

# *UV* (2000 Å) luminosity function of Coma cluster galaxies

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**Abstract.** The *UV* (2000 Å) luminosity function (hereafter *UV* LF) of Coma cluster galaxies, based on more than 120 members, is computed as the statistical difference between counts in the Coma direction and in the field. Our *UV* LF is an up-date of a preliminary constrain on the *UV* LF previously computed without the essential background counts. The *UV* LF is well described by a power law with slope  $\alpha \sim 0.46$ , or equivalently, by a Schechter function with  $M^*$  much brighter than the brightest cluster galaxy and with a slope  $\alpha_S \sim -2.0$  or larger. In spite of what happens in the optical band, low luminosity galaxies give a large contribution to the integral luminosity, and by inference, to the total metal production rate. Galaxies blue in *UV* – *b* and/or *b* – *r* dominate the Coma cluster *UV* LF, both in number and luminosity. The major source of error in the estimate of the *UV* LF comes from the background determination in the Coma direction, which is still uncertain, even though constrained at high and low amplitudes by redshift surveys covering the studied field.

**Key words:** galaxies: elliptical and lenticular, cD – galaxies: spiral – galaxies: luminosity function, mass function – galaxies: clusters: individual: A1656

## 1. Introduction

In spite of the darkness of the sky at ultraviolet wavelengths (O’Connell 1987) and of the crucial role played by the *UV* emission in the determination of the metal production rate, the *UV* band is still one of the less explored spectral regions. This is even more true for objects in the local Universe, because non redshifted *UV* emission can be observed only from space. In both the single stellar population and continuous star formation scenarios, the *UV* luminosity of late-type galaxies appears to be largely dominated by young massive stars, thus implying a direct link between *UV* luminosities and star formation rates (e.g. Buzzoni 1989).

In recent years, the understanding that samples of galaxies at very high redshift can be selected from multicolor deep images (such as the *Hubble Deep Field*), has renewed the interest in *UV* observations, allowing tentative determinations of the *UV* luminosity function (hereafter LF) for galaxies at  $z > 2$

(Steidel et al. 1999, Pozzetti et al. 1998). In the local Universe, available samples of *UV* data for normal galaxies are generally not suitable for these types of studies due to either the lack of well defined selection criteria (see for instance the IUE sample reviewed in Longo & Capaccioli 1992) or to the optical selection of the objects. Exceptions to this rule are the samples produced by the FOCA experiment (Milliard et al. 1991) which allowed to derive, among various other quantities, the *local field UV* luminosity function (Treyer et al. 1998), and to constrain the *UV* luminosity function of galaxies in the Coma cluster (Donas et al. 1991, hereafter DML91).

In this paper we rediscuss the *UV* luminosity function (LF, hereafter) of galaxies in the Coma cluster, first explored by DML91. Since DML91 two important sets of data have been acquired: the sample of galaxies with known redshift in the Coma direction has increased by about 60%, and background counts in *UV*, essential for computing the LF, have been measured.

The paper is structured as follows: we first describe the data used (Sect. 2), then, we present the color–magnitude and color–color relations for galaxies in the Coma cluster direction (Sect. 3) and we show that the availability of colors does not help in identifying interlopers. In Sect. 4 we use field counts and the extensive redshift surveys in the Coma cluster direction to constrain background counts in the Coma direction and to derive the Coma cluster LF, presented in Sect. 5. In Sect. 6 we discuss the bivariate LF and, finally, in Sect. 7 we compare the Coma *UV* LF to the recently determined field LF. A summary is given in Sect. 8.

In this paper we adopt  $H_0 = 50 \text{ km s}^{-1} \text{ Mpc}^{-1}$ .

## 2. The data

Among nearby clusters of galaxies, Coma ( $v \sim 7000 \text{ km s}^{-1}$ ) is one of the richest ( $R = 2$ ) ones. At a first glance, it looks relaxed and virialized in both the optical and X-ray passbands. For this reason it was described by Sarazin (1986) and Jones & Forman (1984) as the prototype of this class of clusters. The optical structure and photometry at many wavelengths, velocity field, and X-ray appearance of the cluster (see the references listed in Andreon 1996) suggest the existence of substructures. Since these phenomena are also observed in many other clusters

(Salvador-Solé et al. 1993), the Coma cluster appears typical also in this respect.

Coma was observed in the  $UV$  with a panoramic detector (FOCA). Complementary data, are taken from Godwin et al. (1983; blue and red isophotal magnitudes designated here  $b$  and  $r$ , respectively) and Andreon (1996; radial velocities taken from the literature and updated for this paper by means of new NED entries and accurate morphological types).

