

A turn-over in the galaxy luminosity function of the Coma cluster core?

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Abstract. Our previous study of the faint end ($R \leq 21.5$) of the galaxy luminosity function (GLF) was based on spectroscopic data in a small region near the Coma cluster center. In this previous study Adami et al. (1998) suggested, with moderate statistical significance, that the number of galaxies actually belonging to the cluster was much smaller than expected. This led us to increase our spectroscopic sample. Here, we have improved the statistical significance of the results of the Coma GLF faint end study ($R \leq 22.5$) by using a sample of 88 redshifts. This includes both new spectroscopic data and a literature compilation.

The relatively small number of faint galaxies belonging to Coma that was suggested by Adami et al. (1998) and Secker et al. (1998) has been confirmed with these new observations. We also confirm that the color-magnitude relation is not well suited for finding the galaxies inside the Coma cluster core, close to the center at magnitudes fainter than $R \sim 19$. We show that there is an enhancement in the Coma line of sight of field galaxies compared to classical field counts. This can be explained by the contribution of groups and of a distant $z \sim 0.5$ cluster along the line of sight.

The result is that the Coma GLF appears to turn-over or at least to become flat for the faint galaxies. We suggest that this is due to environmental effects.

Key words: galaxies: clusters: individual: – galaxies: distances and redshifts – galaxies: luminosity function, mass function – cosmology: observations

1. Introduction

The galaxy luminosity function (GLF hereafter) is a powerful cosmological tool (see e.g. the review by Binggeli, Sandage & Tammann 1988). It is a good indicator of the formation history of both galaxies and clusters of galaxies, and is also directly related to the mass distribution function of structures in the Universe (Press & Schechter 1974). Excluding environmental

effects as a first approximation, hierarchical models predict a mass distribution characterized by an exponential cut-off beyond a characteristic mass M^* and a power-law for low mass structures. Although a detailed analysis presented by Binggeli et al. (1988) shows that individual galaxy types actually have a Gaussian distribution, except for the dwarf ellipticals (probably the dominant type among the faint Coma galaxies), the GLF is now commonly described with a Schechter function (see e.g. Lumsden et al. 1997 or Rauzy et al. 1998 for recent statistical applications). It is possible to find a simple linear relation between the shape of the power spectrum (Fourier transform of the mass function) and the shape of the GLF (see Lobo et al. 1997).

A determination of the GLF in rich clusters such as the Coma cluster (see Biviano 1998 for a review including the article by Godwin, Metcalfe & Peach, GMP hereafter) is interesting as it can provide information about the evolution and formation of small galaxies in rich clusters as well as to place limits to the amount of mass in the cluster in the form of faint galaxies that might have been missed in previous surveys. It is also interesting to ask if the luminosity function varies within projected distance from the core of rich clusters (cf. Secker et al. 1998 and Adami et al. 1998: A98 hereafter) and to determine if the GLF differs in the field versus that in rich clusters (cf. Valotto et al. 1997 or Gaidos 1997). Both of these questions relate to how the environment of rich clusters affects and is related to galaxy formation and evolution. In order to address some of these issues several groups have acquired and analyzed deep images of the Coma cluster to extend the GLF to as faint values as possible (cf. Bernstein et al. 1995, B95 hereafter, Ulmer et al. 1996 and references therein).

B95 concluded that the luminosity function turned up at the faint end as also suggested for the case of Virgo by Binggeli et al. (1988). Phillipps et al. (1998) confirm this trend with a very deep survey of the Virgo cluster (M_R as faint as -13.5). A98 made direct redshift measurements of Coma that tentatively suggested a similar turn up, but A98 did not have enough redshifts to draw a firm conclusion. In order to redress the issue

of too few redshifts, we requested and obtained more observing time at the CFHT. With these data and a compilation of redshifts from the literature, we now have 88 redshifts that cover the region surveyed by B95. We can, therefore, make a more definitive statement about the shape of the luminosity function of Coma at the faint end. We also used our data to compare with indirect methods of determining cluster membership, i.e., statistical inferences of the number of galaxies in the cluster (B95) and the use of the color magnitude relation (e.g. Biviano et al. 1995).

In Sect. 2 of the present paper, we describe our sample of 88 redshifts. In Sect. 3, we discuss the implications of these results. Finally, in Sect. 4 we discuss the GLF.

We will use $H_0=100 \text{ km.s}^{-1}.\text{Mpc}^{-1}$ and $q_0=0$ throughout the paper to be coherent with the previous analysis of A98.

2. The data

2.1. Photometry

We used the photometric catalogue of B95. All the details of this catalogue are described in B95 and A98. Briefly, it covered a $7.5 \times 7.5 \text{ arcmin}^2$ area centered on coordinates (12h 57m 17s, $28^\circ 09' 35''$) (equinox 1950 hereafter). This field is close to the cluster center, located very near the two giant dominant galaxies of the Coma cluster. Each galaxy is characterized by its position and its R and b_j magnitudes.

