

Case I Coherence Effects

Ultrasonic Attenuation

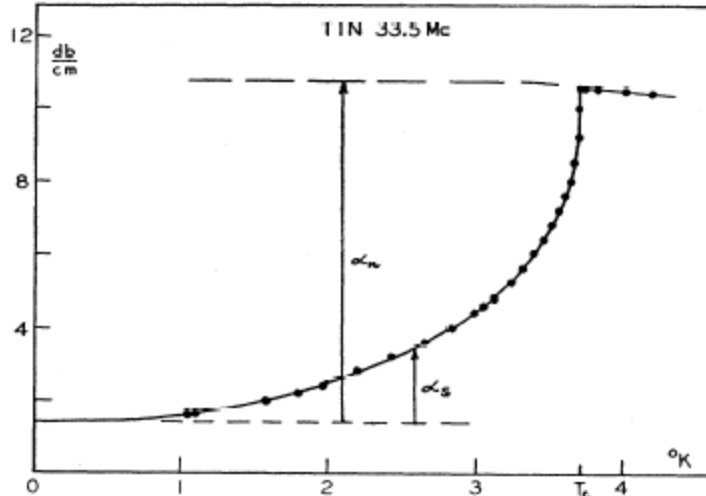


FIG. 1. Measured ultrasonic attenuation of longitudinal waves in a tin single crystal at a frequency of 33.5 Mc/sec.

$$H_{pert} = \lambda q u_0 e^{i(qx - \omega t)} \sum_{k, k', \sigma, \sigma'} c_{k\sigma}^+ c_{k'\sigma'}$$

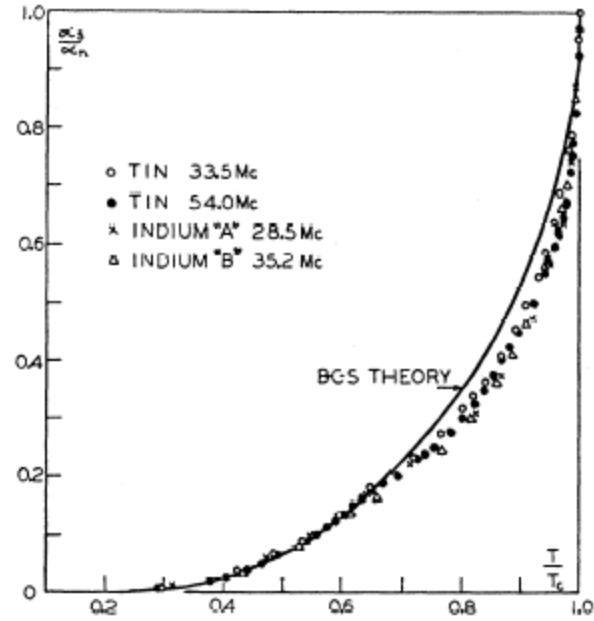


FIG. 2. Measured values of α_s/α_n compared with the theoretical variation of Bardeen, Cooper, and Schrieffer assuming $\epsilon_0(0) = 1.75kT_c$. For tin $T_c = 3.71$ °K and for indium $T_c = 3.40$ °K.

