Explaining Auto-Emergence in Physics and Society

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ABSTRACT: This paper explains how the world that we observe and experience essentially emerges from a behavioral world. The natural selection of so-called 'behavior-pattern species' involving vibrating frozen water molecules determines the structure of snowflakes in much the same way as the natural selection of behavior-pattern species involving fields determines the E8 Lie group. In society, the natural selection of behavior-pattern species involving employees determines organizations. The principles of auto-emergence in both physics and society are identified by extending the paradigm of description in physics, an attempt which also sheds new light on some of the open issues in the world of physics.

NOTES:

This paper led to the book, *A New Leadership Ethos* – The Ability to Predict (2008). The latter is supported by a 'logbook of research', *A New Dimension of Time* (2007).

A new book (in preparation) and a 94-slide presentation (both titled *The Emzine Phenomenon*) explore the principles of auto-emergence and its consequences in more detail.

The above books and slideshow can be downloaded free from http://www.marcvandererve.org

A link to a 5-minute summary video:
http://www.youtube.com/user/EmzineFoundation?feature=mhw4#p/u/2/YyxDhXM5E-8

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1. Introduction

In the domain of physics, evaluations typically depart from certain spatial features and an energy balance to arrive at new spatial features and another energy balance. Interactions ranging from physical collisions to interactions involving waves and/or fields can be explained this way. As such, the 'canonical approach [involves] the product of a (spatial) three-manifold and the real line, representing time' [i]

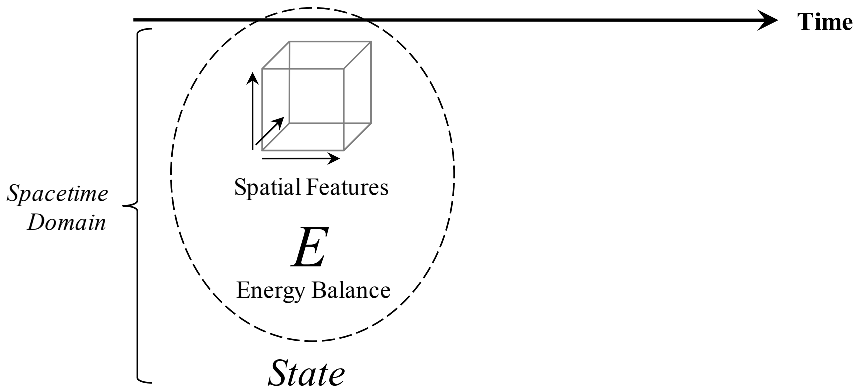

Figure 1: The evolution of a state departs from and arrives at spatial features and an energy balance.

As Henri Poincaré once pointed out, the relative situation at one instant yields a future state. Hence, starting from a certain state, one can calculate probable paths toward future states while, in time-reversible cases, one can also backtrack to possible previous states.

On the whole, the prevailing paradigm of description in physics can be summarized as follows:

$$State\ (Spatial\ Features, Energy) \xrightarrow{Operator} Future\ State\ (Spatial\ Features, Energy)$$

'The task of science is to set up connections between directly observable phenomena.'[ii] In fact, at every level in the hierarchy of the clockwork of nature, physicists seek operators (i.e. connections) that help them describe the transition from one state to another.

1.1. Limits to the Paradigm of Description in Physics

Although the understanding of the clockwork of nature has been advancing consistently, a number of fundamental issues have risen to the surface. These issues indicate that the limits of the current paradigm of description may have been reached.

The Need for an Unmoved Mover

The current paradigm of description in physics allows physicists to explain the working of the clockwork of nature only passively. Subsequent state changes can be traced but of a clockwork *in operation*. The question 'who wound up nature's clockwork originally' remains unanswered. Scientific conceptions of our world's creation, such as the Big Bang, are inspired by mathematical operators that yield a singularity when the time variable nears zero. This indicates the willingness of physicists to accept that time is an absolute phenomenon with a distinct beginning ($t = 0$) and, thus, also end.[iii] Indeed, the state of the art in physics seems still largely based on the thinking of Aristotle. His successors have added operators to his world of *substances of substances* but remain dependent on an *unmoved mover* to explain the transition from not-being to being.[iv]

Auto-emergent Particles in Absolute Vacuum

The interpretation of existence as *being* does not agree with recent research. At quantum levels, experimental evidence regarding the Casimir effect shows that self-creation is unfolding even in absolute vacuum (or quantum vacuum). Such a vacuum does not hold any particles and has a temperature near absolute zero. Within this nothingness, particle-antiparticle pairs may spontaneously emerge and annihilate one another. By applying Heisenberg's uncertainty principle to energy and time ($\Delta E \Delta t \sim h$), one might explain that the energy variable allows for phenomena of self-creation because it peaks at very small time intervals.[v] Yet, the paradigm of description is limited to a mathematical notation that fails to identify the turbulent progression of tradeoffs that is going on to produce these observable, yet fleeting spatial phenomena.

The Need for a Cosmological Constant

Einstein added a cosmological constant to his field equation for general relativity because, without it, the universe would show to be contracting as a result of the gravitational forces produced by matter. Einstein initially believed the universe to be a static phenomenon. Therefore, contraction would have to be compensated by a constant that represented a yet unforeseen effect. After Edwin Hubble had shown that the universe is expanding (*Hubble redshift*), Einstein deserted the idea. Hubble's finding would mean that his constant exerts a compensating force greater than the gravitational forces identified in his original field equation. The cosmological constant has survived Einstein's rejection as some macroscopic measure of negative pressure. The underlying assumption is that the energy needed for the ensuing adiabatic expansion is converted to sustain the *vacuum energy density* of the volume of the universe as it inflates.[vi] This assumption is supported by the idea that vacuum has a minimum level of energy. This so-called *zero-point energy*, which Einstein also identified (together with Stern), has been associated with the ground state of the quantum harmonic oscillator and its null oscillations. Unfortunately, when deriving the cosmological constant from a zero-point-energy, one arrives at an excessive value that does not fall into line in any way with the redshift-inspired calculations by cosmologists. Various other explanations of the cosmological constant have been contemplated, such as a constant that vanishes when the universe interacts through so-called wormholes with another universe containing particles with opposite sign.[vii] However, these explanations have been difficult to substantiate. Voices call for a new physics and, I dare say, an extended paradigm of description in physics to explain the need for a cosmological constant.

The Presumed Existence of Dark Energy and Dark Matter

Dark energy is believed to be the cause of cosmic inflation, that is, the accelerating expansion of the observable universe. At times qualified as phantom energy, dark energy might involve a 'non-standard form of kinetic energy'. The idea of cosmic inflation assumes a homogenous and isotropic (independent of direction) observable universe, yet a universe that might have emerged 'by a random fluctuation from some pre-existent state' and might return to a 'state of decay' eventually. Dark energy is also believed to account for Einstein's cosmological constant. Because it produces inflation, it is referred to as the 'cost of having space'. As such, it functions as a *space-spanning* or *space-bearing medium*. Not observable but assumed to be existent, dark energy reminds of the *light-bearing aether* which Michelson and Morley *dis*proved. A similar reasoning applies to the alleged existence of dark matter. Observations using gravitational lensing show that most stars in spiraling galaxies circle with about the same speed no matter whether they are close to the center or at the edge of the system. According to the so-called virial theorem, the orbit velocity of stars far from the center should be less than the orbit velocity of stars closer to the center of the system. A hypothetical belt of dark matter at the edge of a spiraling galactic system might explain the sustained levels of kinetic energy and, thus, the sustained orbit velocity of stars in spiraling galaxies.

Lack of Emergent Time

Evaluations in the domain of philosophy of science reveal concerns about the lack of time in quantum-gravity environments. The probabilities of observable phenomena occurring at these microscopic levels are in the way of the emergence of time. For example, 'in quantum theories, the state of a system does not assign real-number values to physical quantities but only probabilities for such values if appropriate measures are made.' Time might be 'hidden among the canonical variables that are constrained.' [viii] Hence, 'a sensible quantum theory of gravity may require identifying an *internal* time *before* quantization.' When searching for emergent time, the hope is to find a framework of theory 'that [also] avoids the mathematical singularity that is present in the account of Big Bang cosmology.'[ix] All in all, 'unless the deep structure of the world reveals a hidden unmoved mover, the quantum theory of the deep level is likely to encounter a problem similar to the problem of time, though in *a different guise*.'[x]

The Dynamics of the 'Universe as a Whole' Influencing a State

According to Ernst Mach, 'locally observed inertial properties of particles arise not from some independently existing absolute space but from the combined effect of all the dynamically significant masses in the universe.'[xi] Yet, how is this effect transmitted and accounted for dynamically?

Perhaps not surprisingly, all of the above issues are related in some way. The current paradigm of description in physics is particularly limited in that it treats the universe as a 'clockwork of operators', as a static state-dependent device that, as a Cartesian 'mechanism', fails to lay bare the process of auto-emergence at the various levels of observable existence.

In short, the paradigm of description in physics might need to be extended as to include auto-emergence. In view of the above issues, such an extension may not be a matter of adding another operator or even a collective of operators ('creation operator' or 'ladder operators'). To identify the ability of auto-emergence or self-creation, an approach might be needed that goes beyond the current syntax of description yet prudently.

2. The Spontaneous Emergence of Spatial Features

The structure of snowflakes emerges spontaneously. Typically, each snowflake is unique. As the following hypothetical experiment shows, behavioral rather morphological matters determine the spatial features of snowflakes.

Consider a process chamber with a certain height that contains a sample of the atmosphere. The controlled conditions inside the process chamber involve a weak homogenous electric field and a constant temperature below zero (Celsius). From the top of the process chamber, a mist of water molecules is injected, water molecules that are free from any impurities. The water molecules are followed by a small amount of identical dust particles.

