---------------------------------------------------------------------
Report of the Second Referee -- BG14421/Hirsch
---------------------------------------------------------------------

The manuscript continues the theme of multiple recent writings by the author attempting to disprove the conventional theory of superconductivity. The ironic part is that, while the author claims the faults of the BCS theory, he actually does not use that theory in any of the calculations, relying instead on a two-fluid model, taken so liberally and out of context that it goes beyond physics in the realm of drawing straw figures that one then wants to defeat. One example is eq.(5) of PRL, eq. (39) of PRB, which claims the normal current by Bogoliubov quasiparticles, and then proceeds to point out inconsistencies in Joule heating. What the author seems to have forgotten is that the superconducting condensate shorts the connection, so actually having a finite electric field across a superconducting sample requires either a current exceeding critical current or highly non-equilibrium situation. Neither one can be addressed in the framework of the approach taken in the manuscript. Therefore the inconsistency involving Joule heating is completely made up.

I suggest the author considers a microscopic theory of superconductivity, and determines the Joule heating in the non-equilibrium Keldysh formalism for a superconductor with leads attached, including full self-consistency on the spatial dependence of the order parameter, including near the leads. If such calculation shows discrepancies with prevailing theories, we will be able to have a scientific discussion on where it originates, and whether it is a deficiency of the approach or the underlying assumptions. Since the current calculation does not address this, a constructive physics discussion is impossible, and the manuscript is not appropriate for publication in a reputable scientific journal.

In addition to the extended discussion of the material considered in the paper submitted to PRL, this manuscript makes even more obvious that a fully-self-consistent microscopic non-equilibrium calculation is needed, since only such calculation can answer questions about non-ergodicity and heat generation, the author discusses the angular momentum of the Cooper pairs. This is a topic with rich history, and many of the questions surrounding it have been resolved by considering the detailed variation of the order parameter near the boundaries, see Phys. Rev. B 84, 214509 (2011) for discussion relevant to unconventional superconductors, but many of the arguments remain valid for conventional system.

Therefore I reiterate to the editors of PRB that only a fully microscopic non-equilibrium self-consistent calculation is able to answer the questions posed. I am personally convinced that they would show agreement with the BCS-like theory, but welcome the author to carry them out and resubmit the paper then, and only then.