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PECULIARITIES OF THE ENERGY SPECTRUM OF THE 12C NUCLEUS IN A 3α MODEL

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The aim of present work is to study peculiar properties of the 12C(0+) and 12C(2+) energy spectrum associated with removal of Pauli forbidden states from the 3α functional space. A deep αα-potential of BFW [1] will be employed which has two Pauli forbidden states in the S wave and a single forbidden state in the D wave. A variational method on symmetrized Gaussian basis is employed. For the elimination of the 3α Pauli forbidden states we use the same direct orthogonalization method from [2]. As a possible origin of non-analytical behavior of the 12C spectrum, consequences of the quantum phase transition (QPT) in the 12C nucleus will be discussed.
The direct orthogonalization method [2] is based on the separation of the complete Hilbert functional space into two parts. The first subspace LQ, which we call allowed subspace, is defined by the kernel of the complete three-body projector $\hat{P}$. The rest subspace LP contains 3α states forbidden by the Pauli principle. After the separation of the complete Hilbert functional space of 3α states into the LQ and LP subspaces, at next step we solve the three-body Schrödinger equation in LQ.

In Fig.1 we display the calculated lowest 0+ spectrum of the 12C nucleus as a function of ϵ, the maximal allowed eigen value of the Pauli projection operator. As can be seen from the figure, there exist a special eigen value of the projector $\hat{P}$, which play a decisive role for the 0+ energy spectrum of the 12C nucleus. The corresponding eigen state of $\hat{P}$ creates a ground state of 12C in a deep phase, while from the left side of this point the lowest energy is close to the energy of the Hoyle state. The situation in the 2+ spectrum is similar.

1. B. Buck, H. Friedrich, and C. Wheatley, Nucl. Phys.A 275, 246 (1977).
2. H. Matsumura, M. Orabi, Y. Suzuki, and Y. Fujiwara, Nucl. Phys. A 776, 1 (2006).

The speaker is a student or young scientist

No

Section

1. Nuclear structure: theory and experiment

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