Structures of ^{9}Be studied with tensor-optimized shell model

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We study the structures of ^{9}Be using the tensor-optimized shell model (TOSM) with a bare nucleon-nucleon interaction, AV8′. In TOSM, the 2p2h configurations are variationally treated to describe the tensor correlation in nuclei fully involving the high-momentum components [1]. The short-range correlation is treated with the UCOM. In our previous study [2], we have investigated ^{8}Be. Experimentally, the ^{8}Be nucleus shows two kinds of interesting aspects; one is the α clustering in the yrast band states and the other is the highly excited states in which the α decay process is not necessarily favored. The TOSM results nicely explains this feature of ^{8}Be, except for the small energy spacing between the yrast states and the highly excited states. The small energy spacing is related to the lack of the component of two α clusters in the yrast states of ^{8}Be in TOSM. In this report, we investigate the case of ^{9}Be focusing on the energy spectrum from low-lying to highly excited states.

The TOSM wave function $\Psi_{\rm TOSM}$ is given as

$$\Psi_{\rm TOSM} = \sum_{k_0} A_{k_0}|0{\rm p}0{\rm h};k_0\rangle + \sum_{k_1} A_{k_1}|1{\rm p}1{\rm h};k_1\rangle + \sum_{k_2} A_{k_2}|2{\rm p}2{\rm h};{\rm k}_2\rangle, \quad (1)$$

where all the amplitudes $\{A_{k_0}, A_{k_1}, A_{k_2}\}$ are variational coefficients. The hole states are described by harmonic oscillator basis states. For particle states, we employ the Gaussian expansion method to describe the single-particle basis states [1].

The results of ^{9}Be for negative parity states with $T = 1/2$ and $3/2$ in TOSM are shown in Fig. 1. We normalize the energy spectrum to the T=3/2 state in the highly excited states. This state corresponds to the isobaric analog state of ^{9}Li and the TOSM has nicely described the structures of Li isotopes [3]. For $T = 1/2$ states, it is found that TOSM reproduces fairly well the excitation energy spectrum of ^{9}Be such as the level order, except for the energy spacing between the low-lying states and the highly excited states which are located closely with the $T = 3/2$ states. The small energy spacing indicates the lack of the α clustering component in the low-lying states of ^{9}Be in TOSM, as was similarly discussed for ^{8}Be.

For $T = 3/2$ three states, the calculated spectrum in TOSM reproduces the experimental level order. It is also found that the tensor contributions in the T=1/2 states are entirely stronger than those of the T=3/2 states, which is consistent to the state dependence of the tensor force. The kinetic energy also shows the same relation owing to the high momentum arising from the tensor force.

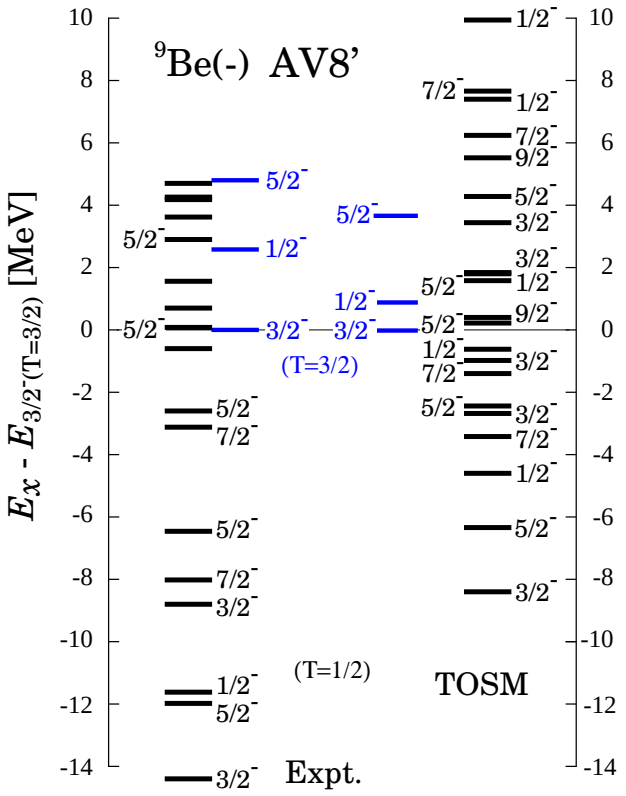

Figure 1: Energy spectrum of ^{9}Be using TOSM, normalized to the T=3/2 state.

References

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