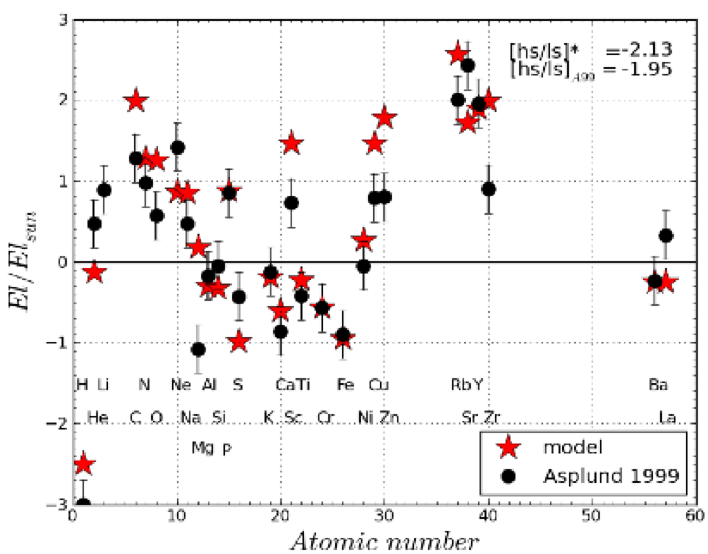
Neutron-capture nucleosynthesis in stellar combustion

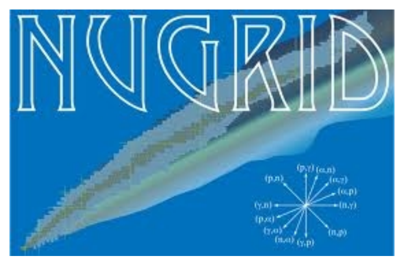
We investigate the nucleosynthesis in combustion events in stellar evolution. These are events where nuclear reactions with large energy depositions operate on the same time scale as convective mixing processes, and are therefore dynamically relevant for mixing. In our attempt to create a nucleosynthesis simulation that reproduces the detailed observed elemental abundances of post-AGB He-shell flash white dwarf Sakurai's object (Asplund etal.) we start with a multi-zone complete post-processing (based on the NuGrid codes) of a one-dimensional stellar evolution model sequence. We show, that the mixing predicted by this mixing-length theory based model is by far unable to account for the significantly non-solar abundance distribution observed in this shell-flash star (elements like RB, Sr and Y are overabundant compared to the sun by a factor of 100).

We then assume an alternative-mixing scenario that is qualitatively based on three-dimensional hydrodynamic simulations of He-shell flash convection. In these models we obtain significantly higher neutron densities (~few 10^{15} cm^{-3}) and reproduce the key observed abundance trends found in Sakurai's object (see Figure). We determine how our results depend on uncertainties of nuclear reaction rates, for example for the $^{13}C(\alpha, n)^{16}O$ reaction.

The next direction of this project is to further investigate the hydrodynamic properties of these combustion events, as well as investigate possible consequences of combustion in other phases of stellar evolution, particularly in stars of very low metal content.



Comparison of observed elemental abundances in Sakurai's object (Asplund etal. 1999, A&A 343, 507) and our model with hydrodynamically motivated mixing.



Researchers:
Falk Herwig (University of Victoria)
Marco Pignatari (University of Victoria, TRIUMF)
Paul Woodward (LCSE, University of Minnesota)
and the NuGrid collaboration
(http://www.astro.keele.ac.uk/nugrid)

Reference:
Herwig etal. 2011, ApJ 727, 89.

Contact:
Falk Herwig, University of Victoria,
fherwig@uvic.ca