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THE BRIGHTEST STARS IN GALAXIES AS DISTANCE INDICATORS

LYO, A-RAN AND LEE, MYUNG GYOON
Department of Astronomy , Seoul National University, Seoul 151-742, Korea
Electronic mail: mglee@astrog.snu.ac.kr
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ABSTRACT

The brightest stars in galaxies have been used as distance indicators since Hubble. However, the accuracy of the brightest stars for distance estimates has been controversial. Recently, Rozanski & Rowan-Robinson [1994 : MNRAS, 271, 530] argued large errors of this method for the distance determination : 0.58 mag and 0.90 mag, respectively, for the brightest red stars and the brightest blue stars, while Karachentsev & Tikhonov [1994 : A&A, 286, 718] suggested much smaller errors in the distance determination than the former: 0.37 mag for the brightest red stars and 0.46 mag for the brightest blue stars. The reasons for these conflicting results are not yet known.

In this study we have investigated the accuracy of this method using a sample of 17 galaxies for which Cepheid distances are known and reliable photometry of the brightest stars are available. We have obtained the calibrations of the relations between the mean luminosities of the three blue and red brightest supergiants (BSGs and RSGs, respectively) and the total luminosities of the parent galaxies: $< M_V(3)_{RSG} >= 0.21 M_B^T - 3.84$, $\sigma(M_V) = 0.37$ mag, and $\delta\mu_0 = 0.47$ mag for the brightest red supergiants, and $< M_B(3)_{BSG} >= 0.30 M_B^T - 3.02$, $\sigma(M_B) = 0.55$ mag, and $\delta\mu_0 = 0.79$ mag for the brightest blue supergiants. Also it is found that the errors in the distance determination are reduced by a factor of two, as the observing wavelengths increase from B-band to K-band. In conclusion, the brightest red supergiants are considered to be useful for determining the distances to resolved late-type galaxies.

Key Words : supergiants – galaxies: distances and redshifts – distance scale.

I. INTRODUCTION

In 1936 Hubble used the brightest stars in resolved galaxies to estimate the distances to the galaxies in his pioneering investigation of the luminosity function of galaxies. He presented a luminosity calibration of the brightest stars based on ten nearby galaxies (LMC, SMC, IC 1613, NGC 6822, M33, NGC 2403, M31, M81, M101 and our Galaxy) that the mean magnitude of the three or four brightest non-variable stars in a galaxy is $< M > = -6.35$ mag with a standard deviation $\sigma = 0.41$ mag. This magnitude is much fainter than the modern values. Since then many studies on using the brightest stars for estimating the distances to galaxies were published. Some important examples among them published before 1990 are Sandage & Tammann (1974a,b,c,d, 1982), de Vaucouleurs (1978a,b), Humphreys (1983, 1987) and Sandage & Carlson (1988).

However, the accuracy of the brightest stars for distance estimates is still controversial, although much effort has been made for calibrating the luminosity of the brightest stars. For example, Rozanski & Rowan-Robinson (1994, called as RR94 hereafter) argued, in their thorough study of the accuracy of the brightest stars for distance estimates, large errors of this method for the distance determination: 0.58 mag and 0.90 mag, respectively, for the brightest red supergiants and the brightest blue supergiants, while Karachentsev & Tikhonov (1994, called as KT94 hereafter) suggested much smaller errors than RR94: 0.37 mag and 0.46 mag, respectively, for the brightest red supergiants and the brightest blue supergiants. The reasons for these conflicting results are not yet known.

Both of the above two studies were based mostly on the photographic photometry of the brightest stars in galaxies. New data for the brightest stars in several nearby galaxies based on CCD photometry were published since these

Table 1. References for the sample galaxies.

Galaxy	Type	References for the brigthest stars	References for the distances
LMC	SBmII	Humphreys (1979a)	Freedman (1991)*
		Elias et al. (1985b)	Walker (1985)
			Walker (1987)
			Walker & Mack (1988b)
			Walker et al. (1987)
SMC	ImIV-V	Humphreys (1979b)	Welch et al. (1987)*
		Elias et al. (1985a)	Walker & Mack (1988a)*
		Elias et al. (1985b)	
		Garmany et al. (1987)	
NGC 6822	IB(s)m	Humphreys (1980)	Lee et al. (1993a)*
		Elias & Frogel (1985)	
		Wilson (1992)	
IC 1613	IAB(s)m	Humphreys (1980)	Freedman (1988)*
		Elias & Frogel (1985)	
		Freedman (1988)	
M31	SbI-II	Humphreys et al. (1988)	Prichet & van den Bergh (1987)*
		Nedialkov et al.(1989)	Freedman (1990)*
		Humphreys et al. (1990)	Welch et al. (1986)
IC 10	ImB	Karachentsev et al.(1993)	Saha et al. (1996)*
M33	Sc(s)II-III	Humphreys (1980)	Freedman et al. (1991)*
		Humphreys et al. (1984)	Freedman (1985)
		Humphreys et al. (1988)	Madore (1985)
WLM	dImIV-V	Sandage & Carlson (1985b)	Lee et al. (1993b)*
		Lee et al.(1993b)	
Pegasus	ImV	Sandage (1986)	Lee (1994)*
		Lee et al. (1994)	
NGC 3109	SmIV	Sandage & Carlson (1988)	Capaccioli et al. (1992)*
		Bresoline et al. (1993)	
		Greggio et al. (1993)	
Sextans B	IB(s)m	Sandage & Carlson (1985a)	Piotto et al. (1994)*
		Piotto et al. (1994)	
Sextans A	IBmIV	Sandage & Carlson (1982)	Piotto et al. (1994)*
		Sandage & Carlson (1985a)	
		Elias & Frogel (1985)	
		Aparicio et al. (1987)	
		Walker (1987)	
		Piotto et al. (1994)	
NGC 300	Sc	Humphreys & Graham (1986)	Freedman et al. (1992)*
			Madore et al. (1987)
LeoA	Im	Demers et al. (1984)	Hoessel et al. (1994)*
		Sandage (1986)	
GR8	dI	Aparicio et al. (1988b)	Tolstoy et al. (1995)*
NGC 2403	ScIII	Sandage (1984b)	Freedman & Madore (1988)*
		Humphreys et al. (1986)	McAlary & Madore (1984)
		Zickgraf & Humphreys (1991)	
M81	Sb(r)I-II	Sandage (1984a)	Freedman et al. (1994)*
		Humphreys et al. (1986)	Freedman & Madore (1988)
		Zickgraf & Humphreys (1991)	Madore et al. (1993)
		Georgiev et al. (1992)	
IC 4182	Sdm	Sandage et al. (1996)	Saha et al. (1994)*
M101	ScI	Sandage (1983)	Alves & Cook (1995)*
		Humphreys et al. (1986)	
NGC 4571	ScII-III	Pierce et al. (1992)	Pierce et al. (1994)*

* : distance estimates adopted in this study.

two studies. In this study, we re-examine the accuracy of the brightest stars as distance indicators using a sample of 17 galaxies for which Cepheid distances are known and reliable photometry of the brightest stars mostly based on CCD photometry are available. This paper is composed as following. Sec. 2 describes briefly how to estimate the distances to galaxies using the brightest stars, and Sec. 3 summarizes the data used in this study. Sec. 4 presents the results, and Sec. 5 discusses the comparison of our results with previous studies and gives new distance estimates for nearby galaxies using our calibrations. Finally, summary and conclusions are given in Sec. 6. The photometries of all the brightest stars in the sample galaxies used in this study are presented in Appendix.

II. METHODS

It is very simple in principle to estimate the distances to resolved galaxies using the brightest stars. We choose the brightest blue and red supergiants in a galaxy (called as BSGs and RSGs, respectively, hereafter) and derive the mean magnitudes of each group of them. In general, we use the three brightest stars rather than the single brightest star to reduce the stochastic effect in obtaining the mean luminosity of the brightest stars. Then we derive the distance modulus with these mean apparent magnitudes of the BSGs and RSGs using the known calibration of the absolute luminosity of the BSGs and RSGs.

However, there are many problems in applying this method to the real data, some of which were recognized early by Hubble (1936). These problems were described in detail in Humphreys (1983, 1987) and RR94. Two serious problems among them are (a) the difficulty in selecting the brightest stars in a galaxy, and (b) the calibration problem for the relation between the luminosity of the brightest stars and the luminosity of the parent galaxies.

In the past there were several developments to overcome the above selection problem, such as combining photometry and spectroscopy, Hα imaging, and high-resolution imaging (e.g. Humphreys *et al.* 1986, Shanks *et al.* 1992). As a result, the brightest stars in some nearby galaxies are reasonably well-identified.

With regard to the calibration problem, reliable photometry of the brightest stars in nearby galaxies and the accurate distances to the parent galaxies are critical factors. With the advent of CCDs and the Hubble Space Telescope, it became possible to obtain these data much better than before. The data used in recent past studies such as RR94 and KT94 are mostly based on the photographic photometry. Now much better data than these are available in the literature.

We investigate the relationship between the mean absolute magnitudes (M_s)of the BSG and RSG and the absolute magnitudes of the parent galaxies (M_g) by applying the linear equation of the form $M_s = aM_g + b$ to the new data as compiled in the following section. If the standard deviation of this relation is σ, and apparent magnitudes of the stars and galaxies are represented by the lower cases, the distance modulus is given by $\mu_0 = m_s/(1-a) - am_g/(1-a) - b/(1-a)$ and the corresponding error in the derived distance modulus is $\delta\mu_0 = \sigma/(1-a)$ (see also RR 94).

III. THE DATA

We have selected the galaxies which will be used as calibrators, applying the following criteria. (a) The distance to the galaxy was determined using the Cepheids for which CCD photometry is available. (b) The CCD photometries of the brightest BSGs and RSGs in the galaxy are available (The exceptions are the LMC, SMC, M31, IC 10, and M33). (c) The color of the BSGs should be bluer than $(B-V) = 0.4$ and the color of the RSGs should be redder than $(B-V) = 1.6$.

Table 1 lists 17 sample galaxies thus selected for calibration and three other resolved galaxies (Pegasus, GR8 and NGC 4571) for which the CCD photometry of the brightest stars are available. Table 1 lists also the corresponding references for the photometry of the BSGs and RSGs and the distances. The last three galaxies were not included for the calibration because of the following reasons.

Pegasus dwarf: Hoessel *et al.* (1992) presented a cepheid distance modulus of $\mu_0 = 26.22 \pm 0.2$ for the Pegasus dwarf galaxy. However, it was found later that the cepheids used for distance determination in their study were not cepheids (Aparicio 1994, Aparicio *et al.* 1995, Lee 1995a,b). The distance modulus for the Pegasus dwarf galaxy listed in Table 2 is from the value based on the tip of the red giant branch which has an accuracy comparable to Cepheids (Lee 1995a,b).

Table 2. Photometric data and distances for the sample galaxies.

Galaxy	B_T^0	V_T^0	$A_g(B)$	$A_i(B)$	$<B(3)_{BSG}>$	$<V(3)_{BSG}>$	$<U(3)_{BSG}>$	$<R(3)_{BSG}>$	$<I(3)_{BSG}>$	$<B(3)_{RSG}>$	$<V(3)_{RSG}>$	$<R(3)_{RSG}>$	$<I(3)_{RSG}>$	$<J(3)_{RSG}>$	$<H(3)_{RSG}>$	$<K(3)_{RSG}>$	$(m-M)_0$
LMC	0.57	0.13	0.27	0.07	9.65 ± 0.30	9.56 ± 0.40	9.12 ± 0.07	—	—	13.75 ± 0.19	11.74 ± 0.15	10.12 ± 0.03	8.80 ± 0.60	8.31 ± 0.41	7.60 ± 0.40	7.34 ± 0.41	18.50 ± 0.10
SMC	2.28	1.87	0.18	0.24	10.63 ± 0.28	10.57 ± 0.38	10.04 ± 0.03	—	—	13.53 ± 0.29	11.69 ± 0.32	10.34 ± 0.31	9.40 ± 0.27	—	—	7.87 ± 0.30	18.90 ± 0.05
NGC 6822	8.38	—	0.93	0.04	16.90 ± 0.17	16.61 ± 0.05	—	—	—	19.23 ± 0.41	17.23 ± 0.37	—	—	13.36 ± 0.16	12.61 ± 0.17	12.39 ± 0.19	23.62 ± 0.20
IC 1613	9.82	9.15	0.02	0.04	17.17 ± 0.51	17.19 ± 0.71	—	17.17 ± 0.83	17.15 ± 0.96	19.61 ± 0.57	17.69 ± 0.73	16.72 ± 0.85	15.82 ± 1.00	14.30 ± 0.56	13.63 ± 0.54	13.45 ± 0.57	24.30 ± 0.10
M31	3.36	2.68	0.33	0.67	16.35 ± 0.22	16.21 ± 0.03	15.69 ± 0.28	—	—	18.59 ± 0.40	16.90 ± 0.33	15.71 ± 0.08	—	—	—	12.89 ± 0.66	24.37 ± 0.04
IC 10	8.23	7.64[b]	3.50	0.07	19.70 ± 0.34	19.07 ± 0.21	—	—	—	23.22 ± 0.63	20.28 ± 0.49	—	—	—	—	—	24.59 ± 0.25
M33	5.75	5.28	0.19	0.33	15.70 ± 0.28	15.59 ± 0.44	14.99 ± 0.10	15.56 ± 0.57	—	18.91 ± 0.34	16.70 ± 0.17	—	—	13.77 ± 0.30	13.14 ± 0.35	12.91 ± 0.37	24.64 ± 0.09
WLM	10.58	10.16	0.10	0.35	18.05 ± 0.15	18.23 ± 0.23	—	—	—	20.29 ± 0.10	18.64 ± 0.11	—	—	—	—	—	24.92 ± 0.21
Pegasus	12.97	12.37	0.10	0.20	20.47 ± 0.17	20.46 ± 0.20	—	—	20.23 ± 0.42	21.91 ± 0.40	20.22 ± 0.34	—	18.14 ± 0.51	—	—	—	25.13 ± 0.11
NGC 3109	9.50	9.19[a]	0.16	0.72	18.36	18.23	—	—	—	20.42	18.58	—	—	—	—	—	25.50 ± 0.19
Sextans B	11.53	11.02	0.05	0.12	19.28 ± 0.19	19.40 ± 0.15	—	—	—	20.63 ± 0.66	19.23 ± 0.59	—	—	—	—	—	25.63 ± 0.21
Sextans A	11.73	11.36	0.07	0.06	18.39 ± 0.82	18.35 ± 0.94	—	—	—	20.22 ± 0.53	18.44 ± 0.51	—	—	15.56 ± 0.16	14.89 ± 0.16	14.75 ± 0.20	25.71 ± 0.20
NGC 300	8.49	7.91	0.02	0.21	—	—	—	—	—	—	18.67 ± 0.15	—	—	15.94 ± 0.18	15.39 ± 0.27	15.21 ± 0.36	26.66 ± 0.10
LeoA	12.68	12.37	0.07	0.16	18.72 ± 0.28	18.94 ± 0.28	—	—	—	21.68 ± 0.21	19.68 ± 0.07	—	—	—	—	—	26.74 ± 0.22
GR8	14.62	14.31	0.04	0.02	18.86 ± 0.19	18.85 ± 0.17	18.36 ± 0.59	—	—	—	—	—	—	—	—	—	26.75 ± 0.35
NGC 2403	8.43	8.04	0.17	0.36	18.84 ± 0.73	18.81 ± 0.79	16.62 ± 0.89	18.57 ± 0.78	—	21.18 ± 0.29	19.57 ± 0.38	18.67 ± 0.38	—	17.60 ± 0.06	16.85 ± 0.06	16.52 ± 0.15	27.51 ± 0.24
M81	7.39	6.57	0.16	0.34	18.94 ± 0.47	18.86 ± 0.63	—	—	—	21.81 ± 0.60	19.97 ± 0.21	—	—	17.20 ± 0.06	16.44 ± 0.04	16.01 ± 0.35	27.80 ± 0.20
IC 4182	11.73	11.36	0.00	0.04	20.18 ± 0.14	20.19 ± 0.26	—	20.24 ± 0.19	20.38 ± 0.34	22.55 ± 0.54	20.76 ± 0.42	19.92 ± 0.49	18.92 ± 0.61	—	—	—	28.36 ± 0.09
M101	8.21	7.77	0.00	0.05	19.35 ± 0.25	19.42 ± 0.25	—	—	—	—	20.63 ± 0.15	—	—	17.49 ± 0.31	16.72 ± 0.41	16.44 ± 0.36	29.18 ± 0.13
NGC 4571	11.73	11.24	0.06	0.07	—	21.30	—	21.10 ± 0.10	—	—	22.70	21.60 ± 0.10	—	—	—	19.20	30.87 ± 0.15

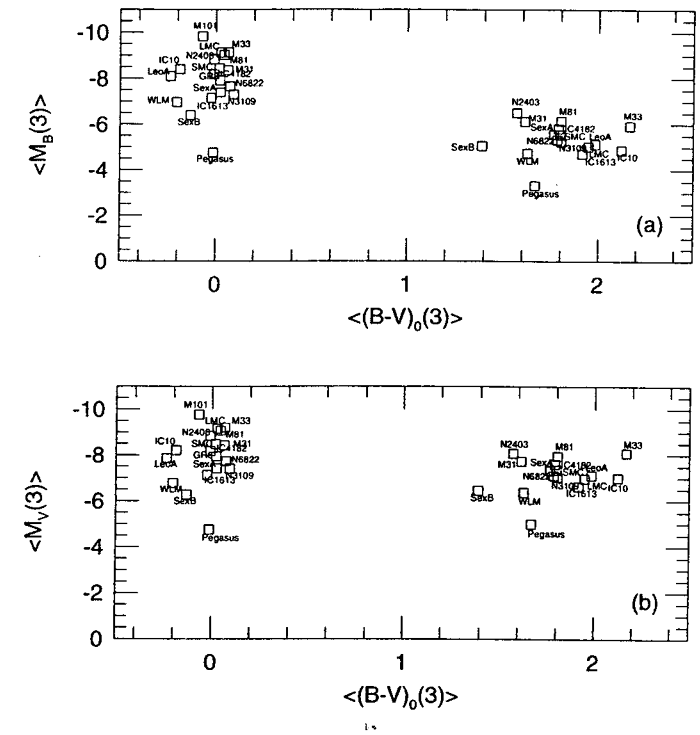

Fig. 1. Color-magnitude diagrams of the brightest blue and red supergiants in galaxies. The magnitudes and colors are average values of the three brightest BSGs and RSGs in each sample galaxy.

