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Nuclear Structure: Going Beyond Standard Methods[1] JENNIFER GLICK, VLADIMIR ZELEVINSKY, Michigan State University — Many features of nuclear structure in medium and heavy nuclei are traditionally described by methods borrowed from macroscopic many-body physics, such as random phase approximation (RPA), or pairing theory according to BCS and HFB. These methods are routinely used when the exact large-scale diagonalization of the Hamiltonian matrix is impossible. The approximations inherently present in such methods, being appropriate in macroscopic physics, may introduce substantial errors for mesoscopic systems, such as atomic nuclei or cold atoms in traps. We develop the theory of collective motion based on exact particle number conservation. The first applications to the ground state physics (collaboration with A. Volya) demonstrated that such an approach avoids well known deficiencies of the standard treatment. Now we apply the method to low-lying collective excitations which are even more sensitive to conservation laws. The new RPA version is reduced to the set of recurrence relations for neighboring nuclei. We show that it is especially important for the cases of strong anharmonicity and in the vicinity of the instability point. Other examples are discussed where the advance beyond standard approaches gives new physical results.

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