Shape Isomer and "j-Isomer" in ^{66}As and ^{67}As

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Structure study along the $N \approx Z$ valley from nickel to $A \sim 100$ nuclei is one of current topics in nuclear physics. These nuclei call much attention because of abundance of interesting phenomena, for instance, rapid shape change from nucleus to nucleus. The unique structure may play an important role in nucleosynthesis such as the rapid-proton capture process along the $N \approx Z$ valley. Information on the nuclear structure in this mass region is anticipated for understanding the problem [1].

Nuclear isomer having long lifetime is a key state in the nucleosynthesis. It has been discussed that there are three mechanisms leading to nuclear isomer: shape isomer, spin trap and K-isomer [2]. The structure of isomeric states in $N \approx Z$ nuclei, however, is not necessarily understood. Challenging experimental study has gathered information about isomeric states in $N \approx Z$ nuclei. The nucleus ^{66}As has aroused a special interest in the study of odd-odd $N = Z$ nuclei since the discovery of two isomeric states, the $J^{\pi} = 5^{+}$ one at 1.357 MeV and the 9^{+} one at 3.024 MeV. The lighter odd-odd $N = Z$ nucleus ^{62}Ga has an isomeric state with 3^{+} at 0.817 MeV. It has also been reported that the odd-mass nucleus ^{67}As has an isomeric state with $9/2^{+}$. On the theoretical side, however, the question of why the above mentioned states become isomeric and what the nature of the isomerism is has not been thoroughly addressed.

In this paper [3], we investigate the structure of isomeric states in odd-odd $N = Z$ nucleus ^{66}As and in adjacent odd-mass nucleus ^{67}As. The calculation is performed by using the spherical shell model (which has recently proven to be rather successful in describing nuclear shapes, energy levels, and band-crossing phenomenon in Ge and Zn isotopes, as well as ^{68}Se [4]). Our discussion on the results will focus on those states that have notably small electromagnetic transition probabilities to the low-lying states. Analysis shows that there are essentially two different types of isomers entering into discussion. Due to the fact that prolate and oblate shapes possibly coexist at the low excitation region, a shape isomer is predicted in ^{66}As. The other type of isomer is related to a suppressed decay between structures based on the high-j $g_{9/2}$ intruder orbital and the pf-shell configurations. We term the latter "j-isomer".

In ^{66}As, our calculation predicts an isomeric state with $T = 0$, 3^{+}. It may represent the first example of a shape isomer in an odd-odd nucleus in this mass region. The occurrence of a shape isomer in ^{66}As may provide a clue to the puzzle of non-observation of the anticipated $T = 0$ bandhead state in some heavier odd-odd $N = Z$ nuclei. The structure of the experimentally known isomeric state 9^{+} in ^{66}As and $9/2^{+}$ in ^{67}As are termed j-isomers, which, unlike the three well-known classes of isomers, are unique to $N \approx Z$ nuclei. The formation of j-isomer requires either an alignment of a $T = 0$, $J = 9$ neutron-proton pair in the high-j intruder orbitals (in ^{66}As), or a simultaneous occupation of these neutron and proton high-j orbitals (in ^{67}As).

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