Study of surface nuclear diffuseness using large angle quasi-elastic scattering for tightly bound, weakly bound and very heavy systems

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Recently, high quality quasi-elastic data, taken at large angles and deep-sub-barrier energies, have been used as a probe in the investigation of the surface diffuseness of heavy ion interaction potential. At this energy regime the open reaction channels and coupled channel effects are negligible, and the quasi-elastic cross sections are sensitive mainly to the surface region of the potential, then probing the diffuseness parameter, since there is a simple correlation between the surface diffuseness and the Woods-Saxon potential parameters which fit the data. Quasi-elastic scattering is defined as the sum of the elastic and inelastic scattering, transfer, break-up and any other direct process, and has been widely used to extract information about the reaction dynamics through their respective quasi-elastic barrier distributions.

The first investigation on this subject was done by Washiyama et al. [1], who studied previously available deep sub-barrier data for spherical and deformed systems. They concluded that the diffuseness values which best fit the spherical systems are within the 0.53 to 0.62 fm range, similar to the usual value of 0.63 fm used traditionally in most calculations. However, for deformed systems, they concluded that much larger values of diffuseness were required to fit the data, close to 1.1 fm. This puzzle motivated other works in this subject. Capurro et al. [2] studied near spherical systems with $Z_pZ_T \approx 780$ and derived diffuseness values around 0.60 fm. Monteiro et al. [3] studied the near-spherical but lighter systems $^{16,17,18}\text{O} + ^{92}\text{Mo}$ and derived diffuseness around 0.70 fm. With much better quality data than those analyzed by Washiyama et al, Gasques et al. [4] studied the same and other spherical and deformed systems and derived diffuseness values for both spherical and deformed systems between 0.65 fm and 0.85 fm. Furthermore, Gasques et al found that channel coupling effects are important for deformed systems even at deep sub-barrier energies, and affect the value of the diffuseness.

Very recently, the investigation of quasi elastic scattering was extended to very heavy systems, such as the near-spherical $^{86}\text{Kr} + ^{208}\text{Pb}$ system, measured by Ntshangase et al [5]. Then, Monteiro et al [6] used the deep sub-barrier part of these data to determine the surface diffuseness for very massive systems. At the present we are extending this investigation to systems with weakly bound projectiles, $^6,^7\text{Li} + ^{144}\text{Sm}$ [7]. In this contribution we will present an overview of this subject, including tightly and weakly bound systems, and very heavy systems, including our new and still unpublished data.

References: