New Modes of Nuclear Excitations for Astrophysics

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The precise knowledge of nuclear response functions plays a key role in the determination of photonuclear reactions cross sections which are of importance for the nucleosynthesis of heavier elements. In this connection information on low-energy excitations located around the neutron threshold is needed. Recently, new low-energy modes called pygmy resonances which reveal new aspects on the isospin dynamics of the nucleus have been observed. Their distinct feature is the close connection to nuclear skin oscillations which become visible in transition densities and currents [1-6].

Here, we present our theoretical approach based on density functional theory and microscopic multi-phonon model [1,2] which is applied for investigations of pygmy resonances and higher-lying excitations with different multipolarities [3] in stable and exotic nuclei. The possible relation of low-energy modes to the properties of neutron or proton skins is systematically studied in isotonic and isotopic chains [1-6]. The fine structure of nuclear electric and magnetic response functions is analyzed in comparison to experimental data [2-7]. Their relevance to nuclear astrophysics is discussed.

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