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The Effect of Reaction Rate on the Pre-supernovae Core Structure and Nucleosynthesis

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The gravitational wave signal GW190521 detected by LIGO/Virgo seems to originate from a binary black hole merger event, with a 99.0% probability that at least one of the black holes falls into the black hole mass gap caused by pair-instability supernova. This conclusion challenges stellar evolution theory and has motivated many attempts to examine the effects of uncertainties involved in stellar evolution. In this talk, we mainly focused on how the $^{12}C(\alpha,\gamma)^{16}O$ reaction rate affects the core structure of progenitors and nucleosynthesis. We will elaborate on the mechanism of this reaction rate's influence on the evolution of massive stars and propose a new criterion for predicting the final fate of core-collapse supernova explosions. Additionally, we also discuss the impact of this reaction rate on the evolution and nucleosynthesis of pair-instability supernovae, predicting the theoretical abundance of various elements after the explosion of first-generation pair-instability supernovae. Comparing the predicted theoretical abundance with the observed abundance of extremely metal-poor stars helps in identifying the chemical imprints left behind by first-generation supermassive stars after their explosions.

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