Multipolarity of γ-rays using the Directional Correlation of Oriented nuclei(DCO) ratios and polarization asymmetry measurement below the I=29/2$^+$ isomer in ^{205}At

S. Kumar[1],* Ksh. Rojeeta Devi[1], Neelam[1], Prerna Singh Rawat[1], Neeraj Kumar[1], Naveen Kumar[1], A. Banerjee[1], C. V. Ahmad[1], Unnati[1], S. K. Mandal[1], A. Sharma[2], S. K. Dhiman[2], Pragati[3], A. Y. Deo[3], P. C. Srivastava[3], S.S. Tiwari[4], S. Chakraborty[4,8], Chandrani Majumder[4], H. P. Sharma[4], S. Bhatacharya[5], T. Trivedi[5,7], and R. Garg[6], S. S. Bhattacharjee[6], Indu Bala[6], R. Kumar[6] R. P. Singh[6], S. Muralithar[6]

[1]*Department of Physics and Astrophysics, University of Delhi, New Delhi-110007, INDIA*
[2]*Department of Physics, Himachal Pradesh University, Shimla-171005, INDIA*
[3]*Department of Physics, Indian Institute of Technology, Roorkee, Roorkee-247667, INDIA*
[4]*Department of Physics, Banaras Hindu University, Varanasi-221005, INDIA*
[5]*Department of Pure and Applied Physics, Guru Ghasidas Vishwavidyalaya, Bilaspur-495009, INDIA*
[6]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi-110067, INDIA*
[7]*Department of Physics, University of Allahabad, Allahabad 211002, INDIA and*
[8]*Variable Energy Cyclotron Centre, 1/AF Bidhannagar,Kolkata - 700064, INDIA*

Introduction

Characterization of the spins and parities of nuclear states is fundamental to nuclear structure physics. The angular distribution and correlation of γ-rays emitted from excited states can be used for spin assignment. In recent years, for large detector arrays, Directional Correlation of Oriented nuclei(DCO) ratios has been used [1] to determine the order of gamma-ray multipole, and clover detectors have been used as Compton polarimeters via polarisation asymmetry measurement [2] to determine the electric and magnetic character of gamma-ray transitions. The electron conversion spectrometer [3, 4] also used as In-beam spectroscopy tool to find the multipolarities of gamma-ray transitions. In the present work, we report on the spin and parity measurement based on the DCO and polarization asymmetry measurement below the I=29/2$^+$ isomer in ^{205}At. The assigned multipolarities are discussed with previous assignment multipolarities based on conversion coefficient measurements.

Experimental Detail

The excited states of the ^{205}At nucleus were populated through the ^{197}Au(^{12}C,4nγ) reaction at about 63 MeV beam energy. This reaction occurred with the ^{197}Au backing. The main target of ^{121}Sb has a thickness of $\approx$ 1.2 mg/cm^2 whereas the thickness of the ^{197}Au backing was 10.0 mg/cm^2. The ^{12}C beam was delivered by the Pelletron accelerator at the Inter-University Accelerator Centre(IUAC), New Delhi, India, and the de-exciting gamma rays were detected by the Indian National Gamma Array (INGA) spectrometer [5].

Results and Discussion

The gated γ-ray spectra of the current experiment at γ-γ coincidence measurement are shown in Fig. 1. The majority of the γ-rays decay from the I=29/2+ isomer is represented by the coincident γ-ray spectra gated on the two strong ground-state transitions at 638 keV and 664 keV In the present study, the values of DCO ratio [1] and polarization asymmetry