R. W. Morse and H. V. Bohm, Phys. Rev. **108**, 1094 (1957)

Hebel-Slichter Coherence Peak

L. C. Hebel and C. P. Slichter,
Phys. Rev. **113**, 1504 (1959).

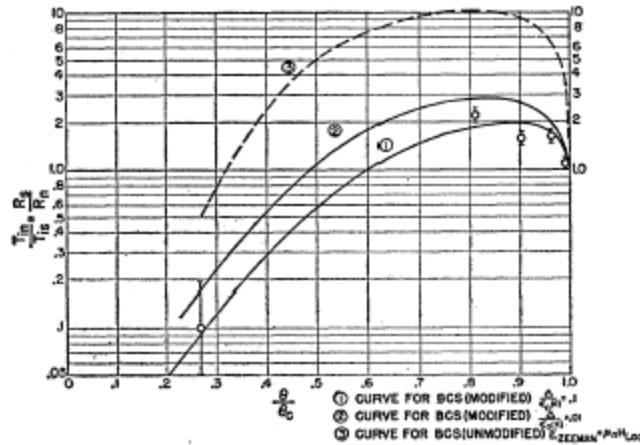
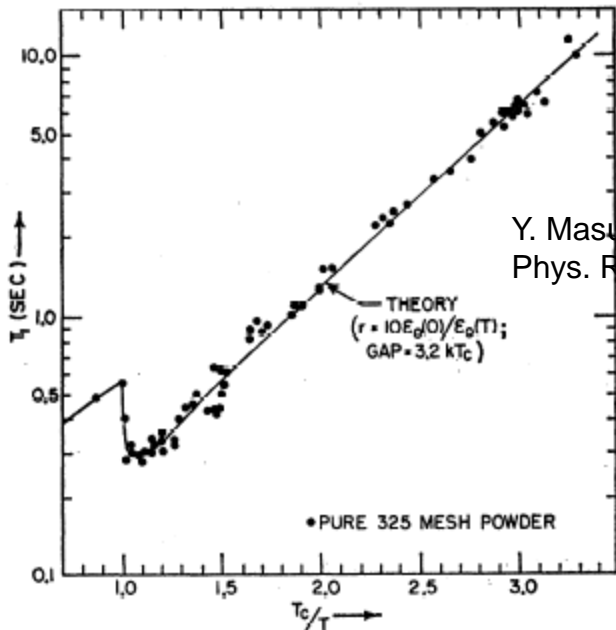


FIG. 3. Relaxation rate in a superconductor, R_s , relative to the zero-field value extrapolated from the normal state, $R_n(0)$, versus reduced temperature θ/θ_c . The three theoretical curves using BCS theory are described in the text.

Case II
Coherence Effects



Y. Masuda and A. G. Redfield
Phys. Rev. **125**, 159 (1962)

FIG. 2. Measured values of T_1 in the powdered sample. No points were rejected, so that the scatter gives a fairly good idea of the accuracy. T_c was taken to be 1.178°K. The theoretical curve is the same as the solid line of Fig. 5.

