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TAGS measurements at GANIL with STARS

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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, this kind of measurement is 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]. This method relies on the detection of the full energy of γ cascades following the decay, achieved through the use of large scintillation crystals with high efficiency that act like calorimeters. The TAGS technique allows for a precise determination of the β strength free of Pandemonium. This is a fundamental quantity that depends on the underlying nuclear structure, making it the ideal tool for providing constraints on theoretical models. The technique has been successfully utilized 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).

Currently, a new-concept hybrid spectrometer, STARS, is under development within the framework of the $(NA)^2$STARS project [4]. STARS will be the first device in the world to combine the large γ efficiency typical of TAGS calorimeters with the excellent energy resolution and timing of $LaBr_3$(Ce) crystals. This unique combination, along with increased segmentation, will enable unprecedented studies further away from nuclear stability, covering a broad range of physics cases and with prospects for use at many international facilities. In particular, our first proposal has already been approved at GANIL: Experiment E891_23 [5], which will be the pioneering measurement performed with STARS. The goal of E891_23 is to measure the β-decay properties of several proton-rich nuclei in the Cr-Zn region, of great interest for nuclear structure (to study isospin symmetry free of Pandemonium in selected Tz=-2 nuclei [6, 7]) and nuclear astrophysics (to constrain reaction rates of interest for the ^{44}Ti nucleosynthesis).

[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] 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.

[5] 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.

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

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

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