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ABSTRACT

Constraining experimentally photon strength functions for p-process nucleosynthesis calculations

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This presentation brings into focus recent 78,80Kr(g,g'), 93Mo(g,n) and 90Zr(g,n) cross section measurements carried out using real photons at the HIGS/TUNL facility. The overarching physics motivation was to advance fundamental knowledge on a forefront topic in nuclear astrophysics – the nucleosynthesis beyond Fe of the rarest stable isotopes naturally occurring on Earth (the origin of p-nuclei). Though simulating the p-process nucleosynthesis is a daunting task, significant progress can be made by performing key measurements, which constrain the statistical models that are used to calculate the unknown stellar reaction rates. In particular, these stellar reaction rates are highly sensitive to the low-energy tail of the nuclear photon strength function (pSF). Due to its high selectivity for dipole excitations, real photon scattering via nuclear resonance fluorescence (NRF) is the method of choice to extract experimentally, with high accuracy and model independently, the dipole pSFs in atomic nuclei. The quasi-monochromatic and linearly polarized photon beam of very high flux available at HIGS makes this facility ideal for investigation of photoabsorption reaction cross section with p-nuclei as targets. We will discuss the status of the data analysis of our very recent NRF measurements on 78,80Kr, which, when complete, will provide for the first time information for the low-energy part of the E1 pSF in 78,80Kr, as direct input into the p-process modeling. The energy dependencies of the ground-state cross sections for ^{94}Mo(γ,n) and ^{90}Zr(γ,n) reactions were also measured recently at HIGS with high precision, from the respective neutron emission thresholds up to 13.5 MeV. In order to constrain the dipole pSFs in the $A \simeq 90$ mass region, the measured cross sections were compared with predictions of Hauser-Feshbach statistical model calculations using two different dipole pSF models. Since these models are based on fundamentally different physics, they can reflect the existing uncertainties affecting the pSF, and also the impact of such uncertainties on reaction cross sections and corresponding astrophysical reaction rates. We will showcase key aspects of the experimental procedure, data analysis, and theoretical calculations pertaining to our final results that show how sensitive the resulting ^{94}Mo(γ,n) and ^{90}Zr(γ,n) stellar reaction rates can be to the corresponding experimental ground-state cross sections, as discussed in detail in our recent publication, Phys. Rev. C 99, 025802 (2019).

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