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RADIAL DEPENDENCE OF EXTINCTION IN PARENT GALAXIES OF SUPERNOVAE

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RESUMEN

El problema de la extinción es el asunto más importante a considerar para obtener magnitudes absolutas verdaderas de las supernovas (SNe). Se ha demostrado que el modelo plano-paralelo, usado extensamente en el pasado, no describe adecuadamente la extinción. Intentamos aplicar un modelo alternativo que introduzca la dependencia radial de la extinción en galaxias que albergan supernovas. Para calcular la extinción en nuestra galaxia utilizamos dos métodos distintos y comparamos los resultados obtenidos. Nuestro análisis se centra particularmente en una muestra selecta de supernovas desprovistas de envolvente, SNe (Ib/c), para la cual encontramos una magnitud absoluta intrínseca en el máximo $\mathrm{M}_{\mathrm{B}}^{0} = -17.80 \pm 0.43$.

ABSTRACT

The problem of extinction is the most important issue to be dealt with in the process of obtaining true absolute magnitudes of core-collapse (including stripped-envelope) supernovae (SNe). The plane-parallel model, widely used in the past, was shown not to describe extinction adequately. We try to apply an alternative model which introduces radial dependance of extinction in parent galaxies of supernovae. For calculating extinction in our Galaxy we use two different methods and compare the results obtained. Our analysis is primarily focused on a chosen sample of stripped-envelope SNe (Ib/c) for which we find intrinsic peak absolute magnitude $\mathrm{M}_{\mathrm{B}}^{0} = -17.80 \pm 0.43$.

Key Words: galaxies: spiral — ISM: dust, extinction — supernovae: general

1. INTRODUCTION

As is well known, the supernovae (hereafter SNe) of type Ia are widely used by astronomers as distance indicators due to their small dispersion in peak absolute magnitude and to their similar light curves. Today, they are thought to originate primarily in the explosion of a Chandrasekhar mass C–O white dwarf in a close binary system, where the secondary star is filling its Roche lobe and transferring mass through the Lagrange point to the white dwarf companion. SNe type II, on the other hand, are a quite heterogenous class. They come from stars of initial mass greater than approximately 8 $\mathcal{M}_{\odot}$, which can have quite different properties. The situation is still unclear regarding stripped-envelope SNe (Ib/c). The progenitors of these SNe are massive stars that have lost most or all of their hydrogen/helium envelopes, by strong winds such as in Wolf-Rayet stars or through mass transfer to a companion star in Roche lobe overflow or a common envelope phase.

Whatever the exact scenario for stripped-envelope SNe is, there is some quite unique physics involved in producing these events characterized by a complete loss of hydrogen/helium. This "uniqueness" may lead to a smaller dispersion in their observational properties (e.g. peak brightness), at least in comparison to more heterogeneous SNe of type II. SNe Ib/c thus may be the second-best "standard candles" among supernovae, after SNe Ia. Our intention is to analyze this possibility. We will primarily focus on finding the peak absolute magnitude for SNe Ib/c. In doing so we must be able to eliminate extinction, which in the case of all core-collapse SNe should be significant.

The problem of extinction is the most important issue to be dealt with in the process of obtaining true absolute magnitudes of core-collapse (including stripped-envelope) SNe. The plane-parallel model which gives absorption dependent on galaxy inclination, $A_g = A_0 \sec i$, widely used in the past, was shown not to describe extinction adequately (Cappellaro et al. 1997). We try to apply an alternative model which introduces a radial dependence of extinction (Hatano et al. 1997; Hatano, Branch, & Deaton 1998).

A certain trend of dimmer SNe with decreasing distance from the center of a galaxy was already found by Arbutina (2007a,b). In the present, more detailed analysis we have increased the number of SNe in the sample, applied a new model for extinction in the parent galaxy, and more carefully calculated Galactic extinction.

