Translationally Invariant Calculations of Form Factors, Densities and Momentum Distributions in Finite Nuclei with Short–Range Correlations Included: a Fresh Look

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Following [1] we would like to show how the approach developed in [2] when handling the one-body and two-body density matrices of finite nuclei can be realized beyond the independent particle shell model. The appropriate treatment of the center-mass-motion (CMM) is combined with the inclusion of the short-range correlations (SRCs) in the nuclear ground state (g.s.), *e.g.*, regarding either the Jastrow ansatz or the unitary correlator operator method (UCOM). In our translationally invariant calculations the one-body density $\rho(r)$ and momentum $\eta(p)$ distributions are expectation values of the A-particle multiplicative operators which are dependent on the relative coordinates and momenta (the Jacobi variables) and sandwiched between intrinsic wave functions (WFs). The latter are constructed in the so-called fixed CM approximation (more precisely, via its operator EST version [3]). We use and develop the formalism based upon the Cartesian or boson representation that allow us to get a <u>own</u> "Tassie–Barker" (TB) factor for each distribution of interest. After the separation of the TB factors we propose additional analytic means in order to simplify the subsequent calculations (including the well-known cluster expansions for the remaining many–body operators). Our numerical calculations (see, e.g., Figs. 1-2) of the charge form factors $F_{CH}(q)$, densities and momentum distributions have been carried out for nuclei ^4He and ^{16}O choosing, respectively, the $1s$ and $1s - 1p$ Slater determinants of the harmonic oscillator model as trial, nontranslationally invariant WFs. Being aware of the necessity of introducing noncentral correlations, one should stress that our method of restoring the translational invariance may be helpful for such complex calculations too, viz., the algebraic technique is effective once the corresponding correlator preserves the rotational and permutable symmetry of a trial WF. Finally, regarding prospects of our approach in describing the interplay between the CMM and SRC effects we mean, first of all, its application for calculations of the two-body momentum distributions in such reactions as $^4He(e, e'NN)X$ and $^{16}O(e, e'NN)X$ (cf. the qualitative findings in [2]).

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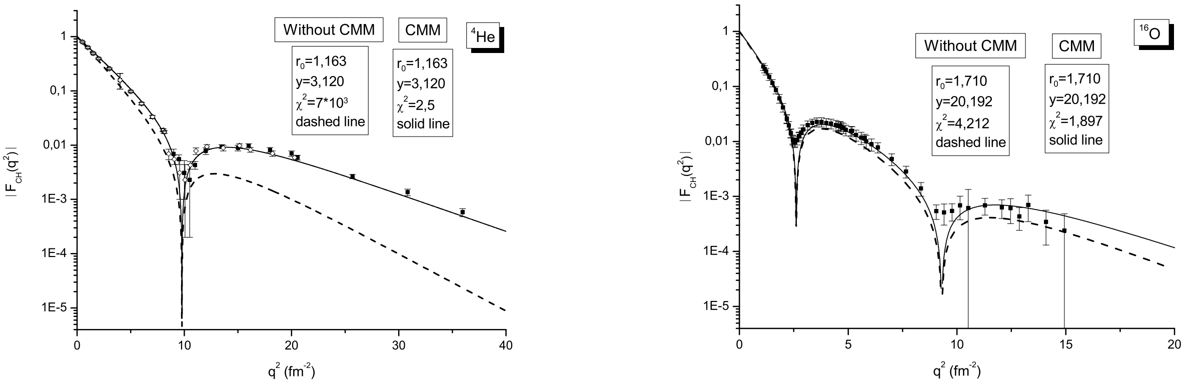

Figure 1: The charge form factor of the nuclei ^4He (on the left) and ^{16}O (on the right) : calculated with the Jastrow WF in the first nonvanishing approximation to the form–cluster Iwamoto–Yamada expansion using the EST prescription (solid curves) and without the CMM correction (dashed curves); experimental points by Frosch, Arnold et al. and Sick et al., respectively. Pointed out the ratio $y = (r_0/r_c)^2$ of the oscillator parameter r_0 to the correlation radius r_c.

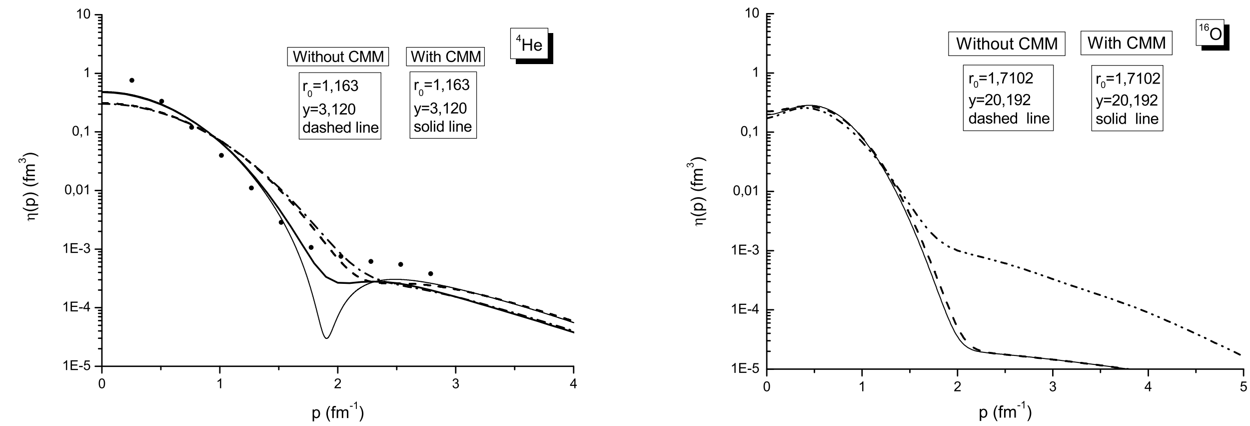

Figure 2: The momentum distributions of the nuclei ^4He and ^{16}O. Together with our calculations for the best density distributions we have depicted the results from [4] (circles on the left) and [5] (the dash-double-dotted curve on the right). Unlike the thin solid and dashed curves the thick solid and dash-dotted ones display our exact (no truncations) calculations, respectively, with the EST prescription and without it.

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