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THE STRUCTURE OF THE NEARBY UNIVERSE TRACED BY THE IRAS GALAXIES

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Final Report

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1. Summary

One of the most important discoveries of the Infrared Astronomical Satellite (*IRAS*) has been the detection of about 20,000 galaxies with $60\mu m$ fluxes above 0.5 Jy. From the observational point of view, the *IRAS* galaxies are ideal tracers of density, since they are homogeneously detected over most of the sky, and their fluxes are unaffected by galactic extinction. The nearby universe has now been mapped by the *IRAS* galaxies to a distance $\sim 200h^{-1}$ Mpc for $|b| > 5°$. The ability to map down to such low galactic latitudes has proven to be particularly important, since some of the most important nearby large-scale structures, such as the Great Attractor, the Perseus–Pisces region, and the Shapley concentration, all lie there.

I have been active in this field since its inception, first showing on the basis of positions and fluxes that the *IRAS* dipole was aligned, within the errors, with the dipole anisotropy of the microwave background radiation (Yahil, Walker, & Rowan-Robinson 1986), and then initiating an extensive, multi-year, redshift survey in collaboration with M. Davis, K. Fisher, J. Huchra, & M. Strauss, which provided the 3–d density maps. (A parallel effort has been undertaken by a British–Canadian collaboration known as QDOT.)

The results of the U.S. *IRAS* redshift survey to date are enumerated in §2. Here I just illustrate two major results. Fig. 1 shows the *IRAS* and CfA power spectra (Fisher *et al.* 1993a), and their relation to the COBE anisotropy measurements (Smoot *et al.* 1992). It is seen that the combined data strongly constrain models of the initial perturbation spectrum of the universe, such as Cold Dark Matter. Fig. 2 shows side by side, an *IRAS* density map of the Supergalactic Plane versus that of mass density derived from peculiar velocities by the *POTENT* method (Bertschinger & Dekel 1989). The velocity data are from a compendium now being put together by Faber *et al.* (1993). The previous discrepancy between *IRAS* and *POTENT* in the Perseus–Pisces region (right hand side of the plots) is giving way to detailed agreement as more peculiar velocities become available in that region. he agreement between theses two totally independent datasets strengthens the gravitational picture of the origin of peculiar velocities, opening the way to a determination of the cosmological density parameter, Ω. Our strongest result (Dekel *et al.* 1993) is $\Omega^{0.6}/b_I = 1.28^{+0.75}_{-0.59}$ at 95% confidence, where b_I is the biasing factor. Small nonlinear effects allow weaker, separate, constraints on Ω and on b_I. Thus if $\Omega = 1$ then $b_I = 0.7^{+0.6}_{-0.2}$, and if $b_I > 0.5$ then $\Omega > 0.46$, both at the 95% confidence level. The constraints on Ω are limited to the simple biasing relation assumed, but the effect of undersampling cluster cores by *IRAS* is negligible, and the results are independent of the cosmological constant Λ.

2. Publications Related to the ADP Grant NAG 51228

1. **Strauss, M. A., Davis, M., Yahil, A., & Huchra, J. P. 1990**, ApJ, 361, 49: sample definition for sources brighter than 1.936 Jy at $60\mu m$.

2. **Fisher, K. B. 1992**, Ph. D. Thesis, University of California, Berkeley: sample definition for sources down to 1.2 Jy.

3. **Strauss, M. A., Huchra, J. P., Davis, M., Yahil, A., Fisher, K. B., & Tonry, J. 1992b**, ApJS, 83, 29: data for the 1.9 Jy sample, also available in machine-readable form via anonymous ftp. At present, the as yet unpublished 1.2 Jy sample consists of 5343 galaxies, of which 30 objects (0.5% of the sample) remain unobserved. Sky coverage for both surveys is complete for $|b| > 5°$, with the exception of a small region of the sky which *IRAS* failed to survey and regions limited by confusion; our samples cover 87.6% of the sky.

4. **Yahil, A., Strauss, M. A., Davis, M., & Huchra, J. P. 1991**, ApJ, 372, 380: methodology of deriving the density field from galaxy counts.