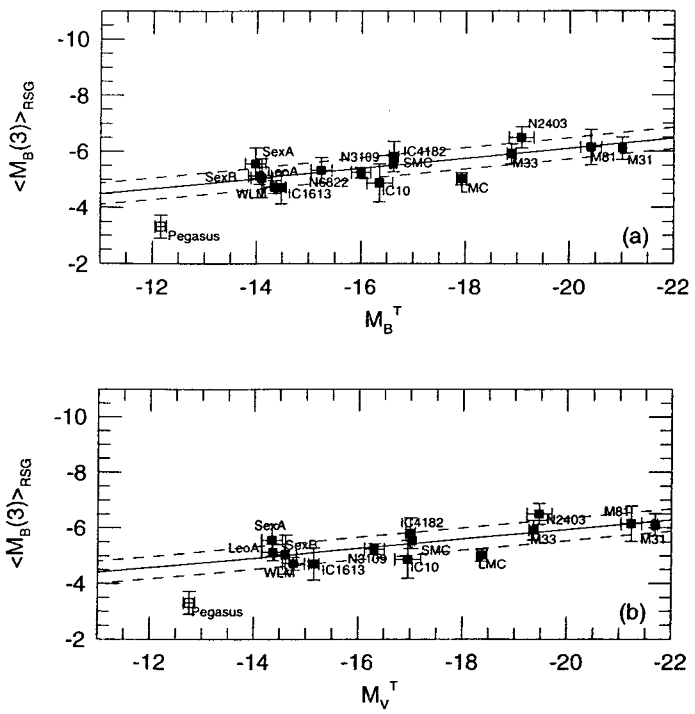

Fig. 2(a). B-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_B(3) >_{RSG}$ vs. M_B^T. (b) $< M_B(3) >_{RSG}$ vs. M_V^T.

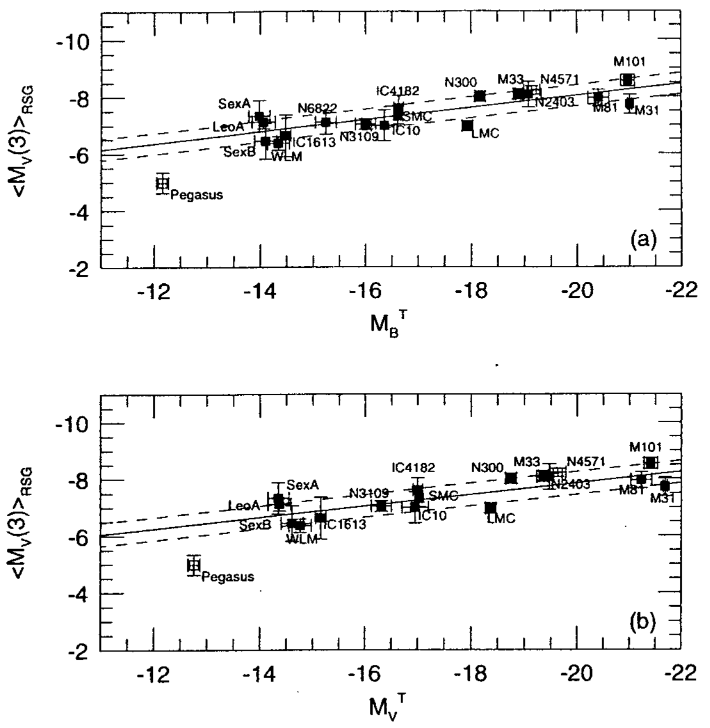

Fig. 2(b). V-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_V(3) >_{RSG}$ vs. M_B^T. (b) $< M_V(3) >_{RSG}$ vs. M_V^T.

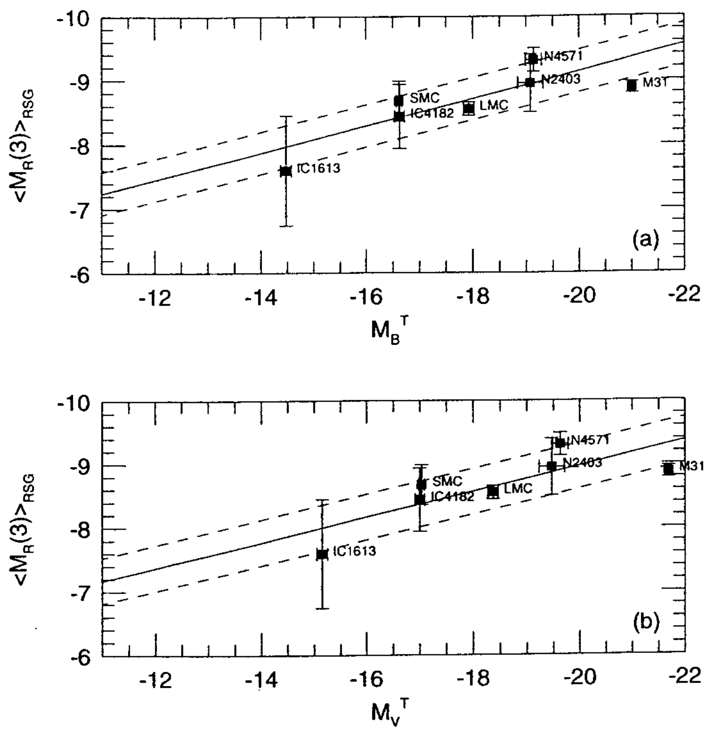

Fig. 2(c). R-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_R(3) >_{RSG}$ vs. M_B^T. (b) $< M_R(3) >_{RSG}$ vs. M_V^T.

Table 3a. Calibrations of the $< M_\lambda(3)_{RSG} > - M_B^T$ relation.

Filter	a	b	σ	$\delta\mu_0$	N^t
B	0.18 ± 0.04	-2.51 ± 0.72	0.38	0.46	15
V	0.21 ± 0.04	-3.84 ± 0.64	0.37	0.47	17
J	0.13 ± 0.06	-8.16 ± 1.12	0.45	0.52	9
H	0.14 ± 0.06	-8.67 ± 1.11	0.45	0.52	9
K	0.15 ± 0.05	-8.72 ± 0.91	0.40	0.47	11

^{t} : Number of the galaxies

Table 3b. Calibrations of the $< M_\lambda(3)_{RSG} > - M_V^T$ relation.

Filter	a	b	σ	$\delta\mu_0$	N
B	0.17 ± 0.04	-2.54 ± 0.77	0.40	0.48	14
V	0.20 ± 0.04	-3.85 ± 0.70	0.40	0.50	16
J	0.15 ± 0.07	-7.82 ± 1.31	0.48	0.56	8
H	0.16 ± 0.07	-8.29 ± 1.29	0.47	0.56	8
K	0.16 ± 0.05	-8.41 ± 1.03	0.42	0.50	10

Table 4a. Calibrations of the $< M_\lambda(3)_{BSG} > - M_B^T$ relation.

Filter	a	b	σ	$\delta\mu_0$	N
B	0.30 ± 0.06	-3.02 ± 0.96	0.55	0.79	16
V	0.32 ± 0.05	-2.69 ± 0.94	0.54	0.79	16

Table 4b. Calibrations of the $< M_\lambda(3)_{BSG} > - M_V^T$ relation.

Filter	a	b	σ	$\delta\mu_0$	N
B	0.29 ± 0.06	-3.08 ± 1.05	0.59	0.83	15
V	0.31 ± 0.06	-2.70 ± 1.03	0.58	0.84	15

Table 5a. Calibrations of the $< M_\lambda(3)_{RSG} > - M_B^T$ relation for seven galaxies.

Filter	a	b	σ	$\delta\mu_0$	N
B	0.17 ± 0.08	-2.65 ± 1.40	0.51	0.61	7
V	0.18 ± 0.07	-4.43 ± 1.17	0.42	0.51	7
J	0.06 ± 0.06	-9.31 ± 0.96	0.34	0.36	7
H	0.07 ± 0.05	-9.86 ± 0.88	0.32	0.34	7
K	0.10 ± 0.05	-9.50 ± 0.83	0.30	0.33	7

Table 5b. Calibrations of the $< M_\lambda(3)_{RSG} > - M_V^T$ relation for six galaxies.

Filter	a	b	σ	$\delta\mu_0$	N
B	0.17 ± 0.10	-2.64 ± 1.75	0.58	0.70	6
V	0.17 ± 0.08	-4.49 ± 1.47	0.49	0.59	6
J	0.08 ± 0.06	-8.96 ± 1.08	0.36	0.39	6
H	0.08 ± 0.05	-9.50 ± 0.97	0.32	0.35	6
K	0.12 ± 0.05	-9.14 ± 0.90	0.30	0.34	6

Table 6a. Comparison with previous studies for the $< M_V(3)_{RSG} > - M_B^T$ relation.

References	a	b	$\sigma(M_V)$	$\delta\mu_0$	N
PCB92	0.21 ± 0.02	-4.01 ± 0.38	$\gtrsim 0.30$	$\gtrsim 0.38$	17
RR94	0.21 ± 0.03	-4.10 ± 0.38	0.46	0.58	22
KT94	0.19	-4.52	0.30	0.37	23
This study	0.21 ± 0.04	-3.84 ± 0.64	0.37	0.47	17

Table 6b. Comparison with previous studies for the $< M_B(3)_{BSG} > - M_B^T$ relation.

References	a	b	$\sigma(M_V)$	$\delta\mu_0$	N
de Vaucouleurs (1978)	0.375	-2.38			
Aparicio *et al.* (1987)	0.37	-2.24			
Sandage & Carlson (1988)	0.4	-1.9			
PCB92	0.36 ± 0.04	-2.29 ± 0.64	0.56	0.88	21
RR94	0.28 ± 0.04	-3.45 ± 0.62	0.65	0.90	22
KT94	0.35	-2.50	0.30	0.46	40
This study	0.30 ± 0.06	-3.02 ± 0.96	0.55	0.79	16

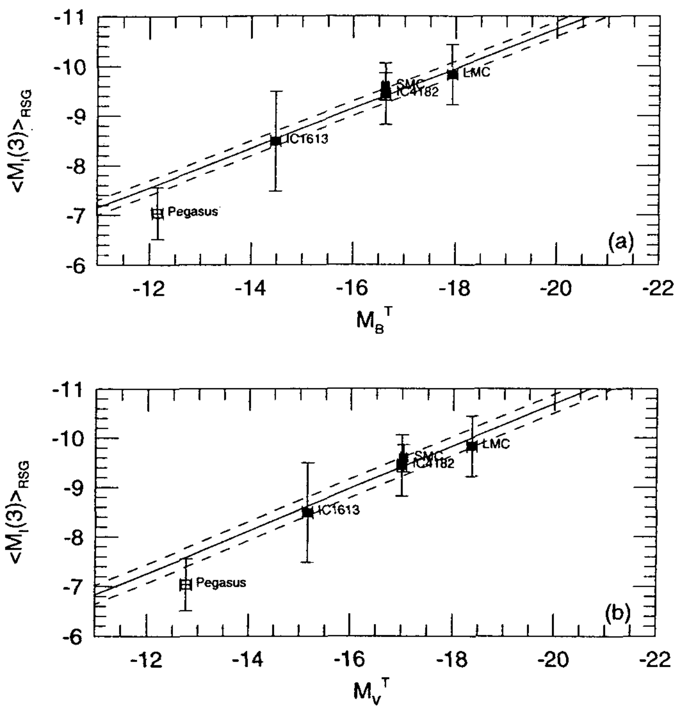

Fig. 2(d). I-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_I(3) >_{RSG}$ vs. M_B^T. (b) $< M_I(3) >_{RSG}$ vs. M_V^T.

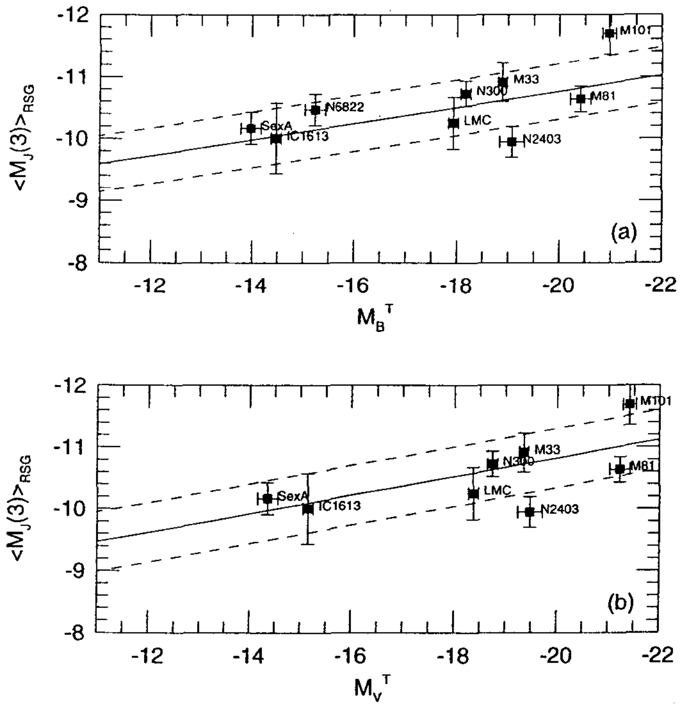

Fig. 2(e). J-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_J(3) >_{RSG}$ vs. M_B^T. (b) $< M_J(3) >_{RSG}$ vs. M_V^T.

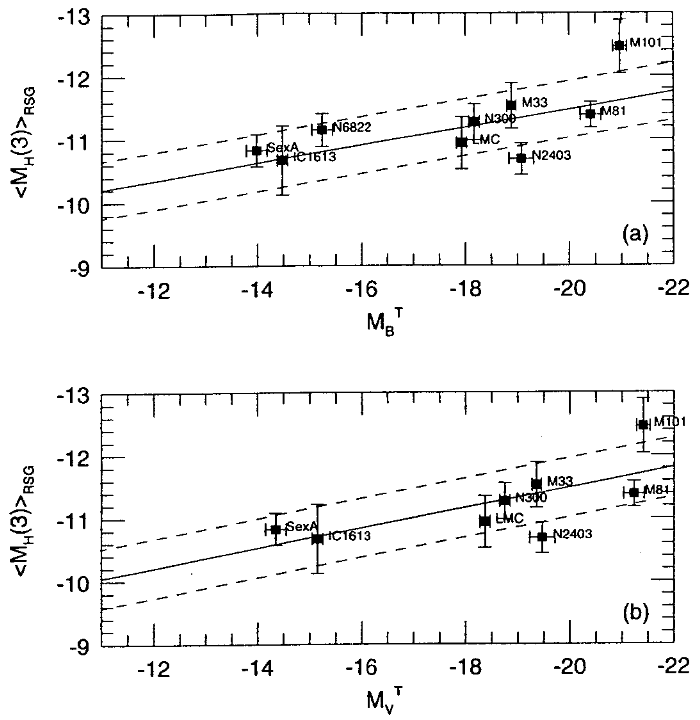

Fig. 2(f). H-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_H(3) >_{RSG}$ vs. M_B^T. (b) $< M_H(3) >_{RSG}$ vs. M_V^T.

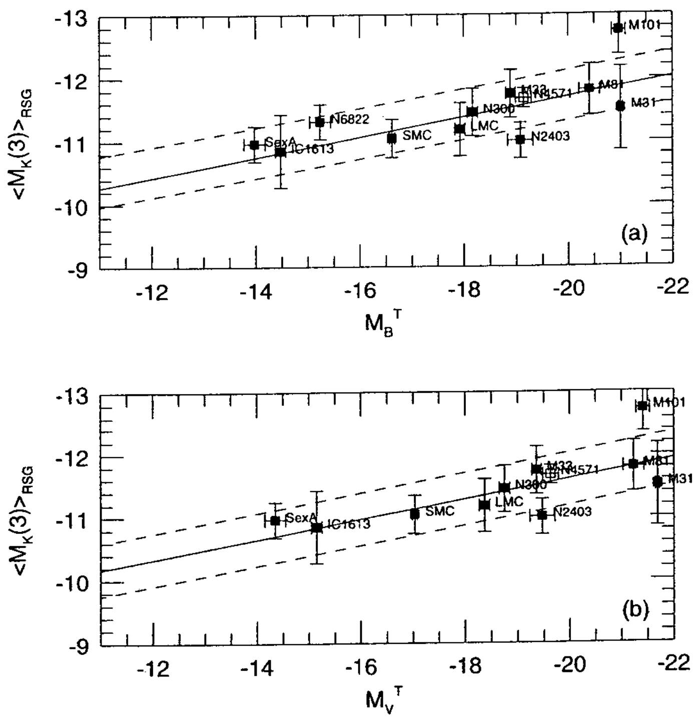

Fig. 2(g). K-band luminosity calibrations for the three brightest red supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are one σ regression errors. (a) $< M_K(3) >_{RSG}$ vs. M_B^T. (b) $< M_K(3) >_{RSG}$ vs. M_V^T.

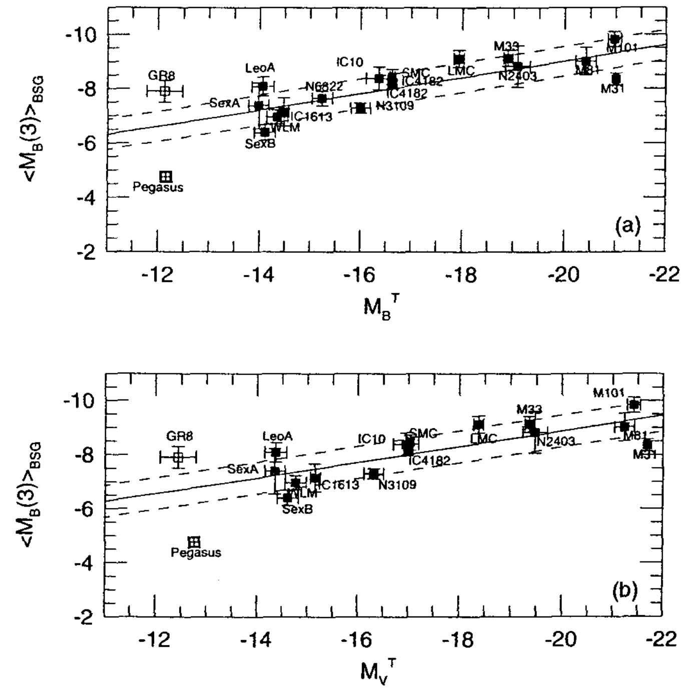

Fig. 3(a). *B*-band luminosity calibrations for the three brightest blue supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_B(3) >_{BSG}$ vs. M_B^T. (b) $< M_B(3) >_{BSG}$ vs. M_V^T.