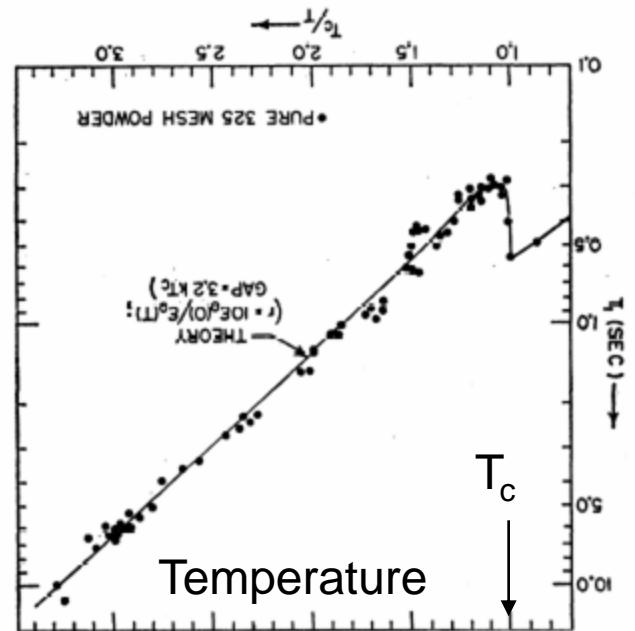


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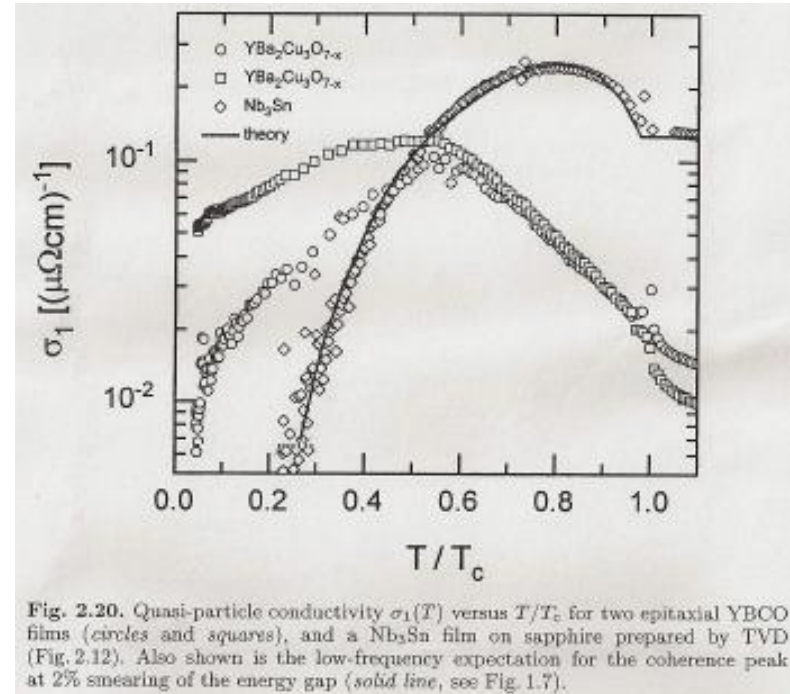
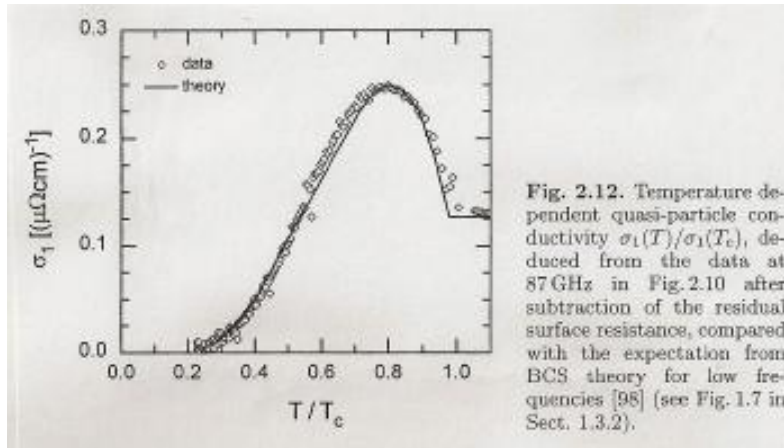
"1/T₁"

Case II Coherence Effects in $\sigma_1(T)$

Nb₃Sn

Nb₃Sn and Cuprate

“BCS Coherence Peak”



Case II Coherence Effects

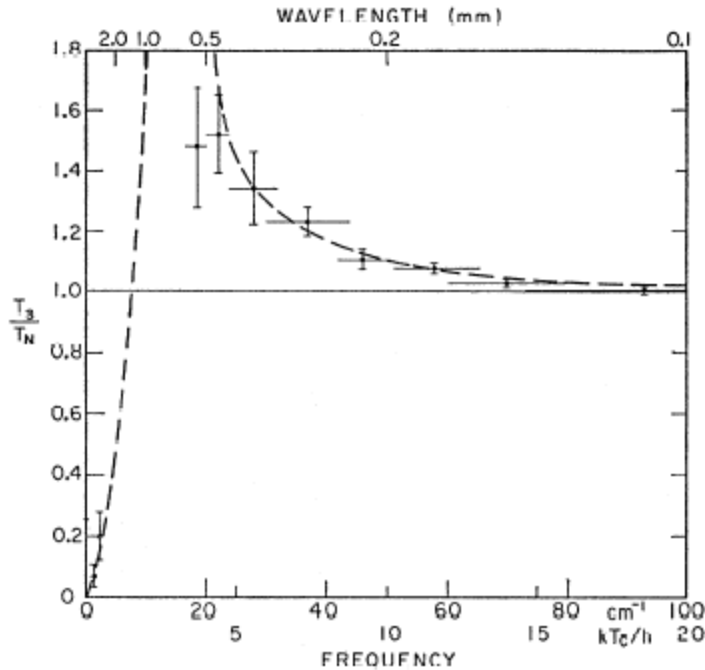


FIG. 1. Experimental transmission ratios of superconducting and normal states of a typical lead film (dc residual resistance 117 ohms; transmission in normal state = $\frac{1}{2}$) at $T/T_c = 0.67 \pm 0.03$. The frequency uncertainty on each infrared point is the half-power width of the continuous spectrum used. The vertical error limits on these points are derived statistically from the data. The dashed curve is one proposed for $T=0$ and an energy gap of $3kT_c$, as described in the following Letter.

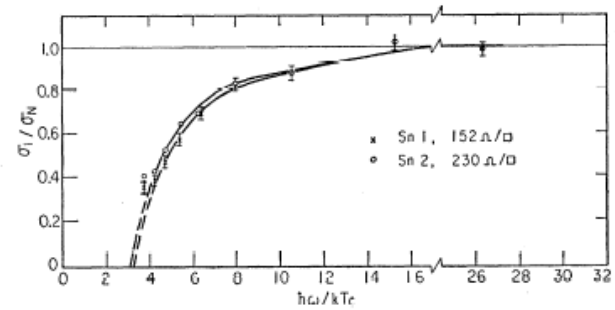


FIG. 8. Frequency dependence of σ_1/σ_N for Sn1 and Sn2.

