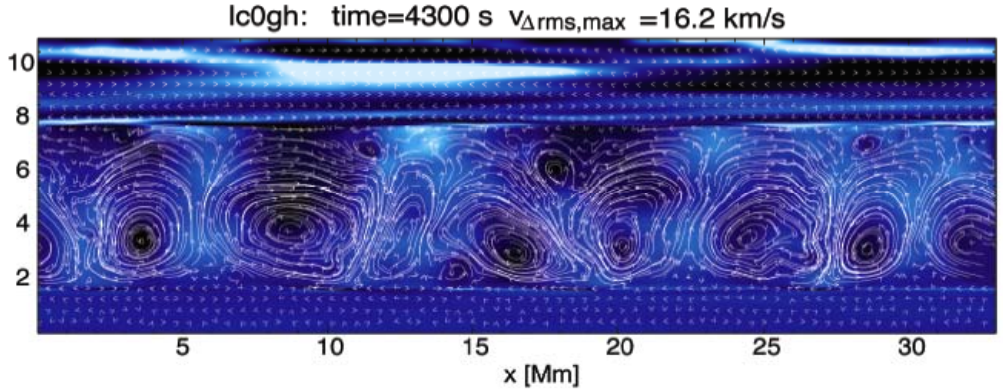
# s-Process branchings in He-shell flash convection




The production of half of all elements heavier than iron takes place through slow neutron capture reactions in He- and C-burning convection layers. As an example, the hydrodynamic flow pattern (pressure fluctuations and quasi-steady streamlines) of He-shell flash convection in an AGB star is shown above. This high-resolution 2D simulation has been performed last year at LANL, within a collaboration that involved MSU/JINA.

s-Process branchings can be used as a diagnostic tool. Temperatures in the stellar interior are often related to the physics of mixing, such as the mixing induced by convective flows shown above. The branching points are radioactive isotopes that can $\beta$-decay on a comparable time-scale as capturing another neutron. Because the neutron flux depends critically on temperature the branching conditions can be used as a thermometer. In order for this tool to work accurate n-capture cross sections of radioactive species need to be measured. At LANL researchers, in collaboration with JINA scientists, have started a new program, initially for three years with the goal of a complete experimental survey of the 5 s-process branch points in the Sm-Eu-Gd region. Target preparation has started in fall 2005. (n,$\gamma$) measurements of radioactive samples with the DANCE 4$\pi$ $BaF_2$ array are in preparation.

Astrophysical simulation tools, like a multi-zone s-process network and a stellar evolution code have been updated and integrated. With these tools we will be able to translate the nuclear physics experimental cross sections in astrophysical observables. By interpreting the experimental data in an observational astrophysics context, we can derive important constraints on hydrodynamic mixing of He-shell flash convection. This will serve as a validation for multi-dimensional hydrodynamic simulations. However, the research serves the ultimate goal to understand and model the stellar production of elements with sufficient accuracy for interpreting observations. This is in particular important and difficult for stars at very low metal-content, like the first generations of stars. Many of those stars will be discovered in the SEGUE (SDSS-II) survey.

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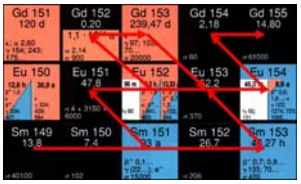
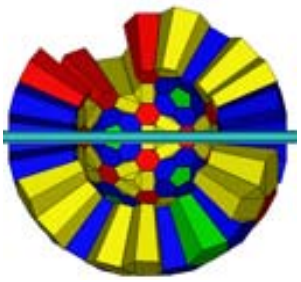



The s-process path in the Sm-Eu-Gd region. The isotopes indicated by the red boxes are long-lived radioactive and represent the likely branching points in this region. The $^{150}$Sm and $^{152}$Gd. $^{154}$Gd isotopes can only be produced by the s-process.



Schematic of the DANCE detector at LANSCE, LANL.

**Investigators:**

F. Herwig[1]
R. Reifarth[1]
F. Timmes[1]
B. Freytag[1,2,3]
M. Pignatari[4,5]

[1] Los Alamos National Laboratory
[2] Michigan State University
[3] University Uppsala
[4] University of Notre Dame
[5] University of Torino