Nucleosynthesis in Type I X-ray Bursts: Exploring the $\alpha p$-Process through High Precision ($p,t$) Measurements

Alexander Long
University of Notre Dame

Shortly after their discovery in 1979, x-ray bursts were determined to be thermonuclear runaways occurring on the surface of neutron stars in binary systems with H/He rich companion stars. During these explosive events thermonuclear burning is driven by the $\alpha p$-process (a sequential series of $(\alpha,p)$ and $(p,\gamma)$ reactions along the proton rich side within the sd-shell nuclei), and the rp-process (a series of $(p,\gamma)$ and $\beta^+$-decays riding along the proton drip line up the $A = 100$ mass region). Current x-ray burst sensitivity studies have revealed that certain $(\alpha,p)$ reactions along the $\alpha p$-process have a direct influence on the early rise-time structure of x-ray burst light curves.

Lacking experimental data, most of these $(\alpha,p)$ stellar rates have been calculated using statistical models, such as Hauser-Feshbach. Recently, it has been pointed out that the level density in many of the compound nuclei along the $\alpha p$-process may be too low to support this statistical approach, resulting in over predictions of stellar $(\alpha,p)$ rates used in x-ray burst models.

In this talk, I will discuss the recent efforts by our group at Notre Dame in trying to indirectly measure important $(\alpha,p)$ reaction rates through high precision ($p,t$) reaction measurements. More specifically, I will present results from our latest ($p,t$) experiment at iThemba LABS, where we indirectly measure the $^{26}\text{Si}(\alpha,p)$ and $^{34}\text{Ar}(\alpha,p)$ reaction rates by investigating $\alpha$-unbound states in the compound nuclei $^{30}\text{S}$ and $^{38}\text{Ca}$, respectively.