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Direct measurement of the ^{15}N$(p,\gamma)^{16}$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}N$(p,\gamma)^{16}$O reaction serving as a crucial branching point connecting the CN and NO cycles. The ratio of reaction rates between ^{15}N$(p,\gamma)^{16}$O and ^{15}N$(p,\alpha)^{12}$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}N$(p,\gamma)^{16}$O reaction cross-section. This work remeasured the ^{15}N$(p,\gamma)^{16}$O reaction using the 350 keV accelerator at INEST (the Institute of Nuclear Energy Safety Technology), in the energy range E_p=110-260 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}N$(p,\alpha\gamma)^{12}$C at E_{cm}=842 keV. The 4π-BGO detector array can effectively absorb nearly all the -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}N$(p,\gamma)^{16}$O data is in progress. In the future, we will conduct low-energy measurements of the ^{15}N$(p,\alpha)^{12}$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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Primary author: WANG, Lin (Beijing Normal University)

Co-author: CHEN, Xin (北京师范大学)

Presenter: WANG, Lin (Beijing Normal University)

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