The FOCA experiment consisted of a 40-cm Cassegrain telescope equipped with an ITT proximity focused image intensifier coupled to a IlaO photographic emulsion. The filter, centered at 2000 Å with a bandwidth of 150 Å, has negligible red leakage for objects as red as G0 stars and little dependence of the effective wavelength upon the object effective temperature. Observations of the Coma cluster were obtained with a field of view of 2.3 deg and a position accuracy of about 5 arcsec. The angular resolution of 20 arcsec FWHM was too coarse to allow an effective discrimination between stars and galaxies (for more details on the experiment see Milliard et al. 1991). The observations consisted of many short exposures, totaling 3000 s, and were obtained in April 1988. The galaxy catalog and details on the data reduction were published in DML91 and Donas et al. (1995, hereafter DML95).

Coma  $UV$  selected sample is found by DML95 to be complete down to  $UV \sim 17$ – $17.5$  mag and 70% complete in the range  $17.5 < UV < 18$  mag and includes only  $UV$  sources with at least one optical counterpart. Detected objects were classified by DML91 and DML95 as stars or galaxies according to their optical appearance.

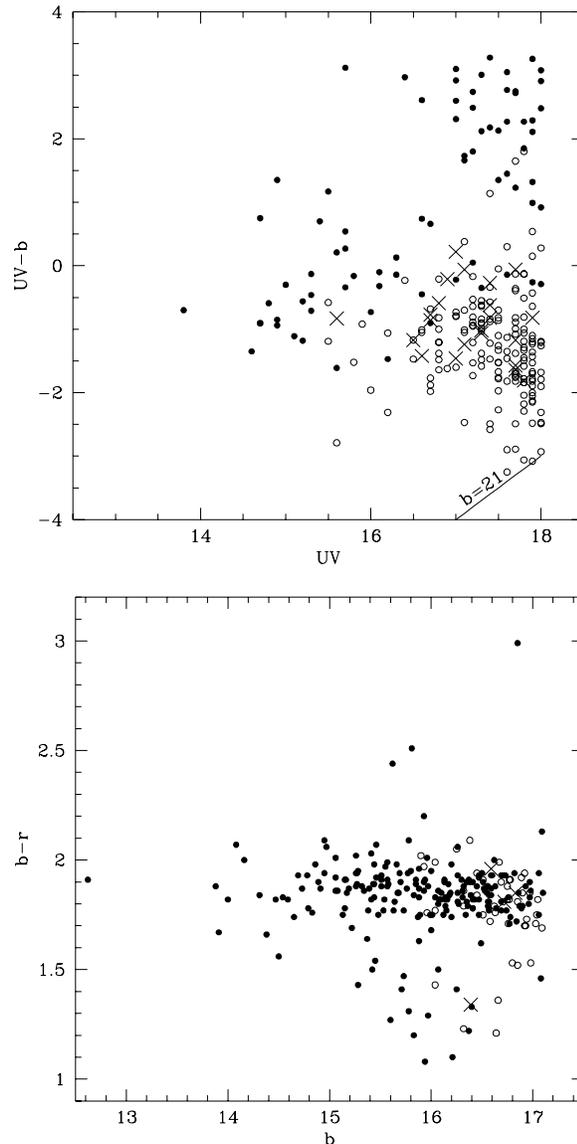
Following DML91, the  $UV$  magnitude is defined by the expression:  $UV = -2.5 \log(F_\lambda) - 21.175$  where  $F_\lambda$  is the flux in  $\text{ergs cm}^{-2} \text{Å}^{-1}$ . Typical photometric errors are 0.3 mag down to  $UV \sim 17$  mag and reach 0.5 mag at the detection limit  $UV \sim 18$  mag.

### 3. Color–magnitude and color–color diagrams

Fig. 1 (upper panel) shows the  $UV - b$  vs  $UV$  color–magnitude diagram for the 254 galaxies detected in the  $UV$  in the Coma field. This sample includes a larger number of galaxies with known redshift than in DML91, due to the numerous redshift surveys undertaken since 1991. We consider as Coma members only galaxies with  $4000 < v < 10000 \text{ km s}^{-1}$  (which is similar or identical to the criteria adopted by Kent & Gunn (1982), Mazure et al. (1988), Caldwell et al. (1993), Carlberg et al. (1996), Biviano et al. (1995), Andreon (1996), De Propris et al. (1998)).

Fig. 1 shows that only a few galaxies detected in  $UV$  are near to the optical catalog limit ( $b = 21$  mag), except at  $UV \sim 18$  mag, suggesting that only a minority of  $UV$  galaxies are missed because they are not visible in the optical<sup>1</sup>. This confirms the DML91 statement that the  $UV$  sample is truly  $UV$  selected, except maybe in the last half–magnitude bin.

