Omega Zero; The Influence of the Future on Evolution

Devin Harris
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Abstract
In considering the recent discovery that cosmological expansion is accelerating at an ever-increasing rate toward the extreme physics of absolute zero, science is understandably at a loss for conceptual representation of the distant future. Cosmology is in an unprecedented adjustment period since the absolute zero future we are being forced to consider was previously ruled impossible. Part one of this essay considers the consequences of admitting absolute zero as a possible state in the partition of states considered available to the evolution of space-time, and considers reasons why reaching zero might be the overall objective of time. In investigating the role of zero within the set of all possible states we recognize that if the direction of time is indeed aimed at zero, then the second law of thermodynamics is too simple to explain time's arrow. Part two, in considering how an absolute zero state fits into an order-disorder gradient, proposes the central theme of the paper, a theory that there are two opposing types of order present in nature, rather than simply order and disorder, a step which directly challenges the second law in a general way not considered previously. The concrete discovery of two orders resolves into focus a major conceptual shift first advocated in western science by physicist David Bohm. It exposes a supreme state in physical reality and leads to a teleological model of cosmological and biological evolution. In support of this shift, part three presents a surprising switch in mathematical modality, what one reader referred to as God's math, where positive and negative numbers, or matter and anti-matter, are understood to combine rather than cancel, making absolute zero a unified whole value, rather than nothing. This essay introduces several valuable and highly thought provoking fundamental concepts which, like the anthropic principle prior to 1974, have not yet been explored in mainstream science.

Part One: The Space of All Possible States

Introduction

The realm of possibilities has been referred to as state space, phase space, configuration space, the physicist John Wheeler referred to it as superspace[1], and Julian Barbour named it Platonia[2]. Ludwig Boltzmann in 1868 first presented a study of the possible states of a thermodynamic system[3], breaking with the mainstream belief that all change was purely deterministic, while his statistical approach led the way for the development of quantum mechanics. A strong advocate of the second law, Arthur Eddington in the 1920's coined the term *time's arrow*[4], designating the second law as holding "the supreme position among the laws of nature". The second law provides a rare ability to appreciate the reason "why" behind a law of nature. The simple logic that *there are fewer ordered states than disordered states* has made a lasting impression upon science even as an ultimate representation of all possibilities, although it should be noted that the second law merely considers the specific states available to a system and not all conceivable states. This fact is normally overlooked.

In his attempt to understand why thermodynamic processes were irreversible, Boltzmann discovered the microstates which led to defining the probability statistics of macrostates available to the system. For example, in the case of a number of gas particles in a closed container, we know, at least now, there are a specific number of energy levels available. The point is that the structure of states suggested by the second law is only a sub-set of possibilities, merely a vague glimpse into a greater composite realm of all conceivable states or patterns. A simple analogy considers the possible states of a coin flip. We recognize heads or tails as available states. We certainly don't consider states where the coin changes shape, disintegrates,

or vanishes into thin air. Nor do we consider states where a tossed coin never falls to the ground but just floats upward into the clouds. Those states, those patterns although imaginatively conceivable are not even science fiction, they're fantasy. But what of fantasy? How different is the space of possible states from the space of all conceivable patterns? Even to speculate we would have to explore and somehow model such a realm. Why bother?

Ultimately we would reasonably expect that the structure of space-time is a product of what is both possible and probable in nature. In any scenario, intelligent design, creation, or happenstance, we should expect the overall big picture so to speak reasonably leads to the universe we experience. If we take into consideration how the second law indicates that our universe is influenced and even controlled by probabilities, and further acknowledge how the entire underworld of atoms and particles is governed by probability waves and their collective fields, so that the unobserved past and future are both definable only as probabilities[5], we could reasonably expect that the states we consider possible are themselves probabilistically governed by a vaster realm, a complex and finely structured aggregate pattern landscape.

The full complexity and magnitude of all conceivable patterns we shall assess is easily underappreciated. Just imagining the alternative coin flip scenarios divergent from the simple results of the coin landing on head or tails is mind boggling. However, the realm of all conceivable patterns is also often imaginatively over appreciated. The ultimate body of possibilities is in no way limitless or unbounded as is commonly assumed. Instead it is structured by ultimate boundaries of extreme possibility which will allow us to model and relate this aggregate *pattern space* to how we have otherwise been led to model all possible states.

The first step toward modeling pattern space is to clearly recognize how we otherwise envision the aggregate structure of possible states as defined by the second law. If we attempt to graphically represent the superset of possible states, along an axis the number of ordered states decreases toward an ever fewer measure of highly ordered states, while in the opposite direction the measure of increasingly disordered states increases. Referred to here as the *wedge model*, the large-scale structure of states has been reservedly portrayed in science as closing at the end of highest possible order at a single extreme state, while in the direction of increasing disorder the general assumption is usually of an endless and indefinite expansion of states without end.