After the mist of water molecules has been injected, its expansion produces a distribution of the speeds with which water molecules shed their energy. As a result, not every water molecule has the same kinetic energy. In the mean time, the dust particles float, following random paths due to collisions with atmospheric molecules in the chamber and too light to be pulled down by gravity.

Suppose that a water molecule collides with a dust particle and, then, settles at a kinetic energy level that is inspired by the chamber temperature. As it settles, its rotational energy reduces to zero and is wasted. Also, part of the vibration energy may be lost this way when electrons that circle the hydrogen and oxygen nuclei move to lower orbits until the vibration energy of the water molecule reflects the chamber temperature.

The final *vibration behavior* of the water molecule is ruled by its internal structure (two hydrogen atoms and one oxygen atom), its orientation due to the presence of a weak homogenous electric field (a water molecule is a dipole), gravity, the van-der-Waals forces (regarding the dust particle), and, last but not least, its kinetic energy. Inspired by the process chamber temperature, *the water molecule wobbles in a certain behavior pattern when it visits each spatial dimension at a particular instant to retreat from it at another, likely entering more than one spatial dimension simultaneously this way.*

Suppose that one records the timeless instants when the vibrating water molecule visits each spatial dimension *afresh* (meaning that such a visit is preceded by a retreat). In Figure 2, an arbitrary example of a full vibration cycle of a water molecule has been depicted. In the *behavioral domain* above the time line, the *entry instants* have been drawn as vertical bars for each spatial dimension. The repeated cycle of entry instants represents the *momentum- and geometry-inspired behavior pattern* of a vibrating water molecule in a controlled environment. This behavior pattern reminds of a *dance pattern*.

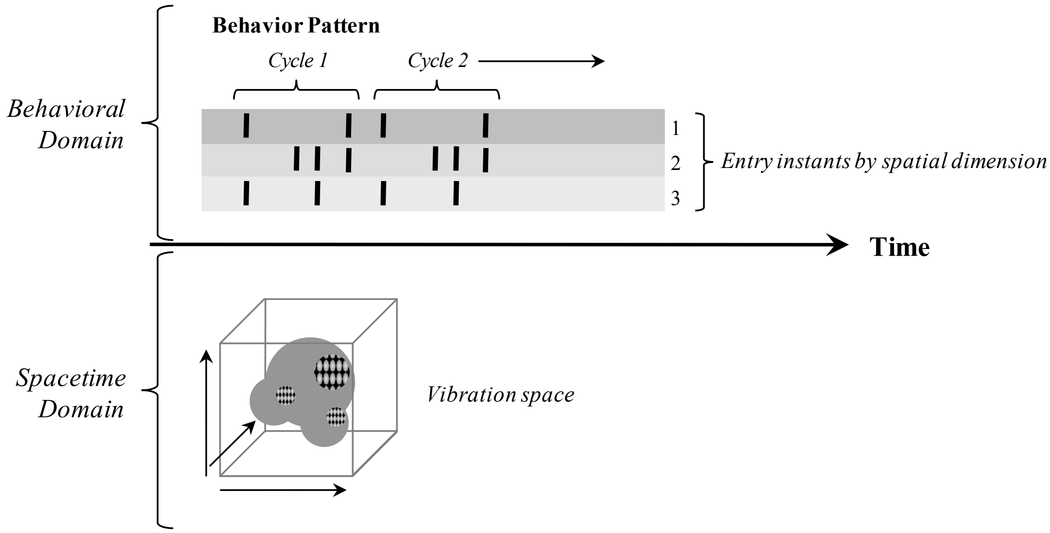

Figure 2: A vibrating water molecule and its momentum- and geometry-inspired behavior pattern.

2.1. Congruent Simultaneity or Least-Energy Fitting

As the dust particle and its partner continue their glide, they are likely to meet other water molecules. Let us assume that the ensemble (of dust particle and water molecule) meets another water molecule with nearly the same kinetic energy and, thus, the same behavior pattern.

When, at a certain instant and during a certain interval, the first water molecule visits a spatial dimension in its vibration space, it vacates space that can be occupied by a newcomer. In other words, the behavior pattern of the first water molecule functions as a dynamic template or *lock* which is only open to newcomers of which the behavioral pattern matches. Alternatively, the behavior pattern of the newcomer functions as a dynamic *key*.

A matching behavior pattern is *congruent* and unfolds *in sync* and, thus, is *simultaneous*. As such, a matching behavior pattern shows a degree of *momentum- and geometry-inspired congruent simultaneity*. *Because congruent simultaneity involves unrestrained or least-energy matching, it also brings a thermodynamic advantage.* All in all, because the newcomer has a behavior pattern that resembles the behavior pattern of the first water molecule, congruent simultaneity allows it to form the beginning of a behavior-inspired crystalline structure together with the first water molecule.

As the mist of water-molecules progressively accommodates to the temperature in the process chamber ($T_{Chamber}$) by wasting energy at a molecular level, the chance of meeting water molecules with different behavior patterns reduces over time. As a result, a consistent spatial structure spontaneously emerges. Eventually, the growing crystalline structure of dust particle and water molecules drifts down when the force of collisions with atmospheric molecules in the chamber is overruled by the force of gravity. At the bottom of the chamber, its growth comes to a standstill when its luck of meeting other water molecules runs out.

Let me take stock of the conclusions so far. First, a behavior pattern does not only function as a dynamic lock but also as a key to settling chances. Second, settling manifests as growth of a spatial structure with specific features. Third, for a settling process to be successful, a degree of momentum- and geometry-inspired congruent simultaneity and, thus, least-energy matching is required. Fourth, congruent simultaneity means that water molecules utilize the behavioral space vacated by others while moving (vibrating) in sync (Figure 3). Fifth, when the level of congruent simultaneity is insufficient, behavior patterns are on a collision course and repulsion may occur. If settling does occur in such case then it will be visible as a disturbance in the crystalline structure. Such disturbances are a result of dissonant behavior-pattern matches.

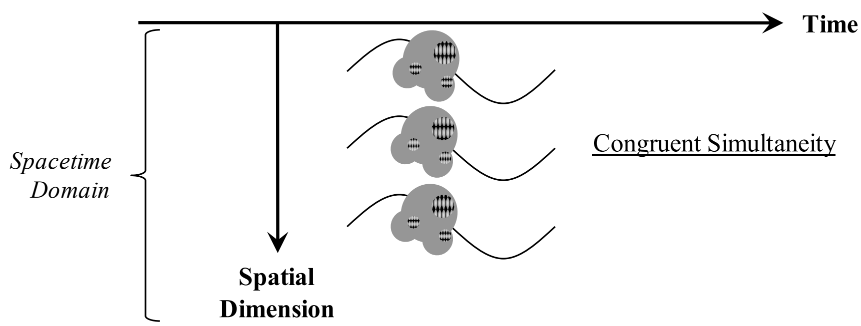

Figure 3: *Congruent Simultaneity* by utilizing the behavioral space vacated by others while moving in sync.

2.2. Natural Selection of Behavior-Pattern Species

In the process chamber, all water molecules share the same conditions. However, in view of the distribution of the speeds with which injected water molecules shed their energy, their vibration patterns may differ. Hence, in practice, the population of water molecules that ends up inhabiting the above crystalline structure strictly embodies a behavior-pattern species (Behavior-Pattern Species inspired by $T_{Chamber}$) that competes in the pursuit of *least-energy settling chances* with other less-fitting behavior-pattern species involving populations of molecules with a different level of kinetic energy. Considering this process of competition, the waxing of the *Population of*

Behavior-Pattern Species at $T_{Chamber}$ must follow a *logistics curve* or *S-curve* which is described by the Verhulst equation:

$$\mathrm{P}(t) = \frac{K\mathrm{P}_0 e^{rt}}{K + \mathrm{P}_0(e^{rt} - 1)}$$

$$Note\colon \lim_{t\to\infty} \mathrm{P}(t) = K$$

Where,

$\mathrm{P}(t)$ = The (growing) *Population of Behavior-Pattern Species at* $T_{Chamber}$ over time

P_0 = The initial P*opulation of Behavior-Pattern Species at* $T_{Chamber}$ (= 1 molecule)

K = The niche size of the *Population of Behavior-Pattern Species at* $T_{Chamber}$

r = The growth rate of the *Population of Behavior-Pattern Species at* $T_{Chamber}$

t = Time

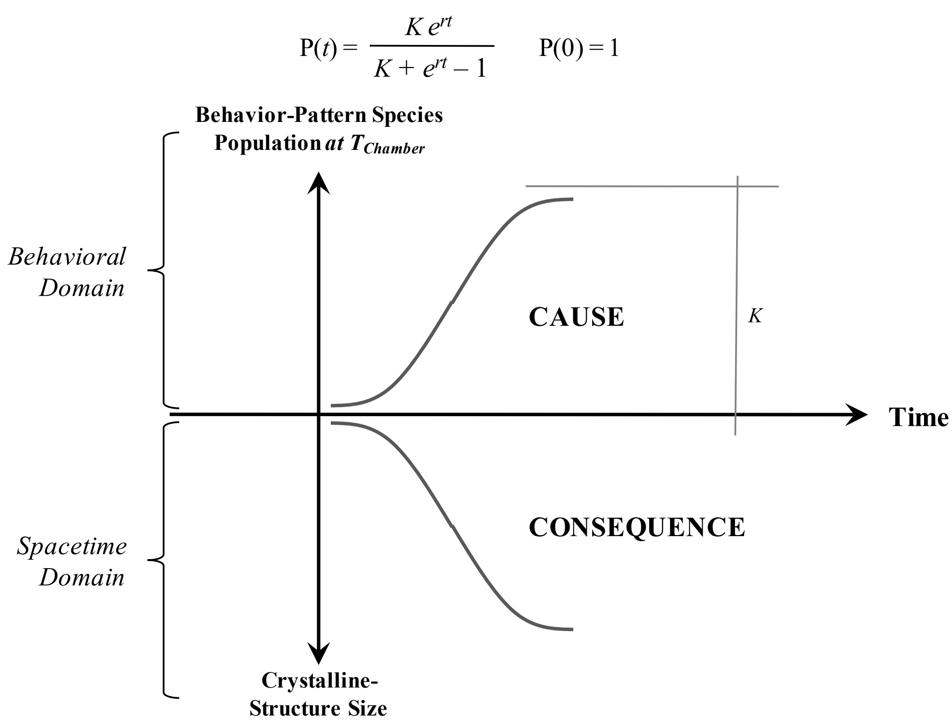

Figure 4: The population growth of a behavior-pattern species produces similarly growing spatial features.

