# The nuclear surface energy in heavy-ion fusion around the barrier

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The nuclear surface energy is a basic component of the liquid drop model of nuclei and as such is a characteristic quantity of finite nuclear systems. A large surface energy indicates stiffness against extending a nucleus's surface, while a small one should give a lower energy penalty to doing so.

Since near-barrier fusion can be influenced by the dynamic shape changes of the fusing nuclei, with the formation of a neck facilitating fusion, one might expect the surface energy to play a significant role in such processes.

We use a set of effective interactions of the Skyrme type, fitted to span a systematic range of surface energies [1] in order to evaluate their role in heavy-ion fusion reactions, and hence what conculsions may be drawn about the surface energy from fusion experiments. We perform calculations using (time-dependent) Hartree-Fock to evaluate fusion properties, such as barrier heights and fusion cross sections.

Following preliminary calculations in $^{40}$Ca + $^{48}$Ca calculations in which one sees an increasing dynamic effect in lowering the barrier as surface energy increases [2], we further present systematic results including reactions involving $^{208}$Pb. Here we find a shift of 400 keV (or 12%) in the position of the $3^-$ octupole state, as calculated with TDHF with linear response theory (Fig. 1). The state systematically shifts higher as the surface energy increases, in agreement with naive expectation. The $3^-$ position measures the ease in which the octupole-shaped neck may be formed, indicating that a lower surface energy help $^{208}$Pb undergo fusion reactions. Full TDHF calculations of cross sections will be presented to confirm the arguments concerning the link between fusion properties and the surface energy.

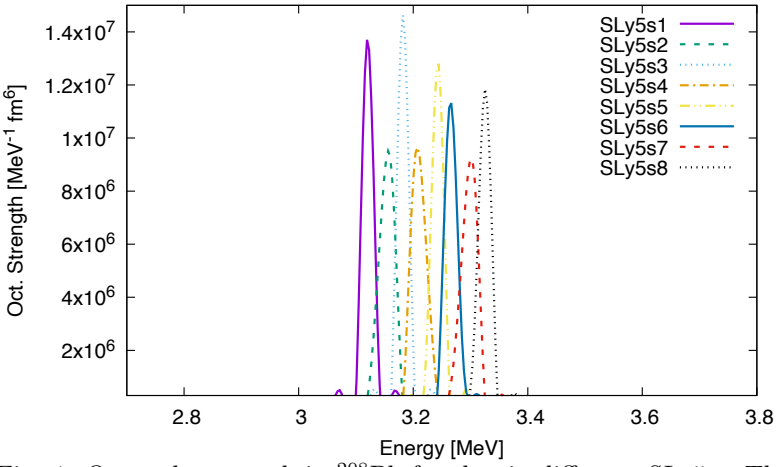


Fig. 1: Octupole strength in $^{208}$Pb for the six different *SLy5sx*. The surface energy increases for increasing $x$ in the force name.

[1] R. Jodon, M. Bender, K. Bennaceur, *et al.*, Phys. Rev. C **94**, 024335 (2016)

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