to field variations in numbers and colours. HH is currently being refurbished and the third year of observations will begin early in 1993.

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Galaxy Clustering at $B \sim 25^m$

The angular two-point correlation function, $\omega(\theta)$, for galaxies can be used as a probe of their redshift distribution N(z) and, therefore, of galaxy luminosity evolution. Without redshift data, we can still observe the projection onto the two-dimensional sky of the three-dimensional clustering of galaxies. The autocorrelation of this projected distribution is described by $\omega(\theta)$. Observations have indicated that $\omega(\theta)$ follows a $\theta^{-0.8}$ power-law (Peebles 1980) and that the index of the power-law remains approximately constant to the faintest limits of photographic surveys (Jones, Shanks & Fong 1987) The $\omega(\theta)$ amplitude is related to the amplitude of the 3-dimensional two-point correlation function $\xi(r)$ by means of an integration over N(z) using Limber's formula (see, for example, Phillipps et al. 1978).

The scaling of the $\omega(\theta)$ amplitude for the galaxies with survey depth will therefore relate to the change with depth of N(z). The wider the range of redshifts over which galaxies are distributed the more the observable clustering will be diluted by projection.

Here we estimate the $\omega(\theta)$ amplitude and investigate its scaling for 4540 galaxies observed on 12 CCD frames (total area 284 arcmin^2) at the INT. These data were published as number counts by Metcalfe et al. (1991) and is limited at $B_{ccd} < 25.0$.

The $\omega(\theta)$ was calculated as described by Infante (1990) and Efstathiou et al. (1991) using a local normalization of the galaxy number density for each field. The resulting $\omega(\theta)$ for all $B_{ccd} \leq 25.0$ galaxies in this survey was fitted with a function '$A(\theta^{-0.8} - 16.1)$' which gave the $\theta^{-0.8}$ power-law amplitude at one degree, corrected for 'integral constraint'. The result was $(4.124 \pm 2.044) \times 10^{-4}$ (field-to-field errors), consistent with the $\omega(\theta)$ results given by Efstathiou et al. (1991) for the deep CCD fields of Tyson (1988). The $\omega(\theta)$ amplitude can similarly be estimated for brighter subsets of our data catalogue, enabling its scaling to be investigated over magnitude limits in the range $23.25 \leq B_{ccd} \leq 25.00$.

In addition we have a new result from the single deeper field described by Metcalfe, Shanks & Fong (1991) in which 1442 galaxies were detected to $B_{ccd} = 27.0$. This gave an even lower clustering amplitude of $(2.971 \pm 1.525) \times 10^{-4}$.

The graph shows our correlation amplitudes for different magnitude limits, compared with those obtained from other surveys. For details of these earlier results see Stevenson et al. (1985), Jones et al. (1987), Koo & Szalay (1984), Infante (1990) and Efstathiou et al. (1991). Our correlation amplitudes appear to be consistent with the photographic data to the final limits of such surveys ($B \approx 24$).

We also compare our results with the predictions of two models, differing only in the evolution with redshift of the characteristic galaxy luminosity L^*. A correlation radius of $r_0 = 4.3h^{-1}$Mpc (fitting the Zwicky catalogue clustering at brighter limits) and a value for q_0 of 0.05 were used. A model without luminosity evolution was computed using the k-corrections given by

