Studying the Photon Strength Function of 97Zr Using the 96Zr(n,γ) and 96Zr(d,p) Reactions

Abstract content

A major barrier in the study of neutron-induced nuclear reactions, which play a critical role in stockpile stewardship and astrophysics, is the impossibility of direct measurements with short-lived radioactive isotopes. Theoretical models can be used to describe these reactions, although the nuclear structure inputs such as the Photon Strength Function (PSF) for these exotic nuclei are often poorly constrained. Recently, a program to investigate the PSF for medium-mass nuclei has begun as a collaboration between Los Alamos National Laboratory (LANL) and Argonne National Laboratory (ANL), combining unique experimental capabilities from both laboratories. At the Manuel J. Lujan Neutron Scattering Center at LANL, The Detector for Advanced Neutron Capture Experiments (DANCE) provides direct measurements of gamma ray cascades from neutron capture reactions on stable or long-lived radioactive nuclei. At the Argonne Tandem Linear Accelerator System (ATLAS) facility at ANL, single neutron transfer reactions in inverse-kinematics provide complementary data on short-lived radioactive nuclei. The Helical Orbit Spectrometer (HELIOS) is a device that was designed to study transfer reactions in inverse kinematics by detecting the charged ejectiles inside of a large-bore solenoidal magnet. The APOLLO array was designed and built at LANL to be placed inside the magnetic field of HELIOS to measure gamma ray cascades from the nuclear states populated in neutron transfer reactions. As a test case for this research program, the 96Zr(n,γ) reaction was measured using DANCE and the 96Zr(d,p) reaction was measured using HELIOS+APOLLO. 96Zr lies near the light mass peak in the 239Pu fission spectrum, so neutron capture rates on the neutron-rich Zr isotopes are important for fission applications. While DANCE provides Multi-Step Cascade spectra from 97Zr as well as cross section information, HELIOS+APOLLO will provide more detailed nuclear structure information about the intermediate states in 97Zr. Initial results from the 96Zr(d,p) and 96Zr(n,γ) measurements will presented. This work benefited from the use of the LANSCE accelerator facility. Work was performed under the auspices of the US Department of Energy by Los Alamos National Security, LLC under contract DE-AC52-06NA25396.

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