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A SEARCH FOR THE CASSIOPEIA A SN PROGENITOR

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The observed abundances in the Cas A supernova remnant (SNR) are used together with the results of evolutionary calculations of massive stars to construct an evolutionary picture for the Cas A progenitor star. From the structure shown by the remnant, it is believed that the precursor star was a WR with a lifetime of 10^4 years. With this assumption and the chemical abundances produced during the stellar nucleosynthesis we present results which suggest that the precursor of Cas A was a star with a mass between 29–30 $M_\odot$ on the ZAMS.

Cas A is an oxygen-rich young supernova remnant with distinct optically emitting regions, which have very different compositions and velocities (see, e.g., Chevalier & Kirshner 1979). For example, the quasi-stationary flocculi (QSFs) have low velocities and show enhanced He/H and N/H ratios, while the fast moving knots (FMKs) show high velocities, are devoid of H, He and N, and are enriched in O and other heavier elements.

Several authors (Peimbert & van der Burgh 1971; Chevalier 1976; Fesen, Becker, & Goodrich 1988) have suggested that the Cas A progenitor star lost its H-He-N envelope prior to the supernova event, thus forming the QSFs. Likewise, it is believed that FMK material was ejected by the star during the SN explosion, and therefore that this material belonged to the stellar interior. García-Segura, Mac-Low, & Langer (1996) postulated that the Cas A progenitor was a WR star with a lifetime of 10^4 years. They postulated that the origin of the QSFs were due the interaction of the fast WR wind with the previous slow, but dense, RSG wind. With these assumptions and the observed abundances of FMKs and QSFs, together with our evolutionary calculations, we here put constraints on the initial mass of the SN progenitor.

In our models we follow the evolution of stars in the range of 28–33 $M_\odot$ from the ZAMS to presupernova stage. The models begin with a chemically homogeneous star with solar metallicity in agreement with the procedure described in García-Segura et al. (1996) and with initial rotation velocities of 200 km s^{-1}.

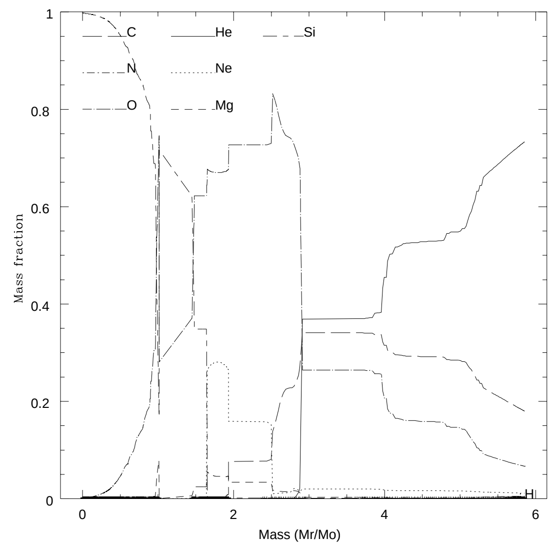

Fig. 1. Abundance profiles within the star at the end of core oxygen burning for a model with a ZAMS mass of 30 $M_\odot$.

We found that almost all stars developed a WR stage, except for the 28 $M_\odot$ case. The lifetimes at WR stage were 9.3×10^4 years for 33 $M_\odot$ and approximately 1.8×10^4 years for 29 and 30 $M_\odot$, which agrees with the models of García-Segura (1996). The abundances of our 29 and 30 $M_\odot$ stars fit well with those observed by Chevalier & Kirshner (1979) if we suppose homogeneous mixing. However, our calculated abundances show an increase in C and the heavy elements produced by O-burning. The Si abundance agrees very well.

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