

Monash Chemical Yields Project (Mon χ ey) Element production in low- and intermediate-mass stars

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Abstract. The Mon χ ey project will provide a large and homogeneous set of stellar yields for the low- and intermediate- mass stars and has applications particularly to galactic chemical evolution modelling. We describe our detailed grid of stellar evolutionary models and corresponding nucleosynthetic yields for stars of initial mass $0.8 M_{\odot}$ up to the limit for core collapse supernova (CC-SN) $\approx 10 M_{\odot}$. Our study covers a broad range of metallicities, ranging from the first, primordial stars ($Z = 0$) to those of super-solar metallicity ($Z = 0.04$). The models are evolved from the zero-age main-sequence until the end of the asymptotic giant branch (AGB) and the nucleosynthesis calculations include all elements from H to Bi. A major innovation of our work is the first complete grid of heavy element nucleosynthetic predictions for primordial AGB stars as well as the inclusion of extra-mixing processes (in this case thermohaline) during the red giant branch. We provide a broad overview of our results with implications for galactic chemical evolution as well as highlight interesting results such as heavy element production in dredge-out events of super-AGB stars. We briefly introduce our forthcoming web-based database which provides the evolutionary tracks, structural properties, internal/surface nucleosynthetic compositions and stellar yields. Our web interface includes user- driven plotting capabilities with output available in a range of formats. Our nucleosynthetic results will be available for further use in post processing calculations for dust production yields.

Keywords. nuclear reactions, nucleosynthesis, abundances, stars: AGB and post-AGB

1. Overview

Low- and intermediate-mass stars are important for galactic chemical evolution as they enrich the environment with C, N, F, and approximately half of all of the elements past Fe via the s-process.

We are currently computing a large grid of stellar evolutionary models using the MON-STAR stellar evolution program (Lattanzio 1986, Campbell & Lattanzio 2008, Constantino *et al.* 2014). These evolutionary models are then post-processed using the MONTAGE nucleosynthesis program (Church *et al.* 2009), a modified version of MONSOON (Cannon 2009, Karakas 2010, Doherty *et al.* 2014). To calculate both light and heavy element nucleosynthesis we use either a network of 475 species from H to Bi, or an extended version with over 700 species, which includes more neutron rich isotopes further from beta stability, appropriate for models which reach higher neutron densities. We include ^{13}C pockets in the low mass models by artificially introducing protons at the deepest extent of third dredge-up using the approach as described in Lugaro *et al.* 2012.

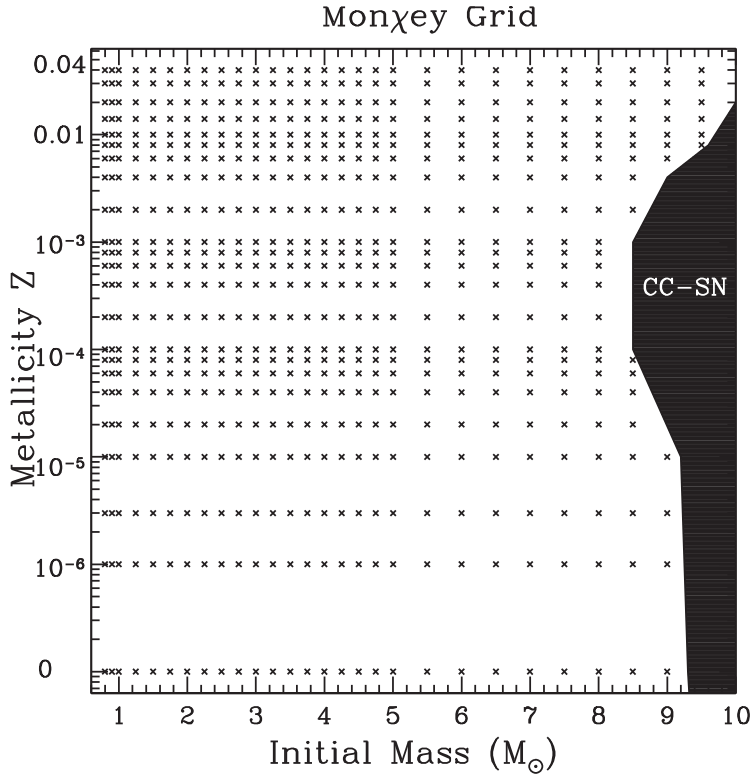


Figure 1. Prospective grid of stellar evolutionary and nucleosynthesis models.

In Fig. 1 we show our planned grid of stellar models which range from initial mass $0.8 M_{\odot}$ up to $\approx 10 M_{\odot}$ and covers a broad range of metallicities, ranging from the first, primordial stars ($Z=0$) to those of super-solar metallicity ($Z=0.04$). At the lower masses we compute stellar models in $0.1 M_{\odot}$ divisions, increasing to $0.25 M_{\odot}$ then $0.5 M_{\odot}$ with increasing initial mass.

Our web-based interface (Mon χ ey online) will include a variety of outputs such as stellar tracks, thermally pulsing AGB star characteristics, stellar yields and estimates on uncertainties for each element/isotope.

Computations for the Mon χ ey project are underway and we expect a release of the first results in early 2016.

References

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