

Review of: "A Law for Irreversible Thermodynamics? Synergy Increases Free Energy by Decreasing Entropy"

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Potential competing interests: No potential competing interests to declare.

Overall the manuscript is poorly written. The quality and style of some of its paragraphs resemble more personal notes or a web blog than a text on physics, social sciences or biological sciences, all of which the author claims their study would provide insight to. Several typos and syntax errors are present in this manuscript.

On multiple occasions, the author confirms that no extensive nor careful literature research was done to back up their results and statements. Additionally, the author admits a bias in their data analysis as is restricted only to ad hoc results previously done by the same author. These points are of major concern regarding suggesting the manuscript for publication.

The manuscript deals with describing open systems that are far from equilibrium. In order to do this, the author invokes thermodynamic concepts such as Free-Energy and Entropy. The main claim of the author is that in non-equilibrium systems the complexity observed, like in life evolution can only be explained via Synergy since the equilibrium Laws of Thermodynamics do not apply. It is evident that the author is not aware of the existence of non-equilibrium versions of the Laws of Thermodynamics. I recommend to the author to read the following references related to the principles of non-equilibrium thermodynamics *D Kondepudi, I Prigogine, **Modern Thermodynamics: From Heat Engines to Dissipative Structures**, (Wiley) I Prigogine, I Stengers, **Order out of Chaos**, (Radical Thinkers UK) S. R. De Groot, P. Mazur, **Non-Equilibrium Thermodynamics**, Dover. C. Jarzynski, **Nonequilibrium equality for free energy differences** *Phys. Rev. Lett.*, 78 (14): 2690, (1997) DOI:10.1103/PhysRevLett.78.2690, in particular the following paper where life's origin and complexity are studied, *K Michaelian, **Non-Equilibrium Thermodynamic Foundations of the Origin of Life Foundations** 2(1):308-337 (2022), DOI: 10.3390/foundations2010022.**

The way the synergy concept is introduced in the manuscript uses a definition of entropy borrowed from information theory while the definition of energy is from physics. In many cases these are incompatible, thus the author's synergy definition may only be useful within a social-science framework but not a fundamental law of thermodynamics. One can easily prove that the author's example of a cannonball and a pile of gunpowder placed inside the cannon will not increase the energy of the total system. In this example, the canon acts as an entropic barrier which reduces the dissipation processes. Without the cannon, the dissipation processes are bigger, but in both cases, the energy of the ball plus gunpowder is exactly the same. For all of these reasons, I cannot suggest this manuscript for publication in any serious peer-reviewed journal in its current form. I suggest the author do deeper literature research compiling advances in non-equilibrium thermodynamics, complex systems, and information theory and after that narrow, their method to the very specific social

aspects of the phenomena studied and avoid claiming a fundamental thermodynamic aspect linked to their results.