OPTICAL MODEL ANALYSIS OF ELASTIC DEUTERON SCATTERING AT 80 MeV

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Using Peter Schwandt's Code SNOOPY8Q,[1] "best fit" optical model potential parameters have been obtained for each of the data sets summarized in Table I for which there is analyzing power data. Large angle analyzing power data is found to be particularly important in constraining parameter selection. In fact, this data forces the use of a Woods-Saxon squared shape for the real central potential and the use of an imaginary spin-orbit term of the Thomas form. The effect on the comparison between the "best fit" calculated cross-section and analyzing power and the data is exemplified in the case of ^{206}Pb in Fig. 1 for the normal Woods-Saxon (WS) shaped potential for a Woods-Saxon squared (WS*2) shape and for the Woods-Saxon squared shape plus imaginary spin-orbit potential (WS*2-SO). Table II lists the potential parameters and χ^2 per point for each case.

TABLE I.

Elastic Deuteron Scattering Data Near Eα = 80 MeV

	^{12}C	^{28}S	^{40}Ca	^{58}Ni	^{116}Sn	^{206}Pb	^{208}Pb
Sigma	9	64	48	89	36	59	87
A_y	9			89	36	59	28
A_{yy}	9			61			
Total # of Pts.	27	64	48	239	72	118	115
Sigma Range (DE6)	23-89	7-93	7-91	8-112	8-60	13-131	8-91
A_y Range (DE6)	23-89			8-112	8-60	13-131	14-54
A_{yy} Range (DE6)	23-89			8-112			

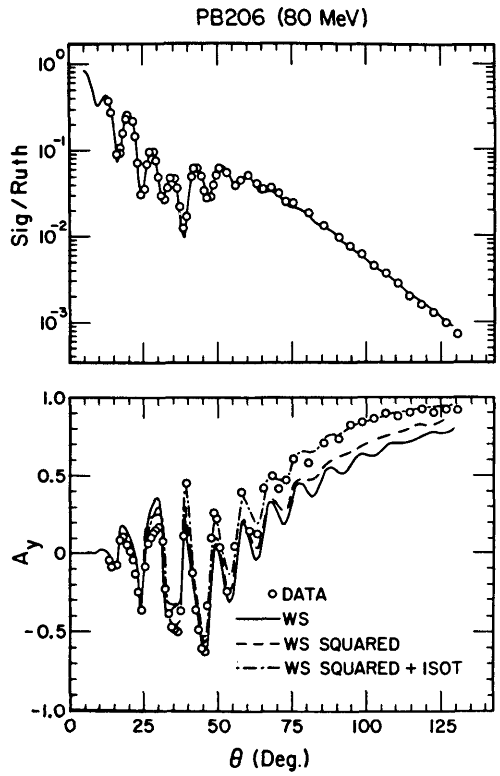

Figure 1. Cross section and analyzing power measurements for elastic scattering of 80 MeV deuterons from ^{206}Pb. The curves represent different optical model parameterizations and are described in the text.

Figure 1 shows that the calculated large angle analyzing powers fall successfully less far below the measured values for the WS*2 and WS*2-SO cases while the quality of agreement between the calculated and measured cross-section angular distribution is not visually changed. However, it is clear from studying the χ-squared per point values in Table II that both cross section and A_y angular distributions are systematically better fit by the WS*2-SO potential for each data set.

Improvement of goodness-of-fit (χ^2) by factors of 3 to 10 over the "best fit" Woods-Saxon (WS) potential for all cases (^{12}C, ^{58}Ni, ^{116}Sn, ^{206}Pb, ^{208}Pb) tried, indicates that a Woods-Saxon squared potential shape and an imaginary spin-orbit potential term of the Thomas form are important, if not unique, for a good representation of elastic deuteron scattering data at energies as high as 80 MeV.

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1) SNOOPY8Q, Optical Model Code for Elastic Scattering Analyses, P. Schwandt, IUCF Report No. 82-3, Sept. 15, 1982.