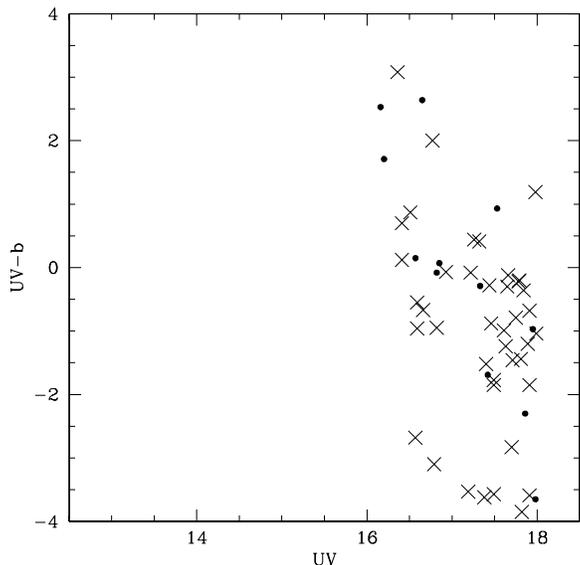
<sup>1</sup> We stress out that the  $UV$  galaxy catalog contains only sources with at least one optical counterpart, see DML95.



**Fig. 1.** Color-magnitude diagrams for galaxies in the Coma cluster direction. Filled circles are redshift confirmed members (galaxies with  $4000 < v < 10000 \text{ km/s}$ ), crosses are redshift confirmed background/foreground galaxies, open circles are galaxies with unknown redshift.

Many optically–faint and  $UV$ –bright galaxies have not measured redshift. The lower panel in Fig. 1 shows the optical  $b - r$  vs  $b$  color-magnitude diagram for the brightest (in  $b$ ) 254 galaxies in the same field. We have accurate morphological types for all galaxies brighter than  $b \sim 16.5$ – $17$  mag (Andreon et al. 1996, 1997). Coma early–type galaxies (i.e. ellipticals and lenticulars) have  $UV - b \sim 3$  mag and  $b - r \sim 1.8$  mag (DML95, Andreon 1996).

The comparison of the two panels in Fig. 1 shows several interesting features. First of all, bright  $UV$  galaxies are blue and not red, as is the case in the optical. In other words, early–type galaxies, due to their  $UV$  faintness, do not dominate the

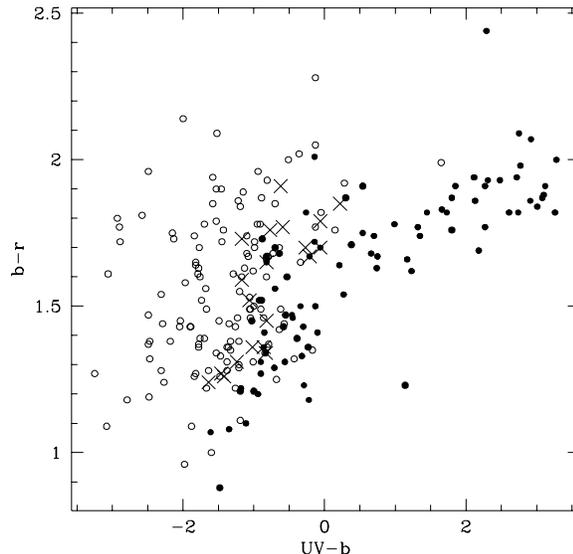


**Fig. 2.** Apparent color–magnitude diagram for field galaxies in a direction close to Coma. Symbols as Fig. 1. Only galaxies brighter than the Coma catalog limit are displayed.

$UV$  color–magnitude diagram. Red and blue galaxies are small fractions of the  $UV$  and optically selected samples, respectively.

Secondly, galaxies show a much larger spread in  $UV - b$  (7 mag for the whole sample, 6 mag for the redshift confirmed Coma members) than in  $b - r$  or in any other optical or optical–near–infrared color (see, for example, the compilation in Andreon (1996)). From the theoretical point of view, such a large scatter in color implies that the  $UV$  and  $b$  passbands trace the emission of quite different stellar populations. For all but the very old stellar populations, the  $UV$  traces mainly the emission from young stars (see for instance Donas & Deharveng 1984; Buat et al. 1989), having maximum main sequence lifetime of a few  $10^8$  years. Therefore, for star forming galaxies the  $UV$  is a direct measure of the present epoch star formation rate. Optical data provide instead a weighted average of the past to present star formation rate. The large scatter in color therefore implies that galaxies bright in  $UV$  are not necessarily massive, but more likely the most active in forming stars.

