Fundamental properties of core-collapse supernova and GRB progenitors: predicting the look of massive stars before death

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We investigate the fundamental properties of core-collapse supernova (SN) progenitors from single stars at solar metallicity. For this purpose, we combine Geneva stellar evolutionary models with initial masses of Mini = 20-120 Msun with atmospheric and wind models using the radiative transfer code CMFGEN. We provide synthetic photometry and high-resolution spectra of hot stars at the pre-SN stage. For models with Mini = 9-20 Msun, we supplement our analysis using publicly available MARCS model atmospheres of RSGs to estimate their synthetic photometry. We employ well-established observational criteria of spectroscopic classification and find that, depending on their initial mass and rotation, massive stars end their lives as red supergiants (RSG), yellow hypergiants (YHG), luminous blue variables (LBV), and Wolf-Rayet (WR) stars of the WN and WO spectral types. For rotating models, we obtained the following types of SN progenitors: WO1-3 (Mini â‰¥ 32 Msun), WN10-11 (25 < Mini < 32 Msun), LBV (20 â‰¤ Mini â‰¤ 25 Msun), G1 Ia+ (18 < Mini < 20 Msun RSGs (9 â‰¤ Mini â‰¤ 18 Msun). For non-rotating models, we found spectral types WO1-3 (Mini > 40 Msun), WN7-8 (25 < Mini â‰¤ 40 Msun), WN11h/LBV (2 25 Msun), and RSGs (9 â‰¤ Mini â‰¤ 20 Msun). Our rotating models indicate that SN IIP progenitors are all RSG, SN IIL/b progenitors are 56% LBVs and 44% YHGs, SN Ib progenitors are 96% WN10-11 and 4% WOs, and SN Ic progenitors are all WO stars. We find that the most massive and luminous SN progenitors are not necessarily the brightest ones in a given filter, since this depends on their luminosity, temperature, wind density, and the way the spectral energy distribution compares to a filter bandpass. We find that SN IIP progenitors (RSGs) are bright in the RIJHKS filters and faint in the UB filters. SN IIL/b progenitors (LBVs and YHGs), and SN Ib progenitors (WNs) are relatively bright in optical/infrared filters, while SN Ic progenitors (WOs) are faint in all optical filters. We argue that SN Ib and Ic progenitors from single stars should be undetectable in the available pre-explosion images with the current magnitude limits, in agreement with observational results.

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