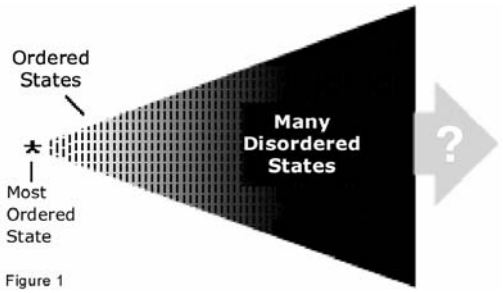


Figure 1

This asymmetric wedge is a vague yet rarely scrutinized construct for how we envision all possibilities. Time itself is imagined as moving in reference to the body of all possible states through this wedge. Odd when considered, the model lacks a boundary in the direction of disorder, in part because time in an ever cooling universe has in the past been theorized as not having an end. The images in figure 2 below represent how a few noted physicists have generally represented state space[1][2].

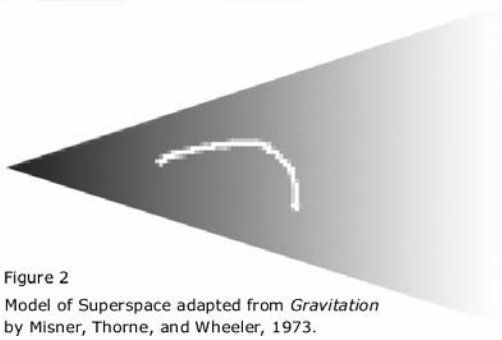
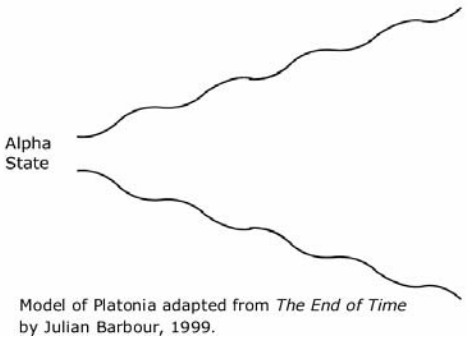


Figure 2
Model of Superspace adapted from *Gravitation* by Misner, Thorne, and Wheeler, 1973.



Model of Platonia adapted from *The End of Time* by Julian Barbour, 1999.

However, the reader may sense something is amiss. We are considering a longstanding yet somewhat vague impression of all possible states cast mainly in the years when physicists predicted one of two possible futures, the big crunch and the endless heat death scenarios. We have since entered a remarkably different era in cosmology, and as we now consider the recent discovery that cosmological expansion is accelerating, it appears that this wedge model of states is outdated. In fact, in both of the new future scenarios currently being debated, where time approaches zero in either infinite or finite time, Boltzmann's overall approach of modeling ordered and disordered states is very clearly too simple to effectively explain time's arrow.

Updating the Wedge

Since 1998, studies of distant Type 1a supernovae[6] have indicated that the expansion of the universe is accelerating, and today it is estimated that the acceleration began nearly six billion years ago, which is nearly half of the age of the universe. In March of 2003 Robert Caldwell and colleagues[7] presented the Big Rip model of the future, which considers the scenario where a dark energy density dubbed phantom energy[8] by Caldwell increases with time, with expansion ripping apart galaxies, stars, and finally atoms. In the Big Rip model the universe is stretched perfectly flat, and the evolution of our universe ends distinctly in finite time at what Caldwell refers to as the ultimate singularity.

We know that once the rate of expansion turns from decreasing to accelerating, the outer horizon of the space-time bubble breaks away from time zero of the big bang and shrinks inward relative to each observer. Eventually all other galaxies leave the event horizon, leaving only the fate of our own galaxy in question. If the acceleration overcomes gravitation and even particle forces, the outer event horizon would collapse inward on every point in space, and space-time is ended, yet it is the physical expansion of space that produces the collapse. Although direction and extension loose meaning within this final state, there is good reason to envision absolute zero relative to space-time as a perfectly flat and empty space extending infinitely in all directions.

Absolute zero is not properly described as a hypothetical temperature of matter at which all motion stops, but rather absolute zero is a common point of zero for all measures in space-time physics, including temperature, mass, energy, density, gravity, volume, and time. Thus the only method of one parameter attaining zero is if all reach zero simultaneously, making zero the ultimate *Omega state*. Although physicists have advocated the possibility that a fluctuation in a

vacuum created a matter universe, the consensus has been that a matter universe cannot become absolutely cold, because matter simply won't cool to zero. The universe might cool forever, endlessly approaching zero, but time would never reach absolute zero. And this explains why absolute zero has not been widely recognized as a member in the *space of all possible states* (SOAPS), not because a perfectly flat space is inconceivable, but because it was believed that such a state is not available to a universe consisting of particles.

So it's particularly interesting that we have now discovered that the expansion of the universe is accelerating, since the only process that would produce a zero temperature in the future is if an accelerating expansion literally stretches the entire universe perfectly flat. A cold inflationary expansion in which every point in space is expanding away from every other at the speed of light stretches all matter and spatial curvature flat, and may even disallow the creation of virtual particles, thereafter erasing all record of physical existence, or so it would seem on the surface of understanding.

To now update how we envision the set of all available states in accordance with accelerating expansion, in the scenario where expansion stretches the universe perfectly flat in finite time, we are required to integrate absolute zero into the set of available states, the broad consequences of which we shall explore throughout this essay. In the scenario where the energy density causing acceleration dissipates, so that accelerated expansion requires infinite time to reach zero, we are required at least to recognize a gradation of low density states available to a cosmological time approaching zero. Although these modifications are required of how we model available states, this outlines for us a first step toward modeling all conceivable states.

