THE STRUCTURE OF THE NEARBY UNIVERSE
TRACED BY THE IRAS GALAXIES

(NAG 51228)

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 60μm 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 \( \sim 200 h^{-1} \) Mpc for \( |b| > 5^\circ \). 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. The agreement between these 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, \( \Omega \). Our strongest result (Dekel et al. 1993) is \( \Omega^{0.6} / b_i = 1.28^{+0.75}_{-0.35} \) at 95% confidence, where \( b_i \) is the biasing factor. Small nonlinear effects allow weaker, separate, constraints on \( \Omega \) 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 \( \Omega \) 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 \( \Lambda \).

2. Publications Related to the ADP Grant NAG 51228


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 \( |b| > 5^\circ \), 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.


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.


REFERENCES

(Not listed in §2)


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