New Cosmological Data and the Values of the Fundamental Parameters
IAU Symposium, Vol. 201, 2005
Anthony Lasenby and Althea Wilkinson, eds.

Two-point Correlation Function and Power Spectrum at Very Large Scales

Z.-G. Deng

Graduate School, CAS and Beijing Astrophysical Center, CAS-PKU, Beijing 100039, China

X.-Y. Xia

Tianjin Normal University and Beijing Astrophysical Center, CAS-PKU, Tianjin 300074, China

Abstract. Subsamples of galaxies with different morphological types have been sorted out from Stromlo-APM redshift survey. Two-point correlation function for each subsample has been calculated. The two-point correlation functions for all subsamples show very large scale fluctuation. We show that the two-point correlation function with fluctuation could be fitted by a modified power spectrum with power excess at wave number comparable to the scale of the fluctuation.

An amount of evidences shown that structures with very large scales do exist and can be probed by analyzing the large scale distribution of various objects, e.g. galaxies and clusters of galaxies (Broadhurst et al. 1990; Mo et al. 1992; Landy et al. 1996). It have also been pointed out that very large scale structures can be used to be a standard ruler to measure cosmological parameters(Deng, Xia & Fang 1994). Stromlo-APM redshift survey is an ideal sample to probe structures at very large scales due to its sufficient depth (with limit magnitude $b_j = 17.15$) and considerable sky coverage(4300 deg^2).

Subsamples consist of elliptical plus lenticular galaxies(EL), spiral galaxies(SP) and the combination of them(EL+SP) and with corrected distance between 20 and 320 h^{-1}Mpc are sorted out from Stromlo-APM redshift survey. We focused on investigating the two-point correlation functions at very large scales. Thus, no correction of redshift distortion has been made. We use the selection function of each subsample by fitting its redshift distribution with cubic polynomial. Two point correlation functions at smaller scales were fitted by a power law function $\xi(r) = (r/r_o)^{-\alpha}$. The best fits provide a $\alpha \sim 1.67$ for all subsamples. and $r_o \sim 6.04$, 4.76 and 5.01 for EL, SP and EL+SP galaxies.

At larger scales, as the left panel of Fig 1. two-point correlation functions reveal fluctuation at very large scales. We can see also that fluctuations in two-point correlation function exists in all subsamples and have similar characters. Existence of very large scale fluctuation would be unexpected from standard models of structure formation.

As one knows that two-point correlation function is Fourier transformation of power spectrum. One may estimate power spectrum from two-point correlation function. We approached this by modified the power spectrum of standard CDM model step by step to fit the two point correlation function obtained above.

https://doi.org/10.1017/S0074180900216616 Published online by Cambridge University Press

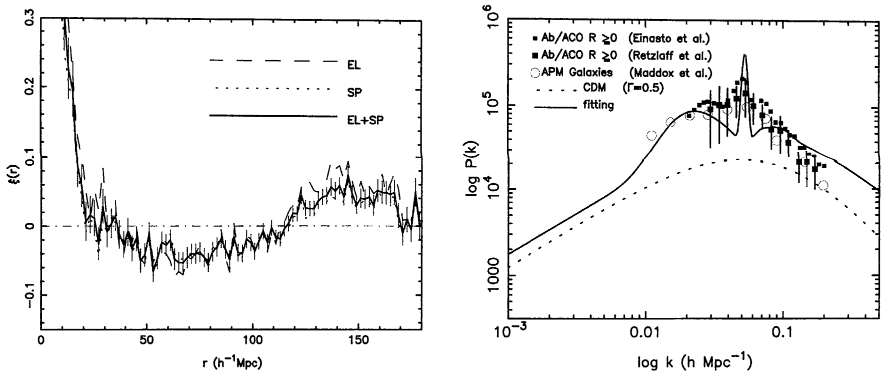

Figure 1. (a) Two-point correlation functions for subsamples EL, SP and EL+SP at large scales. Large scale fluctuation can clearly be seen; (b) Comparison among the power spectra from our fitting and those obtained from analysis of galaxy clusters by other authors.

In this procedure, we keep the power spectrum changes as little as possible at small and very large scales, to guarantee the convergence of integrals in Fourier transformation.

The power spectrum obtained by this process is given in the Fig 1b. It is from subsample EL+SP. As a comparison, results obtained from analysis of clusters of galaxies with other methods are put in the same plot. We can see that a notable feature of the power spectrum is a power excess appearing at about $k = 0.052$, which corresponds to about a wavelength $\lambda \sim 121$ h^{-1}Mpc.

Our analysis presents another evidence on the existence of very large scale structure in the large scale distribution of galaxies. Which may be important for measuring cosmological parameters. The origin of very large scale structure has not well known, though some possibilities have been proposed (Eisenstein et al. 1998). To have better understanding of structures at very large scales redshift survey data on larger spatial size would be crucial.

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https://doi.org/10.1017/S0074180900216616 Published online by Cambridge University Press