The effect of 12C + 12C rate uncertainties on the weak s-process component

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The contribution by massive stars (M > 9 solar masses) to the weak s-process component of the solar system abundances is primarily due to the 22Ne neutron source, which is activated near the end of helium-core burning. The residual 22Ne left over from helium-core burning is then reignited during carbon burning, initiating further s-processing that modifies the isotopic distribution. This modification is sensitive to the stellar structure and the carbon burning reaction rate. Recent work on the 12C + 12C reaction suggests that resonances located within the Gamow peak may exist, causing a strong increase in the astrophysical S-factor and consequently the reaction rate. To investigate the effect of an increased rate, 25 solar mass stellar models with three different carbon burning rates, at solar metallicity, were generated using the Geneva Stellar Evolution Code (GENEC) with nucleosynthesis post-processing calculated using the NuGrid Multi-zone Post-Processing Network code (MPPNP). The strongest rate caused carbon burning to occur in a large convective core rather than a radiative one. The presence of this large convective core leads to an overlap with the subsequent convective carbon-shell, significantly altering the initial composition of the carbon-shell. In addition, an enhanced rate causes carbon-shell burning episodes to ignite earlier in the evolution of the star, igniting the 22Ne source at lower temperatures and reducing the neutron density.

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