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Total Magnitudes of Virgo Galaxies. II. An Investigation into the m_p Scale of Volume I of Zwicky et al.'s Catalogue of Galaxies and of Clusters of Galaxies

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Abstract: We investigate the photographic-magnitude (m_p) scale of Volume I of the *Catalogue of Galaxies and of Clusters of Galaxies* for galaxies in the Virgo direction. It is found that for $11.5 \le B_t < 14.5$, the m_p values listed correspond very closely (with a scatter of only 0.16 magnitude) to blue magnitudes measured to the $\mu_B = 24.4$ isophote. If m_p values need to be used as estimates of total blue magnitude the scatter is 0.27 magnitude over the same range in B_t and the mean offset is $m_p - B_t = 0.28$ magnitude. However, a serious scale error at the bright end causes both the isophotal and total luminosities of galaxies brighter than $B_t \sim 11.5$ to be severely underestimated. At the faint end there also appears to be a significant scale error. This causes galaxy luminosities to be seriously overestimated faintward of $B_t \sim 14.5$. We demonstrate that this is a real effect based on a detailed galaxy-by-galaxy study of the catalogue's completeness down to $B_t = 17.0$. The catalogue is found only to be complete to $B_t \sim 14.7$ whilst its degree of incompleteness is found to be relatively constant at the 30% level over the range $14.75 \le B_t < 15.75$. Most of the missing objects are found to be elliptical galaxies and so late-type objects are over-represented at the faint end.

Keywords: catalogues — galaxies: clusters: individual (Virgo) — galaxies: fundamental parameters — galaxies: photometry

1 Introduction

Zwicky et al.'s (Volume I: Zwicky, Herzog & Wild 1961; Volume II: Zwicky & Herzog 1963; Volume III: Zwicky & Herzog 1966; Volume IV: Zwicky & Herzog 1968; Volume V: Zwicky, Karpowicz & Kowal 1965; Volume VI: Zwicky & Kowal 1968) *Catalogue of Galaxies and of Clusters of Galaxies* (hereunder CGCG) is still one of the most important sources of magnitude measurements of bright galaxies. Its m_p values are now, however, seldom used without the prior application of transformation equations. As B–band total magnitudes of galaxies are used for a large number of applications (e.g. galaxy luminosity functions), most studies of the CGCG's magnitude scales to date have therefore been concerned with whether m_p values can reliably be transformed into B–band total magnitude estimates. This is in spite of the fact that, in their introduction to Volume I, Zwicky et al. (1961) did not actually claim m_p values to be estimates of total apparent luminosity.

As reviewed by Bothun & Cornell (1990), there has long been much debate over the reliability of the CGCG's magnitude measurements, particularly at the faint end. Also, the situation appears to be complicated by systematic differences between individual volumes of the catalogue, as noticed by Kron & Shane (1976) and Takamiya, Kron & Kron (1995). Such issues clearly have implications for the self-consistency of magnitude scales based on transformed m_p values such as those of the *Reference Catalogue*s *of Bright Galaxies* of de Vaucouleurs, de Vaucouleurs & Corwin (1976) and de Vaucouleurs et al. (1991).

In this paper we investigate the degree of completeness of the CGCG as a function of magnitude as well as the nature of the CGCG magnitude scale, with the benefit of the new Virgo galaxy dataset of reliable total-magnitude measurements and detailed luminosity profile information presented in Paper I of this series by Young (2001). Most of Virgo is covered by Volume I of the CGCG, but the northern extremity ($\delta \ge 14°30'$) is covered by Volume II. As most of our sample galaxies are Volume I objects, our investigations are limited primarily to Volume I.

