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# γ angular distribution analysis in (n, γ) reactions of the low energy neutron resonances of natLa and NaI using the GTAF BaF2 array at CSNS Back-n White Neutron Source

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The angular distribution of individual γ-transitions from neutron-induced compound nuclear state via (n, γ) reaction in p-wave resonances of 139La[1], 131Xe[2], 117Sn[3] and other nuclei has been studied using the ANNRI HpGe detector array at J-PARC BL-04 with precise γresolution. Such angular distributions in p-wave resonances may arise from the mixing between s- and p-wave amplitudes[4].

An analysis method based on the asymmetry parameter ALH —defined as defined as ALH = (NL - NH)/ (NL + NH) for NL and NH are the integrals over the lower and higher energy regions of a neutron resonance, respectively, separated by the resonance center —has been employed. ALH can be fitted with A·cos(θ) + B, where θ is the emission angle of the γ-rays.

Certain resonances of interest, such as the low-energy p-wave resonances in 127I, exhibit a high density γ-transitions that cannot be resolved even by the HpGe detectors. Measuring the angular distribution of the summed γ-transitions in 127I using a 4π BaF2 array with high counting statistics in these resonances could provide new insights into the s–p mixing model supplementary to single γ-transition studies using a HpGe array.

In January 2024, we measured the γ angular distributions of 139La and 127I at the Back-n beamline of China Spallation Neutron Source (CSNS), using the Gamma Total Absorption Facility (GTAF) —a 4π $BaF_2$ array offering high detection efficiency and excellent neutron energy resolution owing to the long neutron flight path of approximately 75 meters. This experiment was carried out within the framework of the newly established China NOPTREX collaboration with CSNS Back-n team and Chinese Institute of Atomic Energy (CIAE) GTAF team.

Moreover, the summed γ-transition measurement in nuclei such as 127I, which feature numerous s- and p-wave resonances at low neutron energies, may enable a novel statistical approach for identifying suspected weak p-wave resonances—a method previously unfeasible due to insufficient neutron energy resolution or limited counting statistics.

Reference:

[1]. T. Okudaira, et al. Phys. Rev. C 109, 029903 (2024)

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[3]. J. Koga, et al. Phys. Rev. C 105, 054615 (2022)

[4]. V. P. Gudkov, Phys. Rep. 212, 77 (1992).

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