Structure of ^{132}Te: The two-particle and two-hole spectrum of ^{132}Sn

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Introduction

The spectroscopy of excited states of neutron-rich nuclei near ^{132}Sn is a subject of current interest in nuclear structure. The experimental data and the predictions of large scale shell model calculations using modern effective interactions can be compared from such studies [1,2]. One of the advantages of such comparison is to obtain a more reliable effective nucleon-nucleon interaction which is necessary to understand the evolution of shell gaps with changing isospin. The other advantage is in the understanding of the *p-n* correlations as a function of spin and isospin in addition to the better studied *n-n* and *p-p* correlations. Usually at higher spins, the protons and neutrons align simultaneously and thus the *p-n* interaction can be probed by studying such states. One of the basic building blocks for studying the different types of correlations is a pair of proton particles and neutrons interacting with each other. In this regard, ^{132}Te which consists of a pair of proton particles and neutron holes is an ideal candidate.

In the present work [3], the states above the previously established 10^+ isomer at 2.72 MeV (with $T_{1/2}$ = 3.70(9) μs) in ^{132}Te have been studied. The level scheme has been extended upto J^{π} = (17^+) with an excitation energy of 6.17 MeV.

Experimental Details

The excited states above the long-lived isomer in ^{132}Te were determined from two experiments. The first experiment was carried out using ^{232}Th(^{7}Li, f) at 5.4 MeV/u with a self-supporting target of thickness ~ 12 mg/cm^2 with the Indian National Gamma Array (INGA) at TIFR [4]. The second experiment was carried out using the EXOGAM gamma array [5] coupled with the VAMOS++ spectrometer [6] at GANIL using the reaction ^{9}Be(^{238}U, f) at 6.2 meV/u with a 1.85 mg/cm^2 thick Be target.

Experimental Results and Discussions

The partial level scheme of ^{132}Te has been shown in Fig. 1. All the new transitions have been marked with an asterisk.

The 900 and 624 keV transitions have been observed in the INGA experiment using the prompt-delayed coincidence analysis. An angular correlation analysis has also been done for these transitions to obtain their spins. A description of these two analysis methods for the INGA setup has been given in Ref [7]. The rest of the new transitions have been obtained by a detailed coincidence analysis of the EXOGAM-VAMOS++ experiment. The spin-parities of these states could not be obtained due to the low statistics. The intensities of all the new transitions have been obtained from the EXOGAM-VAMOS++ data. Also, the newly observed levels till 16^+ follow the systematics of the different Te isotopes.

A large-scale shell model calculation using the *jj55pna* [9] interaction with the NuShellX code [10] was carried out for comparison with the obtained experimental level scheme. The present interaction has been modified by reducing the *p-n* interaction strengths. This gives a better agreement with the measurements up to $J^\pi = 15^+$. Furthermore, it was realized from these calculations that an alignment of the particles in the high-j orbitals $\pi g_{7/2}^{2}$ and $\nu h_{11/2}^{-2}$, simultaneously are responsible for the generation of these observed high-spin states.

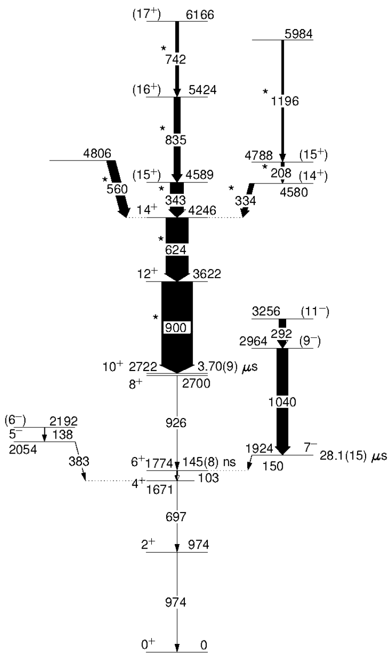

Fig. 1 Partial level scheme of ^{132}Te. An asterisk has been marked for the new transitions observed in the present experiment.

The experimental and calculated level energies for the N = 76, 78 isotones of Te and Sn were compared and this shows an increasing disagreement as a function of spin. The disagreement is worse in Te than in Sn pointing to the fact that there could be deficiencies in the *p-n* correlations, in addition to *n-n* correlations.

Summary

The high-spin states above the 10^+ microsecond isomer in ^{132}Te have been established. Large scale shell model calculations have been undertaken to understand the configuration and the role of *p-n* correlations for these states.

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