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Monash Chemical Yields Project (Monχey) Element production in low- and intermediate-mass stars

Carolyn Doherty[1], John Lattanzio[1], George Angelou[2], Simon W. Campbell[1], Ross Church[3], Thomas Constantino[1], Sergio Cristallo[4], Pilar Gil-Pons[5], Amanda Karakas[6], Maria Lugaro[7] and Richard Stancliffe[8]

[1]Monash Centre of Astrophysics, [2]Max Planck Institut fur Sonnensystemforschung, [3]Lund Observatory, [4]INAF-Osservatorio Astronomico di Collurania, [5]Polytechnical University of Catalonia, [6]Research School of Astronomy and Astrophysics, [7]Konkoly Observatory, [8]Argelander Institute for Astronomy

Abstract. The Monχey 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

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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 sprocess.

We are currently computing a large grid of stellar evolutionary models using the MONSTAR 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.

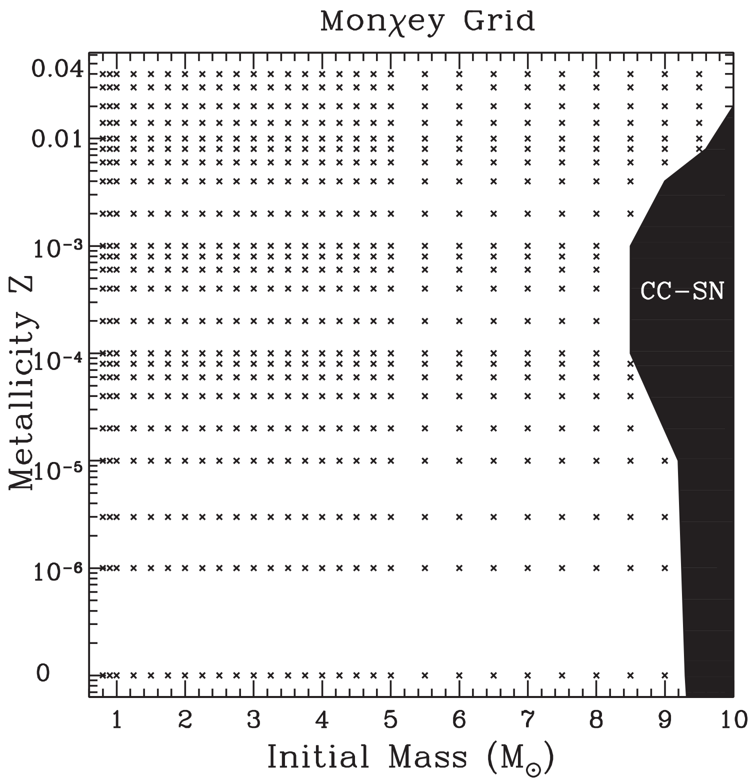

Figure 1. Prospective grid of stellar evolutionary and nucleosynthesis models.

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 (Monχey 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 Monχey project are underway and we expect a release of the first results in early 2016.

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