2.2. Spectroscopy

This new spectroscopic follow-up was done during 1 night (11/12 April 1999) using the CFHT/MOS multi-slit spectrograph with the V150 CFHT grism with a resolution of 10 \AA px^{-1} . We selected as potential targets all the galaxies with magnitudes $R \leq 22.5$ and resolution parameter (see definition in B95) between 0.85 and 2.2. This range of resolution parameters corresponds to the objects securely classified as galaxies. The galaxy selection was confirmed by the very low contamination rate we found with our spectroscopic observations: less than 5% of the targets were found to be stars. The limiting magnitude of $R \simeq 22.5$ is the faintest possible magnitude for a redshift determination in a non-prohibitive exposure time of about 2 hours.

In A98, we used no blocking filters (wavelength range of $\simeq 6000 \text{ \AA}$ and about 30 slits per mask). In the current run, we have chosen to use a 4400 \AA wide filter (CFHT filter #4610) which allows a greater number of slits. The redshift range is lower but is still acceptable (z in the $[0;0.9]$ range for both the H&K lines and the G band within our spectral range). We have shown in A98 that the galaxies in this area of the sky and with magnitudes brighter than 22.5 are unlikely to be more distant than $z=0.9$. Due to bad weather, only 50% of the night was available for spectroscopy. This resulted in a 2 hour exposure with 45 slits (mask 1) and a second 40 minute exposure (mask 2) with 40 slits. Therefore, mask 2 produced a low success rate of redshift determination of about 15% (the mask 1 success rate is about 60%).

The spectra were reduced in exactly the same manner as in A98 i.e. we used both ESO MIDAS and Geotran/RVSAO IRAF. We assumed the derived redshifts were valid only when the absorption lines provided a RVSAO correlation coefficient greater than 3 or when there were more than two well defined and self-consistent emission lines. When both emission (at least 2) and absorption lines were detected, the redshift was computed with the emission lines. Table 1 summarizes all the information we have for the galaxies we used here to derive a GLF (except those of A98).

2.3. Literature compilation

In order to increase the number of redshifts in the Coma core area, we have also searched for velocities available in the literature in the area surveyed by B95 and with a measured magnitude. The compilation of A. Biviano (private communication) gives 23 objects. These 23 objects are also summarized in Table 1 (objects with a GMP number and without a “*”). The colors of these galaxies are from GMP and we have diminished the $b_{26.75}-r_{24.5}$ of GMP by 0.55 in order to match our system of magnitudes, but we note this is only an approximation (the error is about 0.2 magnitude on this number). The objects from Biviano are significantly brighter than the galaxies we have observed, but provide complementary data for the bright portion of the luminosity function.

We note that the objects in Table 1 with a GMP number and a “*” are found both in B95 and GMP.

We had previously described in A98 the data of Secker et al. (1998). These data are not yet public, but they cover a field very close to the B95 area. The galaxies of this sample are in the magnitude range $R=[15.5;20.5]$ and only 4 are in the Coma cluster. These data are not included in the sample used in this paper. We simply use the Secker et al. (1998) results for comparison in Sect. 3.

2.4. Completeness

We show in Fig. 1 the distribution of our 88 redshifts along the B95 line of sight (A98: 32 z, this paper: 33 z, literature: 23 z). We clearly see the Coma cluster at $z \simeq 0.02$ and some other structures along the line of sight (*los* hereafter) (including the distant cluster detected in A98). The Coma cluster comes mainly from the literature.

In order to estimate how complete our sample is in apparent magnitude, we compare the number of redshifts we produced to the number of available targets in the magnitude range ($R=[16.5;22.23]$) in B95 (we ignore the very bright galaxies taken from the literature and not sampled by B95). We find that we covered about 23% of all the available galaxies in this magnitude bin. Fig. 2 shows the magnitude histogram of the galaxies of our sample superimposed on that of all the B95 galaxies in this magnitude range. We see that our completeness level drops abruptly above $R=21.5$. Below this value, our completeness level is 33%.

Table 1. Col.1: redshift (with GMP number when the galaxy is in this catalog); col.2: redshift error; col.3: R magnitude; col.4: b_j -R; col.5: x coordinates (arcmin); col.6: y coordinates (arcmin from the center: 12h 57m 17s, 28°09'35")

