Three years observations of the nearby type II SN2008bk

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Introduction

Supernova 2008bk was discovered by Berto Monart on 2008 March 25.14 UT in the nearby galaxy NGC 7793. Inmediately we started a systematic photometric, spectroscopic observational campaign. How is visible in Fig.1 we obtained extremely well sampled light curve in UBVRI and griz bands. We also gathered through the collaboration with the Carnagie Supernova Project (CSP) a good dataset in the YJHK bands (see Fig 2).

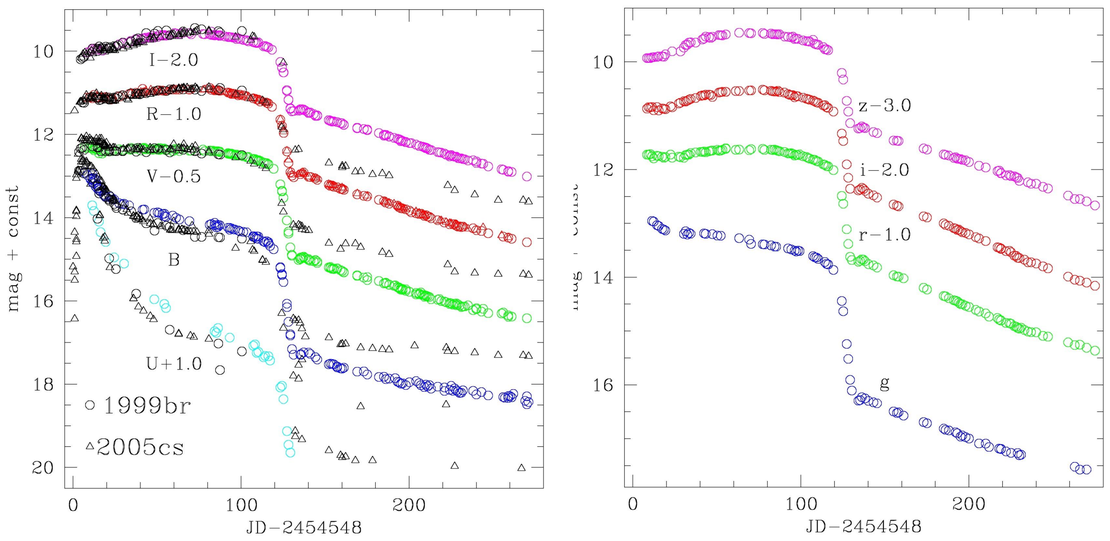
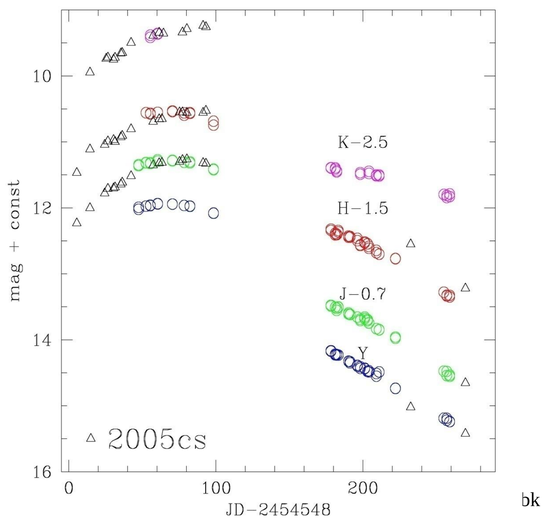


Fig. 1: UBVRI griz light curves of SN 2008bk

Photometric evolution

In Fig. 1 (left side) the BVRI light curve of SN 2008bk are compared with those of the low luminosity SN IIP 1999br (Pastorello 2004) and SN2005cs (Pastorello 2009). The photometric evolution of SN 2008bk is very similar to that of SN1999br especially in the VRI bands. SN2005cs is also similar to SN2008bk at early time, but its fall down from the plateau phase is remarkably larger in all bands.



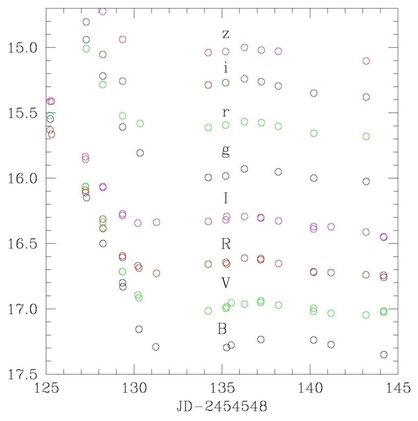


Fig 3: zoom in the BVRIgriz light curve of SN 2008bk

Radiative tail

In the radiative tail the slope of the SN2008bk light curves are steeper than those of SN2005cs indicating a less efficient γ-ray and positron thermalization. In the B band the decay rate is the smallest (0.72 +/- 0.05 mag/100d, between 150 and 280 days) and it is the only one not well fitted by a straight line.