The S-curve in Figure 4 shows the growth of the *Population of Behavior-Pattern Species at* $T_{Chamber}$ until it reaches its niche size (K), particularly when the crystalline structure of water molecules hits the bottom of the process chamber where the chance of meeting other water molecules is slim. The niche size of a population is generally referred to as its *carrying capacity*. By chance, the term, carrying capacity, accurately describes the situation in this example. The height of the process chamber and the growing weight of the crystalline structure of water molecules indeed determine the carrying capacity. The growth rate (r) of the *Population* of *Behavior-Pattern Species at $T_{Chamber}$* governs the steepness of the S-curve and indicates the degree of competition. For example, a high level of competition would produce a slowly rising S-curve. However, because the homogeneous temperature of the process chamber is in the way of molecules with another behavior pattern, the *Population* of *Behavior-Pattern Species at $T_{Chamber}$* does not experience much competition. As a result, the curve with the growth of the *Population* of *Behavior-Pattern Species at $T_{Chamber}$* should be relatively steep.

On the whole, *the uniqueness of the behavioral perspective is in that it identifies emergence in the spacetime domain as a remnant of a process of natural selection in the behavioral domain*. In other words, <u>*behavioral matters drive spacetime matters*</u>. Natural selection involves thermodynamics because the fate of behavior-pattern species is decided by least-energy behavior-pattern matching and, thus, congruent simultaneity. Conversely, <u>*congruent simultaneity is at the heart of natural selection and represents a momentum- and geometry-inspired thermodynamic advantage*</u>.

Whereas the conditions in the above hypothetical example are constant, the conditions in reality are not. This explains why each snowflake is unique. Not only are the properties of a dust particle (at the heart of most snowflakes) different but, when a developing snowflake drifts down, the purity of the water molecules, the electric field and the temperature may all change radically from one layer to the next.

The natural selection of behavior patterns through congruent simultaneity rules the emergence of <u>*all*</u> spatial phenomena. When water runs downhill, for example, its behavior-pattern exploits the best-fitting, least energy-consuming way in each environment that it enters. As such, the spatial features of its path emerge as reflections of the natural selection of behavior-pattern species, however short lived, in the numerous different environments that it traverses.

2.3. The First Three Principles of Auto-Emergence

Based on the above discussion, the following three principles define the emergence of spacetime phenomena.

Principle 1: <u>*Existential phenomena are but remnants of the natural selection of best-matching or least-energy-matching behavior-pattern species*</u>. In other words, nature is essentially a behavioral phenomenon that has spacetime features as remnants.

Principle 2: <u>*The natural selection of behavior-pattern species involves congruent simultaneity*</u>. Congruent simultaneity occurs when the behavioral space vacated by others is utilized while moving in sync. *It entails a momentum- and geometry-inspired thermodynamic advantage which determines the least-energy matching chances of behavior-pattern species*.

Principle 3: Both the population of behavior-pattern species and the remnant features that it produces grow following a logistics curve or S-curve as a result of the process of competition in the pursuit of least-energy matching chances. Hence, *the logistics curve serves as a quantitative link between the behavioral and spacetime domain*.

From a philosophical viewpoint, the first principle reminds of Plato's *cave allegory*. Plato believed that our perception of reality (observable existence) resembles that of cave dwellers who cannot see the true world outside the cave but only the projection of this world on the cave walls by light entering through the mouth of the cave. According to Plato and in line with the first principle, the 2-dimensional projections (essentially, spatial features) are but poor reflections of the true reality *outside* the cave. However, whereas the first principle assumes that the origin of the world outside the cave revolves around the natural selection of behavior-pattern species, Plato envisaged a more static image of the world 'outside', a world of 'perfect forms'.

2.4. Experimental and Theoretical Evidence

The experiments and resulting morphology map of Libbrecht[xii] confirm the conclusions of the above hypothetical example. In agreement with the conclusion that the chamber temperature determines the best-matching behavior pattern and, correspondingly, the spatial features of a crystalline structure of water molecules, Libbrecht showed that the spatial features of snowflakes produced in a controlled environment indeed depend on temperature. In search for an answer that explains the temperature-dependent structure of snowflakes, the hunch of Libbrecht is to investigate the crystallization conditions, referring to the spatial features of a snow crystal (its hexagonal shape) as a lead. However, if all the conditions (but the temperature) remain the same, the kinetic energy and, thus, the vibration behavior of frozen water molecules is the only differentiator during the crystallization process. Hence, the idea here is that *dynamic rather than static matters explain emergent spatial features*. In fact, spatial or morphological features are but remnants of the natural selection of best-matching behavior-pattern species and, therefore, behavioral rather than spatial phenomena are at the heart of observable existence.

When it comes to the root of observable existence, a similar example but of a theoretical nature has been compiled by Lisi.[xiii] Lisi describes what can be identified as the remnant of the natural selection of numerous generations of behavior-pattern species during the early stages of the universe. The geometry-inspired mathematical E_8 structure that Lisi explores revolves around the interaction of fields and shows the emergence of a fundamental particle (or one of its basic versions) at each of the structure's 248 nodes. Lisi identified known particles for all but 20 of the 248 nodes, which means that 20 particles or particle versions remain to be discovered. In view of the conclusions so far, the foundational E_8 structure is not unlike the structure of a snowflake. It is a remnant of the natural selection of behavior-pattern species and shows the *surviving* network of such species. Needless to say, the conditions that led to the emergence of the very first behavior-pattern species through congruent simultaneity essentially determined the blue print of today's universe. Would these conditions have been different, the foundational structure that Lisi unveiled would probably also have been different.

3. The Process of Auto-Emergence

First observed by Henri Bénard in 1900, the *Rayleigh-Bénard instability* represents a more complex example of the natural selection of behavior-pattern species. In a thin layer of liquid that is heated uniformly from below, the latter produce spatial features in the form of convection cells. The physics of convection cells is well understood. For example, the Bénard-Marangoni experiment involves a layer of liquid of which the surface is in direct contact with the air. The Marangoni effect makes liquids in the surface layer flow from (warmer) places with a lower surface tension to (cooler) places with a higher surface tension. At a certain temperature gradient between the bottom and top layer of the liquid, temperature perturbations at the surface induce the flow of liquid. To sustain this flow, liquid is ejected downward at cooler places. When reaching the bottom, the liquid starts moving laterally and reheats. Then, as a result of the force of Archimedes (buoyancy), it rises to the surface again. As a result, looping-like flows develop throughout the liquid, which are visible from above as hexagonal convection cells or Bénard cells. In these cells, hot molecules rise to the surface through the center while cooler molecules descend to the bottom along the cell walls (Figure 5). The emergence of Bénard cells hinges on the 'Rayleigh number' which signifies the value at which heat transfer takes place through convection rather than conduction. It is a compilation of the temperature gradient (ΔT) between the bottom and surface, the depth of the layer, the volume-expansion coefficient of the liquid when reheated, gravity, and the viscosity of the liquid as well as its thermometric conductivity.

However elegant, the calculation of the Rayleigh number ignores the crucial process of natural selection, the dynamic and enduring process of matching-ability tradeoffs between behavior-pattern species from which a multifaceted best-matching behavior-pattern species emerges as ultimate survivor. The spatial (hexagonal) features of convection cells are simply evidence of a complex of best-matching behavior-pattern species at work. This complex manages to achieve and sustain congruent simultaneity *by ensuring that molecules utilize the behavioral space vacated or left open by others while moving in sync* (congruent simultaneity). Unlike the water molecules in the previous example, the best-matching behavior-pattern species in this example do not only involve the vibration energy of molecules but also their translation and rotation energy. Hence, in this case, the selection of best-matching behavior-pattern species entails a compound of behavior-pattern species population growth curves at many timescales and across timescales. Across timescales means that slower congruent-simultaneity development cycles coincide with faster ones and vice versa, setting off new cycles of congruent-simultaneity development this way.