z	err _z	R	b_j -R	x (')	y (')
0.0162 (3400)	1 10 ⁻⁴	13.82	1.33	3.08	-0.10
0.0221 (3201)	1 10 ⁻⁴	14.01	1.36	0.06	1.57
0.0207 (3313)	2 10 ⁻⁴	14.20	1.28	1.74	-3.61
0.0227 (3423)	1 10 ⁻⁴	14.30	1.40	3.41	-2.16
0.0271 (3296)	1 10 ⁻⁴	14.38	1.41	1.53	1.25
0.0266 (3178)	3 10 ⁻⁴	14.68	1.29	-0.29	-1.76
0.0263 (3068)	1 10 ⁻⁴	14.97	1.38	-2.62	2.62
0.0229 (3222)	3 10 ⁻⁴	14.97	1.20	0.53	2.30
0.0123 (3262)	3 10 ⁻⁴	15.27	1.27	1.03	-1.88
0.0328 (3133)	3 10 ⁻⁴	15.73	1.37	-1.17	2.29
0.0214 (3339)	3 10 ⁻⁴	16.04	1.23	2.11	-1.35
0.0263 (3126)	3 10 ⁻⁴	16.05	1.27	-1.37	-3.20
0.0207 (3205)	4 10 ⁻⁴	16.11	1.28	0.13	-1.11
0.0215 (3034)	2 10 ⁻⁴	16.56	1.15	3.26	3.25
0.0228 (3376)	3 10 ⁻⁴	16.74	1.00	2.78	2.10
0.0564 (3225)*	1 10 ⁻⁴	16.75	1.23	0.54	-1.63
0.0153 (3383)	2 10 ⁻⁴	17.00	1.31	2.86	-1.50
0.0140 (3340)	5 10 ⁻⁴	17.04	1.38	2.13	2.94
0.1782	3 10 ⁻⁴	17.11	1.46	1.25	-0.82
0.0128 (3275)	1 10 ⁻⁴	17.16	1.02	1.16	-1.91
0.1715 (3149)*	5 10 ⁻⁴	17.41	1.67	-0.87	-2.30
0.0187 (3424)	2 10 ⁻⁴	17.48	1.81	3.41	3.37
0.0204 (3311)*	4 10 ⁻⁴	17.54	1.23	1.69	-0.93
0.1954 (3095)*	5 10 ⁻⁴	17.62	1.69	-2.17	-2.17
0.0242 (3080)*	6 10 ⁻⁴	17.96	1.19	-2.41	1.89
0.0298 (3325)	5 10 ⁻⁴	18.16	1.45	1.94	1.20
0.2748 (3150)*	2 10 ⁻⁴	18.31	1.66	-0.87	1.02
0.1774 (3284)	3 10 ⁻⁴	18.50	/	1.29	-0.88
0.1922	3 10 ⁻⁴	18.55	1.27	-3.32	-1.64
0.6330 (3353)*	6 10 ⁻⁴	19.43	1.63	2.29	1.36
0.0273 (3370)	3 10 ⁻⁴	19.63	1.53	2.69	-2.07
0.1776 (3137)	3 10 ⁻⁴	19.63	1.02	-1.17	2.64
0.4680	3 10 ⁻⁴	19.97	2.17	2.57	-0.04
0.3162	2 10 ⁻⁴	20.02	1.54	-2.07	-1.14
0.5060	4 10 ⁻⁴	20.43	1.06	2.14	2.06
0.2438	4 10 ⁻⁴	20.43	2.46	0.43	-1.78
0.6142	2 10 ⁻³	20.54	2.30	-1.82	-3.53
0.2415	3 10 ⁻⁴	20.55	1.23	3.67	1.41
0.4606	3 10 ⁻⁴	20.66	1.33	-0.11	3.33
0.2523	4 10 ⁻⁴	21.08	1.12	2.97	-2.99
0.4229	2 10 ⁻⁴	21.13	1.42	3.41	1.82
0.6262	9 10 ⁻⁴	21.16	1.03	1.19	2.87
0.2368	4 10 ⁻⁴	21.20	1.10	-3.62	0.65
0.4035	3 10 ⁻⁴	21.28	1.97	0.60	2.13
0.3127	3 10 ⁻⁴	21.37	0.97	-3.34	-0.76
0.6018	4 10 ⁻⁴	21.41	2.03	3.04	2.95
0.4236	3 10 ⁻⁴	21.63	1.48	1.48	2.48
0.0934	3 10 ⁻⁴	21.95	1.23	-0.22	0.46
0.1622	6 10 ⁻⁴	22.02	1.12	1.71	-0.56
0.5509	2 10 ⁻⁴	22.13	0.89	-3.15	0.54
0.4665	3 10 ⁻⁴	22.23	0.58	-0.48	3.50
0.5188	4 10 ⁻⁴	/	/	5.12	0.62
0.2827	8 10 ⁻⁴	/	/	4.56	0.53
0.0926	7 10 ⁻⁴	/	/	4.38	-2.49
0.0619	4 10 ⁻⁴	/	/	3.89	-2.41
0.2134	3 10 ⁻⁴	/	/	4.44	0.55

