Structure of high-spin states in ^{132}Xe from fusion-evaporation and fusion-fission experiments

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Introduction

The study of high-spin states in ^{132,134}Xe isotopes with N $\sim$ 82 is of interest in order to enrich our knowledge about the excitation of transitional nuclei. Even-even Xe isotopes in the A $\sim$ 130 region are treated as the core for the doubly-odd Cs isotopes which exhibit chiral rotation at medium spin. Therefore, investigation of the high-spin structure of even Xe isotopes will provide additional insight on the chiral phenomena. High-spin states in these isotopes, lying on the line of stability, are difficult to produce. Thus far, low-lying level information exists for ^{132}Xe [1, 2] and ^{134}Xe [1] isotopes. In the present work, high-spin states of ^{132}Xe were produced in two reactions. In the first case, ^{7}Li + ^{130}Te reaction was used to populate excited states in ^{132}Xe. In the second experiment, the fusion-fission reaction ^{7}Li + ^{232}Th was used. The motivation of the present work is to extend the level structure of ^{132,134}Xe up to high spins and compare the yield of various excited states of ^{132}Xe in the two reactions.

Experimental Details

Both the fusion-evaporation and fusion-fission measurements were carried out using the γ -ray spectrometer, Indian National Gamma Array (INGA) at the Tata Institute of Fundamental Research (TIFR), Mumbai. In the fusion experiment, ^{7}Li beam of energy 45 MeV, provided by the TIFR-BARC Pelletron facility, was used to bombard a ^{130}Te target of thickness 5 mg/cm^2 with an Al backing of thickness 2 mg/cm^2. The spectrometer at that time consisted of 15 Compton-suppressed HPGe clover detectors. In the fission experiment, ^{7}Li beam of energy 38 MeV, was used to bombard a self-supporting ^{232}Th target of thickness 12 mg/cm^2. In the fusion-fission experiment, 19 Compton-suppressed HPGe clover detectors were mounted in the array. In both the experiments, two- and higher-fold clover coincidence events were recorded in a fast digital data acquisition system (DDAQ) based on Pixie-16 modules of XIA LLC [3]. E_γ-E_γ matrices and E_γ-E_γ-E_γ cubes were used for the coincidence data analysis.

Results and Summary

Prior to the present work, high-spin states in ^{132}Xe were observed up to an excitation energy of $\sim$ 2.8 MeV. In the present work, we have observed 6 new transitions extending the level structure up to an excitation energy of $\sim$ 4 MeV. A representative double-gated coincidence spectrum is displayed in Fig. 1. Various isotopes of Xe were populated in the fusion-fission experiment. In order to find the yield of a particular isotope, gates were put on the transition from the second to the first excited state, γ_2, and the intensity for the transition from the first excited to the ground state, γ_1, was determined. Figure 2 shows the relative total yield of various isotopes of Xe obtained

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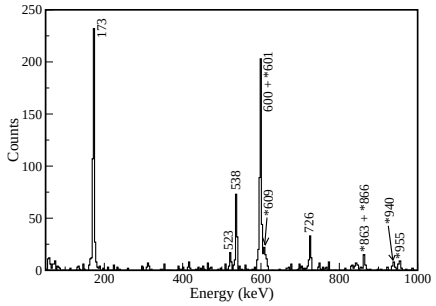

FIG. 1: Preliminary double-gated spectrum showing transitions in ^{132}Xe obtained from the fusion experiment. New transitions are marked with an asterisk.

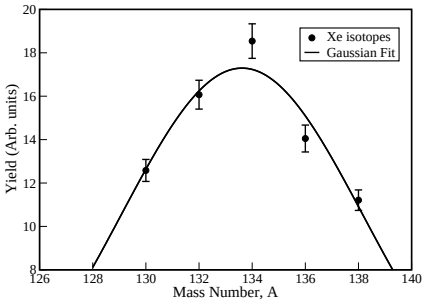

FIG. 2: Relative yield of various isotopes of Xe. A Gaussian function was used to fit the data points.

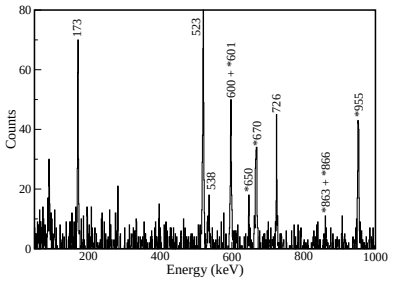

FIG. 3: Preliminary double-gated spectrum showing transitions in ^{132}Xe obtained from the fission experiment. New transitions are marked with an asterisk.

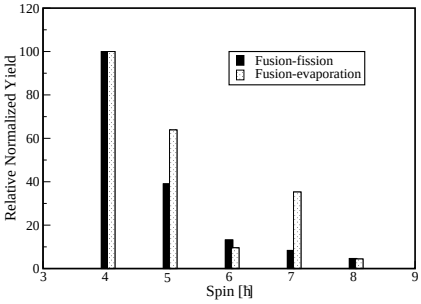

FIG. 4: Relative yields of yrast high-spin states of ^{132}Xe from the fusion-evaporation and fusion-fission experiment.

in the fission experiment. Figure. 3 shows the transitions in ^{132}Xe observed in the fission experiment. The relative yields of the high-spin states of ^{132}Xe were calculated for both the fusion-evaporation and fusion-fission experiments (see Fig 4). Several new transitions were also identified in ^{134}Xe, populated in the fission experiment. The assignment of these new γ rays to ^{134}Xe was confirmed by comparing with the level schemes of Y isotopes which are the partner fission fragments. The results of detailed coincidence analysis, including the newly identified transitions and the relative intensities observed in the two experiments, will be presented. In summary the level structure of ^{132}Xe has been studied in complementary fusion-fission and fusion-evaporation reactions. Six new γ rays have been assigned to the existing level scheme. Relative isotopic yields and the population distribution of high-spin states in ^{132}Xe have been presented.

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References

[1] W. F. Mueller *et.al*. Phys. Rev. C, **73**, 014316 (2006).
[2] A. Kerek *et.al*. Nucl. Phys. A, **172**, 603 (1971).
[3] R. Palit *et.al*. Nucl. Instrum. Methods A, **680**, 90 (2012).