this large extrapolation, there would be no density-independent contribution to the width due to intramolecular interactions. Our data at normal density are in reasonable agreement with those of Sugawara[5] who reports a width of 1.4 G. There is again qualitative confirmation of the expected dependence between linewidth and density [Eq. (7)]. But as seen in Table I, the discrepancy between the experimental and the theoretical second moment is more serious than for H_2. This disagreement was already found by Sugawara *et al.*[4] who suggested that the large linewidth is due to the effect of intermolecular quadrupole broadening. If the broadening were due to zero-point vibration and rotation, one would expect it to be even larger for H_2, which is contrary to experiment. So far the reasons for this discrepancy remain unexplained. The reasons for the slight line asymmetry at low densities are also not understood.

In addition to a study of linewidth, a search was made for a possible transition and splitting of the para-deuterium signal. No such phenomenon was observed at temperatures down to 1.5°K and pressures up to 5400 atm. Even if the transition had been in the range of temperatures and pressure covered, it would have been located with difficulty since only the para D_2 will show a line structure and its signal is only one fifth of that of the ortho molecules at the normal concentration.

V. CONCLUSION

In summary, our measurements on the ortho-para conversion, the transition temperature T_λ, and on the second moment in H_2 have confirmed qualitatively theoretical expectations and are in agreement with the data of McCormick and the specific-heat results. In D_2, there are significant discrepancies between the calculated and the experimental second moment which still are not explained.

Experiments are in progress[42] for a systematic investigation of the transition temperature and the line shape for H_2 at normal densities and temperatures between 4.2 and 0.3°K. We also intend to carry out such measurements on D_2 for various ortho concentrations and on D_2 diluted in para hydrogen. This would correspond effectively to a relative deuterium concentration of less than unity. With a systematic approach along these lines we hope to come nearer to an explanation for several unsolved questions in these solids.

Note added in proof. D. C. Rorer and one of the authors (H.M.) have carried out a careful study of the line shape for normal H_2 and D_2 between 1.25 and 4.2°K at normal density. From the derivative of the lines the second and fourth moments were computed. It was possible to express the second moments roughly as

$$M_2(n\mathrm{D}_2)=0.29+0.115T^{-2}\ (\mathrm{kc/sec})^2 \quad 1.25<T<4^\circ\mathrm{K},$$

$$M_2(n\mathrm{H}_2)=60+300T^{-2}\ (\mathrm{kc/sec})^2 \quad 1.7<T<4.2^\circ\mathrm{K}.$$

The constant term is attributed to the intermolecular dipole-dipole interactions, and the temperature-dependent one to intramolecular dipole-dipole interaction, as predicted by recent calculations of A. B. Harris (to be published). The agreement of the so-obtained constant terms with the calculated on from Eq. (4) is better than before for solid H_2. However, a serious discrepancy still remains for D_2.

We also obtained for the same temperature range the approximate relations

$$M_4(n\mathrm{D}_2)=0.26+0.25T^{-2}\ (\mathrm{kc/sec})^4,$$

$$M_4(n\mathrm{H}_2)=(2+26T^{-2})\times 10^4\ (\mathrm{kc/sec})^4.$$

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[42] See note added in proof.