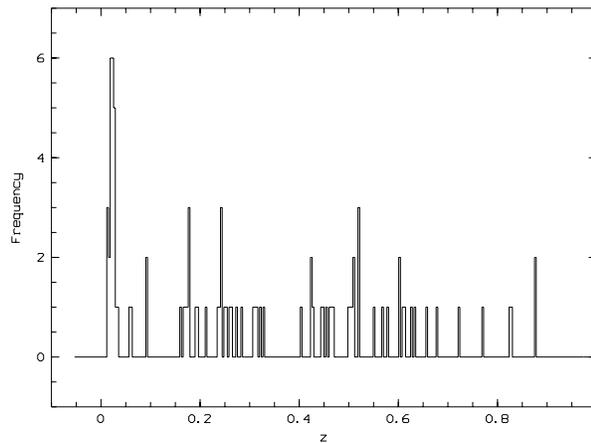


Fig. 1. Distribution along the Coma cluster core line of sight of the 88 redshifts of our sample. The bin width is 1000 km.s⁻¹.

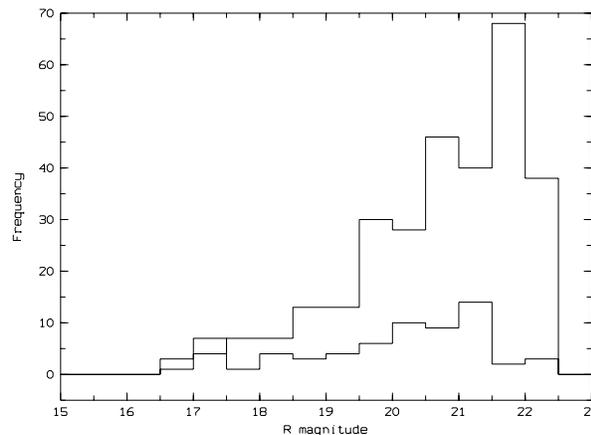


Fig. 2. Magnitude histograms for all the B95 and literature galaxies for which we have a measured redshift.

We have also tested the spatial representativeness of our sample. We have used the same bidimensional Kolmogorov-Smirnov test as in A98 to compare the spatial distribution of the galaxies for which we have a redshift and the spatial distribution of all the galaxies available in B95 in the range $R=[16.5;22.23]$. We find that the probability that the two spatial distributions statistically differ is less than 0.1%. We conclude, therefore, that our sample is a statistically representative sample of the Coma luminosity function and that it is valid to apply corrections to the B95 luminosity function based on the data we use here.

Finally, we note that we are not likely to be strongly biased by non-detected very low surface brightness galaxies. Even the lowest surface brightness galaxies of our sample (described in Fig. 5 of Ulmer et al. 1996) with magnitudes brighter than $R=22$ ($M_B \simeq -12$ in Fig. 5 of Ulmer et al. 1996) have a central surface brightness brighter than $26.5 \text{ mag.arcsec}^{-2}$. On the same figure, the galaxies studied by Ferguson & Binggeli (1994) for a similar magnitude range have the same central surface brightness. We are, therefore, not biased more than Ferguson & Binggeli (1994) are.

3. Implications of the results

3.1. The Color-Magnitude Relation (CMR)

We concluded in A98 that the use of the CMR to find the galaxies inside the Coma cluster for the faint magnitudes (typically fainter than $R=19$) was inefficient. We confirm this statement here. By using all the galaxies for which we have a b_j-R color, we see that some of the galaxies beyond the cluster are included in the envelope expected for Coma (see Fig. 3), while for the bright galaxies the relation is very good. This contamination is likely due to distant intrinsically blue galaxies with a K-dimming that makes them mimic Coma cluster members. Yet, the two galaxies detected inside the Coma cluster in our spectroscopic survey (the two faintest filled circles, see Table 1 for relative coordinates) are redder than this envelope (they are not low surface brightness galaxies and they have a mean surface brightness brighter than $23.5 \text{ mag. arcsec}^{-2}$). We note however that the redshift of the first of these two galaxies is based on only one emission line (see A98). In order to check this tendency with a larger sample, we have plotted on Fig. 3 the running mean (thin solid line with a running window of 10 galaxies) of the mean color of all the galaxies of the GMP catalog belonging to the Coma cluster (with a known redshift), not only in the small field of B95 (redshifts from Biviano et al. 1995 and included in $[3300;10500] \text{ km.s}^{-1}$). Except for a few outliers (a few percent), the Coma galaxies brighter than $R=17.25$ are in good agreement with the mean position of the CMR. For the fainter GMP galaxies the agreement is also good globally, but the percentage of red outliers increases (25%) in the data (according to the envelope of the CMR, see Mazure et al. 1988). Finally, two objects we observed are clearly redder than the CMR envelope.

This is consistent with the suggestion of A98 that there exist high metallicity dwarf galaxies in the Coma cluster core. We do not generalize this hypothesis to all the dwarf galaxies because our statistics are very poor. Different hypotheses can explain, however, the existence of red dwarfs. For example, we can assume that the intra-cluster medium confines these faint galaxies (when they are not destroyed by tidal forces), thereby keeping a high fraction of heavy elements.

