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Analysis of elastic scattering of polarised ^{3}He with folded real and spin-orbit potentials

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Detailed analysis of the 33 MeV polarised ^{3}He elastic scattering data using phenomenological optical potentials has shown that for the best fits spin-orbit diffuseness parameter a_s of 0.3 to 0.1 fm is needed[1]. The smaller value of a_s being necessary for larger mass targets.

An attempt has been made to study the scattering using folded potentials. The real and the spin-orbit folded potentials were calculated[2] using the M3Y[3] effective interaction. The optical model code RAROMP[4] was modified to read in external potentials. It was found that, whereas the real central potential had to be normalised by about 1.1, and the re-normalisation factor needed for the spin-orbit potential was between 1.0 and 2.6. It is also possible to get an equally good fit with a re-normalisation factor for the central potential N_R=0.8. This corresponds to a volume integral of the folding potential of about 450 MeV fm^3, whereas for N_R=1.1 the volume integral is 600 MeV fm^3. The renormalised potentials are shown in Fig.1 and fits to the data in Fig.2. As can be seen the potentials are characterised by a large diffuseness, and the data are reasonably well reproduced, although the fits are not as good as those obtained using phenomenological potentials. The difference is mainly at forward angles (<60°).

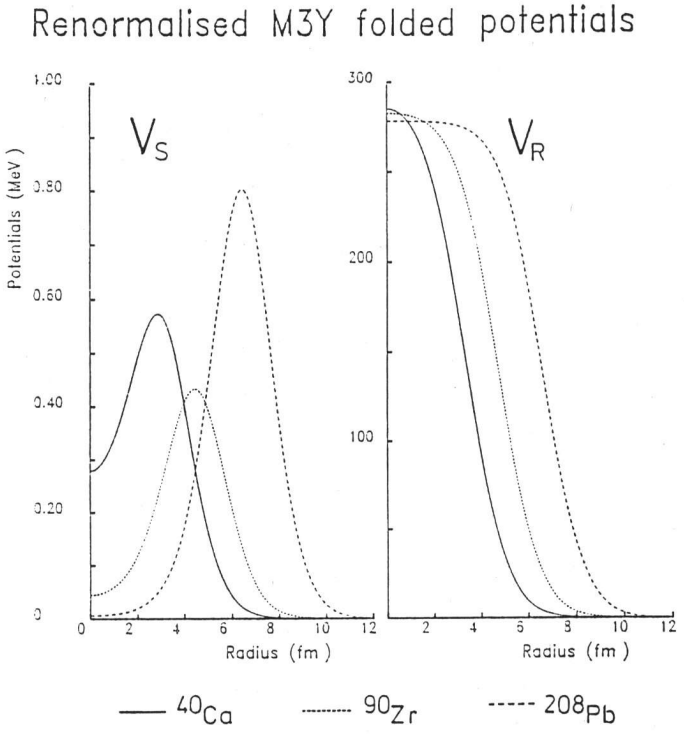

Fig.1. A comparison of the folded potential predictions with the experimental data for the elastic scattering of ^{3}He by ^{40}Ca, ^{90}Zr and ^{208}Pb at 33 MeV.

It has always been difficult to explain the small spin-orbit diffuseness parameter and the decrease in its value with increasing mass would, at first, seem to add to the problem. The calculated potentials give the physical form of the spin-orbit interaction, but the rather low energy ^{3}He projectile is unable to feel the effect of the potential other than its outermost edge. This would then lead to the phenomenological potentials of the form described above with the diffuseness decreasing as the charge of the target nucleus increases.

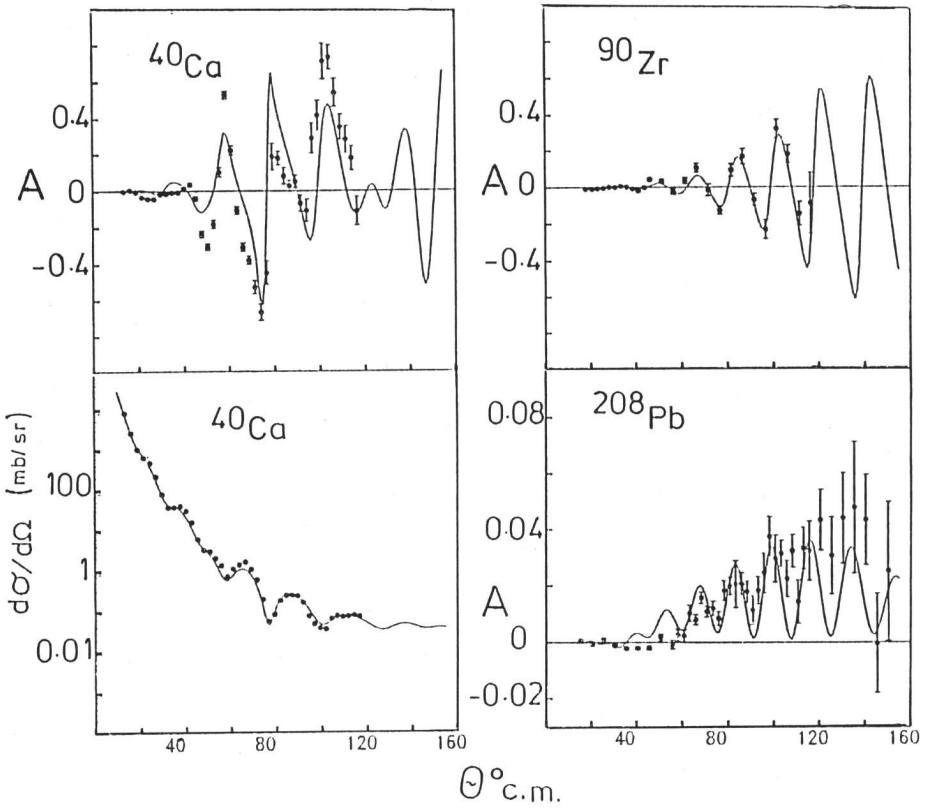

Fig. 2. A comparison of the folded potential predictions with the experimental data for the elastic scattering of ^{3}He by ^{40}Ca, ^{90}Zr and ^{208}Pb at 33 MeV

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