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Cross Section Data of Cadmium

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January 1967

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1. Introduction

Cadmium is one of the well known materials in thermal reactor technology. It finds application as control rod material and in connection with flux detection with foils for the determination of the cadmium ratio. In these applications a very accurate knowledge of the cross section is not necessary. In the last few years, however, cadmium has been used frequently as a resonance absorber in spectrum experiments with homogeneously poisoned liquid moderator assemblies. Such experiments have been performed at the EIR as a check for different thermalization models. The precision of the absorption cross section required for the interpretation of measured spectra in poisoned assemblies is much higher than in the previously mentioned applications. In particular difficulties in the choice of the Cd-input data for the spectrum calculations have been encountered. Furthermore, Cd would be a useful standard for absolute absorption cross section measurements below 1 eV both in integral (danger coefficient or oscillator) measurements or in differential (chopper-time of flight) experiments, since its scattering cross section is very small compared to its σ_t .

In this short note a compilation of the cross section data in the thermal energy range is given and a discrepancy in this data is pointed out.

2. Thermal Cross Sections of Cadmium

Very few total cross section measurements in the thermal energy range have been published. The data of interest are collected in table I. The measurements of the absorption cross section are not listed because they are less accurate. They are tabulated in reference [6].

A first curve of total cross sections measured with good resolution has been published by RAINWATER et al [1]. The measurements have been performed with the Columbia pulsed cyclotron in the energy range from 0.01 eV to 2.1 eV. A value of $\sigma_t = 2440$ barn at 0.0253 eV is read from Columbia's original curve, which is in agreement with the value of 2420 barn calculated from the resonance parameters of the first resonance at 0.178 eV. The cross section σ_0 in the resonance given in Ref. [1] is 7200 ± 200 barn. BROCKHOUSE [2] published his results of measurements of the ratio σ_s/σ_a with a crystal spectrometer in 1953. He gave total cross sections at some selected energy points. For σ_0 in the resonance he gave 7800 ± 150 barn. In BNL 325 [3] the curve of Columbia [1] is given over the thermal energy range, normalized to the BROCKHOUSE data [2] at 0.178 eV. Later SOKOLOWSKY [4] has found a value of 2460 ± 25 b at 0.0253 eV. A recent measurement with the EIR chopper facility resulted in $\sigma_t = 2455 \pm 10$ b [5].

In the very new Supplement to BNL 325 [6] a value of 2450 ± 30 b is recommended for the (n,γ) cross section at 0.0253 eV. As the scattering cross section at this energy is 7 b [2] this recommended value is in good agreement with the data listed in table I. But there exists an inconsistency with the cross section curve in reference [3]. It appears that the normalization of the Columbia data [1] to the BROCKHOUSE values [2] is not justified at least in the energy range around 0.0253 eV.

3. Resonance Parameters of the 0.178 eV Resonance in Cadmium

The resonance parameters of the 0.178 eV resonance in cadmium are collected in table II. One immediately recognizes that there exist two groups of results for σ_0 . Two measurements performed with crystal spectrometers group around a high value of $\sigma_0 \cong 7800$ b. The second group of results obtained with the time of flight spectrometers center around a value of $\cong 7300$ b. The error limits of these two groups do not overlap. This comparison reveals a real discrepancy in a cross section of great interest.

The Turkish data [7] are gained from a recent and careful experiment with a crystal spectrometer which was undertaken in order to clarify this discrepancy. But the preliminary measurements in our institute [5] with a chopper installation resulted in a confirmation of the low values. As they have been started with the aim of clearing up the discrepancy mentioned all precautions have been taken to limit the errors to a minimum.

4. Conclusion

A compilation of the thermal cross section data of cadmium revealed an inconsistency between the cross section values given for 0.0253 eV and the cross section curve in the thermal energy range as they are recommended in BNL 325 references [6] and [3]. At the same time a real discrepancy appears in the cross section data around the peak of the first resonance at 0.178 eV which is often used as a non $1/v$ poison in spectrum experiments. It is therefore proposed that new efforts are started to clarify this unsatisfactory situation.

TABLE I

Total cross section of cadmium at 0.0253 eV in barn

σ_{tot}	Method	Sample	Reference
2420	pulsed cycl.	metal plates	[1] 1947
2456 \pm 30	fast chopper	D ₂ O solutions	[4] 1964
2460 \pm 40	fast chopper	metal plates	
2455 \pm 10	slow chopper	Cd and S powder mixture	[5] 1966

TABLE II

Resonance parameters of the 0.178 eV resonance in cadmium

E_0 (eV)	σ_0 (barn)	Γ (mV)	J	Γ_γ (mV)	$a \Gamma_n$ (mV)	Re- ference
0.176 \pm 0.002	7200 \pm 200	115 \pm 2	1		0.0791 \pm 0.0032	[1] 1947
0.180 \pm 0.003	7800 \pm 150	113 \pm 2				[2] 1953
0.178	7350					[4] 1964
0.181 \pm 0.003	7847 \pm 187	108.7 \pm 3.3				[7] 1965
0.175 \pm 0.002	7250 \pm 50					[5] 1966
0.178 \pm 0.002		114 \pm 2	1	113 \pm 5	0.0797 \pm 0.0025	recommended [6] 1966

$$a = 0.1226 ; \quad g = 3/4$$

References

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