New Radioactive Beam Measurements and Theoretical Calculations Relevant for Novae and X-ray Bursters*

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Novae and X-ray bursters are explosions of stars that occur in binary star systems. These explosions are important because of they generate enormous amounts of energy, they effect the evolution of the binary star system, and they synthesize some of the elements that make up our bodies and our world. These explosions are driven by nuclear reactions on radioactive isotopes that (for the most part) have not been measured in the laboratory. The $^{17}F(p,\gamma)^{18}Ne$ is an important reaction in stellar explosions, and it has large uncertainties due to one nuclear resonance in ^{18}Ne. We have measured the $^{17}F(p,p)^{17}F$ reaction with a ^{17}F radioactive beam at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory to verify the existence of this resonance and determine its properties [1]. We have calculated a new $^{17}F(p,\gamma)^{18}Ne$ rate, which changes the predictions of the abundances synthesized in nova explosions by more than a factor of 1000 for some isotopes. A measurement another astrophysically important reaction $-^{14}O(\alpha,p)^{17}F$ – is currently in progress. Furthermore, a number of direct measurements of astrophysical proton capture reactions with radioactive beams will be performed with the Daresbury Recoil Separator at HRIBF. To support these measurements, we are making unique calculations of isotope synthesis in explosions to determine the effect of nuclear physics uncertainties on explosion model predictions, and we are making detailed evaluations of the values and uncertainties of the rates of some nuclear reactions rates that are important for explosion models.

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Reference

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