COMPARISON OF A QUASIPARTICLE MODEL WITH SOME EXACT CALCULATIONS

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Many features of rotational nuclei can be understood in terms of the cranking model[1]. In most of the calculations the problem is solved within the framework of the Hartree-Fock-Bogoliubov approximation that substitutes the system of interacting particles by an appropriate system of independent quasiparticles. The pair field and the single-particle mean field are calculated either self-consistently[2] or not. In the latter case (Bengtsson-Frauendorf [BF] model)[1] these fields are kept fixed, independent of the cranking frequency ω. This approach can be justified by the fact that a self-consistent calculation without a particle-number projection strongly over-estimates the changes in these fields[1], and very often leads to a spurious pairing collapse. To investigate the BF model we carried out calculations on a single $j=11/2$ shell and compared the results to the results of an exact diagonalisation on the same single-particle basis. We used a cranked axially symmetric quadrupole deformed potential to describe the core-valence nucleon interaction. In the BF case we derived the pair field and the mean field from a self-consistent calculation at zero frequency. Strictly speaking this approach with a delta interaction is slightly more general than the original one, because it allows for a state dependent pair gap. The usual single pair gap comes from the monopole pair force that acts only between nucleons whose angular momentum is coupled to zero. This approach is very widely used and intends to take into account the main effects of a short-range interaction. To investigate the performance of the original model with a single pair gap,

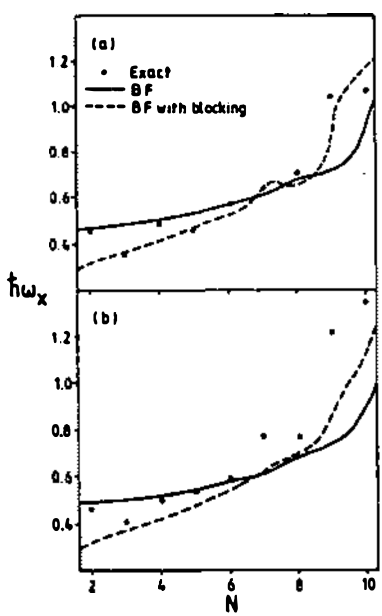

Fig.1. Crossing frequencies calculated with a monopole (a) and a delta (b) force.

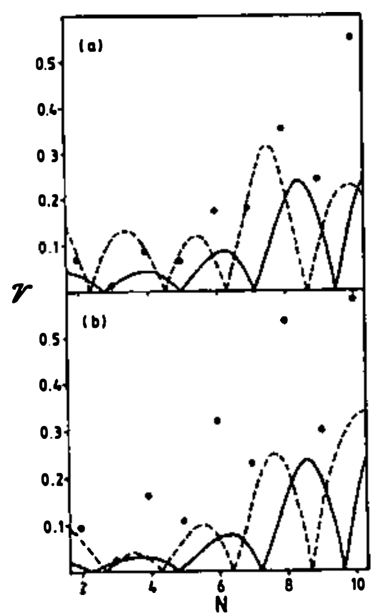

Fig.2. Level interactions calculated with a monopole (a) and a delta (b) force.

we carried out both exact and BF calculations by using only the monopole part of the delta force. The frequency of the AB crossing ω_c^{AB} as a function of the particle number N with the monopole (a) and full delta (b) force is shown in fig.1. The dots and the full lines are results of the exact and BF calculations, respectively. The $\hbar\omega_c^{AB}$ is measured in units of the monopole pair strength G_o. In the monopole case the two calculations agree rather well for even particle numbers. For odd particle numbers it is necessary to take into account the blocking effect explicitly in the BF calculation. When one does this, however, one gets a similarly good agreement. In this case we blocked the $k=m_z=1/2$ level, and the result did not depend strongly on which low k level was blocked. For the delta interaction the results are significantly worse above the middle of the shell. Even though both BF calculations appear reasonable up to the middle of the shell, the differences between the exact monopole and delta results are not well reproduced. The level interaction $\mathcal{V}$ at ω_c^{AB} (half the distance of the levels at the avoided crossing) as a function of N is shown in fig.2. The notations are the same as that of fig.1. Except for some qualitative features (oscillating behaviour[3], increasing trend with N) the agreement is quite poor for the monopole force and even worse for the delta interaction. In the exact calculation $\mathcal{V}$ is usually much bigger for the delta than for the monopole force. The BF calculation can even predict an opposite tendency, which is an indication that very important contributions from the delta force must be neglected in this approach. Moreover, in the blocking calculations we found a strong dependence on the level which is blocked. We are currently investigating various ways to try to improve the BF results quantitatively.

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