From the observational point of view, this large scatter in color is a problem, since deep optical observations are needed to derive optical magnitudes and hence colors (blue galaxies with  $UV = 18$  mag have  $b \sim 20$ – $21$  mag) or even for discriminating stars from galaxies. This limitation makes it difficult to characterize the properties of  $UV$  selected samples, such as, for instance, the optical morphology (a galaxy with  $UV = 18$  mag is bright and large enough to be morphologically classified only if it is quite red); the redshift (since they are usually measured from the optical emission or for an optically selected sample); the luminosity function of galaxies in clusters (the background subtraction is uncertain because the stellar contribution is difficult to estimate in the absence of deep optical imaging), etc. Furthermore, it is dangerous to limit the sample to galaxies with known redshift or morphological type, since, this would intro-



**Fig. 3.** Color–color diagram for galaxies in the Coma cluster direction. Symbols as in Fig. 1.

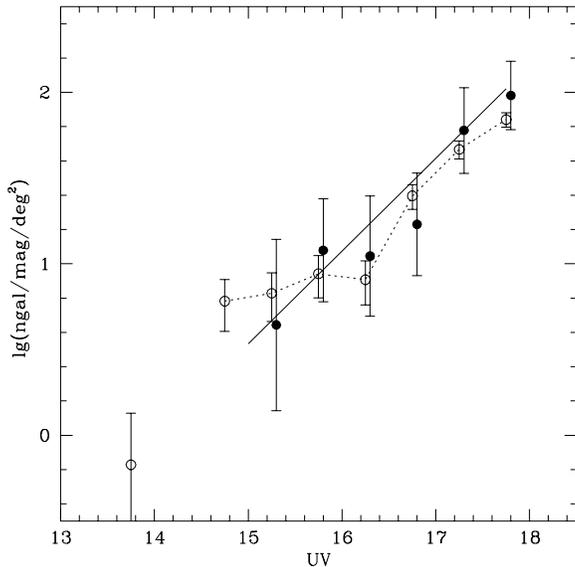
duce a selection criterion (mainly an optical selection) which has nothing to do with the  $UV$  properties of the galaxies.

Fig. 2 shows the color–magnitude diagram for the field in a direction that in part overlaps the Coma optical catalog provided by Godwin et al. (1983) and includes even a few members located in the Coma outskirts. Also these data were obtained with FOCA (Treyer et al. 1998). Most of the background galaxies have blue apparent colors, but with a large spread. Almost no background galaxies lay in the upper–right corner of the graph, i.e. no background galaxy is simultaneously very red ( $UV - b \sim 3$ ) and faint ( $UV \sim 17$ ). The selection criteria used by Treyer et al. (1998) for studying this sample are quite complex and galaxies with missing redshift (failed or not observed) are not listed, so that it is not trivial to perform a background subtraction in the color–magnitude plane (as is sometimes done in the optical; see, for instance, Dressler et al. 1994).

The color–color diagram of galaxies in the direction of Coma (Fig. 3) has already been discussed in DML95. But, in our sample, the number of galaxies having known membership is larger by 60% (from 61 to 99 galaxies). The diagram shows that background galaxies have colors overlapping those of known Coma galaxies, and, therefore, it is not of much use in discriminating members from non–members. This conclusion is strengthened by fragmentary knowledge of colors of  $UV$ –selected samples, which renders it premature to adopt a color selection criterion for the purpose of measuring the LF.

#### 4. Evaluation of background counts in the Coma direction

Since clusters are by definition volume–limited samples, the measure of the cluster LF consists of counting galaxies in each magnitude bin *after* having removed the interlopers, i.e. galaxies along the same line of sight but not belonging to the cluster. In general, interlopers can be removed in three different ways: by determining the membership of each galaxy throughout an



**Fig. 4.** Differential galaxy counts in the Coma cluster direction (open circles and dotted line) and in the field (closed points and solid line). Error bars of our Coma counts are simply  $\pm\sqrt{n}$ .

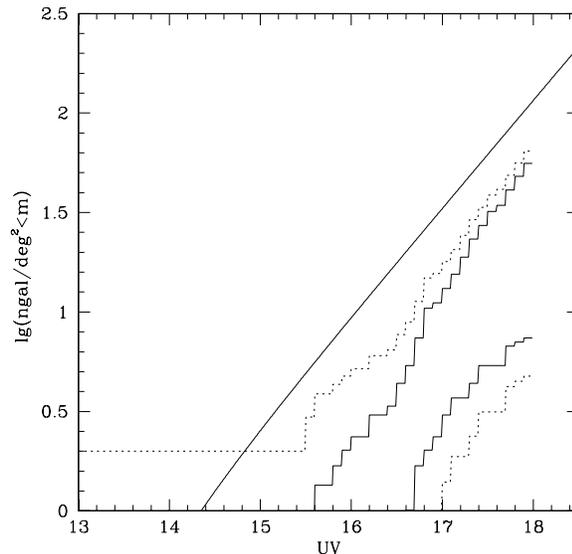
extensive redshift survey, by a statistical subtraction of the expected background contamination (see, for instance, Oemler 1974), or by using color–color or color–magnitude diagrams (see for instance, Dressler et al. 1994 and Garilli et al. 1999).

