
Report of the Editorial Board Member -- BG14421/Hirsch

This manuscript reports theoretical considerations pointing to an inconsistency of the conventional theory of superconductivity. The author describes a Gedankenexperiment which involves the non-equilibrium cooling of a superconductor. The inconsistency consists in that the conventional theory, according to the author's opinion, predicts that the equilibrium state at the end of the process depends on the cooling rate during that process which is inconsistent with general thermodynamics.

The manuscript has been reviewed by three referees, with two negative reports by the first referee and a negative report each by the second and third referee, together resulting in a rejection from PRB. The author has appealed against this decision. In the refereeing process, the critique was focused on different aspects of the author's ideas.

After having studied the manuscript and the correspondence, my impressions are mixed. While I appreciate the author's thoughts and most of his replies to the referees, I think his argumentation is flawed. In this respect I tend to side with the first referee.

Before explaining my concerns, I quickly comment on the issues raised by the second and the third referee. The second referee has argued that a supercurrent shorts an electric field across the superconducting sample and that therefore the author's arguments are incorrect. I agree with the author that this statement does not apply to the situation considered, and therefore is not a valid critique. The third referee has constructed another physics example where he/she argues that if the author's considerations were valid more contradictions would arise. The author has pointed to important differences between his case and the one constructed by the referee, and I tend to agree with the author.

Here is where I think the flaw is: The author assumes that the heat reservoir is infinite (because he assumes that its temperature is not changed), but at the same time talks about a final state of the reservoir and an associated entropy. I think this is problematic, and this has been clearly pointed out in the first referee's second report. If the author were to assume a finite "heat reservoir", then its temperature change would depend on the cooling rate of the process, and hence no contradiction would arise. If the author thinks otherwise, then he should extend his argument with a clean calculation involving a finite reservoir.

Taken together, I do not feel in the position to overrule the collective vote of the referee, and hence I support the rejection of the paper.

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Physical Review B