2 Our Galaxy Samples and CGCG Completeness

The *Virgo Photometry Catalogue* (VPC) of Young & Currie (1998), which is complete to $B_{J_{25}} = 18.0$ magnitude over the whole of its survey area of 23 deg^2, can

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Table 1. Completeness of the CGCG within the VPC survey area as a function of B_t, see text for definitions of galaxy-samples C_I and C_{II}

	Volume I			Volume II		
B_t range (mag.)	$N_{C_I}^{CGCG}(B_t)$ (objects)[1]	$N_{C_I}^{VPC}(B_t)$ (objects)[2]	completeness (%)	$N_{C_{II}}^{CGCG}(B_t)$ (objects)[1]	$N_{C_{II}}^{VPC}(B_t)$ (objects)[2]	completeness (%)
$B_t < 14.0$	57	57	100	11	11	100
$14.0 \leq B_t < 14.5$	16	16	100	3	4	75
$14.5 \leq B_t < 15.0$	9	12	75	4	4	100
$15.0 \leq B_t < 15.5$	10	14	71	2	4	50
$15.5 \leq B_t < 16.0$	17	25	68	0	0	N/A
$16.0 \leq B_t < 16.5$	10	41	24	0	8	0
$16.5 \leq B_t < 17.0$	2	51	4	0	9	0
overall total	121	216	56	20	40	50

Notes: (1) The number of CGCG-listed objects in galaxy-sample C_I or C_{II} (where a subscript I denotes Volume I and a subscript II denotes Volume II). (2) The total number of VPC–listed objects in galaxy-sample C_I or C_{II} including objects omitted from the CGCG (where a subscript I denotes the Volume I survey area and a subscript II denotes the Volume II survey area). This quantity is also the galaxy-sample size on which the corresponding completeness ratio is based.

be used in order to investigate the completeness of Volume I of the CGCG to $B_t = 17.0$ as a function of B_t. It is however, only of limited use in investigating the completeness of Volume II of the CGCG, because most of the VPC survey area lies within the area of sky covered by Volume I. Note that no parts of the VPC survey area lie exterior to those (much larger) areas of sky covered by Volumes I and II of the CGCG and that all CGCG-listed objects lying within the VPC survey area are also listed in the VPC.

For the purpose of studying the CGCG's completeness as a function of B_t, we required a large and complete galaxy sample including every object down to a specified limiting B_t value (that was considerably fainter than the faint-end limit of the CGCG) within a clearly defined area of the sky. Precise B_t values were not essential for every galaxy, and especially at the bright end (where the CGCG could be expected to be 100% complete) some B_t estimates of lower accuracy could be tolerated. However, for the purposes of investigating the CGCG's magnitude scale, only CGCG-listed objects with reliable photometry could be invoked. In order to make optimum use of the data available, we therefore defined two overlapping samples of galaxies for the area of sky covered by Volume I and a further two for the area of sky covered by Volume II, hereunder C_I & M_I and C_{II} & M_{II} respectively. Each Sample C was defined as the set of all galaxies to be used for the CGCG-completeness study, whilst each sample M was defined as the set of all galaxies to be used for the CGCG magnitude-scale studies.

Each Sample C comprised all galaxies listed in the VPC (regardless of whether they are listed in the CGCG or not) which we found to be brighter than $B_t = 17.0$, approximate B_t values having been derived for those objects lacking B_t measurements in the VPC or in Tables 2 and/or 3 of Paper I. For 10 Volume I objects — VPC 64, 99, 159, 171, 242, 379, 505, 863, 878, and 953 — B_{J_t} values are listed in the VPC but B_t values are not,[1] and so the approximation

$$B_t \sim B_{J_t} + 0.35\,(B - V) \tag{1}$$

(with $(B - V)$ set to 0.8 magnitude) was used. For the outstanding high surface-brightness VPC objects for which Young & Currie's (1998) B_J–band photometry was saturated, and for which the VPC therefore does not list B_t or B_{J_t} values, rougher approximations were necessary. These were based on the $B_{J_{25}}$ (B_J–band isophotal magnitude measured to the $\mu_{B_J} = 25.0$ mag.arcsec^{-2} isophote) values listed in the VPC, but most of which were for the bright objects in question based on various sources of magnitude measurements external to the VPC (that are not necessarily of high accuracy and will be investigated in future papers in this series). For these galaxies, we obtained estimates of B_t from Equation 1 (also with $(B - V)$ set to 0.8 magnitude) and

$$B_{J_t} \sim B_{J_{25}} - 0.35\,\text{mag}. \tag{2}$$

(this latter offset being the VPC's mean B_J–band extrapolation). This was of course equivalent to

$$B_t \sim B_{J_{25}} - 0.07\,\text{mag}. \tag{3}$$

and enabled the CGCG's completeness to be quantified as a function of B_t, as documented in Table 1. The galaxy VPCX 50 was also taken into consideration using Equation 3.