3.2. Projection effects

In order to reconstruct the GLF of the Coma cluster core, we need to know the number of galaxies per magnitude bin belonging to the cluster. One of the classical methods to obtain this information is to observe comparison fields (as in B95) and to make differential counts between these fields and the cluster field. We plot in Fig. 4 the percentage of galaxies along the l_{os} which are in the Coma cluster according to the B95 field counts (dotted line with the $\pm 1\sigma$ error bars). The error bars are the rms deviation on the B95 field counts and are described in B95 section 3.1. We also plot on the same figure this percentage according to the redshifts we have (solid line). This curve was computed using a running mean. This running mean was created with an average redshift in each bin of 10 galaxies. The bins were generated by shifting from low to high redshift by

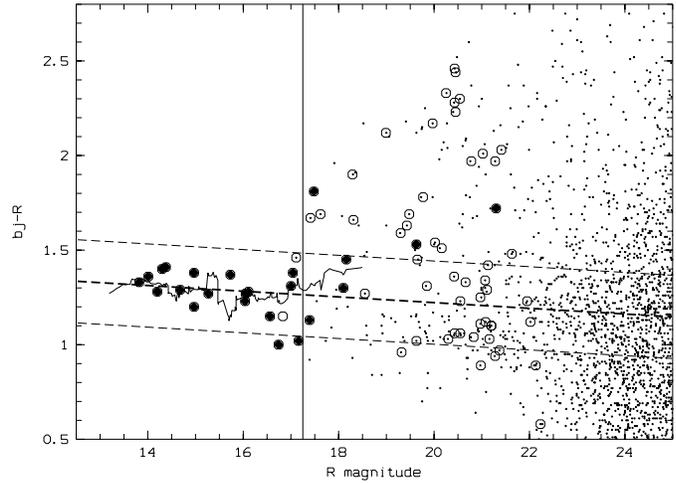


Fig. 3. Colour–Magnitude Relation (CMR) for the galaxies between magnitudes $R=13$ and 25 . The galaxies observed spectroscopically are circled and the galaxies belonging to the Coma cluster are the filled circles (the faintest ones are not from the literature compilation). The mean position of the CMR envelope of the cluster is overplotted as a thick dotted line. We note that the two circles without a point inside are two galaxies classified as stars by B95. We have overplotted the running mean of the GMP galaxies belonging to the Coma cluster (thin solid line inside the CMR envelope). We diminished the $b_{26.75}-r_{24.5}$ of GMP by 0.55 and $b_{26.75}$ by 1.5 in order to match with our system of magnitudes. The thin vertical line shows the magnitude $R=17.25$.

just one galaxy. We used this running mean in order to reduce the noise due to our small sample. We see that the spectroscopic and the B95 field counts are inconsistent at the 1σ level for R fainter than 18.5 . We note that for the two faintest bins, the B95 error bars are large.

We also plot the same percentage, but with all the GMP galaxies with a redshift and not only in the B95 field. For magnitudes brighter than $R=17.75$, the GMP spectroscopic counts are higher than ours indicating a higher percentage of galaxies belonging to the Coma cluster if we consider the whole cluster instead of the small B95 field. They agree well with the field counts of B95. For the faintest magnitudes of GMP, the GMP counts agree better with our counts than with the B95 counts.

We also note that our estimates are the same as those of Secker et al. (1998). These authors have measured 17 redshifts in the magnitude range $[15.5;20.5]$ and find only 4 galaxies in the Coma cluster; this gives a percentage of 24%. If we make the same estimate for the same magnitude bin with the data of this paper, we find that 25% of the galaxies are in the Coma cluster.

3.3. Why do we have so few galaxies belonging to the Coma cluster?

The expected absolute magnitudes for typical cluster galaxies range from $M_R \simeq -23$ to $M_R \simeq -11$ (see e.g. Patterson & Thuan 1996). At the Coma cluster redshift, we should expect a significant number of galaxies for apparent magnitudes R close to $23-24$. The observational evidence is that we do not detect

