minimum and the anomalous variation of the thermoelectric power with temperature.

It seems, therefore, that the interaction introduced by Fröhlich is at least partly responsible for the resistivity minimum and other anomalous properties of metals at low temperatures, although a final decision will of course have to await an improvement in the general mathematical technique.

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Temperature Variation of the Mean Debye Temperature of Cu_3Au, 20°C to 450°C

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The temperature variation of the mean Debye temperature of crystalline Cu_3Au at equilibrium order is computed from the values of the elastic constants at equilibrium order obtained by Siegel. The Debye temperature decreases from the value 272°K at 20°C to the value 234°K at 450°C, with a discontinuous drop from 249°K to 239°K at the critical temperature for disordering, 387°C.

THE mean Debye temperature Θ_D of a cubic crystal is given by the expression

$$\Theta_D=(h/k)v_m\{3N/4\pi V\}^{\frac{1}{3}},$$

where N is the number of atoms in volume V of the crystal and v_m is defined by the formula

$$3/v_m{}^3=\sum_i(1/v_{mi}{}^3),\quad i=1,\,2,\,3,$$

in which the v_{mi} are the three velocities of propagation of plane elastic waves in the crystal, averaged over all directions in the crystal.

A facile method for computing v_m with given values of the crystal elastic constants is described in a recent issue of this journal.[1] The accuracy of the result obtained with this method is determined solely by that of the given data. The method is here applied to the measurements reported by Siegel, of the elastic constants of Cu_3Au in a state of equilibrium order appropriate to the temperature of measurement.[2] The result is given in Table I. The value of $(h/k)\{3N/4\pi V\}^{\frac{1}{3}}$ employed in the calculations in 1.2583×10^{-3} cgs units.

Table I. The temperature variation of the mean Debye temperature of crystalline Cu_3Au at equilibrium order.

T°K	θ_D°K	T°K	θ_D°K
293.3	272.4	653.3	250.6
373.3	268.8	658.3	249.0
473.3	263.5	663.3	238.9
573.3	258.9	673.3	238.1
623.3	254.3	723.3	234.0

The density of crystalline Cu_3Au at 20°C, measured in this laboratory on one of Siegel's specimens, is 12.15 g/cm^3. Densities at other temperatures are computed with Siegel's values of the linear dilatation. These differ slightly from the highly precise measurements of Nix and MacNair,[3] but the latter, of course, appertain to a specimen of slightly different composition. The critical temperature T_c of Siegel's specimens is 660.8°K. Departures of the tabular values from a smooth representative curve are less than 0.5°K.

The Debye temperature decreases linearly with temperature from 20°C to about 280°C, and thereafter at an increasing rate to the critical temperature. A discontinuous drop of about 10°C occurs at T_c, followed by a linear decrease at a rate slightly greater than the preceding. A similar decrease in the characteristic temperatures of ordered and disordered specimens is deduced by Bowen from measurements of electrical resistivity, with the aid of Gruneisen's formula.[4] But the value of Θ_D obtained in this manner is 175°K.

It is of interest to compare the value of Θ_D at 20°C of nearly perfectly ordered Cu_3Au, 272.4°K, with that of Au, 157.6°K, and Cu, 330.7°K. The latter are computed with the elastic constant measurements of Rohl[5] and Goens,[6] respectively.

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[1] S. L. Quimby and P. M. Sutton, Phys. Rev. **91**, 1122 (1953).
[2] S. Siegel, Phys. Rev. **57**, 537 (1940).
[3] F. C. Nix and D. MacNair, Phys. Rev. **60**, 320 (1941).
[4] D. Bowen, Phys. Rev. **91**, 220 (1953).
[5] H. Rohl, Ann. Physik **16**, 887 (1933).
[6] E. Goens, Ann Physik **38**, 456 (1940).