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Nuclear Theory

On a translationally invariant nuclear single particle picture

W. Gloeckle (1), H. Kamada (2), J. Golak (3) ((1) Ruhr-Universitaet Bochum, (2) Kyushu Institute of Technology, (3) Jagiellonian University Krakow)

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If one assumes a translationally invariant motion of the nucleons relative to the c. m. position in single particle mean fields a correlated single particle picture of the nuclear wave function emerges. A single particle product ansatz leads for that Hamiltonian to nonlinear equations for the single particle wave functions. In contrast to a standard not translationally invariant shell model picture those single particle s-, p- etc states are coupled. The strength of the resulting coupling is an open question. The Schroedinger equation for that Hamiltonian can be solved by few- and many -body techniques, which will allow to check the validity or non-validity of a single particle product ansatz. Realistic nuclear wave functions exhibit repulsive 2-body short range correlations. Therefore a translationally invariant single particle picture -- if useful at all -- can only be expected beyond those ranges. Since exact A = 3 and 4 nucleon ground state wave functions and beyond based on modern nuclear forces are available, the translationally invariant shell model picture can be optimized by an adjustment to the exact wave function and its validity or non-validity decided.

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