



Contribution ID: 89

Type: poster

The transition between convective and radiative carbon burning in massive stars

Wednesday, 23 May 2018 16:30 (1h 30m)

Following the convective core burning of hydrogen and helium in massive stars the next phase, core carbon burning, can proceed either convectively or radiatively. Under certain thermodynamic conditions core carbon-burning generates enough energy for the energy released to be transported by convection. Otherwise, the nuclear energy generated is too small relative to thermal neutrino losses to drive convection and the core burns carbon radiatively. The change between the two burning types is a key transition in massive star evolution that is assumed to affect all subsequent stages and result in a bimodal distribution of the remnants of massive stars.

In this work, we analyze the transition between convective and radiative core carbon burning in MESA massive star models between 15 and 21 M_{\odot} as a function of ZAMS mass, initial metallicity, rotation, mass-loss, and the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ rate.

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Session Classification: Poster Session