# Backward Rise in the $^{16}O$-$^{12}C$ Inelastic Scattering and the Deformation of the Repulsive Core Potential.

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Strong absorption is a common observation in the case of heavy ion collision. The strong absorption characteristic arises because of the opening up of large number of reaction channels. For certain light heavy ions such as $^{12}C$ and $^{16}O$ however, weaker absorption has been observed which manifests itself in the form of the presence of fairly high lying molecular resonances as well as nuclear rainbows.For systems in this category with non identical colliding partners there has been observation of significant rise of the elastic cross section at angles larger than $90^0$ which is often accompanied by oscillatory structure. This is usually understood in terms of exchange of projectile target identity by the exchange of the residual entity made up of the differences of their masses and charges. Which can be simulated by a repulsive core potential also [1].

In the inelastic scattering of similar light heavy systems also a similar rise at the backward angles has been observed [2]. This has not been understood so far as the main model for the inelastic scattering in the collective excitation of the colliding fragments is described in terms of non-spherical optical potential[3–5] where the departure from sphericity is contained in the radius parameter, being a function of angular variable $\theta$ and $\phi$ of $\vec{r}$.

$$V(\vec{r},\xi) \equiv \sum_{\ell m} V_{\ell m}(r,\xi)[i^{\ell} Y_{\ell}^{m}(\theta,\phi)] \qquad (1)$$

The amplitude for single excitation of one of the nuclei is therefore given by,

$$T_S = i^{\ell}\beta_{\ell}\langle\chi_f^{(-)}|R_o Y_{\ell}^{m}(\theta,\phi)\frac{dU}{dr}|\chi_i^{(+)}\rangle \qquad (2)$$

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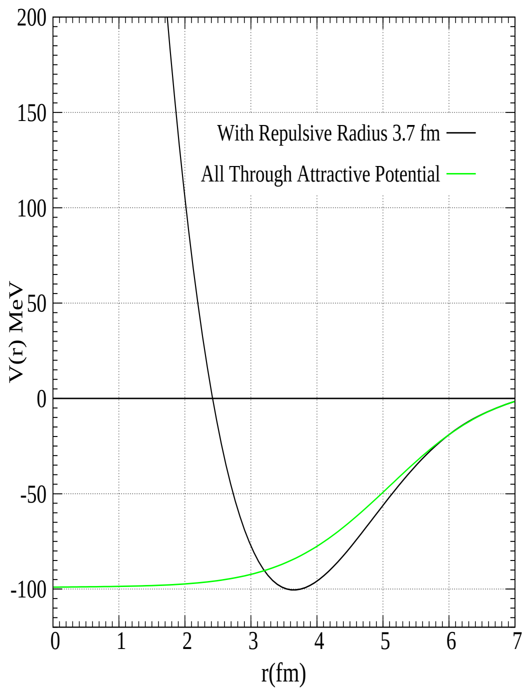


FIG. 1: Two $^{16}O$-$^{12}C$ real parts of the optical potentials used to fit elastic scattering at 132 MeV. One all through attractive potential which fits the elastic scattering at the forward angles only and the other with a repulsive core which we used to fit the forward as well as the backward regions of the elastic angular distributions.

$\beta_L$ is the deformation parameter and $R_0$ is the average radius of the potential. Here in this expression if $R_o$ is replaced by $r$ then one can use this expression when there is a distorted repulsive core present which can give inelastic scattering at backward angles Fig.1.

It is the purpose of this work to indicate that in order to explain the backward rise in the inelastic scattering one has to distort the repulsive core also. It is seen in the adjoining

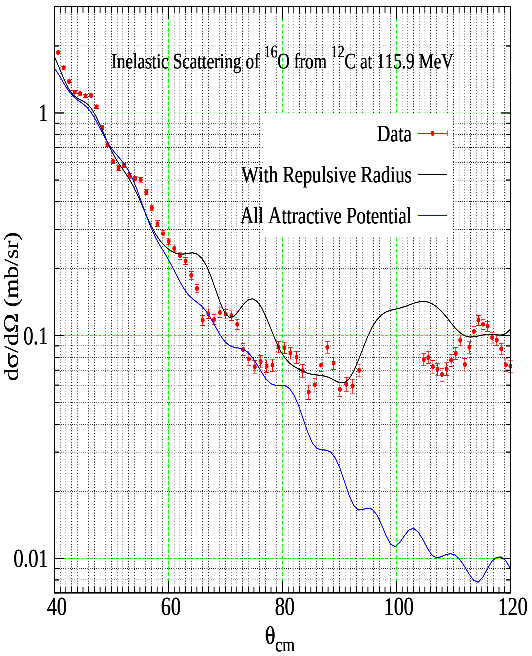


FIG. 2: Experimental inelastic scattering differential cross sections plotted for $^{16}O$ on $^{12}C$ for two $^{16}O$ excited states($3^-$ at 6.13 and $2^+$ at 6.92 MeV combined), Szilner *et al.* [2]. The fittings are using the two potentials reported in Fig.1, one fully attractive and the other with a repulsive core of radius 3.7 $fm$.

Fig. 2 that the backward rise in the $^{16}O$+$^{12}C$ inelastic scattering is nicely reproduced by the deformation of the repulsive core.

It may be puzzling to imagine that how one can deform the core but if it is taken as potential contour then the whole equipotential surface can be deformed. The good fit at the back angles for the inelastic scattering is therefore indicative of equipotential surface deformation. The data at other energies indicate that the backward rise is more pronounced for lower energy data and for higher and higher energies the backward rise goes on reducing. This is an indication that one can use this decrease in the backward rise to assess the slope of the repulsive potential in the interior of the potential energy contours.

The present work indicates that the combined study of elastic and inelastic scattering at various energies can be used as a probe of the slope of the repulsive core potential in the interiors of the potential energy contours. Besides this it makes one ponder over the fact that the whole nuclei take part in the inelastic scattering otherwise the deformation of the interior portion of the potential energy contours can not be deformed. How one gets this core deformation in a theoretical frame work is yet to be understood.

## References

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