2. THE MODEL

Because of their long-lived progenitors, only SNe Ia have been observed in elliptical galaxies, which are, practically, gas and dust free. In spirals SNe Ia can be found in inter-arm regions and galaxy halos. Hence, extinction does not influence their luminosities as much as in the case of core-collapse SNe (Ib/c and II) which are all observed in spiral and irregular galaxies which have significant amounts of dust.

As mentioned in the previous section, we have chosen to work with SNe Ib/c because we expect them to be a relatively homogenous class, at least in comparison to SNe II. Ideally, we should further separate SN Ib from Ic, but the sample is already too small for doing this, as we shall see. On the other hand, a sample of stripped-envelope SNe also comprises peculiar SNe Ic (the so called hypernovae) which can have very different properties, and therefore were not included in this analysis.

Extinction has a selective nature, meaning it depends on wavelength. Shorter wavelengths are more weakened and therefore we expect blue magnitudes (B) to be more extincted than, for example, visual ones (V). Apparent peak B magnitudes for the stripped-envelope SNe that we have focused on have also turned out to be more frequently available in our primary data source (Asiago Supernova Catalogue, Barbon et al. 1999).[1] For the absolute peak blue magnitude we can generally write:

$$M_B^0 = m_B - \mu - A_G - A_g = M_B - A_g, \qquad (1)$$

[1] See Richardson, Branch, & Baron (2006) for a somewhat different analysis of SNe Ib/c peak magnitudes in the V band.

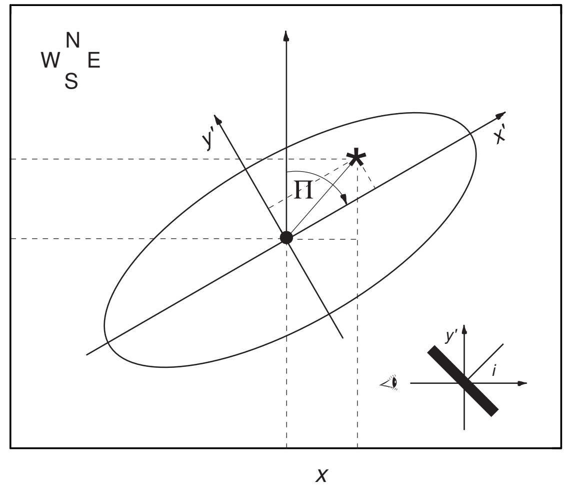

Fig. 1. The figure shows how radial position of a supernova in its parent galaxy was calculated.

where m_B is the apparent magnitude, $\mu = 5\log(d/\mathrm{Mpc})$ is the distance modulus, A_G and A_g are the Galactic extinction and the extinction in the parent galaxy, respectively.

Bearing in mind the short life of their progenitors, we may assume that the stripped-envelope SNe are practically in the galactic plane ($Z = 0$). The radial position of supernova in a galaxy is then (see Figure 1):

$$\begin{aligned} r^2 &= d^2(x'^2 + y'^2 \sec^2 i) \\ &= d^2(x^2 + y^2)(\cos^2(\arctan(\frac{y}{x}) + \Pi - 90^\circ) \\ &+ \sin^2(\arctan(\frac{y}{x}) + \Pi - 90^\circ)\sec^2 i) \quad , \qquad (2) \end{aligned}$$

where x and y give the SN offset from the center of the galaxy in radians, Π is the position angle of the major axis and d is the distance to the galaxy. If not given, offsets can be calculated from the right ascension and declination; $x \approx (\alpha_{SN} - \alpha_g)\cos\delta_g$ and $y \approx (\delta_{SN} - \delta_g)$.

If we assume that

$$A_g = A_0 e^{-ar/R} \quad , \qquad (3)$$

then

$$M_B = M_B^0 + A_0 e^{-ar/R} \quad . \qquad (4)$$

where R is the radius of a galaxy, and A_0 and a are parameters which can be obtained from the fit.

The extinction has been already assumed to follow an exponential law by Hatano et al. (1997). It is known that the dust density in our Galaxy and in M31 actually does not peak at the center (nor in the bulge) but well out in the disk, in a molecular ring where most of the current star formation is taking place (see Figure 9 in Sodroski et al. 1997; Hatano et al. 1998). This shortcoming of the model is not that important for two reasons: (i) there is a selection effect against seeing SNe in an already bright bulge (Shaw 1979); (ii) we do not expect (many) stripped-envelope SNe in the old population rich bulge anyway. We also did not include the dependence on inclination in this preliminary model, which would produce large errors if we had edge-on galaxies with $i \to 90°$. Finally, spiral galaxies are not azimuthally symmetric (there are spiral arms, of course) and the local environment in which a star explodes can be very different from one case to another, an effect that we cannot take into account.

3. DATA

3.1. *Distances*

When possible, the Cepheid-calibrated distance to the parent galaxy, or a galaxy in the same group of galaxies, was used. The distance modulus and its uncertainty were taken directly from the literature (Richardson et al. 2006; Macri et al. 2001; Thim et al. 2003). The second choice was the distance given in the Nearby Galaxy Catalogue (Tully 1988), rescaled from $H_0 = 75$ km s^{-1}Mpc^{-1} to $H_0 = 65$ km s^{-1}Mpc^{-1} for consistency with Arbutina (2007a,b). An uncertainty of 0.2 mag in the distance modulus was adopted as in Richardson et al. (2006). The third choice was the distance calculated from the redshift of the parent galaxy (we have restricted our analysis to the local universe, $z < 0.03$) assuming $H_0 = 65$ km s^{-1}Mpc^{-1}. The redshifts corrected to the Cosmic Microwave Background (CMB) Reference Frame were taken from the June 2007 version of the NED.[2] The uncertainties ware calculated assuming a peculiar velocity of 300 km s^{-1} as in Richardson et al. (2006).

The distance modulus and its uncertainty for SN 1994I were taken from Richmond et al. (1996) (see the references therein) who adopted the surface brightness fluctuations method, while for SN 2002ap they were taken from Foley et al. (2003, and references therein) who used photometry of the brightest red and blue stars in the system.

3.2. *Peak Apparent Magnitudes*

For most SNe, peak B magnitudes were taken from the June 2007 version of the Asiago Supernova Catalogue (Barbon et al. 1999, hereafter ASC).[3] An uncertainty of 0.3 in the apparent magnitudes listed in the ASC, estimated by Richardson, Branch, & Baron (2002), was adopted. The apparent B magnitude at the time of maximum and its uncertainty for SN 1994I were taken from Richmond et al. (1996), for SN 1999ex from Stritzinger et al. (2002) and for SN 2004aw from Taubenberger et al. (2006). The peak apparent B magnitude for SN 1990B was estimated from Clocchiatti et al. (2001) with the highest uncertainty associated.

The peak apparent V magnitudes and their uncertainties were taken directly from Richardson et al. (2006) except for SN 1972R and SN 2004aw for which they were taken from Leibundgut et al. (1991) and Taubenberger et al. (2006), respectively.

3.3. *Galactic extinction*

Two different methods for the calculation of Galactic extinction were used. We thought it would be useful to use values from both methods and see what effect this will have on the results (see Willick 1999).

The first choice were values taken from the RC3 catalogue (de Vaucouleurs et al. 1991) who used the older Burstein and Heiles maps (hereafter BH), which are based on HI column densities and faint galaxy counts (Burstein & Heiles 1982). On the basis of the results of the investigation, it is concluded that a reasonable estimate of the relative accuracy of the HI/galaxy counts method reported by BH is 0.01 mag in $E(\mathrm{B-V})$ or 10% of the reddening, whichever is larger (Burstein & Heiles 1982). The second choice were values for Galactic extinction by the Schlegel, Finkbeiner, and Davis maps (hereafter SFD), based on IRAS/DIRBE measurements of diffuse IR emission (Schlegel, Finkbeiner, & Davis 1998), with values taken from the NED. The reddening estimates from Schlegel et al. (1998) have an accuracy of 16%.

Galactic extinction values $\mathrm{A_G^{SFD}(V)}$ and their uncertainties were taken directly from Richardson et al. (2006) except for SN 1972R and SN 2004aw for which they were taken from NED.

