Progenitors of supernova Ibc: a single Wolf-Rayet star as the possible progenitor of the SN Ib iPTF13bvn

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Core-collapse supernova (SN) explosions mark the end of the tumultuous life of massive stars. Determining the nature of their progenitors is a crucial step towards understanding the properties of SNe. Until recently, no progenitor has been directly detected for SN of type Ibc, which are believed to come from massive stars that lose their hydrogen envelope through stellar winds and from binary systems where the companion has stripped the H envelope from the primary. Here we analyze recently reported observations of iPTF13bvn, which could possibly be the first detection of a SN Ib progenitor based on pre-explosion images. Very interestingly, the recently published Geneva models of single stars can reproduce the observed photometry of the progenitor candidate and its mass-loss rate, confirming a recently proposed scenario. We find that a single WR star with initial mass in the range 31-35 Msun fits the observed photometry of the progenitor of iPTF13bvn. The progenitor likely has a luminosity of log (L/Lsun)~5.55, surface temperature ~45000 K, and mass of ~10.9 Msun at the time of explosion. Our non-rotating 32 Msun model overestimates the derived radius of the progenitor, although this could likely be reconciled with a fine-tuned model of a more massive (between 40 and 50 Msun), hotter, and luminous progenitor. Our models indicate a very uncertain ejecta mass of ~8 Msun, which is higher than the average of the SN Ib ejecta mass that is derived from the lightcurve (2-4 Msun). This possibly high ejecta mass could produce detectable effects in the iPTF13bvn lightcurve and spectrum. If the candidate is indeed confirmed to be the progenitor, our results suggest that stars with relatively high initial masses (>30 Msun) can produce visible SN explosions at their deaths and do not collapse directly to a black hole.

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