Modification 1: Admitting Absolute Zero into State Space

The initial step of structuralizing the grandiose realm of pattern space is the recognition of absolute zero as a boundary state located beyond the bulk of all disordered states [9][10][11]. We might initially represent such a model as shown below, with the overall expanse of states becoming a density gradient, while maintaining Boltzmann's order-disorder gradient adjacent the axis between the alpha state of the big bang and zero. We might initially consider the possibility that Boltzmann has described merely a partition of ordered and disordered states adjacent the deep time axis, which are more readily available and influential to a temporal system in short time durations. In the deep time of cosmological evolution we find ourselves instead representing a gradient of density, a model ordered and structurally established by the average density of a state, spanning from an infinite cosmological density at alpha, to zero density at omega.

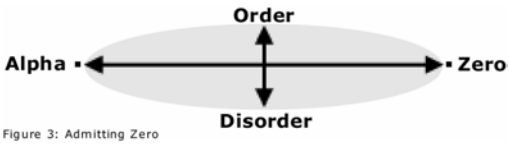


Figure 3: Admitting Zero

Modification 2: Boundary Conditions

With zero recognized as an extreme of possibility in state space the next step is to consider the configuration space boundary conditions of a distant future approaching zero, which relate to similar boundary issues of our past. In the deep past, the collapse of space-time volume is

generally assumed to lead to the highest state of order, a singularity[12][13], referred to here as the alpha state. It is generally agreed that once all known matter and energy is collapsed to a point of zero volume, all potential for physical description ends, and thus beyond the alpha state, no other possibilities exist. All possible paths in reverse time necessarily converge toward the single alpha state, purely due to there being an ever fewer measure of ordered states in that direction.

In considering the distant future the same principles which define the shape of the wedge model apply also to the shape of state space near zero. Regardless of whether we define a zero state in respect to order or disorder, there are obviously fewer states of similarity to the one perfectly flat and empty extreme of zero than not. Thus, similar to the decreasing measure of states near the beginning of time, there is naturally a decreasing measure of states surrounding zero, meaning that the wedge reverses and closes at both ends of state space, toward alpha and toward zero. Thus we also recognize that in the direction toward zero all possible paths necessarily converge in state space toward one single state.

Figure 4: The Gradation of States Near Alpha and Zero

Modification 3: Adjacent Extremes

Next we consider if there may be recognizable boundaries to the structure of all conceivable states at right angles to the deep time axis. There is a vague recognition in cosmology that a smooth configuration is an extreme of possibility or natural boundary in state space at any given average cosmological density or temperature, usually expressed when cosmologists consider that the universe might have remained perfectly smooth after the big bang, and we can easily imagine a uniformly dense expanding space remaining perfectly smooth until a homogenous plasma reaches absolute zero due to an accelerated expansion. This smooth series of states can be recognized as an outer extreme of possibility, an outer boundary beginning at alpha and ending at zero, beyond which no other possibilities exist.

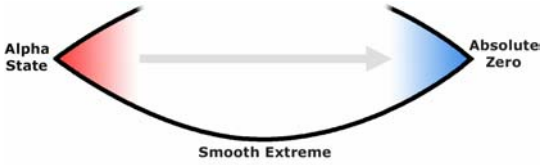


Figure 5: Smooth Boundary

With the smooth boundary recognized, we might also consider that two opposite extremes exist adjacent the axis from alpha to zero, an extreme smooth state, and an extreme lumpy state, even if such a state is initially difficult to envision. The existence of both extremes is evidenced by the ordinary concept of contrast applicable to all images, where color tones are either blended into a single averaged color (low contrast) or the color tones of the image blend into two opposing shades of light and dark (high contrast). We can imagine a contrast gradient of states at each point adjacent the density gradient.

We might apply this contrast gradient, to the question of why the early universe did not remain perfectly smooth. With similar reasoning supporting the second law, we can deduce that the maintenance of a smooth universe during

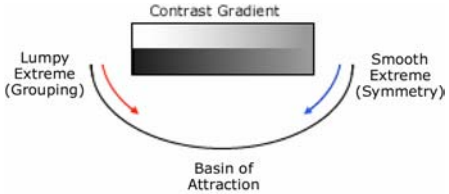


Figure 6: Contrast Gradient

expansion is statistically near impossibility. At each measure of decreasing density, the universe remaining perfectly smooth is one possibility among many other possible states where space does not remain smooth. Further, we can predict that the path of any dynamic system along the deep time path from alpha to zero will probabilistically follow a basin of attraction balanced somewhere between the two contrast extremes, this generally forming a special partition of states available to temporal systems. It might further be argued that the general amount of grouping of matter versus the balanced distribution of galaxies since the big bang, is congruent with this basin of attraction.

The proposal then is that the structure of all conceivable states, or pattern space, is aggregately enclosed, bounded in all directions by extremes, and further that no states outside of this spectrum, beyond the smooth and lumpy extremes, are describable by physics or even imaginable.

