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Progenitor mass distribution of core-collapse supernova remnants in our galaxy and Magellanic Clouds

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We investigate a progenitor mass distribution of core-collapse supernova remnants (CCSNRs) in our Galaxy and the Large and Small Magellanic Clouds, for the first time. We use the zero-age main-sequence mass, $M_{\rm ZAMS}$, estimated from elemental abundances and count the number of the CCSNRs in three mass ranges:
A: $M_{\rm ZAMS} < 15\ {\rm M}_\odot$,
B: $15\ {\rm M}_\odot < M_{\rm ZAMS} < 22.5\ {\rm M}_\odot$,
C: $22.5\ {\rm M}_\odot < M_{\rm ZAMS}$.
Simple compilation of progenitor masses in the literature yields a progenitor mass distribution of $f_{\rm A} : f_{\rm B} : f_{\rm C} = 0.24 : 0.28 : 0.48$, where f is the number fraction of the progenitors. The distribution is inconsistent with any standard initial mass functions. We notice, however, that previous mass estimates are subject to large systematic uncertainties because most of the relative abundances (X/Si) are not really good probe for the progenitor masses. Instead, we propose to rely only on the Fe/Si ratio which is sensitive to the CO core mass ($M_{\rm COcore}$) and $M_{\rm ZAMS}$. Comparing Fe/Si ratios in SNRs in the literature with the newest theoretical model, we estimate 33 $M_{\rm COcore}$ and $M_{\rm ZAMS}$, leading to a revised progenitor mass distribution of $f_{\rm A} : f_{\rm B} : f_{\rm C} = 0.47 : 0.32 : 0.21$. This is consistent with the standard Salpeter initial mass function, implying that the most massive progenitors in $6\ {\rm M}_\odot < M_{\rm COcore}$ or $22.5\ {\rm M}_\odot < M_{\rm ZAMS}$, which have often been considered to collapse to black holes without explosions, can actually explode. However, the relation between $M_{\rm COcore}$ and $M_{\rm ZAMS}$ could be affected by binary evolution which is not taken into account in this study. The effect of stellar multiplicity should be considered in the future work to derive a better progenitor mass distribution estimate.

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