SPIRAL GALAXIES, ELLIPTICAL GALAXIES AND THE LARGE-SCALE VELOCITY FIELD WITHIN 3500 KM/S OF THE LOCAL GROUP

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ABSTRACT. The peculiar motions for spiral galaxies and elliptical galaxies within V = 3500 km/s are compared to the model predictions of the mass concentration (MC) velocity field model of Lynden-Bell et al. The large-scale motions defined by over 600 galaxies from three independent sets of data (Aaronson et al.; de Vaucouleurs and Peters and elliptical galaxies) are in substantial agreement with this model.

1. COMPARISONS OF DATA WITH MODEL

The distances to 400 elliptical galaxies have been used to develop a model of the large-scale velocity field near the Local Group (Lynden-Bell et al. 1987; Faber et al., this volume). As discussed therein, the nearby velocity field is best-described by the combination of a flow towards a mass concentration (MC) centered on $l=307^{\circ}$, $b=9^{\circ}$ at a distance of $R_m = 4350 \pm 350$ km/s in the Hubble flow, together with a Virgocentric motion of 200 km/s at the position of Local Group. This mass concentration (the 'Great Attractor') imparts a streaming motion at the Local Group of amplitude 570 ± 60 km/s, with the amplitude of the motion varying as 1/R from the center of the Great Attractor.

Previous surveys of the distances to spiral galaxies using the Tully-Fisher method [Aaronson et al. (1982; AHMST); de Vaucouleurs and Peters (1984; DVP)] provide large, independent samples of galaxies with which to compare to this velocity field model. Peculiar motions for the spiral galaxies are predicted in the same manner as for the elliptical galaxies, including a Malmquist bias correction. Distances are expressed in units of km/s to combine the data in a Hubble constant-free manner. Some differences in the treatment of these spiral data from that done by the original authors include: a) A one-sigma error of 0.41 magnitude derived for the Aaronson et al. data as a whole (however, see below for a selected subset of these data). b) Only the Tully-Fisher distance predictions used for the DVP data set, with an error of 0.55 mag. c) 129 galaxies are in common between the AHMST and DVP samples.

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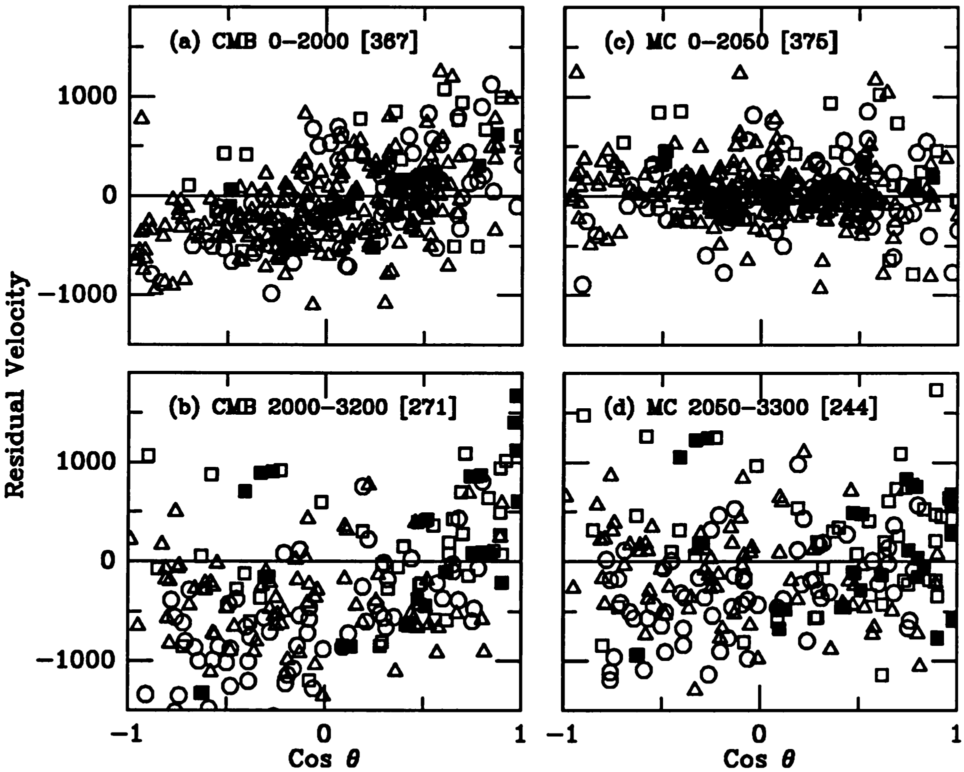

Fig. 1. Residual velocities (obs–model) vs. cos θ, where θ is the angle of the galaxy to direction of streaming motion (l=307°, b=9°). Residual velocities for galaxies in two spiral samples [Aaronson et al. (open triangles); de Vaucouleurs and Peters (open circles)] and the elliptical galaxy sample (open, closed squares) are shown within two distance intervals for: a) and b): motions with respect to the cosmic microwave background (CMB); c) and d): motions with respect to the MC velocity field model (MC). Distance interval (in km/s), number of galaxies (in [ ]) shown in figures.

Only the more accurate AHMST data is used for these galaxies in this analysis, leaving 154 galaxies in the DVP sample.

This short contribution presents two comparisons of the spiral and elliptical galaxy peculiar velocities with various models of the local velocity field. A more detailed analysis, with additional comparisons between different data samples, and between data and model, will be given in Burstein et al. (1988).