3.4. *Other data*

The position angle of the major axis of the parent galaxy (measured North Eastwards) was taken from the ASC, except for SN 1983N, SN 1984I, SN 1991N and SN 1998bw for which they were taken from the July 2007 version of the SAI supernova catalogue.[4]

[2]The NASA/IPAC Extragalactic Database (NED) is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration (available at `http://nedwww.ipac.caltech.edu/`)

[3]Available at `http://web.pd.astro.it/supern/`

[4]Sternberg Astronomical Institute Supernova Catalogue (SAI) by D. Yu. Tsvetkov, N. N. Pavlyuk, O.S. Bartunov and

TABLE 1

DATA AND RADIAL POSITIONS FOR SUPERNOVAE FROM THE SAMPLE

Supernova	SN type	Galaxy	Galaxy type	Inclination $i[°]$	Position angle $\Pi[°]$	Diameter D [kpc]	SN radial position r[kpc]	Apparent magnitude m_B
SN 1972R	Ib?	NGC 2841	Sb	65	147	32	12.6	12.85 ± 0.30
SN 1983N	Ib	NGC 5236	SBc	21	45	17	3.5	11.70 ± 0.30
SN 1984I	Ib	E323–G99	SBcd	25	10	32	11.7	16.60 ± 0.30
SN 1984L	Ib	NGC 991	SBc	28	60	19	4.1	14.00 ± 0.30
SN 2000H	Ib	IC 454	SBab	58	140	32	9.5	17.90 ± 0.30
SN 1999ex	Ib/c	IC 5179	Sbc	61	57	33	2.5	17.35 ± 0.02
SN 1962L	Ic	NGC 1073	SBc	25	15	24	6.6	13.94 ± 0.30
SN 1983I	Ic	NGC 4051	SBbc	35	135	34	7.2	13.70 ± 0.30
SN 1983V	Ic	NGC 1365	SBb	58	32	57	7.2	14.67 ± 0.30
SN 1987M	Ic	NGC 2715	SBc	74	22	33	2.4	15.30 ± 0.30
SN 1991N	Ic	NGC 3310	SBbc	19	139	17	0.9	15.50 ± 0.30
SN 1994I	Ic	NGC 5194	Sbc	48	163	24	1.1	13.77 ± 0.02
SN 1990B	Ic	NGC 4568	Sbc	65	23	20	0.9	16.89 ± 0.60
SN 2004aw	Ic pec	NGC 3997	SBb pec	68	130	38	33.4	18.06 ± 0.04
SN 1998bw	Ic pec	E184–G82	SB	33	150	9	2.7	14.09 ± 0.30
SN 2002ap	Ic pec	NGC 628	Sc	24	25	22	10.3	13.11 ± 0.30

The SN type, the parent galaxy type, the inclination of the polar axis with respect to the line of sight in degrees (0° for face on systems), the SN offset from the galaxy nucleus in arcseconds, and the decimal logarithm of the apparent isophotal diameter in units of 0.1 arcminutes, were taken from the ASC.

There is some discrepancy regarding the type of SN 1972R (Ib in ASC, Ia in Patat et al. 1997, Ib? in Leibundgut et al. 1991, Ipec in the SAI Supernova Catalogue) and SN 1999ex (Ib/c in ASC, Ib in Richardson et al. 2006). We have marked these as Ib? and Ib/c, respectively.

4. ANALYSIS AND RESULTS

Table 1 gives a sample of SNe Ib/c with the known peak apparent B magnitudes and the calculated SN radial positions. Table 2 gives redshift and distance modulus for each supernova in the sample. Tables 3 and 4 give absolute B magnitudes at maximum light, uncorrected for the parent galaxy extinction, for the same sample of SNe, with the BH and SFD models used for the calculation of Galactic extinction, respectively. Table 5 gives peak V absolute magnitudes, uncorrected for the parent galaxy extinction, with only the SFD method used for the calculation of Galactic extinction.

