The time of slowing of the Li particles in FeB is smaller by a factor of about 0.5 than in $B_4C$. A further experiment using this compound as a $\gamma$-ray source together with an improved spectrometer resolving power may make it possible to give a definite value for the mean life of this excited state in $Li^7$ rather than only an upper limit.

The angular momentum of $Li^7$ in the ground state is $\frac{3}{2}$ and the 478.5-kev excited state is commonly supposed[5] to have angular momentum $\frac{1}{2}$ forming with the ground state a doublet, $^2P_{3/2}$ and $^2P_{1/2}$. On this basis the transition takes place by magnetic dipole radiation. The transition probability for this case may be calculated closely by considering the interaction of the magnetic moment $(e/2Mc)(L+5.6S)$ of the $2p$ proton in $Li^7$ with the radiation field. The square of the matrix element[6] representing this interaction is

$$\frac{8}{3}\left(\frac{2.3eh}{4\pi Mc}\right)^2,$$

which together with the energy 478.5 kev available for the transition gives a calculated mean life for the $Li^7$ excited state of $1.5\times10^{-13}$ sec. This is seen to be consistent with the experimental upper limit of $2.0\times10^{-13}$ sec.

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## Microwave Determination of the Molecular Structure of Chlorosilane

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THE second rotational transition, $J=1$ to $J=2$, of $SiH_3Cl^{35}$ and $SiH_3Cl^{37}$ has been measured and analyzed. The Hughes-Wilson Stark modulation technique was used for detection of the absorption lines, and absorption frequencies were determined by comparison with a crystal-controlled secondary frequency standard.

In Fig. 1 is shown the theoretical hyperfine pattern for a nuclear spin of $\frac{3}{2}$ for chlorine which is in satisfactory agreement with the observed spectrum. No lines caused by excited vibrational states were observed. The unperturbed transition frequency $\nu_0$ is 26,695.$2_4$ Mc for $SiH_3Cl^{35}$ and 26,049.$6_0$ Mc for $SiH_3Cl^{37}$. From these frequencies, the $I_B$ and $B_0$ values were calculated and listed in Table I. Since the quadrupole moments of $Cl^{35}$ and $Cl^{37}$ have been measured to be $-7.921\pm0.05\times10^{-26}$ and $-6.189\pm0.05\times10^{-26}$ cm$^2$,[1] respectively, we may evaluate $\partial^2V/\partial Z^2$ at

TABLE I. Nuclear and molecular constants of chlorosilane.

| | $\nu_0$(Mc/sec.) | $I_B$(g-cm$^2$) $\times10^{40}$ | $eQ\left(\frac{\partial^2V}{\partial Z^2}\right)$(Mc) | $B_0$(cm$^{-1}$) |
|---|---|---|---|---|
| $SiH_3Cl^{35}$ | 26,695.$2_4$ | 125.$7_1$ | −40.$0_0$ | 0.2226$_3$ |
| $SiH_3Cl^{37}$ | 26,049.$6_0$ | 128.$8_3$ | −30.$3_3$ | 0.2172$_3$ |

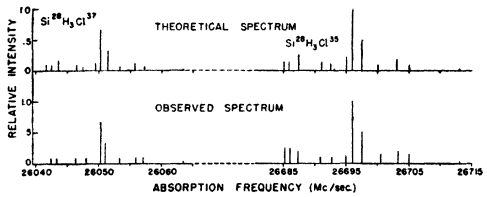


FIG. 1. Microwave absorption spectrum of monochlorsilane ($SiH_3Cl$).

the chlorine nucleus of chlorosilane to be about $7\times10^{15}$ e.s.u. This is to be compared with the value $13\times10^{15}$ e.s.u. as determined by Gordy[2] and his co-workers for methyl chloride.

Assuming the value of 1.456A for the Si−H distance determined from infra-red measurements on silane,[3] we may calculate from the $I_B$ values in Table I, the Si−Cl internuclear distance to be 2.035A, and the H−Si−H angle to be 103° 57′. These are to be compared with the value 2.16A for Si−Cl computed from Pauling's covalent single-bond radii and the tetrahedral angle of 109° 28′. Electron diffraction measurements[4] on this compound yield a value of 2.06±0.05A for the Si−Cl distance.

The lines arising from $K=0\rightarrow0$ and $K=1\rightarrow1$ transitions were expected from theory to show second- and first-order Stark effect, respectively. This was strikingly observed in the experiment when only the $K=1\rightarrow1$ lines appeared at field of 10–20 volts/cm, being augmented by the $K=0\rightarrow0$ lines when the field was increased to several hundred volts/cm. The determination of the quadrupole coupling constants, $eQ(\partial^2V/\partial Z^2)$, was based on the frequencies of the $K=0\rightarrow0$ lines only, since these could be measured more accurately than the $K=1\rightarrow1$ lines because of experimental considerations.

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## Argon and Neon ($pn$) Thresholds

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FROM mass values[1] one calculates a $Q=-1.1\pm1.1$ Mev for the reaction $A^{40}(pn)K^{40}$. Observation of the neutron threshold should give precisely the mass difference between the important isobars $A^{40}$ and $K^{40}$. A gas target was recently available on the Wisconsin electrostatic generator so a quick search was made for this threshold. A $BF_3$ counter surrounded by paraffin served as neutron detector. The high resolution electrostatic analyzer[2] was

not used for these measurements since the somewhat non-uniform aluminum foil (0.00035 in. thick) which separates the gas target from the vacuum system limits the energy homogeneity of the proton beam.

