This basic mechanism is valid in both models. The discrepancy in the results should be attributed to the model-dependent quantities and to the choice of the subspace over which the sum in (3) is taken.

For illustration the Table gives the dominant diagonal and nondiagonal proton matrix elements as well as some characteristic experimental and theoretical values for some isotopes with two protons or two proton holes in the closed shell. In such cases the two proton cluster imposes its motion to the whole nucleus and is almost entirely responsible for the existence of the nonzero quadrupole moment. More details of the calculations as well as references on experiments are given in Ref. 6.

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3.3. Application of the »bootstrap« on the states and processes around the doubly closed shell nuclei. The Pb case

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A unified picture is developed to describe the situation around a closed shell nuclear system[1-8]. This approach is based on the diagrammatic method[1-3], accounting for the dominant processes, in particular for those states which are strongly excited in the (t, p), (p, t) reactions and/or inelastic scattering processes. In the shell-model language these are the 2p, 2h and 1p—1h states (pairing and surface vibrational states), and those generated by coupling these states among themselves (two-phonon states).

The bootstrap study was carried out in three successive steps:

i) the calculation of the elementary modes of excitation, i. e. the low-lying states, of each spin λ and parity $(-)^{\lambda}$. The residual forces which are diagonalized are multipole particle-hole and pairing interactions[2,5-7]. The only free parameters

entering in the calculation are the coupling constants $\varkappa(\alpha = 0, \lambda, \tau)$ and $G(\alpha = \pm 2, \lambda, \tau)$ which are fixed by fitting the experimental energy of the lowest state of each family of levels.

ii) The calculation of the coupling between the particles (holes) and the vibrational modes, i. e. the calculation of the admixture of 1p-states and 2p−1h states. The coupling strength between the particle (hole) and the vibration is fixed self-consistently by the value of the coupling constants determined in step i).

iii) The calculation of the interaction between the two-phonon states of ^{208}Pb. This interaction is built out of a series of particle-vibration vertices, and consequently the magnitudes of the different matrix elements are fixed self-eonsistently by the values of the coupling strengths obtained in step (ii).

In this way an effective interaction between the elementary modes of excitation as well as composed states is obtained. Particularly, the interaction between the $J^\pi = 0^+$ states was calculated and the results compared with the ^{206}Pb(t, p) and ^{210}Pb(p, t) reaction data [5,8]. The effective interaction between the states of two-phonons with $J_R = 2^+$ in ^{208}Pb is also constructed. Special attention was paid to the states $|2_1^+(^{206}\text{Pb}) \cdot \text{gs}(^{210}\text{Pb}); 2\rangle$ and $|\text{gs}(^{210}\text{Pb}) \cdot 2_1^+(^{210}\text{Pb}); 2\rangle$, and the predictions are compared with the reaction data. For the first time the result provides a clear evidence on the existence of isovector quadrupole mode which dramatically renormalizes (screens) the quadrupole interaction between particles and holes.

The ^{208}Pb(t, p) ^{210}Pb(3^-) reaction is analyzed in the coupled channel Born approximation (CCBA)[4,8]. The competition between the effects of the effective interaction, the effective transfer operator and two-step processes was evidenced.

The (t, p) cross section cannot be explained without accounting for the contributions due to the correlations induced in the ^{208}Pb ground state by the 0^+ pairing vibration and the 3^- particle-hole mode. The inclusion of indirect reaction channels which interfere with the direct one brings the improved results in closer agreement with experiment. The importance of these two effects is due to the collect ivity of the pairing and particle-hole modes in ^{208}Pb and ^{210}Pb, respectively.

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3.4. On the BCS and HFB methods in terms of reduced density matrices

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The basic assumption of the BCS model of spherical nuclei, which are characterized by a large number (10—20) of particles outside the inert core of doubly