Evidence of Octupole Excitation in ^{82}Kr

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1. INTRODUCTION

Multipole modes of excitation depend on the occupancy of the valence particles in the particular orbitals, which leads to various nuclear shapes. Octupole correlations in atomic nuclei are due to the interaction between orbitals of opposite parity, whose angular momenta differ by $3\hbar$, lying in the proximity of the Fermi surface. In general, this situation occurs when the Fermi level is found between an intruder orbital and the normal-parity subshell, i.e., for particle (proton or neutron) numbers 34 ($g_{9/2} \rightarrow p_{3/2}$), 56 ($h_{11/2} \rightarrow d_{5/2}$), 88 ($i_{13/2} \rightarrow f_{7/2}$) and 134 ($j_{15/2} \rightarrow g_{9/2}$).

With $Z = 36$ and $N = 46$, valence protons and neutrons in ^{82}Kr may occupy the orbits $g_{9/2}$ and $p_{3/2}$ with opposite parity and $\Delta j = \Delta l = 3\hbar$, which might lead to octupole correlations relating to the reflection symmetry breaking of the nuclear shape. Therefore our present motivation is to investigate the octupole correlation in the ^{82}Kr nucleus.

2. EXPERIMENTAL DETAILS

The excited states of ^{82}Kr have been populated through the reaction of the 31-MeV ^{9}Be projectile with the ^{76}Ge target. The Indian National Gamma Array (INGA), consisting of fourteen Compton-suppressed clover detectors arranged in five different angles 40°, 90°, 115°, 140° and 157° with respect to the beam axis [1], have been employed to detect the γ-rays which were de-excited from the residual nuclei. The data were sorted into γ-γ matrices, symmetric as well as angle dependent, and γ-γ-γ cube using the **MARCOS** code and analyzed using the **INGASORT** and the **RADWARE** packages.

3. RESULTS AND DISCUSSION

A partial level scheme of ^{82}Kr is shown in Fig.1. The present proposed structure of ^{82}Kr exhibits two negative-parity bands (DB1 and DB2) and eleven inter-band parity changing **E1** transitions. Kemnitz *et al.* [2] had observed a quadrupole band structure at the **2828**-keV $\mathbf{5}^-$ excited state, consisting of the 668.4, 1250.2 and 956.0-keV transitions. The

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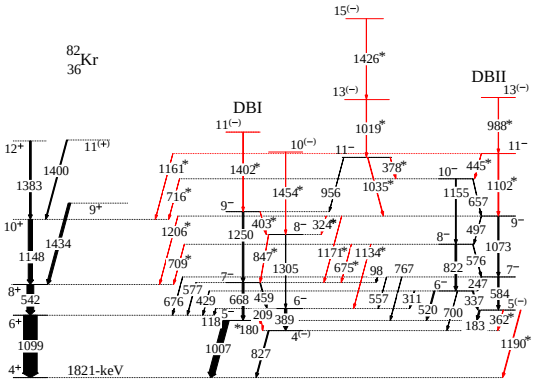

FIG. 1: Partial level scheme of the low-lying structre in ^{82}Kr obtained from the present work. Level energies are rounded off to the nearest keV. Newly observed transitions are coloured by red and marked by asterisk.

states having spin-parities $\mathbf{4^-}$, $\mathbf{6^-}$ and $\mathbf{8^-}$, respectively, had also been reported by Kemnitz *et al.* [2] as non-band levels. We have arranged these states as the signature partner of the band-structure and refereed them as **DB1** along with the placement of five new in-band γ-ray transitions (180, 209, 459, 847, 403, 1402 and 1454-keV) as depicted in Fig. 1. The excited states in **DB2**, built on the 3011-kev excited state, have been reported in Ref. [2] with spin-parity values firmly assigned up to 10^-. We confirmed the previously reported structures of **DB2** and extend it up to the 6757-keV excited state through the placement of the 1102-keV ($11^- \rightarrow 9^-$), $445-keV$ ($11^- \rightarrow 10^-$) and 988-keV($13^- \rightarrow 11^-$) transitions. R_{DCO} and P values of the 445, and 1102-keV transitions are 0.71(7), -0.27(16) and 1.12(10), +0.61(31), respectively, indicating their mixed M1+E2 and E2 character, respectively.We have observed two new transitions of energy 362 and 1190-keV which are depopulating from the 5^- excited state in DB2. Measured $\mathbf{R_{DCO}}$ values of the 1161, and 1206-keV γ-rays showed their dipole character, while 716, and 709-keV transitions indicate the $\Delta I = 0$, E1 nature. The R_{DCO} for different transitions are tabulated in Table I.

The level lifetimes of the four levels (8^- to 11^-) of **DB1**, and five levels (8^- to 12^-) of **DB2** in ^{82}Kr have been extracted using the Doppler Shift Attenuation Methood (DSAM). One of the most striking features of the level scheme of ^{82}Kr is the observation of the strong $E1$ transitions with large $B(E1)$ ($10^{-4}W.u.$) transitions rates (Table I). This enhancement of **E1** transition rates were obtained in the present work supports the existance of octupole correlations in the ^{82}Kr nuclei. Thus the positive parity band and negative parity bands (**DB1** and **DB2**), connected through the parity changing transitions, indicate the existence of octupole correlation in ^{82}Kr. Other details will be presented during the conference.

TABLE I: Measured **DCO**, transition rates $B(E1)$ ($10^{-4}W.u.$), and electric dipole moment in ^{82}Kr.

$\mathbf{E_\gamma}$ **(keV)**	$\mathbf{I_i \rightarrow I_f}$	$\mathbf{R_{(DCO)}}$	**B(E1)**	$\mathbf{D_0}$**(efm)**
827	$4^- \rightarrow 4^+$	0.96(11)	1.1	2.4
1007	$5^- \rightarrow 4^+$	0.47(3)	0.4(1)	2.9(10)
118	$6^- \rightarrow 6^+$	1.15(9)	0.14(5)	1.3(4)
577	$7^- \rightarrow 6^+$	0.48(5)	0.28	1.8(9)
429	$6^- \rightarrow 6^+$	1.16(13)	0.2(1)	1.5(5)
676	$7^- \rightarrow 6^+$	0.51(5)	0.8	3.1
709	$8^- \rightarrow 8^+$	.95(11)	0.2(1)	2.2(10)
1206	$9^- \rightarrow 8^+$	0.53(6)	0.4(1)	2.0(4)
1161	$11^- \rightarrow 10^+$	0.47(6)	0.2(1)	1.3(4)

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