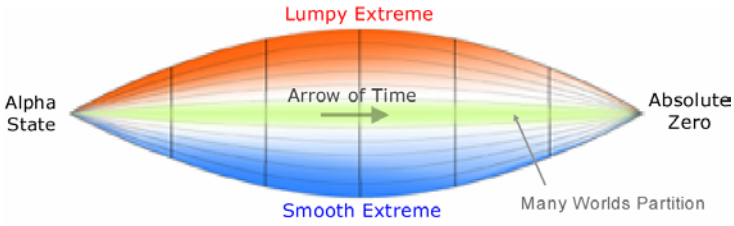


Figure 7: Pattern Space Boundaries

Modification 4: The Target of Time's Arrow

In the early days of big bang cosmology the astronomer Allan Sandage remarked, "The expansion of the entire universe is the most important single hard scientific fact of cosmology". We might now consider how our new discovery of accelerating expansion might eventually reveal the deep time future, perhaps in as much detail as the discovery of red-shifted nebulae revealed our deep time past.

Can an accurate model of state space help us predict a precise future? The most unexplored issue coming from the discovery of accelerating expansion is that regardless of whether the arrival time to absolute zero is finite or infinite, in any scenario where the rate of cosmological expansion increases, the general evolution of space-time in relation to state space is recognizably moving precisely at the outer boundary of absolute zero, as opposed to moving toward any basin of attraction in state space short of zero. Consequently, the logic of Boltzmann's version of the second law breaks down as a means of explaining the direction of time. If time's arrow is established by probabilities then time moves in the direction of greater disorder only because there is a larger group of such states. If we treat zero as the lowest possible disorder, any system residing at zero should be expected to probabilistically gravitate toward greater order.

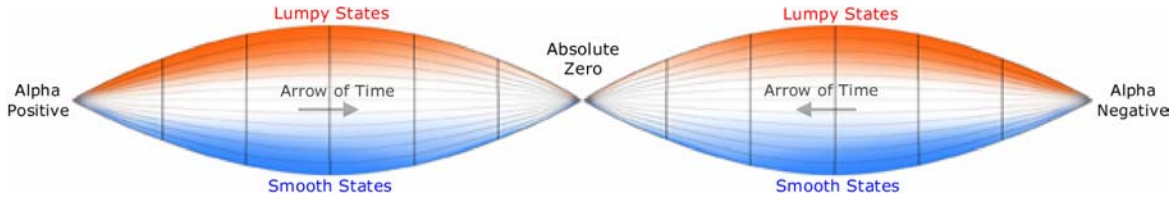
Once we admit zero and recognize there are two boundary states, so that we can consider a high order boundary and a low order boundary, logically there also would exist a balance somewhere in state space between these two extremes, where a set of states of greater order is equal to a set of states of lesser order. If time and change is ultimately probabilistic, and if the set of all possible states is a quiescently existing mediator as we would expect, regardless if we consider the radical diversity and complexity of all conceivables or merely those states we deem available to our cosmological system, in an infinite yet bounded system of states, making the

measure of states countably infinite, there logically would exist a universal basin of attraction for all dynamic systems. In fact the necessity of an ultimate point of balance is built into Boltzmann's own logic, where all systems tend toward a state of maximum probability.

In attributing time's arrow to a greater measure of disordered states, Eddington and others in principle are proposing that the bulk of disordered states is an attracting body which produces the impetus of time, given that a system originates in a state of high order. Yet we know now with considerable certainty that cosmic evolution isn't being drawn toward any basin of attraction short of zero, located somewhere in between alpha and zero, but rather time's arrow is on a crash course, literally accelerating toward the target destination point of absolute zero.

So we are forced to finally ask a question that has been lying in wait since the discovery of accelerating expansion surfaced in the mainstream in 1998. Why is the arrow of time aimed directly at absolute zero, and presently even accelerating toward zero? What specific role does absolute zero play in the space of all states? The simplest and far most cohesive explanation of a direction of time aimed at zero is that a reciprocal negative set of states extends beyond zero, therein making zero the ultimate balance of state space. The overall structure of states would thus include an inverse set of patterns, similar to the extension of negative numbers beyond zero in the mathematical plane of real numbers, which are identical yet opposite. Such a model immediately predicts the potential of two directions of time as shown below, an anti-time also predicted in other works[14][15][16]. This modification should feel intuitively satisfying as it exchanges the asymmetric wedge model for a symmetric superstructure for both possible and conceivable states.

Figure 8: Space of All Possible Patterns



We have now developed a bounded and definite model which for the first time allows us to consider the broad realm of all possibilities, as well as the partition of states available to space-time from what we might call a God's eye perspective. A top-down perspective toward physical reality has in the past been defended by Piet Hut [17] and the necessity of a top-down approach to cosmology was very recently advocated in a paper by Stephen Hawking [18] entitled *Cosmology from the Top-down*. Although there is one more modification, this addition of negative states completes all proposals concerning the large-scale structure of states. In viewing this grand body of all states, we can recognize that definitive boundaries exist in all directions of state space, as opposed to any model indefinite in the direction of disorder. We would say then that the aggregate realm of all possibilities is infinite yet bounded in all directions by extremes of physical possibility.

