However, this must await the clearing up of the values to be assigned the ground states of Co^{61}, Ni^{61}, and Cu^{61}.

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Laboratory Observation of the $A^2\Pi - X^2\Sigma$ Bands of the N_2^+ Molecule

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BOTH the electron configuration[1] of N_2^+ and the observed spectra of isoelectronic molecules lead one to believe that the N_2^+ molecule has a low-lying $^2\Pi$ state. Meinel[2] has observed a system of bands in the infrared spectrum of the aurora which he has attributed to transitions from this $^2\Pi$ state to the ground state. Up until now, however, no such bands have been observed in laboratory spectra. Recently we have succeeded in exciting these bands in a discharge tube.

A mixture of helium and nitrogen was passed through a hollow cathode discharge tube and the spectrum of the discharge photographed on the first order of a twenty-one foot concave grating. When the pressure of the helium in the discharge tube was high and the quantity of nitrogen very small, the first positive bands of nitrogen appeared only weakly while the ultraviolet bands of N_2^+ were strong. Under these conditions the infrared spectrum of the discharge has been photographed on *N* and *M* plates with exposure times of several hours.

Besides the well-known first positive bands of nitrogen, the infrared spectrum of the discharge tube shows a system of bands degraded to the red. Each of these bands has two prominent heads and others less prominent. The positions of the strong heads, together with a possible vibrational numbering, are shown in Table I. On our plates the (4,2) (3,1) and (2,0) bands are strong and free from overlapping lines, while the (2,1) and (2,0) bands are very weak and the (3,0) band is overlapped.

The agreement between our wavelengths and those of Meinel as shown in Table I leaves no doubt that the bands observed here are the same as those observed in the aurora. The consistent difference of about 3A between the two sets of measurements is the result of the fact that Meinel has measured intensity maxima whereas we have measured band heads. Also the assignment of these bands to the N_2^+ molecule appears certain for the following reasons. First, the structure of the bands is very similar to that of the $^2\Pi - ^2\Sigma$ bands of the isoelectronic CN molecule. Second, within the fine structure of the bands the lines of the series show the alternation of intensities which is to be expected in bands of the N_2^+ molecule. Finally, the magnitude of the vibrational quanta of the lower state of these bands agrees with that calculated from the well-known ultraviolet N_2^+ bands.

TABLE I. Infrared bands of N_2^+.

Vibrational numbering	Wavelength, A Authors	Meinel	Vibrational numbering	Wavelength, A Authors	Meinel
1,0	9208.00		2,0	7874.63	7879.6
	9147.31(?)			7825.72	7828.2
2,1	9502.27		3,1	8105.31	8107.0
	9428.90(?)			8053.63	8056.8
3,0	6890.49	6892.2	4,2	8348.25	8349.2
				8293.41	8297.6

An analysis of the fine structure of these bands is in progress and the results will be published in the near future.

We are indebted to Dr. G. Herzberg for helpful discussions of this problem.

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On the Magnetic Moment of $Te^{123,125}$ and Si^{29}*

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NUCLEAR induction signals of $Te^{123,125}$ were detected in a solution of TeO_2 (3.1 molar) in HCl and chemically pure tellurium metal in aqua regia. Signals of Te^{125} with a line width of about 1/10 gauss (probably in part determined by the magnetic field inhomogeneity) were observed in both the above solutions without the addition of paramagnetic ions.

A comparison of the resonant frequency of Te^{125} with that of Na^{23} gives the result

$$\nu(Te^{125})/\nu(Na^{23}) = 1.19457 \pm 0.00004. \quad (1)$$

With the known magnetic moment of Na^{23} and the fact that the spin of the tellurium isotopes is $\frac{1}{2}$,[1,2] the sign and value of the magnetic moment of Te^{125} were found to be

$$\mu(Te^{125}) = -0.88235 \pm 0.00004. \quad (2)$$

This value agrees well with the spectroscopic data in the literature.[3]

The abundance of Te^{123} being only 0.85 percent, one would expect the signal amplitude of the isotope to be about $\frac{1}{8}$ that of Te^{125}, whose abundance is 7.0 percent. If was therefore necessary to modify the present spectrometer[4] with the introduction of an amplifier of higher gain and lower noise figure.[5] This apparatus permitted the detection of Te^{123} signals with a signal-to-noise ratio of about seven. Thus a comparison of the resonant frequency with that of Na^{23} yielded the results[1]

$$\nu(Te^{123})/\nu(Na^{23}) = 0.99085 \pm 0.00003 \quad (3)$$

and

$$\mu(Te^{123}) = -0.73188 \pm 0.00004.^3 \quad (4)$$

The ratio of the magnetic moments of the two isotopes is therefore calculated to be

$$\mu(Te^{125})/\mu(Te^{123}) = 1.20560 \pm 0.00007, \quad (5)$$

which is in good agreement with that of Mack and Arroe.[6] The ratio of signal amplitudes of the two isotopes was found to be in agreement with the known ratio of abundances within an experimental error of about 5 percent.

It is known that there exists monatomic tellurium[7] in acid solutions and further, that these atoms are likely to be paramagnetic in analogy with oxygen. It was for this reason that paramagnetic catalysts were not added to the solutions, and the fact that good signals were detected may be ascribed to the action of these paramagnetic atoms.

The first tellurium signals of a natural line width of one gauss were observed in a sample of powdered tellurium metal. The fact that one deals here with nuclear induction in a semiconductor may be of interest in view of the resonance shifts observed by Knight[8] in metals; no observable shift was found between the resonance frequency of Te^{125} in the metal and in solution. In spite of its low conductivity it was necessary to pulverize the metal in order to reduce losses caused by eddy currents.

