Study of Nuclear Surface Diffuseness in Quadrupole and Hexadecapole Deformed Nuclei

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In low energy heavy ion reactions, the fusion of colliding nuclei has always been of central interest. Significant amount of work is being carried out to portray the addressal of the measured fusion-cross-sections by opting a variety of nucleus-nucleus interaction potential and associated parameters. The nuclear potentials calculated using proximity theorem are characterized via various parameters such as surface energy coefficient, surface diffuseness, potential depth, radius etc. In the past, the surface diffuseness parameter of around 0.63 fm and 0.75 fm – 1.5 fm have been suggested respectively for scattering and fusion problems. The aim of the present work is to investigate the role of diffuseness parameter (b) (varying from 0.60 fm to 1.1 fm) in the fusion dynamics of reactions involving quadrupole (β_2) and hexadecapole (β_4) deformed colliding nuclei. The explicit dependence of deformation is incorporated by choosing oblate ($\beta_2 < 0$) and prolate ($\beta_2 > 0$) shapes of projectile-target nuclei such as ^{28}Si+^{178}Hf ($\beta_{2P} = -0.363$; $\beta_{2T} = 0.278$; $\beta_{4P} = 0.187$; $\beta_{4T} = -0.07$) and ^{32}S+^{184}W ($\beta_{2P} = 0.221$; $\beta_{2T} = 0.232$; $\beta_{4P} = -0.095$; $\beta_{4T} = -0.093$). The calculation suggests that independent of the magnitude and sign of quadrupole deformation of projectile and target, the fusion barrier height VB decreases with increase in value of b. However, overall shift in VB (higher) is seen when hexadecapole deformation of colliding nuclei are included. In addition to this, the fusion excitation functions of considered reactions are calculated using the Wong formula. We find that diffuseness values of 0.99 fm and 1.1 fm are favored to address the experimental data of ^{28}Si- and ^{32}S-induced reactions respectively.