

## V. MICROWAVE SPECTROSCOPY

Prof. M. W. P. Strandberg	B. Josephson, Jr.	M. U. Palma
Dr. D. Kivelson	J. D. Kierstead	M. Peter
C. F. Davis, Jr.	H. Kleiman	I. H. Solt, Jr.
H. Dreicer	S. Krongelb	W. Thompson
J. G. Ingersoll	Maria B. Palma	M. Tinkham

### A. MICROWAVE SPECTRUM OF OXYGEN

In the Quarterly Progress Report of April 15, 1954, we summarized the many quantitative conclusions we have been able to reach from the energy levels and spectrum of the oxygen molecule. On the subject of linebreadths and intermolecular interactions we have less definite conclusions to offer. We can say, however, that the striking dependence of the linebreadth on all quantum numbers reported by Beringer and Castle (1) was the result of improper theoretical interpretation of their experimental data. With the lines which they observed identified by our work, and with the widths correctly interpreted, their work is in fair agreement with ours. Our results show a slight decrease in width with increasing  $K$  but no significant  $M$  dependence. The temperature dependence is as  $T^{-n}$ , where  $n = 0.75 \pm 0.04$ . This indicates a "softer" interaction than that of hard spheres ( $n = 0.5$ ) or the combination of exchange and polarizability interactions considered by Artman ( $n = 0.627$ ). A quadrupole-quadrupole interaction would give  $n = 0.75$ , but it seems likely that other interactions are more important. A review of these interactions, especially as they affect the nondegenerate states produced by the Zeeman splitting, would be a worthwhile extension of the work reported here.

Our final linebreadth result is that air broadening is as effective or slightly more effective than pure  $O_2$  self-broadening. This indicates that for the nondegenerate levels that concern us, the  $O_2-N_2$  collision cross section equals or exceeds the  $O_2-O_2$  cross section. This is contrary to the results of previous investigators on the field-free spectrum, which indicated that  $\sigma_{O_2-N_2} \approx 0.85 \sigma_{O_2-O_2}$ . This discrepancy is explained by the assumption that rotational resonance interactions make an appreciable contribution to the  $O_2$  self-broadening in the field-free case.

M. Tinkham

### References

1. R. Beringer and J. G. Castle, Jr., Phys. Rev. 81, 82 (1951).

### B. CONDUCTION ELECTRON RESONANCE IN METALS

In the Quarterly Progress Report of January 15, 1954, results were given on the magnetic resonance absorption of metallic sodium at 9000 Mc/sec. This included data on the line shape, linewidth, and  $g$ -values at 300°K, 78°K, and 4°K. Since then metallic

## (V. MICROWAVE SPECTROSCOPY)

lithium and potassium have been investigated. As in sodium, colloidal suspensions of lithium and potassium were made by ultrasonically dispersing the metals in paraffin wax.

For lithium, an asymmetric line shape similar to that of sodium was observed, the line shape being proportional to the sum of the real and imaginary parts of the susceptibility. The linewidth (corresponding to the full width at the half-power points of the imaginary part of the susceptibility) differed from sodium in that it was essentially temperature-independent. Its value is approximately 2.7 gauss. The observed g-values are  $g = 2.0024 \pm 0.0001$  at 300°K, and  $g = 2.0022 \pm 0.0001$  at 78°K and 4°K.

For potassium the linewidth was considerably broader and was temperature-dependent. At 300°K it was 254 gauss; at 78°K, 90 gauss; and at 4°K, 32.7 gauss. I have so far been unable to get any accurate measurements of the g-value. At 300°K and 78°K the linewidth is too broad. However, it is hoped that at 4°K sufficient accuracy can be obtained with the narrow line.

With these g-value measurements and temperature dependences of the linewidths, one can then establish whether the latter phenomenon is due to spin-orbit interactions as believed. If so, there should exist a definite relation between them. The data for sodium and lithium agree quite well with these assumptions.

I. H. Solt, Jr.

### C. A PARAMAGNETIC RESONANCE STUDY OF AMMONIUM CHROME ALUM

Additional experimental, theoretical, and calculational work has been done on the line position and intensity of the paramagnetic resonance spectrum of single crystals of ammonium chrome alum. Line positions are calculable from theory to approximately 0.2 percent; relative line intensities to approximately 10 percent (1). The line shape seems to be quite lorentzian for the dilute materials, 1:15, 1:60, and gaussian for straight alum. Linewidth varies characteristically from one line to another; the center absorption is approximately 25 percent narrower than the extremes.

C. F. Davis, Jr.

### References

1. C. F. Davis, Jr. and M. W. P. Strandberg, American Physical Society Meeting, Washington, D. C., April 29, 1954.