Nuclear Seminar

Low-energy nuclear response: structure and underlying mechanisms

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In spite of many advances made over decades of research, the theoretical description of nuclear low-energy response remains a challenge for nuclear structure and nuclear astrophysics. In contrast to high-frequency oscillations which evolve very smoothly with particle numbers, the nuclear response below the particle emission threshold is quite irregular. This phenomenon reflects a complicated interplay of various structure mechanisms and provides a sensitive test for microscopic theories which include complex many-body correlations. It has been pointed out that microscopic structure of the low-energy response may affect nuclear reaction rates in the r-process of nucleosynthesis with a considerable influence on the elemental abundance distributions.

In this talk, various microscopic mechanisms contributing to nuclear response in the energy range ~0-50 MeV are discussed in the framework of the relativistic self-consistent approach. In medium-mass and heavy nuclei, many-body correlations involving the coupling between single-particle and collective degrees of freedom cause the appearance of various typical gross and fine structures in the spectra of nuclear excitations. As certain types of nuclear correlations have their specific fingerprints in the spectra, comparison of the calculated strength functions to spectral data allows identification of the nature and mechanisms of formation of collective and non-collective excited states in nuclei.

As a special case, I consider the low-energy anomaly reported in several recent experimental studies of the radiative dipole strength functions in medium-mass nuclei, in the light of its impact on the radiative neutron capture rates. I show how the strength enhancement can be explained by nucleonic transitions from the thermally unblocked single-quasiparticle states to the single-(quasi)particle continuum in nuclei as open quantum many-body systems.