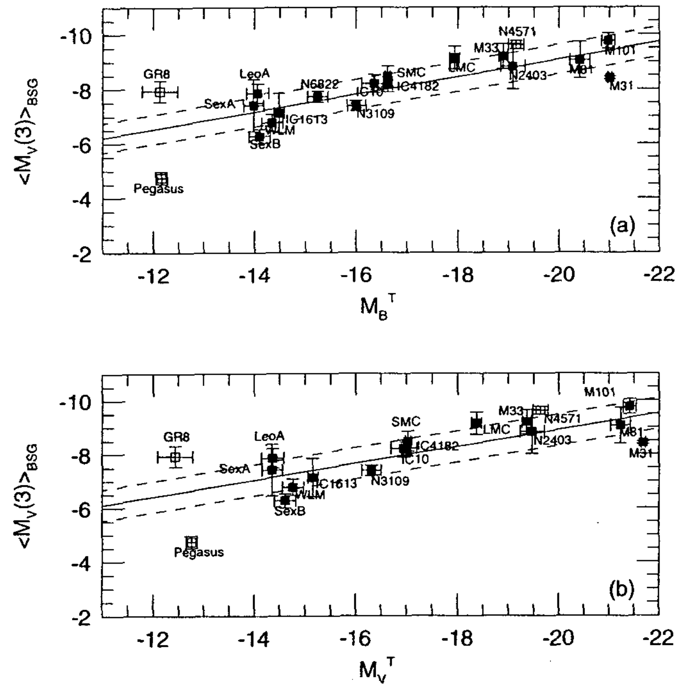

Fig. 3(b). *V*-band luminosity calibrations for the three brightest blue supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_V(3) >_{BSG}$ vs. M_B^T. (b) $< M_V(3) >_{BSG}$ vs. M_V^T.

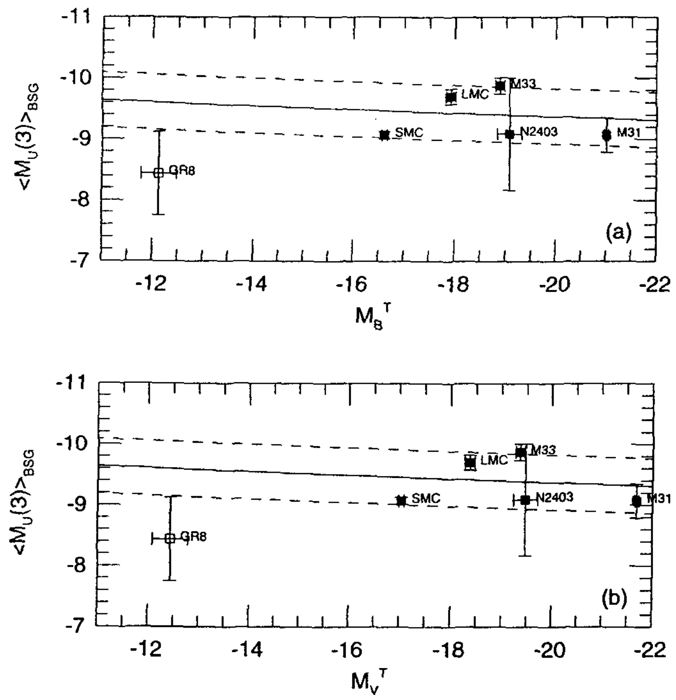

Fig. 3(c). *U*-band luminosity calibrations for the three brightest blue supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_U(3) >_{BSG}$ vs. M_B^T. (b) $< M_U(3) >_{BSG}$ vs. M_V^T.

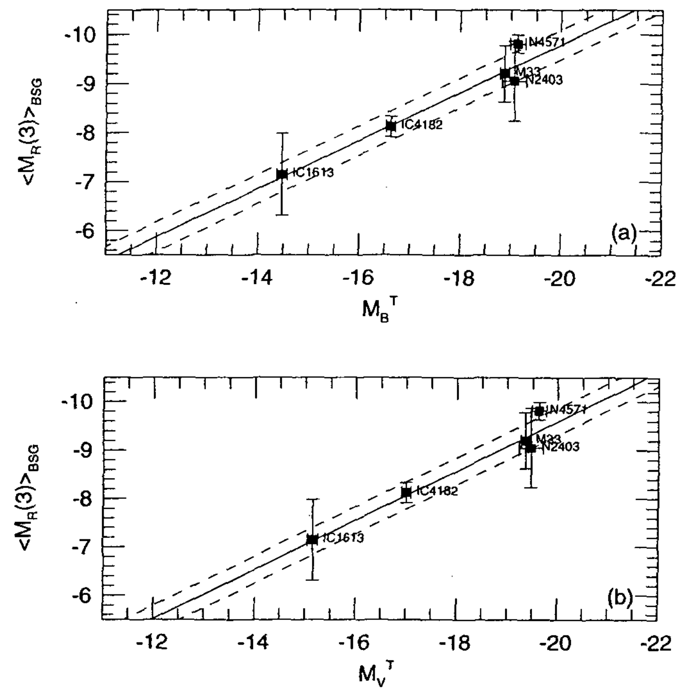

Fig. 3(d). *R*-band luminosity calibrations for the three brightest blue supergiants in each sample galaxy. The open squares are the galaxies which were not used for the calibration. The solid lines represent the linear least-squares fit, and the dashed lines are 1 σ regression errors. (a) $< M_R(3) >_{BSG}$ vs. M_B^T. (b) $< M_R(3) >_{BSG}$ vs. M_V^T.

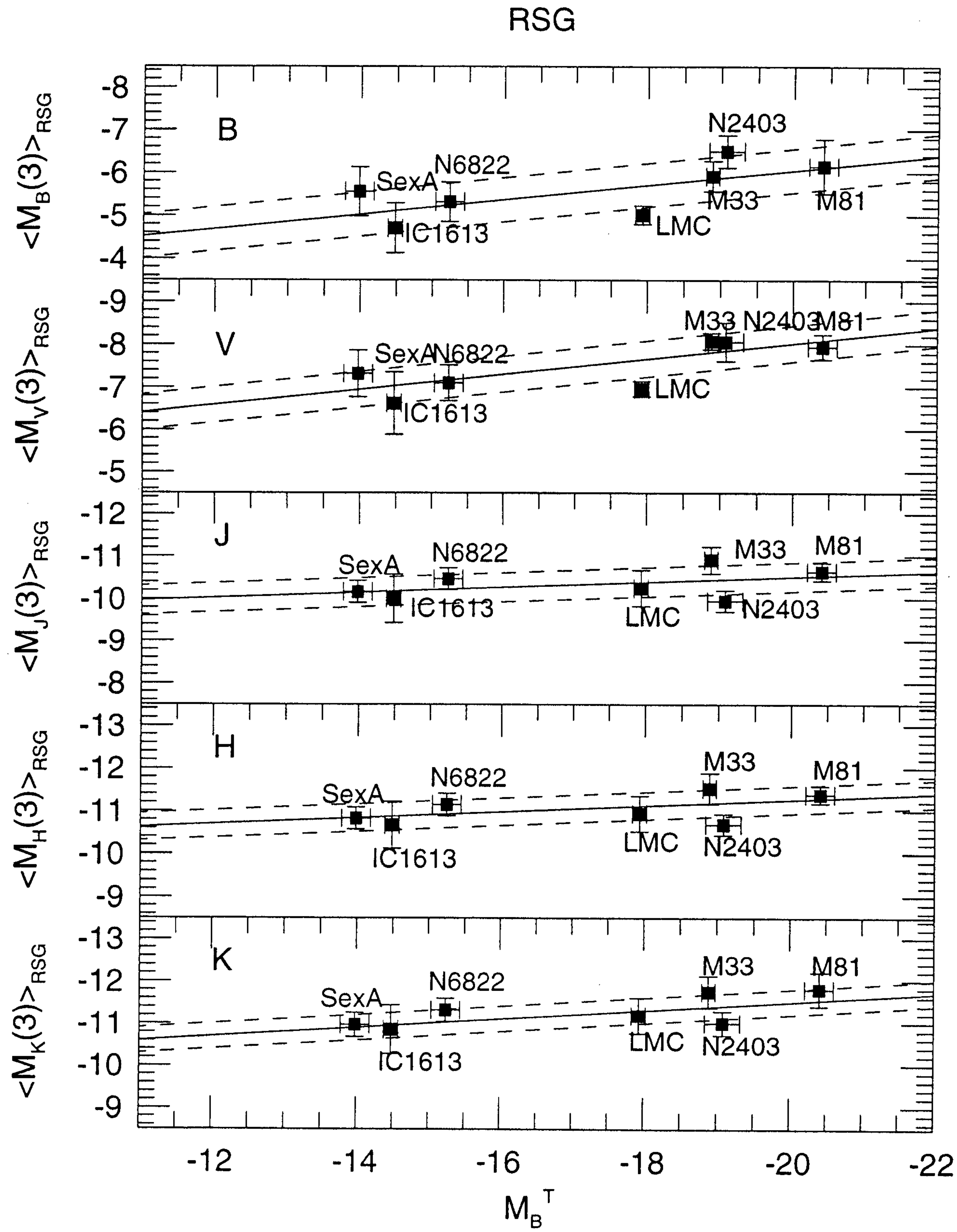

Fig. 4(a). Comparison of the $BVJHK$-band luminosity vs. M_B^T calibrations for the three brightest red supergiants in each of seven sample galaxies for which $BVJHK$ photometry of the brightest red supergiants are available.

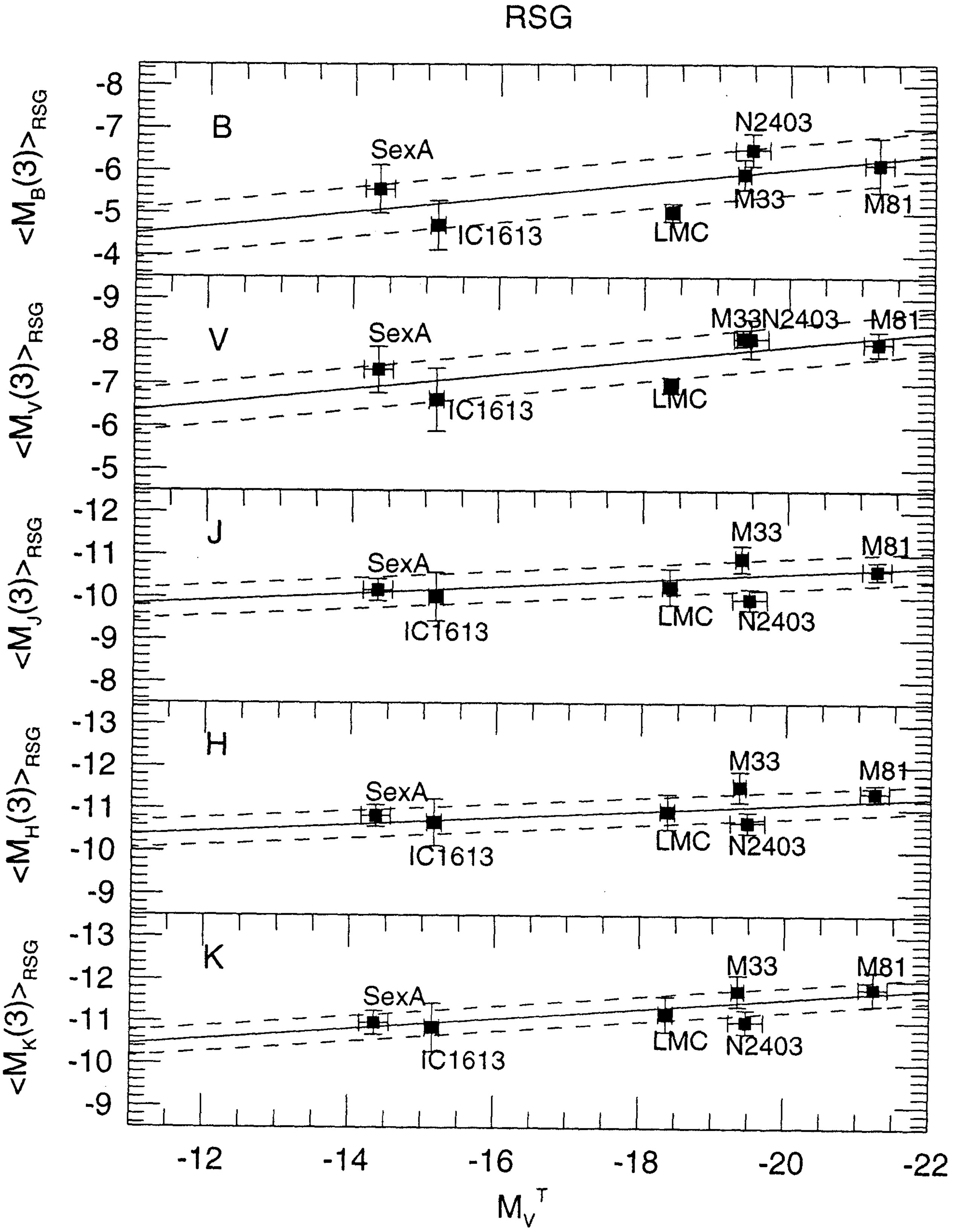

Fig. 4(b). Comparison of the $BVJHK$-band luminosity vs. M_V^T calibrations for the three brightest red supergiants in each of six sample galaxies for which $BVJHK$ photometry of the brightest red supergiants are available.

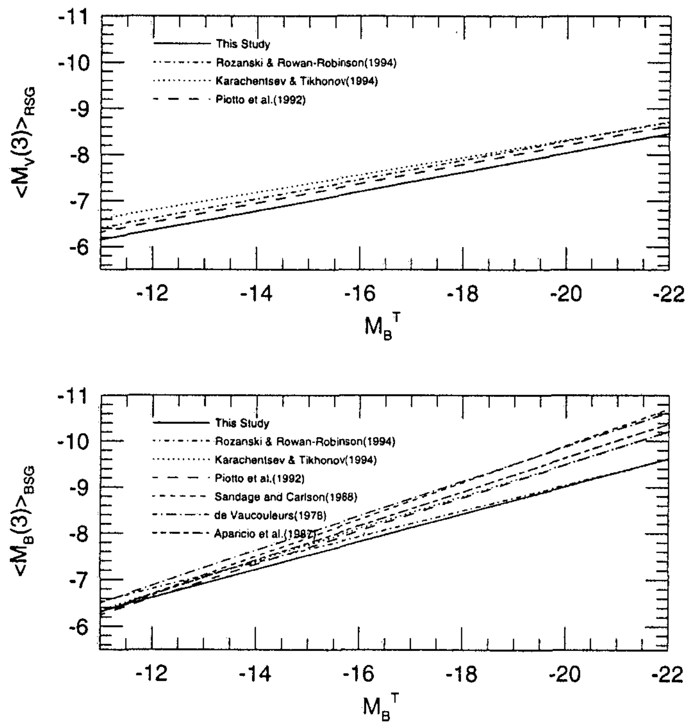

Fig. 5. Comparison of the calibrations of the brightest blue and red supergiants in this study and previous studies. (a) $< M_V(3) >_{RSG}$ vs. M_B^T. (b) $< M_B(3) >_{BSG}$ vs. M_B^T.

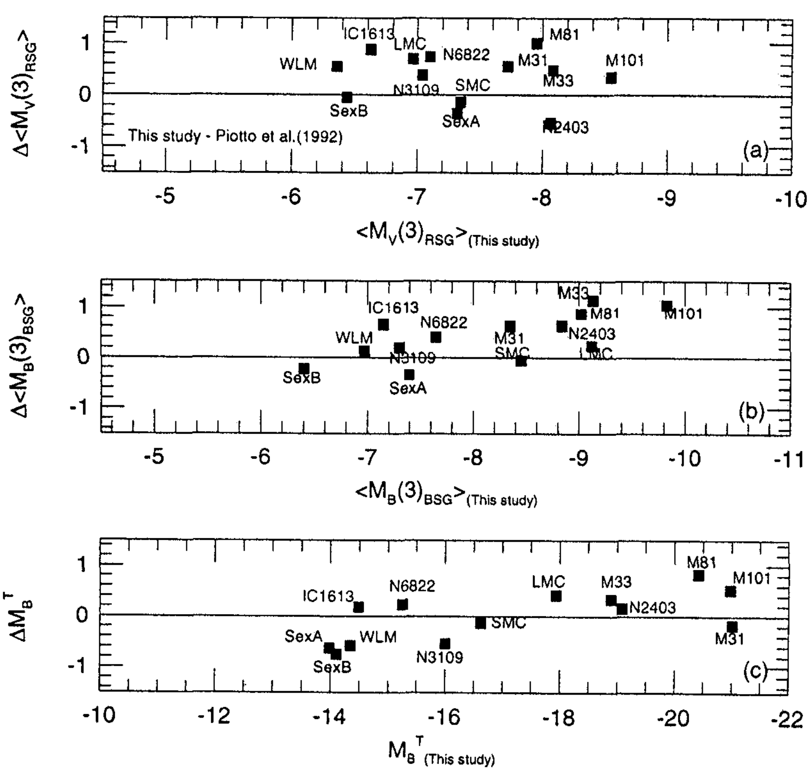

Fig. 6(a). Comparison of the data used in this study and PCB92. Δ represents our values minus others. (a) V magnitudes of the three brightest red supergiants. (b) B magnitudes of the three brightest blue supergiants. (c) B magnitudes of the parent galaxies.

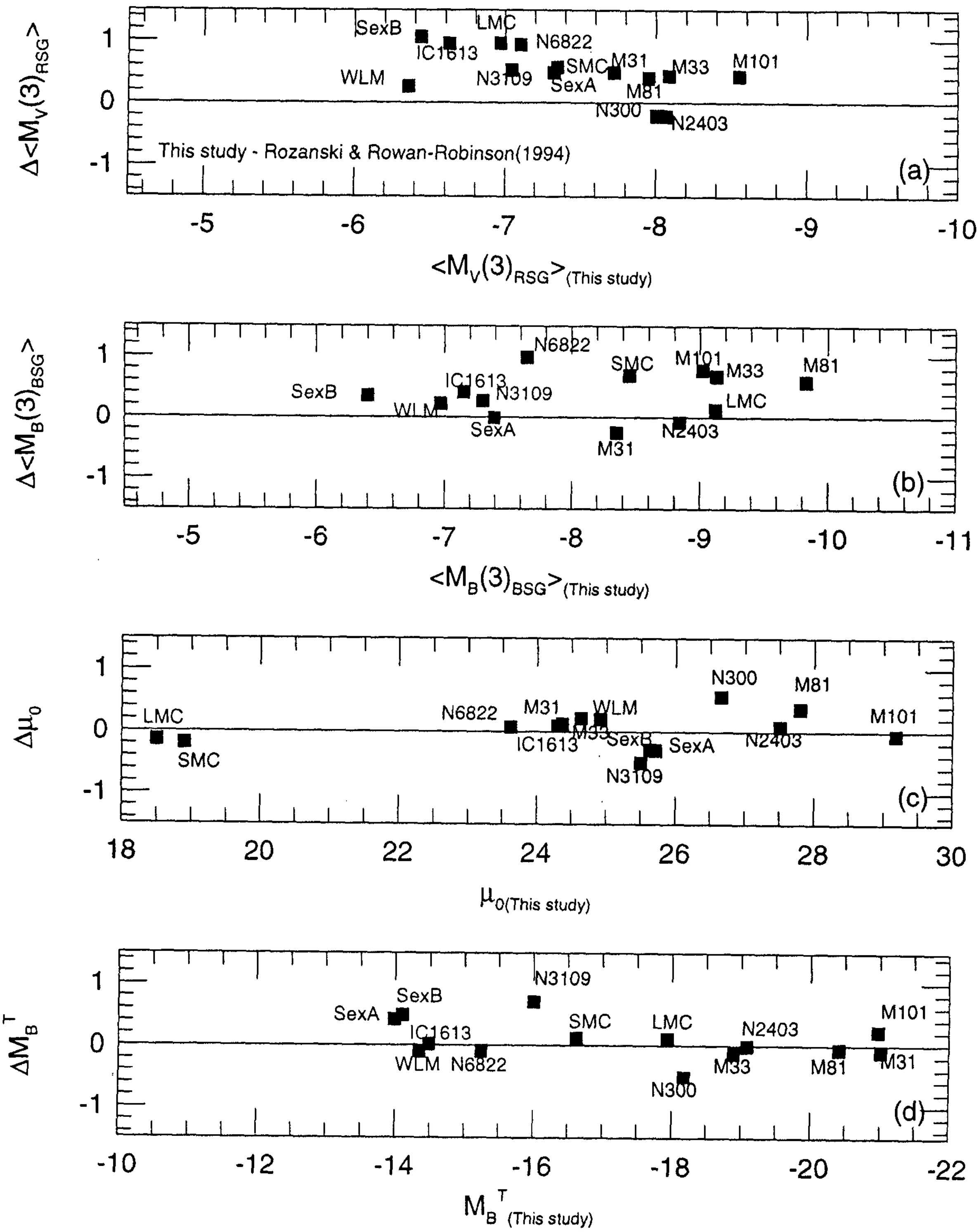

Fig. 6(b). Comparison of the data used in this study and RR94. (a) V magnitudes of the three brightest red supergiants. (b) B magnitudes of the three brightest blue supergiants. (c) distance moduli of each sample galaxy. (d) B magnitudes of the parent galaxies.

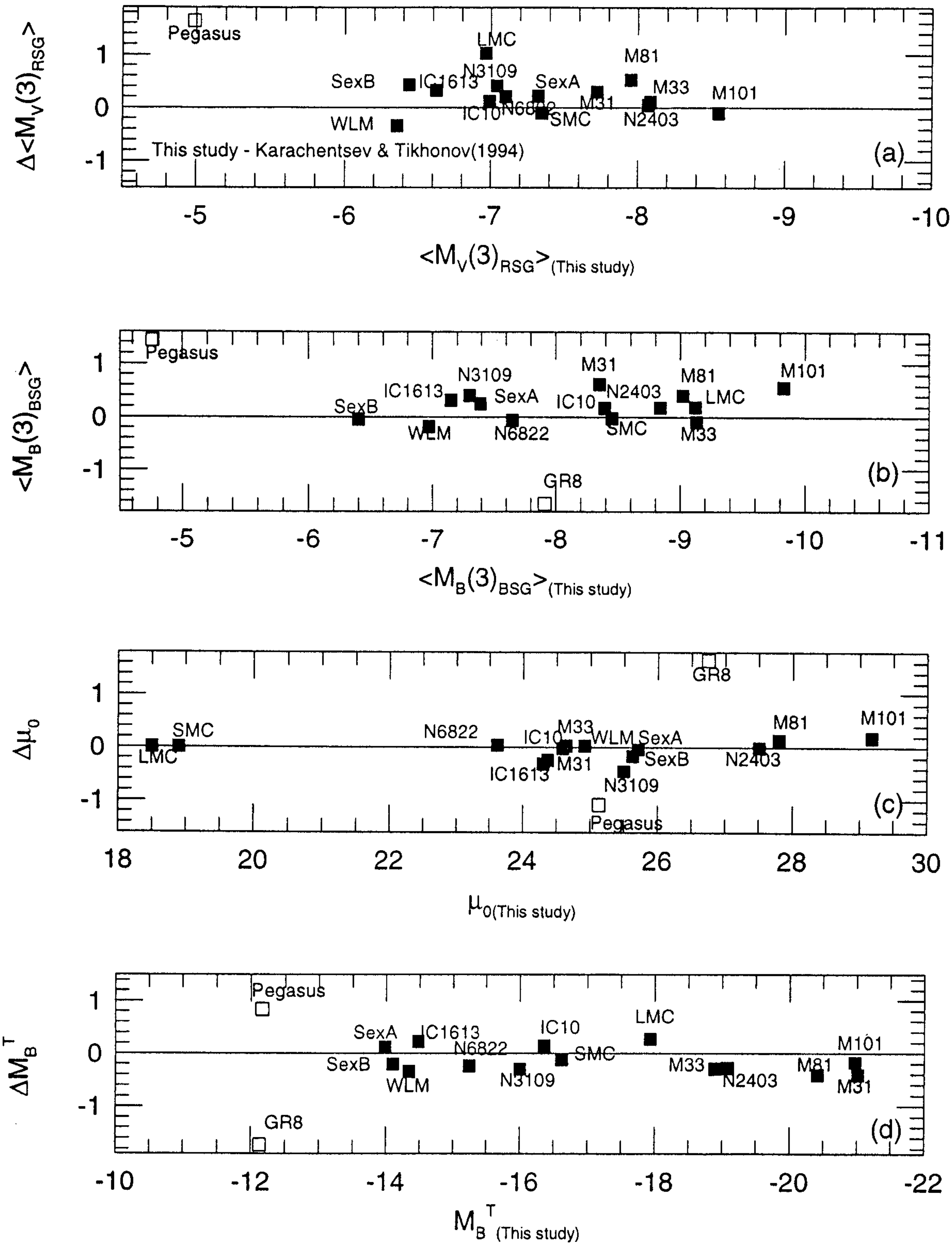

Fig. 6(c). Comparison of the data used in this study and KT94. (a) V magnitudes of the three brightest red supergiants. (b) B magnitudes of the three brightest blue supergiants. (c) distance moduli of each sample galaxy. (d) B magnitudes of the parent galaxies.

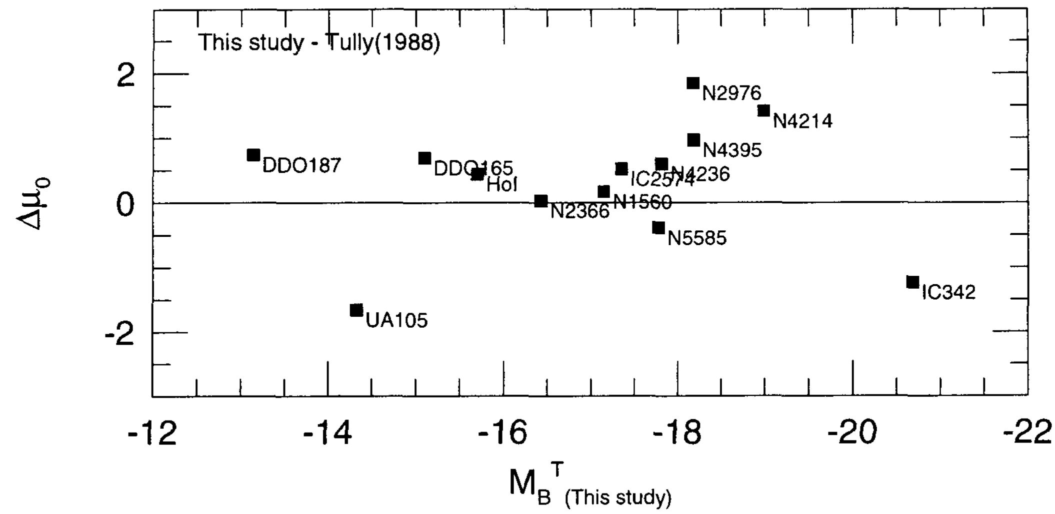

Fig. 7. Comparison of the distance estimates for the 15 galaxies obtained in this study and those given in the Tully(1988)'s Nearby Galaxy Catalog

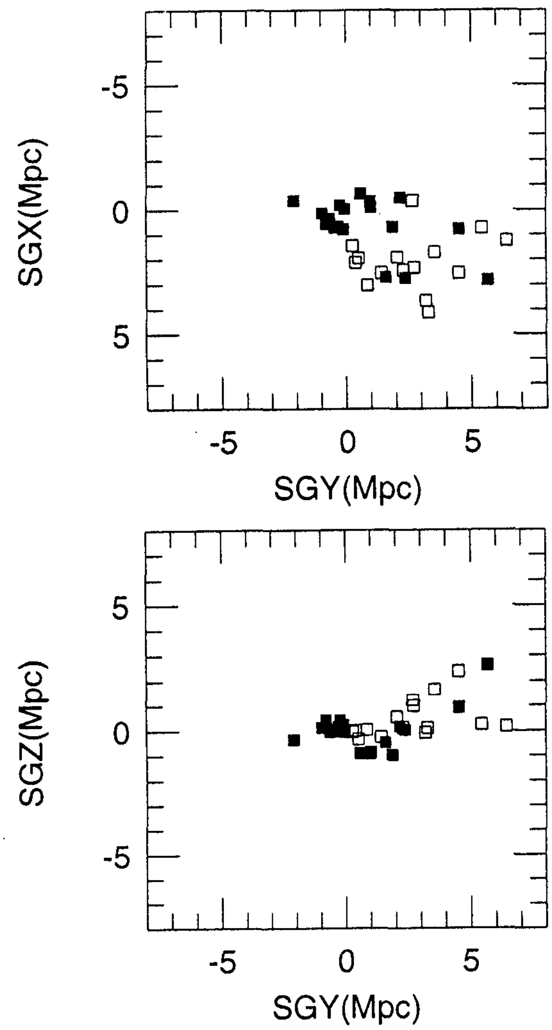

Fig. 8. Spatial distribution of the nearby galaxies in the supergalactic coordinates. The filled squares represent the sample galaxies used as calibrators, and the open squares represent the galaxies to which the distances were determined using the calibrations obtained in this study.

Table 7. Distance estimates for nearby galaxies using the brightest stars.

Galaxy	Type	V_{GSR} (km/s)	B_T^0	V_T^0	$A_g(B)$	$A_i(B)$	$< B(3)_{BSG} >$	$< V(3)_{BSG} >$	$< B(3)_{RSG} >$	$< V(3)_{RSG} >$	References for the brightest stars	$\mu_0(RSG)$	$\mu_0(BSG)$	Tully (1988) catalog
NGC 1560	Sd	106	10.39	9.82	0.67	1.04	19.93 ± 0.17	20.05 ± 0.46	22.53 ± 0.22	20.61 ± 0.04	1	27.54	27.38	27.37
DDO 165	Im	169	12.81	12.48	0.04	0.20	20.29 ± 0.38	20.43 ± 0.37	22.60 ± 0.13	20.93 ± 0.07	1	27.91	27.75	27.22
NGC 2976	Sd	106	10.30	9.75	0.11	0.51	19.48 ± 0.35	19.75 ± 0.27	22.31 ± 0.40	20.90 ± 0.23	1	28.48	27.57	26.63
IC 342	Scd	178	6.04	—	3.05	0.01	19.21 ± 0.25	18.91 ± 0.19	23.16 ± 0.32	20.88 ± 0.13	2	26.72	24.81	27.96
UA 86	Sm	209	10.88	—	3.27	0.05	21.63 ± 0.44	20.80 ± 0.38	—	—	2	—	25.88	28.19
UA 105	Im	223	12.27	—	1.48	0.15	20.87	—	—	20.88	3	26.60	26.76	28.26
Ho I	Im	250	12.96	—	0.06	0.07	21.31	—	—	21.57	3	28.66	29.12	28.22
DDO 187	Im	197	14.28	13.90	0.00	0.08	20.90 ± 0.21	21.05 ± 0.16	22.28 ± 0.91	20.82 ± 0.77	4	27.42	28.05	26.68
NGC 5474	Scdp	395	11.30	10.82	0.00	0.07	20.10	—	—	—	5	—	28.19	28.87
NGC 5585	Sd	436	11.05	10.59	0.00	0.27	20.15	—	—	21.26	5	28.83	28.36	29.22
NGC 4395	Sm	337	10.57	10.11	0.01	0.08	19.29	—	—	21.10	6	28.75	27.33	27.78
NGC 4214	Im	313	10.14	9.68	0.00	0.08	19.23	—	—	21.30	6	29.13	27.44	27.71
NGC 2366	ImB	209	10.95	10.60	0.18	0.29	19.25 ± 0.47	19.46 ± 0.56	22.37 ± 0.85	20.23 ± 0.50	7	27.38	26.86	27.35
NGC 4236	SdmB	127	9.53	9.12	0.06	0.59	19.09 ± 0.30	19.63 ± 0.48	21.39 ± 0.09	19.81 ± 0.10	7	27.34	27.42	26.74
IC 2574	Sm	154	10.33	9.91	0.07	0.40	19.56 ± 0.43	19.99 ± 0.75	21.94 ± 0.24	20.25 ± 0.14	7	27.68	27.73	27.16

1. Karachentsev et al. (1991) 2. Karachentsev & Tikhonov (1993) 3. Tikhonov et al. (1992) 4. Aparicio et al. (1988a) 5. Karachentsev et al. (1994)
6. Sandage & Tammann (1982) 7. Tikhonov et al. (1991)

GR 8: Tolstoy ct al. (1995) presented a cepheid distance modulus of $\mu_0 = 26.75 \pm 0.35$. However, only one cepheid was used for the distance estimate and the color of the cepheid is not known in their study. So further studies are needed for better determination of the distance to this galaxy.

NGC 4571: There are available only B and V magnitudes converted from R-band magnitudes of the BSGs and RSGs (Pierce *et al.* 1992) so that it was not included for the calibration.

We have examined carefully all the data of the brightest stars in the sample galaxies which were listed in Appendix, and have selected the brightest stars in each galaxy using the color-magnitude diagrams. Then we have derived the mean apparent magnitudes of the BSGs and RSGs in each galaxy. Similar data compiled by RR94 were very useful for this procedure. Table 2 presents the data for the mean apparent magnitudes of the BSGs and RSGs and the Cepheid distances for the sample galaxies. Table 2 is composed as follows. Column 1: the name of the galaxy; columns 2 and 3: B, V-band total magnitudes of the galaxy; columns 4 and 5: B-band foreground and internal extinctions of the galaxy; columns 6–10: B, V, U, R, I-band mean apparent magnitudes of the three BSGs; columns 11–17: B, V, R, I, J, H, K-band mean apparent magnitudes of the three RSGs; and column 18: the intrinsic distance moduli of the galaxies. The total magnitudes and extinction values for each galaxy are from RC3 (de Vaucouleurs *et al.* 1991). We have derived the absolute total magnitudes of the sample galaxies using the distance moduli, foreground and internal extinctions listed in Table 2.

Internal extinction correction for the BSGs and RSGs is a controversial problem which was well summarized in RR94. Humphreys (1980) argued that the correct determination of the internal extinction for individual stars in galaxies is necessary to determine the absolute magnitudes of the stars and use them as distance indicators, while Sandage & Tammann (1982) presented counter-arguments. In this study we have derived the absolute magnitudes of the BSGs and RSGs of the sample galaxies using the foreground extinction correction only, because the internal extinctions for the BSGs and RSGs are mostly not known for the sample galaxies and future program galaxies the distances to which to be determined using the calibrations based on the sample galaxies.

IV. RESULTS

(a) Color-Magnitude Diagrams

We display in Fig. 1 the color-magnitude diagrams of the mean magnitudes and colors of the three BSGs and RSGs in the sample galaxies the data of which are listed in Table 2. Following features are seen in Fig. 1. (a) The BSGs in M101 are the brightest and the RSGs and BSGs in Pegasus dwarf galaxy are the faintest among the sample galaxies. (b) The RSGs in M33 are the reddest and the RSGs in the Sextans B dwarf galaxy are the bluest among the RSGs. (c) The brightest BSGs are brighter (by ≈3 mag at B-band and ≈2 mag at V-band) than the brightest RSGs. (d) The color range of the BSGs is smaller than that of the RSGs. (e) The magnitude range of the RSGs is smaller than that of the BSGs.

(b) Luminosity Calibrations

We have plotted $BVRIJHK$ absolute magnitudes of the RSGs vs. B and V absolute total magnitudes of the parent galaxies in Fig. 2, and have plotted $BVUR$ absolute magnitudes of the BSGs vs. B and V absolute total magnitudes of the parent galaxies in Fig. 3.

These figures show approximately linear relations between the absolute mangitudes of the RSGs and BSGs and the absolute total magnitudes of the parent galaxies. We have fitted these data using the linear equation $M_s = aM_g + b$, as given in Sec. 2, the results of which are summarized in Tables 3, 4 and 5. The standard deviations of the fit and the corresponding errors for the distance modulus estimates are also listed in Tables 3, 4 and 5. Among these the most commonly used calibrations are $< M_V(3)_{RSG} >= 0.21M_B^T - 3.84$, $\sigma(M_V) = 0.37$ mag, and $\delta\mu_0 = 0.47$ mag for the RSGs, and $< M_B(3)_{BSG} >= 0.30M_B^T - 3.02$, $\sigma(M_B) = 0.55$ mag, and $\delta\mu_0 = 0.79$ mag for the BSGs.

The number of the calibrator galaxies for URI-bands are very small so that the calibrations errors for these bands are much larger than those for other bands. However, these calibrations, especially those for R and$I$ bands, will be useful, once the number of the calibrators increases, for determining the distances to relatively distant resolved late-type galaxies. For example, R-band photometry has been used for studying the brightest stars in NGC 4571

(Pierce *et al.* 1992) and NGC 4523 (Shanks *et al.* 1992) which are probably more distant than 10 Mpc.

We have investigated the dependence of the σ on the wavelength using seven galaxies for which $BVJHK$ photometry of the RSGs are available, as shown in Fig. 4. The results of the linear fitting to these data are listed in Tables 5a and 5b. These results show that the errors of the brightest red supergiants for distance estimates for seven common galaxies (LMC, NGC 6822, IC 1613, M33, Sextans A, NGC 2403, M31) are estimated to be 0.61, 0.51, 0.36, 0.34, and 0.33 mag, respectively, for the B, V, J, H, and K bands, showing that the errors in the distance determination are reduced, as the wavelengths increase. Therefore the JHK magnitudes of the RSGs will be good distance indicators, once the RSGs in the galaxy are identified by BV photometry and/or spectroscopy and the number of the calibrators for the relations increases.

V. DISCUSSION

(a) Comparison with Previous Studies

We have compared our luminosity calibrations for the BSG and RSGs with previous studies by Piotto *et al.* (called as PCB92 hereafter), RR94, KT94, de Vaucouleurs (1978), Aparicio *et al.* (1987) and Sandage & Carlson (1988). The results of the comparison are listed in Tables 6a and b, and are illustrated in Fig. 5.

From the comparison we have found the followings. (a) In general, our luminosities for the RSGs and BSGs are systematically fainter than other studies. (b) The distance determination error based on the V-band magnitudes of the RSGs in our study, $\delta\mu_0 = 0.47$ mag, is between RR94's and KT94's. (c) The distance determination error based on the B-band magnitudes of the BSGs in our study, $\delta\mu_0 = 0.79$ mag, is much larger than KT94's, and slightly smaller than RR94's and PCB92's. (d) The slope of our calibrations for the RSGs is similar to those of RR94 and PCB92, but larger (i.e. steeper) than that of KT94. (e) Our calibration for the BSGs is steeper than those of PCB92 and KT94, but slightly flatter than that of RR94. (f) The Sandage & Carlson's calibration for the BSGs is the steepest among the BSG calibrations.

In Fig. 6 we have compared the data used in this study and PCB92, RR94 and KT94, respectively, to investigate the reasons for the differences between our results and others: the magnitudes of the BSGs and RSGs, and the distance moduli and total magntidues of the parent galaxies. Fig. 6a shows that the magnitudes of the RSGs and BSGs used in this study are somewhat fainter than those in PCB92 ($\Delta < M_V(3)_{RSG} >= 0.35 \pm 0.50$ mag, and $\Delta < M_B(3)_{BSG} >= 0.41 \pm 0.49$ mag, and that the total B magnitudes of the parent galaxies are almost the same between the two ($\Delta M_B^T = -0.01 \pm 0.52$ mag) (hereafter Δ's represent our results minus others).

Fig. 6b shows that the data used in RR94 show similar trends to those of PCB92, but with larger differences ($\Delta < M_V(3)_{RSG} >= 0.51 \pm 0.41$ mag, $\Delta < M_B(3)_{BSG} >= 0.37 \pm 0.38$ mag, $\Delta\mu_0 = 0.02 \pm 0.30$ mag, and $\Delta M_B^T = 0.08 \pm 0.32$ mag). On the other hand, Fig. 6c shows that the magnitudes of the RSGs and BSGs used in KT94 show similar trends to those of RR94, but with much smaller differences ($\Delta < M_V(3)_{RSG} >= 0.23 \pm 0.34$ mag, and $\Delta < M_B(3)_{BSG} >= 0.19 \pm 0.26$ mag). However, the distance moduli and total magnitudes of the parent galaxies used in KT94 show trends opposite to those for RR94 ($\Delta\mu_0 = -0.06 \pm 0.18$ mag, and $\Delta M_B^T = -0.14 \pm 0.24$ mag).

Inspection of the features seen in Fig. 6 leads us to conclude that the reason for the fainter absolute luminosities of the BSGs and RSGs in our calibrations compared with those in other studies is basically that the absolute magnitudes of the BSGs and RSGs used in this study are fainter than those in previous studies. The differences in the absolute luminosity of the BSGs and RSGs are primarily due to the differences in the extinction corrections, and secondarily due to the different selection of the brightest stars in this study and other studies, as described below.

(a) RR94 and KT94 applied both of the foreground and internal extinction corrections to the photometry of the BSGs and RSGs in most of the calibrator galaxies, while we have applied only the foreground extinction to the data, as described in Section 2. The average values of the internal extinctions RR94 applied are $AV = 0.35$ mag and $A_B = 0.47$ mag. The mean difference in the foreground extinctions used in this study and in RR94 is very small, A_V (this study) - A_V (RR94) = -0.03 mag.

(b) Our data of the BSGs and RSGs are mostly based on the CCD photometry, while the data used in RR94, KT94, and others (except for PCB92) are based mostly on photographic photometry. The differences in the mean apparent V magnitudes of the RSGs in NGC 6822, IC 1613, WLM, Sext A, Sext B, and NGC 3109 in this study and RR94 are 0.32, 0.67, 0.38, 0.10, 0.63, and –0.13 mag, respectively. The differences in the mean apparent V magnitudes of the BSGs in NGC 6822, WLM, Sext A, Sext B, and NGC 3109 in this study and RR94 are –0.17, –0.21, –0.43, –0.17, –0.44, and 0.16 mag, respectively. In the case of the LMC, RR94 selected the BSGs after the total extinction correction, while we selected the BSGs before the extinction correction. This resulted in the difference in the mean B magnitude of the BSGs in this study and RR94, –0.47 mag. Therefore the mean differences are $\Delta < V(3) >_{\rm RSG}$(This study – RR94) = $+0.33 \pm 0.31$ mag and $\Delta < B(3) >_{\rm BSG}$(This study – RR94) = -0.11 ± 0.33 mag.

(b) Distance Estimates for Nearby Galaxies Using New Calibrations

We have estimated the distances to 15 nearby dwarf galaxies at $V = 100 - 500$ km/s using our calibrations for the BSGs and RSGs, as listed in Table 7. These galaxies are late-type spiral or irregular galaxies to which the distances are not yet well-determined, and the photometries of the BSGs and RSGs in these galaxies are available in the literature as shown in Table 7.

Fig. 7 displays the comparison of our results and those given in Tully(1988)'s Nearby Galaxy Catalog which lists the distances based on velocity for an assumed value of the Hubble constant H_0 = 75 km/sec. Fig. 7 shows our estimates for the distance moduli are on average slightly larger than Tully's, but that there is a large scatter around the mean difference: $\Delta\mu_0$(This study – Tully) = 0.32 ± 1.02 mag.

We illustrate the spatial distribution in the supergalactic coordinates of the sample galaxies used as calibrators and the 15 nearby galaxy the distances to which are listed in Table 7. Fig. 8 shows that the RSGs are useful for mapping out nearby resolved late-type galaxies efficiently.

VI. SUMMARY AND CONCLUSIONS

We have re-examined the accuracy of the BSGs and RSGs in galaxies as distance indicators using the 17 sample galaxies for which cepheid distances are known and reliable photometry of the BSGs and RSGs are available. We have obtained new calibrations of the relations between the $BVRIJHK$ absolute magnitudes of the BSGs and RSGs and the BV absolute total magnitudes of the parent galaxies.

The distance determination errors for the BSGs and RSGs obtained in this study are intermediate between the two recent studies by RR94 and KT94 that presented contradictory results. It is also found that the distance determination errors for the RSGs decrease as the wavelength increases from B-band to K-band, suggesting that JHK magnitudes of the RSGs are potentially good distance indicators. In conclusion, the RSGs in galaxies are distance indicators useful for resolved late-type galaxies of which cepheid photometry is difficult to obtain.

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The appendix lists the data for the brightest stars in galaxies examined in this study. A represents the total reddening for the brightest stars. Note that we have applied only the foreground extinction correction to the photometry of the brightest stars, as described in Sec. 3.

1. Large Magellanic Cloud

(1) Humphreys (1979, ApJS, 39, 389)

Table A.1. LMC−RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	$(R-I)$	A
Wb#67	M1Ia	13.43	11.43	2.00	1.58	2.82	0.9
Wb#73	M1Ia	13.78	11.86	1.92	1.62	2.87	0.9
B32	M0Ia	13.93	11.81	2.12	1.68	2.82	1.2
B28	M2Ia	13.99	11.92	2.07	1.67	2.94	0.9

We have selected Wb#67, Wb#73, and B32 as the three brightest RSGs.
$< B(3) >= 13.71 \pm 0.26$ mag, $< V(3) >= 11.70 \pm 0.24$ mag, $< (B-V)(3) >= 2.01 \pm 0.10$ mag, $< R(3) >= 10.07 \pm 0.20$ mag, and $< I(3) >= 7.24 \pm 0.18$ mag.

Table A.2. LMC−BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$
HD33579	A3Ia-0	9.31	9.12	0.19	−0.24
HD32034	B9Iae	9.78	9.69	0.09	−0.61
NS82-68	B5I	9.86	9.88	-0.02	–
NS201-67	A0Iae	9.93	9.88	0.05	−0.59

We have selected HD33579, HD32034, and NS82-68 as the three brightest BSGs.
$< B(3) >= 9.65 \pm 0.30$ mag, $< V(3) >= 9.56 \pm 0.40$ mag, $< (B-V)(3) >= 0.09 \pm 0.11$ mag, and $< U(3) >= 9.12 \pm 0.07$ mag.

(2) Elias *et al.* (1985, ApJS, 57, 91)

Table A.3. LMC−RSG.

Star(H#)	Sp. type	B	V	$(B-V)$	$(V-R)$	$(V-I)$	J	H	K	L	A
46-44(Wb#67)	M1Ia	13.63	11.64	1.99	1.58	2.87	7.92	7.21	6.96	6.59	0.9
46-32(B32)	M0Ia	13.66	11.67	1.99	1.82	3.45	8.29	7.57	7.30	6.98	1.1
53-3	M0Ia	13.97	11.92	2.05	1.48	2.50	8.73	8.01	7.77	7.38	0.7
46-39(Wb#73)	M1Ia	14.30	12.55	1.75	1.68	3.13	8.36	7.62	7.35	6.99	0.9

* H# : Humphreys(1979)'s star number.
We have selected 46-44, 46-32, and 53-3 as the three brightest RSGs.
$< B(3) >= 13.75 \pm 0.19$ mag, $< V(3) >= 11.74 \pm 0.15$ mag, $< (B-V)(3) >= 2.01 \pm 0.03$ mag, $< R(3) >= 10.12 \pm 0.03$ mag, $< I(3) >= 8.80 \pm 0.60$ mag, $< J(3) >= 8.31 \pm 0.41$ mag, $< H(3) >= 7.60 \pm 0.40$ mag, $< K(3) >= 7.34 \pm 0.41$ mag, and $< L(3) >= 6.98 \pm 0.40$ mag.

♣ Summary ♣
RSG : We have selected the stars of Elias *et al.* (1985).
$< B(3) >= 13.75 \pm 0.19$ mag, $< V(3) >= 11.74 \pm 0.15$ mag, $< (B-V)(3) >= 2.01 \pm 0.03$ mag, $< R(3) >= 10.12 \pm 0.03$ mag, $< I(3) >= 8.80 \pm 0.60$ mag, $< J(3) >= 8.31 \pm 0.41$ mag, $< H(3) >= 7.60 \pm 0.40$ mag, $< K(3) >= 7.34 \pm 0.41$ mag, and $< L(3) >= 6.98 \pm 0.40$ mag.
BSG : We have selected the stars of Humphreys(1979).
$< B(3) >= 9.65 \pm 0.30$ mag, $< V(3) >= 9.56 \pm 0.40$ mag $< (B-V)(3) >= 0.09 \pm 0.11$ mag, and $< U(3) >= 9.12 \pm 0.07$ mag.

2. Small Magellanic Cloud
(1) Humphreys (1979, ApJ, 231, 384)

Table A.4. SMC–RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	$(V-I)$
SMC25	K5-M0Ia	13.22	11.34	1.88	1.33	2.21
SMC81	K5-M0Ia	13.79	11.96	1.83	1.33	2.24
HV1475	K0-K5Ia	13.72	12.01	1.71	1.23	2.06

$< B(3) >= 13.58 \pm 0.31$ mag, $< V(3) >= 11.77 \pm 0.37$ mag, $< (B-V)(3) >= 1.81 \pm 0.09$ mag, $< R(3) >= 10.47 \pm 0.41$ mag, and $< I(3) >= 9.60 \pm 0.42$ mag.

(2) Elias *et al.* (1985, ApJ, 289, 141) and Elias *et al.* (1985, ApJS, 57, 91)

Table A.5. SMC–RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	$(V-I)$	$(V-K)$	A
107-1	K5-M0Ia	13.22	11.34	1.88	1.33	2.21	3.76	0.5
HV11423	M0Ia	13.59	11.77	1.82	1.40	2.37	3.93	0.4
120-14	K5-M0I	13.79	11.96	1.83	1.33	2.30	3.78	0.5
118-15	M0I	14.07	12.07	2.00	1.46	2.59	4.18	0.7

We have selected 107-1, HV11423, and 120-14 as the three brightest RSGs.
$< B(3) >= 13.53 \pm 0.29$ mag, $< V(3) >= 11.69 \pm 0.32$ mag, $< (B-V)(3) >= 1.84 \pm 0.03$ mag, $< R(3) >= 10.34 \pm 0.31$ mag, $< I(3) >= 9.40 \pm 0.27$ mag, and $< K(3) >= 7.87 \pm 0.30$ mag.

(3) Garmany *et al.* (1987, AJ, 93, 1070)

Table A.6. SMC–BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$
AV475(HD7583)	A0Iao	10.35	10.22	0.13	−0.34
AV415(HD6884)	B9Iaoe	10.62	10.52	0.10	−0.57
AV443(HD7099)	B3Iao	10.91	10.97	−0.06	−0.85

$< B(3) >= 10.63 \pm 0.28$ mag, $< V(3) >= 10.57 \pm 0.38$ mag, $< (B-V)(3) >= 0.06 \pm 0.13$ mag, and $< U(3) >= 10.04 \pm 0.03$ mag.
♣ Summary ♣
RSG : We have selected the stars of Elias *et al.* (1985).
$< B(3) >= 13.53 \pm 0.29$ mag, $< V(3) >= 11.69 \pm 0.32$ mag, $< (B-V)(3) >= 1.84 \pm 0.03$ mag, $< R(3) >= 10.34 \pm 0.31$ mag, $< I(3) >= 9.40 \pm 0.27$ mag, and $< K(3) >= 7.87 \pm 0.30$ mag.
BSG : We have selected the stars of Garmany *et al.* (1987).
$< B(3) >= 10.63 \pm 0.28$ mag, $< V(3) >= 10.57 \pm 0.38$ mag, $< (B-V)(3) >= 0.06 \pm 0.13$ mag, and $< U(3) >= 10.04 \pm 0.03$ mag.

3. NGC 6822

(1) Humphreys (1980, ApJ, 238, 65)

Table A.7. NGC 6822–RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	A
B110	M0I	18.35	16.46 ± 0.15	1.89 ± 0.27	1.27 ± 0.09	1.2
V18	M1-M2I	18.16	16.72 ± 0.05	1.44 ± 0.11	1.56 ± 0.05	1.3
C79	M0-M1I	19.03	16.96 ± 0.23	2.07 ± 0.16	1.69 ± 0.01	1.0
V19	M1I	19.02	17.55 ± 0.03	1.47 ± 0.10	1.47 ± 0.03	1.7

We have selected B110, V18, and C79 as the three brightest RSGs.
$< B(3) >= 18.51 \pm 0.46$ mag, $< V(3) >= 16.71 \pm 0.25$ mag, $< (B-V)(3) >= 1.80 \pm 0.32$ mag, and $< R(3) >= 15.21 \pm 0.06$ mag.

Table A.8. NGC 6822–BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$	$(V-R)$	A
C74	B1I	16.76	16.44 ± 0.10	0.32 ± 0.05	-0.47 ± 0.09	0.33 ± 0.02	1.6
B1	OB	16.81	16.47 ± 0.15	0.34 ± 0.08	-0.42 ± 0.05	0.39 ± 0.02	1.2
E191	B8-A0I:	17.11	16.77 ± 0.18	0.34 ± 0.14	-0.42 ± 0.06	0.27 ± 0.02	1.0
A153	B5I	17.65	17.05 ± 0.20	0.60 ± 0.10 :	-0.32 ± 0.01	0.77 ± 0.03	2.1

We have selected C74, B1, and E191 as the three brightest BSGs.
$< B(3) >= 16.89 \pm 0.19$ mag, $< V(3) >= 16.56 \pm 0.18$ mag, $< (B-V)(3) >= 0.33 \pm 0.01$ mag, $< U(3) >= 16.46 \pm 0.21$ mag, and $< R(3) >= 16.23 \pm 0.23$ mag.

(2) Elias & Frogel (1985, ApJ, 289, 141)

Table A.9. NGC 6822–RSG.

