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# Present status of the theoretical description of low energy nuclear structure.

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There are two fundamental kinds of excitation modes in the atomic nucleus: collective and single-particle excitations. So far, most of the theoretical effort has focused on the study of the former and the latter has been mostly treated by using the quasiparticle spectrum of neighboring nuclei [1] or the equal-filling approximation [2]. However, these approaches explicitly neglect time-odd fields that can modify in a substantial way the properties of excited states. In order to take them into account, the Hartree- Fock- Bogoliubov (HFB) method with full blocking has to be introduced. The implementation has to be flexible enough as to allow for one-quasiparticle excitations (odd and odd-odd nuclei), two quasiparticle excitations (built on top of both even and odd systems), four quasiparticle excitations (as to study high K isomers), etc. Also, a careful handling of the orthogonality of the different states has to be made in order to obtain an excitation spectrum containing more than one state per quantum number.

In order to study those multiquasiparticle excitations a computer code has been developed to solve in an efficient way the HFB equation with full blocking in the case of the Gogny force [3]. It preserves axial symmetry so that K is a good quantum number. Parity is allowed to break but it turns out that most of the solutions only have a slight breaking of reflection symmetry and therefore the parity quantum number can also be used to characterize the states. The code includes the possibility to impose orthogonality constraints to previously computed states. The results obtained show differences with respect to simpler calculations [1,2] that can amount to a few hundred keV in excitation energy, showing the importance of the time-odd fields and the self-consistency of the HFB+Blocking method. Also the quenching of pairing correlations is very strong in the HFB+Blocking method representing a source for the reduction of the excitation energy as compared to simpler calculations.

Using the HFB+Blocking method along with the finite range, density dependent Gogny force, we have carried out calculations of high-K two and four- quasiparticle isomeric states in even-even and odd-A nuclei. The quite good agreement with experimental data for excitation energies shows the suitability and predictive power of the Gogny force in the study of this kind of physics.

One of the most important consequences of blocking is the severe quenching of pairing correlations. This effect points to an increasing relevance of dynamics pairing in those affected excitations. To gain some understanding on this effect, we have analyzed the sensitivity of the results to the amount of pairing correlations by using larger pairing strengths. The results will also be discussed.

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