Towards superallowed α-decay : the identification of new α-decay chain ^{109}Xe $\rightarrow$ ^{105}Te $\rightarrow$ ^{101}Sn

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The existence of a region of alpha emitting nuclei above ^{100}Sn is due to the presence of the Z=N=50 shell closures. The region is a fertile area to investigate possible enhanced correlations between neutrons and protons filling the same single-particle orbits and a variety of experiments have been conducted to look for evidence of such effects (e.g. [1]). Such correlations could lead to the observation of "superallowed" alpha decay as an approach is made toward the N = Z line [2]. Alpha- and proton-emitting nuclei in the ^{100}Sn region are also involved in the termination of the rp-process [3].

The new isotope ^{109}Xe was produced by using the ^{58}Ni(^{54}Fe,3n) fusion evaporation reaction with a beam energy of 222 MeV at the HRIBF at Oak Ridge National Laboratory. The recoiling products were separated by means of the Recoil Mass Separator [4] and implanted into a Double-sided Silicon Strip Detector. Recoil and decay signals were analyzed using a digital data acquisition system based on XIA DGF modules [5]. The large recoil pulses were analyzed on-board, while 25 microsecond long images of decay pulses below 9 MeV were stored for further analysis. A novel data acquisition technique allowed for the resolution of the two overlapping alpha particles signals into two separate energies despite the submicrosecond half-life of ^{105}Te.

The lightest mass α-radioactivity identified to date, ^{105}Te, was detected through the ^{109}Xe$\rightarrow$^{105}Te $\rightarrow$^{101}Sn alpha decay chain. This marks the closest approach to the N = Z line above ^{100}Sn. Additionally, fine structure in the millisecond alpha decay of ^{109}Xe to ^{105}Te was identified and the energy difference between the $\nu d_{5/2}$ ground state and the $\nu g_{7/2}$ first excited state was determined to be around 140 keV in ^{105}Te. The results, including the reduced width of the observed alpha transitions and corresponding decay schemes will be presented. Prospects for reaching the superallowed alpha decay chain ^{108}Xe$\rightarrow$^{104}Te $\rightarrow$^{100}Sn will be discussed.

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