SECOND-ORDER PHASE TRANSITION IN CuSe

B.Mestnik, D.Djurek and Z.Ogorelec
Institute of Physics of the University, Zagreb

Cupric selenide CuSe has been found to exhibit two phase transitions: from hexagonal to ortorhombic symmetry at 326 K[1,2], and from ortorhombic back to hexagonal around 393 K. Since our measurements of the thermal expansion, resistivity and specific heat showed very small anomaly in the temperature dependence of these properties near to 393 K, the ortorhombic-hexagonal transition can be really considered as a second-order phase transition, in accordance with certain earlier DTA measurements[1].

However, more interesting in this work was the first-order transition at 326 K, where a wide critical range near the transition point occurs.

The lattice expansion (L) through the phase transition was measured using the method of inductive dilatometry. The results are shown in fig.1. Assuming a linear contribution arising from the lattice expansion due to the phonon-phonon interactions, we used the least squares method on the data for $T-T_c > 15$ K (T_c is the transition temperature) to obtain the background term $L_b(T)$. The anomalous contribution $L(T)$ is then given by $\Delta L(T)=L(T)-L_b(T)$. As is known, this quantity follows the relation $\Delta L \sim (T-T_c)^{\delta}$. The critical exponent δ, obtained from the experimental data, is equal to (0.118 ± 0.006).

In order to verify the correlation between the thermal expansion and resistance (or conductivity), measurements of electrical conductivity (σ) were carried out. The results are shown in fig.2. In the critical region the anomalous $\Delta\sigma(T) = \sigma(T)-\sigma_b(T)$ ($\sigma_b(T)$ was determined similar to $L_b(T)$) satisfies the relation: $\Delta\sigma \sim (T - T_c)^{\nu}$. From the experimental results, the value of the critical exponent was obtained. $\nu = 0.87 \pm 0.03$.

Finally, the specific heat also showed a critical

behaviour near the transition temperature. According to the relation: $c_p \sim (T - T_c)^{\alpha}$, the critical exponent was determined. The obtained value is equal to (0.17 ± 0.03).

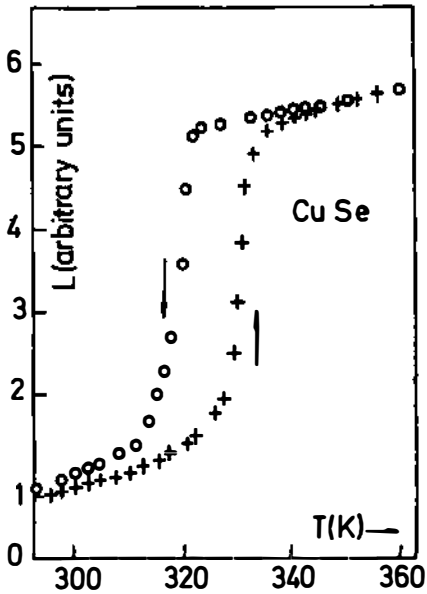

Fig 1.

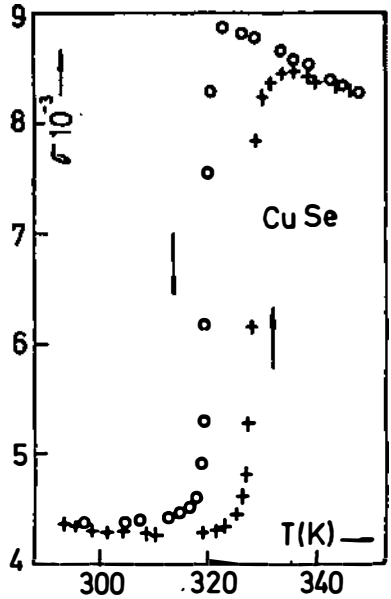

Fig 2.

A thorough study of critical behaviour near the metal -semimetal transition in CuSe would require the measurement of isothermal compressibility. Since it would give the critical exponent δ', the scaling relation $\delta + \delta' + \alpha = 2$ could be proved. As it is pointed out in the percolation model [3], this relation would not be satisfied in a two-dimensional case accompanied with transition in CuSe.

References

1) A.L.N.Stevels, Phil.Res.Rep.Suppl. 9 (1969) 1
2) Z.Ogorelec and D.Selinger, J.Mat.Sci. 6 (1971) 136
3) J.W.Essam and K.M.Gwilym,J.Phys.C. 4 (1971) L 228