The total number of VPC galaxies brighter than $B_t \sim 17.0$ was found to be 256. Of these, 216 were found to

[1]The absence of B_t values in the VPC in such cases is normally on account of the relevant galaxy images overlapping with adjacent images, thus preventing reliable colour determinations on which the B_J to B transformations are based.

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lie within the area of the sky covered by Volume I of the CGCG, whilst only 40 were found to lie within the area covered by Volume II. Galaxies not listed in the CGCG were flagged and divided into would-be Volume I and would-be Volume II objects. The brightest sample object found to be omitted from Volume I is VPC 800 ($B_t \sim 14.7$), whilst the brightest object omitted from Volume II is VPC 283 ($B_t \sim 14.4$).

Each Sample M on the other hand, comprised only of CGCG objects for which reliable B_t measurements are listed in the VPC or Tables 2 and/or 3 of Paper I. Note that not all of the objects listed in Table 3 of Paper I lie within the VPC survey area, but that all of these objects lie within the areas of sky covered by Volumes I and II of the CGCG. At the faint end, it was found that 34 galaxies for which B_t values are listed in the VPC correspond to CGCG objects. As all of the 58 objects listed in Tables 2 and 3 of Paper I are listed in the CGCG, the combined sample comprised 92 galaxies in total, of which 90 were Volume I objects whilst only two were Volume II ones.

For any galaxy of $B_t < 17.0$ then, the following rules determined which subset of each Samples C and/or M it belonged to; the overlap region between each Sample C and M being denoted $C \cap M$, and subsets of C and M not overlapping with M and C respectively being denoted $C \backslash M$ and $M \backslash C$ respectively.

• Reliable B_t available from VPC or Tables 2 and/or 3 of Paper I?
NO: Member of $C \backslash M$.
YES: • Galaxy listed in CGCG?
NO: Member of $C \backslash M$.
YES: • B_t available from Table 3 of Paper I?
NO: Member of $C \cap M$.
YES: • Galaxy outside VPC survey area?
NO: Member of $C \cap M$.
YES: Member of $M \backslash C$.

Bearing in mind that the brightest object found to be omitted from Volume I of the CGCG is of $B_t \sim 14.7$, on the basis of Table 1 we can say that Volume I of the CGCG is only about 70% complete over the range $14.75 \leq B_t < 15.75$. Furthermore, we find that late-type galaxies are heavily over-represented faintward of the CGCG's completeness limit. In fact, out of the 43 VPC galaxies for which $14.5 \leq B_t < 16.5$ but which were omitted from the CGCG, only four are listed as irregulars, probable irregulars or spirals in the VPC and one as a BCD. Apart from a further six whose types are unknown, the remaining 32 are all early-type objects (29 ellipticals, two lenticulars and one probable lenticular). We take this to be evidence that the CGCG selection criteria were heavily morphology dependent at the faint end, at least for Volume I. Unfortunately, our galaxy sample is not extensive enough to be able to confirm this finding with confidence for Volume II.

3 Isophotal magnitudes

Isophotal magnitudes were generated for all 92 Sample M_I and M_{II} objects by integrating the best-fitting Sérsic (1968) profile parameters, as listed in Table 3 of Paper I or in the VPC, to isophotes of one's choice. B–band profile parameters were used when available. Otherwise, preference was given to B_J–band profile parameters over U–band ones. For most objects in Table 2 of Paper I however, only U–band parameters were available. In order to transform non-B–band parameters to B–band ones, it was necessary to work out $X = B_t - B_{J_t}$ or $X = B_t - U_t$ as appropriate, and to add X to the extrapolated central surface brightness ($\mu_{B_{J0}}$ or μ_{U_0} respectively) before performing the integrations to the chosen limiting isophote. In the cases of the B–band profile parameters listed in Table 3 of Paper I, all luminosity excesses or deficits with respect to the best-fitting Sérsic model were taken into account by evaluating $Y = B_t(\text{integ.}) - B_t(\text{syst.})$ and adding Y to μ_{B_0}, after integration. The integrals to the limiting isophotes were performed numerically using the compound form of Simpson's rule and 2000 intervals spanning the range $r = 0$ and the mean (i.e. azimuthally averaged) radius of the limiting isophote.

