
Second Report of the First Referee -- BG14421/Hirsch

The author's reply to my first report shows that there is a fundamental difference of understanding of what BCS theory is and how the physical process considered in his paper should be described by theory. The source of disagreement, in a nutshell, is the following:

The cooling process involving a finite cooling rate takes the system out of equilibrium and therefore cannot be described by equilibrium thermodynamics. As said in my report the correct way of describing the state of the system is in terms of the nonequilibrium Bogoliubov quasiparticle distribution and the variables of the superfluid. Then, it will become clear that the state of the system at the end of the cooling process (the time dependent change of the temperature of the heat reservoir) is out of equilibrium and therefore cannot be described by the thermodynamic variables as in the author's calculation. From this non-equilibrium state the superconductor will relax to equilibrium at temperature T2 within a microscopic relaxation time.

The heat reservoir and the superconductor coupled to it are not a "closed system" of finite extension. Rather, the heat reservoir by definition can absorb heat and entropy without changing its temperature, because it is much bigger than the system under consideration. This implies, in particular, that any heat generated by dissipation in the cooling process in the superconductor will be absorbed by the reservoir. The extra entropy carried by the quasiparticle system at time t2 will also be absorbed by the reservoir. That is the meaning of "cooling." A more detailed theory of the cooling process would involve interaction processes of the quasiparticles with the phonons of the heat bath, as mentioned in my first report.

To summarize, the calculation presented by the author is incomplete. It does not correctly describe the finite rate cooling process. The claim of the author that BCS theory is in conflict with thermodynamics is incorrect. This paper should not be published.