V. From Imbalance to Balance

In considering a state space with zero fully integrated, we consider the possibility that absolute zero, as an attractor in our future is responsible for the origin of time. If accurate this would lead us to replace our previous attempts to explain the first moments of time as arising out of a (zero) vacuum, due to a quantum fluctuation, with the quite different view that time invariably originates from the extreme positive ***or negative*** side of the spectrum of all states, and probabilistically travels toward zero. So rather than the theory that time moves from an initial condition of high order to disorder, the reason for the direction of time becomes a universal principle that systems evolve from imbalance to balance.

As to why any system would originate in a state of imbalance, there is a universal answer to that question which would be as equally effective in Boltzmann's modeling of states as in this new model. If all possible states are not merely ethereal potentialities, but instead physically exist, then in principle the history of any temporal system embedded in those states will necessarily trace backward to improbability rather than probability. In Boltzmann's model, any state not at thermal equilibrium would innately trace back to extremely improbable order. In this new model, any system not at balance will temporally evolve toward balance, so any history, any past record of a system in which any imbalance exists, will inevitably trace backward to an ever greater extreme of imbalance. The temporal evolution of a state more positive will trace back to an extreme positive alpha, a state more negative will trace back to an extreme negative alpha. I shall refer to this as the *Parmenides Principle*.

In now asking, what creates the special partition of states available to our space-time system, the classical assumption is that nature's laws, particularly conservation laws, constants, energy levels, the four forces of nature, all somehow contribute to shaping the partition. However, we might instead entertain the option that available states within the partition merely correlate with such laws and forces. There may not be any overbearing laws regulating temporality's course through the landscape of all states, rather the landscape itself may be intricately shaped by probable and improbable regions. The special many worlds[19] partition of space-time systems like our own may simply be a construct of the most probable courses through an aggregate pattern space.

We might imagine that such temporal pathways move similar to water flow, controlled by a complex contour of attractors and basins of attraction, always generally attracted to higher probability, with currents and eddies flowing into the major riverways, exploring all possible paths but only within the more probable regions. All such pathways may be built into the topology of a complex and finely structured aggregate landscape of all conceivable patterns, where the majority of territory may be so improbable as to be temporally impossible.

In the model so far explored, all space-times begin from either the positive side of the spectrum producing a matter universe, or systems begin from the negative side which yield identical but inverse systems of anti-matter, while both imbalanced systems probabilistically

(and systematically) evolve to zero (the probabilities of this model are explored in part three). As a universal principle, as a supreme law of all naturally (probabilistically) formed temporal universes, already this exploration of the possible realm suggests that all universes begin with a big bang and expand super flat. The proposal being made is that there are natural boundaries to the whole of temporal systems allowed to exist, opposing the existence of all other conceivable cosmological scenarios of a multiverse[20]. If indeed we can exclude the majority of dissimilar cosmological scenarios (dissimilar to our own) from statistical probability, then our dependence upon the anthropic principle for explaining the design of our own universe is greatly lessened.

Timelessness

In support of the Parmenides principle, a concept that resulted from the theory of relativity was that all of space-time forms a unified four dimensional existence. In regards to Minkowski's space world, in his book Relativity[21], Albert Einstein wrote, "Since there exist in this four dimensional structure no longer any sections which represent "now" objectively, the concepts of happening and becoming are indeed not completely suspended, but yet complicated. It appears therefore more natural to think of physical reality as a four dimensional existence, instead of, as hitherto, the evolution of a three dimensional existence." Einstein's belief in the unification of past, present, and future, was expressed most poignantly in a letter to the family of his lifelong friend Michele Besso, who died shortly before his own death. Einstein wrote that although Besso had proceeded him in death it was of no consequence, "for us physicists believe the separation between past, present, and future is only an illusion, although a convincing one."[22] Notably, years later Richard Feynman came to define time as a direction in space [23], and more recently Stephen Hawking has become increasingly adamant in expressing that the universe existing in imaginary time is self contained and has no boundary[24].

It may be that the only solution to why time begins in a state of improbability is that a four dimensional system of space-times is embedded in a foundational matrix which doesn't evolve and is even unable to change; state space simply is. In this modality, there is no distinction between the words *existence* and *time*. We can refer to this mode as timelessness or as a primary reference of time which has no beginning, middle or end. Consequently I personally refer to this time as *one enormous moment*. The physicist Julian Barbour explored timelessness in his book *The End of Time* [1], which calls for a timeless perspective in physics. And the philosopher Huw Price refers to a related perspective as *the view from nowhen*[25].

We turn our focus now on how to properly re-integrate order and disorder into this evolved model, which is far more challenging that one might expect, since although zero is clearly the highest possible state of entropy, the most distinct property of an absolutely flat space is perfect symmetry, which might contradict any designation of zero as the lowest possible order. To explain the fifth and most significant modification brought about by the introduction of absolute zero into both the SOAPS and pattern space models, I must first propose a modification to how we understand order and disorder. What follows in part two is actually the more consequential material of this report.

Part Two: Introducing Two Opposing Types of Order

I. Much ado about nothing (perceptual shift stage one)

In considering why a universe exists, the most common expectation made by scientists is that an absolute nothing is more probable, more simplistic, and more natural than the universe. Max Tegmark points out that nothingness would have zero information content[26], whereas a something universe contains information. For this reason, a nothingness seems to require no cause or explanation where in contrast a world of things being physical, being definitive, being diverse in character and quality, requires an explanation or reason for existing. "The fact is, nothing could be simpler than nothing — so why is there something instead?" remarks the astronomer David Darling. In the case of whether a universe should exist versus nothing at all, the existence of a universe even seems to violate Ockham's razor, which states the simplest answer is most likely the correct one. Hence, *nothing at all* seems more probable than any universe.

