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Hiding in plain sight - red supergiant imposters? Super-AGB stars

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Abstract. Super Asymptotic Giant Branch (Super-AGB) stars reside in the mass range ≈ 6.5-10 $M_\odot$ and bridge the divide between low/intermediate-mass and massive stars. They are characterised by off-centre carbon ignition prior to a thermally pulsing phase which can consist of many tens to even thousands of thermal pulses. With their high luminosities and very large, cool, red stellar envelopes, these stars appear seemingly identical to their slightly more massive red supergiant counterparts. Due to their similarities, super-AGB stars may therefore act as stellar imposters and contaminate red supergiant surveys. The final fate of super-AGB stars is also quite uncertain and depends primarily on the competition between the core growth and mass-loss rates. If the stellar envelope is removed prior to the core reaching ≈ 1.375 $M_\odot$, an O-Ne white dwarf will remain, otherwise the star will undergo an electron-capture supernova (EC-SN) leaving behind a neutron star. We determine the relative fraction of super-AGB stars that end life as either an O-Ne white dwarf or as a neutron star, and provide a mass limit for the lowest mass supernova over a broad range of metallicities from the Z=0.02 to 0.0001.

Keywords. evolution – stars: AGB and post-AGB – stars: white dwarfs – stars: supernovae: general

1. Evolution, Nucleosynthesis and Final fates of Super-AGB stars

Super-AGB stars undergo relatively extreme nucleosynthetic conditions, with very efficient proton-capture nucleosynthesis occurring at the base of the convective envelope and also heavy element (s-process) production during the thermal pulse to be later mixed to the surface during third dredge-up events (e.g. Doherty *et al.* 2014ab). The surface enrichment from these two processes may result in a clear nucleosynthetic signature to differentiate super-AGB stars from red supergiants (RSGs). To further aid in dividing these classes of stars, a fine grid of detailed evolutionary and nucleosynthetic calculations which include stellar rotation are required for both the lowest mass RSGs and the most massive super-AGB stars.

There are many factors which influence the final fates of super-AGB stars such as the efficiency of convection, the mass-loss rates and the third dredge-up efficiency. In Doherty *et al.* 2015 we concluded the EC-SN channel (for single stars) is very narrow in initial mass, at most ≈ 0.2 $M_\odot$ over the metallicity range Z=0.02 to 0.0001.

References

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