

Cluster structures of light nuclei superposing multiple Slater determinants

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We have been developing a computational method which is capable of describing both shell-model-like and cluster structures simultaneously superposing a number of Slater determinants [1]. In the method, the Slater determinants are prepared stochastically utilizing the imaginary-time method and superposed to describe excited as well as ground states. Using the method, we can obtain almost converged solutions once an effective Hamiltonian is specified.

As an example of our calculation, we show results for ^{16}O nucleus in Figs. 1 and 2. In our calculation, we typically prepare and superpose 50 Slater determinants for configuration mixing calculations. Figure 1 shows some of the density distributions of employed Slater determinants. As seen from the figure, Slater determinants with different cluster correlations are included in our method. In Fig 2 we show comparison between calculated and measured spectra of ^{16}O . Our calculation reproduces four excited states, 0_2^+ , 2_1^+ , 4_2^+ , and 6_2^+ which follow a rotational energy sequence, though the calculated excitation energy of 0_2^+ state is about 3 MeV higher than the experimental value. Negative parity levels of 1_1^- , 2_1^- , 3_1^- , are also reproduced reasonably. We also apply our method to ^{12}C and ^{20}Ne . Results of ^{12}C calculation are already published in [2].

[1] S. Shinohara, H. Ohta, T. Nakatsukasa, and K. Yabana, Phys. Rev. C 74, 054315 (2006),

[2] Y. Fukuoka, S. Shinohara, Y. Funaki, T. Nakatsukasa, and K. Yabana, Phys. Rev. C 88, 014321 (2013)

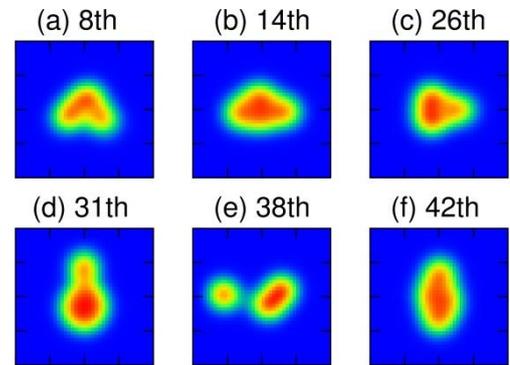


FIG. 1. Contour plots of density distributions of Slater determinants for ^{16}O nucleus which are used in the configuration mixing calculations.

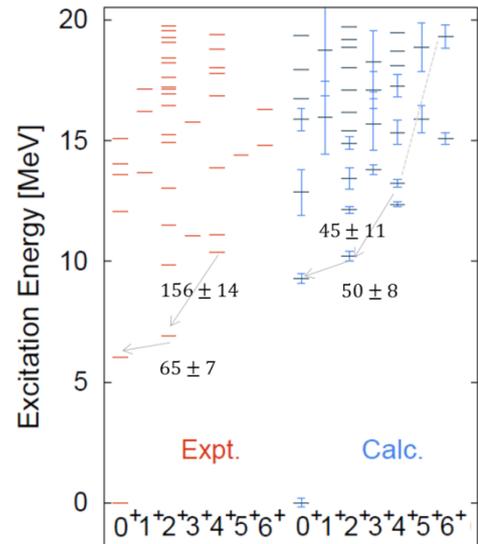


FIG. 2. Excitation energies of positive parity states of ^{16}O nucleus.