Validity of Grodzins relation in high mass region of nuclear chart

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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.

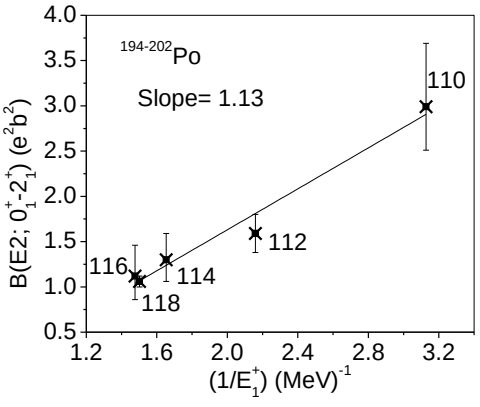

Fig. 1. The reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) with 1/ $E(2^{+}_{1})$ energy of spin I=2 for $^{194-202}$Po.

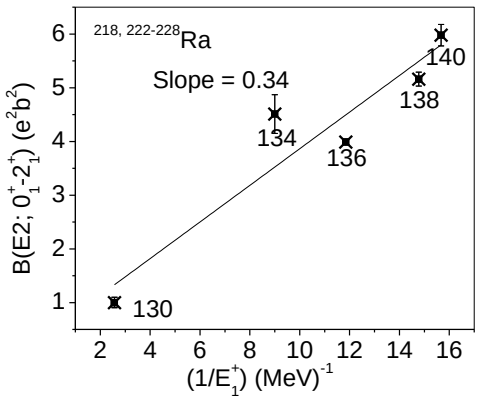

Fig. 2. The reduced transition probability B(E2; 0^{+}_{1}-2^{+}_{1}) with 1/ $E(2^{+}_{1})$ energy of spin I=2 for $^{218, 222-228}$Ra.

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. 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.

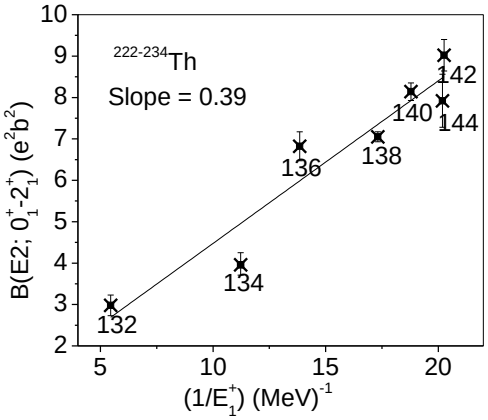

Fig. 3. The reduced transition probability B(E2; 0^+_1-2^+_1) with 1/ $E(2^+_1)$ energy of spin I=2 for $^{222\text{-}234}$Th.

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 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 $1/E(2_1^+)$.

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