Investigation of the Decay of Heavy Sn Nuclei using a Resonance Ionization Laser Ion Source*

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Recent studies on the decay of neutron-rich isotopes with A ~132, have been performed at the ISOLDE facility at CERN using a Resonance Ionization Laser Ion Source. The selectivity and ionization efficiency of this source has allowed for the study of Cu, Mn, Ag, Cd, and Sn neutron-rich species that are near subshell closure N=40 and shell closure N=82 [1,2,3]. The selectivity of the laser ionization source results from the specificity achieved from excitation and then ionization of desired products [4] that are produced from a 1 GeV proton-spallation of a UC_2 target. This ionization mechanism is accomplished by use of three dye lasers that are tuned specifically to electronic transitions of the desired products. By combining gamma, beta, and neutron spectroscopy, data were obtained for the half-lives and P_n values of ^{135,136,137}Sn. In addition, nuclear structure information was obtained for ^{135}Sb following the beta-decay of ^{135}Sn.

Heavy Sn nuclei, and all nuclei in the A~130 region are of both astrophysical and nuclear structure importance. Astrophysical ramifications involve trying to understand the mechanisms responsible for the r process abundance peak in the A~130 mass region. In order to perform accurate r-process calculations, precise measurements for β-decay half-lives, Q_β, S_n, and P_n are needed as far from the β-line of stability as possible. Improved results for r-process nucleosynthetic calculations have been obtained using β-decay half-life and P_n data for waiting point nuclei ^{129}Ag and ^{130}Cd [5].

The nuclear structure data obtained in this area is also of great interest because they allow for testing of the shell model for small numbers of particles or holes outside the Z=50 and N=82 shell closures of ^{132}Sn. Data on nuclei in this area are particularly important for comparison of microscopic nuclear-structure calculations. Studies of ^{133}Sn have already shown the difficulties of *ab initio* mean-field and HFB calculations to be able to account for the ordering and spacing of low-j orbitals [6]. The presence of low-energy $\nu p_{3/2}$ and $\nu p_{1/2}$ in ^{133}Sn, and other nuclei in various mass regions are attributed to monopole shifts of single-particle states. Theoretical studies show that this behavior can be accounted for by a reduction in the l^2 term in the Nilsson potential [7]. Other ambiguities in the theoretical models of nuclei in this region involve predictions for Gamow-Teller and first forbidden transition rates. These rates reveal important features of the structure of nuclei in the A~130 region, and also have serious implications on the development of accurate theoretical astrophysical computations. We report on the half-life and P_n values of heavy Sn nuclei and discuss the potential astrophysical and nuclear structure implications.

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