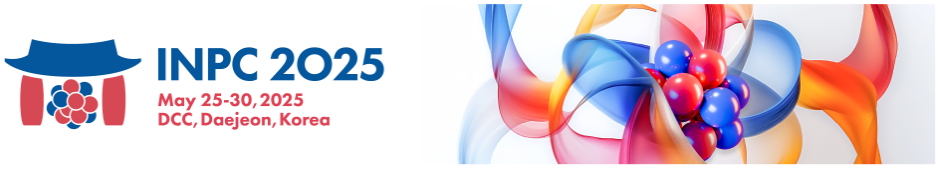

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Monopole decays and studies at iThemba LABS

Electric monopole (E0) transitions are closely tied to shape coexistence in atomic nuclei. The E0 transition strength, ρ^2(E0), is directly connected to nuclear mean-square charge radii. A large E0 transition strength is a reliable indicator of nuclear shape coexistence and strong mixing between admixture states of different deformation. Electric monopole transitions are possible between states of the same spin and parity such as two 0^+ states. They proceed via internal conversion and internal-pair formation.

Detecting conversion electrons and electron-positron pairs is normally done using magnetic lens spectrometers. A solenoid magnetic lens spectrometer was successfully refurbished and upgraded, giving it the capability to measure internal-pair formations (IPF) in addition to internal conversion electrons (ICE), at the iThemba Laboratory for Accelerator Based Sciences, in Cape Town, South Africa. The equipment can be coupled to other facilities or integrated into the existing beamlines. The smaller detector mount point in the original design of the electron spectrometer which only accommodated 300-500 mm^2 active area, 2-5 mm thick single crystal Si(Li) detectors was replaced by a mount point with provision for a much larger 2800 mm^2 active area, 11 mm thick segmented LEPS detector. The LEPS detector was adapted by replacing the thicker, 300 μm beryllium, window on the end-cap with a thinner, 0.5 μm Mylar window in order to minimise particle energy loss. Efficiency of the refurbished spectrometry system was optimised with the aid of Geant4 simulations and was estimated between 45% and 50% for ~1 MeV electrons or positrons at 500 G magnetic field.

The lens spectrometer was coupled with a mini-array comprised of seven Compton-suppressed HPGe Clover detectors, which gave additional experimental capabilities such as measuring γ-rays in coincidence with internal conversion electrons (ICE), and internal-pairs (IPF). An in-beam experiment involving a 30 MeV α-beam on a 96% enriched ^{50}Ti self-supporting target was performed to investigate the 3868.3 keV E0 ($0_2{}^+ \longrightarrow 0_1 1^+$) electric monopole transition and its alternative E2 ($0_2{}^+ \longrightarrow 2_1{}^+$) transition. The in-beam experimental campaign was not only a commissioning experiment for the newly refurbished magnetic lens spectrometer, but it was also part of the larger endeavour to characterise excited 0^+ states and E0 transitions in the N~Z~28 region of the nuclear chart.

The current ongoing upgrade will see the spectrometer fully integrated into the K600 spectrometer at iThemba LABS operating in the 0-degree mode. Furthermore, when combined with other detectors, such as ALBA, utilising high detection efficiency for high-energy gamma rays, then a unique niche area of physics is feasible.

Results of these measurements will be presented together with future plans for the spectrometers and further studies.

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