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THE VIMOS-VLT DEEP SURVEY: THE GROUP CATALOGUE

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Abstract. We present a homogeneous and complete catalogue of optical galaxy groups identified in the VIMOS-VLT spectroscopic Deep Survey (VVDS). We use mock catalogues extracted from the Millennium simulation to study the potential systematics that might affect the overall distribution of the identified systems, and also to asses how well galaxy redshifts trace the line-of-sight velocity dispersion of the underlying mass overdensity. We train on these mock catalogues the adopted group-finding technique (the Voronoi-Delaunay Method, VDM), to recover in a robust and unbiased way the redshift and velocity dispersion distributions of groups and maximise the level of completeness (C) and purity (P) of the group catalogue. We identify 318(/144) VVDS groups with at least 2(/3) members within $0.2 \leq z \leq 1.0$, globally with C=60% and P=50%. We use the group sample to study the redshift evolution of the fraction f_b of blue galaxies within $0.2 \leq z \leq 1$ in both groups and in the whole ensemble of galaxies irrespectively of their environment.

Keywords: galaxies: clusters, high redshift, evolution, statistics, cosmology: large-scale structure

1 This work

We used the data collected for the VVDS-0226-04 deep field ("VVDS-02h" field, Le Fèvre et al. 2005) to produce a homogeneous and complete optically-selected galaxy group catalogue, with reliable properties like redshift and line of sight velocity dispersions (σ_{los}). The aim is to study galaxy properties in very dense regions, on scales at which the physical processes driven by galaxy interactions are believed to play a major role. This work is extensively described in Cucciati et al. (2010). We refer the reader to Gerke et al. (2005, 2007); Knobel et al. (2009) and Iovino et al. (2010) for similar works based on different data sets.

We used galaxy mock catalogues that mimic the VVDS observational strategy, and that were extracted from the Millennium simulations (Springel et al. 2005), coupled to a semi-analytic model for galaxy formation (De Lucia & Blaizot 2007). Using these mocks, we first verified that the VVDS-02h survey sampling rate allows us to recover at least 50% of the groups (with a virial l.o.s. velocity dispersion $\sigma_{vir} \geq 350$ km/s) that are potentially present in the parent photometric catalogue up to $z = 1$. We also tested how well σ_{vir} of the halo mass particles can be estimated using sparsely sampled galaxy velocities. We verified that with this method, given the characteristics of our survey (flux limit, sampling rate, redshift measurement error) we are able to recover a sensible value of σ_{vir} for $\sigma_{vir} \geq 350$ km/s. Finally, we used these mock catalogues to train our group-finding algorithm, based on the Voronoi-Delaunay Method (VDM).

Applying the optimised algorithm to the VVDS real sample, we obtained a catalogue of 318 groups of galaxies (with at least two members) in the range $0.2 \leq z \leq 1.0$. Among these groups, 63 have a measured l.o.s. velocity dispersion >350 km/s. The group catalogue is characterised by an overall completeness of $\sim 60\%$ and a purity of $\sim 50\%$. Nearly 19% of the total population of galaxies live in these systems. We verified that the number density distribution as a function of both redshift ($n(z)$) and velocity dispersion ($n(\sigma)$) of the VVDS groups with σ >350 km/s scales in qualitative agreement with the analogous statistics recovered from the mocks.

Finally, we studied the fraction f_b of blue galaxies ($U - B \leq 1$) in the range $0.2 \leq z \leq 1$. We used a luminosity-limited subsample of galaxies extracted from our data ($M_B \leq -18.9 - 1.1z$), complete up to $z = 1$.

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We found that f_b is significantly lower in groups than in the global galaxy population. Moreover, f_b increases as a function of redshift irrespective of the environment, with marginal evidence of a higher growth rate in groups. We also analysed how f_b varies as a function of group richness, finding that, at any redshift explored, f_b decreases in systems with increasing richness. Further explorations of the properties of VVDS groups is left to future work. We only note that the cross-correlation studies of our optically-selected catalogue with samples inferred in the same field with independent techniques will help us to gain insights not only into cluster selection biases but also the physics at work within these extreme environments.

