

## Towards superallowed $\alpha$ -decay : the identification of new $\alpha$ -decay chain



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The existence of a region of alpha emitting nuclei above  $^{100}\text{Sn}$  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  $^{100}\text{Sn}$  region are also involved in the termination of the rp-process [3].

The new isotope  $^{109}\text{Xe}$  was produced by using the  $^{58}\text{Ni}(^{54}\text{Fe},3n)$  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  $^{105}\text{Te}$ .

The lightest mass  $\alpha$ -radioactivity identified to date,  $^{105}\text{Te}$ , was detected through the  $^{109}\text{Xe} \rightarrow ^{105}\text{Te} \rightarrow ^{101}\text{Sn}$  alpha decay chain. This marks the closest approach to the  $N = Z$  line above  $^{100}\text{Sn}$ . Additionally, fine structure in the millisecond alpha decay of  $^{109}\text{Xe}$  to  $^{105}\text{Te}$  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  $^{105}\text{Te}$ . 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  $^{108}\text{Xe} \rightarrow ^{104}\text{Te} \rightarrow ^{100}\text{Sn}$  will be discussed.

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