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ENTROPY PRIOR TO THE FALL

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The assumption that the second law of thermodynamics was not in effect in the physical universe until after the Fall and imposition of the curse leads to many difficulties. Processes essential to life in the natural order, as well as thermodynamic order and predictability in all of nature are dependent upon the relationships involved in the second law. Scriptural data may be used to deduce that prior to the Fall the state of nature was one of natural, not supernatural order, though the living creatures and ecological systems were in a state of physical perfection.

It is therefore postulated that conditions described by the second law came into existence after Creation and prior to the Fall, that the disruptive and degenerative effects of random processes upon living systems were divinely constrained, and that the removal of this constraint constituted one aspect of the curse.

The assumption that conditions described by the second law of thermodynamics did not exist until after the Fall and the imposition of the curse upon all creation as recorded in Genesis 3 has apparently been widely accepted in creation-science circles without discussion. It would appear, however, upon careful examination of the place of the second law in the natural order that such an assumption leads to many serious problems. The purpose of the author is to consider foundations of the second law and its place in the natural order, and to suggest modifications to the above assumption which will eliminate the difficulties which inhere in it.

Foundations of Thermodynamics

Classical thermodynamics is concerned with energy transformations and equilibrium properties of macroscopic systems, systems sufficiently large for reproducible measurements of their properties to be made. The microscopic or atomic structure of the systems is not in view. The first law is the law of energy conservation.

The second law deals fundamentally with a property of physical systems called entropy, which has been found always to increase in irreversible processes in isolated systems. A thermodynamically reversible process is an ideal, hypothetical process in which all temperature, pressure, concentration and other gradients producing changes are infinitesimally small and all rates are infinitesimally slow. Obviously all real processes are irreversible, since they involve finite gradients and rates, and they therefore produce increased entropy.

The entropy, S, is related to the Gibbs free energy, G, by the equation:

$$G = E + pV - TS,$$

where E = internal energy, V = volume, p = pressure, and T = absolute temperature. For a process occurring at constant temperature and pressure, the change in free energy is $\triangle G = \triangle E + p\triangle V - T\triangle S$. Thus free energy involves the entropy and is therefore related to the second law. But the equilibrium constant for a chemical reaction is related to the free energy by the equation:

$$\log_{10} K = -\frac{\triangle G^0}{2.303\,RT}$$

where R is the gas constant, 1.987 cal/mole-deg; T is the absolute temperature; and $\triangle G^0$ is the increase in standard free energy of the products over the reactants. If $\triangle G^0$ is large positively, the reactants essentially will not react. If $\triangle G^0$ is large negatively, the reaction will go far to completion at equilibrium.[1]

Therefore, the direction of a chemical reaction and the equilibrium point are determined by application of the second law of thermodynamics through the relationship of the equilibrium constant to free energy and thus to entropy. Recall, also, that the second law may be used to describe the direction of the flow of heat and the flow of substances under pressure and concentration gradients, etc. These observations apply to the present natural order in the universe.

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Conditions before Genesis 3

What was the order of nature prior to the curse recorded in Genesis 3? Our first parents, though in an estate of holiness and intellectual and physical perfection, were nevertheless living in a natural, not a supernatural state. This may be deduced from the fact that they subsisted on food, and their bodies were flesh and blood, powered by natural chemical metabolism as ours are. There is every indication in Genesis 1-3 that once the supernatural work of creation was completed, the universe was in an orderly state in which cause and effect were normative.

Could such a state of nature exist independent of the second law? Consider, for instance, the chemical reactions involved in bodily metabolism of man and animals and in photosynthesis and other processes in the plants. Life depends upon these reactions proceeding in the proper direction and, in many instances, upon their attaining proper equilibria. In the human body the acid-base balance or pH of the blood and body fluids depends upon delicate chemical equilibria. Respiration depends upon movement of oxygen and carbon dioxide under the force of concentration gradients.

All of these processes absolutely necessary to physical life occur in accordance with the second law. In other words, the maintenance of orderly conditions and processes essential to living systems is not possible apart from the second law of thermodynamics.

Imagine, too, in the external realm of nature the improbable events, the unpredictability that could result from the absence or abrogation of relationships described by the second law. Adam might suffocate in fresh air or pick up a hot coal and get frost bite! A lake might separate into a solid block of ice at one end and boiling water at the other end. The air might separate into pockets of pure oxygen and pockets of pure, suffocating nitrogen. And these strange events could occur without violation of any physical law if relationships involved in the second law of thermodynamics were not in effect.

Statistical Mechanics Considered

At this point let us consider briefly what is called statistical mechanics or statistical thermodynamics.[2] Classical thermodynamics is not concerned with the atomic-molecular, microscopic structure of matter, but only with the properties and behavior of macroscopic systems consisting of trillions of atoms. On the other hand, statistical mechanics is concerned with the microscopic structure of matter and is used to relate the behavior of the microscopic elements of a system to its macroscopic thermodynamic properties.

Statistical mechanical analysis of a system starts with an assumed atomic-molecular model of the system. It is also assumed that atoms move according to the ordinary laws of mechanics (Newton's laws of motion) plus the energy conservation law. Then, in view of the fact that literally trillions of atoms are involved in the model so that it would be impossible to follow each atom individually, a reasonable assumption is made about the relative probabilities of different microscopic states of the system. Then a mathematical-statistical analysis is made of the behavior of the collection of atoms or molecules in the system.