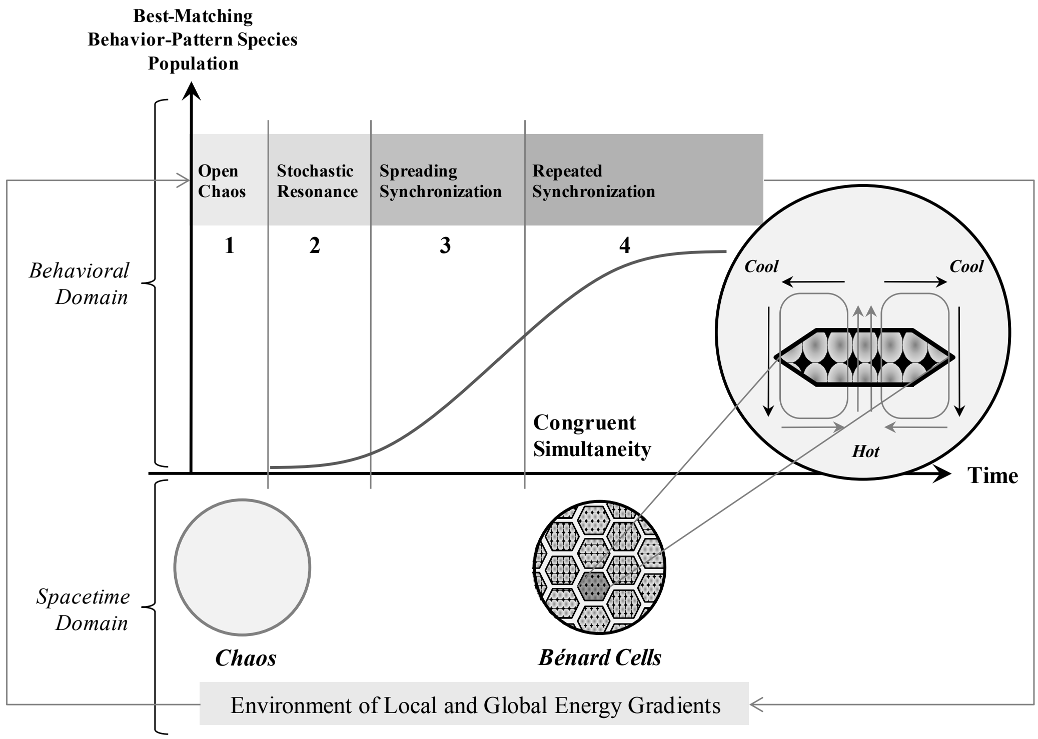

Figure 5: The natural selection of behavior-pattern species unfolds in four unique simultaneity states.

3.1. Congruent-Simultaneity Development States

Clues to the process of auto-emergence are in the fundamental phenomena that contribute to the natural selection of a behavior-pattern species (or complex of behavior-pattern species). *Natural selection means that behavior-pattern species successfully reproduce within a certain environment of gradients so that they first develop and, then, sustain a maximum level of congruent simultaneity.* These fundamental phenomena appear in four ensuing states, each of which concerns a state of affairs that is ruled by *behavioral qualities*. For reference purposes, the four states of natural-selection have been called *congruent-simultaneity development states* or, simply, *simultaneity states*, after the process cycle to which they contribute (Figure 5). With reference to the development of Bénard cells above, the following is a synopsis of each state.

In the *first simultaneity state*, an inequality or gradient (in this example, a temperature gradient) is introduced. Initially, a state of chaos ensues. Chaos is a behavioral state in which *behavior patterns lack a certain minimum degree of congruent simultaneity*. To ensure the natural selection of a behavior-pattern species, a form of chaos is required that offers many degrees of freedom and, thus, abundant dimensions in which congruent simultaneity might possibly be achieved. Kaneko and Tsuda refer to such type of chaos as *open chaos*.[xiv]

In the *second simultaneity state*, weak perturbations (in this case, temperature perturbations at the surface) are introduced. *Stochastic Resonance* (SR) explains how these perturbations emerge and, then, spread across a medium, such as a thin layer of liquid. Benzi et al first identified the SR phenomenon.[xv] On-first-sight-unrelated phenomena may interact and reinforce one another. For example, annual variations in solar radiation may result in noise-like short-term climate changes that amplify the weak temperature perturbations produced by the Earth's rotational irregularities. In turn, these amplified perturbations may induce long-term climate changes. In a nutshell, a weak periodic signal in a non-linear system may be boosted by an increase of the noise intensity. Behaviorally, SR involves the chance-driven synchronization of behaviors from which *congruent simultaneity emerges when one effect utilizes the behavioral space vacated by other effects while moving in sync*. As such, SR relies on behavioral cycles (the natural selection of behavior-pattern species) at various timescales and, also, across timescales. The energy-related outcomes of SR manifest as perturbations that are transmitted spatially. The latter observation reiterates the idea that behavioral matters precede energy-conversion and spatial matters. SR has also been observed at quantum levels. The features of so-called Quantum Stochastic Synchronization 'are robust and are not critically dependent on the details of the underlying dissipation mechanism'.[xvi]

In the *third simultaneity state*, the synchronization of behaviors spreads as the natural selection of best-matching behavior-pattern species advances at various timescales and across timescales. In the spacetime domain, this simultaneity state is marked by the emergence of rudimentary Bénard cells across the surface of the fluid at first which, then, gradually assume their final shape after the complex of best-matching behavior-pattern species starts dominating the scene.

In the *fourth simultaneity state*, the (complex of) best-matching behavior-pattern species which shape the fully developed Bénard convection cells survives (that is, reproduces) as long as the temperature gradient is maintained above a certain level. Momentum- and geometry-related qualities of the liquid environment decide the maximum population size, niche size or carrying capacity of the reproducing complex of best-matching behavior-pattern species. According to the first three principles of auto-emergence, the growth of the features of the Bénard convection cells (that is, from a rudimentary state to their mature shape) also develops along an S-curve (not in Figure 5) in line with the S-curve that depicts the growth of the population of the (complex of) best-matching behavior-pattern species (in Figure 5).

3.2. The Second Three Principles of Auto-Emergence

In view of the above, auto-emergence arises and is transmitted through the next three principles of auto-emergence.

Principle 4: Without exception (see examples further on), *the growth of congruent simultaneity through the natural selection of best-matching or least-energy-fitting behavior-pattern species unfolds in accordance with a universal sequence of four unique congruent simultaneity states, i.e. Chaos, Stochastic Resonance, Spreading Synchronization*, and *Repeated Synchronization*.

Principle 5: A behavior-pattern species population growth cycle translates a global gradient into a dynamic set of local gradients which, in this example, impel the *congruent-simultaneity-inspired* roles of molecules when the latter are moving up, down and sideways to reduce these. To reduce local gradients, similar cycles of behavior-pattern species population growth emerge at many different timescales. On the whole, *when translating a gradient into other gradients, each cycle of behavior-pattern species population growth sparks off other cycles at other timescales*. As a result, *behavior-pattern species population growth cycles at numerous timescales are unavoidably arising together*.[xvii] In point of fact, *only together they arise*.

Principle 6: Stochastic Resonance (SR), a behavior-pattern species population growth cycle itself, explains how congruent simultaneity may be stimulated in cascading and ricocheting manners across a broad range of natural phenomena and across quantum lengths and vast distances and, thus, across all timescales. As such, *SR represents a congruent-simultaneity inspired process that explains how the combined effect of all the dynamically significant masses in the universe is transmitted through a form of positive feedback*.

Whereas principle 5 refers to the relentless self-induced and, also, self-referential generation of behavior-pattern species population growth cycles, principle 6 explains how the effect of each may traverse all time intervals and, thus, all distances.

4. A Universal Signature of Auto-Emergence

For each natural phenomenon, a behavior-pattern species population growth cycle unfolds at a characteristic timescale in keeping with the universal sequence of four unique simultaneity states.

Phase Transitions

For example, mathematical simulation shows how the unfolding of events in the spacetime domain emerges from the behavioral domain. By mathematically replicating a non-dissipative and non-linear system, Maslov identified how parametric resonance emerged as the probable cause of phase transitions.[xviii] In line with the universal sequence of four unique simultaneity states, the phase-transition events seemed to unfold based on the behavioral dynamics alone. Stochastic resonance rather than energy conversion explained the start of phase transitions. In a medium governed by turbulence (open chaos), a new phase emerged in the form of instabilities at first (stochastic resonance). Subsequently, instabilities would turn into tiny bubbles (spreading synchronization, the dispersal of best-matching behavior-pattern species). These tiny bubbles would then expand until they would bump into other expanded bubbles that had developed in the same way elsewhere (repeated synchronization). In the end, the interaction of the expanded bubbles would produce a new state of turbulence, the beginning of another phase transition (open chaos). All in all, the behavioral explanation of phase transitions actually *reduces* the usual spacetime-domain-inspired theory of phase transitions because it explains these transitions *independent of* the environment- and field-specific circumstances.

The Development of Thought

Similar comparisons of more complex phenomena of existence can be made that also manifest in the spacetime domain but find their origin in the behavioral domain. A first example is how neural networks arrive at perception and interpretation.[xix] Suppose the existence of certain chemical-concentration gradients at the level of neurons which developed locally across the brain through early experiences. Suppose at the same time that the brain is governed by a constant state of neural chaos which manifest as noise (open chaos). (In fact, neural chaos is produced by electric currents that are leaking randomly from trillions of neuron connections.) A signal (either from inside the brain or the sensory system) is likely to be amplified by neural chaos and, then, transmitted across the brain (stochastic resonance) where it arouses widely-spread neurons with certain chemical-concentration gradients so that they synchronize their electrical pulse-producing behavior (spreading synchronization, the emergence of behavior-pattern species). This way, signals from inside the brain and the sensory system (internal and external observations) are translated into congruent and simultaneous firing sequences of widely spread neurons. A firing sequence is basically a behavioral-pattern species. Kaneko and Tsuda[xx] refer to a firing sequence as a temporal-code. They also identified the ability of neuron clusters to reproduce temporarily a temporal-code (reproduced synchronization). Observations, perceptions, and interpretations involve behavior-pattern species and depend on a certain level (or lack of) congruent simultaneity. Indeed, thinking, in all its facets, is a behavioral phenomenon. The concerted behavior of neurons, which involves congruent and simultaneous pulse-trains, induce our sense of past, present and future basically by producing, reproducing, and, finally, matching neuron behavior-pattern species. As such, the realities inside our mind find their origin in fundamentally the same behavioral phenomena as phase transitions.