In order to evaluate which limiting isophote would yield isophotal magnitudes most closely resembling the CGCG's m_p values, we measured both the mean $m_p - B$(isophotal) offset and the scatter as a function of limiting isophote. Over the total-magnitude range $11.5 \leq B_t < 14.5$, it was found that using a limiting isophote of $\mu_B = 24.5$ mag.arcsec^{-2} minimised the mean $m_p - B$(isophotal) offset to -0.005 magnitude with a scatter of 0.163 magnitude; whilst using a limit of $\mu_B = 24.3$ mag.arcsec^{-2} minimised the scatter to 0.159 magnitude with a mean $m_p - B_{24.3}$ offset of -0.025 magnitude. However, we have adopted the intermediate limiting isophote of $\mu_B = 24.4$ mag.arcsec^{-2}, because as shown in Figure 1, this offers a scatter of only 0.160 magnitude and a mean $m_p - B_{24.4}$ offset of only -0.01 magnitude. The choice of the bright-end limit to our B_t range avoids the scale error that is clearly visible brightward of $B_t \sim 11.5$ in Figure 1. Our faint-end limit on the other hand was necessitated by the CGCG's increasing incompleteness faintward of $B_t \sim 14.7$ as well as the CGCG's faint-end limit (which is responsible for the absence of data points in the upper right-hand corner of Figure 1).

The consistency of these results appears to confirm that m_p values are essentially B–band isophotal magnitudes (except at the bright and faint ends of the magnitude scale) and that no colour transformation is necessary. Note that there is no conflict with the main conclusion of Bothun & Cornell (1990) whose finding that 'Zwicky magnitudes are *not* very isophotal in nature' was restricted to galaxies for which $m_p \geq 14.0$ magnitude.

Should one wish to convert m_p values into $B_{24.4}$ ones over the whole magnitude range covered by the CGCG, one would need to consider the case shown in Figure 2 in which $B_{24.4}$ is the dependent variable plotted as a function of m_p. Bright-end and faint-end transformations were derived here by fitting straight lines constrained to pass through the points (12.0, 12.0) and (14.7, 14.7)

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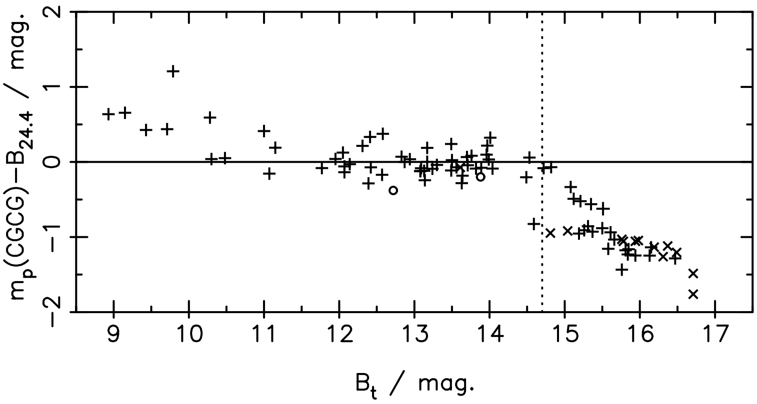

Figure 1 The differences between m_p and $B_{24.4}$ for the 92 Sample M_I and M_{II} galaxies, shown as a function of B_t in order to enable direct comparisons with Figure 3. Objects listed in Volume II of the CGCG are plotted as '◦' symbols, whilst Volume I objects are plotted as '+' symbols if cluster members or '×' symbols if background objects. The dotted line represents the measured completeness limit of Volume I in B_t space ($B_t \sim 14.7$).

