MEASUREMENT OF KEY RESONANCE STATES FOR THE ^{30}P$(p,\gamma)^{31}$S REACTION RATE AND THE PRODUCTION OF INTERMEDIATE-MASS ELEMENTS IN NOVA EXPLOSIONS

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Lack of knowledge of the rate of proton capture on radioactive ^{30}P is the most prominent nuclear physics uncertainty in models of oxygen neon (ONe) nova explosions [1, 2]. Recently, the ^{30}P$(p,\gamma)^{31}$S reaction has been studied by using ^{30}P(d,n)^{31}S transfer reactions in inverse kinematics as a surrogate [3]. A primary beam of ^{36}Ar (150 MeV/A) impinging on a Be target was used to produce the ≈ 30-MeV/u ^{30}P beam, which was separated using the A1900 fragment separator [4] at the National Superconducting Cyclotron Laboratory. The radioactive ^{30}P beam bombarded a 10.7(8)-mg/cm^2-thick CD_2 target surrounded by the Gamma-Ray Energy-Tracking In-beam Nuclear Array GRETINA [5]. The ^{31}S ions were analyzed by the S800 spectrograph [6] and identified by energy-loss and time-of-flight measurements. The γ-rays from the decays of excited states above the proton threshold in ^{31}S were detected in coincidence with the recoiling ^{31}S ions.

In this contribution, I will discuss the first experimental constraints on spectroscopic factors and strengths of key resonances in the ^{30}P$(p,\gamma)^{31}$S. In general, negative-parity states have been found to be most strongly produced but the absolute values of spectroscopic factors are typically an order of magnitude lower than predicted by the shell-model calculations employing WBP Hamiltonian for the negative-parity states. The results clearly indicate the dominance of a single $3/2^-$ resonance state at 196 keV in the region of nova burning $T \approx 0.10 - 0.17$ GK, well within the region of interest for nova nucleosynthesis. Hydrodynamic simulations of nova explosions have been performed to demonstrate the effect on the composition of nova ejecta.

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