The Rise (and Decline) of Human Organization

Another, on-first-sight farther-off example is the emergence of human organization. Because the observation of human organization in the spacetime domain lends itself to be reduced to phenomena in the behavioral domain, it adds to the discussion of emergence even within the context of physics. Indeed, the reality of human organization is not in the spatial structure that contains it or in the chart that depicts it but in congruent roles combined with the timing of action and inaction (congruent simultaneity). In a market with a certain supply-demand gradient, the intrinsic noise of signals in the business world typically pushes the ideas of an entrepreneur over a threshold (stochastic resonance) so that they can spread and entice both collaborators and employees into synchronizing their behavior (the emergence of behavior-pattern species). A best-matching behavior-pattern species may emerge that produces success consistently (congruent simultaneity through natural selection). Then, through convention (rules) and cultural means (values), such a behavior-pattern species is reproduced (repeated synchronization) until it is no longer capable of generating success, such as in a substantially changing market. At that moment, a new state of turbulence develops from which new entrepreneurial ideas are likely to emerge. [xxi]

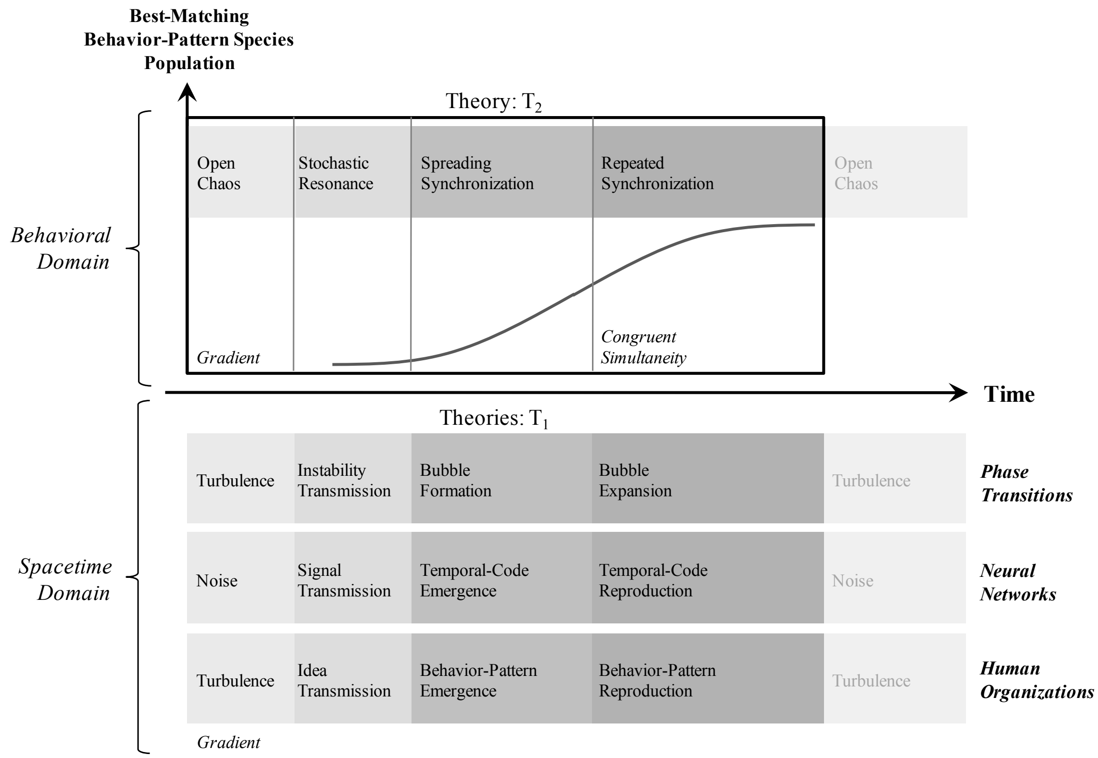

Figure 6: T_1-theories emerge from T_2-theory and function as field-specific definitional extensions.

4.1. A New Logic of Theory Verification

The above discussion shows how examples of auto-emergent phenomena observable in the spacetime domain can be reduced to a common signature in the behavioral domain. In fact, reduction is possible from substantially different fields. Hence, the signature of four simultaneity states in the behavioral domain rises above any field-specific features of emergence.

To summarize the benefits of a universal *logic of emergence* here,[xxii] let a field-specific feature-rich theory be a T_1–theory, such as the above theory of phase transitions or the theories of the development of thought and human-organization, and let the signature of four simultaneity states be the universal T_2–theory. The universal T_2–theory effectively reduces a field-specific T_1–

theory. Of course, reduction 'often involves approximation' yet, at the same time, it produces 'a theory capable of predicting or explaining'. As such, the universal T_2–theory explains a T_1–theory in deductive-nomological terms. The universal T_2–theory also translates field-specific phenomena into a 'language' that can be used across field-specific scientific notions as a means of developing insight into the emergence (and existence) of physical processes. Alternatively, field-specific T_1–theories emerge from the universal T_2–theory and function as *definitional extensions*. As a result, they can and should be used to identify the rate of competition (r) and niche size (K) of a best-matching behavior-pattern species population in a particular field (and, thus, the state or degree of emergence). Indeed, as a universal theory that appears at all timescales, the behavior-inspired T_2–theory is a theory of both emergence and existence. All in all, in line with the first principle, evidence of existence in the spacetime domain can be reduced to matters of emergence in the behavioral domain.

5. The Congruent-Simultaneity Dimension

The conclusions so far shed light on the earlier-mentioned concerns about the lack of time at a quantum scale and the measurement of time at a cosmological scale. At a quantum scale, probabilities are in the way of time as a relative measure of emergence because either the position or momentum of a particle can be measured at that scale. At a cosmological scale, it is impossible to measure how the universe evolves as a whole because this would require a clock that is external to the universe. Indeed, as an interval-measuring device, a clock definitely has its blind spots. At the same time, the question is whether an interval, by itself, is meaningful as a measure of emergence. After all, it only translates change into units of an arbitrary measuring stick which is derived from a distance that is travelled repeatedly, such as the rotation of the Earth, the swing of a pendulum, or the wavelength of light. In other words, time as interval does not really qualify the nature of change and, as such, does not qualify auto-emergence either.

In search of a measure of auto-emergence, a notion of time *other than interval* is needed. The term, 'other than interval,' essentially means *non-interval* or *interval-independent*. Therefore, an *auto-emergence-describing notion of time should arise from what happens at instants* (of which the interval is nil) and, thus, from one instant to the next. *Such a notion of time should also be universal in that it is valid regardless of the interval of the process of emergence* (thus, interval-independent). Needless to say, *at instants, only simultaneity can exist*. Hence, an auto-emergence-describing notion of time must revolve around matters of simultaneity, that is to say, not just around simultaneity by itself but around a form of 'organizing simultaneity'. *At the heart of the process of auto-emergence, momentum- and geometry-inspired growth of congruent simultaneity (the proliferation of best-matching behavior-pattern species) is such a universal form of organizing simultaneity*. Indeed, as maintained in previous sections, congruent simultaneity arranges the best-matching behavior patterns of frozen water molecules to grow snowflake structures in essentially the same way as it arranges the best-matching behavior patterns of fields to grow the foundational E_8 structure. It also brings together the best-matching behavior patterns of people to grow organizations and the best-matching behavior patterns of neurons to grow neuron networks and thought. All in all, *through the distinct signature of congruent-simultaneity growth, time as an interval emerges from time as congruent simultaneity* (Figure 7).

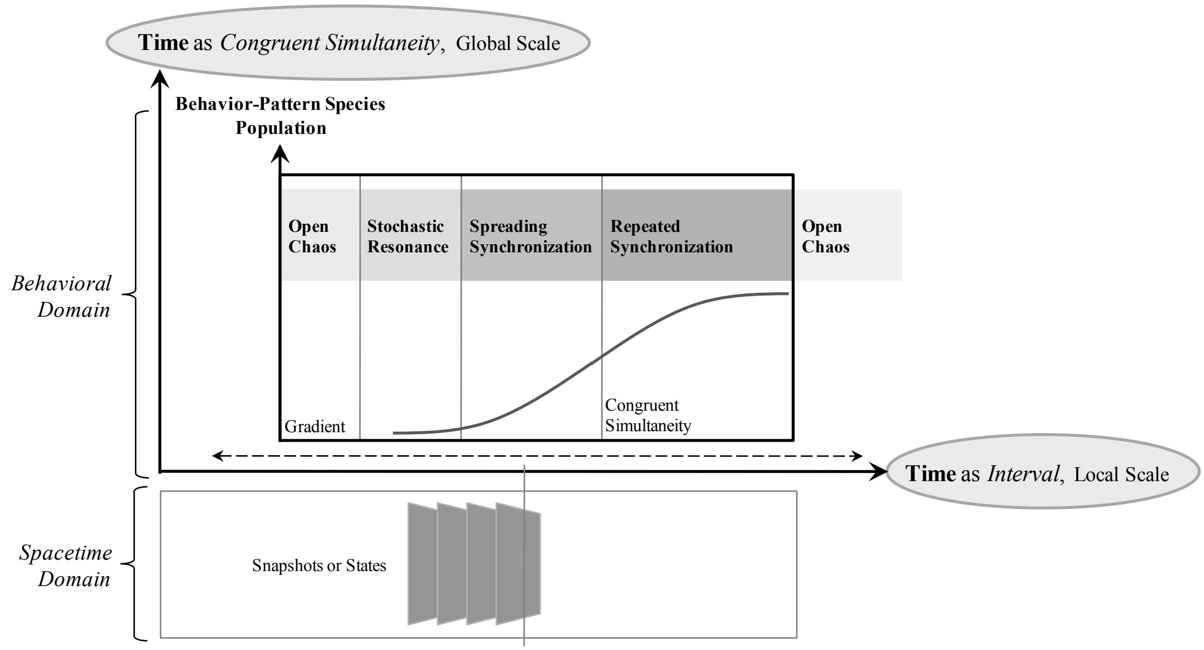

Figure 7: Our experience of time as an interval essentially emerges from time in the behavioral domain.

