L-absorption edge of MgO show that a nearly forbidden range of energies is present at *ca* 12 ev above the first empty level. The energy separation, 13.6 ev, of the third peak from the second peak in Table I agrees well with the x-ray data.

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Saturation in the Microwave Spectrum of Methyl Chloride*

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THE saturation of the microwave transition $J=0\rightarrow1$ of CH_3Sl^{35} has been measured by the method of Baird and Bird.[1] The results constitute the first measurement on saturation of a rotational absorption line, all other microwave saturation measurements having been made on the $J=3$, $K=3$ line of the ammonia inversion spectrum.[2,3] As in the case of the ammonia line, the experimental results are described by the formula derived by Karplus and Schwinger.[4] Their derivation contains the assumption that collisions which broaden the absorption line are identical with collisions which transfer rotational energy and reduce the displacement from thermal equilibrium caused by the absorption of radiation. This corresponds to the case of diabatic (nonadiabatic or inelastic) collisions, which is expected to apply in the microwave region, but is known not to apply in the visible and ultraviolet regions.[5]

The experimental uncertainty in the actual measurement of the rate of saturation with increasing power is about 30 percent and is largely due to uncontrollable variations in the standing wave properties of the Stark-effect absorption cell. Reduction of the uncertainty requires the design of a more satisfactory wave guide, and work on this is now in progress. A detailed discussion of the measurements and calculations has been given elsewhere,[6] and will not be repeated.

The line breadth constant $\Delta\nu/p$ has been measured for each of the three quadrupole fine structure lines of this transition and found to be 21 ± 1 Mc/sec per mm Hg at 300°K, a result largely independent of the errors which enter into the saturation measurements. The intensity of the strongest line ($J=0\rightarrow1$, $F=3/2\rightarrow5/2$) is revised to 7.9×10^{-6} cm^{-1} from the figure of 6.6×10^{-6} cm^{-1} calculated by Kisliuk and Townes[7] for an assumed line breadth of 25 Mc/sec per mm Hg. If the line-broadening interactions are idealized as hard-sphere collisions, a collision diameter of 16.1 A may be calculated. This is much greater than the value of 5.6 A obtained from viscosity measurements and the kinetic theory of gases.[8] The large size of the microwave collision diameter indicates that dipole-dipole interactions are the principal mechanism for line broadening and rotational energy transfer.

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Electron Spin Resonance of an Impurity Level in Silicon*

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ELECTRON spin resonance has been observed in a sample of silicon containing 7×10^{16} lithium atoms per cm^3. The ionization energy of an electron in the impurity level is 0.033 ev, as determined from Hall effect measurements.[1]

A single resonance line was observed throughout the temperature range of 4°K to 20°K by using an rf frequency of about 8800 Mc/sec and a magnetic field of about 3200 oersteds. The same line was also observed on 300-Mc/sec equipment, kindly made available by Mr. G. Feher. Magnetic field modulation was used at both frequencies. The resonance line has a $g=1.999$, and a full width at half-maximum absorption of 1.5 oersteds; the line shape is approximately Gaussian. The resonance shows rf power saturation behavior characteristic of inhomogeneously broadened lines, in which the spins are in thermal equilibrium only through the interaction with the lattice, rather than through spin-spin interaction. The observed line is actually a superposition of many overlapping narrow lines which saturate only over a small portion of the line, rather than over the whole line as in the homogeneous line-broadening situations. This situation is very similar to the one encountered in the *F*-center investigations of Kip, Kittel, Levy, and Portis[2,3]; the quantitative saturation behavior is thoroughly worked out by Portis in reference 3. The most probable mechanism for producing the inhomogeneous broadening of the line is magnetic hyperfine interaction of the electron with the Li and Si^{29} nuclei encompassed in its wave function.

The width of the resonance can be estimated on the basis of magnetic hyperfine interaction for an electron with ionization energy of 0.033 ev. Such an electron encompasses roughly about 600 Si atoms in its orbit, of which about 30 atoms are Si^{29}, the only stable magnetic isotope of silicon. Assuming that each of the silicon atoms share equally in the wave function and making an allowance for possible $\frac{1}{2}$ p character, one estimates an expected line width of about 1 oersted, which is of the order of magnitude of the observed width. If the Li shared equally with the Si in the wave function, there would be four Li hyperfine components of about 0.1 oersted separation between components. These would not be resolved due to the broadening of each component by the Si^{29}. However, the resonance line shape would be flattened at the top. This was not observed, and hence it is likely that Li gets a smaller share of the electron than Si. Upon calculating the line shape due to the Si^{29} and neglecting any width due to the Li hyperfine components, a closely Gaussian shape is found, in agreement with the experimental results. There appears to be a possibility of producing deeper-lying impurity levels by special treatment of the sample.[1] If these levels are connected with Li centers, resolved Li hyperfine structure might be obtained.

The resonance reported here seems to be clearly associated with a low ionization energy impurity level. It is of interest to note that the experimental evidence indicates that the electron is bound to the impurity atom rather than associated with an impurity band. This evidence is, of course, the magnetic hyperfine structure exhibited implicitly by the line.

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Meson-Meson Interaction in Meson Scattering*

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THE purpose of this note is to discuss explicitly an interpretation of low-energy meson-nucleon scattering data which, though not new,[1] is different from that most frequently adopted. It shall be assumed that the meson-nucleon scattering arises from two sources: *A*, the meson-nucleon interaction neglecting any meson-meson collisions that might be suffered in the scattering process, and *B*, meson interaction directly with the mesons of the nucleon's proper field. This latter effect is associated with an interaction assumed to exist between free mesons, which we label *C*.

It seems proper to describe *B* by a potential whose range is of the order of the meson Compton wavelength $1/\mu$ (where $\hbar = c = 1$). This type of description is indicated by the fact that *C* is, in the pseudoscalar (*PS*) theory, probably of range $1/M$ (where M is the nucleon mass). Thus the interaction with the meson cloud will

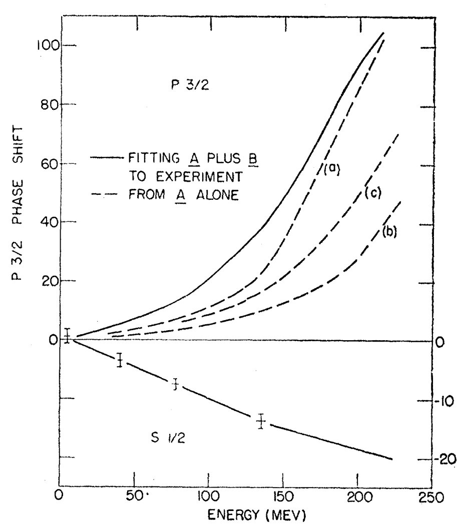

FIG. 1. $S_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ phase shifts for $T = \frac{3}{2}$ (see Table I). Referring to the *S* wave plot, the vertical bars show the phase angles obtained at various energies in fitting the *S* wave data. Exponential potentials (*a*) and (*b*) fit the more positive low-energy *S* phase shifts, while (*c*) fits the more negative. These *S* phase shifts obtained do not necessarily represent the best evaluation of recent results or the bars a good estimate of "experimental errors" at the energies in question.

be a point-by-point effect. This will be represented by a potential function in which is buried both the behavior of the probability density of the cloud and the strength of *C*. One can hope that the momentum dependence of *C* is smeared sufficiently by the momentum spread in the cloud to yield a constant potential over the range of incoming momenta in which we are interested. As a result of the short range of *C* we can assume that *B* is