Star	Sp. type	K	$(J-K)$	$(H-K)$	$(V-K)$
V18	M1-M2I	12.18	1.00	0.24	4.87
C79	M0-M1I	12.48	0.99	0.20	4.48
V19	M1I	12.52	0.92	0.21	4.97

$< V(3) >= 17.17 \pm 0.28$ mag, $< J(3) >= 13.36 \pm 0.16$ mag, $< H(3) >= 12.61 \pm 0.17$ mag, and $< K(3) >= 12.39 \pm 0.19$ mag.

(3) Wilson (1992, AJ, 104, 1374)

Table A.10. NGC 6822–RSG.

Star	B	V	$(B-V)$
24	18.85 ± 0.01	16.96 ± 0.00	1.89
74	19.18 ± 0.03	17.07 ± 0.02	2.11
60	19.67 ± 0.02	17.65 ± 0.01	2.01

$< B(3) >= 19.23 \pm 0.41$ mag, $< V(3) >= 17.23 \pm 0.37$ mag, and $< (B-V)(3) >= 2.00 \pm 0.11$ mag.

Table A.11. NGC 6822–BSG.

Star	B	V	$(B-V)$
117	16.74 ± 0.04	16.57 ± 0.04	0.17
136	16.87 ± 0.01	16.61 ± 0.00	0.26
80	17.08 ± 0.01	16.66 ± 0.01	0.42

$< B(3) >= 16.90 \pm 0.17$ mag, $< V(3) >= 16.61 \pm 0.05$ mag, and $< (B-V)(3) >= 0.28 \pm 0.13$ mag.
♣ Summary ♣
RSG : We have selected the stars of Wilson (1992).
$< B(3) >= 19.23 \pm 0.41$ mag, $< V(3) >= 17.23 \pm 0.37$ mag, and $< (B-V)(3) >= 2.00 \pm 0.11$ mag.
We have selected the stars of Elias & Frogel (1985).
$< J(3) >= 13.36 \pm 0.16$ mag, $< H(3) >= 12.61 \pm 0.17$ mag, and $< K(3) >= 12.39 \pm 0.19$ mag.
BSG : We have selected the stars of Wilson (1992).
$< B(3) >= 16.90 \pm 0.17$ mag, $< V(3) >= 16.61 \pm 0.05$ mag, and $< (B-V)(3) >= 0.28 \pm 0.13$ mag.

4. IC 1613

(1) Humphreys (1980, ApJ, 238, 65)

Table A.12. IC 1613–RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	A
V38	M0Ia	18.50	16.85 ± 0.02	1.65 ± 0.05	1.33 ± 0.01	0.7
V32	M1Ia	18.87	17.05 ± 0.02	1.82 ± 0.02	1.39 ± 0.02	0.4
V43	M1I	18.83	17.46 ± 0.03	1.37 ± 0.05	1.07 ± 0.03	0.3

$< B(3) >= 18.73 \pm 0.20$ mag, $< V(3) >= 17.12 \pm 0.31$ mag, $< (B-V)(3) >= 1.61 \pm 0.23$ mag, and $< R(3) >= 15.86 \pm 0.47$ mag.

Table A.13. IC 1613–BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$	$(V-R)$	A
A43	A0Ia	16.48	16.38 ± 0.01	0.10 ± 0.01	-0.43 ± 0.02	0.15 ± 0.02	0.3
B42	cB	16.60	16.79 ± 0.02	-0.19 ± 0.01	-1.06 ± 0.01	0.00 ± 0.04	0.2
22A	B2-B3I	16.96	17.06 ± 0.02	-0.10 ± 0.01	-0.96 ± 0.03	0.20 ± 0.02	0.3
A42	cB	17.10	17.28 ± 0.09	-0.18 ± 0.02	-0.98 ± 0.05	0.03 ± 0.07	0.2

We have selected 22A, A43, and B42 as the three brightest BSGs.
$< B(3) >= 16.68 \pm 0.25$ mag, $< V(3) >= 16.74 \pm 0.34$ mag, $< (B-V)(3) >= -0.06 \pm 0.15$ mag, $< U(3) >= 15.86 \pm 0.28$ mag, and $< R(3) >= 16.63 \pm 0.35$ mag.

(2) Elias & Frogel (1985, ApJ, 289, 141)

Table A.14. IC 1613–RSG.

Star	Sp. type	K	$(J-K)$	$(H-K)$	$(V-K)$
V32	M1Ia	13.12	0.87	0.22	4.05
V38	M0Ia	13.12	0.84	0.18	3.84
V58	–	14.10	0.84	0.16	3.45

$< V(3) >= 17.40 \pm 0.37$ mag, $< J(3) >= 14.30 \pm 0.56$ mag, $< H(3) >= 13.63 \pm 0.54$ mag, and $< K(3) >= 13.45 \pm 0.57$ mag.

(3) Freedman (1988, AJ, 96, 1248)

Table A.15. IC 1613−RSG.

Star	B	V	R	I	$(B-V)$	$(V-R)$	$(R-I)$
395(V38)	19.09 ± 0.02	17.13 ± 0.02	16.11 ± 0.04	15.24 ± 0.05	1.97	1.02	0.87
11(V32)	19.51 ± 0.04	17.42 ± 0.02	16.35 ± 0.05	15.24 ± 0.05	2.09	1.06	1.12
791	20.22 ± 0.02	18.51 ± 0.03	17.69 ± 0.03	16.98 ± 0.04	1.71	0.82	0.71

$< B(3) >= 19.61 \pm 0.57$ mag, $< V(3) >= 17.69 \pm 0.73$ mag, $< (B-V)(3) >= 1.92 \pm 0.19$ mag, $< R(3) >= 16.72 \pm 0.85$ mag, and $< I(3) >= 15.82 \pm 1.00$ mag.

Table A.16. IC 1613−BSG.

Star	B	V	R	I	$(B-V)$	$(V-R)$	$(R-I)$
91(A43)	16.61 ± 0.03	16.41 ± 0.03	16.24 ± 0.04	16.07 ± 0.03	0.20	0.18	0.17
297(22A)	17.27 ± 0.02	17.39 ± 0.03	17.43 ± 0.05	17.51 ± 0.03	−0.12	−0.04	−0.09
826(B42)	17.62 ± 0.03	17.78 ± 0.03	17.84 ± 0.04	17.88 ± 0.03	−0.15	−0.06	−0.04
137(A42)	18.27 ± 0.03	18.13 ± 0.02	18.25 ± 0.05	18.33 ± 0.04	−0.15	0.02	−0.07

We have selected 91, 297, and 826 as the three brightest BSGs.
$< B(3) >= 17.17 \pm 0.51$ mag, $< V(3) >= 17.19 \pm 0.71$ mag, $< (B-V)(3) >= -0.02 \pm 0.19$ mag, $< R(3) >= 17.17 \pm 0.83$ mag, and $< I(3) >= 17.15 \pm 0.96$ mag.

♣ Summary ♣

RSG : We have selected the stars of Freedman (1988).
$< B(3) >= 19.61 \pm 0.57$ mag, $< V(3) >= 17.69 \pm 0.73$ mag, $< (B-V)(3) >= 1.92 \pm 0.19$ mag, $< R(3) >= 16.72 \pm 0.85$ mag, and $< I(3) >= 15.82 \pm 1.00$ mag.
We have selected the stars of Elias & Frogel (1985).
$< J(3) >= 14.30 \pm 0.56$ mag, $< H(3) >= 13.63 \pm 0.54$ mag, and $< K(3) >= 13.45 \pm 0.57$ mag.
BSG : We have selected the stars of Freedman (1988).
$< B(3) >= 17.17 \pm 0.51$ mag, $< V(3) >= 17.19 \pm 0.71$ mag, $< (B-V)(3) >= -0.02 \pm 0.19$ mag, $< R(3) >= 17.17 \pm 0.83$ mag, and $< I(3) >= 17.15 \pm 0.96$ mag.

5. M31

(1) Humphreys *et al.* (1988, AJ, 96, 1884)

Table A.17. M31−RSG.

Star	Sp. type	B	V	$(B-V)$	$(V-R)$	K	A	A
R143	M0	18.13	16.54 ± 0.17	1.59 ± 0.25	0.90 ± 0.27	12.69 ± 0.03	0.83	0.08
R182	M1	18.89	16.95 ± 0.19	1.94 ± 0.31	1.16 ± 0.29	13.80 ± 0.01	0.55	0.05
R95	M1/M2	18.74	17.20 ± 0.19	1.54 ± 0.29	1.51 ± 0.30	12.98 ± 0.03	0.89	0.08

$< B(3) >= 18.59 \pm 0.40$ mag, $< V(3) >= 16.90 \pm 0.33$ mag, $< (B-V)(3) >= 1.69 \pm 0.22$ mag, $< R(3) >= 15.71 \pm 0.08$ mag, and $< K(3) >= 12.89 \pm 0.66$ mag.

(2) Humphreys *et al.* (1990, AJ, 99, 84)

Table A.18. M31−BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$	A	ref
41-2368	A8Ia	16.10	16.25	-0.15 ± 0.29	-0.63 ± 0.25	0.60	2
41-3654	A2Ia	16.48	16.19	0.29:	−0.47:	0.77	1
41-3712	A3Ia	16.48	16.19 ± 0.17	0.29 ± 0.24	-0.89 ± 0.22	0.64	2

ref : 1 - Massey *et al.* , 1986, AJ, 92, 1303
2 - Berkhuijsen *et al.* , 1988, A&AS, 76, 65
$< B(3) >= 16.35 \pm 0.22$ mag, $< V(3) >= 16.21 \pm 0.03$ mag, $< (B-V)(3) >= 0.14 \pm 0.25$ mag, and $< U(3) >= 15.69 \pm 0.28$ mag.

(3) Nedialkov *et al.* (1989, ApSS, 162, 1)

Table A.19. M31–RSG.

Star	B	V	$(B-V)$
R4	18.29	16.19	2.10
R31	18.51	16.71	1.80
R36	19.70	16.85	2.85

$< B(3) >= 18.83 \pm 0.76$ mag, $< V(3) >= 16.58 \pm 0.35$ mag, and $< (B-V)(3) >= 2.25 \pm 0.54$ mag.

Table A.20. M31–BSG.

Star	B	V	$(B-V)$	$(U-B)$	U
87	16.88	16.90	−0.02	−0.18	16.70
27	17.15	17.18	−0.03	−0.50	16.65
70	17.20	17.23	−0.03	−0.43	16.77
29	17.22	17.37	−0.15	−0.92	16.30

We have selected 87, 27, and 70 as the three brightest BSGs.
$< B(3) >= 17.08 \pm 0.17$ mag, $< V(3) >= 17.10 \pm 0.18$ mag $< (B-V)(3) >= -0.03 \pm 0.01$ mag, and $< U(3) >= 16.71 \pm 0.06$ mag.

♣ Summary ♣

RSG : We have selected the stars of Humphreys *et al.* (1988)
$< B(3) >= 18.59 \pm 0.40$ mag, $< V(3) >= 16.90 \pm 0.33$ mag, $< (B-V)(3) >= 1.69 \pm 0.22$ mag, $< R(3) >= 15.71 \pm 0.08$ mag, and $< K(3) >= 12.89 \pm 0.66$ mag.
BSG : We have selected the stars of Humphreys *et al.* (1990)
$< B(3) >= 16.35 \pm 0.22$ mag, $< V(3) >= 16.21 \pm 0.03$ mag, $< (B-V)(3) >= 0.14 \pm 0.25$ mag, and $< U(3) >= 15.69 \pm 0.28$ mag.

6. IC 10

(1) Karachentsev *et al.* (1993, A&AS, 100, 227)

Table A.21. IC 10–RSG.

Star	B	V	$(B-V)$
59	22.50	19.72	2.78
103	23.70	20.45	3.25
75	23.45	20.66	2.79

$< B(3) >= 23.22 \pm 0.63$ mag, $< V(3) >= 20.28 \pm 0.49$ mag, and $< (B-V)(3) >= 2.94 \pm 0.27$ mag.

Table A.22. IC 10–BSG.

Star	B	V	$(B-V)$
67	19.32	18.83	0.49
66	19.82	19.24	0.58
27	19.96	19.14	0.82

$< B(3) >= 19.70 \pm 0.34$ mag, $< V(3) >= 19.07 \pm 0.21$ mag, and $< (B-V)(3) >= 0.63 \pm 0.17$ mag.
♣ Summary ♣
RSG : $< B(3) >= 23.22 \pm 0.63$ mag, $< V(3) >= 20.28 \pm 0.49$ mag, and $< (B-V)(3) >= 2.94 \pm 0.27$ mag.
BSG : $< B(3) >= 19.70 \pm 0.34$ mag, $< V(3) >= 19.07 \pm 0.21$ mag, and $< (B-V)(3) >= 0.63 \pm 0.17$ mag.

7. M33

(1) Humphreys (1980, ApJ, 241, 587)

Table A.23. M33−RSG.

Star	Sp. type	B	V	$(B-V)$	A
R96	M0Ia	19.30	16.80	2.50	0.9:
R211	M1Ia	18.68	16.50	2.18	0.8:
R244	M1Ia	18.74	16.80	1.94	0.8

* : Humphreys & Sandage (1980)'s star number.
$< B(3) >= 18.91 \pm 0.34$ mag, $< V(3) >= 16.70 \pm 0.17$ mag, and $< (B-V)(3) >= 2.21 \pm 0.28$ mag.

Table A.24. M33−BSG.

Star	Sp. type	B	V	$(B-V)$	$(U-B)$	$(V-R)$	A
B324	A5eIa	15.51	15.20 ± 0.01	0.31 ± 0.01	-0.47 ± 0.01	–	0.65
5-A	A0Ia	15.58	15.50 ± 0.20 :	0.08 ± 0.03	-0.70 ± 0.01	0.34 ± 0.01	1.0 :
110-A	cB	16.02	16.06 ± 0.02	-0.04 ± 0.02	-0.96 ± 0.01	0.08 ± 0.03	0.7

* : Humphreys *et al.* (1990)'s star number.
$< B(3) >= 15.70 \pm 0.28$ mag, $< V(3) >= 15.59 \pm 0.44$ mag, $< (B-V)(3) >= 0.12 \pm 0.18$ mag,
$< U(3) >= 14.99 \pm 0.10$ mag, and $< R(3) >= 15.56 \pm 0.57$ mag.

(2) Humphreys *et al.* (1984, AJ, 89, 1155)

Table A.25. M33−RSG.

Star	Sp. type	V	A	V	K	A	K	$(V-K)$	$(J-H)$	$(H-K)$
R96	M0Ia	16.80	0.5	16.30	13.13	0.04	13.09	3.20	0.68	0.16
R211	M1Ia	17.00	1.4	15.60	12.50	0.12	12.38	3.20	0.60	0.22
R244	M1Ia	17.00	0.3	16.70	13.22	0.03	13.16	3.50	0.60	0.21

$< V(3) >= 16.93 \pm 0.12$ mag, $< V\ (3) >= 16.20 \pm 0.56$ mag, $< K(3) >= 12.95 \pm 0.39$ mag,
and $< K\ (3) >= 12.88 \pm 0.43$ mag.

(3) Humphreys *et al.* (1988, AJ, 96, 1884)

Table A.26. M33−RSG.

Star	Sp. type	J	H	K	$(J-H)$	$(H-K)$
R96	M0Ia	13.86	13.23	13.03 ± 0.08	0.63 ± 0.03	0.20 ± 0.03
R211	M1Ia	13.43	12.76	12.49 ± 0.02	0.67 ± 0.01	0.27 ± 0.01
R244	M1Ia	14.01	13.44	13.21 ± 0.07	0.57 ± 0.01	0.23 ± 0.01

$< J(3) >= 13.77 \pm 0.30$ mag, $< H(3) >= 13.14 \pm 0.35$ mag, and $< K(3) >= 12.91 \pm 0.37$ mag.
♣ Summary ♣
RSG : We have selected the stars of Humphreys (1980).

$< B(3) >= 18.91 \pm 0.34$ mag, $< V(3) >= 16.70 \pm 0.17$ mag, and $< (B-V)(3) >= 2.21 \pm 0.28$ mag.
We have selected the stars of Humphreys *et al.* (1988).
$< J(3) >= 13.77 \pm 0.30$ mag, $< H(3) >= 13.14 \pm 0.35$ mag, and $< K(3) >= 12.91 \pm 0.37$ mag.
BSG : We have selected the stars of Humphreys (1980).
$< B(3) >= 15.70 \pm 0.28$ mag, $< V(3) >= 15.59 \pm 0.44$ mag, $< (B-V)(3) >= 0.12 \pm 0.18$ mag,
$< U(3) >= 14.99 \pm 0.10$ mag, and $< R(3) >= 15.56 \pm 0.57$ mag.

8. Wolf-Lundmark-Melotte

(1) Sandage & Carlson (1985b, AJ, 90, 1464)

Table A.27. WLM–RSG.

Star	B	V	$(B-V)$
28V	19.19	17.23	1.96
63V	19.99	18.17	1.82
6V	20.17	18.23	1.94

$< B(3) >= 19.78 \pm 0.52$ mag, $< V(3) >= 17.88 \pm 0.56$ mag, and $< (B-V)(3) >= 1.91 \pm 0.08$ mag.

Table A.28. WLM–BSG.

Star	B	V	$(B-V)$
22	17.60	17.77	-0.17
61	17.79	17.23	0.56
30	17.83	18.13	-0.30

$< B(3) >= 17.74 \pm 0.12$ mag, $< V(3) >= 17.71 \pm 0.45$ mag, and $< (B-V)(3) >= 0.03 \pm 0.46$ mag.

(2) Lee *et al.* (1993b)

Table A.29. WLM–RSG.

Star(SC#)	B	V	$(B-V)$
(63V)	20.17	18.55	1.62
(6V)	20.34	18.62	1.72
(11)	20.36	18.76	1.60

∗ SC# : Sandage & Carlson(1985)'s star number.
$< B(3) >= 20.29 \pm 0.10$ mag, $< V(3) >= 18.64 \pm 0.11$ mag, and $< (B-V)(3) >= 1.65 \pm 0.06$ mag.

Table A.30. WLM–BSG.