5.1. The Duality of Time

The notion of time as a phenomenon with two faces, one as interval (which typically varies) and one as congruent-simultaneity (of which the S-shaped signature of growth and T_2-theory features seem to apply universally), is reminiscent of *symmetry in physics* and the *gauge theories* that have been derived from it. The *duality of time* also reminds of a *manifold*.

Global Gauge Symmetry

In physics, 'symmetry' concerns a feature of a physical system of which aspects remain unchanged under certain transformations, that is, according to a particular observation. [xxiii] For example, as argued in the previous sections, energy gradients trigger the signature and features of congruent-simultaneity emergence and proliferation independent upon the field-specific variables that describe a system (snowflake, E_8 structure, neuron cluster, and organization). The emergence and proliferation of congruent simultaneity also suggests 'global gauge symmetry'. An example of global gauge symmetry is an electric circuit of which the potential differences across the circuit's components rather than the absolute value of the potential decide its operation. [xxiv] In view of the emergence and proliferation of congruent simultaneity, real-world environments with their specific geometry and components resemble an electric circuit, that is, from a behavioral point of view. Likewise, the energy gradients across their components rather than the absolute level of energy decide the signature and features of congruent-simultaneity emergence and proliferation. As a result, the signature and features of congruent-simultaneity emergence and proliferation and, thus, *time as congruent simultaneity is a global phenomenon*. On the other hand, *time as interval is a 'local symmetry'* because the timescale of congruent-simultaneity development is allowed to vary depending upon the specific spacetime situation.

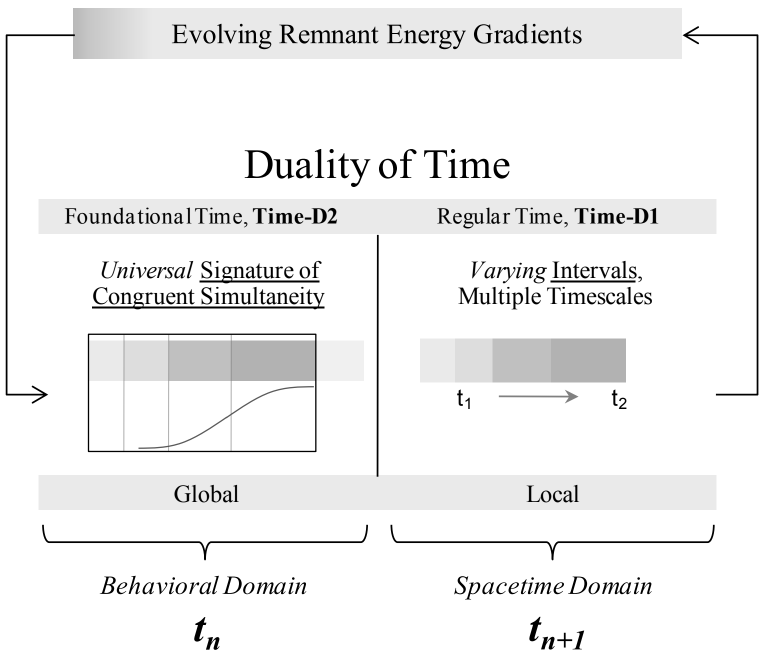

Figure 8: The duality of time involves intervals that emerge from the proliferation of congruent simultaneity.

Manifold

A manifold is an abstract mathematical space in which Euclidean geometry produces acceptable approximations *locally* but in which the *global* structure is more complex.[xxv] An example is the Earth. At a local scale, the Earth is perceived to be flat and, therefore, Euclidean. Yet, it flatness varies greatly. At a global scale, when observed from space, the Earth is spherical and, thus, non-Euclidean. Yet, its spherical shape is constant and, therefore, universal. By using the definition of a 'manifold' as a metaphor, the duality of time can be explained in a similar way. Locally, time as an interval is a time line (lines are Euclidean). Yet, intervals vary greatly. Globally, time is more complex and, as argued above, universal. All in all, metaphorically at the least, the notion of time as a 'manifold' brings the two faces of time neatly together into *one* abstract phenomenon.

Finally, because time as interval is considered to be a dimension (*Regular Time* or T-D1), time as congruent simultaneity must also be a dimension (*Foundational Time* or T-D2) (see Figure 8).

5.2. Gauging Evolution Qualitatively and Quantitatively

As a case of global gauge symmetry and local symmetry, the duality of time makes it possible to measure change both quantitatively (T-D1) and, particularly also, qualitatively (T-D2).

For example, as discussed in section 4, the features of emergence that have been observed in field-specific situations (T_1-theories) reveal the emergence and proliferation of congruent simultaneity in the behavioral domain (T_2-theory). Therefore, these features, as consistent remnants of the progression of simultaneity states, conveniently serve as hands of a universal clock that provides a qualitative measure of the state of evolution. As such, it is no longer necessary to use an external clock to measure the evolution of a phenomenon in spacetime, such as the universe. Instead, the features of congruent simultaneity in the spacetime domain will qualitatively tell 'from the inside out' what 'time' it is (T-D2 in Figure 9).

According to Principle 3, the growth of features in the spacetime domain follows the S-curve-shaped growth of the underlying best-matching behavior-pattern species populations in the behavioral domain. Because the S-curve serves as quantitative link between the progression in the behavioral and spacetime domain, also a quantitative assessment of the evolution of phenomena in the spacetime domain is possible. For example, by using curve-fitting techniques, the S-curve shape that best fits early empirical data of developing features can be identified. The projection of the underlying S-curve reveals not only the growth rate (r) but also the niche size (K) of feature growth and the total duration of feature development (T-D1 in Figure 9).

Consequences of Using One Clock Two Times

According to the duality of time, the array of data concerning the inflation of the universe that has been obtained through the observation of distant supernovae mirrors the population growth of a complex of best-matching behavior-pattern-species populations of which the niche size is determined by the *congruent-simultaneity potential of the universe as a whole* (Figure 9). Hence, an estimate of the lifecycle, age, and size of the universe might be established by identifying an S-curve shape that best fits the inflation-progression data. However, in view of the logic applied here, it would be wrong to explain the inflation of the universe by means of another observable feature, such as the level of energy, simply because such feature is a remnant of congruent-simultaneity itself (of which the emergence and proliferation have been described by the same S-curve). This might explain why, at a cosmological scale, not enough energy has been identified to explain the observed rate of inflation. As such, the remaining congruent-simultaneity potential rather than 'dark energy' explains the rate of inflation of the universe or, alternatively, *dark energy represents a measure of intrinsic and yet-to-unfold momentum- and geometry-inspired form of* *energy*. The latter conclusion prevents the universe from being interpreted as a non-evolving mechanism which is confined to the spacetime domain and which contains all the components necessary to explain its future state. Observable matters in the cosmological spacetime domain, such as the evidence of inflation, energy and matter, are temporal remnants of the momentum- and geometry- inspired unfolding of congruent simultaneity in the behavioral domain.

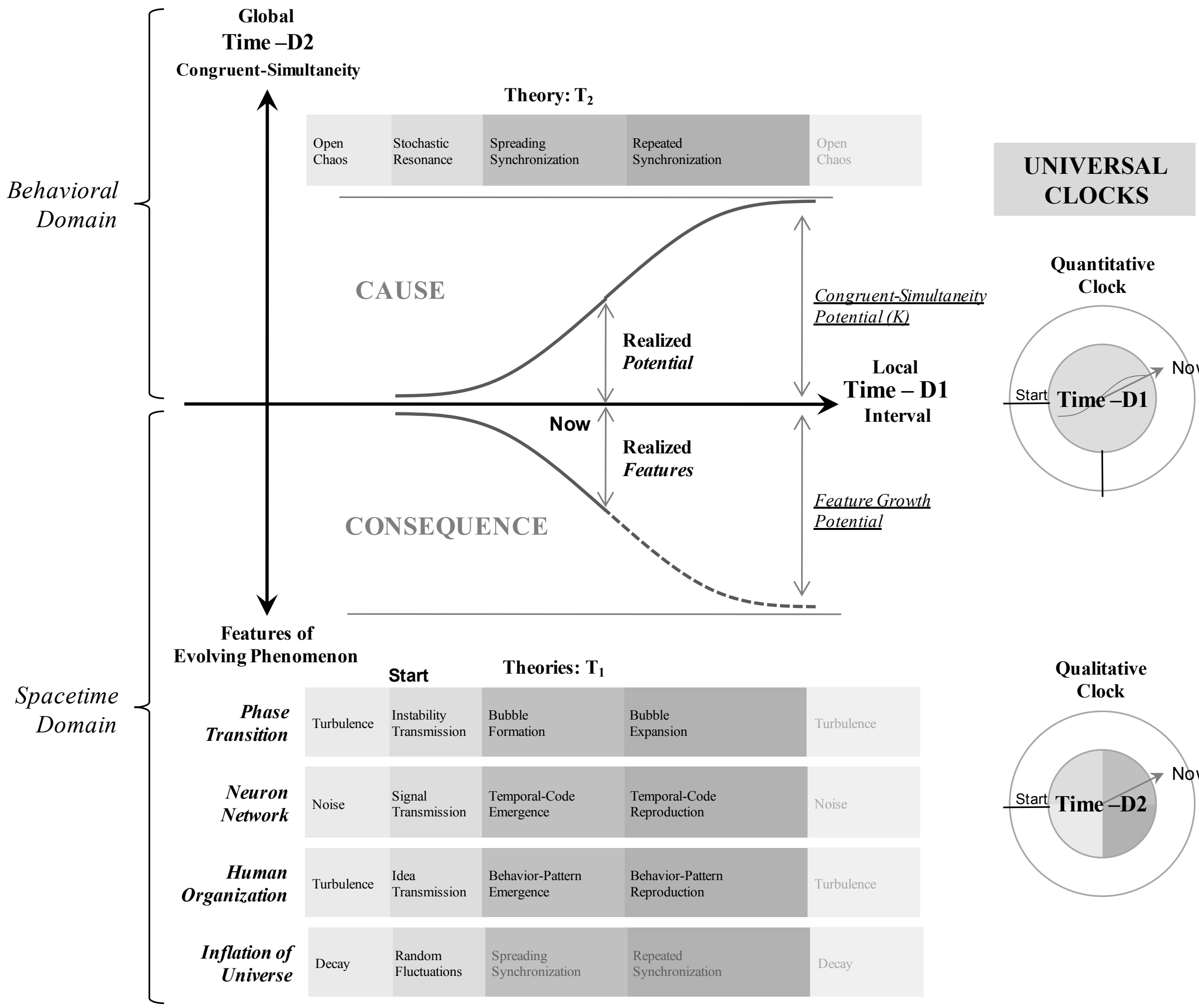

Figure 9: One clock yet two times that describe emerging phenomena from the inside out.