Color evolution

The reddening corrected color evolution of SN2008bk is shown in Fig. 4. At early time both the $(B-V)_0$ and $(V-I)_0$ SN2008bk colors are similar to the these of SN1999br and SN2005cs, while after the plateau phase the SN2008bk color appears much bluer than that of SN2005cs.

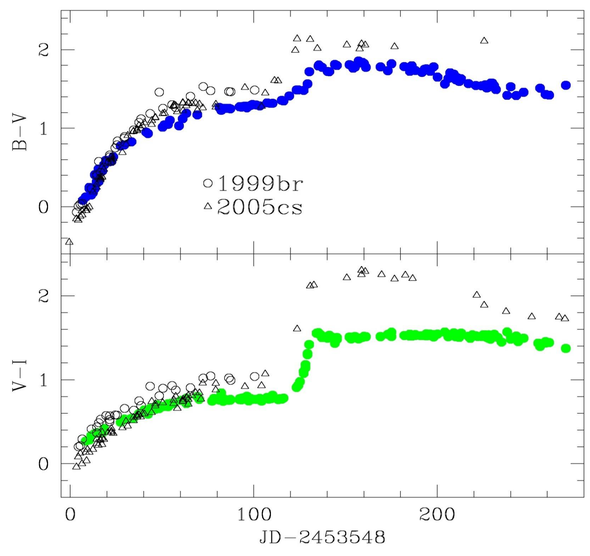


Fig.4: $(B-V)_0$ and $(V-I)_0$ evolution of SN 2008bk

Small features in the light curve

The extremely dense photometric coverage allow us to detect feature in the SN2008bk light curves that were never noted in IIP SNe. How is visible in Fig 3, soon after the fall down from the plateau the SN experiment a small re-brightening in all bands that last for about a week.

Acknowledgment

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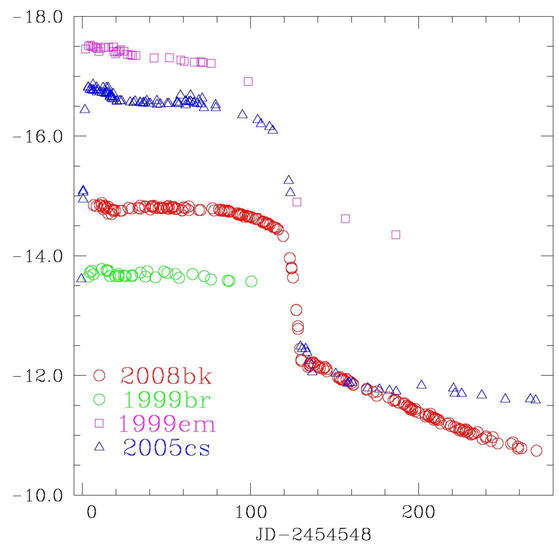

Fig. 5: Absolute V maghitude of SN2008bk

modelling the light curve

We have used a one-dimensional Lagrangian hydrodynamic code (Bersten et al. 2011) to calculate a bolometric light curve and photospheric-velocitiy evolution. Fig. 6 shows a model which reproduces well the observations assuming an explosion energy of E = 0.25 foe, a pre-SN mass of 12 M_{sun}, pre-SN radius of R= 550 R_{sun} and a nickel mass of M = 0.009 M_{sun}. These initial mass and radius are consistent with the values derived from imaging of the progenitor star Also the Computed nickel mass is in good agreement with what obtain rescaling the radiative tail of SN2008bk to that of SN1987A.

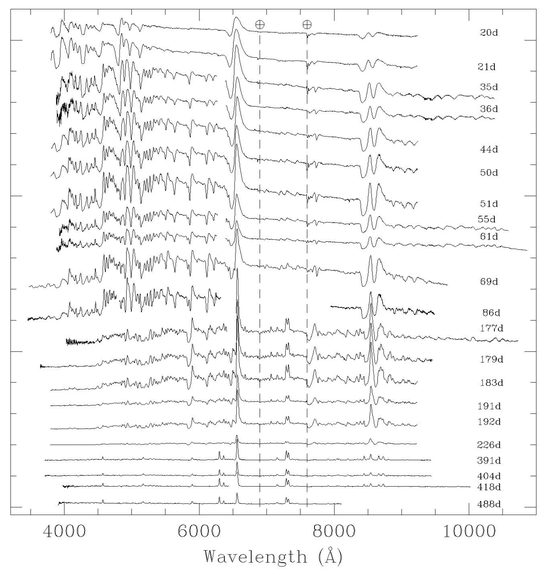

Fig. 7: Spectroscopic evolution of SN2008bk

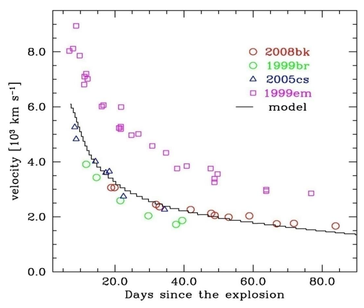

Fig. 8: Evolution of the expansion velocity derived from the FeII λ5169. The velocity computed by our hydrodynamic code are also reported