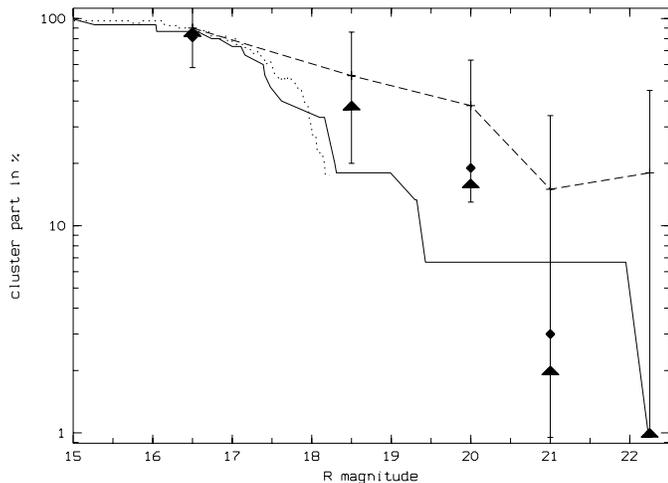


Fig. 4. Percentages of galaxies seen along the *los* which are in the Coma cluster. Dashed line with 1σ error bars: based on the B95 field counts; solid line: from spectroscopy, this curve was computed with a running mean with 10 galaxies in the running window; short dashed line: from the GMP catalogue, this curve was computed with a running mean with 40 galaxies in the running window; filled diamonds and triangles: based on the B95 field counts but corrected for the effect of the distant cluster at $z \simeq 0.5$ and for the effect of groups along the *los* (see text for a description of these corrections). The triangles are the counts corrected with a group luminosity function and the diamonds are the counts corrected with a cluster luminosity function for the groups along the *los*. We note that these diamonds and triangles are overlapping in the first two bins and in the last bin.

such a significant number in the Coma cluster core. Secker et al. (1998) and A98 have suggested that the faint galaxies are disrupted by the giant ellipticals in the center of the clusters. This explanation is theoretically supported by the simulations of Merritt (1984). He predicted a tidal radius (i.e. the lowest possible value for the size of a non tidally disrupted galaxy) of about 15 kpc in the core of clusters. The size of dwarf galaxies is significantly lower. More recent simulations by Moore et al. (1998) also show a similar scenario for the disruption of faint galaxies.

If these galaxies are really destroyed by tidal forces, their luminosities can be transferred from the “galaxy” matter phase to the “diffuse component” phase. Gregg & West (1998) propose such an explanation for the Coma cluster, estimating that 20% of the diffuse luminosity of a cD galaxy may come from these disruptions. More quantitatively, B95 show that the diffuse light profile is strongly peaked at the center of the Coma cluster and Ulmer et al. (1996) reported that the color of the diffuse light is $b_j - R = 1.2 \pm 0.3$, similar to the expected color for dwarf galaxies inside the Coma cluster (slightly redder). These two facts support the disruption hypothesis. Some faint low surface brightness galaxies can also be produced by this process (Ulmer et al. 1996) to fit with our explanation of the death of faint galaxies in the Coma core; however, the overall destruction rate must be faster than the production rate.

There are several other explanations besides tidal disruption for the scarcity of dwarfs in the core of rich clusters. For example,

as suggested by the referee, the formation of faint dwarf galaxies could have been suppressed due to heating of the baryons in the relatively high density fluctuation that caused Coma to form. In this case, such high temperatures could have prevented faint dwarfs from forming.

3.4. Why do we see so many galaxies along the Coma cluster core line of sight?

Five comparison fields (B95) were observed under identical conditions (same telescope, same instrument, same filter) as for the B95 Coma field. They were selected at random and chosen to be free of bright stars or galaxies. The flat-fielding and image combining techniques were the same as for the B95 Coma field. All the details are given in B95. The errors on the B95 counts come from a calculation based on the variations of the counts in these five fields.

The question is why do we see a high number of faint galaxies (in apparent magnitude) along the Coma cluster core *los* compared to these standard empty fields? The only explanation we have is an accidental overdensity of structures along this *los* which artificially increases the counts.

One of these structures has been detected by A98: a cluster at $z \simeq 0.5$. Moreover, using the compilation by A. Biviano of all the literature redshifts for the Coma cluster *los* (not only the B95 *los*), we have detected 8 other structures beyond Coma. The detection in the redshift space is based on the method used for the ENACS clusters of galaxies, described in Katgert et al. (1996). Each structure is sampled with more than 5 redshifts and the estimation of the velocity dispersion σ (Biweight Estimators) ranges from 170 to 500 km s^{-1} . These values are consistent with groups of galaxies (see e.g. Barton et al. 1998).

In order to estimate the contribution of these structures to the counts, we have first searched for the groups that overlap with the B95 field *los*. Assuming that these eight groups are all potentially compact groups embedded in a dense environment, we assumed that their contribution is significant up to 1 Mpc in radial projection from the center of the mass concentration, as suggested by Barton et al. (1998). Fig. 5 shows the location of the B95 field and the $2 \text{ Mpc} \times 2 \text{ Mpc}$ boxes for all these groups. We see that we have three overlapping groups, that contribute 7 %, 4 % and 20 % of their area to the B95 *los*. They are described in Table 2.

We now estimate the contribution of these three overlapping groups and of the distant cluster (detected along the *los* in A98) to the counts. In order to find an upper limit for the effect, we assume that the distant cluster is a very rich one, with the richness of A3112 (the richest cluster in the ENACS sample of Rauzy et al. 1998) and we assume the luminosity function of Rauzy et al. (1998): $\alpha = -1.5$ and $M_{b_j}^* = -19.91$.

