A Transitional Supernova KSP-K2C16-1-2018em

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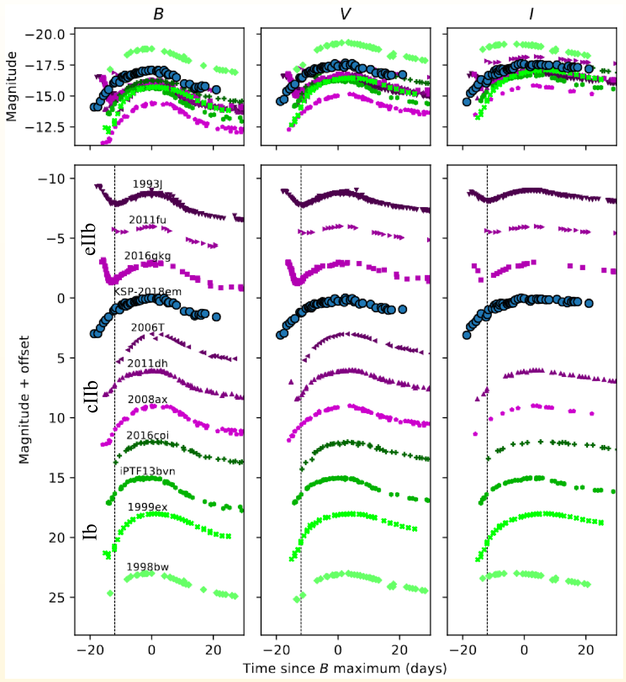
Introduction

Core-collapse supernovae (CCSNe) occur when massive stars reach the end of their lives.

SN KSP-K2C16-1-2018em is a CCSN. Its spectrum shows that its type is IIb, with a depleted hydrogen envelope but rich in helium. SNe IIb are either extended (eIIb) or compact (cIIb). KSP-K2C16-1-2018em appears to be Type cIIb. Unusually, it displays an early-light-curve feature more closely associated with SNe eIIb.



Results and Analysis

We obtained the following light curves for three photometric bands, B, V, and I, showing the evolution of the SN's brightness in the days following the explosion. Data after about 41 days are not available because the field moved too close to the Sun.

The light curve does not show a prominent early peak, which is a feature associated with SNe eIIb. The peak is due to the shock, and rapid cooling, of the extended hydrogen envelope, from the SN explosion. 2018em *does* have an excess light; the double power law fit at right suggests two distinct components powering the light curve.

We also obtained and reduced the spectrum, plotted at right. The redshift was ~0.046, or $D \approx 200$ Mpc.

We compared the light curve and spectrum with those of other SNe IIb. The spectrum was most similar to those of SNe cIIb (e.g., weak hydrogen features). SNe 2008ax and 2000H are cIIb.

An analysis of the early light curve and spectrum of 2018em (using thermodynamics and previous results of other SNe) yielded the results in the table, showing 2018em straddles the line between Types cIIb and eIIb.

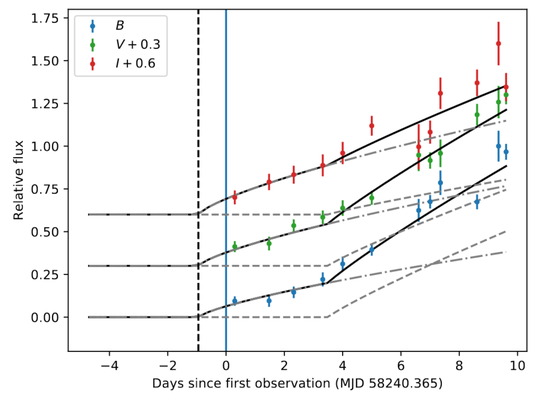
Parameter	Value	cIIb	eIIb
Hydrogen mass ($M_\odot$)	> 0.08	< 0.1	> 0.1
Progenitor radius ($R_\odot$)	< 14	< 1.4	> 140