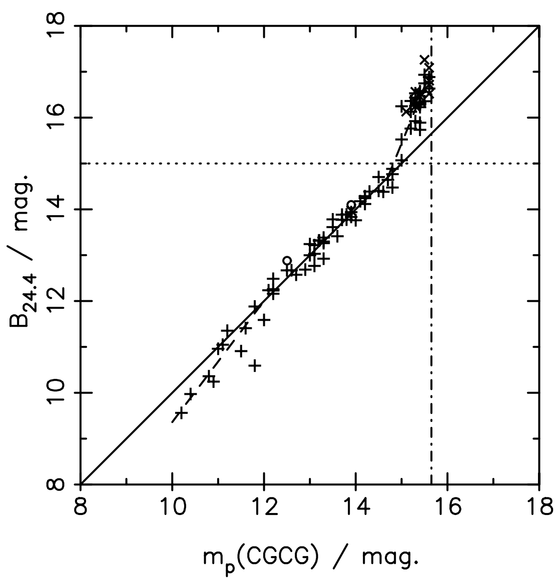

Figure 2 $B_{24.4}$ as a function of m_p for the 92 Sample M_I and M_{II} galaxies. Objects listed in Volume II of the CGCG are plotted as '◦' symbols, whilst Volume I objects are plotted as '+' symbols if cluster members or '×' symbols if background objects. The dashed lines represent the suggested m_p-to-$B_{24.4}$ transformations for Volume I objects over the ranges $10.0 < m_p \leq 12.0$ magnitude and $14.7 \leq m_p \leq 15.6$ magnitude (Equations 4 and 6 respectively). Note that the apparent scale error at the faint end must be real because the datapoints are concentrated away from the dashed-dotted line, which represents the CGCG's $m_p \leq 15.6$ cut-off. The dotted line represents the estimated completeness limit of Volume I in $B_{24.4}$ space and is based on the approximation $B_{24.4} \sim B_t + 0.3$ magnitude.

respectively. Both fits were unweighted[2] and based on Volume I objects only. The m_p-to-$B_{24.4}$ transformations obtained were:

for $m_p \leq 12.0$ (with a scatter of 0.42 magnitude):

$$B_{24.4} = -3.82 + 1.319 m_p; \quad (4)$$

for $12.0 \leq m_p \leq 14.7$ (with a scatter of 0.16 magnitude):

$$B_{24.4} = m_p; \quad (5)$$

and for $14.7 \leq m_p$ (with a scatter of 0.31 magnitude):

$$B_{24.4} = -21.52 + 2.464 m_p. \quad (6)$$

4 Estimating B_t from m_p

The differences between the CGCG magnitudes and the B_t values of the dataset defined in Paper I are shown in Figure 3. From this figure it is clear that there is a very large scale error at the bright end, which causes the CGCG to severely underestimate the luminosities of objects brighter than $B_t \sim 11.5$ magnitude, by of the order of 1.0 magnitude with respect to the B_t scale at $B_t \sim 10.0$ magnitude, and more than 1.5 magnitude at $B_t \sim 9.0$ magnitude. Over the range $11.5 \leq B_t < 14.5$ we find that the difference between the two magnitude scales is relatively constant with a mean $m_p - B_t$ offset of 0.28 magnitude. However, the scatter of 0.27 magnitude is relatively large and the distribution of data points with respect to the line defining the mean offset is certainly not Gaussian. In fact, it actually shows a tendency towards bimodality suggestive of significant systematic differences between the very natures of the m_p and B_t scales.

Should one wish to convert m_p values into B_t ones over the whole magnitude range covered by the CGCG, one would need to consider the case shown in Figure 4 in which B_t is the dependent variable plotted as a function of m_p. An unweighted third-degree polynomial was found to be more than adequate here. The transformation equation obtained, which was based on Volume I objects only but applies to the entire magnitude range of Volume I of the CGCG (with a scatter of 0.45 magnitude), was

$$B_t = -110.39 + 26.194 m_p - 1.9231 m_p^2 + 0.048948 m_p^3. \quad (7)$$

[2]Realistic weighting schemes are problematic in these cases. One certainly cannot assume that $\sigma_{B_{24.4}}$ increases in a predictable manner with magnitude.

