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TOWARDS A MARK III CATALOG OF PECULIAR VELOCITIES: RECALIBRATION OF IRTF GALAXIES

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1 Recalibration of the IRTF Relation

The Near-Infrared Tully-Fisher (IRTF) relation, defined by the papers published by Aaronson et al., Bothun et al. and Mould et al. (ApJ 1979-1989), is one of the cornerstones of our knowledge of the local peculiar velocity field. A recalibration of the full data set of over 550 field and cluster galaxies is desirable for two reasons:

1) Diameters and axial ratios in the original papers are based on optical data defined on several different systems (RC2, UGC, ESO, their own measurements). Fortunately, 85% of the galaxies used in the Aaronson et al. studies (480 out of 567) are in the RC3 (de Vaucouleurs et al. 1991). As the Aaronson et al. definition of $H_{-0.5}$ depends on optical diameters and inclinations, one can use the RC3 data to place most IRTF magnitudes onto a mutually-consistent optical diameter system.

2) Aaronson *et al.* did not give quality assessments of the accuracy of their individual $H_{-0.5}$ magnitudes. Burstein (1989; Mark II catalog) found differences in accuracy among the field galaxies, but could not quantify these differences. Moreover, no such *a priori* discriminant existed for the cluster spiral data. In a reanalysis of both cluster and field data together, it will be possible to define a quality parameter for both sets of data in a mutually-compatible manner (analogous to that used by the 7 Samurai).

2 The Dataset

We collected all the H magnitude aperture measurements published by the Aaronson *et al.* group from 1977 to 1990, including the Ph.D. thesis of of Marc Aaronson. A total of 602 galaxies have published H magnitudes and 567 galaxies were used for peculiar velocity studies, as given in the Mark II catalog. However, one list is *not* a subset of the other: there are 107 galaxies with published H magnitudes not used for peculiar velocity studies; and 72 galaxies used in the Mark II catalog for which we did not find published H magnitudes.

3 Growth Curves, $H_{-0.5}$ Magnitudes and Rotation Velocities

Growth curves are obtained by normalizing the size of each aperture by a fiducial size for each galaxy, here chosen to be the fully corrected diameter D_{RC3} (which is approximately at the 25th mag arcsec^{-2} isophote). D_{RC3} is the isophotal diameter D_{25} given in the RC3 but re-corrected for Galactic extinction via the prescription of Burstein et al. (1982, ApJ 253, 70). Growth curves define how the luminosity of a galaxy increases with aperture size, with apertures normalized to a fiducial size of the galaxy. The $H_{-0.5}$ magnitude of a galaxy is defined as the H magnitude corresponding to a normalized aperture $\log(A/D_{RC3}) = -0.5$.

The galaxy sample is divided into four groups corresponding to four photometric types, which are initially defined by the Hubble types (Sa & Sab; Sb & Sbc; Sc & Scd; Sd–Sm). As is evident from Fig. 1, later-type spirals have steeper H aperture growth curves than do earlier Hubble types.

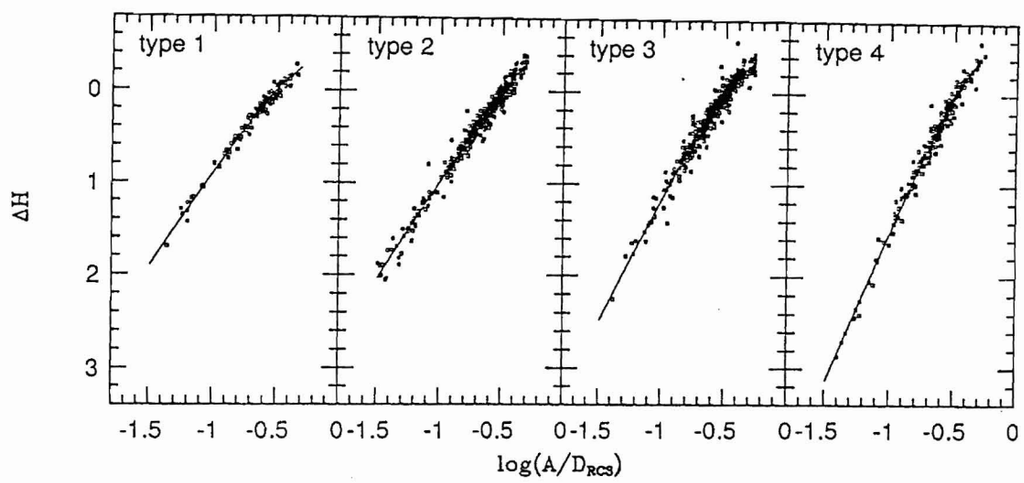

Figure 1: Observed growth curves (square dots) superimposed to their models (solid lines).

For each of the four groups we choose those galaxies having the most observations with different-sized apertures as our starting point. From these observations we make an initial guess for the *reference* growth curve for each of the four types.

The growth curve for each galaxy, including those that define the fiducial sample, is normalized to its initial $H_{-0.5}$ magnitude by translating it along the y axis (magnitude), keeping the x axis (the logarithm of aperture size to D_{RC3}) fixed. The reference growth curves for all galaxies are then refined by looking at the systematic trend of the residuals from all the other galaxies, making corrections, and then iterating. We went through ~ 10 iterations to arrive at the final fiducial growth curves.

The final $H_{-0.5}$ magnitudes are given by a χ–square interpolation of the reference curves to the observed magnitudes, galaxy by galaxy. In Fig. 1 the references growth curves are plotted with the curves for all the galaxies, for the four different photometric types. A quality parameter (from 1 to 3), corresponding to the goodness of the fit, was assigned to each galaxy. Therefore, the final dataset can also be divided in three subsets when a selective use is needed.

As the axial ratios in the RC3 differ systematically from those defined in the RC2, one must correct published rotation velocities for this difference. Unfortunately, only rotation velocities corrected for the inclination are published. Hence, we have to first *uncorrect* the rotation velocities for inclination and then *correct* them for the RC3–derived inclinations.

The end product of our work is a new list of values of $H_{-0.5}$ and ΔV for 344 field and 193 cluster galaxies. This sample of 537 galaxies is different from that of the original Mark II sample (567 galaxies) owing to the elimination of 26 galaxies classified as 'peculiar' and 14 galaxies without H magnitude data, and to the addition of 10 new galaxies that have both H magnitude data and published rotation velocities. These data will be published together as a complete H magnitude catalog and, together with J. Willick, we intend to do a reanalysis of the local velocity field using this new data set.