Validity of Grodzins linearity relation for 4_1^+, 6_1^+ states

J.B. Gupta and Vikas Katoch

Ramjas College, University of Delhi, Delhi
RKG Institute of Technology, Ghaziabad, UP

The well known Grodzins product rule, (GPR) [1] implies that the product of B(E2, 0_1^+-2_1^+) and level energy E(2_1^+) in ground bands of even Z even N nuclei is almost a constant, even if the two entities vary by large amount with N and Z. Raman et. al. (1988) [2] on empirical basis suggested the GPR relation

$$E(2_1^+)\times B(E2)\uparrow=2.57(45)Z^2A^{-2/3} \quad (1)$$

$B(E2)$ is in e^2b^2 units and $E(2_1^+)$ is in keV.

In our earlier study [3, 4], we expressed this relation in the form

$$B(E2)\uparrow=\text{constant}\times(1/E(2_1^+))\times A^{-2/3} \quad (2)$$

For a range of isotopes of any given element, this yields a linear relations of B(E2) versus the reciprocal 1/E(2_1^+). This was verified for the mid mass region, as well as light mass (N< 82) region of nuclei. Here we test the linearity relation for spin 4_1^+ and 6_1^+. However, instead of the reciprocal of energy value E(2_1^+) , we use the reciprocal of energy E_γ for transition from 4_1^+ and 6_1^+. The data is taken from [5].

Results

Out of our study for many nuclei in the Z=54-78 series of isotopes, here we present one example for each of the 4 quadrants for 4_1^+ state, and one for 6_1^+ state. Note that the reciprocal $1/E_\gamma(4\text{-}2)$ is related to the kinetic MoI of 4_1^+ state. The same holds for 6_1^+ state. Thus our linearity plots indicate the linearity relation of B(E2, 4-2) to the corresponding MoI.

Conclusion

Each of our plot also gives an additional information regarding the slow or fast variation of the MoI with neutron number N in the given element. The shape phase transition with N can also be visible. Thus our plots are very useful for the study of structural changes with N.

References

1.L.Grodzins,Phys.Lett.**2**(2)(1962) 88.
2. S. Raman et al. Phys. Rev. **C37** (1988) 805
3. J.B. Gupta and V. Katoch, IJMPE **E27** (04) (2018) 1850033.
4. J.B. Gupta and V. Katoch, IJMPE 27(11), 1850100 (2018).
5. www.nndc.gov.in

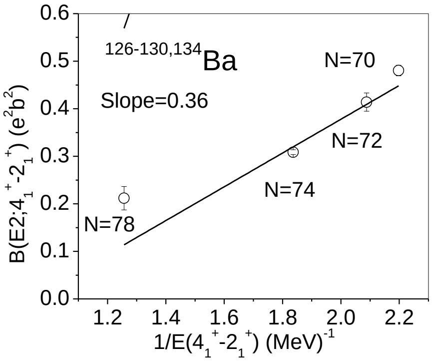

Fig. 1. $B(E2;\, 4_1^+\!\rightarrow\!2_1^+)$ versus $1/E(4_1^+\text{-}2_1^+)$ for $^{126\text{-}134}$B**a** isotopes.

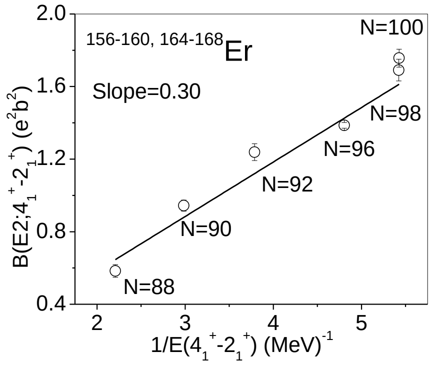

Fig. 3. $B(E2;\, 4_1^+\!\rightarrow\!2_1^+)$ vs $1/E(4_1^+\text{-}2_1^+)$ for $^{156\text{-}160,\,164\text{-}168}$Er isotopes.

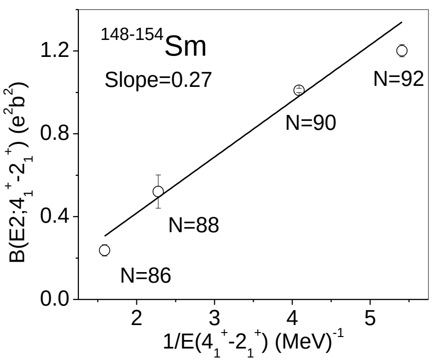

Fig. 2. $B(E2;\, 4_1^+\!\rightarrow\!2_1^+)$ versus $1/E(4_1^+\text{-}2_1^+)$ for $^{148\text{-}154}$Sm isotopes..

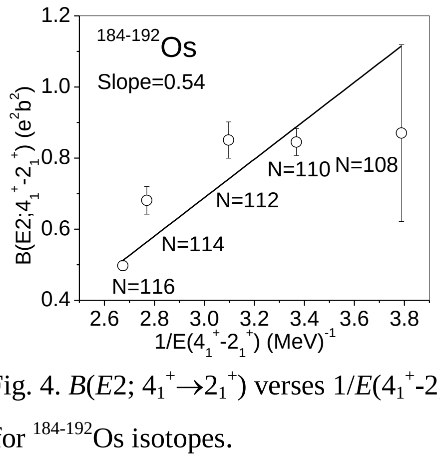

Fig. 4. $B(E2;\, 4_1^+\!\rightarrow\!2_1^+)$ verses $1/E(4_1^+\text{-}2_1^+)$ for $^{184\text{-}192}$Os isotopes.

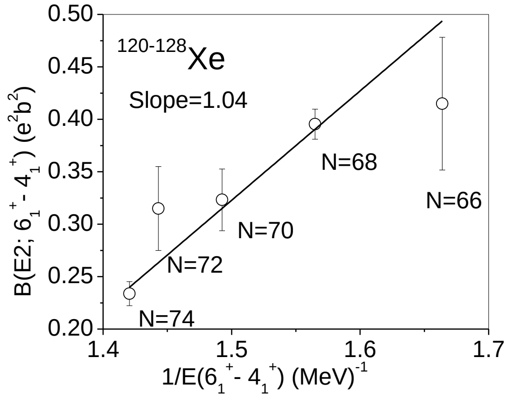

Fig. 5. . $B(E2;\, 6_1^+\!\rightarrow\!4_1^+)$ versus $1/E(6_1^+\text{-}4_1^+)$ for $^{148\text{-}154}$Sm isotopes.