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Particle Number Conserving Approach to the Collective States in a Small Fermi-System[1] JENNIFER GLICK, VLADIMIR ZELEVINSKY, MIchigan State University — The standard Bardeen-Cooper-Schrieffer (BCS) description of pairing theory, random phase approximation (RPA) and Hartree-Fock-Bogoliubov (HFB) methods, routinely used in macroscopic many-body physics when the dimension of the Hamiltonian matrix is prohibitively large, include features which are not well suited to describe mesoscopic systems such as nuclei or cold atoms in traps. Two important disadvantages are the non-conservation of exact particle number through the introduction of quasiparticles, and the absence of a non-trivial paired solution in the discrete spectrum with weak pairing. We develop the pairing theory based on the exact particle number conservation, whose first applications to the ground state physics presented in [A. Volya and V. Zelevinsky, in *50 Years of Nuclear BCS*, World Scientific, 2012] demonstrated that such an approach avoids well known deficiencies of the standard treatment, especially in the region of weak pairing. Now, we use the method for low-lying collective excitations which in many cases are even more sensitive to conservation laws. We show that the RPA version based on solving the operator equations of motion is reduced to the set of recurrence relations for neighboring systems which precisely conserve the exact particle number.

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