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UNIVERSAL DYNAMICS: A THEORY OF EVERYTHING WITHOUT INVENTING ANYTHING

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This paper seeks to reconcile the constructal law with thermodynamics, quantum mechanics, and general relativity. Reconciling the constructal law with the more established laws of thermodynamics, we constitute a more complete and universal model of dynamics capable of explaining emergent and evolving design configurations observable throughout nature. Presented is a theory of universal dynamics, in which a core set of known universal laws can explain the universe's evolution through space, time, and all its emergent properties.

Keywords: Constructal; Quantum; Relativity; Complexity; Evolution; Emergence.

1. INTRODUCTION

Chemist P.W. Atkins wrote of the wonder that life is "not over in a flash" but rather "a slow unwinding of energy [1]." The same could be said for the rest of the universe, otherwise destined for a death state of maximum entropy [2]. But it's not over in a flash; the energy of the Big Bang continues to evolve, with a progressively complex structure that enhances access to flow and throughput of energy [3–5]. The constructal law explains how and why nature does this, despite the 2nd law of ever-increasing entropy. As its author Adrian Bejan explained, "The designs we see in nature are not the result of chance. They emerge to enhance access to flow in time [6]." Enhanced flow means flowing faster and further with less resistance and less energy sacrificed to entropy; this extends the world line of the flow system, increasing its proper time duration, or lifetime. It is thus a universal tendency of every flow system, with the freedom to do so, to structure itself in space-time to maximize its world line, thus forestalling entropy and death.

2. APPROACH

Physicist Neil Turok said earlier this year, "Maybe we don't need extra dimensions." "Maybe we do know the laws of physics….and what we have to do now is to understand how to use these laws to understand nature" [7].

As a thought experiment, assume only that the laws of each of the constructal laws, thermodynamics, general relativity, and quantum mechanics are all true and inviolable but incomplete to the extent they are not clearly reconciled with each other. Rather than invent theoretical constructs to fill the gaps, let's rethink how the four known pieces could logically and physically fit together. Consider a minimum viable universe at the time of the Big Bang, at which only universal law applied and only energy existed. From

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there, using only universal laws, can we explain how everything else in the universe emerged and evolved? Such a universal law, if one exists, must be absolutely universal and apply everywhere, at all times, at all scales of space-time. It must also explain how other laws are derived henceforth, and how such laws relate and apply to each other. This is the lens through which we consider each of the currently disparate models: How universal is it? How can it explain or be explained by each of the others? Finally, how predictive is it, and how is it supported by observational data?

3. **OBSERVATIONS**

• If universal means applicable at any place, any time, and any scale, that rules out quantum mechanics; scale symmetry being broken with the emergence of matter from energy; does not explain the other laws but can be explained by universal dynamics.

• The constructal law implies increasing efficiency (η) in a flow system, which proportionally increases energy rate density (Φ_m[erg/s/g]) over the lifetime or proper time (τ) of the system (see Fig. 1)

$$\Delta\eta \geq 0 \tag{1}$$

$$\eta \propto \Phi_m \tag{2}$$

$$\eta \propto \tau \tag{3}$$

• The constructal law and 2nd law of thermodynamics are closely interrelated [8]; a new insight is that both are monotonically positive and change in efficiency is inversely proportional to the change in entropy (see Fig. 2).

$$\Delta\eta = \frac{1}{\Delta S} \tag{4}$$

• For any system, at any point and any scale of spacetime, universal dynamics dictate that energy remain constant and entropy increases towards dynamic equilibrium or death and also that with the freedom to do so, the flow of energy structures itself to enhance access to flow, thus extending its world line in spacetime and forestalling entropy and death (see Fig. 3).

• The general relativity concept of proper time is integral to universal dynamics; the phenomena of spacetime curvature and gravity cannot explain the other laws but can be explained as manifestations of universal dynamics.

All figures are author's illustrations of the key concepts described.

Universal dynamics predicts directional evolution, towards higher levels of efficiency and energy throughput, through emergent hierarchical structure and complexity which extends the world line and proper time of the system.

To ground this theory in observation, we can look back across several distinct epochs in the evolution of the universe. From the Big Bang to the present, each epoch demonstrates increasing levels of emergent complexity and energy density. This initial analysis shows observations to be consistent with the predictions of the theory.

