Calculation For Multipole Mixing Ratios OF Gamma Transitions From Deformation Levels IN ^{152}Sm Nucleus

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Abstract

In the present work , the a_2 - ratio method has been used to calculate the multipole mixing ratios , δ – values , of γ – transitions from excited levels of deformation nucleus (^{152}Sm) .

The results obtained confirm the validity of this method in calculating the δ - values .

The present results are in good agreement with those of the experimental results, ref.(1,2) , and of theoretical results using interaction boson model (IBM-1) ,ref. (5).

Introduction

The multipole mixing ratio (δ) is physical quantity which can be extracted from angular distribution measurements and it is usually defined as the ratio of the electric quadruple (E2) to magnetic dipole (M1) matrix elements for γ- transition from initial state (J_i) to final state (J_f).

Multipole mixing ratio is used as a source of information about the structure of nuclear levels.

The main aim of the present work is to use a_2 – ratio method to calculate the multipole mixing ratios , δ – values of γ – transitions from levels excited in the deformation nucleus (^{152}Sm) .

In general this method depends only on the experimental a_2 coefficient determined for at least two γ – transitions from the same initial state , one of which is pure transition such as 2-0 , 1-0 , or might be considered a pure(E1) transition such as 2^- - 2^+, 3^- -3^+ , 3^- - 4^+ ,5^- -4^+ ------etc, or pure (E2) transition such as 4-2 , 6-4 , 5-3 ------ ect.

The results obtained have shown that this method is good in calculating the δ – values for γ – transitions.

Data Reduction and Analysis

As it has been mentioned previously this method depends only on the experimental a_2- coefficient obtained for at least two γ – transitions from the same level , one of which is pure transition or may be considered as a pure transition , a_2 – coefficient of the pure transition from a certain initial level given by : ref.(1,2)

$$a_2(J_i - J_f) = \rho_2(J_i)\, F_2(J_f L_1 L_1 J_i) \quad \text{------[1]}$$

and for other transition from the same level , is given by : ref.(1,2)

$$a_2(J_i - J_f) = \rho_2(J_i)\, \frac{F_2(J_f L_1 L_1 J_i) + 2\delta F_2(J_f L_1 L_2 J_i) + \delta^2 F_2(J_f L_2 L_2 J_i)}{1+\delta^2} \quad \text{...[2]}$$

Where L= is angular momentum of the γ – transition

$L_2 = L_1 + 1$ and $L_1 \neq 0$.

Since the statistical tensor $\rho_2(J_i)$ is the same for both transition , then:

$$\frac{a_2(J_i - J_f)_2}{a_2(J_i - J_f)_1} = \frac{F_2(J_f L_1 L_1 J_i) + 2\delta F_2(J_f L_1 L_2 J_i) + \delta^2 F_2(J_f L_2 L_2 J_i)}{F_2(J_f L_1 L_1 J_i)(1+\delta^2)} \quad \text{---[3]}$$

The a_2 – coefficients used in these equations are reported in ref.(1,2). F_2 coefficients have been taken from ref.(3,4).

For γ – transitions from levels of deformation nucleus (^{152}Sm) , equation (3) become;

For $J_i^{\pi} = 2_2^{+}$, $J_{f1}^{\pi} = 4_1^{+}$ and $J_{f2}^{\pi} = 2^{+}$

$$\frac{a_2(2_2{}' - 2_1{}^{+})}{a_2(2_2{}^{+} - 4_1{}^{+})} = \frac{F_2(2112) + 2\delta F_2(2122) + \delta^2 F_2(2222)}{F_2(2224)\,(1+\delta^2)}$$

$F_2(2112) = -0.41833$, $F_2(2122) = -0.61238$, $F_2(2222) = 0.12806$
$F_2(2224) = -0.17075$

For $J_i^\pi = 4_2^+$, $J_{f1}^\pi = 2_1^+$ or to $J_{f2}^+ = 4_1^+$

$$\frac{a_2(4_2^+ - 4_1^+)}{a_2(4_2^+ - 2_1^+)} = \frac{F_2(4114) + 2\,\delta\, F_2(4124) + \delta^2 F_2(4224)}{F_2(4222)\,(1 + \delta^2)}$$

$F_2(4114) = -0.43875$, $F_2(4124) = -0.33541$, $F_2(4224) = 0.26455$
$F_2(4222) = -0.44770$

Results and Discussion

The multipole mixing ratios of γ – transitions from excited levels of deformation nucleus (^{152}Sm) calculated by equation (3) are presented in table (1) with those of ref.(1,2)and ref.(5).