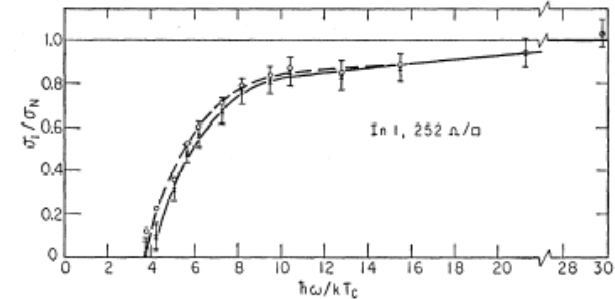


FIG. 9. Frequency dependence of σ_1/σ_N for In1. The solid curve is calculated using the measured film resistance, the broken curve using the calculated value. (See text.)

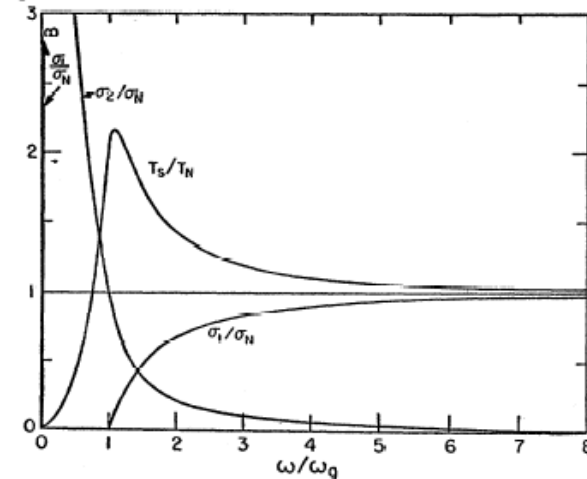


FIG. 10. Frequency dependence of σ_1/σ_N , σ_2/σ_N , and T_S/T_N according to the calculation of Mattis and Bardeen. The transmission curve is for a film resistance $377/(n+1)$ ohms per square, where n is the refractive index of the substrate.

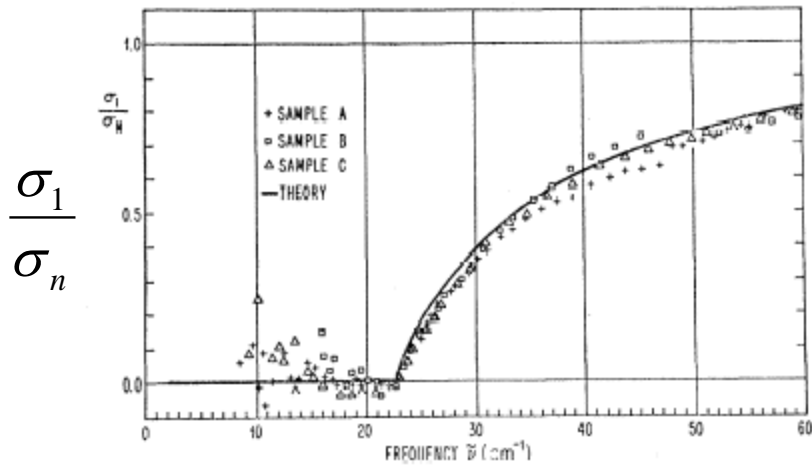


FIG. 3. Results of measurements of the real part of the normalized conductivity of three thin lead films at 2°K, compared with Mattis-Bardeen theory with gap frequency fitted to 22.5 cm^{-1} . To reduce the clutter in the figure, only about one fourth as many points are shown as were taken and recorded in Ref. 7. The points shown are selected typical points above the gap and local averages below the gap.

