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A Survey of the Most X-Ray Luminous Galaxy Clusters

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We present a survey of 22 very X-ray luminous galaxy ($L_x \geq 0.5 \times 10^{45}$ erg/sec in the 0.5-2keV band) clusters selected from the ROSAT Bright Survey. Because of their tremendous X-ray luminosity all clusters are assumed to be very massive systems. In addition, the medium redshift range $0.1 \leq z \leq 0.52$ was chosen, hence the probability for these clusters to act as gravitational lenses is very high. In these proceedings we present R- and V-band observations of the three clusters RBS325, RBS653 and RBS864 and discuss their photometric properties.

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1. Introduction

Galaxy clusters are assumed to be the largest and most massive bound structures in the universe. Located in an appropriate distance these structures are very good gravitational lens candidates which are useful probes for mass determinations, galaxy evolution and even cosmological purposes, e.g. arc statistics (Bartelmann et al [1998], Wambsganss et al [2004]).
Our sample of galaxy clusters consists of 22 members, which are assumed to belong to the most X-ray luminous systems. As there is a direct correlation between the X-ray luminosity and the mass (Reiprich et al [1999], Schindler et al [1999]), they are assumed to be very massive. All clusters are located in the medium redshift regime, hence they are situated in the best distance range for lensing investigations on cosmological purposes.

2. Data Selection

All 22 clusters of our sample are selected from the ROSAT Bright Survey (Schwope et al [2000], henceforth RBS) with the following selection criteria: (a) classified in the RBS as cluster, (b) not in the Abell catalogue, (c) redshift range $0.1 \leq z \leq 0.52$, (d) bolometric X-ray luminosity $L_x \geq 0.5 \times 10^{45}$ erg/sec (0.5-2keV band), and, finally, (e) declination $\delta \leq 20^{\circ}$ (observability from La Silla/Paranal). The observations were done either with the Wide Field Imager (WFI@ESO2.2m), SUperb Seeing Imager 2 (SUSI2@ESONTT) or with FORS2@ESO-VLT. All clusters were observed in the R and V band, except RBS1319/RXJ1347-1145, which was observed in U, B, V, R and I.

3. WFI observations

In these proceedings contribution we present and discuss optical images of three clusters, RBS325, RBS653 and RBS864. All observations were done at good seeing conditions ($\sim$ 1") with the Wide Field Imager during April 2002. In total there are 30 R-band images (ESO filter BB#Rc/162_ESO844) with an exposure time t_{exp} $\sim$4.46h of the coadded image, and 15 V-band images (BB#V/89_ESO843, t_{exp} $\sim$2.23h) per cluster, except RBS653 where we have obtained only 15 R-band images due to bad weather conditions (t_{exp} $\sim$2.23h in both R and V). More details are given in Tab.1. The photometric zeropoints were determined by fitting galaxy number counts to a known, well calibrated distribution (McCracken et al [2004])

4. Methods

For establishing catalogues of the objects we used SExtractor 2.3.2 (http://terapix.iap.fr/). All objects with CLASS_STAR parameter < 0.95 and a seeing dependent FLUX_RADIUS $> 2.8/2.7$, 3.5/2.9 and 3/3 pixels for RBS325 (R/V), RBS653 (R/V) and RBS864 (R/V), respectively, were regarded as galaxies. The galaxy density plots in Fig. 1 are derived by creating a blank image of 1500×1500 pixel image (corresponding to a Field of View of $\sim 6' \times 6'$), allocating pixel value "1" to all positions of Red Sequence (henceforth RS) galaxies and a subsequent smoothing with a gaussian of 300 pixels. The RS galaxies are derived from color-magnitude ((V-R) vs. R) diagrams,

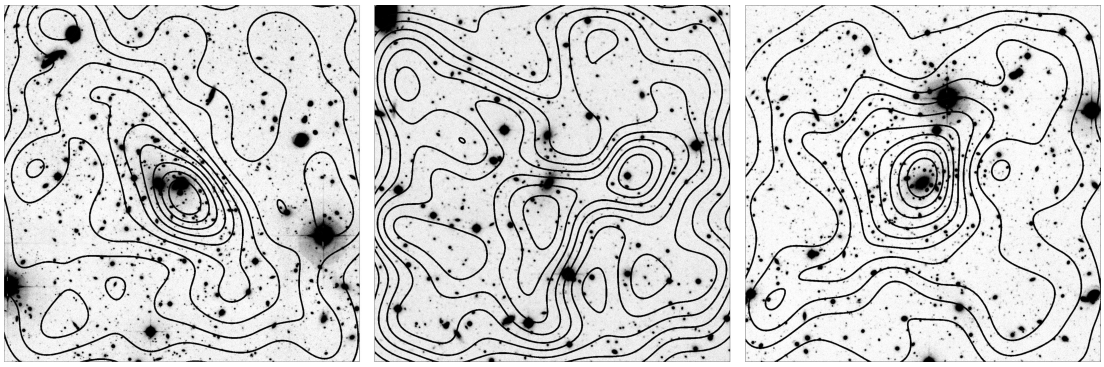

Figure 1: R-band images of RBS325 (left), RBS653 (middle) and RBS864 (right). The FoV is $\sim 6' \times 6'$ ($\sim$2Mpc$\times$2Mpc) in all images. The contours show the galaxy number densities of the RS-galaxies.