The first comparison (Fig. 1) shows the peculiar motions of galaxies with respect to the cosmic microwave background (CMB) and to the MC velocity field model, for two different distance intervals (approx. 0 - 2000 km/s and 2000 - 3200 km/s). A bulk flow would produce

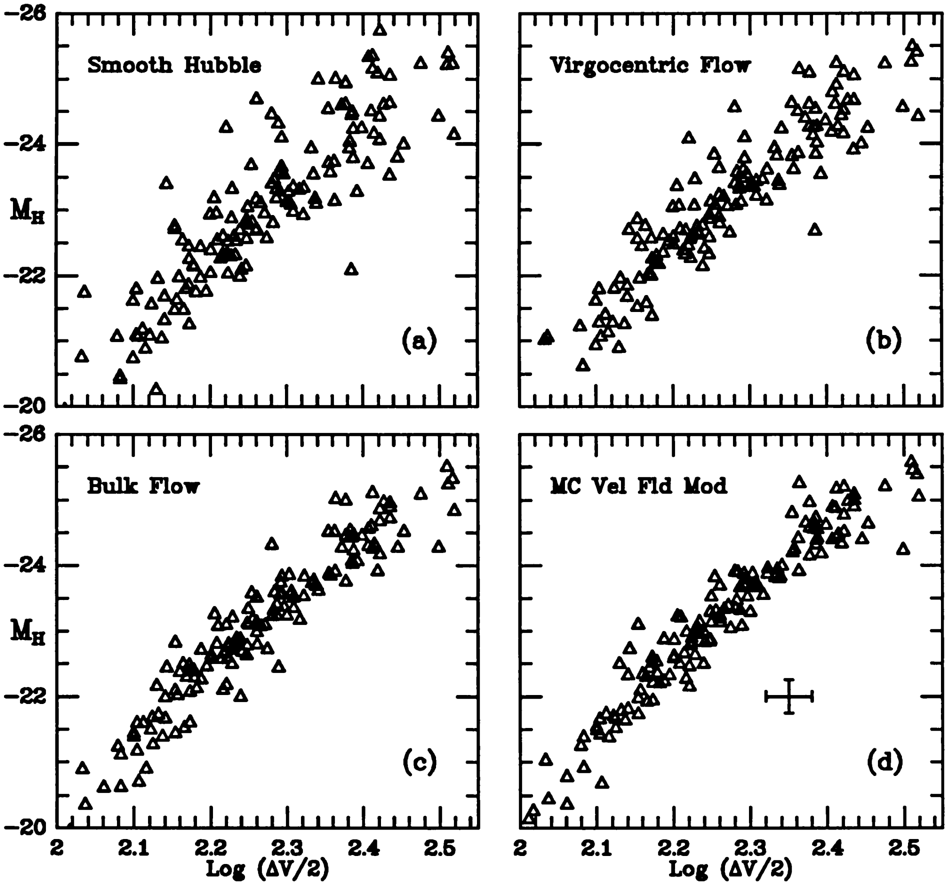

Fig. 2. The predicted IR Tully-Fisher relations for the 150 best-observed spirals from the AHMST sample with V < 3000 km/s for 4 models of the local velocity field: a) a smooth Hubble flow; b) a Virgocentric infall model only, with a velocity at the Sun of 250 km/s; c) a best-fit bulk motion of 400 km/s for these galaxies, plus a Virgocentric motion of 250 km/s; d) the MC velocity field model, including both the MC motion of 570 km/s at the position of the Sun plus a Virgocentric motion of 200 km/s.

a linear slope in Figs. 1a,b; the MC flow produces a non-linear motion, which is well-fit by the MC velocity field model (Figs. 1c,d).

The second comparison (Fig. 2) compares the near-infrared Tully-Fisher relations (M_H = absolute H magnitude) for 150 of the best-observed spirals from AHMST, as predicted by four kinds of velocity field models: a) A smooth Hubble flow (i.e., no large-scale motions); b) A Virgocentric flow model (similar to that used by AHMST), with a Virgocentric motion of 250 km/s at the position of the Local group; c) a bulk motion (i.e., the same average motion over the whole volume) of 400 km/s, derived from the whole AHMST sample, combined with a Virgocentric infall of 250 km/sec; and d) the MC velocity field model derived from the elliptical galaxies combined with a Virgocentric motion of 200 km/s. The error bar for absolute H magnitude in Fig. 2d corresponds to ± 0.25 mag. Thus, the best-observed AHMST spirals define an IR Tully-Fisher relationship much tighter than that estimated from the AHMST sample as a whole.

2. DISCUSSION

Figs. 1a and 1b demonstrate that both spiral and elliptical galaxies define the same large-scale motions within V = 3500 km/s. Figs. 1c and 1d show that the mass concentation velocity field model fits the main features of this large-scale motion very well. Comparisons to be presented in Burstein et al. (1988) show that the MC velocity field model fits large-scale motions over a range of at least 7000 km/s in distance: to 3000 km/s from the Local Group in the direction away from the motion, and to 4500 km/s from the Local Group in the direction of motion.

The MC velocity field model works very well in describing the motions of galaxies in directions away from the Great Attractor. Most of the AHMST spiral galaxies in Figs. 2 are at distances of less than 2000 km/s from the Sun, with few galaxies lying in the direction of motion. This accounts for the marked improvement of the bulk flow plus Virgocentric model over the Virgocentric model alone: these spirals are at distances of 2500 - 5000 km/s from the Great Attractor, so that the predominant motion is that of a uniform flow over the observed volume. However, there is still enough differential motion over these distances to have the MC velocity field model produce an equally significant improvement over the bulk flow model.

Finally, the MC velocity field model only fits motions on the largest scales in the local volume of space. Additional, smaller-scale, flow-like motions of 1000-2000 km/s in size (e.g., Virgocentric motion) are also present in this volume, and must be separately mapped.

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