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Recent developments in photonuclear reaction studies with quasi-monochromatic photon beams

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Photons provide a particularly clean probe for studying a wide range of nuclear structure phenomena [1]. Their interaction with the nucleus is described by the electromagnetic interaction, so that the nuclear response can be separated almost model-independently from the details of the reaction mechanism. Hence, photon-induced reactions are important tools in nuclear physics for determining properties of low-spin excited states in atomic nuclei.

Important quantities for the modeling of nuclear and stellar reaction rates are photon strength functions (PSF) and nuclear level densities (NLD). Systematic studies of PSFs and NLDs across the nuclear chart are an important testing ground for benchmarking microscopic and macroscopic models that allow extrapolation from mostly stable isotopes to experimentally unreachable exotic neutron-rich isotopes.

Many different experimental approaches are used to study PSFs, either by studying photoabsorption cross sections or by observing the γ-decay behaviour of excited nuclear states [2]. In several cases, results from complementary methods show discrepancies, in particular when comparing data from real-photon scattering and particle-induced reactions [3,4,5].

In this contribution, recent results for PSFs from coincidence experiments with quasi-monoenergetic photon beams at the High Intensity γ-Ray Source (HIGS) at Duke University are discussed [6].
Moveover, the nuclear self-absorption method offers a completely new approach to the determination of NLDs in the energy range below the neutron separation energy. For a given integrated cross section in a defined excitation energy interval, the amount of self-absorption depends on the number of levels in this interval. Hence, a pilot experiment is presented for the determination of NLD of ^{88}Sr exploiting nuclear self-absorption measurements with quasi-monoenergetic photon beams [7].

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