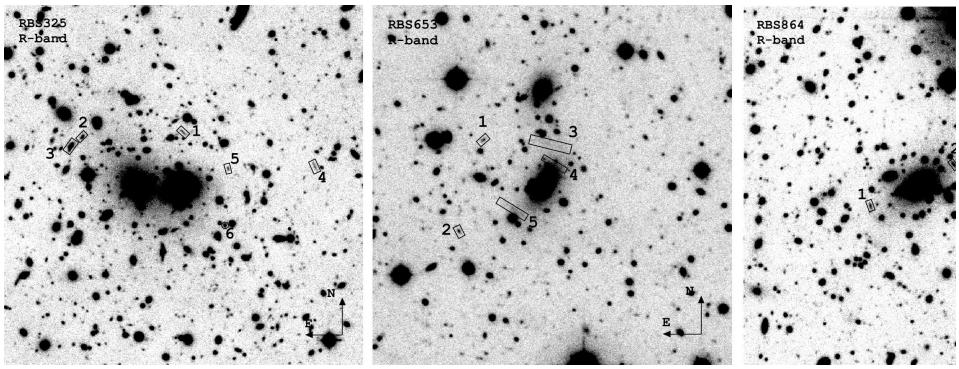

Figure 2: The central $\sim 3' \times 3'$ ($\sim$1Mpc$\times$1Mpc, assuming $H_0 = 75$km/s/Mps, EdS universe) of the clusters, North is up, East to left, arc candidates are numbered (see text for more details).

the magnitudes are obtained using MAG_AUTO. The length of an arc given in Tab. 2 is defined as the chord between the pixels with largest distance.

5. Preliminary Results

RBS325 and RBS653 seem to undergo a current merging process. This is indicated by the galaxy density plots shown in Fig. 1, which are extracted from the Red Sequence galaxies. In these plots several substructures, which indicate infalling subclusters can be seen. In addition, the optical and X-ray center of RBS653 differ by $\sim$ 40 arcsec (Schwope et al. [2000]), which is a further indication for such a merging process.

RBS864 is the cluster with a very massive cooling flow (Edge et al. [1994]), hence it is no surprise that the galaxy density plot in Fig. 1 shows no major fluctuations.

All three clusters show distinct lensing features (see Tab. 2 for more details). RBS325 contains five arc candidates and one very red object (#6), which might be a highly magnified very distant object. RBS864 shows three such candidates, two on opposite sides of the elliptical central galaxy (#1 and #2) and another one (#3) in a distance of about $\sim$ 62 arcsec from the cluster center given in the ROSAT Bright Survey.

The most remarkable cluster of this sample is RBS653. Apart from two arclets in a distance of 40

cluster	α	δ	z	$\log(L_x)$ [erg/sec]	R_{lim}	V_{lim}
RBS325	02 32 16.4	–44 20 48	0.282	44.8	25	25
RBS653	05 28 52.7	–39 28 18	0.286	44.9	25	24.5
RBS864	10 23 39.6	+04 11 10	0.2906	45.3	25	25

Table 1: Summary of the cluster properties. All data are taken from Schwope et al. [2000], R_{lim} and V_{lim} denote the limiting magnitudes of the final images.

cluster number	# of object in Fig.2	Dist. to cc [arcsec]	Dist. to cc [kpc]	length L [arcsec]	L/W	R [mag]	V [mag]
RBS325	1	27	14.7	4	4	23.6	23.7
	2	55	30.1	2.5	1.6	22.9	23.6
	3	60	32.8	5	2	21.7	21.8
	4	65	35.5	5	5	23.5	24.4
	5	24	13.1	2.5	2.5	24.3	24.8
	6	28	15.3	–	–	24.3	24.3
RBS653	1	40	22.2	3	3	23.4	23.4
	2	50	27.7	3	3	23.0	23.3
RBS864	1	27	15.2	3.5	2.3	22.6	24.8
	2	20	11.3	4	2.6	21.5	21.4
	3	62	35	3.5	2.7	24.6	–

Table 2: Summary of the arc properties. "cc" denotes the optical cluster center, given in Schwope et al. [2000], usually the position of the central galaxy, L/W is the length to width ratio.

arcsec (#1) and 50 arcsec (#2) it shows three giant arcs denoted with #3, #4 and #5. Object #3 is located in a distance D of roughly $\sim$21 arcsec with a length L of $\sim$16 arcsec, #4 has a distance from the cluster center of about $\sim$10" arcsec and a length of roughly 7 arcsec and #5 has a D $\sim$20 arcsec with L $\sim$9 arcsec. The width W of each of them is $\leq$ 1 arcsec.

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