Study of excited states of ^{35}Ar through β-decay of ^{35}K for nucleosynthesis in novae and X-ray bursts

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The thermonuclear runaway in close binary systems such as novae and X-ray bursts proceeds through proton-rich nuclei and many of the radiative proton capture reactions (p,γ) involving sd-shell nuclei close to the drip-line are dominated by resonant capture. The key parameters in understanding the astrophysical reaction rates are the energies, decay widths and spins of these resonances. One of the reactions for which improved data are needed and which determines the synthesis of nuclei beyond sulfur and chlorine is the radiative proton capture ^{34}Cl(p, γ)^{35}K. At the moment the properties of the excited states of ^{35}Ar above the proton separation threshold are rather poorly known and the astrophysical reaction rate is based on statistical Hauser-Feshbach calculations.

In a recent experiment we have studied the excited states of ^{35}Ar selectively through the β-decay of the 3/2+ ground state of ^{35}K. A beam of ^{35}K was made at the Cyclotron Institute in inverse kinematics through reaction ^{1}H(^{36}Ar,^{35}K)2n by bombarding LN_2 cooled H_2 gas cell with 36-MeV/u ^{36}Ar beam. The reaction products were separated by using the Momentum Achromat Recoil Spectrometer (MARS), resulting a 70% pure beam as shown in Fig 1. The beam was

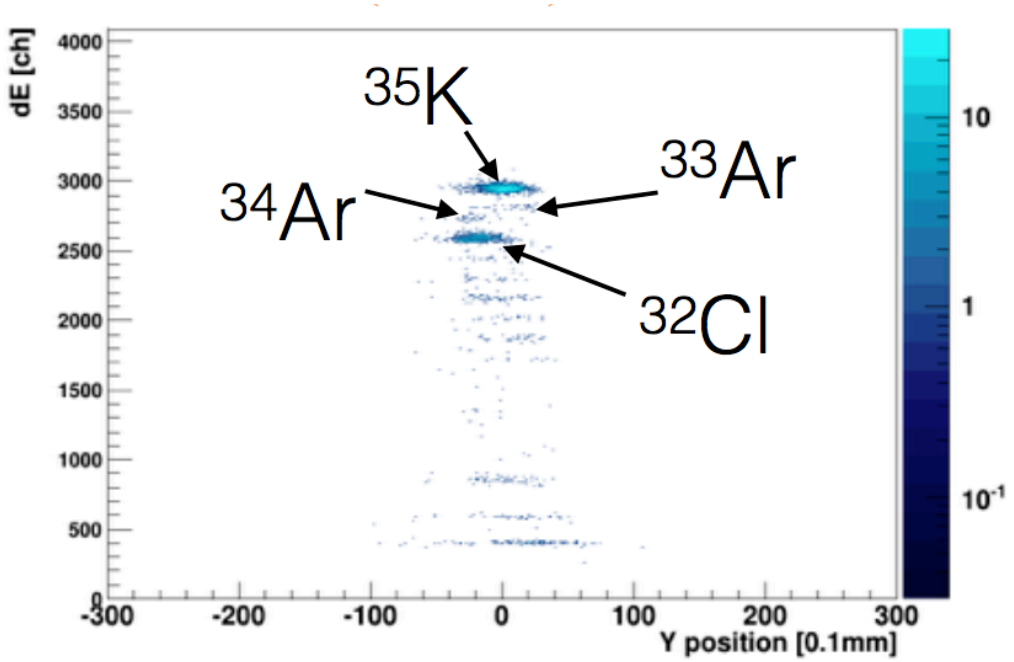

FIG. 1. Particle ID of the separated ^{35}K beam.

implanted into the Si implantation setup [1], consisting of a stack of Si detectors accompanied by two 70% HPGe detectors. This setup allows measuring β-delayed protons and γ-rays simultaneously, including coincidences. The setup was calibrated with standard offline sources and with ^{32}Cl and ^{36}K beams produced with the same primary beam.

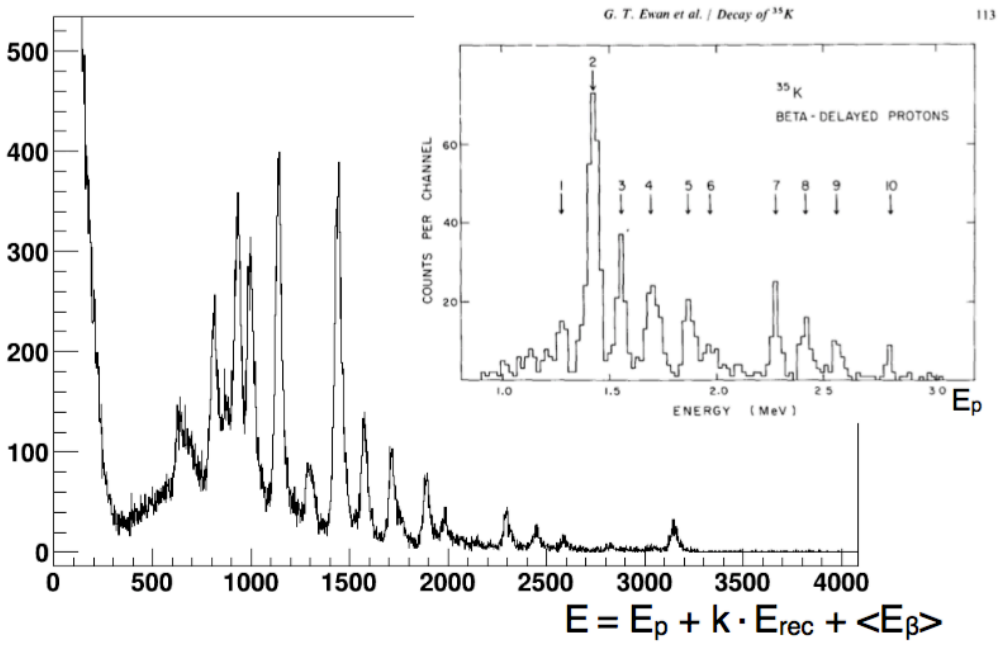

FIG. 2. Beta-delayed particles from ^{35}K decay. Inset shows previously known data (taken from from [**2**]).

In this experiment, we observed several new proton groups as shown in Fig. 2, first direct observation of the Isobaric Analogue State of ^{35}K ground state in ^{35}Ar in β-decay and determined an improved half-life of ^{35}K. The analysis of the data is in progress.

[1] M. McCleskey *et al.*, Nucl. Instrum. Methods Phys. Res. **A700**, 124 (2013).
[2] G.T. Ewan *et al.*, Nucl. Phys. **A343**, 109 (1980).