2^{nd} Report on LG18284

J.E. Hirsch

Thermodynamic inconsistency of the conventional theory of superconductivity

The problem of this paper is that the question posed by the author and answered by him in a way called “application of BCS theory” is ill-posed. A finite rate cooling process cannot possibly be described by thermodynamics and linear response equations. The partial result derived by the author and considered by the author to be the central point, namely the entropy generated by dissipative normal fluid currents, does not prove that the final state is not an equilibrium state. As I said in my first report, there are even additional dissipative processes involved in the relaxation of the system to equilibrium. All the entropy generated by these processes is absorbed by the thermal reservoir. This is the meaning of “cooling”! The thermal reservoir is by definition a system that can absorb an arbitrary amount of heat from the system under consideration, which implies that it is infinitely larger.

A valid theory of the cooling process involves the energy exchange of the electrons of the superconductor (or better, the Bogoliubov quasiparticles and the superfluid) with the entities carrying energy (heat) in the reservoir (e.g. the phonons). Microscopic BCS theory, which is to say a theory of the collective variables of the superfluid and the Bogoliubov quasiparticle distribution function out of equilibrium, will no doubt be sufficient to describe the process of cooling starting from the equilibrium state at temperature T1 to the equilibrium state at temperature T2<T1.

The author writes: *The change in entropy of the reservoir is Q/T_2. Q is independent of the speed of the process, it is entirely determined by the initial and final states, which are independent of the speed of the process, as I show in my paper. Both the change in entropy of the system and the reservoir are entirely determined by the initial and final states, which are the same no matter what the speed of the process was. Therefore, the entropy generated by the Joule heat Q_J, that does depend on the speed of the process, has nowhere to go.*

The problem with this argument is that the system and the reservoir are both considered as closed finite systems. But the reservoir is an open system, or equivalent, an infinite system. If it were not so, the entropies of both systems would decrease in the cooling process, in contradiction with the second law. The role of the reservoir in a cooling process is to absorb any heat/entropy from the system until the system has reached thermodynamic equilibrium at the final temperature.

To summarize, the calculation presented by the author is not adequate for describing the finite rate cooling process. The claim of the author that BCS theory is inconsistent is incorrect. This paper should not be published.