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CFA LECTURES

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Solving the mysteries of $^{12}C(\alpha,\gamma)^{16}O$

Of all the reactions important to nuclear astrophysics, solving the puzzle of $^{12}C(\alpha,\gamma)^{16}O$ may be the most intensely studied and sought after. Massive stars are extremely important for our understanding of the chemical evolution of the universe. When these stars die, they generate so much power that they can explode in a supernovae showering the interstellar medium with their ashes providing the building blocks for future generations of stars. While the general framework of supernovae explosions is well established, many questions still remain. Of the nuclear physics uncertainties, chief among them is the $^{12}C(\alpha,\gamma)^{16}O$ reaction rate (≈20% uncertainty or perhaps much more!), which together with the 3α process determines the ratio of ^{12}C to ^{16}O produced during helium burning. Stellar models have shown that this has a strong effect on the later burning stages and resulting nucleosynthesis. Over the last 60 years, a great deal of experimental effort has been expended in determining the low energy cross section to a value of <10% uncertainty called for by stellar modelers. In the last 15 years several key measurements, introducing new ways of studying the reaction both directly and indirectly, may be finally getting us close to this goal. In this talk I will summarize the state of the data and highlight the recent studies which each provide important clues. By way of a phenomenological *R*-matrix model I will combine the results of these different studies in order to explore the impact of the different data sets and examine their level of consistency. Finally I will talk briefly about a proposed experiment that may be able to provide another piece in the puzzle.

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