Low Energy Measurement of the ^{13}C(α,n)^{16}O Reaction for s-process Nucleosynthesis

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Abstract

The slow neutron capture process (s-process) is a key mechanism in heavy-element synthesis, and is responsible for approximately half of the heavy elements over ^{56}Fe. It creates elements along the line of beta-stability via neutron capture and beta decay in low neutron flux environments such as low-mass asymptotic giant branch stars. The dominant source of neutrons for the main branch of the s-process is the ^{13}C(α,n)^{16}O reaction, which occurs at stellar temperatures of ~ 0.1 GK (~ 200 keV). This makes direct measurement of the reaction rate in the Gamow window ($\sim 140 - 230$ keV) experimentally challenging due to the low yields and high beam currents required. There have been international efforts to measure this reaction at astrophysically relevant energies utilizing different experimental techniques. One recent measurement, performed at Oak Ridge National Laboratory, utilized a quasi-spectroscopic approach to neutron detection with the aim of reducing uncertainties in current measurements. The experimental challenges and techniques involved with the measurement of this reaction will be discussed.

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