Outskirts of Galaxy Clusters: Intense Life in the Suburbs
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Structure and dynamics of the Shapley supercluster

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Abstract. We present results of our wide-field redshift survey of galaxies in a 285 square degree region of the Shapley Supercluster (SSC).

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1. Introduction

The Shapley supercluster (SSC) is a remarkably rich concentration of galaxies centred around R.A.= 13^h25^m Dec. = $-30°$ which has been investigated by numerous authors since its discovery in 1930 (see Quintana *et al.* 1995). It consists of many clusters and groups of galaxies in the redshift range $0.04 < z < 0.055$, and lies in the general direction of the dipole anisotropy of the CMB. It is located $130\,h^{-1}$ Mpc beyond the Hydra-Centaurus supercluster. The SSC is one of the most massive concentrations of galaxies in the local universe, so it is also of particular interest to consider its effect on the dynamics of the Local Group. We present an analysis of the Shapley supercluster based on the most complete velocity catalogue obtained up to now. We discuss the completeness and overdensities of the velocity sample and the structure and dynamics of the supercluster using the spherical collapse model.

2. The velocity catalogue

We have made an investigation into the larger scale distributions of galaxies throughout the entire SSC region and close environs using data from wide-field multi-fibre spectrographs such as OPTOPUS and MEFOS at the 3.60m ESO telescope (Quintana *et al.* 1997), the fiber spectrograph at the 100" DuPont telescope at Las Campanas, Chile (Proust *et al.* 2004), the UKST/FLAIR-II system, Australia (Drinkwater *et al.* 1999, 2004), and more recently the UKST/6dF instrument (Jones *et al.* 2004). Combined with already published redshift sets from several surveys and papers (see Quintana *et al.* 1995, 2000, Bardelli *et al.* 2001, Kaldare *et al.* 2003) and data from the NED NASA/IPAC

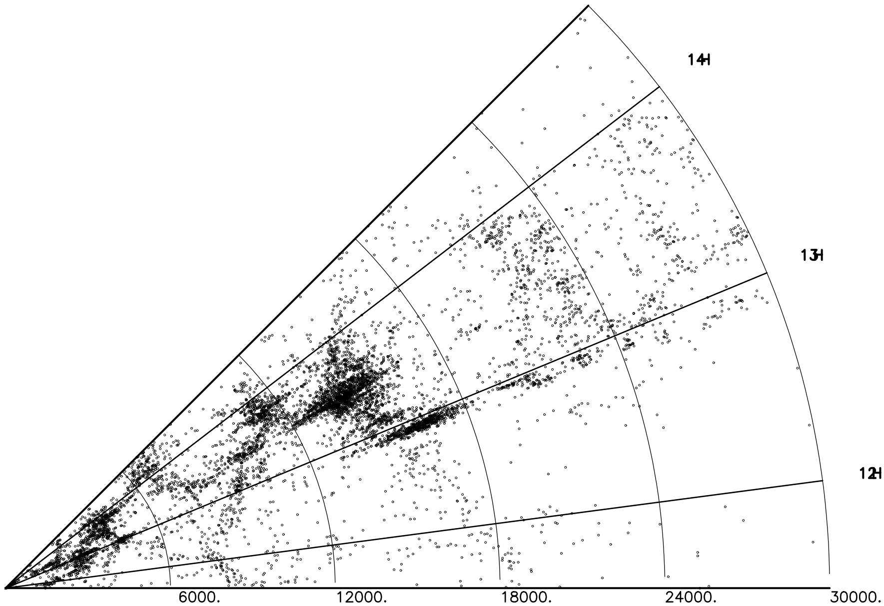

Figure 1. Wedge diagram in Right Ascension.

database, we obtain the most complete velocity catalogue for the SSC containing 10225 velocity measurements for 8341 galaxies (Figure 1). 4212 (50%) galaxies belong to the SSC with velocities in the range 9000–18000 km s^{-1} (a total depth of 90 h^{-1} Mpc).

3. Galaxy sample, completeness and overdensities

We compare our sample of observed galaxies to the total magnitude-limited galaxy distribution in the 225 square degrees survey region. We use the SuperCOSMOS sky survey to construct the parent galaxy catalogue for the region and analyse b_j magnitudes of all galaxies. Then, we determine the completeness of our survey (Drinkwater *et al.* 2004) as a function of 4 limiting magnitudes (Table 1) for both the full and the intercluster regions. It is highest for the brighter magnitude limits, peaking at 60 % for the whole sample at $b_j < 17.0$. In the velocity range ($9000 < cz < 18000\,\text{km s}^{-1}$) of the SSC, we calculate galaxy overdensities of 7.0 ± 0.2 over the 225 square degree central region and 4.8 ± 0.2 in a 192 square degree region excluding rich clusters. Over the large region of our survey the inter-cluster galaxies make up 48 % (3705 objects) of all galaxies in the SSC region, and assuming a similar mass function they contribute a similar amount of mass to the cluster galaxies.