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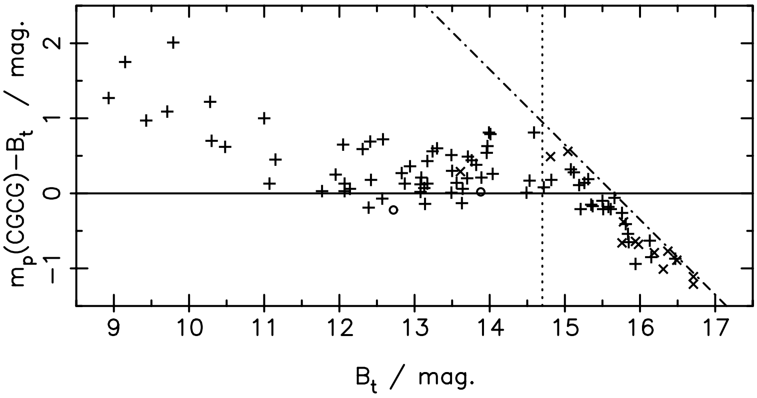

Figure 3 The differences between m_p and B_t for the 92 Sample M_I and M_{II} galaxies. Objects listed in Volume II of the CGCG are plotted as 'o' symbols, whilst Volume I objects are plotted as '+' symbols if cluster members or '×' symbols if background objects. The dotted line represents the measured completeness limit of Volume I in B_t space ($B_t \sim 14.7$), whilst the dashed-dotted line represents the CGCG's faint-end limit of $m_p \leq 15.6$ magnitude.

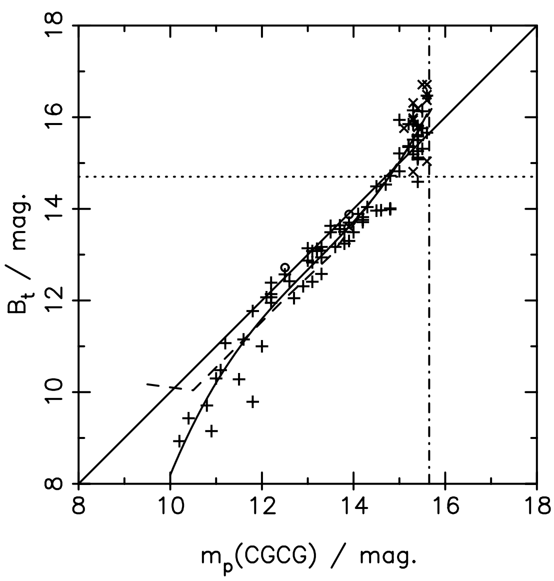

Figure 4 B_t as a function of m_p for the 92 Sample M_I and M_{II} galaxies. Objects listed in Volume II of the CGCG are plotted as 'o' symbols, whilst Volume I objects are plotted as '+' symbols if cluster members or '×' symbols if background objects. The solid curve represents our suggested m_p to B_t transformation for Volume I objects (Equation 7), whilst the dashed curve represents Kron & Shane's (1976) suggested corrections to Volume I m_p values. Faintward of $B_t \sim 14$, the two curves are barely distinguishable. The dashed-dotted line represents the CGCG's $m_p \leq 15.6$ cut-off whilst the dotted line represents the measured completeness limit of Volume I in B_t space ($B_t \sim 14.7$).

As shown in Figure 4, this transformation is in excellent agreement with Kron & Shane's (1976) suggested corrections to Volume I m_p values at the faint end, though the agreement is less good elsewhere.

5 Estimating m_p from B_t

Should one wish to estimate m_p values for would-be CGCG objects not actually listed in the catalogue, it would first be necessary to ascertain whether the m_p scale suffers from a genuine faint-end scale error. This is not a trivial problem because, as is evident from Figure 3, the hard faint-end limit of the CGCG makes it difficult to deduce how much of the skewness in the faint-end distribution of data points (with respect to the equality line) is due to noise and how much is due to scale errors. If one now considers the case shown in Figure 5 in which m_p is the dependent variable plotted as a function of B_t, we would need information about 'missing' points above the dashed-dotted line representing the hard faint-end limit of the m_p scale, in order to be able to pursue our investigation to the right of the dotted line, representing the $B_t \sim 14.7$ magnitude measured completeness limit of the CGCG.