Such logic has seemed inescapable, however the solution to this absurd problem lies in recognizing that there are two concepts entangled together in the common meaning of the word *nothing*, and at this time in history they are regularly confused as one concept in modern science and philosophy, and even in the dictionary. If we carefully study the common meaning of *nothing* we can discover two distinct references, one toward something that is real and exists but has no discernable form or substance, such as a white canvas, a void, or an empty space. The other reference is toward a different and much more radical concept, that of *non-existence*.

Imagine you find yourself in a world of white that extends away from you, yet because there is just the one color you can't tell if this world extends out forever or its edge remains just out of reach. Only your physical body provides a sense of distance. If you further paint yourself white, suddenly all sense of dimension is erased from your experience, and soon even the color white disappears from your experience. Someone who is blind doesn't see black, because even if they did upon initially going blind, the black would quickly loose meaning for them because it is just one color and without differentiation the mind interprets such a world as a perceptual nothing. And in fact the mind is correct because a world of singularity is all *nothing* can ever be.

The real *nothing* that exists is merely singular form, and such singularities are one of the most common features found in nature, space being the most obvious example. If we remove all the ordinary matter from space it has merely been reduced to a singular expression of nature. We do then loose our ability to reference the space, but we shouldn't make the mistake of associating this perceptual failure with the idea of non-existence. Singularities exist, but they don't in any way relate to non-existence. In fact non-existence shouldn't even be recognized as a word.

When the dictionary defines nothing as something that does not exist, it is reasonably obvious that there is something at odds with the syntax of the phrase, simply the reference to a *something* which 'does not exist', commits an obvious semantic error. The problem in defining the term is that it is impossible to meaningfully define what non-existence refers to. How can we

possibly reference non-existence when there is no such state or form? In fact the term non-existence is actually an anomaly in language.

The term is entirely unique from all other words in that it attempts to borrow meaning in a way that no other concept or idea borrows meaning. All other cases of borrowed meaning refer to something of meaning, something not denied. If we refer to non-Euclidean or non-standard, what is being referred to has meaning independently. If something is non-white, we know the color is some other, at minimum, off-white color. If we say a temperature is not cold, the reference is to "being greater than cold", so something is warm or just right, or perhaps its not merely cold, but extremely cold. Anything that is not, is something else, except non-existence. In fact the term non-existence does not refer to anything else having any meaning whatsoever, so only the negating *non-* and the word *existence* have meaning individually.

The universe is everywhere we go and everywhere we see. There is no place where the universe is not. Yet we still imagine in a vague way an alternative, as if the universe could stop existing, as if we ourselves might not exist. We accept the word non-existence because it makes sense to say unicorns or square circles don't exist. And if there is nothing in the refrigerator, we can say, the milk doesn't exist in the refrigerator. But what we are really saying is that the milk isn't in this location at this point in time. As the physicist John Wheeler said, time is what keeps everything from happening all at once. The absence of the infinity of things that might exist in the space inside the refrigerator doesn't ever create a black hole of non-existence. It merely reduces that space to the seeming formlessness of a singularity, what we define as empty space. Similarly, in the absence of magical unicorns the universe still exists, so all that we can really properly say is that imaginary things don't have form like we have form.

We know that form in some way establishes or relates to what is meaningful, and we know that square circles don't exist, because the meaning of each separate form contradicts the other when defined as one thing. So again there is a reliance on form. Non-existence cannot by definition be form, and the term does not produce any more true meaning than a square circle manages to have meaning. So any attempt to define a non-existence using any meaningful idea or thought, by using the meaning that otherwise defines all language, that defines reality, is predetermined to fail. Meaningfulness is purely unable to refer to a complete negation of existence. So non-existence is not cold or dark, or a void or an abyss, and its not even the most simple state imaginable, it is just a misconception, an anomaly in language we ourselves have created.

Physicists and mathematicians commonly make conceptual relationships between nothing and other concepts such as zero, the empty set, a vacuum, and empty space, all of which is fair and accurate, until we step over the line and pollute these existent phenomena with the notion of a non-existence. Indications of a vacuum or empty space having a hidden content, producing things such as virtual particles, is expressed as one of the great curiosities of physics and nature. More than once a scientist has remarked that apparently you CAN get something from nothing. But when we view *something from nothing* as some kind of miracle, behaving as if we gained

‘something’ physically existent from non-existence, then we have crossed the line, because the *nothing* that we get something from in nature is always just a singularity.

Once we acknowledge that a real *nothing* commonly exists disparate from non-existence, then we are ready to consider that we shouldn’t expect a *nothing* in nature to be absent of content. We can easily create a singularity by combining many things together. If we take everything out of the refrigerator, throw it in a large stew pot, and cook it for ten hours, all the ingredients blend together. All the many separate forms, the vegetables and meats, and all the liquids, end up unified into a single medium. We could go further and heat the particles into a plasma or cool them into a condensate. Either way we create a uniformity.

