New Levels and Gamma Transitions in ^{131}Xe from Precision Electron-Gamma decay Spectroscopic Study of ^{131}I

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Introduction

The Xe nuclides have proven to be a fertile ground for attempts to account for the properties of nuclides undergoing a transitions from a closed shell structure observed near N = 82 to structures that have increased deformation near mid-shell. Systematic changes in magnetic dipole and electric quadrupole moments and mean square charge radii for Ba and Cs nuclides have been interpreted as indicating smooth increases in deformation as neutrons are removed from N = 82 closed shell.

Although ^{131}Xe has been extensively studied with a variety of experimental techniques, the spins and parities of a number of a number of low lying energy levels are still uncertain. Coulomb excitation and (α,nγ) studies were first made by Palmer et al [1]. They reported excitations of states at 80, 163, 341, 364, 404, 505,636, 666, 699, 722, 913 and 971 keV. The levels at 565, 666, and 913 keV have been reported in the particle transfer reactions. These levels were not reported in decay spectroscopy. Search for certain expected (from reaction data or model prediction) levels, which are yet to be observed in decay studies. Careful electron-gamma spectroscopic investigations have been undertaken to examine the evidence for unconfirmed or disputed levels. Particular attention was put to identify relatively weaker transitions. An exhaustive and careful study of the conversion electron spectrum to clear the reported uncertainties.

Experimental

In the present work, these questions are addressed through precision measurements of gamma ray energies and relative intensities using large volume HPGe detector and similar measurements for conversion electrons using a Mini-Orange electron spectrometer [2].

The radioactive ^{131}I sample was obtained from Board of Radiation and Isotope Technology (BRIT), Bhabha Atomic Research Center, Mumbai in liquid form in Sodium Thiosulphate solution. The source was allowed to decay for at least two half-lives so as to purify the sources of any short-lived impurities. Two different sources were prepared, one for gamma spectra and the other for conversion electron spectra

Gamma spectra: Singles gamma spectra are recorded with the 60 cc HPGe detector coupled to an 8 K PC based MCA. Gamma singles spectra were acquired at a source-to-detector distance of 25 cm. Counting periods lasted on an average of 4.5×10^5 seconds per spectrum. Gamma spectra were analysed using the computer codes FIT [3] and GAMMAVISION [4].

Conversion electron spectra: Specially prepared sources for the Mini-Orange spectrometer, having source thickness of the order of 100 $\mu g/cm^3$ have been used. Mini-Orange Spectrometer has been adjusted for the values of 'f 'and 'g' respectively as 7.5 cm and 4.5 cm. Conversion electron were recorded for a minimum period of 10^5 seconds. Several runs have been taken with different sources of different thicknesses. The count rates for different sources for all measurements were maintained between 500-1000 counts/second. The conversion electron spectra were analysed using the computer codes FIT and GAMMAVISION for precise energies and area under the peaks.

Results and discussion

Nine new transitions, not given in NDS [6] or any earlier report, have been observed. Three levels with excitation energies 565.16, 699.90 and 913.836 keV were added. Also, multipolarities have been deduced for the first time for 3 transitions, namely; 85.9 keV (M1+E2); 313.90 keV (M1+E2) and 642.72 keV (E2). Using the precisely determined transition energies as input data for the application of Ritz combination principle, the computer code GTOL[5] has been used to construct the new level scheme. Excitation energies of all new levels and the energies and intensities of the de-exciting gamma transitions are presented in Table 1. The decay scheme showing only the new transitions is shown in Figure.1.

Present level scheme (Figure 2) includes three additional levels with energies 565.17, 699.90 and 913.84 keV; all 9 gammas identified in the present work pertain to these levels. Further, multipolarities have been deduced for the 85.9, 318.09 and 642.71 keV transitions as M1+E2, M1+E2 and E2 respectively which had no assignment in earlier studies.

Table 1: New Gamma transitions and relative intensities in ^{131}Xe

Energy (keV)	Relative intensity	Levels	*Transitions* $J_i \rightarrow J_f$
134.74	0.011 4	699.9 → 565.17	$3/2^+_3 \rightarrow 1/2^+_2$
213.93	0.004 2	913.84 → 699.9	$7/2^+_2 \rightarrow 3/2^+_3$
246.937	0.0037 2	913.84 → 666.9	$7/2^+_2 \rightarrow 7/2^-_1$
484.985	0.0080 9	565.17 → 80.16	$1/2^+_2 \rightarrow 1/2^+_1$
509.00	0.00127 8	913.84 → 404.81	$7/2^+_2 \rightarrow 3/2^+_2$
565.163	0.007 5	565.17 → 0	$1/2^+_2 \rightarrow 3/2^+_1$
572.669	0.0006 1	913.84 → 341.14	$7/2^+_2 \rightarrow 9/2^-_1$
833.654	0.0012 1	913.84 → 80.18	$7/2^+_2 \rightarrow 1/2^+_1$
913.832	0.002 3	913.84 → 0	$7/2^+_2 \rightarrow 3/2^+_1$

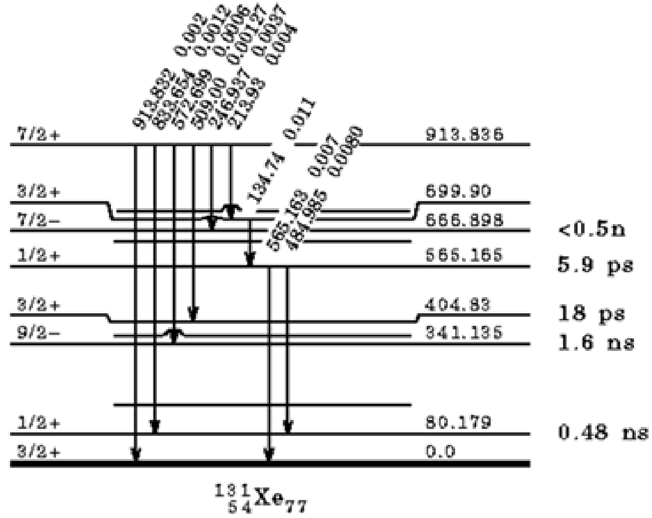

Fig. 1: Decay scheme showing only New Transitions

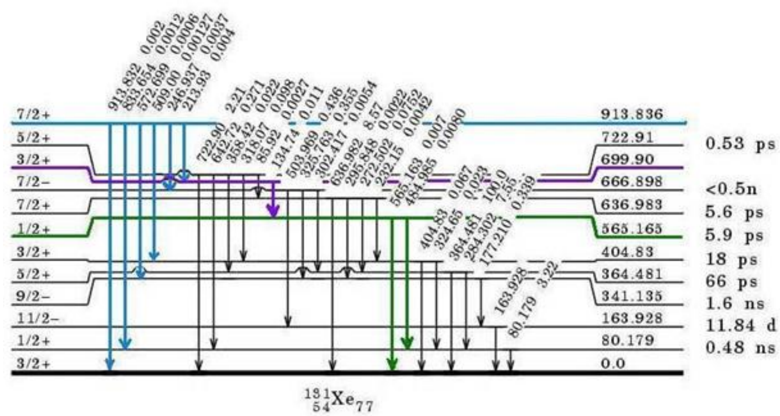

Fig. 2: Decay scheme of ^{131}Xe nucleus showing the New Levels and Transitions

References

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