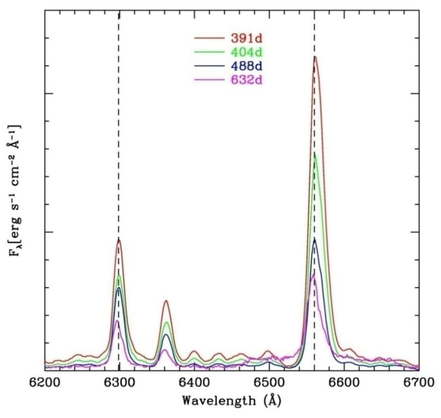

Fig. 10: zoom on the [O I] *λλ6300, 6354 and Hα region*

Reddening, distance and absolute magnitude

In none of the SN2008bk spectra there is sigh of NaID at the recession velocity of NGC 7793. This points to a low extinction suffered by the SN in its host. The Schlegel et al. 1998 maps report an E(B-V)=0.019 for the line-of-sign of NGC7793. The latter value of reddening is compatible with the estimation we got from the modelling of the SN2008bk spectroscopic time series. We therefore assume that the extinction toward SN 2008bk is only Galactic. A Cepheid distance modulus of NGC 7793 has been reported by Pietrzynsky et al. 2010 to be μ=27.68. Taking into account the reddening and the distance, as is visible in Fig. 5 the absolute V magnitude of SN2008bk is around -15 during the plateau phase. This is ~ 1 mag brighter than that of SN1999br. Nevertheless, taking into account the great similarity between the two objects and the fact that the distance of the host galaxy of SN1999br is not as well constrained as that of SN2008bk, the comparison between the absolute magnitude of SN2008bk and SN1999br suggests that SN1999br is probably closer than what reported in Pastorello et al. 2004. It is worth noting that during the plateau phase SN2005cs is ~2.0 mag brighter than SN2008bk, but after, it reach a comparable luminosity at the beginning of the radiative tail.

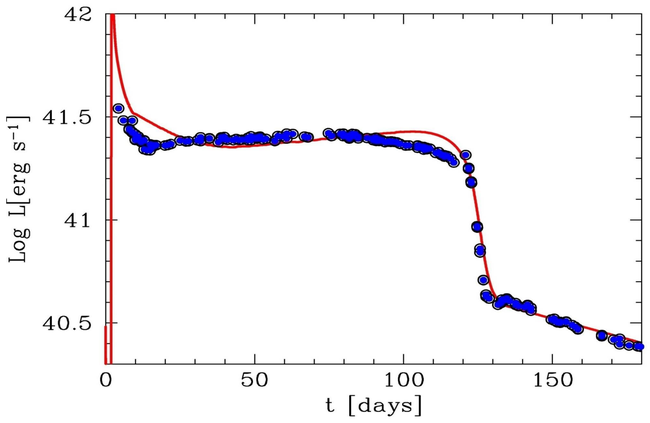

Fig. 6: Comparison of the our synthetic bolometric LC (red line) with the observations (blue dots) for SN 2008bk.

Spectroscopic evolution

In Fig. 7 we report the spectroscopic evolution of SN2008bk. Spectra were taken from the beginning of the plateau until almost thousand days after the explosion. As it is visible in Fig 8 the expansion velocities are typical of under-luminous SN IIP. They are only slightly greater than these of SN1999br. Indeed as visible in Fig 9 the spectra of the two SNe are almost identical.

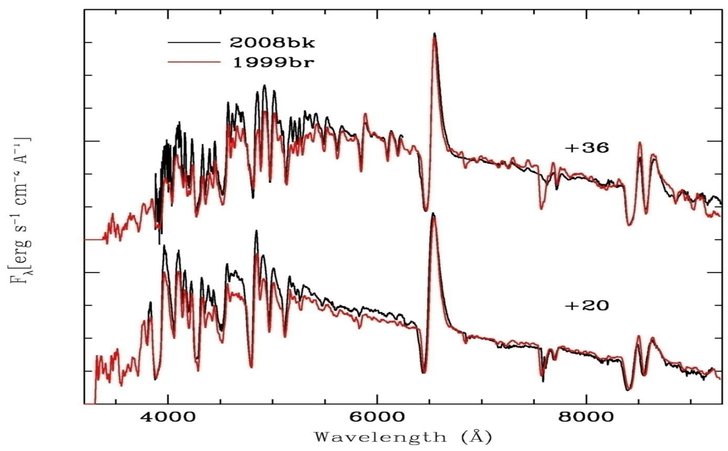

Fig. 9: Comparison between SN 2008bk and SN 1999br spectra at two different epochs

Dust production

In Fig. 10 we show a zoom on the [O I] λλ6300, 6354 and Hα region for a set of SN2008bk spectra. In the nebular spectrum taken at 632 days past the explosion, it is evident a blue shift on the emission line profile due to self absorption. The latter feature was observed also in the nebular spectra of SN1987A and SN1999em (Elmhamdi et al. 2003) and is believed to be due to dust production within the ejecta. From our spectroscopic time series we can infer that the dust start to condensate after ~490 days.

References

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