Phason Anomalies in Alkali Metals

Early data[1] on the heat capacity, C, of K (0.26 to 4 K) and Rb (0.20 to 4 K) were taken to be consistent with conventional assumptions about the temperature dependence of the phonon and electron contributions, but the identification of phason anomalies has recently been reported[2,3] for both metals. Plots of new data for K and Cu are reproduced from Ref. 2 in Figs. 1(a) and 1(b). The identification of a phason anomaly in the K data depends on the sharp break near 0.85 K in the deviation of C from a reference expression C_0. *However, the Cu data, which were intended to provide support for the temperature scale, show a feature that is similar in both magnitude and temperature dependence.* Thus, the Cu data suggest a temperature scale error that is common to both measurements and responsible for the anomaly in K. Figure 1(c) demonstrates the possibility of representing the K data without a phason anomaly, but with the same temperature scale errors (to within the combined precision of the data) as evident in the Cu data. Independent support for this interpretation is provided by the other measurements[1,4] on K, which are represented by curves in Fig. 1(a): All three sets of data agree to within 1.5% above 0.85 K, and *only* the data of Amarasekara and Keesom[2] show the sharp break at that temperature. At 0.26 K the data from Lien and Phillips[1] are 12% high relative to the C_0 corresponding to the phason anomaly and used as a basis for Fig. 1(a), well outside the apparent[1,5] accuracy. The data[1] for Rb have been reinterpreted in terms of both a phason anomaly[3] (2% at 0.5 K) and phonon dispersion.[6] The accuracy and temperature range of the data are marginal for the purpose of identifying a 2% effect, and certainly inadequate to distinguish between the two models. The question of a phason contribution to C is thus still open for both metals.

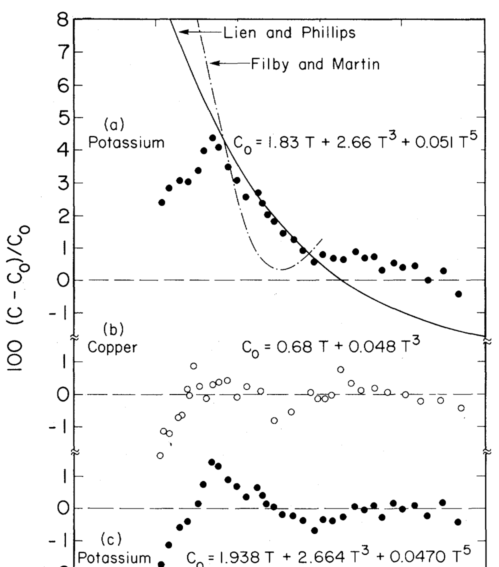

FIG. 1. The heat capacities of K and Cu.

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[4] J. D. Filby and Douglas L. Martin, Proc. Roy. Soc. London, Ser. A 284, 83 (1965), measured C between 0.4 and 1.5 K, but they noted errors in C below 0.7 K, and they gave no weight to those data. The bend in their data at 1.2 K is also typical of results obtained near the limit of a thermometer calibration.

[5] Thermal equilibrium problems that gave high results from 0.7 to 1.2 K did not extend to 0.26 K. The original estimate of 1% maximum errors arising from the temperature scale, although probably somewhat optimistic, was generally supported by subsequent experience with the apparatus [Norman E. Phillips, Phys. Rev. 134, A385 (1964)].

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