CLUSTER CORRELATIONS FOR SCALE-FREE SPECTRA

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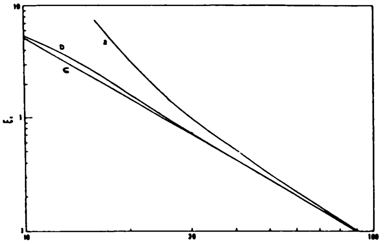
The cluster autocorrelation function ξ_c and the galaxy-cluster cross correlation ξ_{gc} are used to test the biased structure formation for scale-free spectra $P(k) \propto k^n$. Following Kaiser (1984), we assume that rich clusters form only at high density regions with the matter distribution represented by a Gaussian random field. Then, the correlation ξ of two regions with characteristic scales R_1 and R_2 lying above the thresholds ν_1 and ν_2 ($\delta \equiv \nu\sigma$), is given by the expression for the bivariate Gaussian

$$\xi(r, R_1, \nu_1, R_2, \nu_2) = -1 + \frac{2}{\pi^{1/2}} \left[erfc\left(\frac{\nu_1}{2^{1/2}}\right) erfc\left(\frac{\nu_2}{2^{1/2}}\right) \right]^{-1} \int_{2^{-1/2}\nu_1}^{\infty} dx \, e^{-x^2} erfc\left[\frac{2^{-1/2}\nu_2 - \tau x}{(1-\tau^2)^{1/2}} \right] ,$$

where $\tau(r)$ is the coviance function, i.e. $\tau \equiv \xi_\rho(r)/\xi_\rho(0)$ and $\xi_\rho(r)$ is the correlation of the matter distribution Gaussian filtered on the comoving scales R_1 and R_2 . From the previous equations, one can obtain for $P(k) \propto k^n$, $\tau \ll 1$ and large r a power-law form either for ξ_c or ξ_{gc} . Moreover, the amplification factor $A_{c-gc} \equiv \xi_c / \xi_{gc}$ is

$$A_{c-gc} \simeq \left[\frac{G(\nu_1)}{G(\nu_2)} \right]^{1/2} 2^{n+1} \left(\frac{R_2}{R_1} \right)^{\frac{n+3}{2}} \quad , \quad G(\nu) \equiv e^{-\nu^2} \left[erfc\left(\frac{\nu}{2^{1/2}} \right) \right]^{-2} .$$

If we want to reproduce the observed autocorrelation $\xi_c = (r_0/r)^{1.8}$, $r_0 \simeq 25\ h^{-1}$ Mpc, we should then take n=-1.2, R_c =4.5 h^{-1} Mpc (which implies ν_c =2.9 for the observed number density $n_c \simeq 6 \times 10^{-6} h^3$ Mpc^{-3}). Let us consider that the same index n=-1.2 applies to galaxies, then one obtain in the best case for the values of R_g - allowed by the observed masses of galaxies - a decrement $A_{c-gc} \simeq 0.2$. This is in clear contrast with the observations, where it is found an amplification of $\simeq 4$. The previous result do not changes for different R_c . Therefore, our conclusion is that a scale-free spectrum can reproduce ξ_c (see Fig.) but is in contradiction with ξ_{gc} .



Cluster autocorrelation function $\xi_c(r)$ for $R_c = 4.5\ h^{-1}$ Mpc.
a) Exact expression.
b) Approximated $\xi_c \simeq G(\nu)\tau$.
c) Observed $\xi_c = (25/rh)^{1.8}$.

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