordinates

Cluster	RA h m s	Dec d m s	V_{cmb} km s^{-1}	n_z
A 168	011234	–000144	13067(69)	43
A 397	025412	+154500	9651(76)	38
A 569	070524	+484200	6032(55)	36
A1139	105530	+014600	12218(59)	24
A1228	111848	+343600	10830(39)	32
A1983	145024	+165700	13721(46)	76
A1983b	144724	+170600	11521(102)	14

3 Observations

The I band CCD photometry for the project is being obtained at the KPNO and CTIO 0.9m telescopes and is nearly completed. Only apparent magnitudes with photometric calibrations accurate to 0.02 mags or better are used.

We use the H_α spectral line to obtain rotation curves of the galaxies. This is being done at the Mt. Palomar 5m and the CTIO 4m telescopes using long–slit spectroscopy with high dispersion gratings (1200 l mm^{-1}; $\sim$ 7 km s^{-1} pixel^{-1}). Typically, 30–45 minute exposures are sufficient to trace the outer disk regions.

4 Results

Figure 3 gives the TF plots for the first Abell clusters in our project, using data that has not been corrected for sample incompleteness. The dashed line plotted is the relation derived from the G97a,b study of 24 clusters, the relative proximity of which enables an accurate determination of the TF slope due to the broad stretch in galactic parameters observed.

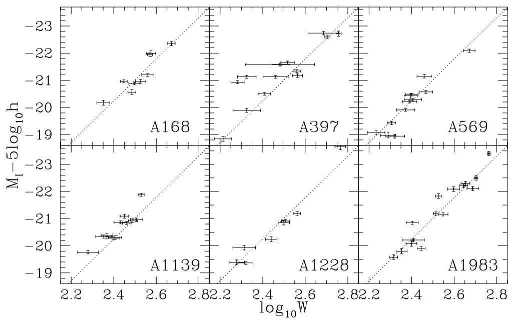

Fig. 2. "Raw" TF plots for the first six clusters in our sample. The dashed line is the TF relation from G97a,b. The A1983 panel includes A1983b. The rotational velocity width, W, has been corrected for rotation curve shape, disk inclination, and cosmological broadening.

This research was supported by NSF grant AST94–20505 to RG.

References

Abell, G., Corwin, H., Olowin, R. (1989): ApJS **70**, 1–138
Bahcall, N., Oh, S. (1996): ApJ **462**, L49–L52
Giovanelli, R., Haynes, M., Wegner, G., da Costa, L., Freudling, W., Salzer, J. (1996): ApJ 464, L99–L102
Giovanelli, R., Haynes, M., Herter, T., Vogt, N., Wegner, G., Salzer, J., da Costa, L., Freudling, W. (1997a): AJ, in press
Giovanelli, R., Haynes, M., Herter, T., Vogt, N., da Costa, L., Freudling, W., Salzer, J., Wegner, G. (1997b): AJ, in press
Lauer, T., Postman, M. (1994): ApJ, **425**, 418–438
Riess, A., Press, W., Kirshner, R. (1995): ApJ, **445**, L91–L94
Tully, R., Fisher, J. (1977): A&A, **54**, 661-673