Correlated two-neutron emission in decay of unbound nucleus ^{26}O[†]

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We study the two-neutron decay of the unbound ^{26}O nucleus with a three-body model assuming an inert ^{24}O core and two valence neutrons. In order to describe the decay properties of the neutron unbound nucleus, we take into account the couplings to the contium by using the Green's function technique.

In the experiment of Ref.[1)], the ^{26}O nucleus was produced in a single proton-knockout reaction from a secondary ^{27}F beam. Therefore, we first construct the ground state of ^{27}F with a three-body model, assuming the ^{25}F+n+n structure. We then assume a sudden proton removal; that is, the ^{25}F core changes to ^{24}O keeping the configuration for the n+n subsystem of ^{26}O to be the same as that in the ground state of ^{27}F. This initial state, Ψ_i, is then evolved with the Hamiltonian for the three-body ^{24}O+n+n system for the two-neutron decay.

We consider two three-body Hamiltonians, one for the initial state ^{25}F+n+n and the other for the final state ^{24}O+n+n. For both cases, we use the Hamiltonian

$$H = \hat{h}_{nC}(1) + \hat{h}_{nC}(2) + v(1,2) + \frac{\vec{p}_1 \cdot \vec{p}_2}{A_c m}, \qquad (1)$$

where A_c is the mass number of the core nucleus, m is the nucleon mass, and $\hat{h}_{nC}$ is the single-particle (s.p.) Hamiltonian for a valence neutron interacting with the core. We use a contact interaction between the valence neutrons. See ref.[2)] for details of the parameters of Eq. (1) and the contact interaciton between the neutrons.

With the initial wave function from the three-body model, the decay energy spectrum can be computed as[3)]

$$\frac{dP}{dE} = \frac{1}{\pi}\Im\langle\Psi_i|G(E)|\Psi_i\rangle, \qquad (2)$$

with $G(E) = G_0(E) - G_0(E)v(1+G_0(E)v)^{-1}G_0(E)$, where $\Im$ denotes the imaginary part. $G(E)$ is the perturbed Green's function, while $G_0(E)$ is the unperturbed Green's function given by

$$G_0(E) = \sum_{1,2} \frac{|(j_1j_2)^{(0^+)}\rangle\langle(j_1j_2)^{(0^+)}|}{e_1+e_2-E-i\eta}, \qquad (3)$$

where the sum includes all independent two-particle states coupled to the total angular momentum $J=0$ with positive parity, as described by the three-body Hamiltonian for ^{24}O+$n+n$.

Figure 1 shows the decay energy spectrum obtained

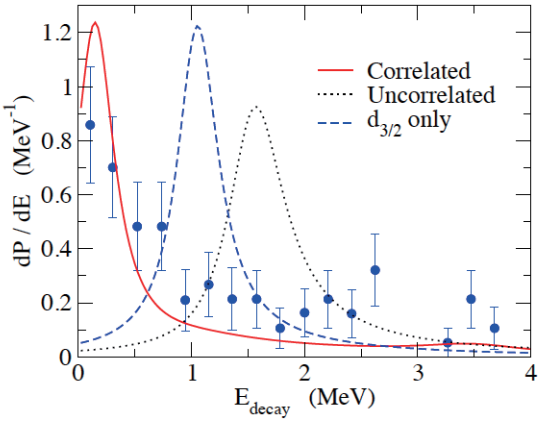

Fig. 1. (Color online) Decay energy spectrum for the two-neutron emission decay of ^{26}O. The solid line shows the result with the full inclusion of the final–state neutron-neutron (nn) interaction, while the dotted line shows the result without the final–state nn interaction. The dashed line is obtained by including only the $(d_{3/2}d_{3/2})^{(0^+)}$ configurations in the unperturbed Green's function of Eq. (3). The theoretical curves are drawn with a finite width of 0.21 MeV, which is the same as the experimental energy resolution. The experimental data are taken from Ref.[1)].

with Eq. (2). The solid line shows the correlated spectrum, in which the final–state nn interaction is fully taken into account, while the dotted line shows the result without the final–state nn interaction. The latter corresponds to the term $G_0(E)$ in $G(E)$. Without the final–state nn interaction, the two valence neutrons in ^{26}O occupy the s.p. resonance state of $1d_{3/2}$ at 770 keV, and the peak in the decay energy spectrum appears at twice this energy. When the final–state nn interaction is taken into account, the peak is drastically shifted towards a lower energy and appears at 0.14 MeV, in good agreement with the experimental data. The figure also shows with the dashed line the result obtained by including only the $(d_{3/2}d_{3/2})^{(0^+)}$ configurations in the unperturbed Green's function of Eq. (3). This corresponds to the case without the dineutron correlation in the final state, as the dineutron correlation is caused by an admixture of several configurations with different parities. The dineutron correlation shifts the peak position further down, making the peak appear at an energy close to the threshold, as shown by the solid line.

We discuss the role of neutron-neutron correlation in the decay probability as well as in the energy and the angular distributions of the emitted neutrons in Ref.[2)]

References
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