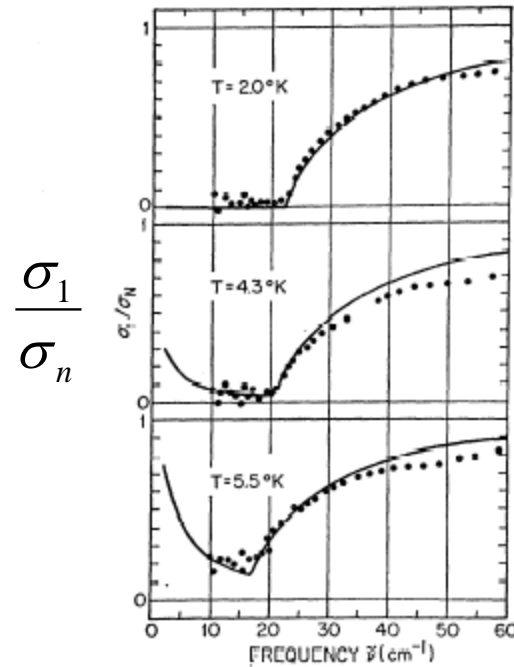
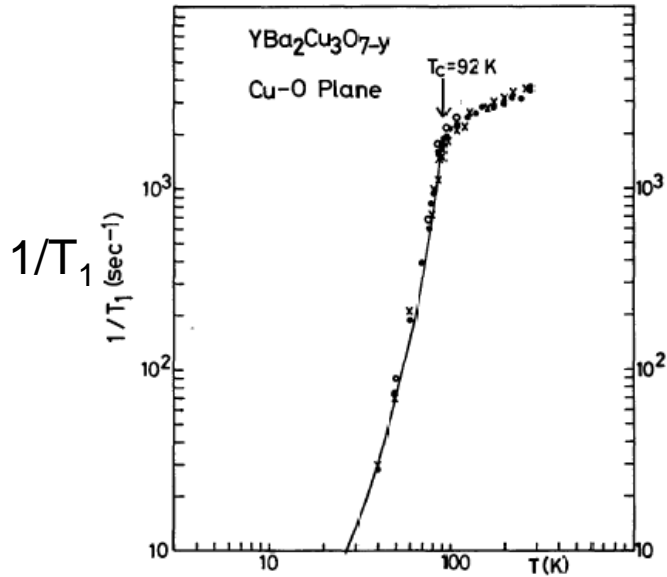


FIG. 4. Temperature and frequency dependence of normalized conductivity σ_1/σ_N in a thin superconducting lead film (sample C), compared with predictions of Mattis-Bardeen theory (calculated with the assistance of a program supplied by Harris), shown as solid curve. The gap frequency was fitted only for the low-temperature limit. The number of data points shown has been reduced as in Fig. 3.

L. H. Palmer and M. Tinkham, Phys. Rev. **165**, 588 (1968)

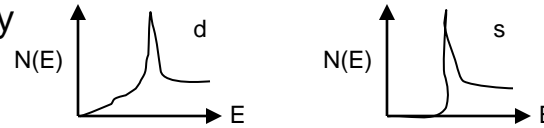
Absence of Case II Coherence Effects in Cuprates



Y. Kitaoka, *et al.*, J. Phys. Soc. Japan **57**, 30 (1988)

Reasons for absence of coherence effects in high- T_c cuprates

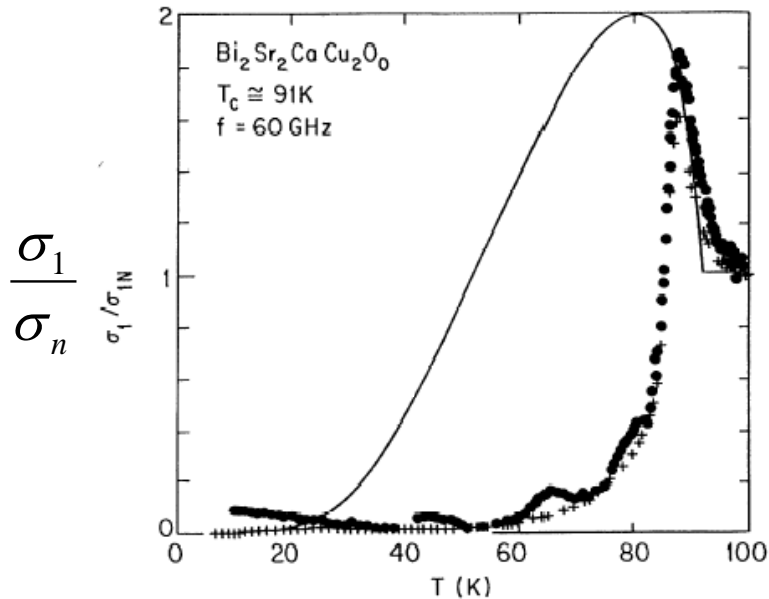
Gap anisotropy



Spin fluctuations (not QPs) dominate spin relaxation

Clean limit electrodynamics (suppresses “coherence peak”)

The absence of “coherence effects” does not rule out a BCS-like description of the cuprates



K. Holczer, *et al.*, Phys. Rev. Lett. **67**, 152 (1991)