Total Neutron Cross Sections of Chlorine and Carbon*

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Using CCl_4 in good geometry, $Li^7(p,n)$ neutrons and a pressurized hydrogen counter, σ_t(Cl) has been measured by the transmission method from 0.4 to 1 Mev at 30-kev intervals and from 0.15 to 0.75 Mev at 2-kev intervals.

THE total neutron cross section of chlorine has been measured at Columbia by time-of-flight techniques up to about 300-ev neutron energy.[1] Aoki[2] obtained values of 2.66 to 2.84 barns in the energy range from 2.2 to 2.85 Mev. Zinn *et al.*[3] obtained 3.42 barns at 2.85 Mev, and Sherr,[4] using $C^{12}(n,2n)$ as a threshold detector, obtained 1.88 barns at 25 Mev. Snowdon[5] has recently made measurements from about 100 kev to 500 kev with 40-kev resolution.

Using the $Li^7(p,n)$ reaction and the Rockefeller

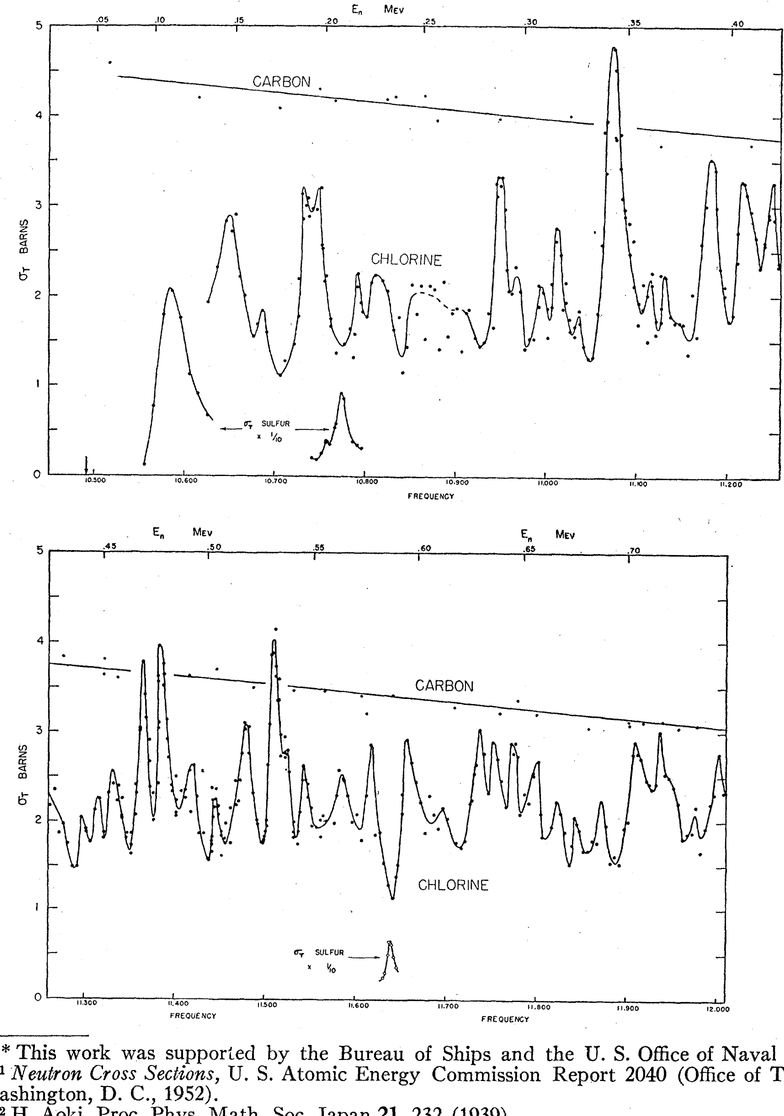

FIG. 1. Total neutron cross section of chlorine and carbon *vs* incident neutron energy in the laboratory coordinate system (upper scale) and *vs* frequency of proton resonance magnet control in megacycles (lower scale). Carbon tetrachloride contained in a thin-walled iron cylinder (7.5×2.6 cm) was used in the chlorine measurements. Correction for carbon content was made from similar measurements for a number of the same frequency settings using a graphite cylinder (2.5×2.5 cm) as a scatterer. The three resonance peaks of sulfur, plotted at $\frac{1}{10}$ scale for σ_t, were used as secondary energy calibrations and as an over-all check on the experimental method.

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[1] *Neutron Cross Sections*, U. S. Atomic Energy Commission Report 2040 (Office of Technical Services, Department of Commerce, Washington, D. C., 1952).
[2] H. Aoki, Proc. Phys. Math. Soc. Japan **21**, 232 (1939).
[3] Zinn, Seely, and Cohen, Phys. Rev. **56**, 260 (1939).
[4] R. Sherr, Phys. Rev. **68**, 240 (1945).
[5] S. C. Snowdon and W. D. Whitehead, Phys. Rev. **90**, 615 (1953).