For the groups, we have used the relation $\sigma = 5.28 \times N + 106$ given by Barton et al. (1998) to evaluate their richness N to a given limiting magnitude. For their luminosity function, we have both used the Rauzy et al. (1998) cluster function and the Muriel et al. (1998) group function ($\alpha = -1.0$ and $M_{b_j}^* = -19.6$).

Table 2. Description of the three groups and of the cluster along the line of sight. Line (1): mean redshift; line (2): estimate of the velocity dispersion; line (3): estimate of the contribution in term of number of galaxies along the line of sight down to $R=16.5$; line (4): estimate of the contribution in term of number of galaxies along the line of sight in $R=[16.5, 19.5]$; line (5): estimate of the contribution in term of number of galaxies along the line of sight in $R=[19.5, 20.5]$; line (6): estimate of the contribution in term of number of galaxies along the line of sight in $R=[20.5, 21.5]$; line (7): estimate of the contribution in term of number of galaxies along the line of sight in $R=[21.5, 23]$. For the 3 groups, the first number of galaxies is the contribution assuming the Rauzy et al. luminosity function, and the second number is if we assume the Muriel et al. luminosity function.

	Group1	Group2	Group3	dist. cluster
Mean z	0.0907	0.0970	0.2753	~ 0.5
σ (km.s $^{-1}$)	510	235	170	660
$R \leq 16.5$	0 or 0	0 or 0	1 or 1	0
$16.5 \leq R \leq 19.5$	1 or 1	0 or 0	3 or 4	1
$19.5 \leq R \leq 20.5$	1 or 1	0 or 0	6 or 6	6
$20.5 \leq R \leq 21.5$	2 or 1	0 or 0	11 or 7	17
$21.5 \leq R \leq 23.0$	4 or 2	1 or 0	23 or 10	60

We have then predicted the number of galaxies along the Coma cluster core *los* coming from these groups and from the distant cluster. Subtracting these numbers to the B95 field counts, we plot the corrected values in Fig. 4 as filled symbols: triangles when we used the Rauzy et al. (1998) function for the groups and squares when we used the Muriel et al. (1998) function. We see that we are able to produce values in agreement with those derived spectroscopically in the two faintest bins. With these corrections, the $[17.5; 19.5]$ and $[19.5; 20.5]$ bins also become consistent with the spectroscopic results. We therefore conclude that the presence of groups and of the distant cluster along the line of sight can explain the difference between the B95 and the spectroscopic counts. However, we have used an extreme hypothesis for the richness of the groups and of the distant cluster.

We note that such superpositions are found in the ENACS clusters as shown in Katgert et al. (1996). However, this study also shows that the contamination level spreads over a wide range and that all the clusters are not subject to such superposition effects.

4. The GLF

We show in Fig. 6 the GLF of B95 (rebinned to conform better to our sample) and the GLF constructed with our own spectroscopic counts. We produced the brightest two points of our GLF by using the Lobo et al. (1997) photometric data included in the B95 field and by applying the spectroscopic percentages of galaxies belonging to the cluster (see Fig. 4: $\sim 100\%$ of the galaxies in the Coma cluster). We produced the last five points of our GLF by using the spectroscopic counts computed with the B95 data and by applying the spectroscopic percentages of galaxies belonging to the cluster (instead of the field counts).

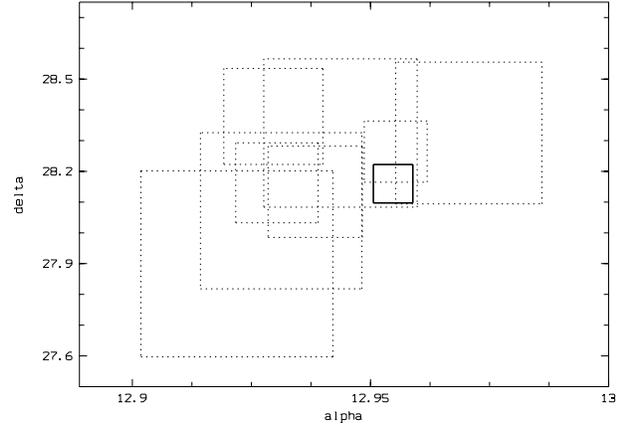


Fig. 5. Location of the B95 field (thick box) and of the 2 Mpc side boxes (dashed lines) for all the groups along the Coma line of sight.

