Response to Referee A

I would like to start by thanking the referee for the time and effort spent in reviewing my paper. I have made some changes to the manuscript to make it clearer. In the following I respond to the referee's comments in detail.
The referee says
"The papers call into question the long accepted notion that the equilibrium state of a type I superconductor depends only on the state variables temperature and magnetic field and NOT on the history leading to that state."
That is a misunderstanding of what I say. I fully agree that the equilibrium state of a type I superconductor only depends on the state variables. That is why the inconsistency arises. The resolution to the inconsistency that I propose is NOT to call the above into question. Rather, it is to propose that in the process described in my paper no Joule heat is dissipated, contrary to what BCS theory would predict.

The referee further says:
"the author concludes that there is a conflict with the statement that the final state of the cooling process should be a thermal equilibrium state."
and
"In my opinion the solution to this seeming conundrum is as follows. In the case of finite cooling rate the entropy is expected to increase beyond the thermodynamic entropy change. The final state is necessarily a nonequilibrium state."
I am considering the situation where the cooling occurs at a finite rate, during which the states are nonequilibrium states. at the end when the system reaches the final temperature we wait long enough until the system reaches its equilibrium state at that temperature. That is the final state I am considering. So to say " *The final state is necessarily a nonequilibrium state"* is not correct. In my final state, the Bogoliubov quasiparticle distribution IS a Fermi distribution.

The referee further says:
"However, the coupling to the thermal reservoir causes the system to equilibrate. As a consequence the extra entropy is removed."
That is exactly the point. My paper shows that the extra entropy is NOT "removed". Removed to where? The "universe" is system plus reservoir. 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. And entropy is a function of state, given initial and final states of the "universe" the difference in entropy is entirely determined, independent of the path or speed of process connecting the given initial and given final states.

The referee further says:
"So, in my view, the thermodynamic process considered by the author is incomplete. If a

finite cooling rate is employed, at the end of the process the relaxation to the equilibrium state necessarily has to be included."
As explained above, the relaxation to the final equilibrium state is included in the process I am considering. There is no need for me to describe in any detail that relaxation process. I wait until it has happened, take the resulting final state, consider the initial and final states, and point out the inconsistency.

The referee further says:
"To summarize, the conclusion that the result of the calculation presented in the paper proves the thermodynamic inconsistency of the conventional theory of superconductivity is not correct."
As argued above, the result of the calculation presented in the paper does prove the above, and the statement of the referee is not correct.

As my paper says, the inconsistency would be resolved if there is no Joule heat dissipated in the process. That is what I am proposing is the case, and it is in contradiction with BCS theory. Other possible resolutions would be:
(a) The final state of the superconductor depends on the process, i.e. is different depending on whether the process was slow or fast. I don't believe that's the case, I don't think the referee does either, and in any event that would contradict BCS.
(b) The London penetration depth below T_c does not change with temperature. I don't believe that's the case, I don't think the referee does either, and in any event that would contradict BCS.
I don't believe there is any other alternative, but invite the referee to find one.

I would like to ask the referee to consider my comments above, and if he/she still thinks I am wrong let me know why, or else reconsider his/her recommendation.

Thank you for the time and effort spent in reviewing this response.

Jorge E. Hirsch