In our case, the available color information is not sufficient to discriminate members from interlopers, and surveys in the Coma direction available in literature are not complete down to the magnitude limit of our sample. Therefore we were forced to use a hybrid method to estimate and remove the background contribution.

Because the available membership information is qualitatively different for bright and faint galaxies, we consider them separately. For almost all galaxies brighter than  $M_{UV} = -19.7$  mag, redshifts are available in the literature, and interlopers can be removed one by one. For fainter galaxies we compute the LF from a statistical subtraction of the field counts, and, therefore, the largest source of error may come from possible large background fluctuations from field to field.

Milliard et al. (1992) present galaxy counts in three random fields, measured with the same experiment used to acquire the Coma data. One of the pointings is very near in the sky to the Coma cluster. The slope is nearly Euclidean for the total (i.e. galaxy+stars) counts ( $\alpha \sim 0.54$ ) with a small scatter among the counts in the three directions (roughly 10%). After removing the stellar contribution, galaxy counts have again a nearly Euclidean slope, but an amplitude which is half the previous one.

Dots in Fig. 4 show galaxy counts (i.e.  $n(m)$ ) in the Coma direction (we simply count all galaxies in each bin, open dots and dashed line in the figure) and the average of the three “field directions” (solid dots and solid line). At magnitudes fainter than  $UV = 16$  mag, galaxy counts in the Coma direction are *lower* than those in directions not including clusters of galaxies, although errorbars are quite large. At first sight, this plot



**Fig. 5.** Integrated galaxy counts in different directions: the expected counts in the field (solid line), the maximum background counts in the Coma cluster direction (upper solid histogram) and the minimum background counts (lower solid histogram). Dotted histograms are  $1\sigma$  confidence contours computed according to Gehrels (1986). At  $UV = 18$  mag histograms stop because the catalog is limited at that magnitude

is surprising: clusters are overdensities and therefore counts in their directions should be higher than field counts. However, this expectation is not necessarily correct in the  $UV$  band. Star formation is inhibited in the high density environments (Hashimoto et al., 1998, Merluzzi et al., 1999) and therefore counts in the direction of the cluster can be similar to, or even lower than, counts not having clusters on the line of sight. The  $UV$  luminosity is, in fact, a poor indicator for the galaxy mass.

Another possible explanation could be related to large errors and large background fluctuations from field to field. We discuss now in depth this point, taking advantage of the existence of redshift surveys available in the Coma cluster direction.

Fig. 5 shows *integral* counts (i.e.  $n(< m)$ ). The solid line is the integral of the solid line in Fig. 4, i.e. it gives the *expected integral* field galaxy counts. All other lines refer instead to true measurements in the Coma cluster direction. The lower solid histogram in Fig. 5 is the lower limit to the background in the Coma cluster direction, computed as the sum of the galaxies having (known) velocity falling outside of the assumed range for Coma. The upper solid histogram is the upper limit to the background in the Coma cluster direction, given, instead, as the sum of the galaxies outside of the assumed velocity range and the galaxies with unknown membership. The dotted lines are the  $1\sigma$  confidence contours, for the lower and upper limits, computed according to Gehrels (1986). They simply account for Poissonian fluctuations and show how large (or small) the real background could be (at the 68% confidence level) in order to observe such large (or small) counts. A background lower than the lower dotted histogram would produce too few (at the 68% confidence level) interlopers in the Coma cluster direction with respect to the observed ones; whereas a background

higher than the higher dotted histogram would imply (always at the 68% confidence level) a number of galaxies larger than the size of the sample (once the Coma members are removed). To summarize, in order to be consistent (at the 68% confidence level) with redshift surveys in the Coma direction, background counts in the Coma direction must be bracketed in between the two dotted histogram. Assuming smooth counts of nearly Euclidean slope, we consider the most extreme amplitudes for the background that are still compatible at the 68% confidence level with the two dashed histograms in at least one magnitude bin, and in what follow we call them “maximum+1 $\sigma$ ” and “minimum-1 $\sigma$ ”. Under the hypothesis of a nearly Euclidean slope, the background in the Coma direction turns out to be between 2.8 and 17.8 times smaller than the expectation shown by the line in Fig. 5. The expected field counts (i.e. the line in Fig. 5) are  $\sim 3\sigma$  away from the maximum background allowed by the Coma redshift survey (i.e. the upper solid histogram). This is an unlikely but not impossible situation, in particular when we take into account that the stellar contribution has been assumed and not measured in two background fields and that counts are slightly over-estimated, due to the presence of the Coma cluster and supercluster (Treyer et al. 1998) in the last field.

