Study of proton-decaying states important for classical novae using the Silicon Array for Branching Ratio Experiments*

J. C. Blackmon[1], C. M. Deibel[1], E. C. Good[1], K. H. Pham[1], B. Sudarsan[1], I. Wiedenhöver[2], S. Ajayi[2], B. W. Asher[2], L. T. Baby[2], C. Benetti[2], A. Bhardwaj[1], W. D. Braverman[1], A. C. Conley[2], K. S. Davis[1], J. C. Esparza[2], K. G. Hanselman[2], D. He[1], B. Kelly[2], S. Lopez-Caceres[1], K. T. Macon[1], G. W. McCann[2], M. McLain[1], A. B. Morelock[2], J. F. Perello[2], Z. M. Purcell[1], G. C. Ragsdale[2], T. J. Ruland[1], E. L. Saavedra[2], R. M. Shaffer[1], V. Sitaraman[2], E. S. Temanson[2], and C. Wibisono[2]

[1]*Louisiana State University, Baton Rouge, LA 70803, USA and*

[2]*Florida State University, Tallahassee, FL 32306, USA*

Charged-particle reaction rates important for astrophysics are often dominated by a few resonances at low energies above the particle threshold. Direct measurements of resonance strengths are challenging, especially in cases where radioactive ions are involved, as is the case with many reactions important for explosive astrophysical scenarios like classical novae and Type I X-ray bursts. The Silicon Array for Branching Ratio Experiments (SABRE) [1] is a charged-particle detector array that is used in conjunction with the Super-Enge Split-pole Spectrograph at the Fox Laboratory at Florida State University to perform complementary indirect measurements of resonance properties. Transfer reactions using stable beams populate states of interest that are tagged in the Split-pole, while protons from decaying unbound states are detected in coincidence in SABRE. The key properties of SABRE are to operate with low thresholds and high counting rates, while achieving good sensitivity to weak branching ratios using coincidence techniques with digital signal processing. Resonance energies and proton-branching ratios are directly measured, while good constraints can also typically be placed on the transferred angular momentum.

We will review some of the first measurements with SABRE that are important for classical novae. These measurements include studies of the properties of states in ^{19}Ne, ^{27}Si, ^{31}S, and ^{35}Ar that are important for the ^{18}F(p,α)^{15}O, ^{26}Al(p,γ)^{27}Si, ^{30}P(p,γ)^{31}S, and ^{34}Cl(p,γ)^{35}Ar reaction rates, respectively. The ^{18}F(p,α)^{15}O and ^{26}Al(p,γ)^{27}Si reactions are important for understanding the production of gamma-ray emission from classical novae, while the ^{30}P(p,γ)^{31}S and ^{34}Cl(p,γ)^{35}Ar reactions are important for understanding isotopic abundances and presolar grains. In the ^{31}S and ^{35}Ar cases, the (^{6}Li,t) reaction was used, which provides different state selectivity than previous studies. Preliminary results will be presented emphasizing the capabilities (and limitations) of the approach.

[1] E. C. Good *et al.*, Nuclear Instrum. Meth. Phys. Res. **A1003** (2021) 165299.

*This work is supported by the U.S. Department of Energy and the National Science Foundation.