On the Mass Dependence of Isotopic Effects in Fusion Process

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The systematic study of any process observed in heavy-ion reaction in isotopic-mass plane has special place in nuclear physics research since it establishes its validity across the periodic table. The discovery of large number of proton-rich as well as neutron-rich nuclei and subsequently, their fusion makes fusion process as one of the hottest candidates for the above study. We here report our analysis for the fusion process over wide range of isotopic-mass plane to look whether isotopic effects reported in the fusion of heavy–ion reactions are universal or depend on the masses of colliding nuclei.

This present study is undertaken within the framework of Skyrme energy density formalism developed by Denisov in terms of a parameterised form [1] and upgraded version of the proximity potential [1]. The advantage of these formalisms is that these have isospin dependence embedded into the potentials by dividing it into a geometrical factor and universal function.

Using these formalisms, we studied the fusion of stable as well as neutron / proton-rich nuclei. In the first case, we studied the fusion of ^{12}C, ^{16}O, ^{28}Si and ^{35}Cl with ^{92}Zr and compared our results with experimental data [2]. Both formalisms are able to reproduce the measured fusion-barrier heights, positions as well as fusion cross-sections quite reasonably [3].

In the second step, we studied the collisions of X+X, X being ^{A1}C, ^{A1}O, ^{A1}Ne, ^{A1}Si, ^{A1}S, ^{A1}Ar, ^{A1}Ca & ^{A1}Ni over wide isotopic range between $0.4 \le N/Z \le 2.0$. In fig. 1, we display the (preliminary) normalized fusion barrier heights and positions as a function of (N/Z-1). We observed that the barrier positions and heights as well as Coulomb and nuclear potentials at barrier (not shown here) can be parameterized in terms of a second order non-linear equation. Further, as evident, the results are independent of the masses of colliding nuclei suggesting a universal isotopic effects in fusion process [4].

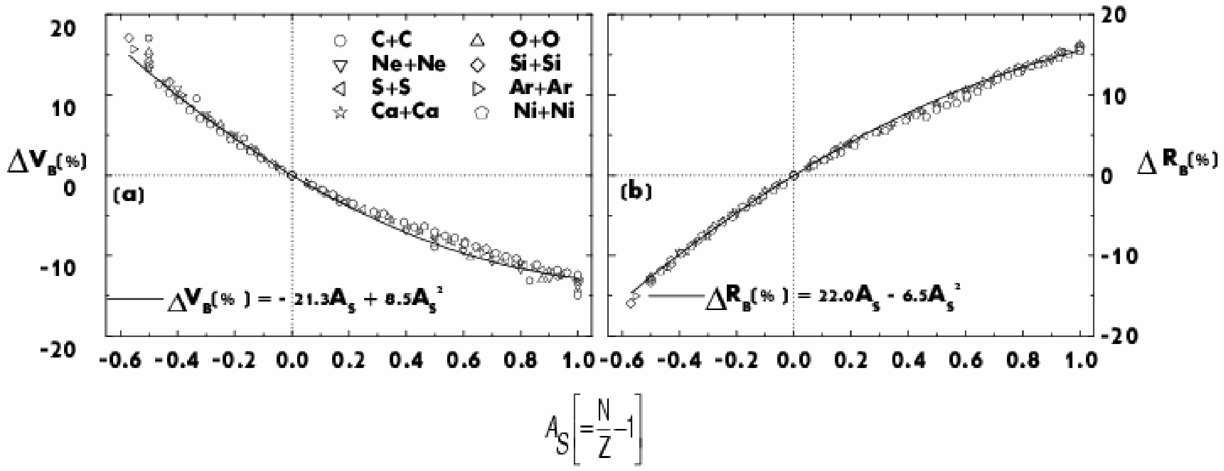

Fig. 1: Normalized Fusion Barrier Heights and Positions as a Function of (N/Z-1).

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[4] Narinder K. Dhiman and Rajeev K. Puri, Eur. Phys. J. **A-** submitted (2005).