Nambu-Goldstone modes in superfluid atomic nuclei

The Nambu-Goldstone mode appears in the excitation spectrum of a physical system when a global continuous symmetry is spontaneously broken [1]. The associated Nambu-Goldstone bosons can be found in diverse physical systems, including superconductors, magnets, fluids, atomic nuclei, and elementary particles. The recent work [2], based on nuclear density functional theory, shows that the formalism of the broken gauge symmetry in the presence of the nucleonic pairing condensate offers a quantitative description of the binding energy differences of superfluid nuclei. In particular, the moments of inertia associated with the rotational excitations of the Nambu–Goldstone neutron and proton modes are excellent indicators of nucleonic pairing (Fig. 1). The work also demonstrates the mixing of the neutron and proton pairing rotational modes in nuclear ground states (Fig. 1b).

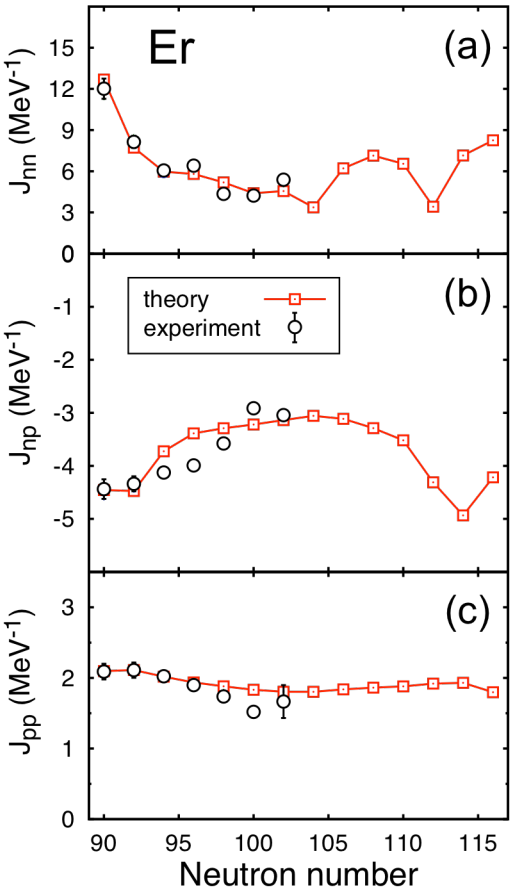

Figure 1. Pairing rotational moments of inertia tensor J_{nn} (a), J_{np} (b), and J_{pp} (c) for open-shell Erbium isotopes computed theoretically using nuclear density functional theory compared to experiment.

[1] P.W. Anderson, Phys. Rev. **112**, 1900 (1958); Y. Nambu, Phys. Rev. **117**, 648 (1960); J. Goldstone, Il Nuovo Cimento **19**, 154 (1961).

[2] N. Hinohara and W. Nazarewicz, Phys. Rev. Lett. **116**, 152502 (2016).