Star(SC#)	B	V	$(B-V)$
2182(22)	17.87 ± 0.03	17.97 ± 0.03	-0.10 ± 0.07
1936(30)	18.13 ± 0.02	18.37 ± 0.02	-0.24 ± 0.03
1091(35)	18.14 ± 0.02	18.35 ± 0.02	-0.21 ± 0.03

$< B(3) >= 18.05 \pm 0.15$ mag, $< V(3) >= 18.23 \pm 0.23$ mag, and $< (B-V)(3) >= -0.18 \pm 0.07$ mag.

♣ Summary ♣

RSG : We have selected the stars of Lee *et al.* (1993b)
$< B(3) >= 20.29 \pm 0.10$ mag, $< V(3) >= 18.64 \pm 0.11$ mag, and $< (B-V)(3) >= 1.65 \pm 0.06$ mag.
BSG : We have selected the stars of Lee *et al.* (1993b)
$< B(3) >= 18.05 \pm 0.15$ mag, $< V(3) >= 18.23 \pm 0.23$ mag, and $< (B-V)(3) >= -0.18 \pm 0.07$ mag.

9. Pegasus

(1) Sandage (1986, AJ, 91, 496)

Table A.31. Pegasus–RSG.

Star	B	V	$(B-V)$
50	21.18	19.14	2.04
51	21.80	19.80	2.00
52	21.80	20.00	1.80

$< B(3) >= 21.59 \pm 0.36$ mag, $< V(3) >= 19.65 \pm 0.45$ mag, and $< (B-V)(3) >= 1.95 \pm 0.13$ mag.

Table A.32. Pegasus–BSG.

Star	B	V	$(B-V)$
45	19.76	20.00	–0.24
46	20.20	20.38	–0.18
14	20.34	20.37	–0.03

$< B(3) >= 20.10 \pm 0.30$ mag, $< V(3) >= 20.25 \pm 0.20$ mag, and $< (B-V)(3) >= -0.15 \pm 0.11$ mag.

(2) Lee *et al.* (1995)

Table A.33. Pegasus–RSG.

Star(S#)	B	V	$(B-V)$	I	$(V-I)$
1593(50)	21.49 ± 0.03	19.84 ± 0.01	1.65 ± 0.03	18.22 ± 0.01	1.61 ± 0.02
1550(52)	21.95 ± 0.04	20.33 ± 0.02	1.62 ± 0.05	17.59 ± 0.01	2.76 ± 0.02
1529(8)	22.30 ± 0.06	20.49 ± 0.02	1.81 ± 0.06	18.60 ± 0.01	1.87 ± 0.02

* S# : Sandage (1986)'s star number.

$< B(3) >= 21.91 \pm 0.40$ mag, $< V(3) >= 20.22 \pm 0.34$ mag, $< (B-V)(3) >= 1.69 \pm 0.10$ mag, and $< I(3) >= 18.14 \pm 0.51$ mag.

Table A.34. Pegasus–BSG.

Star(S#)	B	V	$(B-V)$	I	$(V-I)$
2331(45)	20.28 ± 0.01	20.28 ± 0.02	0.00 ± 0.02	19.88 ± 0.03	0.39 ± 0.03
1813(14)	20.52 ± 0.02	20.68 ± 0.02	-0.15 ± 0.03	20.70 ± 0.05	-0.03 ± 0.06
1261(39)	20.60 ± 0.02	20.42 ± 0.02	0.19 ± 0.03	20.10 ± 0.03	0.31 ± 0.04

$< B(3) >= 20.47 \pm 0.17$ mag, $< V(3) >= 20.46 \pm 0.20$ mag, $< (B-V)(3) >= 0.01 \pm 0.17$ mag, and $< I(3) >= 20.23 \pm 0.42$ mag.

♣ Summary ♣

RSG : We have selected the stars of Lee *et al.* (1995)
$< B(3) >= 21.91 \pm 0.40$ mag, $< V(3) >= 20.22 \pm 0.34$ mag, $< (B-V)(3) >= 1.69 \pm 0.10$ mag, and $< I(3) >= 18.14 \pm 0.51$ mag.

BSG : We have selected the stars of Lee *et al.* (1995)
$< B(3) >= 20.47 \pm 0.17$ mag, $< V(3) >= 20.46 \pm 0.20$ mag, $< (B-V)(3) >= 0.01 \pm 0.17$ mag, and $< I(3) >= 20.23 \pm 0.42$ mag.

10. NGC 3109

(1) Sandage & Carlson (1988, AJ, 96, 1599)

Table A.35. NGC 3109–RSG.

Star	$<B>$	$<V>$	$(<B> - <V>)$
55	20.78	18.29	2.49
72	21.17	18.82	2.35
48	21.16	19.02	2.14

$<B(3)>= 21.04 \pm 0.22$ mag, $<V(3)>= 18.71 \pm 0.38$ mag, and $<(<B> - <V>)(3)>= 2.33 \pm 0.18$ mag.

Table A.36. NGC 3109–BSG.

Star	B	V	$(B-V)$
80	18.49	18.47	0.02
56	18.89	18.85	0.04
75	19.01	18.70	0.31

$<B(3)>= 18.80 \pm 0.27$ mag, $<V(3)>= 18.67 \pm 0.19$ mag, and $<(B-V)(3)>= 0.12 \pm 0.16$ mag.

(2) Bresolin *et al.* (1993, AJ, 105, 1779)

RSG

: He selects 55, 48, and 140 star number of Sandage & Carlson (1988, AJ, 96, 1599).
$<B(3)>= 20.42$ mag, $<V(3)>= 18.58$ mag, and $(<B(3)> - <V(3)>) = 1.84$ mag.

BSG

: He selects 80, 75, and 155 star number of Sandage & Carlson (1988, AJ, 96, 1599).
$<B(3)>= 18.36$ mag, $<V(3)>= 18.23$ mag, and $(<B(3)> - <V(3)>) = 0.13$ mag.

(3) Greggio *et al.* (1993, AJ, 105, 894)

Table A.37. NGC 3109–RSG.

Star(SC#)	B	V	$(B-V)$
36A(56)	19.87	18.21	1.66
3B	20.67	18.77	1.90
724A	20.61	18.82	1.79

* SC# : Sandage & Carlson (1988)'s star number.
$<B(3)>= 20.38 \pm 0.45$ mag, $<V(3)>= 18.60 \pm 0.34$ mag, and $<(B-V)(3)>= 1.78 \pm 0.12$ mag.

Table A.38. NGC 3109–BSG.

Star(SC#)	B	V	$(B-V)$
555A	17.94	17.99	−0.05
1011A(80)	18.12	18.25	−0.13
223B	18.15	18.23	−0.08
940A(75)	18.45	18.52	−0.07
52A(56)	18.55	18.63	−0.08

We have selected 555A, 1011A, and 223B as the three brightest BSGs.
$<B(3)>= 18.07 \pm 0.11$ mag, $<V(3)>= 18.16 \pm 0.14$ mag, and $<(B-V)(3)>= -0.09 \pm 0.04$ mag.
♣ Summary ♣
RSG : We have selected the stars of Bresoline *et al.* (1993).
$<B(3)>= 20.42$ mag, $<V(3)>= 18.58$ mag, and $(<B(3)> - <V(3)>) = 1.84$ mag.
BSG : We have selected the stars of Bresoline *et al.* (1993)
$<B(3)>= 18.36$ mag, $<V(3)>= 18.23$ mag, $(<B(3)> - <V(3)>) = 0.13$ mag,
and $<I(3)>= 20.23 \pm 0.42$ mag.

11. Sextans B

(1) Sandage & Carlson (1985a, AJ, 90, 1019)

Table A.39. Sextans B–RSG.

Star	B	V	$(B-V)$
80	20.51	18.61	1.90
27V	21.13	18.90	2.23
73V	21.50	19.31	2.19

$< B(3) >= 21.05 \pm 0.50$ mag, $< V(3) >= 18.94 \pm 0.35$ mag, and $< (B-V)(3) >= 2.11 \pm 0.18$ mag.

Table A.40. Sextans B–BSG.

Star	B	V	$(B-V)$
44	19.21	19.08	0.13
5	19.41	19.41	0.00
60	19.72	19.21	0.51

$< B(3) >= 19.45 \pm 0.26$ mag, $< V(3) >= 19.23 \pm 0.17$ mag, and $< (B-V)(3) >= 0.21 \pm 0.27$ mag.

(2) Piotto *et al.* (1994, A&A, 287, 371)

Table A.41. Sextans B–RSG.

Star(SC#)	B	V	$(B-V)$
(27)	20.28	18.87	1.41
(80)	20.22	18.91	1.31
(73)	21.40	19.91	1.49

* SC# : Sandage & Carlson (1985)'s star number.

$< B(3) >= 20.63 \pm 0.66$ mag, $< V(3) >= 19.23 \pm 0.59$ mag, and $< (B-V)(3) >= 1.40 \pm 0.09$ mag.

Table A.42. Sextans B–BSG.

Star(SC#)	B	V	$(B-V)$
(44)	19.06	19.23	-0.17
(60)	19.43	19.43	0.00
(5)	19.35	19.53	-0.18

$< B(3) >= 19.28 \pm 0.19$ mag, $< V(3) >= 19.40 \pm 0.15$ mag, and $< (B-V)(3) >= -0.12 \pm 0.10$ mag.

♣ Summary ♣

RSG : We have selected the stars of Piotto *et al.* (1994).

$< B(3) >= 20.63 \pm 0.66$ mag, $< V(3) >= 19.23 \pm 0.59$ mag, and $< (B-V)(3) >= 1.40 \pm 0.09$ mag.

BSG : We have selected the stars of Piotto *et al.* (1994)

$< B(3) >= 19.28 \pm 0.19$ mag, $< V(3) >= 19.40 \pm 0.15$ mag, and $< (B-V)(3) >= -0.12 \pm 0.10$ mag.

12. Sextans A

(1) Sandage & Carlson (1982, ApJ, 258, 439)

Table A.43. Sextans A–RSG.

Star	B	V	$(B-V)$
50	20.11	18.05	2.06
56	20.25	18.10	2.15
21	20.05	18.11	1.94

$< B(3) >= 20.14 \pm 0.10$ mag, $< V(3) >= 18.09 \pm 0.03$ mag, and $< (B-V)(3) >= 2.05 \pm 0.11$ mag.

Table A.44. Sextans A–BSG.

Star	B	V	$(B-V)$
15	17.47	17.25	0.22
4	18.02	18.38	-0.36
52	18.16	18.32	-0.16

$< B(3) >= 17.88 \pm 0.36$ mag, $< V(3) >= 17.98 \pm 0.64$ mag, and $< (B-V)(3) >= -0.10 \pm 0.29$ mag.

(2) Sandage & Carlson (1985a, AJ, 90, 1019)

Table A.45. Sextans A–RSG.

Star	B	V	$(B-V)$
50V	20.55	18.22	2.33
56V	20.70	18.27	2.43
21V	20.49	18.28	2.21

$< B(3) >= 20.58 \pm 0.11$ mag, $< V(3) >= 18.26 \pm 0.03$ mag, and $< (B-V)(3) >= 2.32 \pm 0.11$ mag.

Table A.46. Sextans A–BSG.

Star	B	V	$(B-V)$
4	18.38	18.59	-0.21
52	18.53	18.52	0.01
53	19.09	18.99	0.10

$< B(3) >= 18.67 \pm 0.37$ mag, $< V(3) >= 18.70 \pm 0.25$ mag, and $< (B-V)(3) >= -0.03 \pm 0.16$ mag.

(3) Elias & Frogel (1985, ApJ, 289, 141)

Table A.47. Sextans A–RSG.

Star	K	$(J-K)$	$(H-K)$	$(V-K)$
21	14.57	0.93	0.24	3.74
50	14.70	0.74	0.09	3.55
56	14.97	0.77	0.11	3.33

$< V(3) >= 18.29 \pm 0.03$ mag, $< J(3) >= 15.56 \pm 0.16$ mag, $< H(3) >= 14.89 \pm 0.16$ mag, and $< K(3) >= 14.75 \pm 0.20$ mag.

(4) Aparicio *et al.* (1987, A&AS, 71, 297)

Table A.48. Sextans A–RSG.

Star(SC#)	B	V	$(B-V)$	$(U-B)$
1706(50V)	19.76	18.13	1.63	1.29
1082(21V)	19.92	18.18	1.74	1.38
1886(56V)	20.14	18.46	1.68	0.98

∗ SC# : Sandage & Carlson (1982)'s star number.
$< B(3) >= 19.94 \pm 0.19$ mag, $< V(3) >= 18.26 \pm 0.18$ mag, $< (B-V)(3) >= 1.68 \pm 0.06$ mag, and $< U(3) >= 21.16 \pm 0.13$ mag.

Table A.49. Sextans A–BSG.

Star(SC#)	B	V	$(B-V)$	$(U-B)$
539	17.56	17.44	0.12	–0.15
1647(52)	18.42	18.55	–0.13	0.30
850(12)	18.56	18.63	–0.07	–0.36
1325(40)	18.72	18.50	0.22	0.42

We have selected 539, 1647, and 850 as the three brightest BSGs.
$< B(3) >= 18.18 \pm 0.54$ mag, $< V(3) >= 18.21 \pm 0.67$ mag, $< (B-V)(3) >= -0.03 \pm 0.13$ mag, and $< U(3) >= 18.11 \pm 0.66$ mag.

(5) Walker (1987, MNRAS, 224, 935)

Table A.50. Sextans A–RSG.

Star(SC#)	B	V	$(B-V)$
(21)	19.96	18.23	1.73
(50)	20.07	18.31	1.76
(56)	20.54	18.53	2.01

$< B(3) >= 20.19 \pm 0.31$ mag, $< V(3) >= 18.36 \pm 0.16$ mag, and $< (B-V)(3) >= 1.83 \pm 0.15$ mag.

Table A.51. Sextans A–BSG.

Star(SC#)	B	V	$(B-V)$
(52)	18.57	18.55	0.02
(4)	18.58	18.57	0.01
(12)	18.81	18.78	0.03

$< B(3) >= 18.65 \pm 0.14$ mag, $< V(3) >= 18.63 \pm 0.13$ mag, and $< (B-V)(3) >= 0.02 \pm 0.01$ mag.

(6) Piotto *et al.* (1994, A&A, 287, 371)

Table A.52. Sextans A–RSG.

Star(SC#)	B	V	$(B-V)$
(21)	20.18	18.27	1.91
(56)	20.43	18.64	1.79
(50)	20.95	19.17	1.78

$< B(3) >= 20.52 \pm 0.39$ mag, $< V(3) >= 18.69 \pm 0.45$ mag, and $< (B-V)(3) >= 1.83 \pm 0.07$ mag.

Table A.53. Sextans A–BSG.

Star(SC#)	B	V	$(B-V)$
(15)	17.67	17.48	0.19
(52)	18.58	18.48	0.10
(4)	18.80	18.69	0.11

$< B(3) >= 18.35 \pm 0.60$ mag, $< V(3) >= 18.22 \pm 0.65$ mag, and $< (B-V)(3) >= 0.13 \pm 0.05$ mag.

♣ Summary ♣

RSG : We have selected the stars of Aparicio *et al.* (1987), Walker (1987), and Piotto *et al.* (1994).
Straight mean :

$< B(3) >= 20.22 \pm 0.53$ mag, $< V(3) >= 18.44 \pm 0.51$ mag, and $< (B-V)(3) >= 1.78 \pm 0.18$ mag.
Weighted mean :
$< B(3) >= 20.08 \pm 0.21$ mag, $< V(3) >= 18.34 \pm 0.10$ mag, and $< (B-V)(3) >= 1.75 \pm 0.07$ mag.
We have selected the stars of Elias & Frogel (1985).
$< J(3) >= 15.56 \pm 0.16$ mag, $< H(3) >= 14.89 \pm 0.16$ mag, and $< K(3) >= 14.75 \pm 0.20$ mag.
BSG : We have selected the stars of Aparicio *et al.* (1987), Walker (1987), and Piotto *et al.* (1994).
Straight mean :
$< B(3) >= 18.39 \pm 0.82$ mag, $< V(3) >= 18.35 \pm 0.94$ mag, and $< (B-V)(3) >= 0.04 \pm 0.14$ mag.
Weighted mean :
$< B(3) >= 18.61 \pm 0.13$ mag, $< V(3) >= 18.60 \pm 0.11$ mag, and $< (B-V)(3) >= 0.02 \pm 0.02$ mag.

13. NGC 300

(1) Humphreys & Graham (1986, AJ, 91, 522)

Table A.54. NGC 300–RSG.

Star	Sp. type	V	J	H	K	$(J-H)$	$(H-K)$
R13	M1Ia	18.50	16.01	15.47	15.31 ± 0.08	0.54 ± 0.09	0.16 ± 0.09
R10	M0-M1I	18.70	15.74	15.09	14.81 ± 0.04	0.65 ± 0.06	0.28 ± 0.04
R15	K5-M0I	18.80	16.08	15.61	15.51 ± 0.08	0.47 ± 0.10	0.10 ± 0.07

$< V(3) >= 18.67 \pm 0.15$ mag, $< J(3) >= 15.94 \pm 0.18$ mag, $< H(3) >= 15.39 \pm 0.27$ mag, and $< K(3) >= 15.21 \pm 0.36$ mag.

♣ Summary ♣

RSG : We have selected the stars of Humphreys & Graham (1986).
$< V(3) >= 18.67 \pm 0.15$ mag, $< J(3) >= 15.94 \pm 0.18$ mag, $< H(3) >= 15.39 \pm 0.27$ mag, and $< K(3) >= 15.21 \pm 0.36$ mag.

14. Leo A

(1) Demers *et al.* (1984, AJ, 89, 1160)

Table A.55. Leo A–BSG.

Star	B	V	$(B-V)$
198	19.04 ± 0.11	19.47 ± 0.18	-0.43
113	19.17 ± 0.03	19.59 ± 0.13	-0.42
194	19.22 ± 0.82	19.15 ± 0.12	0.07

$< B(3) >= 19.14 \pm 0.09$ mag, $< V(3) >= 19.40 \pm 0.23$ mag, and $< (B-V)(3) >= -0.26 \pm 0.29$ mag.

(2) Sandage (1986, AJ, 91, 496)

Table A.56. Leo A–RSG.

