The Joint Institute for Nuclear Astrophysics

β-delayed proton emission of ^{69}Kr and the ^{68}Se rp-process waiting point

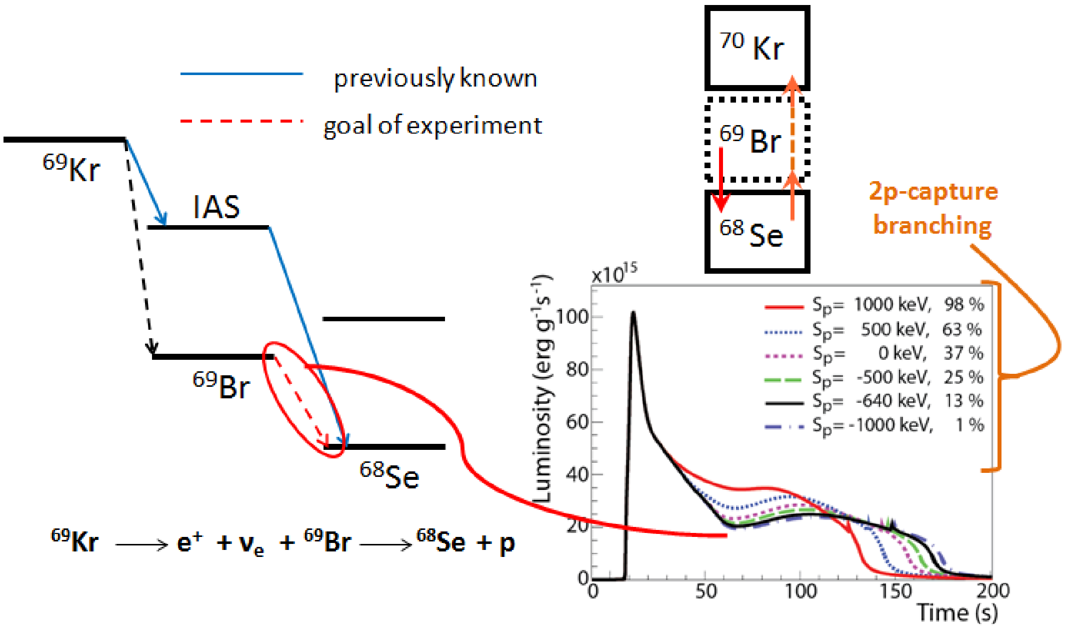

Figure: Impact of ^{69}Br proton separation energy on the calculated x-ray burst light curve. Large proton separation energies increase the ^{68}Se two proton capture branch and consequently shorten the burst duration.

X-ray bursts are the most frequently observed thermonuclear explosions in the universe. X-ray bursts occur on the surface of a neutron star which has accreted hydrogen and/or helium from a main sequence companion. The energy produced in a burst is created in a series of rapid proton captures and beta-decays on the neutron-deficient side of the valley of stability. This nuclear reaction sequence, the rp-process, processes material on the neutron star surface, changing its composition and ultimately the composition of the neutron star crust. Reliable models with accurate input data are required to interpret x-ray burst observations in terms of resulting crustal composition. The shape of the light curve of the x-ray burst, the light emitted as a function of time, is primarily dependent on nuclear reactions occurring with waiting point nuclei in the rp-process. The rp-process will stall at these nuclei waiting for them to beta-decay unless they can be bypassed via proton-capture.

Until now it remained uncertain as to the extent which ^{68}Se was an rp-process waiting point nucleus. This problem has now been addressed with an experimental determination of the proton-separation energy of ^{69}Br (-641± 42 keV). Proton emitting states in ^{69}Br were accessed through β-delayed proton emission of ^{69}Kr in order to overcome the extremely short lifetime of ^{69}Br (<24 ns). The experiment was enabled by the RFFS separator at NSCL that purifies beams of neutron deficient rare isotopes.

The measurement has experimentally confirmed ^{68}Se is a strong rp-process waiting point, with bypass by two proton capture having only a 13 ± 4 % branching.

Investigators:

M. del Santo, Z. Meisel,
D. Bazin, A. Becceril,
B.A. Brown, H. Crawford,
R. Cyburt, S. George,
G. Grinyer, G. Lorusso,
P. Mantica, F. Montes,
J. Pereira, H. Schatz,
K. Smith

Michigan State University

Contact: meisel@nscl.msu.edu

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