The B(E2) transition Probabilities for $^{122-130}$Te (Tellurium) Even-Even Isotopes with the help of Cubic terms from Casimir Invariant Operators and IBM-1

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Abstract

The interacting boson model-1 has been used to calculate the reduced electric transition probability B(E2) ↓ of even-even $^{122-130}$Te (Tellurium) isotopes with even neutrons from N = 70 to 78. The three-three boson interactions are also formed in the Hamiltonian from casimir invariant operators. The parameters of best fit to measure the data is used from the experimental value of B (E2; $2_1^+ \rightarrow 0_1^+$) for even-even $^{122-130}$Te isotopes. The theoretical values are good in agreement especially with the experimental ones. The branching ratios B (E2; $4_1^+ \rightarrow 2_1^+$) / B (E2; $2_1^+ \rightarrow 0_1^+$) is less than 2 represents U (5) symmetry in $^{122-130}$Te isotopes.

Key words: **Interacting Boson Model-1, even-even Tellurium, reduce electric transition probabilities, three-three interactions.**

INTRODUCTION

Iachello and Arima developed the Interacting Boson Model-1, a nuclear model for the description of collective states. The nucleus is represented in the IBM in terms of interacting s and d bosons. The shell model reveals that the low-lying states of the even-even nuclei are made up predominantly by nucleon pairs with total spin 0 and 2. The spins of such pairs of even number nucleons shows the antisymmetric state. The basic assumption of IBM is that the nucleon pairs are represented by bosons with angular momenta l = 0 or 2.

When the number of bosons depends on the number of active nucleon pairs it builds a closed shell. S-and d-boson has its own binding energy within the closed shell. The IBM describes the even-even nuclei as an inert core combined with bosons which represent pairs of identical nucleons. Each boson has a wave function but two bosons not represent the wave function because they are interchanged. The interacting boson-fermion model which deals with odd number of identical nucleons, bosons are coupled to nucleons.

THEORETICAL CALCULATIONS

U (6) ⊃ U (5) ⊃ SO (5) ⊃ SO (3)
U (6) ⊃ SU (3) ⊃ SO (3)
U (6) ⊃ SO (6) ⊃ SO (5) ⊃ SO (3)

The Casimir invariant operators of U (6) and its subgroups in the pattern are given below:

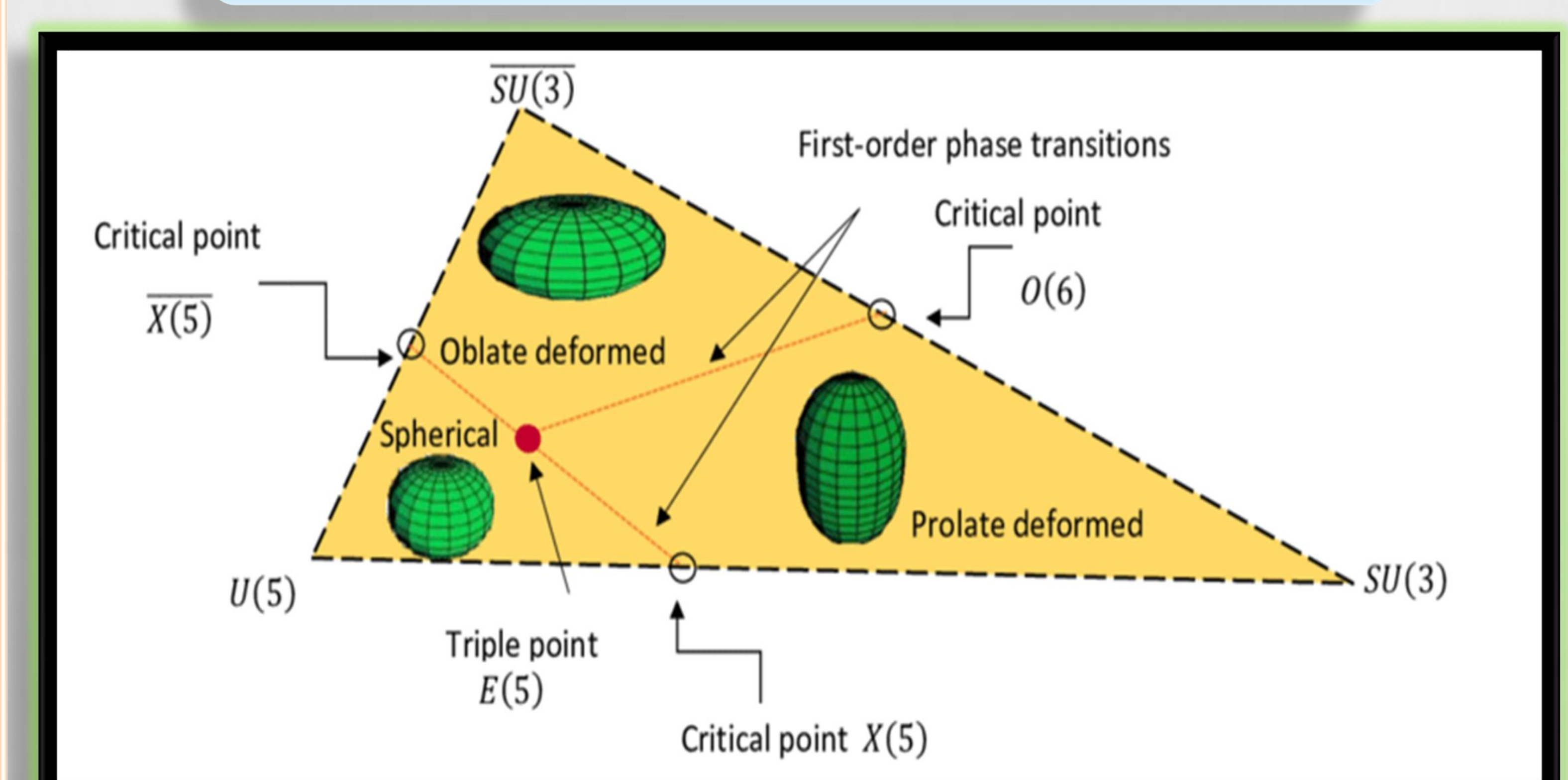
$C_{1, U(6)} = N$, $C_{1, U(5)} = n_d$, $C_{2, U(5)} = n_d (n_d + 4)$, $C_{2, U(6)} = N (N + 5)$,

