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How nuclear physics experiments shape our understanding of supernova γ-ray signatures

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The long-lived γ-ray isotopes observed in core-collapse supernovae remnants are direct signatures of the nucleosynthesis processes that occurred during the explosion. However, interpreting these signatures to understand the explosion dynamics requires precise nuclear physics input. Recent sensitivity studies have identified the $^{13}N(\alpha,p)^{16}O$ reaction as a major nuclear uncertainty affecting the production of observable isotopes like ^{44}Ti, ^{56}Ni, and neutron-rich iron-group elements [1,2]. However, the reaction remains poorly constrained, with existing estimates relying on statistical models or indirect measurements and only one direct measurement at relatively high energies [3,4]. To directly address this uncertainty, we performed a new measurement of the $^{13}N(\alpha,p)^{16}O$ reaction cross section. Using the thick-target inverse kinematics technique with a high-intensity radioactive ^{13}N beam at the CRIB facility (RIKEN), we probed the astrophysically relevant energy range (E ≈ 1.2–5.0 MeV). This talk will present our experimental approach and the preliminary results from this campaign. This work shows how targeted nuclear physics experiments provide critical data needed to interpret astrophysical observations. By constraining this key reaction rate, we will directly refine nucleosynthesis models, improve the interpretation of current γ-ray data from supernova remnants, and enable more accurate predictions for next-generation space-based observatories.

References

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