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The evolving structure of the Cd isotopes

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The even-even Cd isotopes have long been cited as one of the prime examples of vibrational behaviour (see, e.g., Ref.[1]). Indeed, the low-lying level schemes of the mid-shell Cd isotopes display excitation energy spectra that are nearly idyllic for an vibrational nucleus, but also include additional states that were identified with deformed intruder-band structures. Initial measurements [2,3] of absolute $B(E2)$ values for transitions between the multiphonon states appeared to reinforce the structural interpretation of mixing between a family of normal vibrational states and coexisting deformed states [4].

Motivated by the question of how high in excitation the collective vibrational states survive, a series of measurements with the powerful $(n, n'\gamma)$ reaction on ^{110,112,114,116}Cd were made [2,3,5,6,7]. Each study found deviations between detailed Interacting Boson Model-2 (IBM-2) model predictions and the experimental data that, when viewed separately, were not necessarily considered serious. However, when the ensemble of data was considered, a compelling case for serious departures from vibrational behaviour could be made [8]. This motivated a program of highly-detailed studies by our group using the 8π spectrometer at the TRIUMF-ISAC radioactive ion beam facility, as well as a program of study by the UNIRIB collaboration of the neutron-rich Cd isotopes at HRIBF [9,10]. The studies with the 8π spectrometer have included to date the β decay of ^{110}In and ^{112}In/Ag to populate states in ^{110,112}Cd, with a focus on very weak γ-ray branches between highly-excited states. Further, we have also pursued studies of the nuclear structures of the even-even Cd isotopes using transfer reactions, such as the $(\vec{d}, p)$, (p, α), (d,^{3}He), and (p, t) reactions. These new data have resulted in a paradigm shift in our understanding of the structure of the Cd isotopes, in particular that the even-even Cd isotopes may represent deformed γ-soft rotors rather than spherical vibrators [11,12], a suggestion backed by recent theoretical calculations [13].

This presentation will focus on the long journey of the evolution in our understanding of the structure of the Cd isotopes starting with the ground-breaking systematic studies of the Jyvaskyla group (see, e.g., Ref. [14]), the necessity of multi-spectroscopic probes being brought to bear, and the usefulness of taking a new look at our “well-known” paradigms and the surprises they may have in store.

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