Validity of Grodzins relation in high mass region of nuclear chart

Vikas Katoch[1,*] and J. B. Gupta[2]

[1]*Raj Kumar Goel Institute of Technology, Ghaziabad-201003, India*

[2]*Ramjas College, University of Delhi, Delhi-110007, India*

[*]*E-mail id –t9289267850@gmail.com*

The nuclear chart of the nuclei contains the light mass region having atomic mass A ≥ 100, medium mass region having mass between 100 < A < 200 and high mass region A >200. The Grodzins relation between the energy of spin $I^{\pi} = 2^{+}$ $E(2^{+}_{1})$and the electro- magnetic transition probability B(E2) to be a constant (1962) [1]. The data of transition probability B(E2) was compiled by Stelson et. al. (1965) [2].

These data also are updated and compiled by Raman et. al. [3]. Recently Pritychenko et. al. revised, updated and compiled [4] these data. Gupta et. al. [5] studied the linear relation of 1/ $E(2^{+}_{1})$ and B(E2)↑ for medium mass nuclei. Here the application of this linearity relation and phase transition is verified in high mass region.

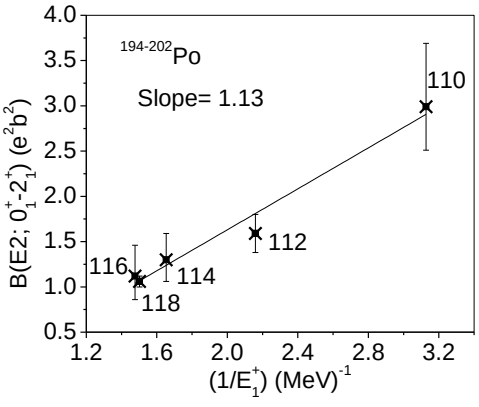

Fig. 1. The reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) with 1/ $E(2^{+}_{1})$ energy of spin I=2 for $^{194-202}$Po.

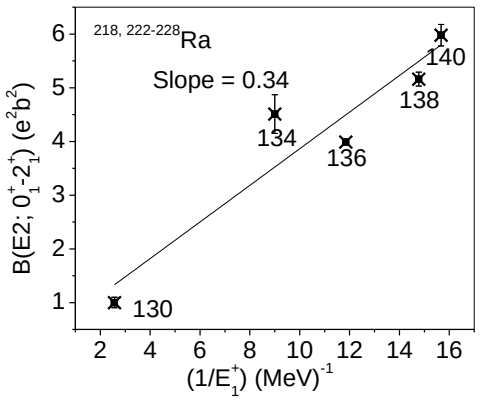

Fig. 2. The reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) with 1/ $E(2^{+}_{1})$ energy of spin I=2 for $^{218, 222-228}$Ra.

The data of energy $E(2^{+}_{1})$ and reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) for spin $I^{\pi} = 2^{+}$ are taken from ref. [4] and [6]. Here the reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) increases as the 1/ $E(2^{+}_{1})$ energy increase and shows the linear relation having slope is 1.13. For N=110 to 112, there is sharp phase

transition. For N=114-118 nuclei shows collective nature in fig. 1.

For $^{218,\ 222\text{-}228}$Ra, the energy ratio R_4 for N=130 is 2.1 and the nuclei are vibrational. As the neutron number N increases, the energy ratio R_4 increases, and the shape of the nuclei slowly approaches to the rotational at N=140.

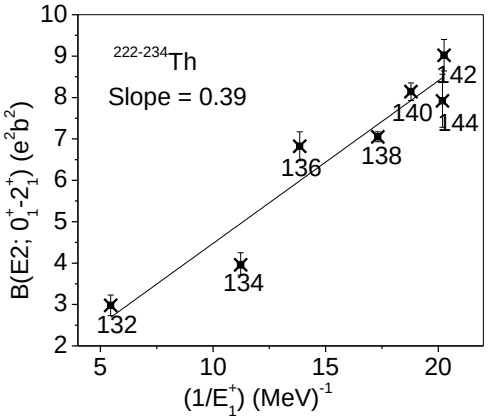

Fig. 3. The reduced transition probability B(E2; 0^+_1-2^+_1) with 1/ E(2^+_1) energy of spin I=2 for $^{222\text{-}234}$Th.

In fig. 3. The $^{222\text{-}234}$Th nuclei shows the linear nature having slope is 0.39 between 1 /E(2^+_1) energy of spin I=2 and reduced transition probability B(E2; 0^+_1-2^+_1). From N=132 to

Here the energy 1/E(2^+_1) increases, also reduced transition probability B(E2; 0^+_1-2^+_1) increases and shows the linear rise nature with slope 0.34 and shown in fig. 2.

134 and 134 to 136, there is sharp phase transition where as from N = 136 to 142 nuclei shows slow increase.

Result: Like medium mass nuclei, the high mass region nuclei show the linear rising nature of B(E2)↑ versus 1/E(2_1^+).

References: [1]. L. Grodzins, Phys. Lett. 2, 88 (1962).

[2] P. H. Stelson & L. Grodzins, Nuclear Data Sheets Section A, Volume 1,1965, Pages 21-102 (1965).

[3] S. Raman, C.W. Nestor Jr., and P. Tikkanen, At. Data Nucl. Data Tables 78, 1 (2001).

[4] B. Pritychenko et. al. Atomic Data and Nuclear Data Tables, Vol. 107, pages 1-139 , Jan 2016

[5] J. B. Gupta and Vikas Katoch, IJMPE april, 2018

[6] nndc.bnl.gov.in (Sept., 2018)