We see in Figure 2 and 4 that there is a certain trend of dimmer SNe with decreasing distance from the center of a galaxy which can be attributed to extinction. It can also be seen in Figure 2 that SNe Ic show larger dispersion than SNe Ib.

Peculiar SNe Ic, also known as hypernovae, show very large dispersion (see Figure 2), they may have very different properties and are therefore excluded from the fit. SN 2004aw appears to be a link between a normal Type Ic supernova like SN 1994I and the group of broad-lined SNe Ic like 1998bw and 2002ap (Taubenberger et al. 2006). NGC 3997, the host of SN 2004aw, could be a merger of two spiral galaxies showing tidally deformed spiral arms (Taubenberger et al. 2006), which may explain the SN position. Another supernova that was excluded from the fit is SN 1990B. It shows some kind of anomalous extinction. The reasons may lie in a specific environment. The unusually high value of $M_{B/V}$ could be due to the high value of the host galaxy extinction (as estimated in Richardson et al. 2006).[5]

Yu. P. Pskovskii, Sternberg Astronomical Institute, Moscow University, Moscow, Russia (available at `http://www.sai.msu.su/sn/sncat/`)

[5]There are a few SN Ib/c from ASC excluded from this analysis; SN 1954A is located in an irregular galaxy, SN 1966J was shown to be SN Ia (Casebeer et al. 2000), SN 2001B

TABLE 2

SN REDSHIFT AND DISTANCE MODULUS

Supernova	Redshift z	Distance modulus μ	Reference
SN 1972R	0.002128	30.74 ± 0.23	1
SN 1983N	0.001711	28.25 ± 0.15	2
SN 1984I	0.010737	33.64 ± 0.20	3
SN 1984L	0.005110	31.68 ± 0.20	4
SN 2000H	0.013159	33.99 ± 0.17	3
SN 1999ex	0.011415	33.44 ± 0.22	3
SN 1962L	0.004030	31.22 ± 0.20	4
SN 1983I	0.002336	31.72 ± 0.14	5
SN 1983V	0.005457	31.27 ± 0.05	5
SN 1987M	0.004466	31.86 ± 0.20	4
SN 1991N	0.003312	31.67 ± 0.20	4
SN 1994I	0.001544	29.60 ± 0.30	6
SN 1990B	0.007522	30.92 ± 0.05	5
SN 2004aw	0.015914	34.46 ± 0.14	3
SN 1998bw	0.008670	32.93 ± 0.28	3
SN 2002ap	0.002192	29.30 ± 0.14	7

REFERENCES: (1) Macri et al. 2001; (2) Thim et al. 2003; (3) NED (References are for redshifts); (4) Tully 1988; (5) Richardson et al. 2006; (6) Richmond et al. 1996; (7) Foley et al. 2003.

TABLE 3

ABSOLUTE MAGNITUDE M_B^{BH}

Supernova	Galactic absorption $A_G^{BH}(B)$	Absolute magnitude[a] M_B^{BH}
SN 1972R	0.00 ± 0.04	-17.89 ± 0.57
SN 1983N	0.15 ± 0.04	-16.70 ± 0.49
SN 1984I	0.45 ± 0.04	-17.49 ± 0.54
SN 1984L	0.00 ± 0.04	-17.68 ± 0.54
SN 2000H	1.44 ± 0.04	-17.53 ± 0.51
SN 1999ex	0.00 ± 0.04	-16.09 ± 0.28
SN 1962L	0.07 ± 0.04	-17.35 ± 0.54
SN 1983I	0.00 ± 0.04	-18.02 ± 0.48
SN 1983V	0.00 ± 0.04	-16.60 ± 0.39
SN 1987M	0.02 ± 0.04	-16.58 ± 0.54
SN 1991N	0.00 ± 0.04	-16.17 ± 0.54
SN 1994I	0.00 ± 0.04	-15.83 ± 0.36
SN 1990B	0.01 ± 0.04	-14.04 ± 0.69
SN 2004aw	0.00 ± 0.04	-16.40 ± 0.22
SN 1998bw	0.00 ± 0.04	-18.84 ± 0.62
SN 2002ap	0.13 ± 0.04	-16.32 ± 0.48

[a] M_B^{BH} is absolute magnitude uncorrected for extinction in the parent galaxy.

