From: **Jorge E. Hirsch** jhirsch@physics.ucsd.edu
Subject: Re: Your_manuscript BG14421 Hirsch
Date: December 4, 2019 at 19:00
To: prb@aps.org
Bcc: jhirsch@physics.ucsd.edu

JH

Dear Dr. Melikyan,

Thank you for informing me of your decision and sharing the report of the Editorial Board Member (EBM).

I am surprised by your decision, given that the EBM says:
"The second referee has argued...is not a valid critique.”;
"The third referee has constructed... I tend to agree with the author.”;
"I tend to side with the first referee...If the author thinks otherwise, then he should extend his argument with a clean calculation involving a finite reservoir.”

The fact is, such a “clean calculation” was contained in the response I sent to referee A report of my PRL submission several weeks ago, attached. Its essence was also contained in my response to the PRB “first referee” but I guess it wasn’t very clear and the EBM did not appreciate it.

I reproduce the “clean calculation” below.
I would appreciate if in view of this you would reconsider your decision to conclude the scientific review of this manuscript, and have the EBM consider my “clean calculation” and consider whether or not it is appropiate to revise his recommendation.

Thank you for your consideration and I look forward to your response.

Jorge E. Hirsch

"Clean calculation":

Following common practice, I assumed the "reservoir" is substantially larger than the system **only for simplicity**, so I don't have to worry about how much its temperature changes. But there is no reason to do that. The system starts at temperature T1, the (finite) "reservoir" starts at temperature T2<T1, when they have reached thermal equilibrium they will both attain temperature T3, with T2<T3<T1. If the "reservoir” is large, T3 will be very close to T2, if not it will not, but it doesn't matter. The key point is that **the value of T3 cannot depend on whether Joule heat was generated or not**, by **conservation of energy.**

Let me prove it cleanly. Energy is a function of state. So the energy of the system at temperatures T1 and T3 are fixed, so are the energies of the "reservoir" at temperatures T2 and T3. The "system plus "reservoir"" is the universe, there is nothing else. So by conservation of energy

Esys(T1)+Eres(T2)= Esys(T3)+Eres(T3) (1)

If, by having the process go at different speed, with different Joule heat generated, the system plus reservoir would attain an equilibrium temperature T4, we would have by conservation of energy

Esys(T1)+Eres(T2)= Esys(T4)+Eres(T4) (2)

Therefore combining (1) and (2),

Esys(T3)+Eres(T3)= Esys(T4)+Eres(T4) (3)

hence from (3)

Esys(T3) - Esys(T4)= Eres(T4) - Eres(T3) (4)

If T3 is not identical to T4, this equation ((4)) implies that either the system or the ‘reservoir’ have a negative heat capacity, right?
I.e. for example, if T3>T4 and the left side is positive, the right side is positive hence Eres(T3)- Eres(T4) is negative, hence the `reservoir' has negative heat capacity. But thermodynamic systems with negative heat capacity can’t exist.

Therefore, T3=T4. Therefore, system plus the (finite) 'reservoir' have to reach a unique final equilibrium temperature, independent of how much Joule heat is generated in the process. All the arguments in my paper apply to the system plus ‘reservoir’ reaching a **unique** final temperature T3 with T2<T3<T1. Therefore the criticism of first referee is invalid

reservoir" reaching a **unique** final temperature T_3 with $T_2 < T_3 < T_1$. Therefore the criticism of first referee is invalid.

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response to PRL referee A submitted 11/7/2019 (contains “clean calculation” given above)

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