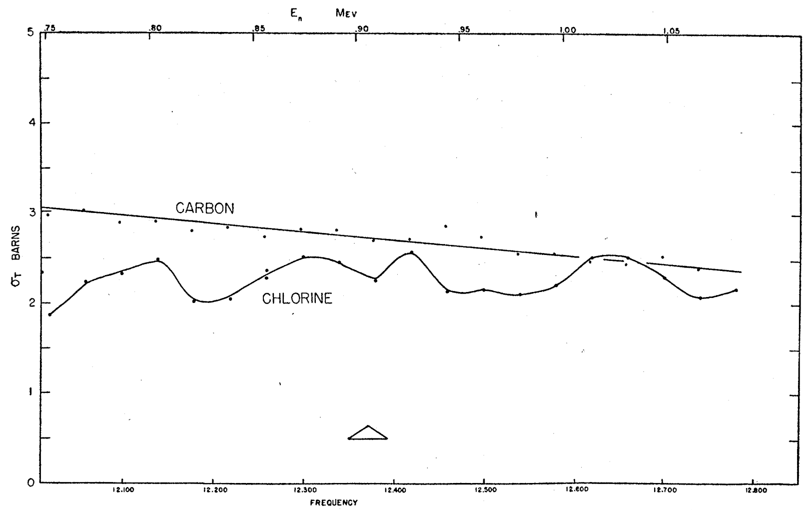

FIG. 1 (*continued*).

generator as a neutron source, and CCl_4 as a scatterer, σ_t(Cl) was measured in good geometry at approximately 2-kev intervals from 150 kev to 750 kev. The targets used were 2 to 4 kev thick at the lower neutron energies. From 750 kev to 1.1 Mev, the resolution was approximately 25 kev.

The detector was a pressurized (70-psi) hydrogen recoil counter,[6] the bias voltage of which was changed continuously to cut out low energy neutron background. Two BF_3 counters, at 15° and 90°, served to monitor the neutron beam, in addition to proton current integration. Corrections were made for the carbon in the CCl_4 by measuring the total cross section of carbon, using graphite as a scatterer. Corrections have also been made for the thin-walled iron tube used as a container.

Assuming isotropic scattering in the center-of-mass system, the scattering-in correction was less than one percent. Figure 1 summarizes the results. Though it is impossible to distinguish between the different isotopes of Cl (24.6 percent Cl^{37}, 75.4 percent Cl^{35}) the average level spacing is ~14 kev, in accord with the high level density expected for odd-odd compound nuclei. It is felt that many of the resonances are not yet resolved, and a few small energy regions need more work. The average cross section observed, $\sigma_t(\mathrm{Cl}) \approx 2.5$ barns, is relatively low compared to neighboring elements.

Energy calibration of the proton resonance controlled magnetic analyzer was made using the $Li^7(p,n)$ threshold at $E_p = 1.882$ Mev.[7] As an operational check, a few of the resonances of sulfur were done simultaneously with the chlorine. The sharp resonances in sulfur[8] not only lend themselves as secondary energy calibrations, but also give a measure of the experimental resolution, see Fig. 1. The sixth resonance in sulfur was also used to test the experimental reproducibility and as a guage of the thickness of the targets as shown in Fig. 2.

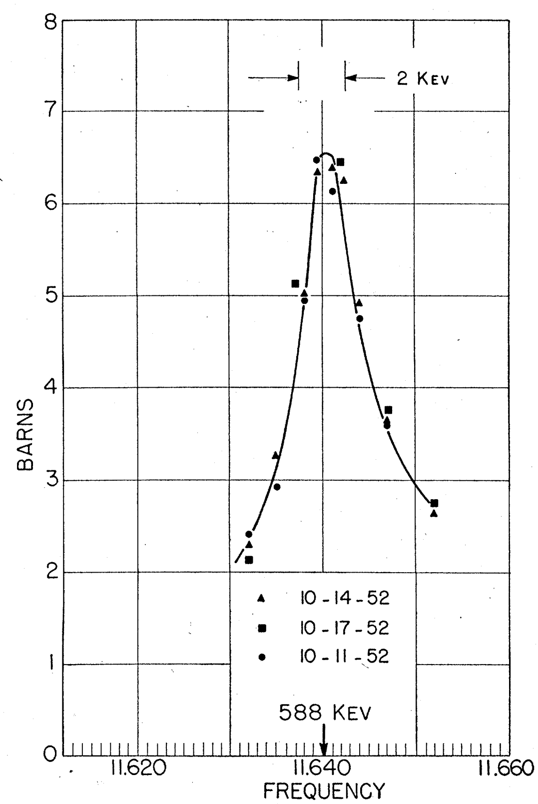

FIG. 2. Repeated measurements on a major resonance of sulfur (observed as 588 kev relative to the $Li^7(p,n)$ threshold which was reported by Peterson *et al.* (reference 8) as 585 kev). During an interval of 2 months, the data fall on the same resonance curve within the statistical uncertainty of the measurements.

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[6] F. S. Replogle, Servomechanisms Engineering Memo No. 29, Massachusetts Institute of Technology, March 18, 1952 (unpublished).
[7] Herb, Snowdon, and Sala, Phys. Rev. **75**, 246 (1949).
[8] Peterson, Barschall, and Bockelman, Phys. Rev. **79**, 593 (1950).