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CLUSTERING AND PROPERTIES OF GALAXIES AROUND HIGH REDSHIFT RADIO SOURCES

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RESUMEN

Se presentan mediciones de clustering de galaxias en el campo de radio-galaxias con Espectros Ultra Steep (USS) con $0.5 \lesssim z \lesssim 1.5$, seleccionadas de los catálogos SUMSS y NVSS. Se midió un parámetro de correlación $r_0 = 14.0 \pm 2.8\ h^{-1}$ Mpc. Comparamos nuestros resultados con aquellos obtenidos en simulaciones cosmológicas de N-cuerpos formadas por galaxias semianalíticas de tipo GALFORM. Encontramos que los cúmulos de galaxias con masas en el rango $M = 10^{13.4-14.2}\ h^{-1}\ M_\odot$ poseen una amplitud de correlación comparable con aquellos encontrados entre las fuentes USS y las galaxias en estos entornos. Estos resultados sugieren que las radio-galaxias distantes representan excelentes trazadores de sobredensidades de galaxias y se pueden localizar con ellas, los progenitores de los cúmulos ricos de galaxias observados en el Universo Local.

ABSTRACT

We present measurements of the clustering properties of galaxies in the field $0.5 \lesssim z \lesssim 1.5$ Ultra Steep Spectrum (USS) radio sources selected from SUMSS and NVSS surveys. We find a comoving correlation length of $r_0 = 14.0 \pm 2.8\ h^{-1}$ Mpc. We compare our findings with those obtained in a cosmological N-body simulation populated with GALFORM semi-analytic galaxies. We find that clusters of galaxies with masses in the range $M = 10^{13.4-14.2}\ h^{-1}\ M_\odot$ have a cluster-galaxy cross-correlation amplitude comparable to those found between USS hosts and galaxies. These results suggest that distant radio galaxies are excellent tracers of galaxy overdensities and pinpoint the progenitors of present day rich clusters of galaxies.

Key Words: galaxies: high-redshift — large-scale structure of universe

1. INTRODUCCION

High redshift radio galaxies are ideal targets for pinpointing massive systems. Recently, galaxy overdensities comparable to that expected for clusters of Abell class 0 richness are found near radio galaxies up to $z = 1.6$ (Best et al. 2003). In this paper we estimated the spatial correlation length for galaxies in the fields of USS targets selected from the SUMSS and NVSS surveys, through the Limber's equation. We compared our results with those obtained in cosmological N-body simulations.

2. THE DATA

The USS sample selection, radio data and redshifts used for this analysis was presented and described by (De Breuck et al. 2004, 2006). Detailed descriptions of the construction of the galaxy catalogue is given in Bornancini et al. (2006). In summary, we used 11 K_s-band images centered in Ultra Steep Spectrum (USS) radio sources selected from the SUMSS and NVSS in the range $0.5 \lesssim z \lesssim 1.5$, obtained with the instrument `IRIS2` at the AAT telescope.

3. CROSS-CORRELATION ANALYSIS

In order to obtain the cross-correlation length r_0 we first determine the projected cross-correlation function $\omega_{ug}(\sigma)$, where σ is the projected separation between a USS target and a galaxy at redshift z. We use the Peebles' estimator of the projected cross-correlation (Peebles 1980). We estimate the corresponding correlation length using the Limber equation (Limber 1953) and the using the redshift distribution of $K_s < 20$ galaxies published by Cimatti et al. (2002). In Figure 1 we show the projected cross-correlation function $\omega_{ug}(\sigma)$ for USS targets with redshifts in the range $0.6 \lesssim z \lesssim 1.5$ and galaxies with $K_s < 20$. We estimate cross-correlation function error bars using the $jackknife$ technique (Efron 1982). We find a comoving correlation length $r_0 = 14.0 \pm 2.8\ h^{-1}$ Mpc with slope $\gamma = 1.98 \pm 0.04$.

