Inverse kinematics studies of $^{20,21}\mathrm{Ne}(p,\gamma)^{21,22}\mathrm{Na}$ relevant to $^{22}\mathrm{Na}$ production in oxygen-neon novae with DRAGON

D. Connolly[a], J. Karpesky[b], M. Lovely[b], C. Akers[c], D. S. Burke[d], G. Christian[e], B. Davids[a], J. Fallis[f], A. Firmino[g], U. Greife[b], U. Hager[b], D. A. Hutcheon[a], A. Rojas[a], C. Ruiz[a]

[a]TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia V6T 2A3, Canada, [b]Department of Physics, Colorado School of Mines, Golden, Colorado 80401, USA, [c]Rare Isotope Science Project, Institute for Basic Science, 70 Yuseong-daero 1689 gil, Yusung-gu, Daejeon 305-811, Korea, [d]Department of Physics & Astronomy, McMaster University, Hamilton, Ontario L8S 4K1, Canada, [e]Department of Physics, Texas A & M University, College Station, 77843 Texas, USA, [f]North Island College, Courtenay, British Columbia V9N 8N6, Canada, [g]University of Alberta, Edmonton, Alberta T6G 2E1, Canada

Oxygen-neon (ONe) novae are cataclysmic events resulting from thermonuclear runaway on the surfaces of accreting oxygen-neon white dwarfs in close binary systems, and can reach peak temperatures in the range of $T = 0.1 - 0.4$ GK [1]. The radioisotope ^{22}Na can be produced and subsequently ejected into the interstellar medium during such events. Sodium-22 β-decays ($t_{1/2} = 2.6$ y) primarily to the first excited state in ^{22}Ne, which transitions to its ground state via emission of a 1.275 MeV γ-ray. The combination of long half-life and characteristic γ signature makes ^{22}Na a possible probe of the nuclear physics of novae [2], as γ-rays of this energy are detectable with current orbiting satellite observatories [3]. To date, observation of a 1.275 MeV γ signal from novae has been elusive. The lack of a verifiable detection of a 1.275 MeV γ signal gives an accepted upper limit on the production of ^{22}Na in novae of $3.7 \times 10^{-8} M_\odot$ [4]. The next generation of orbital observatories are expected to have the sensitivity required to detect a galactic ^{22}Na β-decay signal [5], thus minimization of uncertainties underlying ^{22}Na production in novae is desirable for an accurate comparison of novae nucleosynthesis models with astronomical observations. During ONe novae, production of ^{22}Na can proceed via the reaction path $^{20}\mathrm{Ne}(p,\gamma)^{21}\mathrm{Na}(\beta{+}\nu_e)^{21}\mathrm{Ne}(p,\gamma)^{22}\mathrm{Na}$, which comprises a portion of the neon-sodium cycle in hydrogen burning. Considerable uncertainties exist in the $^{20,21}\mathrm{Ne}(p,\gamma)^{21,22}\mathrm{Na}$ reaction rates. New measurements of $^{20,21}\mathrm{Ne}(p,\gamma)^{21,22}\mathrm{Na}$ have been performed in inverse kinematics using the DRAGON recoil separator [6], with the aim of reducing experimental uncertainties in the thermonuclear reaction rates. Experimental methods and preliminary results will be discussed.

References

[1] J. Josè and M. Hernanz. Astrophys. J. **494** 680 (1998).

[2] D. D. Clayton, and F. Hoyle 1974, Astrophys. J. Lett. **187**, L101

[3] M. Hernanz and J. Josè, New Astro. Rev. **48**, 35 (2004).

[4] A. F. Iyudin et al., Astron. Astrophys. **300**, 422 (1995)

[5] A. De Angelis, et al. Exp. Astron. **44** 25 (2017).

[6] D. A. Hutcheon *et al.*, Nucl. Instrum. Meth. A **498**, 190 (2003).