The use of metallic tellurium was encouraged by previous experiments in which signals of Si^{29} were found in powdered silicon metal. Signals were also found in a solution of 2.5 molar SiO_2 in

NaOH and 0.5 molar $K_3Fe(CN)_6$ and further in different types of glasses: *viz.*, cobalt, lead, uranium, vicor, soft, and Pyrex glasses. This confirms the suggestion by Hatton, Rollin, and Seymour[9] that these latter signals must indeed be attributed to Si^{29}. A comparison of the resonance frequency of Si^{29} signal in cobalt glass with that of deuterium in D_2O gave

$$\nu(Si^{29})/\nu(H^2)=1.29410\pm0.00007. \quad (6)$$

Assuming the spin of Si^{29} to be $\frac{1}{2}$, the sign and value of the magnetic moment were determined to be

$$\mu(Si^{29})=-0.55492\pm0.00004. \quad (7)$$

Experiments are at present under way to determine the spin of Si^{29}. If one accepts the shell model of Mayer,[10] one is led to the conclusion that since the sign of the moment of Si^{29} was found to be negative the spin can only be 1/2 or 5/2 and, inasmuch as the latter value is quite improbable, it is likely that the above assumption about the spin will be justified.

We would like to express our appreciation to Professor Felix Bloch for his continued interest in our work.

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Line Breadths in the 5-mm Microwave Absorption of Oxygen*

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DIRECT measurement of line breadths in the microwave absorption spectrum of oxygen at $\lambda=5$ mm has been reported by Burkhalter *et al.*[1] and by Anderson *et al.*[2] From these reports it may be seen that the agreement between the two investigations is not entirely satisfactory. Hence it seems desirable to report measurements that we have made.[3]

The measurements were made by means of a Zeeman modulation spectrograph using a modulation frequency of 26.5 cps. The direction of the Zeeman field was chosen to be at right angles to the direction of the magnetic field vector in the radiation. This was accomplished by using two long magnets in the shape of hollow cylinders of rectangular cross section, each having a slot along its length for insertion of the wave-guide absorption cell. The lines of flux were all parallel to a plane at right angles to the length of the cylinder. The direction of the field in the gap was parallel to the electric vector of the radiation in the wave guide, which was propagating in its lowest mode.

The strength of the field was varied between zero and about 50 gauss to produce a square wave time variation. The strength of the field was sufficient to "modulate away" completely the absorption lines at the pressures used (0.75 mm to 6 mm of mercury) during the "field-on" half of the cycle. With the direction of the field as described above, only the transitions $\Delta M=\pm1$ (σ transitions) are responsible for the absorption. This arrangement may be seen to give a stronger signal than any other field direction.

Five-mm microwave power was generated by a crystal doubler driven by a 1-cm klystron. The latter was locked to the resonant frequency of a K-band wave meter by means of the Pound circuit. The wave meter was slowly tuned to change the frequency. A second 1-cm klystron was made to follow the signal generator at a frequency difference of 12 Mc/sec to provide superheterodyne detection. The shape of the line was ultimately traced on an Esterline-Angus recorder.

TABLE I. Observed line-breadth parameters.

Transition	Frequency, in Mc/sec	Half-breadth at half-intensity, in cm^{-1}/atmos
$K_+=1$	56,265.2±0.5	0.035±0.007
$K_+=3$	58,446.3±0.4	0.028±0.003
$K_+=13$	62,412.9±0.8	0.025±0.003
$K_-=3$	62,486.2±0.4	0.037±0.003
$K_-=7$	59,164.2±0.2	0.028±0.005
$K_-=9$	58,324.9±0.3	0.021±0.003
$K_-=11$	57,612.3±0.4	0.034±0.006
$K_-=15$	56,364.2±0.5	0.048±0.003

Observations were usually made at four different pressures (about 6, 3, 1.5, 0.75 mm Hg) and the observed widths plotted against the pressure. A straight line was then drawn through these points so as to give the least-square deviation. The slope of this line gave the line-breadth parameter. This straight line shows a nonzero line breadth at zero pressure, presumably caused by residual field in the gap, which could not be balanced out completely. This residual breadth was of little concern since line breadth varied by a factor of about 3 over the range of pressures used in the investigation. Table I gives the results and their probable errors.

These results cannot be immediately compared with those given in references 1 and 2 since they do not contain any limits of error.

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The Diffusion of Metastable Neon Atoms in Mixtures of Helium and Neon*

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A SHORT time after the cessation of excitation, the $^3P_2$ metastable level of neon decays exponentially, and the mean life T_m is defined by the equation

$$N=N_0\exp(-t/T_m),$$

in which N is the number of metastable atoms per cc.

T_m can be expressed as a function of the pressure by the equation:[1]

$$1/T_m=(B/p)+Z,$$

in which

$$B=[(5.81/c^2)+(\pi^2/L^2)]Dp,$$

where p is the pressure in mm of mercury, c is the discharge tube radius in cm, L is the discharge tube length in cm, and D is the diffusion coefficient. The term Z is not proportional to the pressure, but the experimental results are consistent with an equation of the type

$$1/T_m=(B/p)+Cp^n,$$

in which n is 0.7 for pure neon,[2] and approaches 0.5 as the helium-neon ratio increases.

If p/T_m is plotted as a function of Cp^{n+1}, a straight line is obtained; B is the intercept on the p/T_m axis, and C is the slope.

In pure neon the B/p term represents the rate of diffusion to the walls of the energy of excitation of the metastable atoms. This process is complicated by the phenomenon of the imprisonment of resonance radiation. To reduce the relative importance of this effect, helium gas was introduced in the discharge tube. The energy levels of helium are all above the energy of excitation of the $^3P_2$ metastable neon level.