necessary to use a Te sample with a different isotopic composition. This was accomplished by using enriched tellurium in which the content of Te^{122} had been increased from the natural abundance of 2.46 to 79.4 percent. Using 7.4-Mev protons again, the 3.6-minute activity was produced 46.5 times larger in intensity than the 25-minute activity, whereas in the previous case where Hilger material had been used the 3.6-minute activity was 1/4.4 times as large. The ratio of these two relative numbers, 46.5 and 1/4.4, which is 205, is very close to the ratio of the abundances of Te^{122} and Te^{128} for the two bombarded samples, namely, 210. It is thus concluded that the 3.6-minute activity is made from Te^{122}.

The 3.6-minute activity must then be attributed to either I^{122} by the (p, n) reaction or to I^{123} by the (p, γ) reaction.

Though in general the (p, n) reaction proceeds with a larger yield than the (p, γ) reaction, nevertheless it was considered desirable to examine the relative branching of these two reactions on other neighboring isotopes of Te. In particular, Te^{124} and Te^{125} had been bombarded with protons of the same energy. In both cases it was observed that the (p, n) reaction proceeded very readily whereas the (p, γ) reaction did not, with any appreciable yield.

It seems, therefore, reasonable to conclude that the strong 3.6-minute activity be assigned to I^{122}.

By absorption measurements the maximum energy of the positron spectrum was found to be 3.08±0.1 Mev.

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Resonant Absorption of Oxygen at 2.5-Millimeter Wavelength*

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A SINGLE resonant absorption peak of oxygen has been theoretically predicted to occur near 2.50-millimeter wavelength.[1] Because of the difficulties of making measurements in this region of the spectrum, the line has not previously been observed. With the millimeter wave harmonic generators previously described[2] and with the Zeeman modulation spectrograph developed in this laboratory[3] for detecting the resonant lines of oxygen in the 5-mm wave region, we have succeeded in detecting and accurately measuring the 2.5-mm line. Its position and line breadth are given in Table I. Figure 1 shows a recorder tracing of the line both at room temperature and at the temperature of dry ice. The line position deviates only 25 Mc from that predicted by Van Vleck[1] with Schlapp's formula.[4] Because of the low intensity of the line, an accurate measurement of its breadth could not be made. However, from measurements as accurate as we could make, the breadth appears to be greater than for the other lines in the millimeter region.[5]

The 2.5-mm line corresponds to the $J=0\rightarrow1$, $K=1$ transition in the spin-type triplet. The Zeeman pattern for this transition is particularly simple, and has been completely resolved. It consists of two components, of equal intensity, corresponding to $\Delta M=\pm1$, which are shifted equally one to higher and one to lower frequencies by the magnetic field, and a third component corresponding to $\Delta M=0$ which is not displaced by the field. The undisplaced line cannot be detected with the Zeeman modulation method used here. Hence, only the two lines corresponding to $\Delta M=\pm1$ were observed. The recorder tracing of these components is shown in Fig. 2. Figure 3 shows the measured displacements of these lines as a function of field strength. It is seen that the displacement is directly proportional to the field up to the highest value employed (22 gauss). Thus it appears that the first-order Zeeman treatment (weak field case) should account satisfactorily for the splitting. However, the g factor observed, 1.22±0.05, does not correspond to that predicted, 1.00, for the normal Zeeman effect of Hund's case (b). So far we have been

TABLE I. $J=0\rightarrow1$, $K=1$ line of oxygen.

Frequency Mc/sec	Line breadth parameter	Zeeman displacement of each component ($\Delta M=\pm1$) Mc/gauss
118,745.5±0.3	0.12 cm^{-1}/atmos ($T=193°K$)	1.70_6

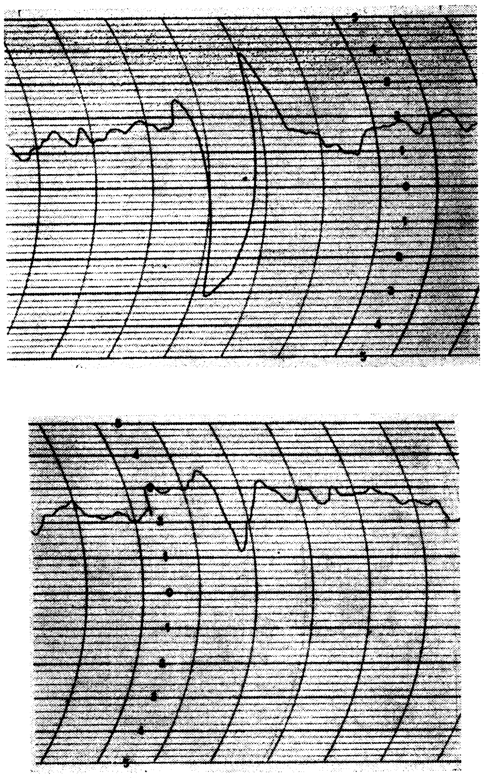

FIG. 1. Recorder tracings of the $J=0\rightarrow1$, $K=1$ transition of oxygen occurring at 118,745.5 Mc. The upper recording shows the line at dry ice temperature and the lower at room temperature.

