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## LOW SPIN STRUCTURE STUDIES OF EXOTIC STATES AND NUCLEI: NEW CAPABILITIES AT ITHEMBA LABS

Excited  $0^+$  states are the least understood of any low-energy degree of freedom in nuclei.  $E0$  transition strengths are a measure of the off-diagonal matrix elements of the mean-square charge radius operator. Mixing of configurations with different mean-square charge radii produces  $E0$  transition strength. The study of low-lying  $0^+$  states has been a focus of attention in the last two decades because of their implications regarding shape coexistence in nuclei.

New capabilities are underway to be added to the arsenal of cutting-edge spectroscopy techniques at iThemba LABS. Through the application of electron and pair spectroscopy, and with the addition of magnetic spectrometers new avenues of nuclear structure will be opened and explored.

In addition, an array of  $\text{LaBr}_3(\text{Ce})$  detectors ( $2'' \times 2''$ ) for fast-timing measurements have been commissioned. With excellent timing resolution ( $< 350\text{ps}$ ) and good energy resolution these will be used to study the decays of the photon branch of these states. Measurements of lifetimes of these states, and their associated feeding/decaying states are also extremely important in understanding the associated wave functions and orbital assignments of states. With the combination of an array of fast-timing detectors, this enhances the motivation for these nuclear structure studies over a region of nuclear structure.

A review of these capabilities will be presented and commissioning experiments presented.

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