Below $E_p=2.4$ Mev the neutron yield from the argon was so very low that an accurate determination of threshold was not possible in the short time at our disposal. However, a very intense sharp rise in the neutron yield from the argon was observed for $E_p=2.4$ Mev (see Fig. 1). It is, of course, possible that the mass values are in error and that this rise is near the argon threshold. An alternate and more probably explanation[3] is that the large angular momentum difference between $K^{40}$ ($I=4$) and $A^{40}$ ($I=0$?) makes the *pn* reaction near threshold very highly forbidden. The sudden sharp rise for $E_p=2.4$ Mev could be the threshold for the formation of $K^{40}$ in an excited state of angular momentum 1 or 0. The lifetime of the excited state will be of the order of $10^{-6}$ sec. if $\Delta I=4$ and of the order of $10^{-9}$ sec. if $\Delta I=3$, so such an isomeric state would be difficult to observe experimentally. (These lifetime estimates assume the energy level to be 1.3 Mev above the ground state.)

The rise in background (argon gas replaced by hydrogen) neutron yield which starts at 2.35 Mev probably comes from protons hitting oxide surfaces ahead of the gas target. The aluminum foil is 230 kv thick for 2.35-Mev protons so the energy of the protons outside the foil is 2.6 Mev which is sufficient for the $O^{18}(pn)F^{18}$ reaction.

At $E_p=2.9$ Mev the argon *pn* cross section is about $10^{-25}$ cm$^2$ so the neutron yield is comparable[4] with the $Li^7(pn)Be^7$ reaction. The neutron energy at the 2.4-Mev threshold should be 1.4 kv so if suitable thin targets of argon could be used it might provide a variable energy neutron source superior for low energy neutrons to the lithium reaction.

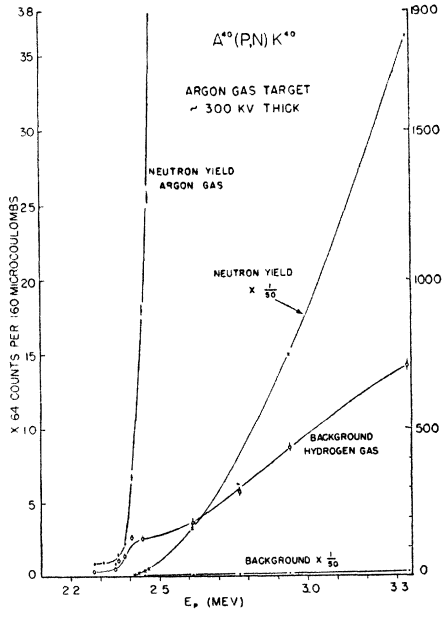


FIG. 1. Neutron yield, argon target.

A quick search was also made for a *pn* threshold with neon gas in the target. Bethe's mass values[1] predict a $Q=-2.1$ Mev for the $Ne^{22}(pn)Na^{22}$ reaction, but his mass of $Na^{22}$ is a considerably in error since it has been shown by $\beta\gamma$-coincidences[5,6] that the beta-decay of $Na^{22}$ goes entirely to 1.3-Mev excited state of $Ne^{22}$. No neutron yield from neon gas in the target could be detected for protons up to 3.35 Mev, which energy was the maximum available for the protons after passing through the aluminum foil to the gas target. The present negative neutron results and the beta-gamma-cascade decay of $Na^{22}$ are consistent if the mass of $Na^{22}$ is taken as 22.00152 m.u. when $Ne^{22}$ is taken as 21.99844 m.u.

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## Deuterium (*pn*) Threshold

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A DEUTERIUM gas target has recently been in use on the Wisconsin electrostatic generator for another experiment.[1] While the target is available, we have, therefore, made a quick search for the threshold of the simple but important reaction

$$D+H\rightarrow 2H+n+Q,$$

whose $Q$ is, of course, negative and equal to the binding energy of the deuteron. Conservation of momentum requires that the proton energy at threshold be $(3/2)Q$ or about 3.3 Mev. Although the above reaction has been observed for 5.1-Mev protons,[2] it was anticipated that observation of the threshold would be difficult for two reasons: (1) From statistical arguments one expects the cross section for a three-particle disintegration to be very low at threshold; (2) the outgoing protons have a Coulomb barrier to penetrate. However, there are two other factors which assist in the threshold detection. First, momentum conservation confines all the neutrons to the forward direction at threshold, and second, the neutron energy at threshold is already 370 kv because of the velocity of the c.g. system.

These last factors were exploited by choosing a long but small diameter hydrogen recoil counter for the neutron detector and placing it directly in front of the target. It was possible in this manner to obtain a detection efficiency of $>10^{-3}$ and yet at the same time reduce background counting rate to a small fraction of that present in a $BF_3$ counter surrounded by paraffin. With this arrangement the results shown in Fig. 1 were obtained in one evening's run.