Microscopic mechanism to break gauge invariance

Box 4 ① App. 2.D

Pairing is intimately connected with particle number violation and thus spontaneous breaking of gauge invariance, as testified by the order parameter $\langle BCS|P^{+}|BCS\rangle = \alpha_0$. Now, in the nuclear case and at variance with condensed matter, dynamical breaking of gauge symmetry is equally important (pairing vibrations around closed shell nuclei, cf. Fig. 2 box 3). The fact that the average single-particle field acts as an external potential (like e.g. magnetic field in metallic superconductors) is at the basis of of the existence of a critical value of the pairing strength G to bind Cooper pairs in nuclei. In fact, spatial quantization in finite systems at large and in nuclei in particular, intimately connecte with the paramount role the surface has in these systems, is at the basis of the existence of a critical G value. Also of the fact that in nuclei an important fraction (30-50%) of Cooper pair binding is due to the exchange of collective vibrations between the partners of the pair, the rest being associated with the bare NN interaction in the $^1S_0$ channel (cf. Fig. 1)

Now, there are situations in which spatial quantization screens, essentially completely, the NN-interaction. This happens in the case in which the nuclear valence orbitals are s,p-states at threshold (pairing anti-halo effect). Examples of situations of this