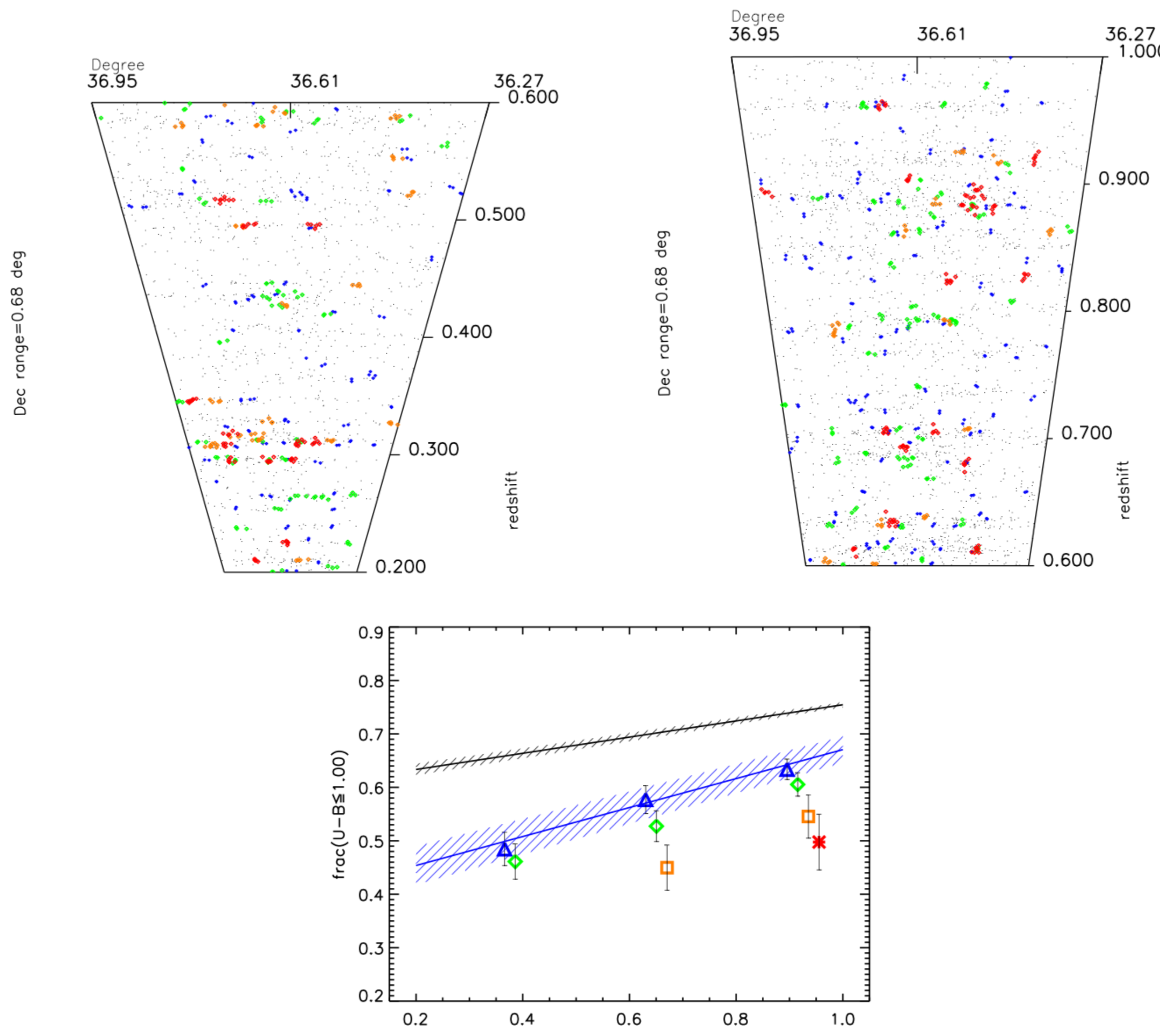

Fig. 1. *Top panels*: Two-dimensional VVDS galaxy distribution as a function of Right Ascension and redshift (points are compressed on the Declination dimension), for two different redshift bins ($0.2 \leq z \leq 0.6$ and $0.6 \leq z \leq 1.0$). Black dots are field galaxies, coloured dots are group members: blue dots are pair members, green are triplet members, orange are quartet members and red dots are members of groups with 5 or more members. *Bottom panel*: Fraction of blue galaxies ($U - B \leq 1$) as a function of redshift for group galaxies (blue empty triangles). The linear fit to these points is over-plotted as a blue line, while the upper black line is the linear fit for f_b computed within the 'total' sample. The dashed areas along the two linear fits show the locus where the linear fits could lie considering their 1-σ error on both intercept and slope. Other symbols are for group galaxies in groups with increasing richness (richness increases from blue triangles to red stars, passing by green diamonds and orange squares).

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