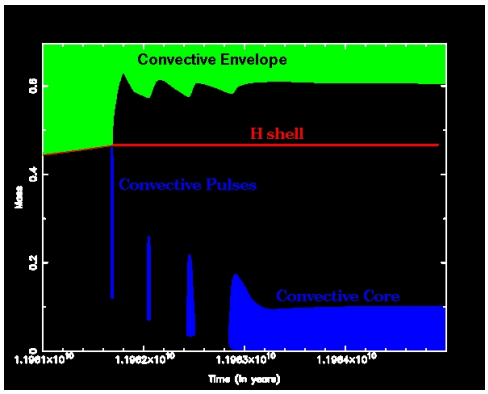
The core helium flash with FLASH



Convective region inside a star during the core helium flash.

The core helium flash (CHeF) is the thermonuclear runaway that occurs in the cores of evolved low mass stars. It marks the end of their ascent of the red giant branch. This event has mostly been addressed using one-dimensional stellar evolution codes in the past. The development of multi-dimensional tools such as the FLASH code offers new possibilities regarding the helium core flash. These new tools allow researchers to carefully check the structure of the star at a given time and in particular can give us clues about the internal convective region that is associated to the triple alpha reaction.

We plan to study the extent of the mixing during the helium core flash in the stellar center and the associated convective velocities. In particular the ingestion of hydrogen rich layers into the helium burning convection zone has been proposed to explain some chemical characteristic of the oldest stars. The fraction of carbon and nitrogen rich objects increases when the metallicity decreases. To date this observational fact receives no explanation in terms of stellar nucleosynthesis. One possibility is that the convective region associated with helium burning engulfs hydrogen present in the layers lying above subsequently inducing an hydrogen flash. This in turn enhances the convective motions in the stellar core which eventually get partly mixed to the envelope of the red giant. However the possibility of such mixing depends on the extension of the convective motions. It also depends on the actual efficiency of the mixing which tunes the temperature of hydrogen burning of the hydrogen flash and therefore the associated luminosity. These quantities cannot be computed if using one dimensional tools where the convection is modelled using phenomenological theories such as the mixing length theory. However thanks to the FLASH code we can perform a direct evaluation of the convection occuring at a given time in the deep layers during the helium flash. This in turn allows to correctly estimate the extent of convection during the flash in a classical stellar evolution code.

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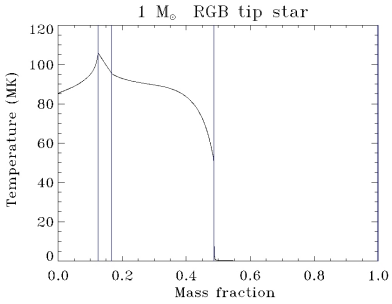
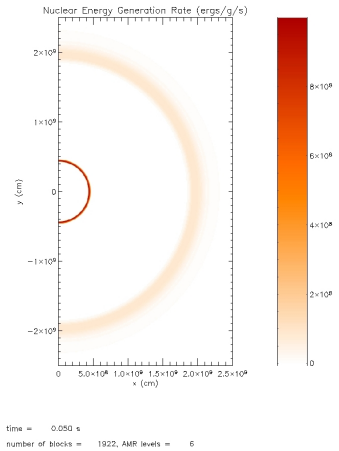


Temperature vs mass as predicted at the begining of the CHeF. The vertical bars display the limits of convection zones. 0.5 $M_\odot$: base of the outer convective envelope. 0.15 $M_\odot$: inner convection zone associated with the 3α runaway.



Nuclear energy generation vs radius during the CHeF computed in two dimensions using the FLASH code. $2\,10^9$ cm of the center: edge of the helium core and hydrogen burning by the CNO cycle. $5\,10^8$ cm: helium flash.

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