## 5. $UV$ luminosity function

In the previous section we derived an estimate for the background in the Coma cluster direction or, to be more precise, a range for the amplitude of background counts under the further assumption of nearly Euclidean slope for background counts. We can, therefore, statistically remove the background contribution and compute the faint end of the LF (at bright magnitudes the membership is known for each individual galaxy) and look at the dependence of the LF on the assumed values of the background amplitude. Therefore, the determination of the faint end of the LF still depends in part on the poorly known background counts, but much less than in DML91 since at that time the slope and the amplitude of the background contribution were almost unknown and it was left free to span over a range extending from almost all the data to zero.

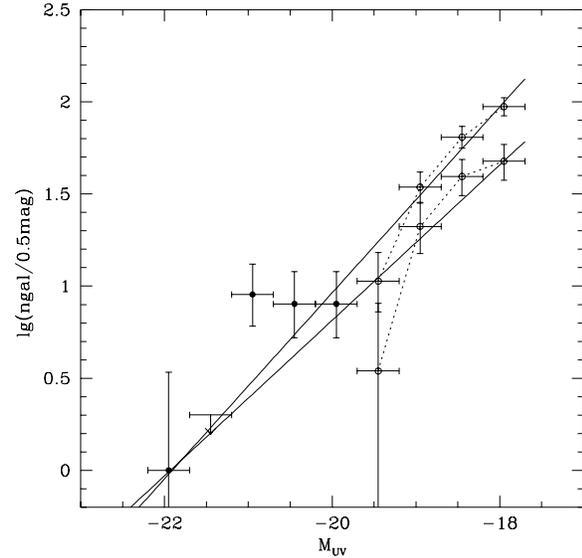
In order to clarify the error implied by our limited knowledge of the background counts, we compute twice the lower end of the LF, assuming a minimum-1 $\sigma$  background and a maximum+1 $\sigma$  one. The actual Coma  $UV$  LF is bracketed in between.

We made use of a maximum-likelihood method (Press et al. 1992) to fit the differential LF of Coma with a Schechter (1976) or power law functions:

$$f(m) = \phi^* 10^{0.4(\alpha_S+1)(m^*-m)} \exp(-10^{0.4(m^*-m)})$$

$$f(m) = k 10^{\alpha m}$$

The most important advantage of the maximum-likelihood method is that it does not require us to bin the data in an arbitrarily chosen bin size and works well also with small samples where the  $\chi^2$  fitting is not useful. It also naturally accounts for lower limits (bins with zero counts if data are binned).



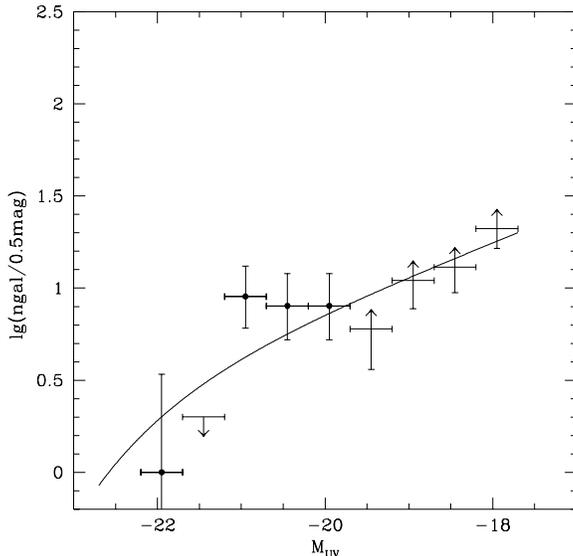
**Fig. 6.** The  $UV$  luminosity function of Coma cluster galaxies. Data in this plot are arbitrarily grouped in 0.5 mag bins for presentation purposes only, but in the analysis we used non binned data. Error bars in the ordinate direction and upper limits are  $\pm 1\sigma$  and are computed according to Gehrels (1986). Error bars in the abscissa direction show the bin width. Lines are best fit with a power law. Details in the text.

The maximum likelihood method leaves the normalization factor undetermined (since it is reduced in the computation). We therefore derived it by requiring that the integral of the best fit is equal to the observed number of galaxies. In our case we have 125 and 233 galaxies in the Coma sample, depending on the adopted background subtraction.

The Coma cluster  $UV$  LF - the first ever derived for a cluster - is shown in Fig. 6. Error bars are large, and only the rough shape of the LF can be sketched.