5.3. The Final Two Principles of Auto-Emergence

The duality of time yields two gauging-related principles.

Principle 7: *A symmetry-inspired phenomenon, time is a duality. The regular dimension of time as interval emerges from foundational time as congruent simultaneity*. This duality makes it possible to measure the state of evolution from the inside out both qualitatively and quantitatively.

Principle 8: *The future evolution of a phenomenon in the spacetime domain is determined by its remaining congruent-simultaneity potential and not by the resultant features of its evolution so far*. Because the S-curve serves as a quantitative link between the behavioral domain and spacetime domain, an estimate of the remaining congruent-simultaneity potential can be established by curve-fitting techniques that involve empirically obtained data of feature development.

5.4. Some Historical Perspectives

As early as 4500 years ago, the ancient Egyptians started referring in their Pyramid texts to two dimensions of time: the 'time of reality' and the 'time that goes by', that is, 'Time Great' and 'Time Small'.[xxvi] Time Great (*djet*) is the time used in the divine world. Time Small governs on Earth. The king's tomb is 'the gate' that gives access to the land of the gods and its primordial time. Time Small is like a dream that passes while the time of reality, Time Great, lasts forever. In view of the assertions about the spacetime domain in this paper, the following observations are even more striking. Time Great 'is *not* about the spacetime domain but about stability'. It is the time of 'unity, of pre-existence and post-existence, a time which is not linear but a time of cycles, endless in the cosmic life'.

The theoretical physicists, Christopher Isham and Konstantina Savvidou, affirm the duality of time.[xxvii] They refer to a 'time of being' and a 'time of becoming', putting these conceptions into a historical setting through sources, such as St Augustine and the ancient Persian religion of Zoroaster. In the work of the British artist, Johan Latham, they find an explanatory example that reflects their representation of time. Apparently inspired by distinct metaphysical views, Latham created an artistic contraption that symbolizes the features of time as a mechanical phenomenon. In Latham's creation, 'time as being' is represented by the rotation of a long horizontal roller with several neighboring blinds each marked with certain spatial features. 'Time as becoming' is represented by the vertical motion of the blinds when they are unrolled, an event that reveals the spatial features on each blind. Isham and Savvidou also refer to the views of Whitehead[xxviii] who speaks of duration (time of being) versus instantaneousness (and, thus, simultaneity) which involves all nature at an instant (becoming). When evaluating the notion of time in quantum theory, they finally conclude that their question about the 'appropriate mathematical structure' for the representation of time remains unanswered. In other words, being confined to the current paradigm of description in physics, the search for a mathematical 'operator' that describes (internal) time does not lead to a satisfactory solution.

The need to extend the paradigm of description in physics is the root of the proposition in this paper. A clue is provided by the philosopher, Henri Bergson,[xxix] who, incidentally, influenced the thinking of Whitehead. Bergson refers to time as a duality of duration and *self-creation* (and, thus, *auto-emergence*). Indeed, the central question is 'who or what unrolls the blinds of Latham'. Or, alternatively, 'who or what paints the spatial features on these blinds?' Supported by experimental and theoretical evidence, the first three principles of auto-emergence explain how observable spatial features might be 'written' in the behavioral domain, that is, by the natural selection of behavior-pattern species that best achieve congruent simultaneity. The second three principles explain how 'the writing' in the behavioral domain might *self-create* and *spread*. The final two principles of auto-emergence state how 'time of being' emerges from 'time of becoming' and how the latter might be measured by means of two universal clocks that work 'from the inside out' (internal time). To paraphrase Isham and Savvidou, these clocks allow making predictions about the unfolding of reality 'in a physically meaningful way.'

At least on one other occasion, mention is made of 'a new dimension of time' along the lines of thinking in this paper. In an article published in *The Philosophical Review* of 1892 (published by *Sage School of Philosophy*), the following is stated.

'*Time represented by the fourth coordinate of the spacetime continuum is relative; but evolution we insist calls for a new dimension of time, a new form of temporal organization. This historically new dimension of growth is the n + 1 dimension, where n is any lower spatial dimension of materiality out of which the higher temporal organization of growth appears. Thus, in our conception, emergence adds a degree of reality to any lower plane of being. Whenever we refer to a system, as a whole, with its spatial coordinates and its own local time, this time is transposable across an entire philosophy of nature.*'

6. Extending the Paradigm of Description in Physics

Confined to the spacetime domain by its syntax, the current paradigm of description in physics does not reach into the realm of auto-emergence, the arena of congruent-simultaneity. Indeed, as specified at the beginning of this paper, it seems to fall short of embracing fully the emergent nature of our world. However, there is reason as well as experimental and theoretical evidence to believe that there is a behavioral domain from which the spacetime domain might be emerging. As such, the 'syntax' and principles that describe the events in the behavioral domain might be considered as an extension to the current paradigm of description in physics.

In the behavioral domain, the symmetry-inspired duality of time fosters the natural selection of behavior-pattern species of which the remnants appear as features and forms in the spacetime domain. One might say that these features and forms are 'written' in the behavioral domain. Hence, if the spacetime domain is the existential *manifold of features and forms*,[xxx] then the behavioral domain is the 'zine' (from 'magazine') in which the existential manifold is written. Succinctly, the behavioral domain is the *Existential Manifold's Zine* or *Emzine* (Figure 10).

Needless to say, mathematical physics continues as the only source of description when it comes to the explanation of observable existence. It helps translate our perception of reality into the universal language of mathematics involving laws that explain features, forms (of both matter and energy) and their relationships. However, when the question of auto-emergence is discussed, the principles of auto-emergence offer a 'perception of our spacetime-inspired perception' (a 'meta-perception' if you'd like), that helps make predictions about the unfolding of reality 'in a physically meaningful way'. The principles of auto-emergence are relevant across many fields (e.g. the social sciences) because they prove to explain the evolution of observable phenomena beyond the ambitions of physics.

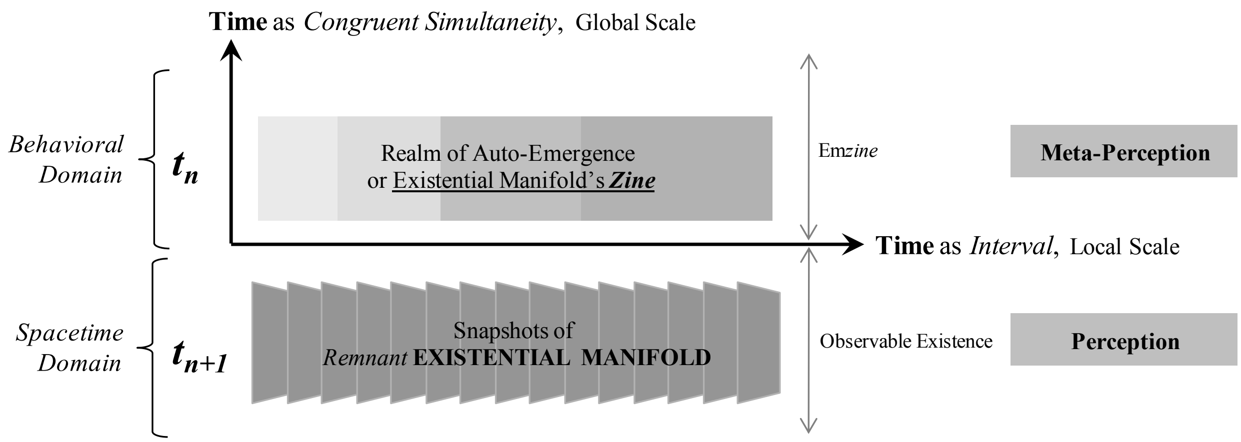

Figure 10: In the realm of auto-emergence, the existential manifold is written.

6.1. Theoretical Relevance

The principles of auto-emergence shed new light on some of the outstanding auto-emergence-related theoretical issues in physics.

On the Unmoved Mover

Outside the traditional paradigm of description in physics, the domain of auto-emergence is the domain of the unmoved mover, a domain where streams of congruent simultaneity in the shape of behavior-pattern species develop tirelessly at all timescales on the back of other streams of congruent simultaneity. In other words, behavior-pattern species are not just arising together but, more importantly, only together they arise. Because the emergence of behavior-pattern species functions as a condition for the emergence of other behavior-pattern species and vice versa, both auto-emergence and the unmoved mover essentially symbolize a social phenomenon. The social phenomenon in question might be referred to as *reciprocal conditioning*.[xxxi]

In view of the symmetry-inspired duality of time, *time as interval is not absolute* but emerging from time as congruent simultaneity. Hence, conceptions of our world's creation that have been inspired by mathematical operators which yield a singularity at $t = 0$ (Big Bang) might need to be reconsidered. Then again, conceptions, such as a universe that emerges 'by a random fluctuation from some pre-existent state' to return to a 'state of decay', may be more in line with the universal sequence of four simultaneity states (Figure 9). As such, the evolution of our universe might involve oscillating concentrations of congruent simultaneity that use reciprocal conditioning as positive feedback, a form of existence or becoming that reminds of the *Belousov-Zhabotinsky reaction* of which the oscillating chemical reactions are sustained by positive feedback.

