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Investigating the key rp-process reaction ^{61}Ga(p,γ)^{62}Ge reaction via ^{61}Zn(d,p)^{62}Zn transfer

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Type-I X-ray bursts are interpreted as thermonuclear explosions in the atmospheres of accreting neutron stars in close binary systems \cite{Schatz1}.
During these bursts, sufficiently high temperatures are achieved ($T_{peak} \sim$ 0.8–1.5 GK) such that "breakout" from the hot CNO cycle occurs. This results in a whole new set of thermonuclear reactions known as the *rp*-process \cite{Schatz2}. This process involves a series of rapid proton captures resulting in the synthesis of very proton-rich nuclei up to the Sn–Te mass region.

Recent studies \cite{Cybert, Meisel} have highlighted the ^{61}Ga(p,γ)^{62}Ge reaction as significant in its effect on nucleosynthesis along the *rp*-process path within X-ray bursts, as well as on resultant light curves and final isotopic compositions.
Despite this, the stellar reaction rate at X-ray burst temperature range is effectively unknown.
Like many reactions that occur in explosive astrophysical environments, the ^{61}Ga(p,γ) reaction is expected to be dominated by resonant capture to excited states above the proton-emission threshold in ^{62}Ge.

Studying systems far from stability such as this can prove extremely challenging and, in fact, in many cases impossible at this present time.
Recent investigations of mirror nuclei \cite{Margerin, Pain, Lotay} however have been shown to offer a unique solution to this issue.
The properties of excited states in pairs of mirror nuclei are almost identical, such that spectroscopic information of the neutron-rich system can be used to accurately determine the rates of astrophysical processes within the proton-rich system that cannot be accessed experimentally \cite{Margerin, Pain, Lotay}.

The ISOL Solenoidal Spectrometer at the ISOLDE facility has been used recently to study (d,p) transfer reactions in inverse kinematics \cite{Tang, MacGregor}. In this experiment, we aim to use similar techniques to perform the ^{61}Zn(d,p)^{62}Zn transfer reaction for the first time.
Analysis of excited states in the astrophysically important mirror nucleus ^{62}Zn will then place the first ever constraints on the astrophysical ^{61}Ga(p,γ)^{62}Ge reaction rate in X-ray burst environments, thereby allowing a detailed comparison between the latest theoretical models and astronomical observations.

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