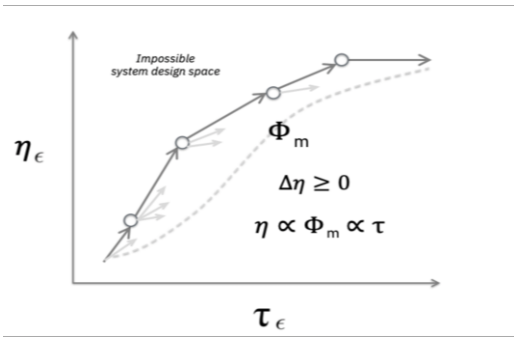

Fig. 1

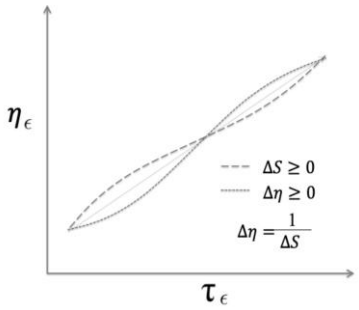

Fig. 2

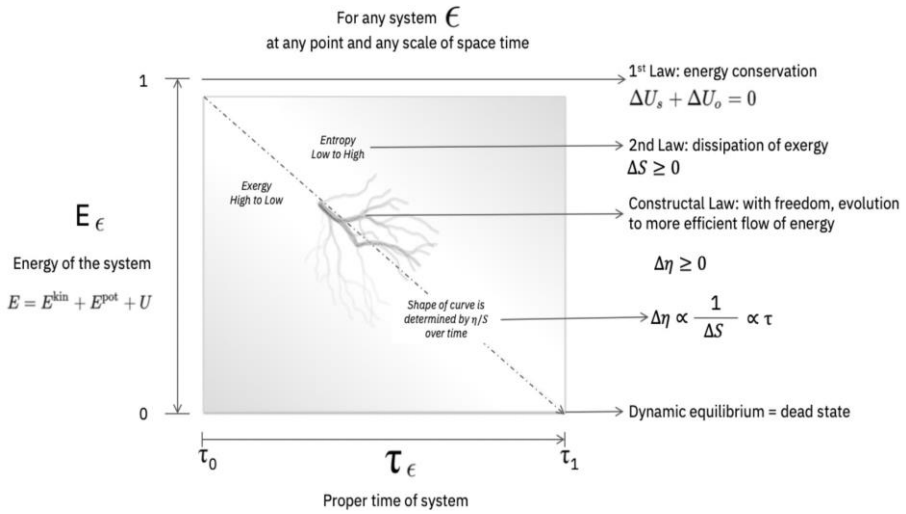

Fig. 3

Table 1

Predictions and observations across epochs of evolution in the universe

Predictions	**Fields and spacetime**	**Particles and matter**	**Stars and galaxies**	**Planets and plants**	**Animals and society**	**Technology**
Directional	yes	yes	yes	yes	yes	yes
Emergent structure	yes	yes	yes	yes	yes	yes
Hierarchical structure	yes	yes	yes	yes	yes	yes
Increasing energy rate density Φ_m [erg/s/g] (source: [3])	TBD	TBD	Milky Way, 12 Gya: 0.5 erg/s/g	Earth geosphere, 4 Gya: 4 erg/s/g Plants generally, 3 Gya: 900 erg/s/g	Animals, 0.5 Gya: 40,000 erg/s/g; Human society, 0 Gya: 500,000 erg/s/g; Hunter-gatherers, 300 Kya: 4×10^4 erg/s/g	Agriculturalists, 10 Kya: 10^5 erg/s/g Industrialists, 0.2 Kya: 5×10^5 erg/s/g Technologists 0 Kya:2×10^6 erg/s/g

4. **CONSIDERATIONS**

This view of universal dynamics is based entirely on a set of known laws that seem able to explain emergence and evolution, including emergent phenomena of spacetime curvature and quantum mechanics. A preliminary review of relevant data seems to correspond with its predictions. What one must believe is not the existence of unobserved phenomena but simply that the emergence and evolution of quantum mechanics is not the source but an early outcome of universal dynamics, consistent with all other emergence and evolution according to the constructal law and other laws of thermodynamics. Current alternative explanations are not as simple or satisfactory. Space here does not permit, but more analysis is called for. Validation through experimentation and data analysis is necessary. The good news is that the theory is predictive, and observational data that already exists is vast. More rigorous mathematical analysis is needed, and any observations that contradict the theory will dispel any illusions. If the theory does hold, it offers a reconciliation of known but otherwise disparate laws, thus advancing our understanding of nature and the evolution of the universe.

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