Number-projected quasiparticle random phase approximation

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The quasiparticle-RPA (QRPA) is one of the most used microscopic approaches for the study of collective excitations including the various types of giant resonances and beta and double-beta decay. However, with the quality improvement of experimental data, it became clear that for a better description of these processes it is necessary to go beyond the QRPA [1].

In the present contribution, we propose an improvement of the QRPA approach using a number-projected quasiparticle mean-field. The method is based on a discrete particle-number projection before variation which is very powerful for the extraction of the spurious components [2,3]. It has been applied to the two-level pairing model that is exactly solvable and allows a comparison with other approaches. In a first step, we were interested in the ground state energy (see fig.1.a). The obtained results are in very good agreement with the exact ones for any value of the pairing-strength. In particular, in the vicinity of the critical strength, the comparison between the present approach and the QRPA shows a clear improvement. In a second step, the excitation energy of the first 0^+ state has been studied (see fig.1.b). The improvement due to the present method is more visible in this case than in the ground-state one. Indeed, it well reproduces the excitation energy behavior throughout the whole range of the pairing strength. It is not the case with the QRPA and most of its variants that are valid only in restricted areas.

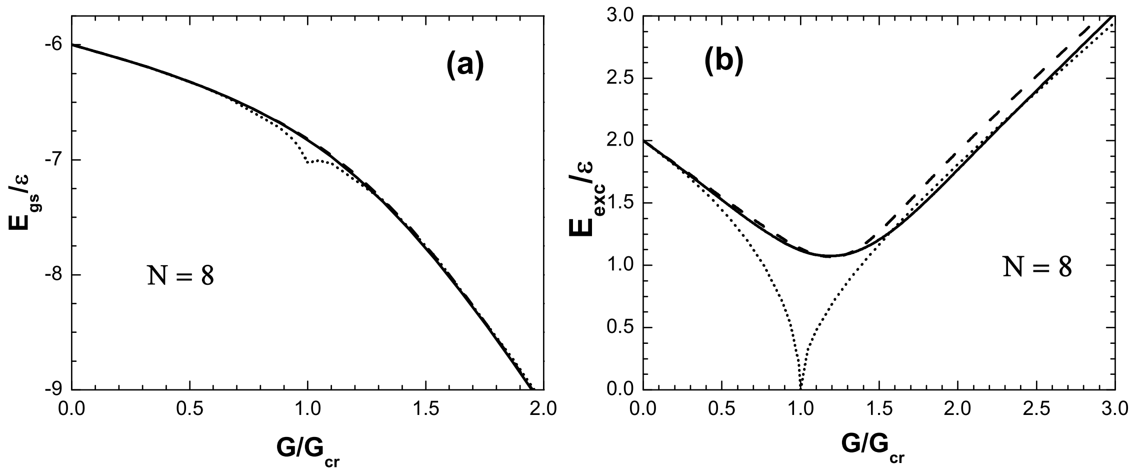

Figure 1: *Ground state energy (a) and excitation energy of the first 0^+ state (b), in unit of the spacing ε between the two levels, as a function G/G_{cr}, G_{cr} being the critical value of the pairing strength. The results refer to exact calculations (solid lines), QRPA (dotted lines) and the present approach (dashed lines).*

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