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DESCRIPTION OF COLLECTIVE STATES IN THE PARTICLE-HOLE SPACE

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We use as the definition of the particle-hole space the space spanned by the basis $|ab\rangle = (a_a^+ a_b - \rho_{ab})|\psi_g\rangle$, where $\rho_{ab} = \langle\psi_g|a_a^+ a_b|\psi_g\rangle$ is the one-body density matrix. For the "approximate ground state" $|\psi_g\rangle$ we use a correlated state which represents closely the ground state $|g\rangle$ and which is available from other calculations.

There are some qualitative arguments for the relevance of the particle-hole space.

(i) There are several examples in the modern formalisms like Projected Hartree-Fock, N-projected BCS, Generator Coordinate Method, where some low-lying excited states lie entirely in the particle-hole space of the ground state.

(ii) Low-lying states are likely to have many correlations similar to the ground state. So it is usually convenient energywise not to break correlations when constructing low-lying excited states.The particle-hole states are constructed by acting with a one-body operator on the correlated ground state; therefore one may except that many correlations characteristic for both the ground state and low-lying excited states are preserved.

(iii) At higher energies, the particle-hole states may represent some "mean levels" for a particular transition rather than individual levels. The argument is based on the property that particle-hole states as defined above exhaus all transition probability for one-body transition operators (which usually appear in physical situations). Also, in our formalism, the transition probabilities to particle-hole states fulfill bothn both the energy-weighted and the non-energy weighted and the non-energy weighted sum rules. Therefore, even where the particle-hole states do not represent individual levels, they represent that component of neighbouring physical states which determines the transition probability.

For the calculation of the excitation energy ω of particle-hole states $Q\,|\psi_g\rangle$ one needs in general the expectation value of a four-body operator: $\omega = E_{exc} - E_g = \langle\psi_g|Q(H-E_g)Q|\psi_g\rangle$ .In order to reduce this expression to the expectation value of a two-body operator, we introduce the restriction $Q^+=Q$ and we call the new method[1] "Hermitian Operator Method (HOM)". For an exact ground state one than has the identity $\langle g|\ Q(H-E_g)Q|g\rangle = 1/2\ g|\left[Q,\left[H,Q\right]\right]|g\rangle$ and we assume the same relation to be approximately valid also for $|\phi\rangle$ giving $\omega \simeq 1/2\ \langle\psi_g|\left[\ Q,\left[H,Q\right]\right]|\psi_g\rangle$.The operator Q is obtained by solving the Schroedinger equation within the particle-hole space:

$$\langle\ \psi_g\ |\left[R,\ \left[H,Q\right]\right]\ |\psi_g\rangle = \langle\psi_g|RQ + QR\ |\psi_g\ \rangle$$

Here, R is any hermitian one-body operator. To solve this equation, one expands $Q = Q_{ab}\ a^+_a\ a_b$ (and similarly R) and one gets a secular equation for the expansion coefficients Q_{ab}(see ref.1). On both sides of the equation there appear expectation values of two-body operators, therefore one needs as input data rather good two-body density matrix elements of the ground state. Nowadays, this input information is getting awailable (automatic shell model with full diagonalization within a given shell [4,5], extensive variational calculations like PHF, direct Variational Approach to Density Matrices[6].

So far, the calculation of particle-hole states with the Hermitian Operator Method has been performed on schematic models[3] (Lipkin's monopole-monopole model, and pairing-force model), on nuclei ^{8}Be and ^{12}C (using the PHF ground state)[1] and on nuclei ^{16}O, ^{20}Ne and ^{28}Si (see-tables 1 and 2). Several levels show a rather good agreement with the exact values, On the other hand, the alternative method for the particle-hole space, the extended RPA [2)1] usually disagrees (especially for states of positive parity).

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MASS DISTRIBUTION OF FRAGMENTS FROM THE TERNARY FISSION OF ^{235}U INDUCED BY THERMAL NEUTRONS

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Abstract: An investigation of the ternary fission yield and the mass distribution of ternary fission fragments was carried out with a solid-state track detector (makrofol) sensitive to particles of $A \geq 16$. The yield of ternary fission with respect to binary fission was found to be $(4 \pm 0.2) \cdot 10^{-5}$. The mean values of the masses of ternary fission fragments are $M_1 = 36$, $M_2 = 72$ and $M_3 = 128$.