THRESHOLD SATURATION OF RESONANCE IN ANTIFERROMAGNETIC $MnCO_3$

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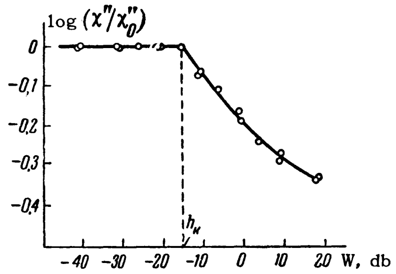
It is well known that the saturation of ferromagnetic resonance occurs at relatively low power levels and has a threshold character. According to Suhl,[1] the threshold saturation is due to the fact that at a certain amplitude an intense transfer of energy from uniform precession ($\mathbf{k} = 0$) to spin waves with $\mathbf{k} \neq 0$ begins to occur. Analogous calculations for antiferromagnetism were carried out by Heeger,[2] who showed that the threshold field is

$$h_k = 4\Delta H_0 (\gamma \Delta H_k / \omega_0)^{1/2}, \qquad (1)$$

where ΔH_0 and ΔH_k are the resonance line widths for excitation of uniform precession and the corresponding spin wave, and ω_0 is the resonance frequency. Saturation of antiferromagnetic resonance has been observed experimentally only in $KMnF_3$.[2]

We have investigated the resonance absorption in a single crystal of $MnCO_3$[1)] at high microwave power levels. Antiferromagnetic resonance in $MnCO_3$ was observed at a frequency of 9.4 Gc. The dc field lay in the basal plane and had a magnitude of 1.5 kOe. The crystal used was relatively large (weight 23 mg); the width of the resonance line was $\Delta H_0 = 200$ Oe. The source of microwave power was a pulsed magnetron (pulse length 2 μsec). A cavity with a Q of $\sim 10{,}000$ was used to increase the sensitivity.

The figure shows the dependence of the imaginary part of the high frequency susceptibility at resonance (χ'') on the power W. The values of power shown are those dissipated in the cavity in the absence of absorption in the crystal. From the magnitude of this power was calculated the high frequency magnetic field (h) in the region where the sample was placed. From the figure it is seen that at $h > h_k = 0.2$ Oe, a sharp decrease in χ'' begins. No additional absorption maxima in the region of lower dc fields were observed up to the largest values of h.



Dependence of the imaginary part of the high-frequency susceptibility at resonance on power. χ''_0 is the mean value of the susceptibility for $h < h_k$. Zero db corresponds to ~ 1 W of power dissipated in the cavity.

Thus, the saturation of antiferromagnetic resonance in $MnCO_3$ shows two of the features of the mechanism of Suhl: 1) a sharp decrease in χ'' beginning at a definite value of h_k and 2) a small value of h_k in comparison to the resonance line width. This suggests that in antiferromagnetic $MnCO_3$ saturation of the resonance occurs because of the parametric excitation of short-wavelength spin waves. The lifetime of these spin waves, according to [1], is equal to $\eta_k = (\gamma \Delta H_k)^{-1} = 5 \times 10^{-3}$ sec. This estimate is based on the assumption that the observed resonance line width corresponds to the intrinsic width of the uniform resonance. There is reason to believe, however, that the intrinsic width is at least ten times less.[3] Then we obtain for η_k the value 5×10^{-5} sec. A more detailed discussion of the results obtained will be given later.

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