4. N-BODY SIMULATIONS

We interpret our results with the aid of a cosmological N-body simulation populated with GALFORM semi-analytic galaxies (Cole et al. 2000) at different outputs corresponding to different redshifts, $z = 0, 1$, and 3. For full details on the procedure by which galaxies are assigned their properties the

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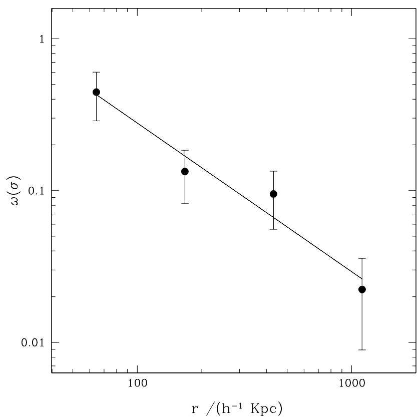

Fig. 1. Projected cross-correlation function $\omega_{ug}(\sigma)$ for USS targets with $0.6 \lesssim z \lesssim 1.5$.

reader is referred to Cole et al. (2000). We calculate the cross-correlation function using the simulation haloes with masses above a lower mass limit as centres, and as tracers, the GALFORM semi-analytic galaxies. This comparison will make it possible to infer the mass of the structures associated to the USS hosts.

Figure 2 shows the resulting real-space cross-correlation functions between haloes and semi-analytic galaxies at $z = 1$ (top panel) for different halo masses. The shaded area corresponds to the power law fit for the real-space correlation function inferred from the cross-correlation function for USS sources with $0.6 \lesssim z \lesssim 1.5$. In the middle panel, we compare the values of USS-galaxy cross-correlation length as a function of halo mass for three different redshift outputs from the numerical simulations; as can be seen, the observed values are consistent with cluster masses within $M = 10^{13.4-14.2}$ h^{-1} $M_{\odot}$ at redshift $z = 1$. In order to check whether our observational estimate of r_0 is affected by systematic biases, we calculate the projected correlation function in the numerical simulation and recover the real-space correlation length with the same range of separations available in the real data. The results for $z = 1$ are shown in filled circles in the middle panel. As can be seen, our conclusions on the mass of USS host haloes changes only slightly to $M = 10^{13.2-13.8}$ h^{-1} $M_{\odot}$. A further indication of the mass of USS galaxy host haloes comes from the lower panel of this figure, where the lines correspond to the projected cross-correlation function measured in the GALFORM simulation for different masses (High to low masses from top to bottom lines at $\log_{10}(\sigma/h^{-1}$ Mpc$)= -0.3$). The grey area shows the measured values of $\omega(\sigma)$ from the USS sample; as can

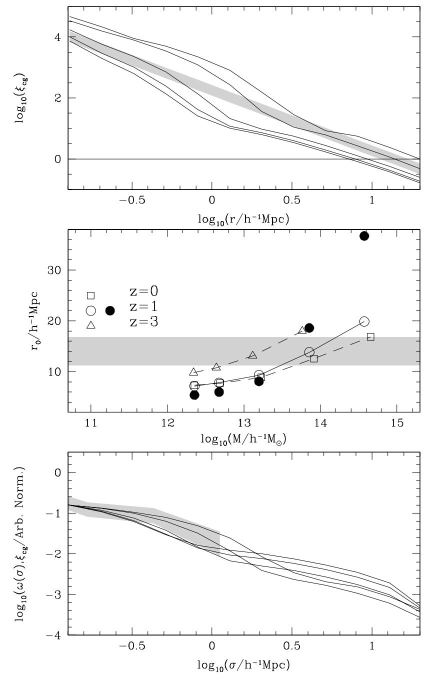

Fig. 2. See the text.

be seen the measured projected correlation function is in best agreement for $M \sim 10^{13.85}$ h^{-1} $M_{\odot}$.

5. CONCLUSIONS

We estimated the spatial clustering correlation lenght for galaxies in the field of $0.6 < z < 1.5$ USS sources. A comoving correlation lenght $r_0 = 14.0 \pm 2.8$ h^{-1} Mpc, for the USS sample with $0.6 < z < 1.5$. From our comparison with numerical simulations, we find that clusters of galaxies with masses $M = 10^{13.4-14.2}$ h^{-1} $M_{\odot}$ have a cluster galaxy correlation amplitude comparable to those found between USS hosts and galaxies. Our results suggests that distant radio galaxies are excellent tracers of galaxy overdensities and may pinpoint the progenitors of present day rich clusters of galaxies.

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