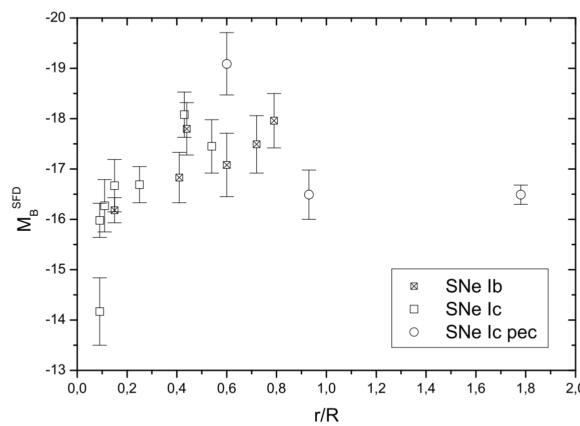

Fig. 2. The SN B absolute magnitudes, uncorrected for the parent galaxy extinction, are plotted against the relative radial positions of a SN in the galaxy.The SFD method for calculation of Galactic extinction is used.

In Figure 3 the SN V absolute magnitudes, uncorrected for the parent galaxy extinction, are plotted against relative radial position of a SN in the galaxy, using the SFD method for the calculation of Galactic extinction. Contrary to the case of the B magnitudes, a significant trend of dimmer SNe with decreasing radius cannot be observed here. This is understandable because the extinction should have weaker influence on the V magnitudes than on the B magnitudes.

If we assume that the extinction is negligible when $r/R \to \infty$ a fit to data can give us intrinsic absolute magnitudes for SNe Ib/c (see Figure 4). These are: $M_B^0 = -17.86 \pm 0.46$, using the BH method and $M_B^0 = -17.74 \pm 0.40$, using the SFD method. Figure 5 shows the effect of using the BH/SFD method in the calculation of Galactic extinction on the assumed extinction trend and the resulting peak absolute magnitude. As we can see the effect is not large.

We will thereby adopt the mean value:

$$M_B^0 = -17.80 \pm 0.43 \quad . \tag{5}$$

The curves in Figures 4 and 5 have the form of equations (3) and (4). In Table 6 we give the fit parameters.

was excluded because of the unknown peak B luminosity, SN 2006tq because of some other unknown properties.

TABLE 4

ABSOLUTE MAGNITUDE M_B^{SFD}

Supernova	Galactic absorption $A_G^{SFD}(B)$	Absolute magnitude[a] M_B^{SFD}
SN 1972R	0.067 ± 0.011	-17.96 ± 0.54
SN 1983N	0.284 ± 0.045	-16.83 ± 0.50
SN 1984I	0.452 ± 0.072	-17.49 ± 0.57
SN 1984L	0.119 ± 0.019	-17.80 ± 0.52
SN 2000H	0.991 ± 0.159	-17.08 ± 0.63
SN 1999ex	0.087 ± 0.014	-16.18 ± 0.25
SN 1962L	0.169 ± 0.027	-17.45 ± 0.53
SN 1983I	0.056 ± 0.009	-18.08 ± 0.45
SN 1983V	0.088 ± 0.014	-16.69 ± 0.36
SN 1987M	0.110 ± 0.018	-16.67 ± 0.52
SN 1991N	0.097 ± 0.016	-16.27 ± 0.52
SN 1994I	0.150 ± 0.024	-15.98 ± 0.34
SN 1990B	0.141 ± 0.023	-14.17 ± 0.67
SN 2004aw	0.089 ± 0.014	-16.49 ± 0.19
SN 1998bw	0.253 ± 0.040	-19.09 ± 0.62
SN 2002ap	0.301 ± 0.048	-16.49 ± 0.49

[a] M_B^{SFD} is absolute magnitude uncorrected for extinction in the parent galaxy.

