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Calculation of Resonance Self Shielding in U^{235}

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CALCULATION OF RESONANCE SELF SHIELDING IN U^{235}

E. F. Plechaty and D. E. Cullen

Analytic and Monte Carlo calculations of the Bramblett-Czirr⁽¹⁾ U^{235} transmission experiment have been completed. The ENDF/B-III⁽³⁾ cross sections replaced those in ENDF⁽⁴⁾ for the isotopes, reactions and energy ranges given in Table I.

TABLE I

<u>Isotope</u>	<u>Reaction</u>	<u>Energy Range (MeV)</u>
U^{235}	elastic	0 to .00019
	fission	0 to .0001
	n, γ	0 to .000082
U^{238}	elastic	0 to .001
	n, γ	0 to .001

The Czirr-Bramblett experiment gives the ratio of the number of fissions with the U^{235} target in to the number with the target out. The secondary fissions in the target do not contribute to experimental results (see Fig. 1 for simulated experimental configuration). As pointed out by Czirr, the experimental configuration allows only the uncollided flux to reach the detector; hence the number of fissions from the uncollided flux as a function of depth can be calculated from

$$\int_{E_g}^{2.15 E_g} \frac{\Sigma_f(E) - \Sigma_t(E)}{E} e^{-\Sigma_t(E)x} dE \quad (1)$$

where Σ_t and Σ_f are respectively the total and fission microscopic cross sections, and E_g is energy of lower group bound.

Results of calculations using Eq. (1) agreed with the 2000 group TART⁽²⁾ calculations over all energy ranges and target thicknesses. Table II gives the results of experiment and the Monte Carlo calculations. Figure 2 gives the experimental and the results from Eq. (1). Figure 3 is a plot of the U^{235} cross section data for fission and total cross sections.

Conclusion

In view of the agreement between the analytic and Monte Carlo calculation it appears that the ENDF/B-III U^{235} cross sections are inadequate to calculate the Czirr-Bramblett experiment. The reactor community has observed the same problem using the ENDF/B-III cross sections in this energy range. The U^{235} cross sections have been revised for ENDF/B-IV. When ENDF/B-IV is available this calculation will be redone.

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Table II

g/cm ²	Exp	Calc	% Error	Exp	Calc	% Error	Exp	Calc	% Error
THICKNESS	GROUP ENERGY			GROUP ENERGY			GROUP ENERGY		
	<u>.464 — 1.0 eV</u>			<u>1.0 — 2.15 eV</u>			<u>2.15 — 4.64 eV</u>		
.141	.983	.969	- 1.42	.942	.970	+ 2.97	.975	.978	+ .31
.260	.937	.945	+ .85	.949	.948	- .1	1.0	.963	-3.7
.504	.880	.896	+ 1.82	.895	.898	+ .34	.903	.928	+2.77
.794	.848	.839	- 1.06	.821	.843	+ 2.68	.876	.892	+1.83
1.968	.662	.651	- 1.66	.661	.661	0	.788	.763	-3.17
3.852	.462	.428	- 7.36	.453	.467	+ 3.09	.585	.597	+2.05
9.473	.152	.126	-17.1	.199	.191	- 4.52	.316	.325	+2.85
19.04	.028	.017	-39.3	.072	.064	-11.11	.147	.144	-2.05
THICKNESS	<u>4.64 — 10.0 eV</u>			<u>10.0 — 21.5 eV</u>			<u>21.5 — 46.4 eV</u>		
	Exp	Calc	% Error	Exp	Calc	% Error	Exp	Calc	% Error
.141	.867	.881	+ 1.61	.878	.878	0	.937	.933	- .43
.260	.800	.800	0	.790	.807	+ 2.15	.874	.886	+ 1.37
.504	.646	.677	+ 4.80	.655	.675	+ 3.05	.755	.807	+ 6.89
.794	.525	.566	+ 7.81	.551	.576	+ 4.54	.704	.723	+ 2.70
1.968	.345	.345	0	.364	.382	+ 4.94	.466	.501	+ 7.51
3.852	.192	.214	+11.5	.249	.260	+ 4.42	.280	.320	+14.3
9.473	.073	.091	+24.7	.095	.113	+18.9	.100	.129	+29.0
19.04	.027	.034	+25.9	.038	.038	0	.030	.042	+40.0

Table II (contd)

g/cm^2	Exp	Calc	% Error	Exp	Calc	% Error	Exp	Calc	% Error
	GROUP ENERGY			GROUP ENERGY			GROUP ENERGY		
THICKNESS	<u>46.4 — 100 eV</u>			<u>100 — 215 eV</u>			<u>215 — 464 eV</u>		
.141	.976	.962	- 1.43	.983	.983	0	.988	.985	- .30
.260	.924	.931	+ .76	.945	.966	+ 2.22	.956	.973	+ 1.78
.504	.842	.873	+ 3.68	.898	.937	+ 4.34	.930	.949	+ 2.04
.794	.758	.813	+ 7.26	.826	.905	+ 9.56	.926	.921	- .54
1.968	.589	.622	+ 5.60	.666	.787	+18.2	.779	.822	+ 5.52
3.852	.375	.428	+14.1	.528	.622	+17.8	.621	.676	+ 8.86
9.473	.118	.188	+59.3	.233	.332	+42.5	.336	.395	+17.6
19.04	.039	.062	+58.9	.090+.01	.120	+33.3	.155	.163	+ 5.16
	<u>464 — 1000 eV</u>			<u>1000 — 2150 eV</u>					
.141	1.011	.989	- 2.18	.995	.992	+ .30			
.260	.988	.980	- .81	.941	.986	+ 4.78			
.504	.945	.962	+ 1.80	.973	.973	0			
.794	.942	.941	- .11	.921	.957	+ 3.91			
1.968	.786	.858	+ 9.16	.847	.900	+ 6.25			
3.852	.676	.744	+10.1	.779	.811	+ 4.11			
9.473	.433	.483	+11.5	.541	.596	+10.2			
19.04	.231	.239	+ 3.46	.299	.353	+18.1

FIGURE 1

Figure 2

Figure 3

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