The formlessness of a uniformity should never be confused with non-existence. Formlessness is merely turning the contrast knob from high to extremely low and finally down to zero contrast. Therefore, turning up the contrast, and dividing up a singularity into individual things, and thus seeing form arise from uniformity, should not be any more of a surprise than the disappearance of form. The only scientific issue then is how to correlate conservation laws with the transition of definitive form to formlessness, although in order to accomplish this task we must make a major step forward, we must modify how we perceive order and disorder, because the formlessness of a singularity isn’t disorder either.

II. Introducing Grouping Order and Symmetry Order (stage two)

Much in the same way our very existence seems an impossibility, as if instead there should be nothing at all, so also are we perplexed at the order that is such an elementary part of the universe in which we live. There should instead be disarray, it seems much more logical, for we naturally consider the infinity of chaotic universes that could exist in place of the one ordered and systematic universe that is present. Yet perhaps our universe is not unordinary or an exception to what should be, but rather we have made a fundamental mistake in how we conceptualize order.

At present order has a complex yet singular meaning. Order is most commonly defined as a grouping of separate elements or a regular arrangement of objects, colors, or events in time. Although the following is a more accurate and fully developed comprehension of order, what follows is by no means complex or difficult to imagine. There are two principle classifications of order in nature, not merely a single order opposing disorder [9][10][11]. Two orders blend to produce all the diverse shapes and patterns that are observed in nature. Each has its own distinct direction of increasing order and an individual increase in either type produces opposite results.

The more commonly recognized order type will be specified as *Grouping Order* which can be understood as any class, or similar kind of thing grouped together, and thus located in a specific area, or separate place apart from another group. The second type of order is identified as *Symmetry Order*, which if we simplify its definition to extreme, is an even and regular pattern or arrangement in which all different types of things are combined and distributed uniformly throughout a frame of reference. In extreme this type of order produces a perfectly smooth and

uniform pattern. The most relevant clarification to be made is the opposition of these two types. Only as the two orders combine, and cancel the extremity of each, can they produce all the diverse shapes and patterns that we observe in nature. In fact it can be shown that each type of order is disorder to the other, which therein forces a redefinition of the very meaning of order and disorder.

Grouping in reference to similarities is the most commonly recognized order. The prototype example is a grocery store exquisitely divided into multiple sections where each type of product is then also attractively grouped.

In nature, the sun and planets together form a group, a solar system. Stars are grouped into galaxies, while galaxies group into clusters and superclusters. Grouped elements create gases, metals, fluids. Elements produce molecules, and grouped molecules produce compounds. The Earth is a collected mass of groups and sub-groups of materials as are all the planets, as is the sun. All such order and structure exists in stark contrast to another universe we might imagine void of grouping, a cosmic soup of all particles blended uniformly so that there are no stars or planets, or further still, the absence of particle form and instead only a smooth fluidic plasma spread evenly across the entire landscape.

Yet just as groups of elements and solar masses give the universe its definition and bring about order as we know it, grouping is not the only way in which the universe is organized. The universe also utilizes mixing to produce different degrees of uniformity, balance, and formlessness. Elements mix to form molecules. The oceans, the soil, and atmosphere are each compounds of many unique materials. Rock, glass, wood, soil, plastics, and metals such as bronze and steel are all various mixtures of atomic materials. And on the largest scale there is an isotropic distribution of galaxies and dark matter. Yet it is recognized that after such discussion the exact character of mixing and uniformity remains vague.

Piet Hut has said "the paradox of limits lies in the fact that limits combine two opposite functions: setting apart and joining[27]." Likewise, opposite directions of transformation are not uncommon. Particles can only attract or repel, space can only expand or contract, and material form can only create pronounced groups (lumpy) or blend homogenously (smooth). To explain this more clearly, the most lucid analogy I have found that establishes one order apart from the other is the simple method in which a chess or checker game is set up. In preparing the game, black and white game pieces are separated and grouped together. Each color is grouped and set in a location at opposite positions upon a board.

Yet now we change our focus to consider the checkerboard on which the game is played out. Serving as a moderately neutral background, the admixture of colored squares spaced evenly in alternating rows is certainly also a distinct expression of order. The most evident property of this archetypal checkerboard pattern is its overall uniformity and balance produced by the symmetrical placement of squares. This balanced order exists in stark contrast to the set pattern of game pieces which are not integrated but divided purely into two separate groups.

Opposing Extremes of Order (stage three)

The distinction between these patterns is ever more evident as we consider extremes. If instead the individual squares of the checkerboard gravitate together by color then they would unify on each side of the board forming two solid colors, now grouped rather than mixed evenly. How might we continue to increase the grouping order produced in this way? To push this pattern further would require that we deflate the frame of reference and so increase the density of the particles of each side. As the volume of the reference frame collapses the separated groups move toward an extreme of becoming two points, the extreme in any case of grouping order.

