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Intertwined quantum phase transitions in the Zr isotopes

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In this talk I will discuss our latest work on the Zr isotopes with A =92−110, which have one of the most intricate evolutions of structure in the nuclear chart.
We explain their structural evolution using the notion of intertwined quantum phase transitions (IQPTs), for which a QPT involving a crossing of two configurations (Type II QPT) is accompanied by a shape evolution of each configuration with its own separate QPT (Type I QPT). We demonstrate the relevance of IQPTs to the zirconium isotopes by employing a calculation using the interacting boson model with configuration mixing (IBM-CM). Such a symmetry-based framework enables us to examine a large range of experimental data such as energy levels, two neutron separation energies, $E2$ and $E0$ transition rates, isotope shifts and magnetic moments. We consequently find the occurrence of Type II QPT between the normal and intruder configurations. Alongside the Type II QPT, we find that the Type I QPT takes place within the intruder configuration, which changes from weakly deformed to prolate deformed and finally to γ-unstable, associated with the U(5), SU(3) and SO(6) dynamical symmetry limits of the IBM, respectively. In such a situation, both Types I and II have a critical-point near $A \approx 100$.

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