TABLE 5

ABSOLUTE MAGNITUDE M_V^{SFD}

Supernova	m_V	$A_G^{SFD}(V)$	$M_V^{SFD\,a}$
SN 1972R	13.4 ± 0.3	0.052 ± 0.008	-17.39 ± 0.54
SN 1983N	11.3 ± 0.2	0.228 ± 0.037	-17.18 ± 0.39
SN 1984I	15.98 ± 0.20	0.344 ± 0.055	-18.00 ± 0.46
SN 1984L	13.8 ± 0.2	0.091 ± 0.015	-17.97 ± 0.42
SN 2000H	17.30 ± 0.03	0.760 ± 0.122	-17.45 ± 0.32
SN 1999ex	16.63 ± 0.04	0.067 ± 0.011	-16.88 ± 0.27
SN 1962L	13.13 ± 0.10	0.130 ± 0.021	-18.22 ± 0.32
SN 1983I	13.6 ± 0.3	0.043 ± 0.007	-18.16 ± 0.45
SN 1983V	13.80 ± 0.20	0.068 ± 0.011	-17.54 ± 0.26
SN 1987M	14.7 ± 0.3	0.085 ± 0.014	-17.25 ± 0.51
SN 1991N	13.9 ± 0.3	0.075 ± 0.012	-17.85 ± 0.51
SN 1994I	12.91 ± 0.02	0.115 ± 0.018	-16.81 ± 0.34
SN 1990B	15.75 ± 0.20	0.108 ± 0.017	-15.28 ± 0.27
SN 2004aw	17.30 ± 0.03	0.069 ± 0.011	-17.23 ± 0.18
SN 1998bw	13.75 ± 0.10	0.194 ± 0.031	-19.37 ± 0.41
SN 2002ap	12.37 ± 0.04	0.161 ± 0.026	-17.09 ± 0.21

[a] M_V^{SFD} is absolute magnitude uncorrected for extinction in the parent galaxy.

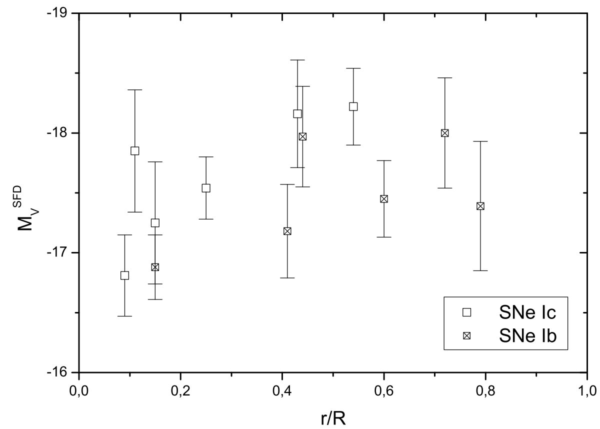

Fig. 3. The SN V absolute magnitudes, uncorrected for the parent galaxy extinction, are plotted against relative radial positions of a SN in the galaxy. The SFD method for the calculation of Galactic extinction is used. SNe Ic pec are excluded, as well as SN 1990B.

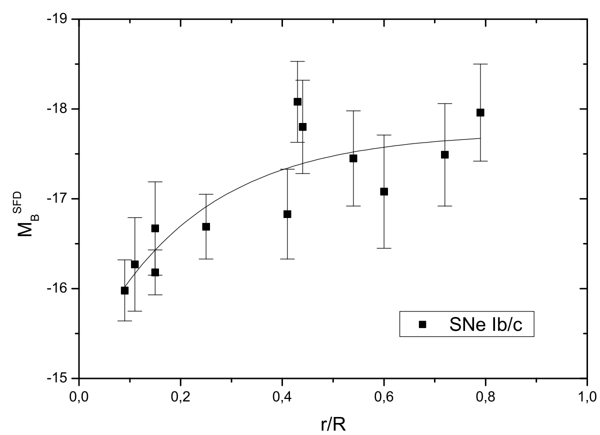

Fig. 4. The curve represents the best fit for the data sample of 12 SNe Ib/c. The SFD method for the calculation of Galactic extinction is used. SN 1990B is excluded from the fit.