By using a_2 – ratio method , there is two values for δ can be obtained as shown in table (1) , the present results confirm the validity of this method in calculating δ – values.

The variation in sign and magnitude between the experimental and theoretical values of mixing ratios for the same class of gamma transition as seen in table (1) is given a microscopic approach is needed to explain the data theoretically.

Conclusion

In the present work, the a_2 –ratio method has been used as a tool to calculate the multipole mixing ratios of γ – transitions from excited levels of the nucleus (^{152}Sm).

The experimental values of multipole mixing ratios for γ – transitions from excited levels in deformation nucleus have provided the most accurate results for comparison with theoretical calculations based on different nuclear models.

References

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Table (1) : Multipole mixing ratios of γ- transitions from energy level of (^{152}Sm) calculated by a_2 – ratio method

E_i (MeV)	E_γ (MeV)	J_i^π- J_f^π	a_2	δ – mixing ratio		
				a_2 – ratio P.W.	Exp. Ref.[1,2]	IBM-1 Ref.[5]
0.814	0.6887	2_2^+ - 2_1^+	-0.230(10)	4.29(15) -0.19(1)	19.0(55)	
			-0.082(15)	6.76(38) -0.28(1)	36(00)	
			-0.131(90)	$(5.69)^{+2.23}_{-1.30}$ -0.25(6)	67(27)	
			-0.071(20)	7.06(53) -0.29(2)	15(2)	5.00
			-0.125(55)	7.33(214) -0.29(6)	13(15)	
			-0.160(40)	5.2(8) -0.23(3)	8(6)	
			-0.020(70)	8.89(13) -0.32(4)	8(6)	
	0.4440	2_2^+ - 4_1^+	-0.230(10)	E2	----------	-1.457

Table (1) :Continued

E_i (MeV)	E_γ (MeV)	$J_i^\pi - J_f^\pi$	a_2	δ – mixing ratio		
				a_2 – ratio P.W.	Exp. Ref.[1,2]	IBM-1 Ref.[5]
1.0229	0.9012	$4_2^+ - 2_1^+$	0.330(40)	E2	------ ------	- 4.623
	0.6566	$4_2^+ - 4_1^+$	-0.070(20)	$(4.64)^{+0.88}_{-0.64}$ -0.68(5)	5.8(5)	
			0.014(130)	2.88(18) -0.52(3)	2.9(1)	-6.590)
			-0.150(44)	6.27(18) -0.89(14)	8(3)	
			-0.120(99)	$(1.91)^{+0.91}_{-0.54}$ -0.34(16)	2.1(3)	

حساب نسب الأختلاط لأنتقالات أشعة كاما من المستويات المشوهة في نواة (^{152}Sm)

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الخلاصة

تم في هذا البحث استعمال طريقة نسبة (a_2 – ratio) لحساب نسبة الاختلاط (قيم δ) للانتقالات الكامية بين المستويات المتهيجة للنواة المشوهة (^{152}Sm) .

وقد تمت المقارنة بين قيم(δ) المحسوبة بهذه الطريقة مع كل من قيم(δ) المحسوبة نظريا" باستعمال أنموذج البوزونات المتفاعلة (IBM – 1) في البحث (5)والقيم المحسوبة في البحثين (1,2) ، اذ أثبت الأتفاق الجيد صحة طريقة نسبة (a_2 – ratio) أداة لحساب قيم (δ) للانتقالات الكامية .