On Auto-emergent Particles

Cascading, ricocheting, and interacting behavior-pattern-species population growth cycles at all timescales explain how matter might materialize in spacetime-domain nothingness. The Casimir-effect-inspired experiments in which auto-emergent particles are observed demonstrated that the emergence of fundamental particles is codetermined by the nanometer size of the spatial cavity in which the phenomenon takes place. The latter reveals the functioning of the second principle of auto-emergence which states that the emergence of behavior-pattern species is dependent on *momentum- and geometry-inspired* natural selection.

On the Need for a Cosmological Constant

According to the principles of auto-emergence, the evolution of a phenomenon is determined by its remaining congruent-simultaneity potential and not by the outcomes of its evolution in the spacetime domain. Hence, whereas Einstein's field equation describes the state of features in the spacetime domain, the cosmological constant represents the remaining congruent-simultaneity potential of which the remnants in the spacetime domain have yet to materialize. As such, the cosmological constant may not be a constant because, in keeping with the S-curve, the remaining congruent-simultaneity potential is bound to gradually reduce. Even so, it is crucial to identify the evolving phenomenon of which the remaining congruent-simultaneity potential is calculated. For example, whereas the redshift-inspired calculations of cosmologists might refer to the universe as a whole, the zero-point energy-based calculations might not.

On the Existence of Dark Energy and Dark Matter

As discussed in the previous section, the inflation of the universe might mirror the population growth of a complex of best-matching behavior-pattern-species populations of which the niche size is determined by the congruent-simultaneity potential of the universe as a whole. As such, the remaining congruent-simultaneity potential rather than 'dark energy' explains the rate of inflation of the universe. Alternatively, dark energy represents a measure of intrinsic (that is, yet-to-unfold) momentum- and geometry-inspired energy. Following the same path of reasoning, the features of stellar systems, particularly the sustained orbit velocity of stars in spiraling galaxies, reflect both the realized and remaining congruent-simultaneity potential of stellar systems as evolving and materializing rather than predefined mechanical systems. Like dark energy, dark matter might refer to intrinsic (yet-to-unfold) momentum- and geometry-inspired matter.

On the Lack of Emergent Time

The appraisal in this paper provides both rationale and evidence of emergent time at quantum levels. The 'robust findings' of Stochastic-Resonance phenomena at quantum levels indicate that one of the prime processes contributing to the emergence of behavior-pattern species extends into the domain of quantum theory. Indeed, time as congruent simultaneity might be the dimension of time 'in a different guise' that helps explain the transition from non-being to being.

On the Influencing Dynamics of the Universe as a Whole

The principles of auto-emergence maintain the observation of Ernst Mach that 'locally observed inertial properties of particles arise not from some independently existing absolute space but from the combined effect of all the dynamically significant masses in the universe.' First, *reciprocal conditioning* explains how cycles of behavior-pattern-species population growth spark off other cycles across the entire spectrum of timescales. Second, *Stochastic Resonance* explains how the development of congruent simultaneity might involve the effect of all the dynamically significant masses in the universe.

6.2. Practical Relevance

The principles of auto-emergence may also persuade the engineering and organizational development communities to reach for help into the behavioral domain. Here are two examples.

Material Sciences

Obviously confined to the spacetime domain, the typical approach of engineers today when trying to improve a process is to experiment with the process environment and its gradients until a desired effect is achieved. Guided by (e.g. crystallization-) examples in nature, engineers often feel their way through the dark, sometimes helped by chance, to arrive at a desired result or, as more often is the case, to arrive at an unanticipated result which, then, triggers ideas about new applications in the mind of keen observers. For example, IBM engineers have now patented a process that produces the environmental conditions for polymer compounds to self-assemble with trillions of nano-scale holes across a 300 millimeter wafer. The insulating qualities of the vacuum in these holes help improve the speed of microprocessors and reduce their energy consumption.[xxxii] Considering the domain of auto-emergence, the approach followed by engineers might be improved. Rather than experimenting with environmental conditions, engineers might want to examine the effect of a range of behavioral-pattern species first, particularly, by means of momentum- and geometry-inspired behavior-pattern modeling techniques. As the snowflake example in this paper illustrates, a behavior pattern essentially determines the spatial structure. After identifying the behavior-pattern species that produce the desired spatial structure, the simplest environmental conditions necessary can be identified by mathematical modeling initially and by experiment eventually.

Nuclear-Fusion Dynamics and Human Organization

Another example involves the development of nuclear-fusion reactors. Decades of painstaking research at the cost of billions of dollars are invested in the development of a process chamber in which an environment can be sustained that mimics the conditions inside a star. The idea is to compress nuclei until they fuse, a process that takes nearly as much energy as it produces. From a behavior-pattern species point of view, nuclear-fusion process development is not unlike the development of organizational processes. In an organization, no 'components' can be forced to work together however strong the confining (i.e. reward and punishment) environment. Success requires best-matching behavior-pattern species that accomplish a maximum level of congruent simultaneity. Such behavior-pattern species also function as templates which filter our species of which the behavior patterns compare. Rather than people, fusion processes involve nuclei that require a certain level of congruent simultaneity or least-energy matching in order to fuse. Like the behavior-pattern species in an organization, the behavior patterns of nuclei (as well as of their components and subcomponents) play a crucial role in the achievement of sustainable fusion processes. So, from a behavior-pattern point of view, nuclear-fusion research should start with the modeling of best-matching behavior-pattern species of fusing nuclei. Based on this research, new technologies might be identified that achieve least-energy matching. For example, a strong laser field may be applied not to create a confining environment but to bring nuclei into a behavior mode (dance pattern) that triggers nuclear fusion at lower temperature-gradients.

On the whole, also in the physical and social engineering worlds, the clue is in the exploration of behavior-pattern species. *Whether it concerns microchips, nuclear fusion, or organizations, the crux of future design techniques is in the tinkering of behavior-pattern species rather than in the trial and error discovery of recipes that produce certain spacetime features*.

7. Summary

Auto-emergence seems to be driven from a behavioral domain of which the governing principles might be considered as an extension of the current 'paradigm of description' in physics. Based on a momentum- and geometry-inspired thermodynamic advantage, the natural selection of behavior-pattern species determines the features and forms that manifest as remnants in the spacetime domain. In a perpetual way, the evolving conditions of the spacetime domain influence the evolution of the behavioral world in turn. The principles of auto-emergence can be subdivided in three groups (Figure 11). The first three principles are *Definitional Principles*. They state how behavioral matters produce realities that can be observed in the spacetime domain. The second three principles are *Diffusion Principles*. They state how behavior-pattern species self-create and how the effect of their existence is transmitted. The final two principles are *Gauging Principles*. They provide qualitative and quantitative anchors that can be used to evaluate the state of evolution in both the behavioral and spacetime domain.

Behavioral Domain | *Spacetime Domain*

Principles of Auto-Emergence

Definitional Principles

I. Existence in the spacetime domain is a 'remnant' of behavior-pattern species in the behavioral domain.

II. Natural selection depends on dynamic 'least-energy matching' or 'congruent simultaneity'.

III. The growth of both behavior-pattern-species populations and their remnants follows an S-curve.

Diffusion Principles

IV. The development of congruent simultaneity unfolds through a universal sequence of four unique states.

V. Behavior-pattern species arise together at numerous time scales and, only together, they arise.

VI. Congruent simultaneity is transmitted by means of stochastic resonance.

Gauging Principles

VII. Time is a measurable as local time (interval) arising from global time (congruent simultaneity).

VIII. The future is determined by (the unfolding of) remaining congruent-simultaneity potential.

Typical Remnants

Organization	*Human Level*
Thought	*Neuron Level*
Snowflake	*Molecular Level*
E_8 Geometry	*Quantum Level*

Figure 11: The 8 principles of behavior-pattern-inspired auto-emergence.

8. Discussion and Conclusion

In no way does this paper aim to question any of the theories in physics that deal with the explanation of the fundamental structure(s) of nature. Rather, the intent is to provide a perimeter perspective that might help deepen our understanding of the emergence of such structures assuming that our world is a constantly evolving phenomenon which is centered on 'movement' and, thus, 'behavior'.

The proposition in this paper represents perhaps one of the very few cases where a point of view is offered that originated in the domain of the social sciences to clarify findings and issues in the domain of the natural sciences. The contributed insights are hoped to expand, if not shift the explanation of auto-emergence in physics.

The existence of the two universal clocks that might help measure change both quantitatively and qualitatively deserves much more attention. Also, the mathematical implications of the two identified dimensions of time (time as interval and time as congruent simultaneity) need to be explored in more depth particularly their role as devices that help us keep a finger on the pulse of nature and society. The confirmation of the assumption that the duality of time is a case of *global gauge symmetry* and *local symmetry* should probably be at the heart of such an exploration.

Considering the views of Henri Bergson, who was not a physicist, and those of Alfred Whitehead, who was, the account in this paper articulates once more that existence is not a static state but a state of emergence or, rather, auto-emergence which, paradoxically, occurs in conjunction with auto-emergence elsewhere. This might explain why auto-emergence is a social phenomenon.

Finally, if the idea of the behavioral origin of reality is upheld then evolution is not just a matter of the survival of the fittest (successful reproduction) but particularly a matter of the survival of least-energy-fitting or best-matching behavior-pattern species. The conclusions in this paper not only affect the premises of the natural sciences but, also, those of the social sciences.

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