Resolving discrepancies about the ^{38}K(p,gamma)^{39}Ca reaction in classical novae

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Direct and indirect measurements of the ^{38}K(p,gamma)^{39}Ca reaction, which is important in understanding the potassium production in classical novae, are in disagreement over the energy of a critically important resonance at E_r = 515 keV. This resonance was measured by DRAGON to be at E_r = 515 keV but indirect measurements of the energy of a nearby state place it at E_r = 455 keV. Similar disagreements exist for other resonances. These discrepancies are rather worrying since the resonance energy enters into the reaction rate as an exponential factor; even small uncertainties in the resonance energy for a known resonance strength result in a significant uncertainty in the reaction rate.

To try to resolve some of these problems, a ^{40}Ca(p,d)^{39}Ca experiment was performed at iThemba LABS with the K600 magnetic spectrometer. This experiment is very similar in intent and operation to a previous nuclear-structure experiment performed at RCNP Osaka with two additional improvements. The first was that a thinner target was used for the experiment to optimise the energy resolution. The second was that the focal plane detection system consisted of two vertical drift chambers allowing the scattering angle to be reconstructed and used for the offline correction of kinematic aberrations in the rigidity

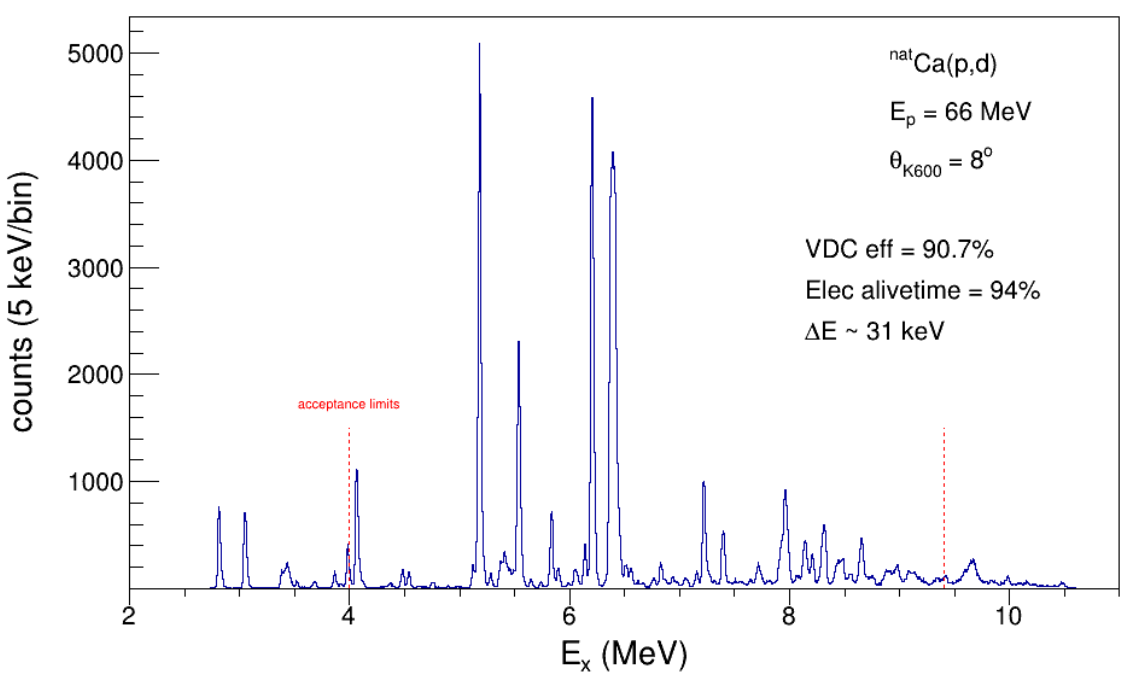

Fig. 1. Preliminary excitation-energy spectrum for the ^{nat}Ca(p,d) reaction with a proton beam of 66 MeV and the K600 magnetic spectrometer placed at 8 degrees.

spectrum. In addition, much higher statistics were taken in this experiment to observe weakly populated

states which were not observed in the previous $^{40}Ca(p,d)^{39}Ca$ measurement which was mainly focussed on understanding the shell structure and generally did not care about the population of weak states.