III. RESULTS

A. Attenuation in the Disordered Cubic Phase

Longitudinal waves. The attenuation α of longitudinal waves propagating in the [100] direction (c_{11} wave) has been measured as a function of temperature at 10, 30, and 50 MHz. Plots of the observed α values versus f^2 at various constant temperatures between 236 and 255 °K gave a family of straight lines with a common intercept $\alpha_0 = 0.3 \pm 0.1$ dB cm^{-1}. Thus the total attenuation consists of a large critical attenuation α_c related to the order-disorder transition and a small background attenuation α_0 which is independent of frequency and temperature. This background attenuation is caused by various effects such as beam spreading due to the finite size of the transducer, scattering from imperfections in the sample, and energy losses in the bond between the transducer and the sample.

The behavior of the critical attenuation $\alpha_c = \alpha_{obs} - \alpha_0$ is shown in Fig. 1, where $\log\alpha_c$ is plotted against $\log(T - T_\lambda)$. The straight lines shown in this figure represent the best fit to the data with a power-law of the form

$$\alpha_c(\mathrm{Np\,cm^{-1}}) = S\omega^2\epsilon^{-l}, \quad (1)$$

where $\omega = 2\pi f$ and ϵ is the reduced temperature $|T - T_\lambda|/T_\lambda$. The values of the parameters are $S = (1.4 \pm 0.3) \times 10^{-19}$ sec^2 cm^{-1} and $l = 1.35 \pm 0.05$. In fact, the data show a definite systematic deviation from a simple power law. Smooth-curve values of α_c/ω^2 as obtained from the slopes of α_{obs}-vs-f^2 plots are given in Table I and will be used in further analysis of these data.

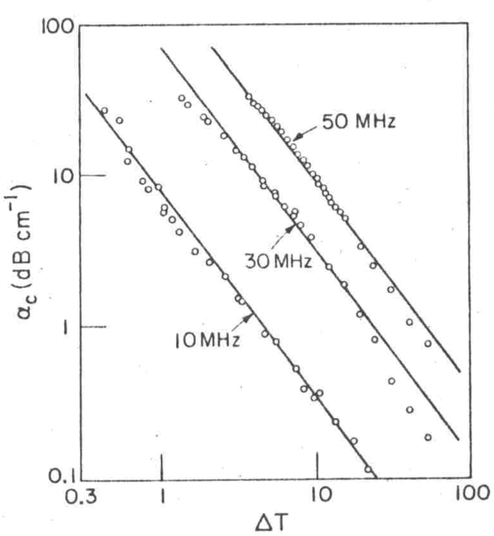

FIG. 1. Log-log plots of α_c vs ΔT (in °K) for [100] longitudinal waves in the disordered cubic phase of NH_4Br. The lines represent a simple power-law fit to the data using Eq. (1).

TABLE I. Smooth-curve values of α_c/ω^2 (in units of 10^{-18} Np sec^2 cm^{-1}) at different values of $\Delta T = T - T_\lambda$.

c_{11} wave		c' wave		c_{long} wave	
ΔT (°K)	α_c/ω^2	ΔT (°K)	α_c/ω^2	ΔT (°K)	α_c/ω^2
1.5	96.5	0.8	77.4	−1.57	530
2.0	74.3	1.0	65.2	−1.89	471
2.5	60.2	1.2	59.8	−2.44	389
3.0	48.5	1.5	47.2	−3.06	332
3.5	40.9	1.8	40.4	−4.21	238
4.0	35.6	2.0	35.7	−5.99	191
4.5	30.8	2.5	28.3	−7.45	170
5.5	24.6	3.0	23.2	−9.46	145
6.5	20.2	3.5	18.4	−11.27	133
7.5	16.7	4.0	14.6	−12.84	117
8.5	14.0	4.5	12.3	−15.09	99
10.5	10.3	5.0	10.5	−17.74	92
12.5	7.82	5.5	9.34	−20.18	79
13.5	6.90	6.0	8.09	−22.98	67
15.5	5.64	6.5	7.21	−24.98	66
17.5	4.65	7.0	6.42	−28.15	59
20.5	3.60	7.5	5.84	−32.51	51
		8.0	5.28	−36.56	50
		9.0	4.23	−42.07	46
		10.0	3.50	−52.21	40
		12.0	2.63	−63.29	36

The most important factor limiting the accuracy of the attenuation is a slight nonexponential character in the echo pattern. The average deviation in the α_{obs} values obtained from adjacent pairs of echoes was ~ 10% in regions of small or moderate attenuation. Since the character of the echo pattern remained essentially the same throughout a run, changes in α_{obs} with temperature could be determined with somewhat higher accuracy. The scatter in the data indicates that 5% would be a reasonable estimate of the random error.

The attenuation of longitudinal waves propagating in the [110] direction was measured only at 10 MHz since good echo patterns could not be obtained at higher frequencies. The (110) faces of crystal II had deteriorated during an extensive set of earlier measurements on the c' shear wave, and recutting this crystal did not improve the parallelity of the faces or reduce the distortion in the high-frequency echo pattern. The critical attenuation for this wave could be shown to agree with that for the c_{11} wave at 10 MHz if the background attenuation α_0 was assumed to have the rather large value of 1.8 dB cm^{-1} in the [110] direction. However, these limited data did not permit us to make any conclusive determination of the dependence of α_c/ω^2 on the direction of propagation of longitudinal waves in NH_4Br. Attenuation measurements on NH_4Cl have shown that α_c values in the disordered phase of that crystal are essentially the same for longitudinal waves propagating in the [100] and [110] directions,[8]