TABLE II

SUMMARY OF OPTICAL MODEL PARAMETERS

^{12}C 79.41 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	WSO	RWS	AWS	RC	X*2TOT/PT
Global WS	70.16	1.17	.844	6.67	7.59	1.325	.676	5.027	1.07	.66				1.3	88.90
Best Fit WS	73.31	1.171	.742	7.61	9.51	1.348	.586	5.783	.92	.722				1.3	56.77
Best Fit WS*2	72.55	1.499	.493	5.75	7.93	1.361	.614	5.286	.844	.683				1.3	7.53
Best Fit WS*2-SO	72.54	1.512	.49	5.89	7.89	1.391	.596	4.433	.933	.616	-.811	.696	.5	1.3	5.58

^{28}S 79.2 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	RC	X*2TOT/PT
Global WS	71.96	1.17	.84	6.64	7.61	1.325	.742	5.033	1.07	.66	1.3	26.08

^{40}Ca 79.2 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	RC	X*2TOT/PT
Global WS	73.05	1.17	.844	6.64	7.61	1.325	.729	5.033	1.07	.66	1.3	27.73

^{58}Ni 79.5 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	WSO	RWS	AWS	RC	X*2TOT/PT
Global WS	74.07	1.17	.845	6.75	7.53	1.325	.786	5.01	.07	.66				1.3	85.86
Best Fit WS	69.4	1.216	.76	4.22	9.54	1.318	.763	5.731	1.015	.814				1.3	26.73
Best Fit WS*2	75.71	1.407	.552	4.89	7.92	1.294	.892	5.921	.957	.853				1.3	18.39
Best Fit WS*2-SO	80.72	1.378	.58	4.72	7.96	1.257	.934	5.697	.938	.828	-1.239	.603	.5	1.3	8.31

^{116}Sn 79.04 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	WSO	RWS	AWS	RC	X*2TOT/PT
Global WS	76.78	1.17	.843	6.62	7.64	1.325	.871	5.039	1.07	.66				1.3	135.35
Best Fit WS	77.14	1.165	.852	7.18	7.62	1.291	.891	5.729	1.136	.447				1.3	42.07
Best Fit WS*2	88.73	1.3	.676	6.03	7.55	1.193	1.18	7.108	1.035	.559				1.3	16.74
Best Fit WS*2-SO	88.69	1.3	.676	.6	7.56	1.189	1.184	7.71	1.031	.582	-.19	.803	.5	1.3	16.06

^{206}Pb 79.35 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	WSO	RWS	AWS	RC	X*2TOT/PT
Global WS	80.09	1.17	.844	6.66	7.6	1.325	.929	5.029	1.07	.66				1.3	155.92
Best Fit WS	80.05	1.182	.843	5.95	9.29	1.298	.86	5.067	1.052	.837				1.3	99.75
Best Fit WS*2	89.05	1.311	.638	7.14	7.6	1.291	.967	5.988	1.063	.758				1.3	65.48
Best Fit WS*2-SO	88.98	1.306	.632	6.7	7.86	1.282	.99	5.512	1.023	.755	-.744	.859	.5	1.3	9.06

^{208}Pb 79.2 MeV	V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	WSO	RWS	AWS	RC	X*2TOT/PT
Global WS	80.09	1.17	.844	6.64	7.61	1.325	.905	5.033	1.07	.66				1.3	65.87
Best Fit WS	79.42	1.183	.85	6.74	8.18	1.301	.891	4.314	1.138	.508				1.3	57.54
Best Fit WS*2	87.42	1.314	.631	6.97	7.23	1.285	1.041	5.567	1.094	.614				1.3	38.86
Best Fit WS*2-SO	87.43	1.314	.63	7.01	7.23	1.283	1.044	5.582	1.075	.649	-.238	.909	.5	1.3	5.87

Global parameters are from W.W. Daehnick, J.D. Childs, and Z. Vrcelj, Phys. Rev. C21, 2253 (1980). Parameters are for non-relativistic kinematics.

WS = Woods-Saxon, WS*2 = Woods-Saxon Squared, SO = Imaginary Spin-Orbit, X*2 = Chi Squared, X*2/PT = Chi Squared Per Data Point.