5. **Strauss, M. A., Yahil, A., & Davis, M. 1991**, PASP, 103, 1012: further methodological details.

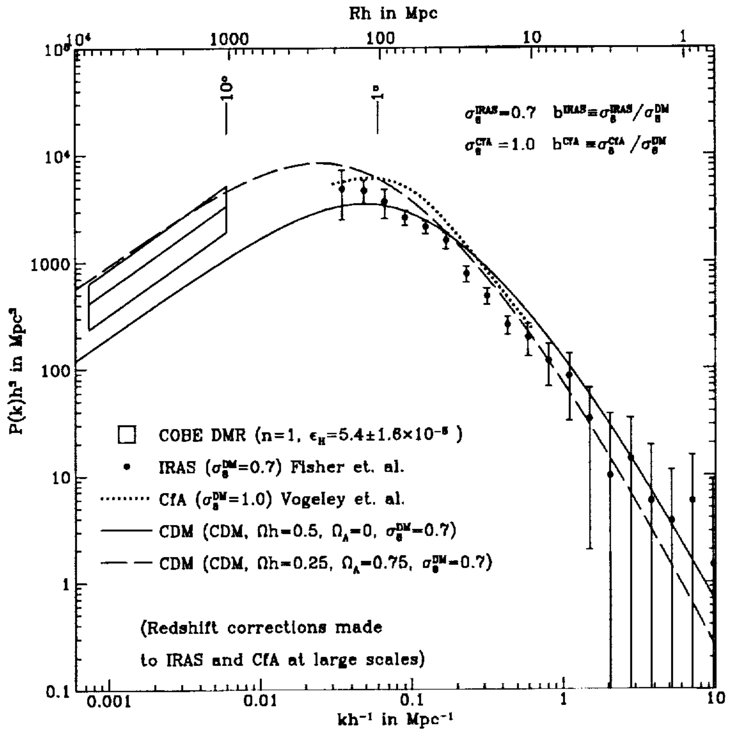

Figure 1: Power spectra of the *IRAS* and CfA galaxies compared with those determined by COBE.