Star(DKIB)	B	V	$(B-V)$
90(182)	21.80	19.60	2.20
30(93)	21.80	19.72	2.08
52(87)	21.44	19.73	1.71

* DKIB : Demers *et al.* (1984)'s star number.
$< B(3) >= 21.68 \pm 0.21$ mag, $< V(3) >= 19.68 \pm 0.07$ mag, and $< (B-V)(3) >= 2.00 \pm 0.26$ mag.

Table A.57. Leo A–BSG.

Star(DKIB)	B	V	$(B-V)$
64(198)	18.45	18.92	-0.47
39(113)	18.70	19.23	-0.53
65(194)	19.00	18.68	0.32

$< B(3) >= 18.72 \pm 0.28$ mag, $< V(3) >= 18.94 \pm 0.28$ mag, and $< (B-V)(3) >= -0.23 \pm 0.47$ mag.
♣ Summary ♣
RSG : We have selected the stars of Sandage (1986).
$< B(3) >= 21.68 \pm 0.21$ mag, $< V(3) >= 19.68 \pm 0.07$ mag, and $< (B-V)(3) >= 2.00 \pm 0.26$ mag.
BSG : We have selected the stars of Sandage (1986).
$< B(3) >= 18.72 \pm 0.28$ mag, $< V(3) >= 18.94 \pm 0.28$ mag, and $< (B-V)(3) >= -0.23 \pm 0.47$ mag.

15. GR8

(1) Aparicio *et al.* (1988, A&AS, 74, 375)

Table A.58. GR8–BSG.

Star	B	V	$(B-V)$	U	$(U-B)$
55	18.73	18.90	-0.17 ± 0.06	17.71	-1.02 ± 0.05
125	18.81	18.67	0.14 ± 0.02	18.85	0.04 ± 0.01
87	19.09	18.99	0.10 ± 0.01	18.52	-0.57 ± 0.01

$< B(3) >= 18.88 \pm 0.19$ mag, $< V(3) >= 18.85 \pm 0.17$ mag, $< (B-V)(3) >= 0.02 \pm 0.17$ mag, and $< U(3) >= 18.36 \pm 0.59$ mag.
♣ Summary ♣
BSG : We have selected the stars of Aparicio *et al.* (1988)
$< B(3) >= 18.88 \pm 0.19$ mag, $< V(3) >= 18.85 \pm 0.17$ mag, $< (B-V)(3) >= 0.02 \pm 0.17$ mag, and $< U(3) >= 18.36 \pm 0.59$ mag.

16. NGC 2403

(1) Sandage (1984, AJ, 89, 630)

Table A.59. NGC 2403–RSG.

Star(TS#)	B	V	$(B-V)$
156(TS20)	21.12	19.41	1.71
57	21.28	19.45	1.83
95(TS72)	21.39	19.76	1.63

∗ TS# : Tammann & Sandage (1968)'s star number.
$< B(3) >= 21.26 \pm 0.14$ mag, $< V(3) >= 19.54 \pm 0.19$ mag, and $< (B-V)(3) >= 1.72 \pm 0.10$ mag.

Table A.60. NGC 2403–RSG.

Star	B	V	$(B-V)$
V41	22.40	19.98	2.42
V57	22.50	20.05	2.45
V16	22.62	20.17	2.45

$< B(3) >= 22.51 \pm 0.11$ mag, $< V(3) >= 20.07 \pm 0.26$ mag, and $< (B-V)(3) >= 2.44 \pm 0.02$ mag.

Table A.61. NGC 2403–BSG.

Star	B	V	$(B-V)$
179	18.76	18.69	0.07
29	18.93	18.89	0.04
76	19.21	19.22	–0.01

$< B(3) >= 18.97 \pm 0.23$ mag, $< V(3) >= 18.93 \pm 0.27$ mag, and $< (B-V)(3) >= 0.03 \pm 0.04$ mag.

(2) Humphreys *et al.* (1986, AJ, 102, 113)

Table A.62. NGC 2403–RSG.

Star	K	$(J-H)$	$(H-K)$
V41	16.37 ± 0.06	0.83 ± 0.09	0.42 ± 0.08
V57	16.54 ± 0.08	0.75 ± 0.09	0.36 ± 0.10
V60	16.66 ± 0.09	0.68 ± 0.08	0.19 ± 0.11

$< J(3) >= 17.60 \pm 0.06$ mag, $< H(3) >= 16.85 \pm 0.06$ mag, and $< K(3) >= 16.52 \pm 0.15$ mag.

(3) Zickgraf & Humphreys (1991, AJ, 102, 113)

Table A.63. NGC 2403–RSG.

Star	V	$(B-V)$	$(V-R)$
332(TS28)	19.13 ± 0.15	1.76 ± 0.19	0.90 ± 0.19
1650	19.35 ± 0.11	~1.02	0.92 ± 0.16
1701(TS40)	19.44 ± 0.12	~1.31	1.13 ± 0.15

$< V(3) >= 19.31 \pm 0.16$ mag, $< R(3) >= 18.32 \pm 0.10$ mag, and $< (V-R)(3) >= 0.98 \pm 0.13$ mag.
⇒Since the colors of the stars 1650 and 1701 are bluer than $(B-V) = 1.60$, we have not chosen them.

Table A.64. NGC 2403–RSG.

Star	B	V	$(B-V)$	$(V-R)$
332(TS28)	20.89	19.13 ± 0.15	1.76 ± 0.19	0.90 ± 0.19
560(TS26)	21.18	19.76 ± 0.13	1.42 ± 0.18	0.88 ± 0.18
357(TS6)	21.46	19.82 ± 0.11	1.64 ± 0.16	0.91 ± 0.17

$< B(3) >= 21.18 \pm 0.29$ mag, $< V(3) >= 19.57 \pm 0.38$ mag, $< (B-V)(3) >= 1.61 \pm 0.17$ mag, and $< R(3) >= 18.67 \pm 0.38$ mag.

Table A.65. NGC 2403–BSG.

Star	B	V	$(B-V)$	$(U-B)$	$(V-R)$
912(S179)	18.27	18.28 ± 0.15	-0.01 ± 0.24	-0.40 ± 0.23	0.28 ± 0.20
553	18.60	18.44 ± 0.13	0.16 ± 0.16	-0.20 ± 0.13	0.19 ± 0.17
946	19.66	19.72 ± 0.17	-0.06 ± 0.25	-0.06 ± 0.23	0.27 ± 0.21

$< B(3) >= 18.84 \pm 0.73$ mag, $< V(3) >= 18.81 \pm 0.79$ mag, $< (B-V)(3) >= 0.03 \pm 0.12$ mag, $< U(3) >= 18.62 \pm 0.89$ mag, and $< R(3) >= 18.57 \pm 0.78$ mag.

♣ Summary ♣

RSG : We have selected the stars of Zickgraf & Humphreys (1991).
$< B(3) >= 21.18 \pm 0.29$ mag, $< V(3) >= 19.57 \pm 0.38$ mag, $< (B-V)(3) >= 1.61 \pm 0.17$ mag, and $< R(3) >= 18.67 \pm 0.38$ mag.

We have selected the stars of Humphreys *et al.* (1986).
$< J(3) >= 17.60 \pm 0.06$ mag, $< H(3) >= 16.85 \pm 0.06$ mag, and $< K(3) >= 16.52 \pm 0.15$ mag.
BSG : We have selected the stars of Zickgraf & Humphreys (1991).
$< B(3) >= 18.84 \pm 0.73$ mag, $< V(3) >= 18.81 \pm 0.79$ mag, $< (B-V)(3) >= 0.03 \pm 0.12$ mag, $< U(3) >= 18.62 \pm 0.89$ mag, and $< R(3) >= 18.57 \pm 0.78$ mag.

17. M81

(1) Sandage (1984, AJ, 89, 621)

Table A.66. M81−RSG.

Star	B	V	$(B-V)$
48	22.25	20.20	2.05
103	22.25	20.35	1.90
156	~23.20	20.40	~2.80

$< B(3) >= 22.57 \pm 0.55$ mag, $< V(3) >= 20.32 \pm 0.10$ mag, and $< (B-V)(3) >= 2.25 \pm 0.48$ mag.

Table A.67. M81−BSG.

Star	B	V	$(B-V)$
75	18.95	18.72	0.23
49	19.38	19.58	-0.20
15	19.53	19.42	0.11

$< B(3) >= 19.29 \pm 0.30$ mag, $< V(3) >= 19.24 \pm 0.46$ mag, and $< (B-V)(3) >= 0.05 \pm 0.22$ mag.

(2) Humphreys *et al.* (1986, AJ, 91, 808)

Table A.68. M81−RSG.

Star	K	$(J-H)$	$(H-K)$
R48	16.23 ± 0.06	0.70 ± 0.06	0.24 ± 0.08
R103	16.19 ± 0.06	0.70 ± 0.06	0.27 ± 0.07
R156	15.60 ± 0.06	0.86 ± 0.07	0.80 ± 0.07

$< J(3) >= 17.20 \pm 0.06$ mag, $< H(3) >= 16.44 \pm 0.04$ mag, and $< K(3) >= 16.01 \pm 0.35$ mag.

(3) Zickgraf & Humphreys (1991, AJ, 102, 113)

Table A.69. M81−RSG.

Star(S#)	B	V	$(B-V)$	$(V-R)$
587(R48)	21.60	20.23 ± 0.09	1.37 ± 0.13	0.79 ± 0.16
379(R103)	21.96	20.37 ± 0.10	1.59 ± 0.12	0.60 ± 0.14
1261(R156)	-	20.56 ± 0.10	-	1.51 ± 0.16

* S# : Sandage (1984)'s star number.
$< B(2) >= 21.78 \pm 0.25$ mag, $< V(3) >= 20.39 \pm 0.17$ mag, $< (B-V)(3) >= 1.48 \pm 0.16$ mag, and $< R(3) >= 19.42 \pm 0.36$ mag.

Table A.70. M81–BSG.

Star(S#)	B	V	$(B-V)$	$(V-R)$
224	18.86	18.76 ± 0.07	0.10 ± 0.19	0.28 ± 0.17
642	19.08	19.10 ± 0.10	-0.02 ± 0.12	–
784(S15)	19.57	19.55 ± 0.08	0.02 ± 0.10	0.38 ± 0.12

$< B(3) >= 19.17 \pm 0.36$ mag, $< V(3) >= 19.14 \pm 0.40$ mag, and $< (B-V)(3) >= 0.03 \pm 0.06$ mag.

(4) Georgiev *et al.* (1992, A&AS, 95, 581)

Table A.71. M81–RSG.

Star	B	V	$(B-V)$
16	21.07	19.13	1.94
23	21.13	19.22	1.91
NW39	21.08	19.27	1.81

$< B(3) >= 21.09 \pm 0.03$ mag, $< V(3) >= 19.21 \pm 0.07$ mag, and $< (B-V)(3) >= 1.89 \pm 0.07$ mag.

Table A.72. M81–BSG.

Star	B	V	$(B-V)$
263	18.33	18.06	0.27
26	18.35	18.16	0.19
90	18.41	18.34	0.07

$< B(3) >= 18.36 \pm 0.04$ mag, $< V(3) >= 18.19 \pm 0.14$ mag, and $< (B-V)(3) >= 0.18 \pm 0.10$ mag.

♣ Summary ♣

RSG : We have selected the stars of Sandage (1984), Zickgraf & Humphreys (1991) and Georgiev *et al.* (1992).

Straight mean :

$< B(3) >= 21.81 \pm 0.60$ mag, $< V(3) >= 19.97 \pm 0.21$ mag, and $< (B-V)(3) >= 1.87 \pm 0.51$ mag.

Weighted mean :

$< B(3) >= 21.10 \pm 0.11$ mag, $< V(3) >= 19.66 \pm 0.55$ mag, and $< (B-V)(3) >= 1.83 \pm 0.16$ mag.

We have selected the stars of Humphreys *et al.* (1986)

$< J(3) >= 17.20 \pm 0.06$ mag, $< H(3) >= 16.44 \pm 0.04$ mag, and $< K(3) >= 16.01 \pm 0.35$ mag.

BSG : We have selected the stars of Sandage (1984), Zickgraf & Humphreys (1991) and Georgiev *et al.* (1992).

Straight mean :

$< B(3) >= 18.94 \pm 0.47$ mag, $< V(3) >= 18.86 \pm 0.63$ mag, and $< (B-V)(3) >= 0.09 \pm 0.25$ mag.

Weighted mean :

$< B(3) >= 18.39 \pm 0.15$ mag, $< V(3) >= 18.37 \pm 0.38$ mag, and $< (B-V)(3) >= 0.07 \pm 0.06$ mag.

18. IC 4182

(1) Sandage *et al.* (1996, AJ, 111, 1872)

Table A.73. IC 4182–RSG.

Star	$B(Pal)$	$V(HST)$	$R(Pal)$	$I(HST)$	$(B-V)$
$21(Pal)$	21.95	20.35	19.44	18.37	1.60
$12(HST)$	22.70	20.75	19.89	18.82	1.95
$43(HST)$	22.99	21.19	20.42	19.57	1.80

Pal: Palomar CCD Photometry.
HST: HST Photometry.

$< B(3) >= 22.55 \pm 0.54$ mag, $< V(3) >= 20.76 \pm 0.42$ mag, $< (B-V)(3) >= 1.78 \pm 0.18$ mag, $< R(3) >= 19.92 \pm 0.49$ mag, and $< I(3) >= 18.92 \pm 0.61$ mag.

Table A.74. IC 4182–BSG.

Star	$B(Pal)$	$V(HST)$	$R(Pal)$	$I(HST)$	$(B-V)$
2(HST)	20.02	19.90	20.03	19.99	0.12
3(HST)	20.25	20.26	20.29	20.59	-0.01
8(HST)	20.27	20.40	20.39	20.55	-0.13

$< B(3) >= 20.18 \pm 0.14$ mag, $< V(3) >= 20.19 \pm 0.26$ mag, $< (B-V)(3) >= -0.01 \pm 0.13$ mag, $< R(3) >= 20.24 \pm 0.19$ mag, and $< I(3) >= 20.38 \pm 0.34$ mag.

♣ Summary ♣

RSG : We have selected the stars of Sandage *et al.* (1996).

$< B(3) >= 22.55 \pm 0.54$ mag, $< V(3) >= 20.76 \pm 0.42$ mag, $< (B-V)(3) >= 1.78 \pm 0.18$ mag, $< R(3) >= 19.92 \pm 0.49$ mag, and $< I(3) >= 18.92 \pm 0.61$ mag.

BSG : We have selected the stars of Sandage *et al.* (1996).

$< B(3) >= 20.18 \pm 0.14$ mag, $< V(3) >= 20.19 \pm 0.26$ mag, $< (B-V)(3) >= -0.01 \pm 0.13$ mag, $< R(3) >= 20.24 \pm 0.19$ mag, and $< I(3) >= 20.38 \pm 0.34$ mag.

19. M101

(1) Sandage (1983, AJ, 88, 1569)

Table A.75. M101–BSG.

Star	B	V	$(B-V)$
2	19.06	19.21	-0.15
7	19.27 :	19.70	-0.43
8	19.29 :	19.51	-0.22

$< B(3) >= 19.21 \pm 0.13$ mag, $< V(3) >= 19.47 \pm 0.25$ mag, and $< (B-V)(3) >= -0.27 \pm 0.15$ mag.

⇒ Stars 7 and 8 have inaccurate values in B band. So we have not chosen them.

Table A.76. M101–BSG.

Star	B	V	$(B-V)$
2	19.06	19.21	-0.15
170	19.48	19.35	0.13
185	19.52	19.69	-0.17

$< B(3) >= 19.35 \pm 0.25$ mag, $< V(3) >= 19.42 \pm 0.25$ mag, and $< (B-V)(3) >= -0.06 \pm 0.17$ mag.

(2) Humphreys *et al.* (1986, AJ, 91, 808)

Table A.77. M101–RSG.

Star	Sp. type	V	K	$(H-K)$	$(J-H)$
HS58	M1I	20.50	16.82 ± 0.10	0.32 ± 0.03	0.70 ± 0.07
R7	-	20.60	16.40 ± 0.09	0.28 ± 0.10	0.73 ± 0.05
HS57	M2-M3I	20.80	16.11 ± 0.11	0.22 ± 0.11	0.90 ± 0.09

$< V(3) >= 20.63 \pm 0.15$ mag, $< J(3) >= 17.49 \pm 0.31$ mag, $< H(3) >= 16.72 \pm 0.41$ mag, and $< K(3) >= 16.44 \pm 0.36$ mag.

♣ Summary ♣
RSG : We have selected the stars of Humphreys *et al.* (1986).
$< V(3) >= 20.63 \pm 0.15$ mag, $< J(3) >= 17.49 \pm 0.31$ mag, $< H(3) >= 16.72 \pm 0.41$ mag, and $< K(3) >= 16.44 \pm 0.36$ mag.
BSG : We have selected the stars of Sandage (1983).
$< B(3) >= 19.35 \pm 0.25$ mag, $< V(3) >= 19.42 \pm 0.25$ mag, and $< (B - V)(3) >= -0.06 \pm 0.17$ mag.

20. NGC 4571

(1) Pierce *et al.* (1992, ApJ, 393, 523)

RSG :

$< R(3) >= 21.60 \pm 0.10$ mag.
$< V(3) >= 22.70$ mag. $\longleftarrow < V - R > \; = 1.1$ mag. (Elias *et al.* 1985, ApJS, 57, 91)
$< K(3) >= 19.20$ mag. $\longleftarrow < R - K > \; = 2.4$ mag. (Elias *et al.* 1985, ApJS, 57, 91)

BSG :

$< R(3) >= 21.10 \pm 0.10$ mag.
$< V(3) >= 21.30$ mag. $\longleftarrow < V - R > \; = 0.2$ mag. (Zickgraf & Humphreys 1991, AJ, 102, 113)

♣ Summary ♣
RSG : We have selected the stars of Pierce *et al.* (1992).
$< V(3) >= 22.70$ mag, $< R(3) >= 21.60 \pm 0.10$ mag $< K(3) >= 19.20$ mag.
BSG : We have selected the stars of Pierce *et al.* (1992).
$< V(3) >= 21.70$ mag, $< R(3) >= 21.10 \pm 0.10$ mag.