The result of this analysis is the fact that the equilibrium thermodynamic properties of the system—such as the temperature, pressure, energy, entropy and free energy—can be related to the average behavior of the large numbers of microscopic elements contained in the system. In particular it can be shown that the equilibrium state toward which the system spontaneously moves is the state of maximum probability, maximum entropy, maximum disorder or uncertainty on the atomic scale or level.

This leads us to the statement of a seeming paradox: The thermodynamic orderliness and predictability of the natural order depends upon the second law of thermodynamics, which is used to describe the fact that the natural order is tending spontaneously toward the state of greatest disorder on the microscopic level. Without these conditions the thermodynamics of the natural order would be characterized by disorder and lack of predictability. Also observe that the second law is of a character apparently different from such laws as the law of conservation of energy, the laws of mechanics, or the laws of gravitational and electrical forces. The second law appears to arise from the action of these other physical laws which exist independently of the second law.

Summary and Proposal

In summary, if relationships involved in the second law of thermodynamics were not in effect prior to the Fall, the thermodynamic order essential to the existence of physical life would be absent, and there would be no thermodynamic order or predictability in nature apart from special divine supervision or control, which would accomplish everything which the second law involves in the way of time-irreversible direction for the natural order.

The replacement by such total special divine controls of that which is the natural composite effect described by the other fundamental laws ordained by the Creator seems to be an unreasonable procedure. The Scriptures do not imply that the divine purpose was to block or reverse all of the effects of the second law, but rather to maintain the original physical perfection of His creatures corresponding with the total moral perfection of the creation.

I would propose, therefore, a three-part formulation:

(1) The second law of thermodynamics, as far as its general implications for physical and chemical processes are concerned, was in effect as soon as the supernatural work of creation was completed.

(2) In the original state of the world prior to the Fall, all disruptive effects of random processes upon the perfect physical design and order of living things and upon the balanced natural order of ecological systems were prevented by special divine constraints.

(3) The removal of these constraints constituted one aspect of the curse.

This formulation avoids the difficulties inherent in the concept of post-Fall imposition of the second law, for it correlates with:

(1) The data of Genesis 1-3 from which an orderly, natural physical-chemical order after the completion of creation can be deduced.

(2) The biblical data relative to the perfect natural order prior to the Fall.

(3) The biblical data relative to the corruption and degeneration of the natural order following the imposition of the curse.

It is hoped that this proposal may lead to further and more careful analysis of this and other questions and to increased discussion and interaction between creationists, to the end that a creation model may be continually improved and thus brought into closer conformity with the data of the Scriptures and with the realities of our heavenly Father's creative handiwork.

References

[1]The fundamental principles of classical thermodynamics may be found in any standard text on Thermodynamics or Physical Chemistry.

[2]The fundamentals of statistical mechanics may be found in any standard text on Statistical Mechanics, Statistical Thermodynamics or Thermal Physics.

RESPONSE TO ROBERT KOFAHL

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Dr. Kofahl makes the assumption that the present is the key to the past in his article on the second law and the Fall. He is extrapolating present processes into the past where no observational information on metabolism, chemical reactions, etc., exists. If natural processes were different before the Fall, we have no justification for extrapolating into that period.

Drastic natural changes have occurred in the earth according to the Bible. For instance, animals initially ate vegetation (Genesis 1:30). However today there are many flesh-eating animals. What changes occurred to their metabolism and digestive processes because of this? The confusion of tongues at the Tower of Babel is another example. Something natural may have occurred to accomplish this, but we have no known means of study "at this point in time."

Considering the above unusual changes in living organisms, we cannot extrapolate particular present processes into the past any further than to the remarkable event. Frankly I am not willing to speculate about what existed before the Fall. The Bible is not that detailed in its description of natural processes.

However, there is nothing wrong with honest speculation into the past as long as it does not violate the clear teaching of Scripture. But any such speculation will always remain tentative and doubtful because of the lack of empirical evidence.

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I see no compelling reason that conditions described by the second law had to exist before the Fall. If such conditions were absent, then all processes that occurred would have been 100% efficient. Heat could have moved from a hot object to a cold object, and there would have been 100% efficient transfer. Human beings could have eaten food and their bodies would have utilized 100% of the energy value of the food. There would have been waste products, but all metabolism within the body would have been 100% efficient.

It must be remembered that the flow of heat from hot to cold objects is an observable fact and the second law was structured to fit this observation. The second law was also structured to fit the phenomenon of the mixability of gases. In the beginning was **not** the second law; it is a *mental construct* of men developed as a result of observations of the direction taken by natural processes.

Also, if conditions described by the second law did not exist before the Fall, then no entropy potential would have existed. This does not mean that heat did not flow from hot to cold objects, or that chemical reactions did not proceed in the same direction as now. It simply means that certain thermodynamic potentials such as free energy would have different meanings and interpretations.

I offer some unknowables that possibly could affect "science" before the Fall. The answer to these would change considerably any thermodynamic interpretations. Before the Fall: