Study of the Two-Body Momentum Distribution in Finite Nuclei

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Beyond the one-body density matrix and the momentum distribution, rich information on the nuclear ground state and nucleon-nucleon correlations is contained in the two-body density matrix $\rho_2(\vec{r}_1, \vec{r}_2; \vec{r}_{1'}, \vec{r}_{2'})$ and its various Fourier transforms in momentum space. Experimentally, exclusive two-nucleon knockout reactions can provide information on the relative behaviour of nucleon pairs embedded in the nuclear medium [1,2]. In this work [3], we focus on the two-body momentum distribution $\eta_2(\vec{p}_1, \vec{p}_2)$, the Fourier transform of $\rho_2(\vec{r}_1, \vec{r}_2; \vec{r}_{1'}, \vec{r}_{2'})$ in the variables $\vec{r}_1 - \vec{r}_{1'}$ and $\vec{r}_2 - \vec{r}_{2'}$. First, an analytical expression is derived for the $\eta_2(\vec{p}_1, \vec{p}_2)$ of $Z = N$, ℓ-closed nuclei within the context of the independent-particle shell model with harmonic oscillator wavefunctions, based on the method used in Refs. [4,5] for the study of the nuclear form factor, the nuclear charge and matter distributions, the generalized momentum distribution etc. An application to the ^{16}O nucleus revealed interesting features rising from the Fermi statistics and the finite nuclear size. Next, the effect of the short-range correlations is investigated by including Jastrow-type correlations in the calculation of $\eta_2(\vec{p}_1, \vec{p}_2)$, of the ^{4}He nucleus, using the low-order approximation of Ref. [6] and a correlation function with overshooting. Deviations from the independent-particle picture were found for large values of p_1 and/or p_2 and for angles between the vectors $\vec{p}_1$ and $\vec{p}_2$ close to 180° and 0°. Finally, the effect of the short-range correlations on the two-body momentum distribution of the nuclei ^{16}O and ^{40}Ca is studied, using the above calculated $\eta_2(\vec{p}_1, \vec{p}_2)$ of ^{4}He.

References

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