The Coma  $UV$  LF is well described by a power law (or alternatively by a Schechter function with a characteristic magnitude  $M_{UV}^*$  much brighter than the brightest galaxy): a Kolmogorov-Smirnov test could not reject at more than 20% confidence level, the null hypothesis that the data are extracted from the best fit (whereas we need a 68% confidence level to exclude the model at  $1\sigma$ ). The best slope is  $\alpha = 0.42 \pm 0.03$  and  $\alpha = 0.50 \pm 0.03$  assuming a maximum+1 $\sigma$  and minimum-1 $\sigma$  background contamination, respectively. In terms of the slope of the Schechter (1976) function  $\alpha_S$ , these values are -2.06 and -2.26 respectively. The exact value of the background amplitude, once bound by redshift surveys, have small impact on the slope of the LF, which is quite steep. The Coma  $UV$  LF is steeper than the optical LF, ( $\alpha_S \sim -1.0$ , from 5000 Å to 8000 Å, Garilli et al. 1999), when computed within a similar range of magnitudes (i.e. at  $M_3 + 3$ , where  $M_3$  is the magnitude of the 3th brightest galaxy of the cluster).

It needs to be stressed, however, that the computed slope of the LF depends on the assumption of a nearly Euclidean slope for galaxy counts (the amplitude is constrained by the redshift survey). We now measure the effect of neglecting this hypothesis.

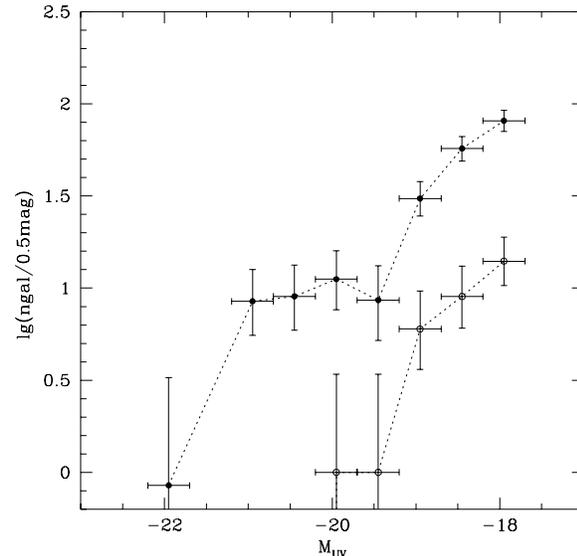


**Fig. 7.** Very low limit to the  $UV$  luminosity function of Coma cluster galaxies. Only redshift confirmed members have been considered and we have no more assumed a nearly Euclidean slope for background counts. Data in this graph are arbitrary binned by 0.5 mag for presentation purposes, but in the analysis we use unbinned data. Errorbars are as in previous figure. The line is the best fit with a Schechter (1976) function.

A very low limit to the slope of the Coma LF can be computed under the extreme assumption that all galaxies not confirmed as Coma members (i.e. all galaxies without known redshift and those with redshifts outside the velocity range of Coma members) are actual interlopers. The resulting LF is shown in Fig. 7. No matter how large and how complex the shape of background counts in the Coma direction is, this estimate provides the very low limit to the slope of the Coma LF because galaxies with unknown membership are only faint, and they could only raise the faint part of the LF. In such an extreme case, we find  $M_{UV}^* = -22.6$  mag, brighter than the brightest cluster galaxy. Fitting a power law, we find instead  $\alpha = 0.21 \pm 0.04$ . Even in this case, however, the slope is larger than what is found in the optical (at  $M_3 + 3$ ). This LF is computed with no assumption about the shape of the background counts.

This LF is unlikely to be near to the “true” Coma  $UV$  LF, because the assumption that all galaxies with unknown redshift are interlopers is unrealistic and implies an over-Euclidean slope ( $\alpha \sim 0.75$ ) for the background, which is much steeper than those observed in the three field pointings by Milliard et al. (1992). Nevertheless, this very low limit LF gives the very minimum slope for the Coma  $UV$  LF,  $\alpha_S = -1.45$ .

The steep Coma  $UV$  LF implies that faint and bright galaxies give similar contributions to the total  $UV$  flux, and that the total  $UV$  flux has not yet converged 4 magnitudes fainter than the brightest galaxy (or, which is the same, at  $M_3 + 3$ ). Therefore, in order to derive the total luminosity and hence the metal production rate, it is very important to measure the LF down to faint magnitude limits.



**Fig. 8.** Bivariate luminosity function of Coma galaxies. Close points refer to blue ( $UV - b < 1.7$ ) galaxies, open points refer to red ( $UV - b > 1.7$ ) galaxies. For sake of clarity, upper limits are not drawn. Errorbars are as in the previous figure.

