Elastic Scattering Between Loosely Bound p-shell Nuclei: An Update

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Last year we summarized our experimental and theoretical study of the optical model potentials involving loosely bound p-shell nuclei around 10 MeV/nucleon with the publication of a paper summarizing the results of seven earlier experiments and of a large search for double folding potentials using various effective nucleon-nucleon interactions [1]. We found that a good description of the data can be obtained with double folded potentials, provided that good care is taken to properly describe the density distributions of the two nuclei, that density dependence is included and the real part of the potential is renormalized. The data were best described using the nucleon-nucleon interaction of Jeukenne, Lejeune and Mahaux [2] that gives a real part of the potential and an independent imaginary part. Not only the depth of the imaginary potential is independent, but also its shape is different, and the procedure allows the imaginary part to be wider than the real one. The results enabled us to predict optical model potentials that successfully described elastic scattering and proton transfer reactions involving radioactive beams in the same mass region and energy [3]. In addition to that, last year we continued to work on experiments related to the subject: first we extended previous measurements with ^{7}Li at 9 MeV/nucleon on ^{9}Be and ^{13}C targets at larger angles (2_{lab} = 28°-56°), reported in [1], and then measured elastic scattering of ^{6}Li at the same energy (9 MeV/nucleon) on ^{12}C and ^{13}C targets.

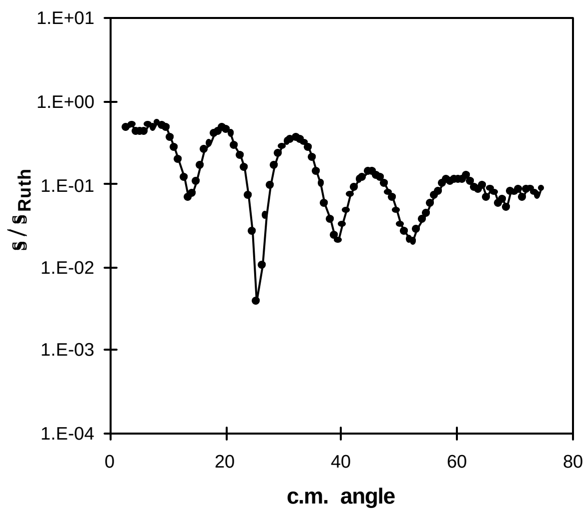

Figure 1. The angular distributions (ratio of cross section to the Rutherford cross section) for ^{6}Li+^{12}C measured at 9 MeV/nucleon incident energy.

The experimental conditions in these last two cases were similar to those of the elastic scattering experiments described in previous Progress Reports [3] and details are included in Ref. [1]. They were carried out with a ^{6}Li beam at 54 MeV provided by the K500 superconducting cyclotron and using the MDM spectrometer. Angular distributions were measured for both targets by moving the spectrometer from 2=4° to 54°. In both cases energy resolutions of the order of 120 keV and angular resolutions around 0.20° were obtained. The measurements allowed us to determine the elastic scattering angular distributions for broad angular ranges: 2_{cm}=5°-75°. They are shown in

Figure 1. The data show the typical Fraunhoffer diffraction pattern, without much absorption setting in, or the rainbow scattering observed for ^{7}Li at 18 MeV/nucleon on the same targets ([1], Fig. 2). The data look very similar for the scattering on the two targets, as expected given the fact that they only differ by one neutron.

A phenomenological analysis of the data using optical model potentials of Woods-Saxon volume form for both the real and imaginary parts was done. The results are given in Table I.

Table I. The parameters of the phenomenological optical model potentials for ^{6}Li (54 MeV)+^{12,13}C. Only volume terms of Woods-Saxon form were considered in the analysis.

	V [MeV]	W [MeV]	r_V [fm]	a_V [fm]	r_w [fm]	a_w [fm]
^{12}C	67.54	19.24	0.98	0.63	0.99	0.94
	126.1	19.28	0.86	0.66	1.07	0.81
	190.3	23.2	0.81	0.64	1.01	0.84
^{13}C	66.95	19.46	0.99	0.63	1.01	0.94
	125.5	19.76	0.85	0.68	1.08	0.81
	189.4	24.0	0.80	0.66	1.01	0.86

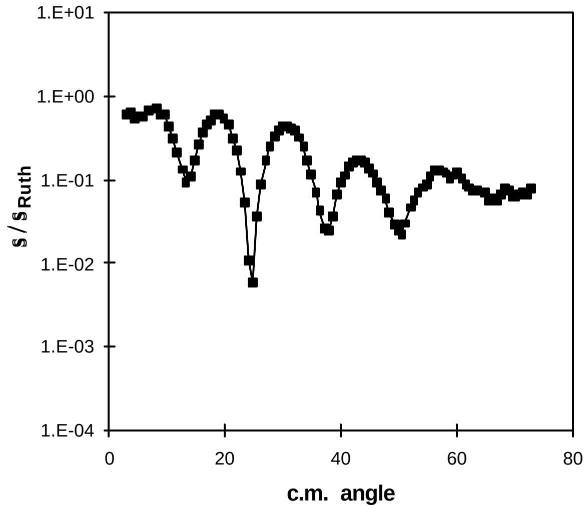

Figure 2. Same as Figure 1, for ^{6}Li+^{13}C.

References

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