

Direct measurement of the $^{15}\text{N}(p, \gamma)^{16}\text{O}$ cross sections at low energy

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The CNO cycle is the primary energy production mechanism in massive stars, with the $^{15}\text{N}(p, \gamma)^{16}\text{O}$ reaction serving as a crucial branching point connecting the CN and NO cycles. The ratio of reaction rates between $^{15}\text{N}(p, \gamma)^{16}\text{O}$ and $^{15}\text{N}(p, \alpha)^{12}\text{C}$ directly determines the nitrogen and oxygen abundances within the CNO cycle, which in turn affect stellar evolution and nucleosynthesis. However, there is significant discrepancy in the existing low-energy experimental data for the $^{15}\text{N}(p, \gamma)^{16}\text{O}$ reaction cross-section. This work remeasured the $^{15}\text{N}(p, \gamma)^{16}\text{O}$ reaction using the 350 keV accelerator at INEST (the Institute of Nuclear Energy Safety Technology), in the energy range $E_p=110\text{-}260$ keV. We used the FCVA (Filter Cathodic Vacuum Arc) technology to enrich Ti^{15}N targets and measured the target thickness by scanning the resonance of $^{15}\text{N}(p, \alpha\gamma)^{12}\text{C}$ at $E_{cm}=842$ keV. The 4π -BGO detector array can effectively absorb nearly all the γ -rays produced by the reaction. The detector is shielded and counter-coincident on the outside, which significantly reduces the measurement background. We used γ -ray summing detection techniques and Bayesian analysis method to fit the single spectra and summing spectra, yielding the γ -ray transition branching ratios and the detection efficiency of the summing peak, and further calculated the S-factor. Currently, R-matrix analysis of the $^{15}\text{N}(p, \gamma)^{16}\text{O}$ data is in progress. In the future, we will conduct low-energy measurements of the $^{15}\text{N}(p, \alpha)^{12}\text{C}$ direct reaction and calculate the impact of the ratio of these reaction rates on the abundances of nitrogen and oxygen in the CNO cycle.

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