The γ-ray Strength Function Method*

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Radiative neutron capture cross sections for unstable nuclei are of direct relevance to nucleosynthesis of heavy elements referred to as the s- and r-process in nuclear astrophysics and to nuclear data in nuclear engineering. The surrogate reaction method is proposed and currently in active utilization in the latter field. We propose an alternative and less model-dependent method based on the γ-ray strength function (γSF) which is a nuclear statistical ingredient common to *(γ,n)* and *(n,γ)* reactions. The validity of this method is demonstrated in its application to zirconium, tin and palladium isotopes, predicting (n,γ) cross sections for unstable nuclei ^{93}Zr ($T_{1/2}$=1.6×10^{6} y), ^{95}Zr (64 d) and ^{107}Pd (6.5×10^{6} y). The source of uncertainties of this method, the nuclear level density and low-lying strength, is discussed quantitatively.

The γSF is best probed above neutron threshold by a measurement of photoneutron cross sections for stable nuclei including those with low neutron separations energies (6 -8 MeV) and justified by reproducing experimental *(n,γ)* cross sections for stable nuclei that are sensitive to γSF below neutron threshold. Thus, the method requires both (γ, *n*) and (*n*, γ) cross sections for stable isotopes as systematic as possible. Laser-Compton scattering γ-ray beams at AIST, Duke-HIGS, and NewSUBARU and pulsed- spallation neutron beams at CERN, LANSCE, and J-Parc could contribute to providing the required data.

Some important cases to be studied with the γSF method are discussed along with experimental techniques. For a versatile application of the γSF method, the fundamental structure of the γSF needs to be understood in terms of extra strengths of pigmy E1, giant M1 and other multipolarity on top of the low-energy tail of GDR. Especially, nuclear physics study of the systematics of pygmy E1 strength, which is valid throughout the chart of nuclides, and a persistent improvement of nuclear physics models of γSF are indispensable.

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