One approach to the problem is that adopted by Gaztanaga & Dalton (2000), in which one assumes that the data points define a Gaussian distribution about a straight line defining the magnitude scale at the faint end on a graph analogous to Figure 3. The main limitation with this method is that it is difficult to know a priori whether a straight line is a good approximation or not to the magnitude scale. Also, one needs very large samples of CGCG objects and even then, it is difficult to probe much deeper than $B_t \sim 15.75$, beyond which the locus of data points becomes too detached from the equality line for one to be able to get a good handle on the parameters of the Gaussian distribution.

Although our faint-galaxy sample is considerably smaller than that of Gaztanaga & Dalton (2000), thus ruling out the use of their method here, we were able to probe as deep as $B_t = 16.0$ without the need for a straight-line approximation. This was possible because, within the VPC survey area at least, we knew precisely the CGCG's degree of completeness as a function of magnitude. We therefore adopted the following procedure. The 90 Sample M_I objects were first sorted into bins of 0.5 magnitude width (in B_t space). Although this sample is smaller than the VPC galaxy sample used to measure the completeness of the CGCG, we were still able to use the completeness ratios derived from the much larger Sample C_I, as summarised in Table 1 and Table 2. Assuming that for each bin separately, the m_p and missing m_p values collectively

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Table 2. Measured (when $B_t < 14.5$) or estimated (when $B_t \geq 14.5$) mean m_p and associated scatter, σ_{m_p}, as a function of B_t based on a maximum-likelihood analysis of the 88 Sample M_I objects for which $B_t < 16.5$

B_t range (mag.)	sample size (objects)	CGCG completeness	σ_{m_p} (mag.)	mean m_p (mag.)
$B_t < 10.0$	5	1.000	0.55 (±0.17)	10.82 (±0.25)
$10.0 \leq B_t < 10.5$	3	1.000	0.22 (±0.09)	11.20 (±0.12)
$10.5 \leq B_t < 11.0$	0	1.000	N/A	N/A
$11.0 \leq B_t < 11.5$	3	1.000	0.33 (±0.13)	11.60 (±0.19)
$11.5 \leq B_t < 12.0$	2	1.000	0.20 (±0.10)	12.00 (±0.14)
$12.0 \leq B_t < 12.5$	8	1.000	0.35 (±0.09)	12.50 (±0.12)
$12.5 \leq B_t < 13.0$	5	1.000	0.29 (±0.09)	13.04 (±0.13)
$13.0 \leq B_t < 13.5$	11	1.000	0.32 (±0.09)	13.45 (±0.10)
$13.5 \leq B_t < 14.0$	13	1.000	0.37 (±0.07)	14.08 (±0.10)
$14.0 \leq B_t < 14.5$	3	1.000	0.21 (±0.08)	14.53 (±0.12)
$14.5 \leq B_t < 15.0$	5	0.750	0.49 (±0.09)	15.32 (±0.09)
$15.0 \leq B_t < 15.5$	9	0.714	0.28 (±0.03)	15.49 (±0.03)
$15.5 \leq B_t < 16.0$	14	0.680	0.28 (±0.02)	15.52 (±0.02)
$16.0 \leq B_t < 16.5$	7	0.244	0.29 (±0.06)	15.85 (±0.06)

