Astronomers investigate type IIP supernova with a long plateau

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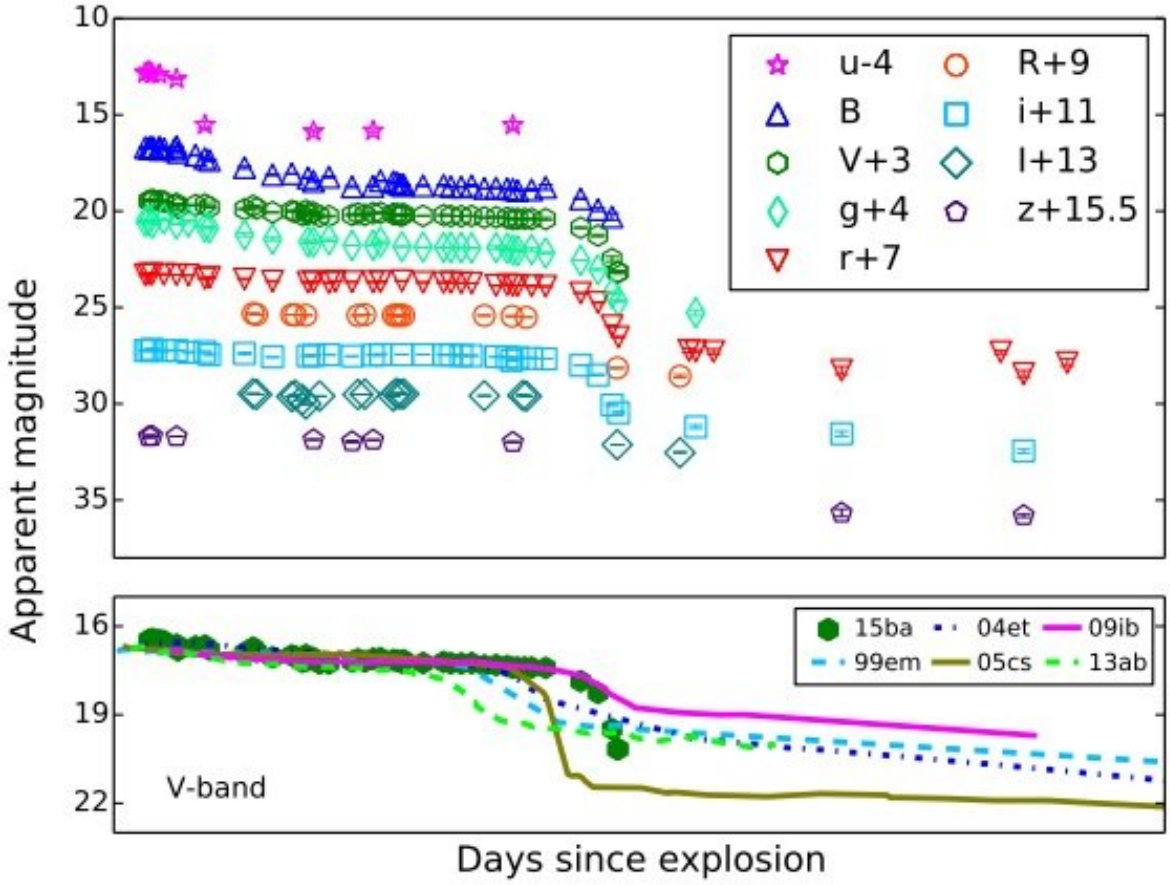

Top panel: Broadband uBVgrRiIz light curves of SN 2015ba shifted arbitrarily for clarity. Bottom panel: The V-band light curve of SN 2015ba compared with other SNe IIP. Credit: Dastidar et al., 2018.

Astronomers have investigated a type IIP supernovae known as SN 2015ba, which exhibits a long plateau in its light curve. The new study provides essential information about the properties of this explosion and could be helpful in improving our understanding of type IIP supernovae. The research is presented in a paper published June 14 on the arXiv pre-print server.

Based on the shape of light curves, astronomers generally divide type II supernovae (SNII) into two classes. Type II-Linear supernovae (SNe IIL) have a fairly rapid, linear decay after maximum light, while type II-Plateau supernovae (SNe IIP) remain bright (on a plateau) for an extended period of time after maximum. This plateau in the light curve of a standard SN IIP typically lasts about 100 days.

It is assumed that SNe IIP originate from precursor stars that retain a substantial amount of their hydrogen layers (greater than three solar masses) before exploding as core-collapse supernovae (CCSNe). Although many studies of SNe IIP have been conducted in the last two decades, some of their properties are still not well understood.

SN 2015ba was first spotted on November 28, 2015 in the galaxy IC 1029, at an estimated distance of at least 100 million light years away from the Earth. A team of astronomers led by Raya Dastidar of the University of Delhi in India commenced observations of this event three days after its discovery. For their photometric and spectroscopic observational campaign, which lasted almost nine months, they employed eight ground-based telescopes located worldwide.

"In this paper, we present the detailed analysis of SN 2015ba, a relatively bright SN IIP, which exploded in the nearly edge-on galaxy IC 1029," the researchers wrote in the paper.

The observations revealed that SN 2015ba showcased a strikingly long

plateau, lasting approximately 123 days. According to the paper, the event had an absolute V-band magnitude of −17.1 at 50 days since the explosion.

The researchers found that when compared to its brightness, the production of one of the isotopes of nickel (^{56}Ni) in SN 2015ba is much lower than in a similar supernova designated SN 2004et. They also analyzed the temperature evolution after the explosion, estimating that the temperature was as high as about 20,000 K at early epochs, falling to around 6,300 K at 50 days and finally settling to approximately 4,800 K at late epochs.

The astronomers concluded that hydrodynamical and analytical modelling of SN 2015ba is indicative of a massive progenitor of this supernova with a pre-explosion mass of around 25 solar masses. However, they noted that the massive precursor hypothesis is not supported by the nebular spectra of SN 2015ba as they exhibit insignificant levels of oxygen.

"This might be suggestive of the non-monotonical link between oxygen-core masses and the zero-age main-sequence mass of pre-supernova stars and/or uncertainties in the mixing scenario in the ejecta of supernovae," the paper reads.

More information: SN 2015ba: A type IIP supernova with a long plateau, arXiv:1806.05470 [astro-ph.HE] arxiv.org/abs/1806.05470

Abstract
We present optical photometry and spectroscopy from about a week after explosion to ~272 d of an atypical Type IIP supernova, SN 2015ba, which exploded in the edge-on galaxy IC 1029. SN 2015ba is a luminous event with an absolute V-band magnitude of -17.1±0.2 mag at 50 d since explosion and has a long plateau lasting for ~123 d. The distance to the

SN is estimated to be 34.8±0.7 Mpc using the expanding photosphere and standard candle methods. High-velocity H-Balmer components constant with time are observed in the late-plateau phase spectra of SN 2015ba, which suggests a possible role of circumstellar interaction at these phases. Both hydrodynamical and analytical modelling suggest a massive progenitor of SN 2015ba with a pre-explosion mass of 24-26 M⊙. However, the nebular spectra of SN 2015ba exhibit insignificant levels of oxygen, which is otherwise expected from a massive progenitor. This might be suggestive of the non-monotonical link between O-core masses and the zero-age main-sequence mass of pre-supernova stars and/or uncertainties in the mixing scenario in the ejecta of supernovae.