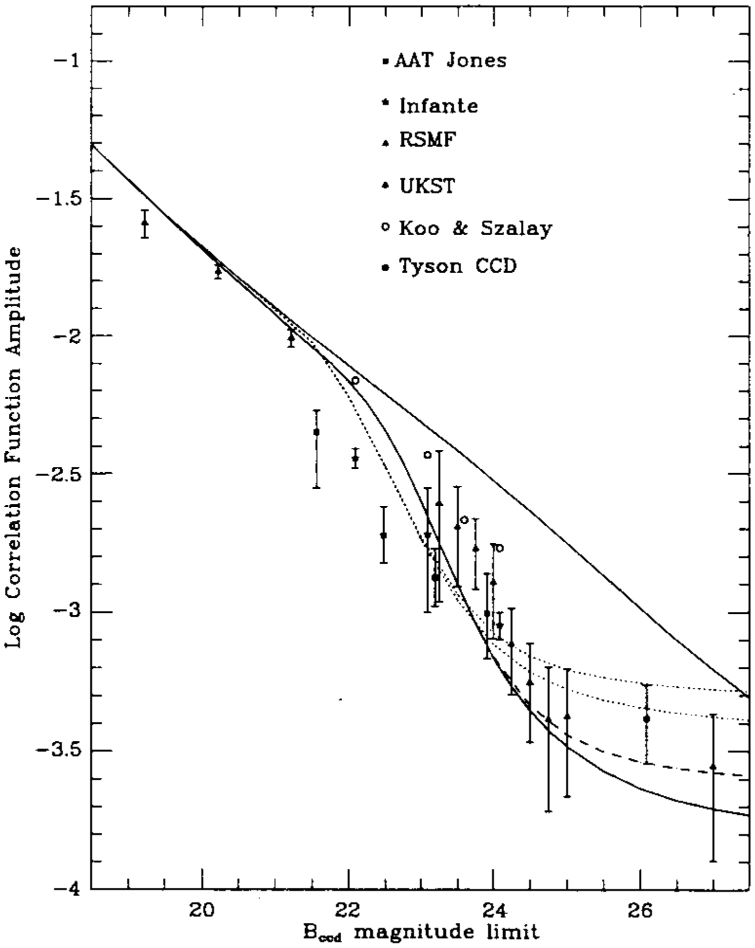

Figure 1. Estimates of the correlation function amplitude obtained from photographic surveys and from CCD frames, compared with the predictions of a non-evolving model (upper curve) and a model incorporating pure luminosity evolution (lower curve), over a range of blue magnitude limits. The solid curves are the two models computed with $q_0 = 0.05$ and a maximum redshift of 4. The dashed curve shown at B > 24 is the Bruzual model with N(z) cut off at $z = 3$ rather than at $z = 4$. The dotted curve shows the evolving model with the same (k+e)-corrections as previously, but computed with $q_0 = 0.5$ giving it a higher amplitude at faint limits. This divides into two at B > 23 to show the predictions for $z_{max} = 3$ (upper) and $z_{max} = 4$ (lower).

Metcalfe et al. (1991). Our evolving model, also described by Metcalfe et al. (1991), used the pure luminosity evolution models calculated by Bruzual (1981), with an exponentially decreasing ($\mu = 0.5$) star-formation rate for the early type galaxies.

The effect of luminosity evolution is to enable more galaxies to be seen at higher redshifts, so giving a *lower* $\omega(\theta)$ amplitude. The Bruzual model N(z) is bimodal at B = 23 – 25 with a very broad second peak of starbursting galaxies, centred at about $z = 1.85$. This model gives a reasonable fit to the number counts whereas a no-evolution model underpredicts them. However, as far as the $\omega(\theta)$ scaling is concerned no-evolution may approximately represent pure density evolution or an extremely merging-dominated model where N(z) has been hypothesised to have a similar form (Lilly, Cowie & Gardner 1991). Evolution of this type essentially raises the normalisation of N(z), rather than enabling galaxies to be seen to higher redshifts, so would have little effect on $\omega(\theta)$.

It is clear that our correlation amplitudes do not follow the no-evolution scaling, being significantly lower at $B_{ccd} > 23$ and much closer to the Bruzual model predictions. The no-evolution model is in fact rejected by 4σ at B = 24.5. Any conclusions about the redshift distribution on the basis of correlation amplitudes depend on the assumption, which is made in these models, that galaxy clustering is stable in proper coordinates. However, to fit the $\omega(\theta)$ amplitudes with a no-evolution N(z) would require clustering evolution much greater than would be predicted by any simple gravitational model. If galaxies at B ∼ 24 and fainter are found to have such a redshift distribution, then more complicated models such as the inclusion of a numerous and very weakly clustered population of dwarf galaxies which is no longer visible at the present day (Babul & Rees 1992), may be required.

To summarise, we find the $\omega(\theta)$ amplitude for faint galaxies to be significantly lower than would be expected for a model in which clustering is stable in proper co-ordinates and the redshift distribution maintains a no-evolution form. The low $\omega(\theta)$ amplitudes are most easily explained if the very blue (flat-spectrum) galaxies appearing faintward of B ∼ 23 are at $1 \leq z \leq 3$ (and are undergoing rapid star-formation), as their colours suggest (Tyson 1988; Koo 1990; Metcalfe et al. 1991). An alternative explanation is that they are at lower redshifts and very weakly clustered in comparison to other galaxies.

Additionally, taking our results in conjunction with those of Efstathiou et al. (1991) it appears that the $\omega(\theta)$ amplitude may reach a lower limit at $B_{ccd} = 24.5 - 25.0$, remaining approximately constant for even fainter limits. This could be due to the N(z) reaching an upper redshift cut-off at these deep limits, caused either by the epoch of galaxy formation or by the Lyman limit entering the B passband. The amplitude at which the $\omega(\theta)$ scaling levels out appears to be in the range we would expect for stable clustering and reasonable values of q_0 (i.e. 0 to 0.5) and the cut-off redshift $(3 \leq z_{max} \leq 4)$.

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