$C_{2, SO(6)} = N (N + 4) - \{\sqrt{5} [d^\dagger \times d^\dagger]^{(0)} - s^\dagger s^\dagger\} \{\sqrt{5} [\tilde{d} \times \tilde{d}]^{(0)} - ss\}$

$C_{2, SO(5)} = n_d (n_d + 3) - 5 \{[d^\dagger \times d^\dagger]^{(0)} [\tilde{d} \times \tilde{d}]^{(0)}\}$

$C_{2, SO(3)} = -10\sqrt{3} \{[d^\dagger \times \tilde{d}]^{(1)} \times [d^\dagger \times \tilde{d}]^{(1)}\}$

$C_{2, SU(3)} = \sum_\mu (-1)^\mu Q_\mu Q_{-\mu}$, Where $Q_\mu = \{d_\mu^\dagger \tilde{s} + s^\dagger \tilde{d}_\mu - \sqrt{7}/2 [d^\dagger \times \tilde{d}]_\mu^{(2)}\}$



Casten Triangle

$$H = a_1 C_{1,U(5)} + a_1' C_{2,U(5)} + a_2 C_{1,U(6)} + a_2' C_{2,U(6)} + a_3 C_{1,U(6)} C_{1,U(5)} + a_4 C_{2,SO(5)} + a_5 C_{2,SO(3)} + a_6 C_{2,SO(6)} + a_7 C_{2,SU(3)} + b_1 [C_{1,U(5)}]^3 + b_2 C_{2,SO(5)} C_{1,U(5)} + b_2' C_{2,SO(3)} C_{1,U(5)} + b_3 C_{2,U(6)} C_{1,U(6)} + b_4 C_{1,U(6)} C_{2,U(5)} + b_5 C_{2,SO(5)} C_{1,U(6)} + b_6 C_{2,SO(3)} C_{1,U(6)} + b_7 [C_{1,U(6)}]^3$$

Even-even nuclei with Z = 52 and N = 70-78 offer good chances to analyse the behaviour of total low-lying E2 strengths in the transitional region between deformed and spherical nuclei. To determine the reduced transition probabilities strengths B(E2), the calculated absolute strengths B(E2) of the transitions within the ground state band can be fitted to the experimental ones. The vibrational limit U (5) has been used in IBM-1 to describe the Tellurium nuclei.

RESULTS & DISCUSSIONS

The B(E2) values for the so-called cross-over $2_2^+ \rightarrow 0_2^+$ transition is well reproduced and they are very small. This indicates that in the theoretical B(E2) values, the particle and collective contributions are out of phase. Transition from $2_2^+ \rightarrow 2_1^+$, B(E2) values are larger when compared to the ones in $2_2^+ \rightarrow 0_2^+$ transition for $^{122-130}$Te isotopes. This is due to the fact that both contributions are included in phase.

The branching ratios B (E2; $4_1^+ \rightarrow 2_1^+$) / B (E2; $2_1^+ \rightarrow 0_1^+$) is less than 2 represents U (5) symmetry, less than 1.42 for O (6) symmetry and zero for SU (3) symmetry. We investigate U (5) symmetry as B (E2; $4_1^+ \rightarrow 2_1^+$) / B (E2; $2_1^+ \rightarrow 0_1^+$) = 1.71($e^2 b^2$), 1.67($e^2 b^2$), 1.61($e^2 b^2$), 1.49($e^2 b^2$) and 1.33($e^2 b^2$) of $_{52}Te^{122}$, $_{52}Te^{124}$, $_{52}Te^{126}$, $_{52}Te^{128}$ and $_{52}Te^{130}$ respectively

CONCLUSION

One can show the two phonon excitations by close the energy level 0_2^+ from the twice value of the energy level 2_1^+ and the closest of the energy levels (4_1^+, 2_2^+ and 0_2^+). A quantitative comparison with experimental data is not possible because these small components are not stable enough against small changes in the model parameters. Also, the reduced transition probabilities between $4^+ \rightarrow 2^+$, $6^+ \rightarrow 4^+$, $8^+ \rightarrow 6^+$ of even-even Te (Z = 52, N = 70 to 78) have been studied within the framework of interacting boson model-1. It is found that electric quadrupole reduced transition probability are in good agreement with the experimental results for $^{122-130}$Te nuclei.