## 6. Bivariate LF

Since the redshift information is quite different for blue ( $UV - b < 1.7$ ) and red ( $UV - b > 1.7$ ) galaxies, the two  $UV$  LFs are computed in different ways. Redshifts are available for all the red galaxies (which all belong to the cluster) and the respective  $UV$  LF is easy to compute. Almost all blue galaxies brighter than  $M_{UV} \sim -20$  mag have known redshift, and therefore the determination of this part of the blue LF is quite robust. For the faint part of the blue LF, we adopt an “average” background, given as the average normalization between the maximum  $+1\sigma$  and minimum  $-1\sigma$  backgrounds previously computed.

The resulting bivariate color–luminosity function is given in Fig. 8. The bulk of the  $UV$  emission comes from blue ( $UV - b < 1.7$ ) galaxies while all red galaxies have  $M_{UV} > -20$  mag. Therefore, since blue galaxies dominate the  $UV$  LF both in number and luminosity, the Coma  $UV$  LF is dominated by star forming galaxies and not by massive galaxies. From previous morphological studies (Andreon 1996) it turns out that Coma red galaxies in our sample are ellipticals or lenticulars. The fact that early-type galaxies contribute little to the  $UV$  LF may be explained as a consequence of the fact that these systems have a low recent star formation histories. Please note that in the optical, the LF is dominated at the extreme bright end by the early-type (i.e. red) galaxies (Binggelli et al. 1988, Andreon 1998), and not by blue ones as it is in  $UV$ .

## 7. Comparison with the $UV$ field LF

The  $UV$  LF of field galaxies has been recently measured by Treyer et al. (1998) in a region close to Coma, where they found  $\alpha_S = -1.62_{-0.21}^{+0.16}$ ,  $M_{UV}^* = -21.98 \pm 0.3$  mag for a sample of 74 galaxies. As pointed out by Buzzoni (1999), this slope is

quite different from that assumed for the distant field galaxies by Madau (1997).

Is there any significant difference between the Coma cluster and the field *UV* LFs? The best Schechter fit to the field data satisfactorily matches both the very low limit of the Coma LF and the Coma data after the subtraction of the maximum+1 $\sigma$  background contribution (the probability of a worse fit is 0.1, according to the Kolmogorov-Smirnov test, whereas we need a probability of 0.05 to call the fit worse at 2 $\sigma$ ), but does not in the case of minimum−1 $\sigma$  background contribution (the probability of a worse fit is 0.00078, according to the same test, i.e. the two LF differ at  $\sim 4\sigma$ ). However, using  $\alpha_S - 1\sigma$  instead of  $\alpha_S$  for the field LF, the fit to the Coma data cannot be rejected with a probability larger than 0.02, i.e., the 1 $\sigma$  confidence contour of the field LF crosses the  $\sim 2\sigma$  confidence contour of the Coma LF. Therefore, given the available data, Coma and field *UV* LFs are different at 2–3 $\sigma$  at most. Given the large errors involved, the field and cluster LFs results are therefore compatible with each other.

## 8. Conclusions

The analysis of *UV* and optical properties of Coma galaxies is indicative of the difficulties encountered in studying *UV* selected samples: background galaxy counts are uncertain (as well as their variance); the background contamination in the *UV* color–magnitude plane is poorly known. In spite of these difficulties we found:

- 1) galaxies in Coma show a large range of *UV*–optical color (6–7 mag), much larger than what is observed at other redder passbands.
- 2) Blue galaxies are the brightest ones and the color–magnitude relation is not as outstanding as it is at longer wavebands. Early-type or red galaxies are a minority in the Coma *UV* selected sample. In *UV*, the brightest galaxies are the most star forming galaxies and not the more massive ones.
- 3) In spite of the rather large errors, the *UV* LF discussed here is the first LF ever derived for a cluster. The major source of error in estimating the *UV* LF comes from the field to field variance of the background, that it is subtracted statistically. Present redshift surveys in the studied field constrain at high and low amplitudes the background contribution in the Coma direction, as shown in Fig. 5. The Coma *UV* LF is steep and bracketed between the two estimates shown in Fig. 6, with a likely Schechter slope in the range  $-2.0$  to  $-2.3$ . Even under the extreme hypothesis that all galaxies with unknown membership are interlopers, the very minimum slope of the UV-LF is  $\alpha_S \lesssim -1.45$ .
- 4) The steep Coma *UV* LF implies that faint and bright galaxies give similar contributions to the total *UV* flux, and that the total *UV* flux has not yet converged 4 magnitudes fainter than the brightest galaxy (or, which is the same, at  $M_3 + 3$ ). Therefore, in order to derive the total luminosity and hence the metal production rate, it is very important to measure the LF down to fainter magnitude limits.
- 5) The Coma *UV* LF is dominated in number and luminosity by blue galaxies, which are often faint in the optical. Therefore

the Coma *UV* LF is dominated by star forming galaxies, not by massive and large galaxies.

- 6) The Coma *UV* LF is compatible with the field LF at  $\sim 2-3\sigma$ .

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