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Single-Neutron States in ^{101}Sn populated via α-decay[1]

IAIN DARBY, University of Tennessee

The region of exotic nuclei around doubly-magic ^{100}Sn is an important test-field for the nuclear shell model. A requirement for an accurate understanding of this nucleus and nearby higher mass nuclei is knowledge of single-particle energies, particularly the energy separation between the νd5/2 -νg7/2 orbitals. This information can be obtained by studying the low excitation energy states generated by the interactions between valence d5/2 and g7/2 neutrons in the odd-N Sn isotopes above ^{100}Sn. In particular for the ^{100}Sn region, the energy separation can be best extracted from the energy of the first excited state in ^{101}Sn. In experiments performed at the Holifield Radioactive Ion Beam Facility using sophisticated signal processing equipment we have studied the alpha-decay chain: ^{109}Xe$\rightarrow$^{105}Te$\rightarrow$^{101}Sn. This decay chain has been observed to proceed through ground state to ground state transitions via pure alpha decay and also to proceed via alpha decay fine structure branches which subsequently depopulate via gamma-decay. The observation of coincidences between alpha-alpha and gamma signals has enabled us to unambiguously conclude that the first excited state in ^{101}Sn is at an excitation energy of 172keV and that, surprisingly, the majority of the α-decay branching ratio from ^{105}Te populates the first excited state in ^{101}Sn. We assert that these observations support assignment of a d5/2 neutron single particle character to the first excited state in ^{101}Sn and a g7/2 character to the ground state, in stark contrast to previously held views on the structure of neutron-deficient Sn isotopes. Using the most recent parametrizations of the nucleon-nucleon potential, a set of realistic residual interactions has been derived (M. Hjorth-Jensen, this conference) which we have used in order to apply the shell model interpretation of the lowest excited states in this series of neutron deficient tin isotopes. The result of this approach is not only in agreement with the experimental result, but provides a clear explanation of the properties of heavier Sn isotopes. I shall present our experimental results and discuss the implications of them with regard to the properties of heavier tin isotopes.

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