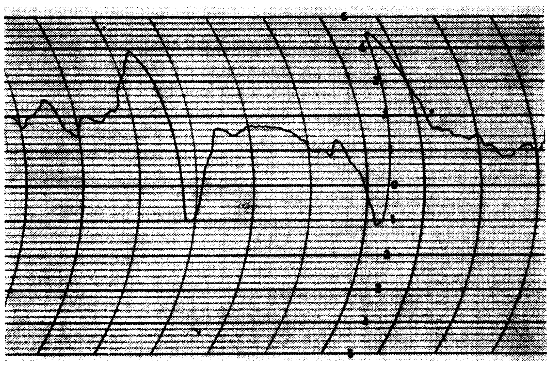

FIG. 2. Recorder tracing of the $J=0\rightarrow1$, $K=1$ transition of oxygen, showing the Zeeman splitting of the line into $M=+1$ and $M=-1$ components. The field in this case was 22 gauss.

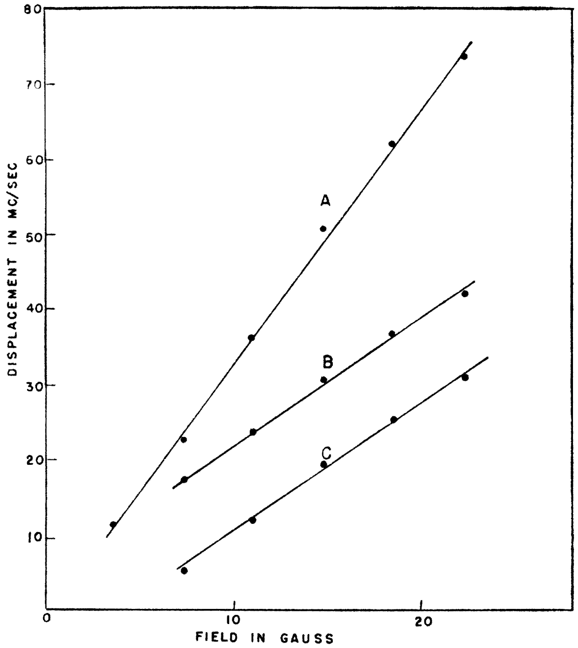

FIG. 3. Measured Zeeman displacements as a function of field strength for the $\Delta M=\pm 1$ components of the $J=0\rightarrow 1$, $K=1$ transition of O_2; (A) total separation of components, (B) displacement of high frequency components, (C) displacement of low frequency components.

unable to account for this discrepancy. Neglecting possible systematic errors of unknown origin, the disagreement lies well outside the estimated range of errors. It is surprising that the strong field magnetic resonance measurements of Beringer and Castle[6] and the strong field Zeeman measurements in the optical region by Schmid, Budó, and Zemplén[7] yield a g factor in agreement with the weak field case of the present measurement. Because of the apparent inconsistency further measurements of the weak field Zeeman effect are being made.

We wish to thank Dr. Allan Henry for a helpful communication.

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Nuclear Relaxation in Gases by Surface Catalysis

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WHILE the interaction between the rotational motion and the nuclear moment provides, in the case of diatomic and polyatomic gases, an effective mechanism for the establishment of thermal equilibrium,[1] it is necessary for nuclear induction experiments with noble gases to provide a catalyst in order to obtain sufficiently short relaxation times. The admixture of oxygen was originally suggested for this purpose[2] and has since been successfully used[3] for He^3. However, the partial pressure of oxygen must be chosen here as high as 10 atmospheres to attain even a relaxation time $T_1 \cong 1$ sec, and appreciably shorter relaxation times which are otherwise desirable would require excessive pressures. It seemed worth while, therefore, to consider another mechanism, which can lead to short relaxation times without an increase of pressure. Such a mechanism can be realized if the sample consists of a fine powder of a paramagnetic substance with the gas under investigation filling the space between the powder particles. Even with a densely packed powder, there will still be about half of the total volume available for the gas, so that under the same pressure the reduced amount of sample substance within the volume of the receiver coil does not cause serious reduction of the signal. Because of the molecular magnetic moments of the powder, there exist strong irregular magnetic fields within atomic distances from the surface of the powder particles. Consequently, the impact of a gas atom upon a surface causes a similar reorientation of the nuclear moment as is otherwise achieved in an impact with a molecule of admixed oxygen, and one can therefore expect that this mechanism can likewise contribute effectively towards establishment of thermal equilibrium.

