THE LAW OF MAXIMUM ENTROPY PRODUCTION (LMEP, MEP)

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"(E)volution on planet Earth can be seen as an epistemic process by which the global system as a whole learns to degrade the cosmic gradient at the fastest possible rate given the constraints"

- *Rod Swenson, (1989), Emergent Evolution and the Global Attractor: The Evolutionary Epistemology of Entropy Production Maximization*

The Law of Maximum Entropy Production (LMEP or MEP) was first recognized by American scientist Rod Swenson in 1988, and articulated by him in its current form (below) in 1989. The principle circumstance that led Swenson to the discovery and specification of the law was the recognition by him and others of the failure of the then popular view of the second law or the entropy principle as a 'law of disorder'. In contrast to this view where transformations from disorder to order were taken to be 'infinitely improbable" such transformations are seen to characterize planetary evolution as a whole and happen regularly in the real world predictably and ordinarily with a "probability of one"[6]), The Law of Maximum Entropy Production thus has deep implications for evolutionary theory, culture theory, macroeconomics, human globalization, and more generally the time-dependent development of the Earth as a ecological planetary system as a whole.

It is given as follows:

THE LAW OF MAXIMUM ENTROPY PRODUCTION

***A system will select the path or assemblage of paths out of available paths that minimizes the potential or maximizes the entropy at the fastest rate given the constraints* (2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13).**

Discussion:

1. ENERGY, ENTROPY, GRADIENTS AND THE FIRST TWO LAWS OF THERMODYNAMICS

"(T)he laws of thermodynamics", as Swenson (12) has stated, "are special laws that sit above the other laws of physics as laws about laws or laws on which the other laws depend."

a) **THE FIRST LAW** (the 'law of energy conservation') says that all real world processes involve transformations of energy and that the total amount of energy is always conserved. It expresses time-translation symmetry, without which there could be no other laws at all (12).

b) **THE SECOND LAW** ('the entropy principle') as understood classically by Clausius and Thomson **captures the idea that the world is inherently active and whenever an energy distribution is out of equilibrium a gradient of a potential (or thermodynamic force) exists that the world acts to dissipate**

or minimize. Whereas the first law expresses that which remains the same, or time-symmetric, the second law expresses the fundamental broken symmetry, or time-assymetry of the world. **Clausius coined the term "entropy" to refer to the dissipated potential, and the second law in its most general form thus states that the world acts spontaneously to minimize potentials (or equivalently maximize the entropy).**(12)

The active nature of the Second Law is intuitively easy to grasp and demonstrate. If a cup of hot liquid, for example is placed in a colder room a gradient of a potential exists and a flow of heat is spontaneously produced from the cup to the room until the potential is minimized or dissipated (the entropy is maximized) at which point the temperatures are the same and all flows stop (the cup/room system is 'in thermal equilibrium").

2. WHAT THE LAW OF MAXIMUM ENTROPY PRODUCTION SAYS THAT THE SECOND LAW DOES NOT

Whereas the Second Law says that the world acts to minimize potentials it does not say which out available paths it will take to do this. This is the question the Law of Maximum Entropy Production answers. (Note: The Law of Maximum Entropy Production does not contradict or replace the second law. It is another law that is in addition to it). What Swenson pointed out as the answer to this question, as above, was that it will "select the path or assemblage of paths out of available paths that minimizes the potential or maximizes the entropy at the fastest rate given the constraints" (12). Like the classical view of the Second Law, although LMEP has profound and remarkable consequences, it is actually simple to grasp and empirically demonstrate.

Swenson & Turvey (6) provided the example of a warm mountain cabin in a cold snow-covered woods with the fire that provided the heat having burned out. Under these circumstances there is a temperature gradient between the warm cabin and cold woods. The second law tells us that over time the gradient or potential will be dissipated through walls or cracks around the windows and door until the cabin is as cold as the outside and the system is in equilibrium. We know empirically though that if we open a window or a door a portion of the heat will now rush out the door or window and not just through the walls or cracks. In short whenever we remove a constraint to the flow (such as a closed window) the cabin/environment system will exploit the new and faster pathway thereby increasing the rate the potential is minimized. Wherever it has the opportunity to minimize or 'destroy' the gradient of the potential (maximize the entropy) at a faster rate it will. exactly as the Law of Maximum Entropy Production says. Namely, it will "select the pathway or assembly of pathways that minimizes the potential or maximizes the entropy at the fastest rate given the constraints". Once this principle is grasped, examples are easy to recognize and show in everyday life

The profound implications of this deceivingly simple law are discussed in numerous other places (5,6,7,9, 13). (For additional discussion also see: (i) The problem with Boltzmann's view of the Second Law, (ii) Why the world is in the order production business, (iii) Entropy production and order from disorder, (iv) Planetary evolution and entropy production, (v) Ecological relations and entropy production.

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