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Beta-decay studies with the Total Absorption technique

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Conventional high-resolution techniques for β-decay spectroscopy utilize high-purity germanium detectors to measure individual γ rays emitted after β decay. However, these measurements are affected by the Pandemonium systematic error [1], resulting in many high-energy γ rays and a significant portion of the β strength being missed. The Total Absorption γ-ray Spectroscopy (TAGS) technique effectively addresses this issue [2, 3]. It relies on detecting the full energy of γ cascades following the decay, achieved through the use of large, high-efficiency scintillation crystals acting as calorimeters. This technique allows for a Pandemonium-free determination of the β strength, a fundamental quantity that depends on the underlying nuclear structure, thus the ideal tool for constraining theoretical models.

The TAGS technique has been successfully utilized in β-decay studies for many years, yielding important results relevant to nuclear structure, nuclear astrophysics, and applications in reactor and neutrino physics (see Ref. [3] for a recent review). In my talk, I will highlight some selected achievements. I will then introduce Experiment E891_23 [4], which has been granted beam time at the GANIL laboratory in France. The experiment aims to measure the β-decay properties of several proton-rich nuclei in the Cr-Zn region, of significant interest for both nuclear structure [5, 6] and nuclear astrophysics. This experiment will be performed with a new-concept hybrid spectrometer, STARS, currently under development within the $(NA)^2$STARS project [7]. STARS will be the world's first device to combine the large γ efficiency characteristic of TAGS calorimeters with the superior energy resolution and timing of $LaBr_3$(Ce) crystals. This unique combination will enable unprecedented studies further away from nuclear stability.

[1] J.C. Hardy et al., Phys. Lett. B 71, 307 (1977).

[2] B. Rubio et al., J. Phys. G Nucl. Part. Phys. 31, S1477 (2005).

[3] A. Algora et al., Eur. Phys. J. A 57, 85 (2021).

[4] Experiment E891_23: "Total Absorption Spectroscopy for Nuclear Structure and Nuclear Astrophysics" (spokespersons: M. Fallot, S.E.A. Orrigo, A.M. Sánchez Benítez), approved by the GANIL Program Advisory Committee, Nov. 2023.

[5] S.E.A. Orrigo et al., Phys. Rev. Lett. 112, 222501 (2014).

[6] S.E.A. Orrigo et al., Phys. Rev. C 93, 044336 (2016).

[7] Project $(NA)^2$STARS: "Neutrinos, Applications and Nuclear Astrophysics with a Segmented Total Absorption with a higher Resolution Spectrometer"(spokesperson: M. Fallot), endorsed by the GANIL Scientific Council, Jan. 2023.

session

I. Nuclear Structure and Reactions

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