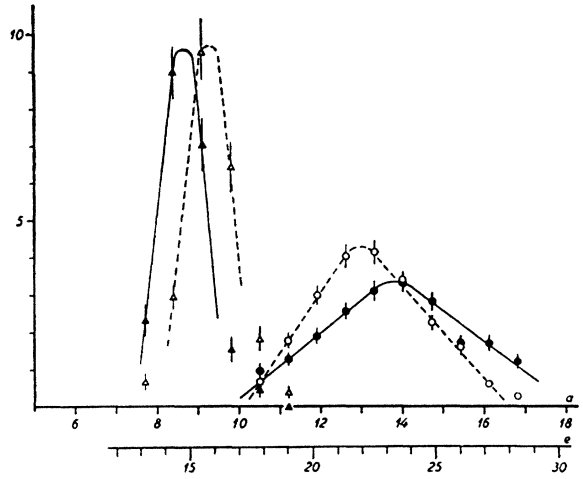

FIG. 1. Distribution of deflection of fission fragments. Abscissa: Deflection $a = \text{const.} \times e/mv$. Approximate scale of e below. Circles refer to fragments having traversed a thin Be layer and emerging into vacuum. Triangles refer to fragments emerging into argon at a pressure of 0.9 mm. White and black points correspond to the light and heavy fragments, respectively.

As an example Fig. 1 shows the result of two measurements, one giving the charges in beryllium, the other giving the charges in argon. Only small differences were found between the charges in various solid stopping media or between the charges in various gases, but, as is seen, the charges are much lower in gases than in solids. In gases the light fragment has the higher charge, opposite to what is the case in solids. This order of the charges is in agreement with previous determinations of the effective charges from ionization measurements.[3,4] The latter charges were somewhat higher than the values now obtained, but at least part of the difference may be accounted for as due to a dependence of the charge on pressure, see below. The difference between the widths of the distribution curves in gases and in solids gives an nteresting illustration of the fluctuation of the charges. With a gas at a sufficiently high pressure in the chamber many interchanges of charge occur along the path, and the deflection is determined merely by the mean value taken over the part of the range considered.

Figure 2 gives the most frequent deflections obtained for various pressures of argon in the chamber. As mentioned, the initial values of the deflections correspond to the most frequent charges

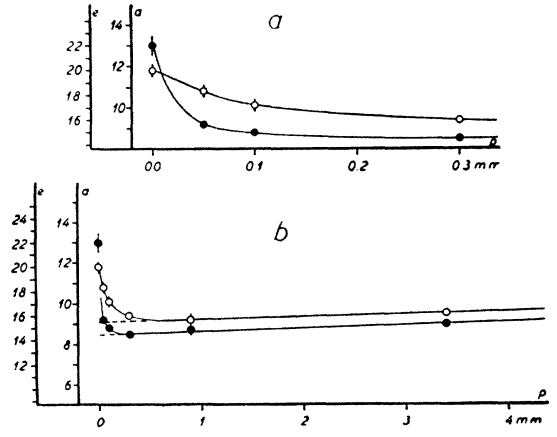

FIG. 2. Most frequent deflections of fission fragments *vs.* pressure of argon in the deflection chamber. Open and full circles refer to the light and heavy fragments, respectively.

in uranium, and the deflections for a pressure ~1 mm or argon correspond to the equilibrium charges in argon. The rate of decrease of the deflections for increasing pressure between 0 and 0.5 mm is determined by the rate with which the charges decrease due to capture of electrons. The cross sections estimated from the curves are in rough agreement with theory; they are of the order of magnitude 10^{-16} cm².

The curves are not horizontal for pressures above 1 mm. Since, as was shown by direct measurements, the charge varies in the beginning of the range very nearly proportional to the velocity, the increase of the deflection can only be caused by an increase of e with increasing pressure. The increase is rather small but safely outside the limits of error; it is found for both fragments in a number of gases investigated. An attempt has been made to follow the increase of the charges up to higher pressures. The rate of increase is found to be markedly smaller for $p > 10$ mm of argon. It is planned to examine the charges at much higher pressures.