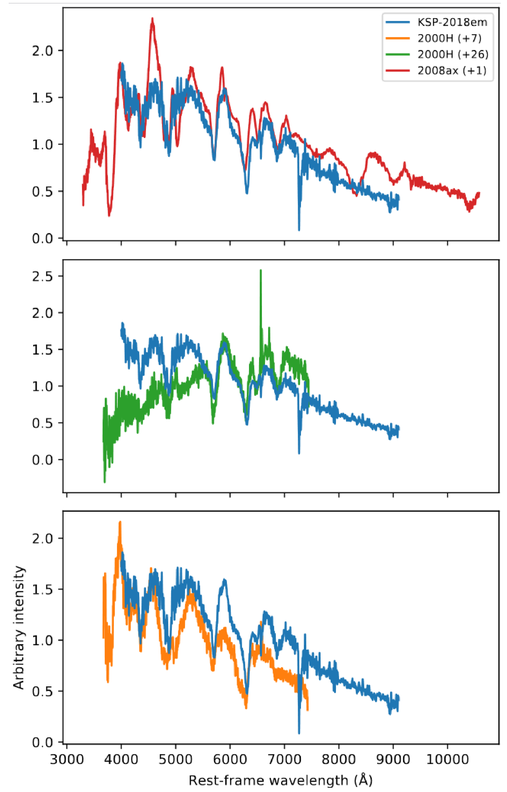
$$M_{\rm ext} = 5\times10^{-3}\left(\frac{\kappa}{0.34\,{\rm cm^2\,g^{-1}}}\right)^{-1}\left(\frac{v_{\rm ext}}{10^9\,{\rm cm\,s^{-1}}}\right)\left(\frac{t_p}{1\,{\rm day}}\right)^2 {\rm M_\odot},$$

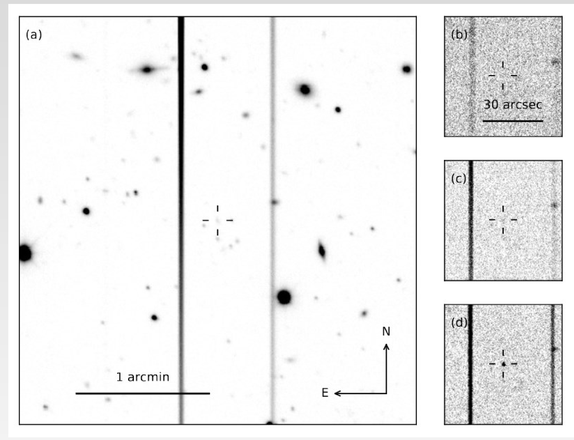
$$R_{\rm ext} = 2\times10^{13}\left(\frac{\kappa}{0.34\,{\rm cm^2\,g^{-1}}}\right)^{-1}\left(\frac{L_{\rm p}}{10^{43}\,{\rm erg\,s^{-1}}}\right)\left(\frac{v_{\rm ext}}{10^9\,{\rm cm\,s^{-1}}}\right)^{-2}\,{\rm cm},$$

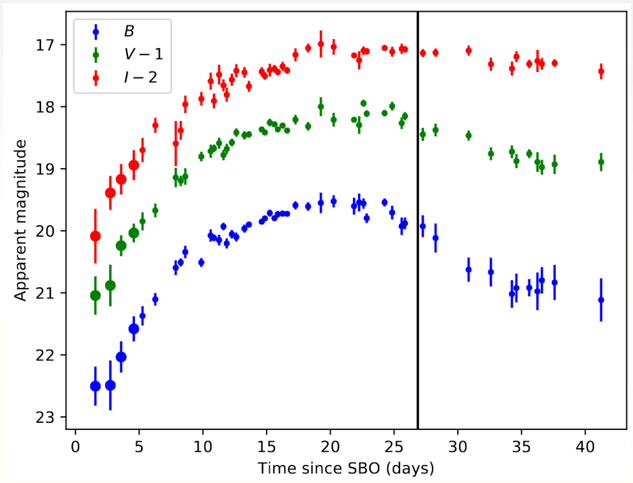
Equations: Nakar & Piro (2014).

eIIb/cIIb limits: Chevalier & Soderberg (2010).









Conclusions and Future Work

This is a surprising SN. It has most of the characteristics of SNe cIIb – for example, it is rather poor in hydrogen mass, and it lacks a prominent shock-cooling peak. However, it still does show excess light, which suggests the presence of a small hydrogen envelope. It may well be a transitional event. If so, this will constrain the nature of the progenitor of 2018em and shed light on SNe IIb progenitors as a whole.

Literature cited

Nakar, E., & Piro, A. L. 2014, ApJ, 788, 193.

Chevalier, R. A., & Soderberg, A. M. 2010, ApJL, 711, L40