To obtain a quantitative treatment of this surface catalysis, it is necessary to consider the self-diffusion of the gas in the space between the powder particles. It requires a slight generalization of the macroscopic differential equations which we gave earlier[4] with the difference that the components of the polarization vector **M** must be considered as functions not only of the time but also of the space coordinates. We shall assume that the mean change of the nuclear moment $\boldsymbol{\mu}$ by an impact on the surface is

$$\langle\delta\boldsymbol{\mu}\rangle_{\mathrm{Av}}=-w(\langle\boldsymbol{\mu}\rangle_{\mathrm{Av}}-\boldsymbol{\mu}_0), \tag{1}$$

where w measures the transition probability in an impact and $\boldsymbol{\mu}_0$ is the equilibrium value of $\langle\boldsymbol{\mu}\rangle_{\mathrm{Av}}$. The rate of change of the total moment, contained in a gas volume V with the arbitrary boundary surface B can then be written in the form

$$\frac{d}{dt}\int_V \mathbf{M}d\tau=D\int_{B_1}\mathrm{grad}_\sigma\mathbf{M}d\sigma-\frac{w\bar{v}}{4}\int_{B_2}(\mathbf{M}-\mathbf{M}_0)d\sigma+\int_V\left[\gamma[\mathbf{M}\times\mathbf{H}]-\frac{\mathbf{M}_{tr}}{T_2'}\right]d\tau. \tag{2}$$

The first integral on the right side extends over the part B_1 of B which is situated within the gas and represents the contribution due to diffusion with the coefficient D. The second integral represents the effect of impacts, taking place over the part B_2 of B which is formed by the surface of powder particles; it follows from (1), since the mean number of impacts per unit area and unit time is given by $n\bar{v}/4$ (n = number of gas atoms per unit volume, $\bar{v}$ = mean velocity) and since $n(\langle\boldsymbol{\mu}\rangle_{\mathrm{Av}}-\boldsymbol{\mu}_0)=\mathbf{M}-\mathbf{M}_0$. The last integral represents the additional change of **M** within V due to the external field **H** and a possible field inhomogeneity ΔH, affecting the transverse part $\mathbf{M}_{tr}$ of **M** and measured by $1/T_2'=\gamma\Delta H$. An equivalent differential form of (2) is

$$\partial\mathbf{M}/\partial t=D\nabla^2\mathbf{M}+\gamma[\mathbf{M}\times\mathbf{H}]-\mathbf{M}_{tr}/T_2' \text{ within the gas,} \tag{3}$$

$$0=D\,\mathrm{grad}_\sigma\mathbf{M}+\tfrac{1}{4}w\bar{v}(\mathbf{M}-\mathbf{M}_0) \text{ on the surface.} \tag{3a}$$

In (2) and (3a) the subscript σ indicates the external normal component to the boundary B_1 and to the powder surface, respectively.

The variation of **M** in space can be neglected if the order of magnitude d of the distance between powder particles is sufficiently small. Extending V over the total volume of the gas, so that $B_2=S$ is the total surface of the powder particles, one obtains then from (2) the same differential equations for the time dependence of **M** as were obtained before (see reference 2) if

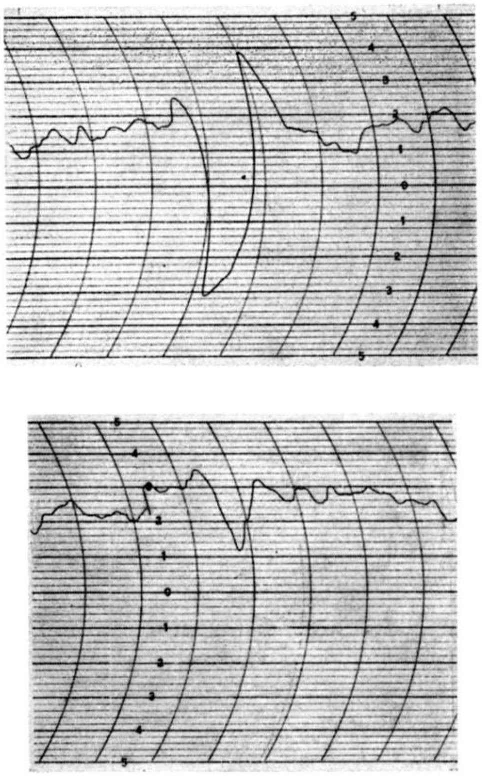
$$T_1=4V/w\bar{v}S \tag{4}$$

and

$$T_2=T_1T_2'/(T_1+T_2') \tag{4a}$$

are taken as longitudinal and transverse relaxation times, respectively. The necessary smallness of d implies merely that the time d^2/D, which is of the order of the time between impacts upon different particles, is small compared with either T_1 or T_2 and is well realized under normal conditions.

The effectiveness of this mechanism can be best estimated by comparing (4) with the value $(T_1)_{O_2}$ which one would obtain with a given partial pressure $(p)_{O_2}$ of admixed oxygen. Assuming the



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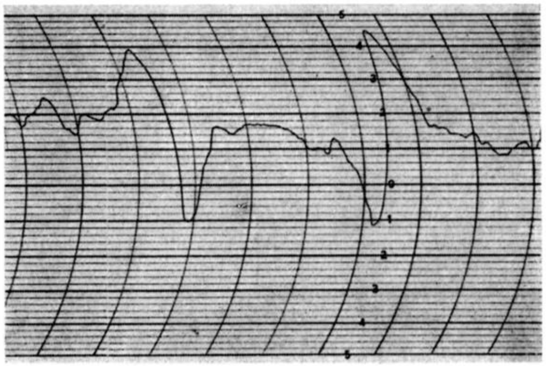

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