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Electron spectroscopy @LNL: Present and future perspectives

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Electron spectroscopy is a powerful tool in the investigation of fundamental properties of the atomic nucleus, essential in the study of nuclear structure, where empirical nuclear models provide a framework to understand many nuclear phenomena. The study of electric monopole transitions between nuclear states having the same spin and parity can make an important contribution to clarifying the configuration of the nuclear states. Electric monopole (E0) transitions are determined by a change in the radial distribution of the electric charge inside the nucleus, and high E0 transition strengths are expected whenever configurations with different mean-square charge radii mix. In this regard, an enhancement of the monopole strength in transitions between $\Delta J = 0$ states may be considered as a "signature"for shape coexistence.
Shape coexistence, according to Poves [J. Phys. G: Nucl. Part. Phys. 43, 020401 (2016)], is "a very peculiar nuclear phenomenon consisting in the presence in the same nuclei, at low excitation energy, and within a very narrow energy range, of two or more states (or bands of states) which: (a) have well defined and distinct properties, and, (b) can be interpreted in terms of different intrinsic shapes.". The distinctive character of shape coexistence lies in the interplay between two opposing trends: shell and subshell closures have a stabilizing effect leading to sphericity while residual interactions between protons and neutrons outside closed shells drive the nucleus to deformation.
The measurement of the monopole strength is complicated by the fact that E0 transitions can proceed solely via internal conversion or pair production (if the transition energy is larger than $2m_0c^2$). Simultaneous emission of two photons is a higher-order process (relative probability $\sim 10^{-3} : 10^{-4}$) and is usually neglected.
The measurement of conversion electrons is typically achieved using silicon detectors, drifted with lithium (Si(Li)), coupled with a magnetic transport system. The latter allows a high efficiency for electron collection on the detector together with the powerful rejection of background γ-rays.
As an example, the features of SLICES (Spes Low energy Internal Conversion Electron Spectrometer), installed at Legnaro National Laboratories, will be presented in this seminar. SLICES consists of a large area Si(Li) detector used in conjunction with a magnetic transport and filter system. The large unconventional size of the lens and detector, compared to a traditional mini-orange arrangement, will grant a large acceptance in both electron energy and emission angle, ensuring the high efficiency of the apparatus.

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