The Colour Dependence of the Galaxy Correlation Function and Its Evolution in the CNOC2 Redshift Survey

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Abstract. We present an analysis of the spatial correlation function for 2435 galaxies from the CNOC2 Field Galaxy Redshift Survey. The sample is volume-limited and evolution-corrected, so that redshift-selected subsamples will contain consistent sets of objects.

We find that the colour-dependence of the correlation length is similar to that observed locally; early-type (red) objects are more strongly clustered than late-type (blue) objects.

The redshift evolution of the correlation length also depends on colour; the clustering amplitude for late-type objects decreases with redshift, while \( r_0 \) for early and intermediate-type objects actually increases. Colour evolution may contribute to this effect.

The CNOC2 Field Galaxy Redshift Survey (Yee et al. 2000) comprises over 6000 redshifts with \( R_c \leq 21.5 \) in four widely-separated L-shaped "patches", each approximately \( 75' \times 50' \); the total angular size of the survey is about 1.5 square degrees. We use here a subsample of the full survey, with evolution-corrected \( R_c \)-band absolute magnitude limit \( M_{R,c,0} \leq -20 \), and redshifts \( 0.05 \leq z \leq 0.65 \).

The evolution correction arises from the fact that galaxies are found to brighten with redshift (Lin et al. 1999); \( M(z) = M(0) - Qz \), where \( Q = 1.51 \pm 0.53 \) for early, \( 1.11 \pm 0.78 \) for intermediate, and \( 0.22 \pm 0.76 \) for late-type objects. With this correction, our sample is volume-limited below \( z = 0.65 \), so that this sample should represent a constant-mass population.

In addition to the large number of redshifts, the CNOC2 survey also has five-band \( UBV R_c I_c \) colour photometry for all objects. By comparing the observed colours to those predicted by redshifted template spectra (Coleman, Wu & Weedman 1980), we classify each object as having an early (E/S\(_0\)), intermediate (S\(_{bc}\)), or late-type (S\(_{cd}/I_m\)) spectral energy distribution (SED). We are then able to investigate the evolution of clustering of galaxies as a function of their SED class, rather than simply as a function of any one particular colour index.

The clustering amplitude is found to depend on SED class, with early-type objects being the most strongly clustered, late-type objects being the least, as observed locally (Loveday et al. 1995). The line in Figure 1a is the best-
Colour Dependence of the Correlation Function

Figure 1. The projected two-point correlation function \( w_p \) as a function of co-moving projected separation \( r_p \) for the entire data set, and for each SED class (left panel). Co-moving correlation length as a function of redshift for each SED class (right panel).

fitting model \( w_p(r_p) = C\gamma r_0(r_p/r_0)^{1-\gamma} \), with co-moving \( r_0 = 4.20 \pm 0.52 \, h^{-1} \text{Mpc} \) and \( \gamma = 1.8 \). The early, intermediate and late-type samples have \( r_0 = 6.04 \pm 0.34 \, h^{-1} \text{Mpc} \), \( r_0 = 3.85 \pm 0.56 \, h^{-1} \text{Mpc} \) and \( r_0 = 2.90 \pm 0.25 \, h^{-1} \text{Mpc} \), respectively.

Figure 1b shows the evolution of the co-moving correlation length for each SED class; late-type objects have a clustering length which decreases with redshift. For early and intermediate-type objects, however, \( r_0(z) \) increases with redshift, so that structure appears to be disappearing with time. The line represents a correlation length fixed in physical coordinates, as is observed if objects of all SED classes are taken together (Carlberg et al, 1999).

One possible contribution to this effect is colour evolution: If spiral galaxies become redder with time, then some of the low-\( z \) objects classified as having early-type SEDs are actually spirals, thereby lowering the observed correlation for the low-\( z \), early-type SED sample and creating the appearance of dissipating structure. The next step in our analysis will be to use evolving template SEDs in an attempt to define non-evolving samples based on SED class.

References