It is still possible that there is a substantial range of absolute magnitudes for Ib/c events. If such is the case, we will have a Malmquist bias — only brighter SNe would be observed at large distances (high z) (see Richardson et al. 2006). Figure 6 shows M_B^{SFD} against distance modulus for the analysed Ib/c supernovae. We do not see any distance dependence, which is quite understandable since we have limited our analysis to the local universe ($z < 0.03$).

5. CONCLUSIONS

Measuring the radial dependence of controlled samples of SNe in galaxies appears to be a promising

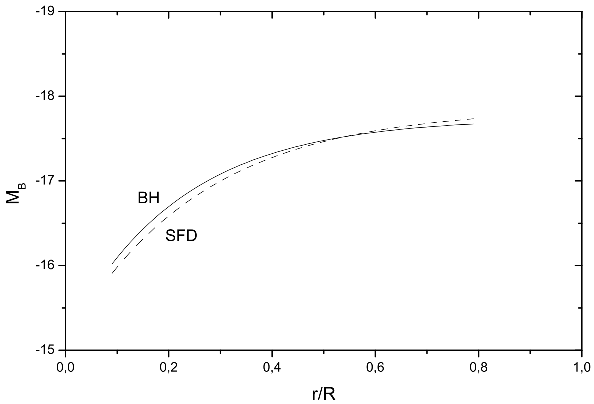

Fig. 5. The effect of BH/SFD method used in determining peak absolute magnitude on the results.

TABLE 6

FIT PARAMETERS

Method	M_B^0	A_0	a
BH	-17.86 ± 0.46	2.77 ± 0.51	3.89 ± 2.55
SFD	-17.74 ± 0.40	2.60 ± 0.71	4.55 ± 3.38

way to constrain the amount and the distribution of dust in galaxies (Hatano et al. 1998). As pointed out by Hatano et al. (1998) the extinction by dust in parent galaxies can also affect the observed SNe properties.

In this paper we analysed a sample of SNe Ib/c in neighboring spiral galaxies. We have chosen to work with SNe Ib/c since we expect them to be a relatively homogenous class, at least in comparison to SNe II. B magnitudes were considered because the extinction has stronger influence on them, as well as because of the larger quantity of data available (in the ASC). A certain trend of dimmer SNe with decreasing distance from the center of a galaxy was observed. Such an effect can be attributed to extinction. We have adopted as mean value for the SNe Ib/c intrinsic absolute magnitude:

$$M_B^0 = -17.80 \pm 0.43 \quad , \tag{6}$$

obtained from the fit.

We made a comparison of the results obtained by using values for A_G from different methods for Galactic extinction calculation. The effect is not significant. Both methods give similar results.

To conclude, analysing the dependence of SN observational properties on radial position in their parent galaxies may hold some promise. Nevertheless, more data are needed to reach stronger conclusions.

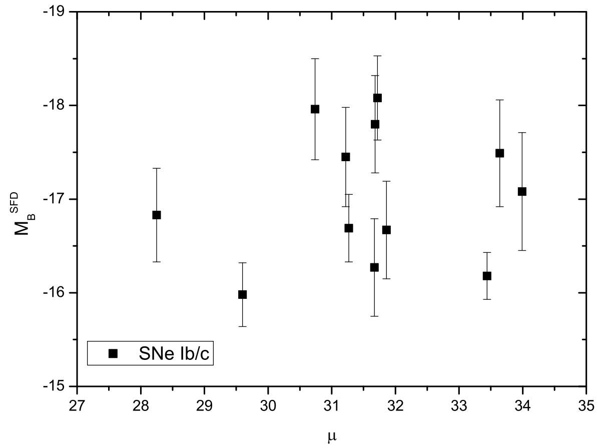

Fig. 6. The M_B^{SFD} dependence on distance modulus.

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