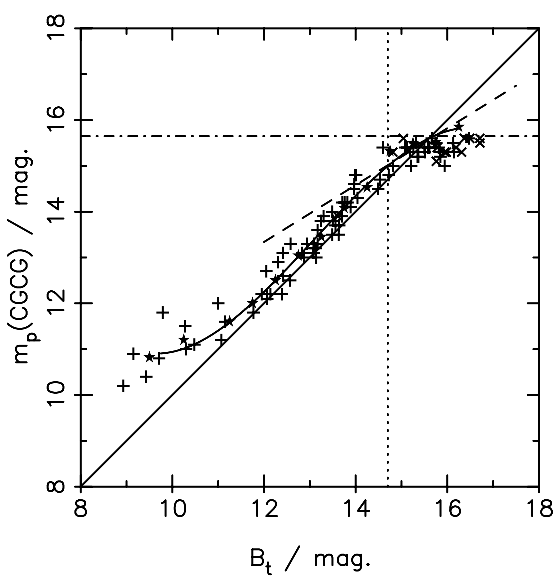

Figure 5 m_p as a function of B_t for the 92 Sample M_I and M_{II} galaxies, which are plotted as '+' symbols if cluster members or '×' symbols if background objects. The '⋆' symbols represent the measured (when $B_t < 14.5$) or estimated (when $B_t \geq 14.5$) mean m_p values for bins of 0.5 magnitude width (in B_t space) as tabulated in Table 2. Faintward of $B_t = 14.5$, they take into account 'missing' points (for which B_t but not m_p are known) that must lie above the dashed-dotted line, which represents the CGCG's $m_p \leq 15.6$ cut-off, and to the right of the dotted line, which represents the measured completeness limit of Volume I in B_t space ($B_t \sim 14.7$). The solid curve represents a weighted cubic fit to these data points and is only intended as an *approximate* B_t to m_p transformation equation. The dashed straight line on the other hand represents Gaztanaga & Dalton's (2000) transformation based on a sample of mainly Volume V objects.

observed a Gaussian distribution about a mean m_p value with a sample standard deviation of σ_{m_p}, we then had enough information to recover an estimate of the mean m_p value and its corresponding σ_{m_p} by means of a maximum-likelihood analysis. Our results are tabulated in Table 2 and plotted on Figure 5. The latter figure appears to confirm that there is indeed a serious scale error faintward of $B_t \sim 14.5$ if m_p values are treated as total magnitudes. We have computed the best fitting weighted cubic curve in order to provide an *approximate* transformation equation for obtaining m_p from B_t for objects missing from the CGCG over the range $B_t < 16.5$:

$$m_p = 67.69 - 14.626B_t + 1.2015{B_t}^2 - 0.030640{B_t}^3. \quad (8)$$

Although the associated scatter is only 0.32 magnitude for $B_t < 14.7$, polynomial fits such as this have their limitations — mainly at the faint end in this case. Therefore, when higher precision is required we recommend *interpolation* of the mean m_p values listed in Table 2 (which also gives a detailed breakdown of the measured scatter, σ_{m_p}, as a function of B_t). As is evident from Figure 5, we find that faintward of $B_t \sim 14.7$, the Volume I magnitude scale deviates even more from a Pogson one than does the Volume V scale, as investigated by Gaztanaga & Dalton (2000).

6 Conclusions

For Volume I of the CGCG, [3] we have found that:

(1) over the magnitude range $11.5 \leq B_t < 14.5$, m_p values are B–band and isophotal in nature and correspond to $B_{24.4}$ with a scatter of only 0.16 magnitude;
(2) even after transformation, m_p values are relatively poor measures of B_t owing to the fundamentally different natures of the m_p and B_t scales;

[3] There are no bright resolved Local Group galaxies in the VPC field. However, Leo I ($m_p = 11.3$) and two dwarfs near the perimeter of the Local Group, Sextans B ($m_p = 12.2$) and GR 8 ($m_p = 15.3$), are listed in Volume I of the CGCG. These objects (as well as the Sextans dwarf spheroidal which is missing from Volume I) are therefore beyond the scope of the current investigation.

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(3) whether m_p values are treated as $B_{24.4}$ or B_t, due to the presence of scale errors, galaxy luminosities are seriously underestimated at the bright end ($B_t \lesssim 11.5$) and seriously overestimated at the faint end ($B_t \gtrsim 14.5$);
(4) the catalogue is complete only to $B_t \sim 14.7$ magnitude;
(5) over the range $14.75 \lessapprox B_t < 15.75$, the degree of incompleteness is relatively constant at about the 30% level; and
(6) most of the omitted objects are elliptical galaxies implying that late types are over-represented at the faint end.

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