The experiments reveal a marked difference between the mechanism of electron capture and loss in solid and gaseous materials. In particular, the dependence of the mean charge on gas pressure shows that excited states of the fragment ions with lifetimes comparable with intervals between successive collision play an essential part in the phenomenon. A theoretical treatment of electron capture and loss with special reference to these points will be given in a paper by N. Bohr and J. Lindhard to appear in the *Communications of the Danish Academy of Science*. Also, a detailed paper on the present experiments with a closer discussion of the observations will be published shortly.

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Improved Map of the Solar Spectrum between 9 and 10μ*

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DURING the mapping program of the infra-red solar spectrum being carried out at the Ohio State University the 9 to 10μ region has recently been investigated with a 3600-line/inches replica echelette grating and the apparatus described in a previous communication.[1] Figure 1 is a composite diagram of the best records so far obtained, the most prominent absorption in this region being a band of ozone, the center of which occurs near 9.58μ. Comparison with the solar spectrum taken by Adel[2] in this region shows that many lines have now been resolved into doublets.

A weak band of carbon dioxide near 9.4μ partially overlaps the ozone band and the frequencies of the rotational lines of the band have been measured in the laboratory by Barker and Adel.[3] Many of these lines have also been observed in the solar spectrum by Adel,[4] who found a maximum absorption of eight percent for the strongest lines in spectra taken in December, 1940 at Flagstaff, Arizona.

The observations taken at Columbus, Ohio, with a solar altitude of 60° show a maximum absorption of 20 percent for the strongest lines. Comparison of CO_2 lines in our solar spectrum, in regions where there are no other obscuring lines, with the laboratory data of Barker and Adel show a small (0.2 cm^{-1}) systematic difference in frequency. In Fig. 1 this difference has been added to the values of Barker and Adel and the frequencies thus obtained are indicated by arrows, the lengths of the arrows giving the relative intensities of the lines.

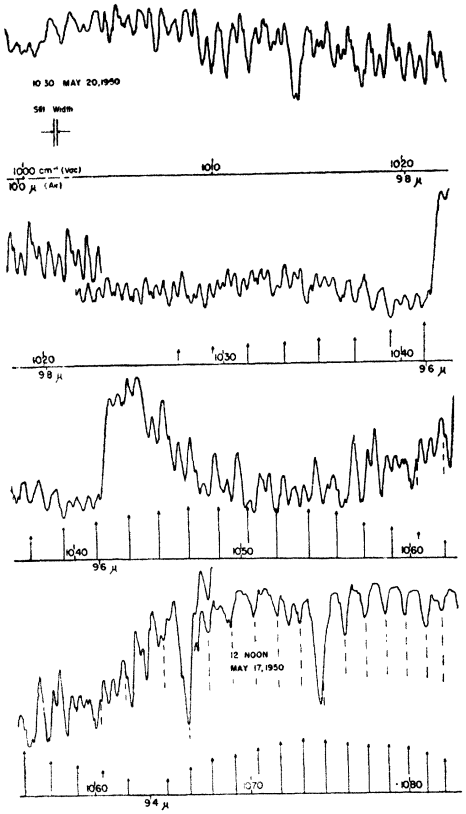

FIG. 1. The ozone band at 9.6μ in the solar spectrum.

It is not yet known whether other bands contribute to the absorption in this region or whether the structure, apart from the comparatively weak CO_2 lines, is entirely due to ozone.

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Neutron Scattering Resonances of Lithium*

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IT has been noted that lithium, in contrast to most elements, scatters slow neutrons with a positive phase shift or a negative scattering length.[1] Since such behavior may be associated with the presence of a virtual level near threshold, it seemed interesting to search for such a level by measuring the total neutron cross section of lithium as a function of energy.

