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Constraining the Astrophysical γ Process: Cross Section Measurements of (p,γ) Reactions in Inverse Kinematics

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Heavy element nucleosynthesis is largely governed by n-capture processes. However, a group of neutron-deficient isotopes, the p nuclei, cannot be formed by any of those processes. These ~ 30 nuclei are believed to be formed in the γ process through a sequence of photodisintegration reactions on preexisting r- and s-process seeds. Reproducing the solar p-nuclei abundances using nuclear reaction networks requires input on a vast network of mostly radioactive isotopes. As experimental cross sections of γ-process reactions are almost entirely unknown, the related reaction rates are based on Hauser-Feshbach calculations and therefore carry large uncertainties. Therefore, it is crucial to develop techniques to measure these important reactions within the astrophysically relevant Gamow window with radioactive beams. The SuN group at FRIB has been developing such a program for the past decade.
This work focuses on two of the first measurements of (p,γ) reactions in inverse kinematics with this setup, namely the $^{82}\mathrm{Kr}(\mathrm{p},\gamma)^{83}\mathrm{Rb}$ with a stable beam, and the $^{73}\mathrm{As}(\mathrm{p},\gamma)^{74}\mathrm{Se}$ reaction in our first radioactive beam experiment. Specifically, the latter reaction is found to be of significant importance to the final abundance of the lightest p-nucleus, $^{74}\mathrm{Se}$, as the inverse reaction $^{74}\mathrm{Se}(\gamma,\mathrm{p})^{73}\mathrm{As}$ is the main destruction mechanism of $^{74}\mathrm{Se}$.

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