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X-ray bursts: Indirect measurement of the astrophysical 23Al(p,γ) reaction

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X-ray bursts are the most frequent stellar explosions to occur throughout the cosmos and as such, represent key research environments for the field of nuclear astrophysics. These cataclysmic binary systems are known to exhibit distinctive light curves, which have now been observed with unprecedented sensitivity, that provide a detailed reflection of the underlying nuclear physics processes involved. Consequently, an accurate understanding of the observed light curves may hold the key to the unraveling of the burst mechanism, as well as the companion neutron star properties.

Recently, an in-depth study of the dependence of X-ray burst models on nuclear reaction rates has highlighted the 23Al(p,γ)24Si as being of particular significance in determining the shape of the X-ray burst light curve [1]. A direct investigation of this reaction is presently unfeasible due to the current low intensities of radioactive 23Al beams. As such, an innovative indirect approach is required.

In this talk, I will present the first ever study of the 23Ne(d,p)24Ne transfer reaction, which was recently performed at the ISAC-II facility at TRIUMF using a radioactive beam of 23Ne. Here, the high-granularity TIGRESS γ-ray array was used in conjunction with the SHARC silicon detection system to extract spectroscopic information on excited states in 24Ne. These states represent key isobaric analogs of resonances in 24Si and therefore, by measuring their spectroscopic strengths and employing mirror symmetry, it is possible to indirectly determine the 23Al(p,γ) stellar reaction rate. Such investigations have been extremely successful in recent years in constraining astrophysical reactions that lie outside the reach of direct measurements [2,3].

[1] R.H. Cyburt et al., Astrophys. J. 830, 55 (2016).
[2] V. Margerin, G. Lotay et al., Phys. Rev. Lett. 115, 062701 (2015).
[3] S.D. Pain et al., Phys. Rev. Lett. 114, 212501 (2015).

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