*Electronic address: sursvmk123@gmail.com

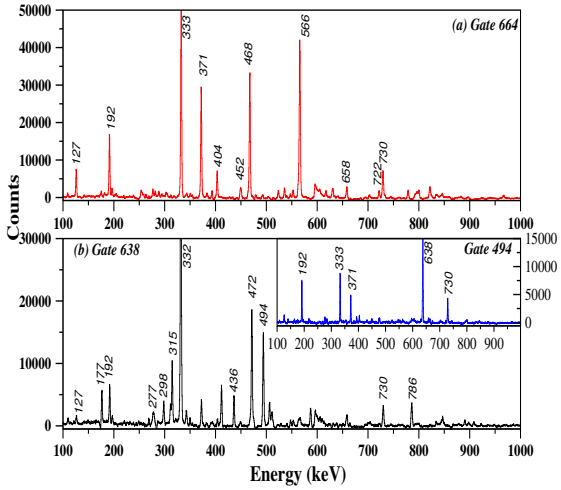

FIG. 1: Coincidence spectra of (a) 664.0 keV γ-ray, (b) 638.5 γ-ray showing the γ-ray transitions in the decay of I=$29/2^+$ isomeric state.

[2] were measured to re-confirm the multipole character of the γ-rays decaying out of this isomer. The results are listed in Table I. The results can be compared with the angular distributions, conversion coefficients, and multipolarities as reported in Ref. [6]. The E2 character is the same as that assigned in Ref. [6] for the 332.9-, 494.1-, 566.4-, 664.0-, 730.0-, and 786.2 keV γ-rays. The M2 character of 969.6 keV γ-ray is also consistent with the angular distributions and conversion coefficients measured [6].

The M1/E2 multipole character for 314.9-, 372.4-, 436.3-, 468.0-, 471.5-, and 638.5 keV is also supported by previous measurements [6]. A +0.067(51) value for polarisation asymmetry is obtained for the 403.5 transition, which is assigned as an E3 transition [6]. The work to find value of the mixing ratio is in progress.

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TABLE I: Energy of γ -ray (Eγ), initial and final spin and parity of the levels (J_i^π(i) and J_i^π(f)), $R_{DCO}(Q)$, $R_{DCO}(D)$ and polarization asymmetry (Δ) of the γ -ray transitions in ^{205}At nucleus

Eγ	J_i^π(i)	J_i^π(f)	R$_{DCO}(Q)$	R$_{DCO}(D)$	Δ	Mult
126.7	$25/2^+$	$23/2^-$		1.64(12)		
176.5	$21/2^+$	$17/2^+$		1.96(18)		Q
192.1	$21/2^+$	$19/2^-$	0.96(7)			Q
277.2	$29/2^+$	$25/2^+$	0.72(21)			D/Q
298.3	$21/2^+$	$17/2^+$		1.88(23)		Q
314.9	$17/2^+$	$15/2^+$	0.81(9)	1.15(7)	-0.005(45)	M1/E2
331.6	$13/2^+$	$11/2^-$			+0.038(30)	[E1]
332.9	$21/2^-$	$17/2^-$	1.08(5)	1.62(8)	+0.089(29)	E2
372.4	$23/2^-$	$21/2^-$	0.69(4)		-0.053(27)	M1/E2
403.6	$29/2^+$	$23/2^-$	1.03(8)	1.15(7)	+0.067(51)	[E3]
436.3	$17/2^+$	$15/2^+$		1.11(8)	-0.026(56)	M1/E2
468.0	$15/2^-$	$13/2^-$	0.45(3)	0.84(6)	-0.022(30)	M1/E2
471.5	$15/2^+$	$13/2^+$	0.66(7))		-0.036(26)	M1/E2
494.1	$15/2^-$	$11/2^-$	1.11(9)	1.49(13)	+0.038(42)	E2
566.4	$17/2^-$	$13/2^-$	1.01(5)	1.55(9)	+0.077(21)	E2
631.8	$19/2^-$	$17/2^-$	0.62(7)			D/Q
638.5	$11/2^-$	$9/2^-$	0.63(5)	1.09(5)	+0.014(24)	M1/E2
664.0	$13/2^-$	$9/2^-$		1.55(8)	+0.075(19)	E2
730.0	$19/2^-$	$15/2^-$	1.09(12)		+0.102(47)	E2
786.2	$17/2^+$	$13/2^+$	1.13(14)		+0.137(53)	E2
969.6	$13/2^+$	$9/2^-$	1.3(4)	2.02(22)	-0.084(59)	M2

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