

Negentropy Second Law Proof

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Abstract

In this letter, we provide a simple proof of a Negentropy Second Law. Although simple, the results may help clear up such confusion as the Schrödinger Paradox. This is because we contend that the Negentropy Second Law is already a part of the Second Law.

Key Words: *Negative Entropy, Second Law*

1. Introduction

Negative entropy was first introduced by Erwin Schrödinger in 1944 [1] in a non-technical field in the popular science book, *What is Life*. Schrödinger uses it to identify the propensity of the living system to want to organize, which is seemingly contrary to the Second Law and is sometimes referred to as Schrödinger's paradox. That is, for most of us, we like to build houses, build cities, and organize our way of life. This is also observed in lower life forms. Thus, the second law, when it comes to spontaneous order is somewhat controversial among some scientists [1,2]. However strictly, the second law applies to closed systems that are adiabatically isolated, i.e. living systems are open. Nevertheless, the concept of spontaneous negative entropy is a subject of confusion. Furthermore, the concept of closed systems can be very broad when it comes to its deduced application statement that the entropy of the universe is increasing where living systems tend to organize which can add an element of even more misunderstanding. However, if we derive a simple proof that negative entropy is part of traditional thermodynamics second law, it should help diminish the notion of the Schrödinger paradox.

2. Negentropy Second Law Proof

It is a convenience in thermodynamics to have a science with emphases on disorder. However, without order, we cannot have disorder. Thus, without order, the science of thermodynamics could not exist. This is the basis for our proof. Any change in entropy must correspond to a change to the negative entropy that has already occurred at one time. A system that undergoes an internal entropy change according to the Second Law must obey

$$\Delta S_{i_System} \geq 0 \quad (1)$$

where the term ΔS_{i_System} represents a quantity internal irreversibility in the system. However, the order in the system is diminished, thus the negative entropy change that had to have taken place at one time to allow this disorder, must be equal to the system's entropy change, so that

$$\left| \Delta S_{i_System} \right| = \left| \Delta S_{i_NSystem} \right| \quad (2)$$

where the term $\Delta S_{i_NSystem}$ represents a quantity of internal order in the system so that

$$\Delta S_{i_NSystem} < 0 \quad (3)$$

Given the Second Law statement

$$\Delta S_{Environment} + \Delta S_{i_System} \geq 0 \quad (4)$$

where $\Delta S_{Environment}$ is the entropy exchange with the surrounding environment. Then it is also true from Eq. 2 and 4 that

$$\Delta S_{Environment} + \left| \Delta S_{i_NSystem} \right| \geq 0 \quad (5)$$

However, given Equation 2, this is a trivial case. But from the Second Law itself, given by Eq. 4, it must also be true that

$$\Delta S_{Environment} + \Delta S_{i_NSystem} \geq 0 \quad (6)$$

Equations 1 and 4 comprise the Second law, while Equations 3 and 6 comprise the Negentropy Second Law which has always existed since, without order, we cannot have disorder. Therefore, thermodynamics provides a measure for order as the science must.

Finally, adding the element of time may be helpful since living systems' ability to generate negative entropy varies over time. Since it is possible to write Eq. 1 as

$$\Delta S_{i_System}(t) \geq 0 \quad (7)$$

Since the entropy of an isolated system can increase in time, similarly we can write

$$\Delta S_{i_NSystem}(t) < 0 \quad (8)$$

This allows us to write Eq. 6 in a time-dependent way that may be useful in describing living systems more generally, writing the equation as

$$\Delta S_{Environment} + \Delta S_{i_NSystem}(t) \geq 0 \quad (9)$$

We also note from Equations 6 or 9 that any new order that occurs in a living system, for example, the inequality suggest that the total entropy must still be positive allowing for inefficiency in the living system to occur creating some irreversibility, such as waste to the environment. However, the equal sign suggest that any order that is created must be balance with the entropy in the environment.

4. Conclusion

In this paper, we have provided a Negentropy Second Law proof. The proof itself, while quite simple, may help reduce the confusion surrounding the Schrödinger Paradox since it is apparent that the Negentropy Second Law is in fact, part of thermodynamics since without order, we cannot have disorder.

References

1. Schrödinger E., *What is Life?* Cambridge University Press, Cambridge, 1944.

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