The Progenitor Mass of SN 2011dh from Stellar Populations Analysis

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Using Hubble Space Telescope (HST) photometry, we characterize the age of the stellar association in the vicinity of supernova (SN) 2011dh and use it to infer the zero-age main sequence mass (M_{ZAMS}) of the progenitor star. We find two distinct and significant star formation events with ages of <6 and 17^{+3}_{-4} Myrs, and the corresponding M_{ZAMS} are >29 and 13^{+2}_{-1} M_{Sun}, respectively. These two bursts represent 18^{+4}_{-9}% (young) and 64^{+10}_{-14}% (old) of the total star formation in the last 50 Myrs. Adopting these fractions as probabilities suggests that the most probable M_{ZAMS} is 13^{+2}_{-1} M_{Sun}. These results are most sensitive to the luminosity function along the well-understood main sequence and are less sensitive to uncertain late-stage stellar evolution. Therefore, they stand even if the progenitor suffered disruptive post-main-sequence evolution (e.g. eruptive mass loss or binary Roche-lobe overflow). Progenitor identification will help to further constrain the appropriate population. Even though pre-explosion images show a yellow supergiant (YSG) at the site of the SN, panchromatic SN light curves suggest a more compact star as the progenitor. In spite of this, our results suggest an association between the YSG and the SN. Not only was the star located at the SN site, but reinforcing an association, the star's bolometric luminosity is consistent with the final evolutionary stage of the 17 Myr old star burst. If the YSG disappears, then M_{ZAMS}=13^{+2}_{-1} M_{Sun}, but if it persists, then our results allow the possibility that the progenitor was an unseen star of >29 M_{Sun}.

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