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Constraining the Cosmic Mass Density from the SBF Survey Peculiar Velocities

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Abstract. The recently completed I-band SBF Survey of Galaxy Distances contains about 300 galaxy distances within $cz \lesssim 4000$ km/s. These data allow for good constraints on the local mass density and velocity fields. The mass density parameter $\beta_I \equiv \Omega^{0.6}/b_I$, where b_I is the biasing factor of the *IRAS* redshift survey galaxies, is found to be $\beta_I \approx 0.45$.

1. The SBF Method and Survey

The SBF Survey is a ground-based I-band distance survey using the **S**urface **B**rightness **F**luctuations method (Tonry & Schneider 1988). The survey includes about 300 galaxies with $cz \lesssim 4000$ km/s and a median total distance error of 10%. SBF results from *HST* go to about twice this distance. About half of the survey galaxies are ellipticals; the rest are mainly lenticulars with about 5% being spiral bulges. Results from the SBF survey are published in a series of papers (Tonry et al. 1997, 2000a, 2000b; Blakeslee et al. 1999), with more in preparation. Dressler has reviewed results on the local velocity field and the distance scale. Blakeslee et al. (2000) and Liu et al. (2000) present new theoretical work on SBF from stellar population modeling. Here, we focus on the results for the large-scale mass density derived from SBF data.

2. From Distances to Densities

Observed galaxy peculiar velocities (differences between the observed radial velocity v_r and the Hubble velocity $v_H = H_0\,d$ at distance d) are the result of the time-integrated gravitational accelerations from all nearby mass concentrations. We have explored various means for probing the mass density field and the mean cosmic density Ω using SBF-determined peculiar velocities, including (1) parametric modeling of the mass distribution (Tonry et al. 2000a); (2) non-parametric reconstruction of the mass-density field from the divergence of the velocity field (Eldar et al., in preparation); and (3) comparisons of the observed peculiar velocities to the gravity field derived from the galaxy distribution in complete redshift surveys (Blakeslee et al. 1999; in preparation).

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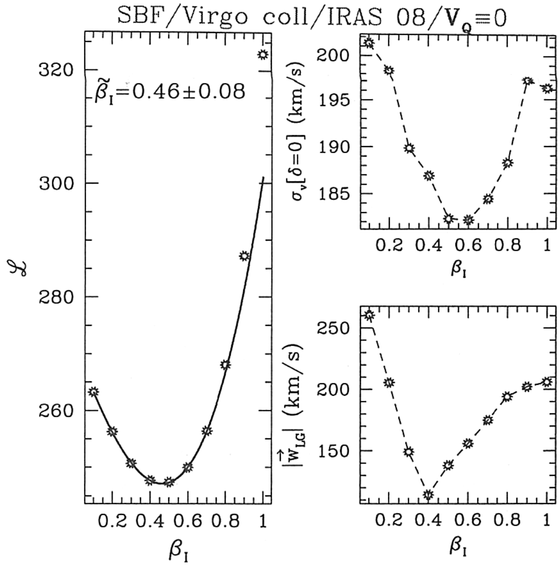

Figure 1. Preliminary results of a VELMOD (Willick et al. 1997) comparison between the SBF peculiar velocities and *IRAS* predictions using a nonlinear reconstruction. Left: the (negative) likelihood of the fit as a function of the IRAS β_I parameter. Top right: the maximum likelihood value of the cosmic thermal velocity dispersion as a function of β_I. Lower right: results for the magnitude of the Local Group's peculiar velocity, i.e., the residual motion not accounted for by the gravity field as traced by the IRAS galaxies.

In most cases what we derive is the parameter $\beta \equiv \Omega^{0.6}/b$, where b is the linear biasing factor of the galaxies with respect to the mass. When we compare the observed peculiar velocities to those predicted by the galaxy density field of the *IRAS* flux-limited redshift survey or optically-selected galaxies using linear theory, we find $\beta_I = 0.44 \pm 0.08$ and $\beta_O = 0.26 \pm 0.06$, respectively (Blakeslee et al. 1999). Both strongly indicate a low-density universe. For instance, if the *IRAS* galaxies are unbiased with respect to the mass, then $\Omega = 0.25 \pm 0.05$. More recent results using a "Velmod" analysis and a nonlinear reconstruction are shown in Figure 1. This work, and analyses using higher quality *HST* data, is ongoing. Stayed tuned for further SBF results on the galaxy density field.

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