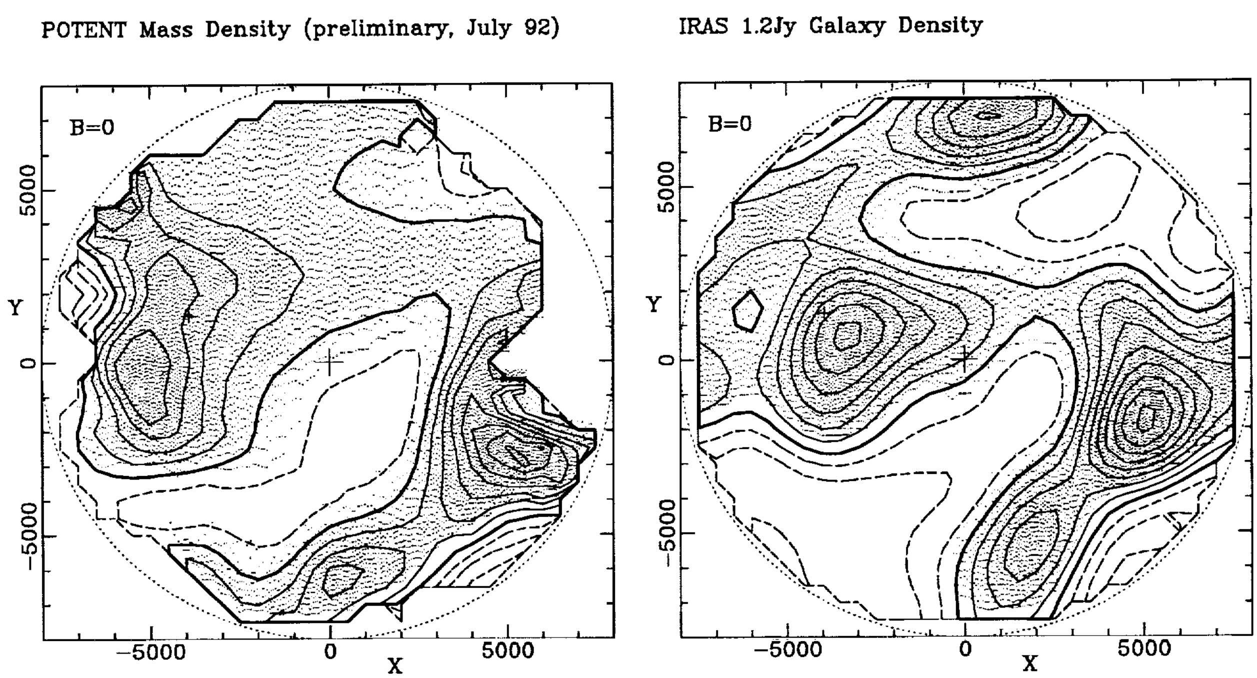

Figure 2: *POTENT* mass density fluctuations *versus* *IRAS* galaxy density fluctuations in the Supergalactic Plane. Gaussian smoothing of 1000 km s^{-1}has been applied to the data, and the contours are spaced by 0.2.

6. **Davis, M., Strauss, M. A., & Yahil, A. 1991**, ApJ, 372, 394: check of methodology in mock *IRAS* samples extracted from N-body simulations.
7. **Strauss, M. A., Davis, M., Yahil, A., & Huchra, J. P. 1992a**, ApJ, 385, 421: density determination and mapping.
8. **Strauss, M. A., Yahil, A., Davis, M., Huchra, J. P., & Fisher, K. B. 1992c**, ApJ, 397, 395: determination of the acceleration of the Local Group.
9. **Fisher, K. B., Strauss, M. A., Davis, M., Yahil, A., & Huchra, J. P. 1992**, ApJ, 389, 188: assessment of the possible evolution of *IRAS* galaxies.
10. **Fisher, K. B., Davis, M., Strauss, M. A., Yahil, A., & Huchra, J. P. 1993a**, ApJ, 402, 42: determination of the power spectrum of *IRAS* galaxies.
11. **Davis, M., Meiksin, A., Strauss, M. A., da Costa, L. N., & Yahil, A. 1988**, ApJ, 333, L9: the universality of the two-point galaxy correlation function.
12. **Fisher, K. B., Davis, M., Strauss, M. A., Yahil, A., & Huchra, J. P. 1993b**, MNRAS, submitted: redshift and real space correlation functions.
13. **Bouchet, F., Strauss, M. A., Davis, M., Fisher, K. B., Yahil, A., & Huchra, J. P. 1993**, ApJ, submitted: determination of relations between higher order moments of the density fields.
14. **Yahil, A. 1989**, in *Large Scale Motions in the Universe*, eds. V. Rubin & G. Coyne (Princeton: Princeton University Press), pp. 219–253: prediction of large-scale peculiar velocity fields.
15. **Górski, K., Davis, M., Strauss, M. A., White, S. D. M., & Yahil, A. 1989**, ApJ, 344, 1: velocity correlation function.
16. **Yahil, A. 1991**, in *The Early Universe and Cosmic Structures*, eds. J.-M. Alimi *et al.* , (Gif-sur-Yvette: Editions Frontières), pp. 483–500: initial comparison of the density of *IRAS* galaxies versus the mass density derived from peculiar velocities by the *POTENT* method, using linear dynamics.
17. **Dekel, A., Bertschinger, E., Yahil, A., Strauss, M. A., Davis, M., & Huchra, J. P. 1993**, ApJ, in press: comprehensive *IRAS–POTENT* comparison, including nonlinear dynamics.
18. **Juszkiewicz, R., & Yahil, A. 1989**, ApJ, 346, L49: comparison of positional and velocity correlation functions.
19. **Giavalisco, M., Mancinelli, B., Mancinelli, P., & Yahil A., 1993**, ApJ, in press: nonlinear dynamics using a generalized Zel'dovich approximation.
20. **Strauss, M. A., Kirhakos, S. D., & Yahil, A. 1988**, ApJ, 332, L45: serendipitous discovery of a nearby QSO close to the galactic plane.

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Smoot, G., *et al.* 1992, ApJ, 396, L1

Yahil, A., Walker, D., & Rowan-Robinson, M. 1986, ApJ, 301, L1

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