

DOES THE SECOND LAW OF THERMODYNAMICS ONLY HOLD FOR CLOSED SYSTEMS?

by: William DeJong

A common defense against criticism that the theory of evolution contradicts the Second Law of Thermodynamics is to object that the second law only holds for closed systems; not for open systems, as the earth. This assertion is false. The second law also holds for open systems, if the sum of the energy flows that pass their system boundary is zero. It can be proven that the earth, after removing living nature, is such an open system.

The mathematical formulation of the second law

The second law states, in the language of mathematics, that the disorder of a system ('entropy') increases, if the sum of all energy flows that pass its boundary is zero. In case of a closed system, it is evident that the sum is zero, since no energy flows can pass the system boundary. In case of an open system, however, the sum of the flows can also be zero, namely, if the energy flows that enter the system are as big as the energy flows that leave the system. In such an open system, the disorder will increase, as it does in a closed system. Notice that in our physical reality only open systems exist.

Thought experiment 1

Let Earth-2 be identical to our Earth, except the presence of living organisms. Place Earth-2 in space in the light of the sun. Draw an imaginary sphere around Earth-2 with a radius of 100,000 kilometers, and measure the energy flows entering and leaving this sphere. Initially, the sum of energy flows that enter the sphere will be greater than the sum of energy flows leaving it, since Earth-2 is warming up in the sun. But after some time, equilibrium will be reached and on average the sum of all energy flows that pass the sphere around Earth-2 will be zero. According to the second law, the disorder on Earth-2 will increase. Large molecules, probably produced by lightning, will ultimately fall apart; the larger the molecules, the faster.

Thought experiment 2

Let S be an open system that is positioned in an environment where random (= non directed) energy flows pass its boundary. On average, the sum of the energy flows that pass its boundary will be zero. According to the second law, the disorder in S increases. An example of such a system can be found on a beach. The wind and sea will produce ridges in the sand of a certain area A. But these random energy flows are not directed, and on average the sum of energy flows over the boundary of A will be zero, and the disorder within A will increase: rocks, stones, sand and shells will fall apart, finally into the smallest possible entities. Only directed energy can maintain the sand ridges within A and expand them into sandcastles.

Order out of chaos

Ilya Perigone [1] has shown that ridges in the sand can emerge by random energy flows; but he overlooked that these ridges are not maintained by these random energy flows; the next day they disappear again and are replaced by other ridges in an other direction. Perigone has also shown that living nature is constantly transforming molecules, cells and organisms into more complex structures; but he overlooked that this ordering is driven by the DNA program present in any cell, and not by random energy flows.

In the chemical industry simple molecules are transformed into complicated molecules by directed energy flows, not by random natural processes. If random, natural processes would be able to turn chaos into order, complicated molecules would become available for free; all energy problems on earth would be solved and the chemical industry would be out of business.

The second law and the natural course of events

The Second Law of Thermodynamics captures a fundamental property of our physical reality: everything will ultimately decay, driven by natural processes. Only directed effort can maintain, expand, or transform a system, resulting in a decrease of its entropy. The assertion that the second law does not hold for open systems denies a fundamental property of our physical reality.

The second law and mutations of the DNA

The natural course of events (mathematically described by the second law) also affects the DNA. In every cell, every day, hundred thousands of mutations of the DNA occur, which can cause hereditary diseases and cancer. Fortunately, this decay is antagonized by mutation protection and mutation repair mechanisms, for the discovery of which the Nobel Prize for Chemistry 2015 was awarded. The natural processes of mutation and decay can not produce these mutation protection and repair mechanisms, because a process that produces M cannot simultaneously produce NOT-M. [2].

Conclusion

Thought experiment 1 proves that evolutionary theory ("natural processes can produce living nature") is in contradiction with the Second Law of Thermodynamics. In more general terms: Evolutionary theory is in contradiction with the natural course of events and with the fundamental properties of our physical reality [3].

Notes:

1. Ilya Prigogine and Isabelle Stengers, *Order Out of Chaos: Man's new dialogue with nature* (New York: Bantam Books, 1984); Ilya Prigogine, *End of Certainty* (New York: The Free Press, 1997); Stuart Kaufman, *At Home in the Universe* (New York: Oxford University Press, Inc., 1995); and Christian De Duve, *Vital Dust: Life as Cosmic Imperative* (New York: Basic Books, 1995).
2. See: *Ten misconceptions of how the DNA changes*, at <http://www.evoskepsis.nl/docs/Ten%20misconceptions%20about%20how%20the%20DNA%20changes.pdf>
3. For a more elaborate discussion, see: *The theory of evolution in the perspective of Thermodynamics and everyday experience*, at: <http://www.evoskepsis.nl/docs/Evolutionary%20theorie%20and%20empirical%20science.pdf>

Dr. W.M. DeJong studied Mathematics and Thermodynamics at the University of Technology in Delft, The Netherlands. He is consultant and researcher of innovation and change at INI-Consult, respectively INI-Research.