Study of ^{57}Zn β-delayed proton emission and its impact on the ^{56}Ni rp-process waiting point

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Type-I X-rays bursts are thermonuclear flashes ignited on the surface of a neutron star which is accreting hydrogen and helium-rich material from its companion star. With an hours-long stellar half-life and a low proton capture Q value, doubly magic ^{56}Ni has long been defined as one of the waiting points in the rapid proton capture (rp) process that powers type-I X-ray bursts. However, a strong bypass circumventing ^{56}Ni and diverting the rp-process flow through the path ^{55}Ni(p,γ)^{56}Cu(p, γ)^{57}Zn(β^+)^{57}Cu(p,γ) ^{58}Zn has been proposed [1]. The ^{55}Ni(p,γ) and ^{56}Cu(p,γ) reaction rates calculated with the recently measured mass of ^{56}Cu [2] show that the rp-process flow can redirect around the ^{56}Ni waiting point through the ^{55}Ni(p,γ) route. However, the dominant source of uncertainty regarding the strength of this bypass is the β^+- delayed proton emission decay branch of ^{57}Zn, having a present estimate of 78±17% [3].

We measured β-delayed proton-emission of ^{57}Zn at the National Superconducting Cyclotron Laboratory using implantation in a double-sided silicon strip detector surrounded by a clover array for gamma-coincidences. We substantially improved the precision for the proton-emission branching ratio and identified new γ-ray transitions that each correspond to the exotic β-γ-p decay mode. These results, along with the impact on the rp-process flow will be discussed in the presentation.

References:

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3. B. Blank *et. al*, Eur. Phys J. A, **31** (3) 267-272 (2007)