4. Velocity dispersions of ACO clusters in the Shapley supercluster

Velocity dispersions are an essential piece of information to study cluster dynamics, because they probe directly the cluster potential. To study the distribution of velocity dispersions of the Shapley clusters that are in the ACO catalog, we examined the velocity distribution of galaxies within 0.5 degree ($\sim$ Abell radius at $z = 0.05$ with $h = 0.7$) of each cluster center in the ACO catalog. The number of clusters with at least 6 galaxies in our velocity sample is 46. For a sample of 36 clusters in the best sampled region, the median velocity dispersion is $727\,\text{km s}^{-1}$. All clusters in the SSC with velocity dispersion larger than $1000\,\text{km s}^{-1}$ present evidence of substructures.

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Table 1. Completeness of the velocity catalogue for 4 b_j magnitude limits.

Field	b_j Mag lim.	Catalogue	Velocities	Differential
Full	17.0	2981	1796 (60%)	
Full	17.5	6331	2810 (44%)	[30%]
Full	18.0	13361	3931 (29%)	[16%]
Full	18.5	27177	4793 (18%)	[6%]
Inter-cluster	17.0	2404	1166 (49%)	
Inter-cluster	17.5	5105	1693 (33%)	[20%]
Inter-cluster	18.0	10862	2285 (21%)	[10%]
Inter-cluster	18.5	21917	2887 (13%)	[5%]

5. The spherical collapse model

We have applied the spherical collapse model (Regös & Geller 1989) to the SSC. The resulting mass enclosed by radius $r = 8h^{-1}$ Mpc lies between 2.0×10^{15} and $1.3 \times 10^{16} h^{-1} M_{\odot}$, corresponding to a density range $\rho/\rho_c \sim 3-20$ (Reisenegger *et al.* 2000). Diaferio's (1999) method gives similar results for the lower limit of the virialized mass in clusters. The mass required at the distance of the SSC to produce the observed motion of the Local Group with respect to the CMB is $M_{dipole} \approx (2-5) \times 10^{17} h^{-1} M_{\odot} \Omega^{0.4}$ (Reisenegger *et al.* 2000, Hoffman *et al.* 2001). The mass within $8h^{-1}$ Mpc can therefore produce at most $\simeq 5-10\%$ of the observed Local Group motion, which makes it unlikely that even the whole SSC would dominate its gravitational acceleration. On the other hand, consistent models of the density and velocity distribution on large scales (where density fluctuations are small) in the local Universe can now be built (e.g. Branchini *et al.* 1999). In these, the SSC figures prominently, although the Local Group motion originates from a combination of several "attractors".

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References

Bardelli S., Zucca E., Baldi A.: 2001, *MNRAS* **320**, 387.
Branchini E. *et al.* : 1999, *MNRAS* **308**, 1.
Diaferio A: 1999, *MNRAS* **309**, 610.
Drinkwater M.J., Proust D., Parker Q.A., Quintana H., Slezak E.: 1999, *PASA* **16**, 113.
Drinkwater M.J., Parker Q.A., Proust D., Quintana H., Slezak E.: 2004, *PASA* **21**, 89.
Hoffman Y., Eldar A., Zaroubi S., Dekel A.: 2001, *astro-ph/0102190v1.*
Jones H., *et al.* (6dFGRS): 2004, *MNRAS* submitted.
Kaldare R., Colless M., *et al.* : 2003, *MNRAS* **339**, 652.
Proust D., Quintana H., Reisenegger A.: 2004, *A&A* in preparation.
Quintana H., Ramírez A., Melnick J., *et al.* : 1995, *AJ* **110**, 463.
Quintana H., Melnick J., Proust D., Infante L.: 1997, *A&AS* **125**, 247.
Quintana H., Carrasco E.R., Reisenegger, A: 2000, *AJ* **120**, 511.
Regös E., Geller M.J.: 1989, *AJ* **98**, 755.
Reisenegger A., Quintana H.., *et al.* : 2000, *AJ* **120**, 523.