While B95 quotes a best fit to the $R \simeq 15-24$ GLF of -1.42 ± 0.05 , the GLF in the $R \simeq 15-22$ range is consistent with a Schechter function with a slope of $\alpha = -1$. After our corrections are applied, the GLF seems to be flat after $R = 13$ and may actually be begin to turn over at $R \simeq 17$ or higher. We note, however, that this turn-over is not statistically significant given the size of the error bars and the turn-over (if there is one) could take place anywhere between $R \simeq 17$ and $R \simeq 21$. These errors are difficult to estimate due to our limited number of redshifts, but we have assumed that they have the same values as those of B95. Given these uncertainties, we conclude that the GLF is most likely flat (flatter than deduced by B95), though a moderate rise or decrease are not excluded. The GLF slope (using dwarf galaxies) is the same as in Loveday et al. (1992: $\alpha = 0.20 \pm 0.35$ in a magnitude range $b_j = [-22; -15]$) for “normal” elliptical field GLF and we have overplotted this function in Fig. 6. Their turn-over, however, begins around $b_j = -19.75$ ($R \simeq -21.25$), sooner than for our GLF as we can see on Fig. 6. We therefore conclude that the GLF of the Coma cluster core is not in agreement with the field elliptical GLF. However, the Coma cluster core GLF is also significantly different from the GLF for the whole Coma cluster of Lobo et al. (1997) or Smith et al. (1997) (the faint ends of the GLF are respectively at $M_R \simeq -14$ and $M_R \simeq -14.5$), or of Phillipps et al. (1998) for the Virgo cluster. These authors find a slope for the GLF of $\alpha \simeq -1.8$ or greater. The conclusion is that the Coma cluster core GLF has a peculiar shape that was probably induced by environmental effects. This shape is flat for the faint magnitudes, similarly to what is observed in the field (e.g. Lin et al. 1996 without morphological distinctions). However, we stress here that any general conclusion concerning the similarity between the Coma inner core GLF and the GLF in the field is not valid because we are very likely to have strong environmental effects in the inner core of the Coma cluster.

A lack of faint galaxies is likely to be due in a large part to the tidal forces created by the two giant dominant galaxies, and an interesting question is: what is the variation of the efficiency of this disruption versus the distance from the center? Do environmental effects dominate the shape of the faint end of the

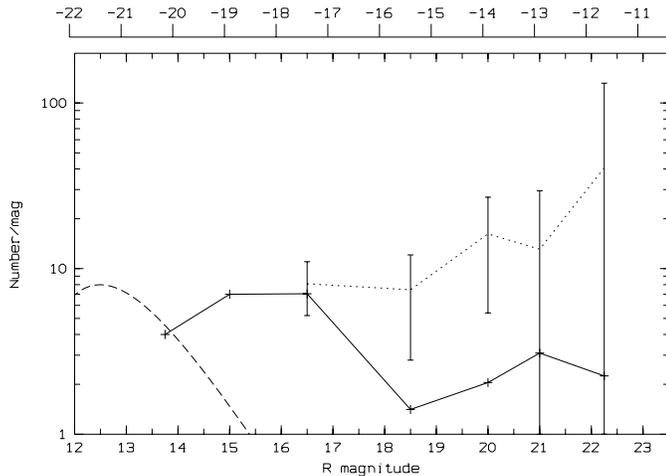


Fig. 6. Galaxy Luminosity Function constructed with the B95 counts (dashed line with 1σ error bars) and with the spectroscopic counts (solid line). The long-dashed line is the GLF of Loveday et al. (1992) for the field elliptical galaxies. This GLF has been arbitrary normalized at eight galaxies for $R = 12.5$. We have used a distance modulus of 33.90 for the Coma cluster and we give the corresponding R band absolute magnitudes at the top of the figure. The number of galaxies per unit of magnitude is in the B95 field.

GLF at larger radii? If this phenomenon is localized to the few central 100 kpc of the cluster, the effect on the global GLF of the entire cluster will be limited to a correction of a few percent. Another question to address is do we see the same tendency in the clusters where we have only one giant dominant galaxy or none? In order to answer these questions, more spectroscopic data are required with at least a similar magnitude depth over a larger area of the Coma cluster and other clusters need to be studied as well.

5. Conclusion

We have used a sample of 88 redshifts along the B95 *los* to investigate the GLF in the Coma cluster core. We find that the only two faint Coma galaxies in our sample (R fainter than 19), are redder than the envelope of the CMR in the Coma cluster core. The explanation could be the confinement of the metal-rich gas of these galaxies by the intra-cluster medium. Alternatively, these two galaxies can also have formed from the recent disruption of old infalling galaxies.

We find that there are only a few galaxies in the Coma cluster with magnitudes fainter than $R=18.5$. The field counts of B95 predicted significantly more galaxies in the Coma cluster velocity field, but this can be explained by accidental superposition effects of 3 groups and 1 distant cluster along the B95 field *los*.

Using the spectroscopic counts to correct the GLF of B95, we find a nearly flat shape for this function for the magnitudes fainter than $R=17$ and possibly a turn-over in the GLF between $R \simeq 17$ and 21. This is likely due to environmental effects leading to the disruption of most of the faint galaxies by the two dominant galaxies of the Coma cluster core.

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