The cross section was determined in a manner similar to that described for sodium.[2] Measurements were made from 20 to 1400 kev with a neutron energy spread of about 20 kev. Elastic scattering is presumed to be the only process contributing appreciably to the cross section. The cross section near an isolated resonance for the scattering of neutrons with unit orbital angular momentum to form a compound state of spin J will then equal:

$$[(2J+1)/2(2I+1)](4\pi/k^2)\sin^2\delta_{lJ}$$

where

$$\delta_{lJ}=\tan^{-1}(\Gamma_{lJ}/E_r-E)+\varphi_l$$

is the neutron phase shift. Γ_{lJ} is the width of the resonance and E_r is the resonance energy. I is the spin of the target nucleus and k is the neutron wave number. φ_l is equal to the phase shift associated with hard sphere scattering. This will be equal to $-ka$ for $l=0$ where a is the nuclear radius and will be negligible in this experiment for higher l-values. The total cross section is then equal to the sum over l and J values of these partial cross sections.

Figure 1 shows the total cross section of lithium. Since the spin of Li^7 is $\frac{3}{2}$ of the peak cross section should equal $[(2J+1)/8]4\pi k^{-2}$ times the isotopic abundance of Li^7 (92.5 percent). The height of the 270-kev peak is then only compatible with $J=2$. If the peak were the result of the interaction of S-neutrons a dip should be observed, either before or after the peak, due to interference between resonance scattering and background scattering. Following Wigner[3] it is convenient to write the width Γ of a level as $\Gamma_l=2k\gamma^2T_l$ where T_l is the centrifugal potential barrier for l-neutrons. The reduced width, γ^2, is then energy independent. The width of the 270-kev level was measured to be 45 kev. If the resonance were caused by D neutrons the reduced width would be greater than $3\hbar^2/2ma$ where m is the mass of the neutron. This violates a completeness relation of Wigner.[3] These considerations lead us to attribute the peak to the interaction of P neutrons with Li^7 to form an excited state of Li^8 with spin 2. The reduced width of this level is then $(\Gamma/2k)[(ka)^2+1]/(ka)^2$, or $3.5\cdot10^{-13}$ Mev cm. Because of the centrifugal barrier for P-neutrons this level will have no effect on the low energy cross section.

This 270-kev resonance coincides with a peak in the $Li^6(n,\alpha)$ cross section.[4] It seems possible that some of the alpha-particles contributing to this peak are the result of the $Li^7(n,\gamma)Li^8$ reaction, where Li^8 decays with a half-life of 0.87 sec. to excited states of Be^8 which immediately break up into two alpha-particles.[5]

The rise in cross section to 1.6 barns at 1400 kev is explained as being mainly due to a broad elastic scattering resonance. The shape of a broad level is complicated by the variation of Γ and φ_l with energy as well as by the $1/E$ dependence of the cross section [Eq. (1)]. A qualitative fit to the experimental results could be obtained only by attributing the rise to the resonant interaction of S-neutrons to form a state of spin 2 in Li^8 at a neutron energy of about 1.15 Mev. Inelastic scattering to the 480-kev excited state of Li^7 would tend to reduce the observed cross section. The results are best fitted by assuming the inelastic scattering width is small. The width at resonance of this level was taken as 2.4 Mev, leading to a reduced width, $\Gamma/2k$ of $5.6\cdot10^{-13}$ Mev cm. Taking the binding energy[6] of a neutron to Li^7 as 2.03 Mev, these levels lie 2.27 and 3.03 Mev above the ground state.

The S-wave resonance will have a large influence on the scattering at low energies. In this connection it is convenient to speak of the coherent scattering length l, the average of $-\delta/k$, over isotopes and spin orientations. Using Eq. (2) for δ and neglecting

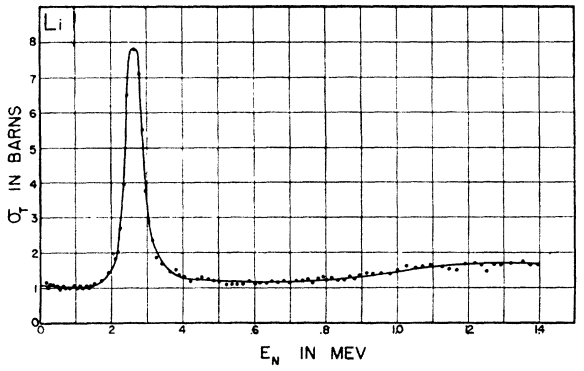

FIG. 1. Total neutron cross section of lithium as a function of neutron energy.