A fit of the angular 3–point function and biased galaxy formation

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A study of the 3-point function, based on the analysis of momenta (as was done, e.g., in Sharp *et.al.* 1984) deduced from the Zwicky catalog, indicates that an expression containing a cubic term, besides the usual second degree polynomials of 2–point functions, provides a good fit of angular data.

It is to be outlined that the use of the Zwicky sample, to fit a clustering model containing an angular cubic term is preferable to the use of deeper samples. In fact the values of the angular 2–point function $w(\theta) \propto \theta^{1-\gamma}$, which scale with the depth D of the sample according to the law $w(\theta) \propto D^{-\gamma}$, at the Zwicky catalog depth turn out to be $\simeq 1$ and would be smaller at greater depths, potentially depressing the extra contribution.

The fit is based on a reduction of the data operated restricting the sample to galaxies with $m < 15$, $\delta > 0^o$ and $b > 40^o$. In order to perform error estimates, a split of the whole sample into two subsets A and B was performed along a line of constant galactic longitude (A: $123^o < l < 303^o$, 2298 objects; B: $l < 123^o$ and $l > 303^o$, 1485 objects). For the sets A+B, A and B the number $N(\theta_n)$ of galaxies in the ring centered on $\theta_n = \Delta\theta(n-1/2)$ and of width $\Delta\theta = 0\ .2$ was evaluated (n=2,...,20). Correcting for border effects we worked out $w(\theta_n) = < N(\theta_n) > /n\Omega_n - 1$ and the moment $P_2(\theta_n) = < [N(\theta_n) - < N(\theta_n) >]^2 >$ (Ω_n is the angular area of the n-th ring). Herefrom, correcting for the discreteness of the sample, we evaluated

$$\tilde{\omega}(\theta_n) \equiv P_2(\theta_n)\{n\Omega_n w(\theta_n)[1 + w(\theta_n)]\}^{-2} \tag{1}$$

to be compared with a theoretical expression we shall discuss shortly.

In a recent work (Bonometto *et.al.* 1987) we started from the expression

$$\delta^{(3)}P = n^3 F_{123}(1 + w_{12})(1 + w_{23})(1 + w_{31})\delta\Omega_1\delta\Omega_2\delta\Omega_3 \tag{2}$$

for the joint probability of finding 3 galaxies in the solid angles $\delta\Omega_i$ (i=1,2,3) of the celestial sphere. Here n is the angular galaxy number density, w_{ij} are 2–point angular correlation functions. Expression (2) applies whenever observed objects are selected as high peaks of an underlying distribution within a *bias* context (see, e.g., Kaiser, 1984; Politzer and Wise, 1984; Bardeen *et.al.*, 1986). $F = 1$ if the distribution is Gaussian. As was shown by Matarrese *et.al.* (1986), a similar relation holds also if the distribution is non–Gaussian, the only difference being that F becomes a known function of $1, 2, 3$.

According to (2) it can be shown that $\tilde{\omega}$ is expected to take the simple form

$$\tilde{\omega}(\theta) = [< F > -1]/w(\theta) + f < F > \tag{3}$$

where, at 0–th order in $\Delta\theta/\theta$,

$$f = 2^{\gamma-1}\pi^{-1/2}\Gamma(1-\gamma/2)/\Gamma(3/2-\gamma/2) \tag{4}$$

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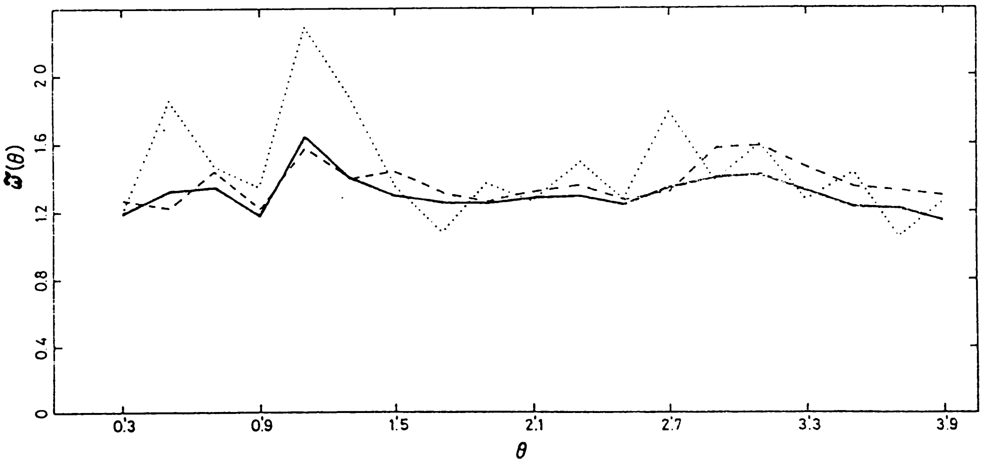

Fig.1 *Observational values of $\tilde{\omega}(\theta)$. The heavy line refers to the whole set of data. Dashed and dotted lines correspond to the subsets A and B respectively. Data indicate a constant $\tilde{\omega}$, apart Poisson scatter.*

In Fig.1 the behaviour of $\tilde{\omega}(\theta)$ is given for the whole sample and its subsets A and B. This yields a direct insight into the fact that the term $\propto w^{-1}$ can only have a negligible weight. In turn this means that $< F >= 1$ and can be interpreted to mean that the underlying matter distribution is Gaussian. A quantitative confirm is obtainable from a least square fit wherefrom γ and $< F >$ can be obtained. The results are given in Table 1.

TABLE 1: *Least square fit of the parameters*

	$< F > -1$	$< Ff >$	γ
whole sample	-1.68×10^{-2}	1.29	1.67
subset A	2.15×10^{-2}	1.27	1.68
subset B	-2.73×10^{-2}	1.45	1.71

A parallel fit aimed to test an expression for the 3–point function without the cubic term was also performed. It leads to discrepancies among the results obtained fitting data coming from the sets A+B, A and B which exceed the ones of the above fit by a factor ~ 7. A similar fit for the 4–point function was also performed. The results will be reported in detail elsewhere.

The above results concern angular functions. The usual way of relating angular to spatial functions makes appeal to the Limber equations. In this frame, however, the term $\propto w^3$ does not yield an analogous spatial term and has no direct interpretation. The way–out from this *empasse* is probably linked to the fact that some of the assumptions required for the validity of the Limber equations – e.g., the independence between space and luminosity distributions – cease to hold in the frame of biased galaxy formation theories. These points will be discussed in more detail elsewhere.

References

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