СОФИЙСКИ УНИВЕРСИТЕТ
„СВ. КЛИМЕНТ ОХРИДСКИ“

ФИЗИЧЕСКИ ФАКУЛТЕТ

SOFIA UNIVERSITY
ST. KLIMENT OHRIDSKI

FACULTY OF PHYSICS

FACULTY SEMINAR

Venue: day Tuesday, date 28.03 2023, Lecture Hall B29a & Zoom, 16:15h

Zoom: https://cern.zoom.us/j/63240758382?pwd=MmVNaE04UzA1SXFPalUwZ0NtK2Q0QT09

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Quantum phase transitions in the shapes of atomic nuclei

This review is focused on various properties of quantum phase transitions (QPTs) in the Interacting Boson Model (IBM) of nuclear structure. The model describes collective modes of motions in atomic nuclei at low energies, in terms of a finite number N of mutually interacting s and d bosons. In the N going to infinity limit, the ground state is a boson condensate that exhibits shape-phase transitions between spherical (I), deformed prolate (II), and deformed oblate (III) forms when the interaction strengths are varied. Finite-N precursors of such behavior are verified by robust variations of nuclear properties across the chart of nuclides. Signatures of criticality in the evolution of the nuclear ground-state shapes across the N-Z plane are discussed. Attention is paid to specific data (nuclear masses, excitation energies, transition probabilities for low-lying levels) indicating sudden structural changes in various isotopic and isotonic chains of medium-mass and heavy even-even nuclei. Simultaneously, the model serves as a theoretical laboratory for studying diverse general features of QPTs in interacting many-body systems, which differ in many respects from lattice models of solid-state physics. We outline the most important fields of the present interest: (a) The coexistence of first- and second-order phase transitions supports studies related to the microscopic origin of the QPT phenomena. (b) The competing quantum phases are characterized by specific dynamical symmetries, and novel symmetry related approaches are developed to also describe the transitional dynamical domains. (c) In some parameter regions, the QPT-like behavior can be ascribed also to individual excited states, which is linked to the thermodynamical and classical descriptions of the system. (d) The model and its phase structure can be extended in many directions: i.e. by considering odd-fermion degrees of freedom. All these aspects of IBM phase transitions are relevant in the interpretation of experimental data, and important for a fundamental understanding of the QPT phenomenon.