What then is the reverse process? Rather than unify the two colors into separate pure groups, the opposite process of creating symmetry order is to divide and blend the colors evenly, in this case creating a checkerboard pattern. Of course each square represents a measure of grouping a color. So to push this pattern toward its own extreme we subdivide each square and evenly distribute the finer pieces. In repeated steps this moves the pattern toward becoming increasingly variegated and smooth. In this process the colors are continually merging, transforming into one color, like mixing two colors of paint. In this direction of order, as many individual parts are either dissipated, stretched, or merged, into a singularity, all grouping order is sacrificed. The final product of symmetry order is a uniformity neutralized of difference and form, yet still the sum of its parts. Although symmetry order is otherwise visible, in extreme it becomes the order David Bohm identified as *Implicate Order*[28]. And the chemist Shu-Kun Lin has exposed similar issues in regards to how we conceptualize order and symmetry[29], defining a correlation between entropy and symmetry.

A key to understanding and appreciating the subdued nature of symmetry order lies in recognizing that that extremes of balance, uniformity, and neutrality, are produced from the union of groups and parts into the reference frame, a perfect distribution, rather than a destruction, cancellation, or absence that leaves the reference frame empty. Order is plainly evident in any chequered pattern, and our failure in the past has been in not relating that order directly to the less apparent order of uniformity or implicate order, which has just been shown to be the extreme or intensified case of visible measures of symmetry order.

The very nature, the tendency of extreme symmetry order is toward formlessness, which is starkly overshadowed by the pronounced nature of grouping order. In fact this overshadowing of our senses is the reason why symmetry order has not yet been recognized as a direction of increasing order. In the absolute extreme of combining all duality and form, symmetry order expands to engulf all possible space into a single whole. In our ordinary perceptual mode that whole is invisible and undetectable, even a collapse to non-dimensionality. Yet the visible patterns of symmetry order are indicative of an underlying order, in Bohm's words, "a total order is contained in some implicit sense, in each region of space and time." Examples of extreme yet visible or detectable symmetry order include Einstein-Bose Condensate, the particle-less form of an isotropic dark matter, the expansion and flattening of the universe, the even distribution of galaxies, and finally ordinary space, which not only utilizes balance to maintain a formless

uniformity against a consortium of virtual particles, but notably also maintains uniformity against the infinity of potential universes.

III. The Evolution from Grouping to Symmetry (stage four)

The observable history of our universe most evidently records the divergent evolution from an extreme state of grouping order to an intermediary transitional phase between both orders. This phase in any transposition from grouping to symmetry order can be considered rather plainly if we imagine setting up a checkerboard game and move the game pieces out of their initial grouping order positions toward a pattern which identically matches the symmetry order of the board of squares. As we randomly select game pieces to move toward our symmetrically ordered objective, at any point in time along this procedure until it is completed there exists irregularities within both orders or what we would normally consider to be a measure of disorder. In fact no general disorder exists, since the condition of any state can only be retarded or advanced in either type of order. Interchanged adjacent squares in a chequered pattern inevitably produces an isolated increase in grouping, in which case the symmetry order of the pattern is lessened. Likewise, the decay of grouping inevitably integrates opposing groups, and balances the reference frame toward uniformity. Surprising, yet quite congruent with our mysteriously ordered universe, we must conclude that it is inaccurate to consider any pattern as exhibiting a general disorder. The concept of general disorder has no application to nature.

There is no such thing as general disorder, only the irregularity possible of two orders. Any definition whatsoever is a form of grouping order. Any lack of form is a product of symmetry order. And in this construct of two orders, the order of one type is the disorder of the other type. So it follows that all patterns are produced from a combination or synthesis of two separate types of order, the only exception being the two extremes or highest order of each type.

IV. Integrating Two Orders into State Space

The second law presently describes the dissipation of materials as an increase in disorder. That an evolution is taking place, that entropy is increasing, or that equilibrium states exist, is not herein doubt, however, a gas that dissipates from a condensed grouping, spreading evenly throughout a room or any frame of reference in which the gas escapes from confinement, until reaching a thermodynamic equilibrium, is not at any point a case of increasing disorder but rather an increase in the balanced distribution of the particles throughout its reference frame, and therefore constitutes an increase in symmetry order. Any short-term settlement of a system into an equilibrium state can be associated with a local basin of attraction within the contrast gradient. While on a much greater time scale under a much more gradual evolution, all systems in a process of integration are converging together toward the same macrocosmic equilibrium.

Once these concepts are accepted and applied, the complex struggle between two orders, and the multi-faceted transition from grouping to symmetry is visible in everything from red hot flowing materials that solidify into rock or steel, to droplets of water which crystallize into a snowflake. At ultra cold temperatures, order is less complex than a snowflake and consequently

expresses the simplicity of the archetypal checkerboard pattern. At temperatures near absolute zero, materials such as cesium gas particles even organize into orderly columns and rows. Less than a millionth degree away from zero the definition of the particle itself is lost as atoms blend into a unified Einstein-Bose condensate[30], perhaps the most evident expression of symmetry order. Even hidden within the symmetry of a seemingly empty space, virtual particles leap out and back, when for an instant grouping order emerges spontaneously from formlessness until the balance of symmetry order returns.

To integrate two types of order into the SOAPS and pattern space models requires only that we associate the extreme of grouping order (the example of checkers divided by color into two pure groups) with the positive alpha and the negative alpha states, and we associate the extreme of symmetry order with absolute zero and the omega state.

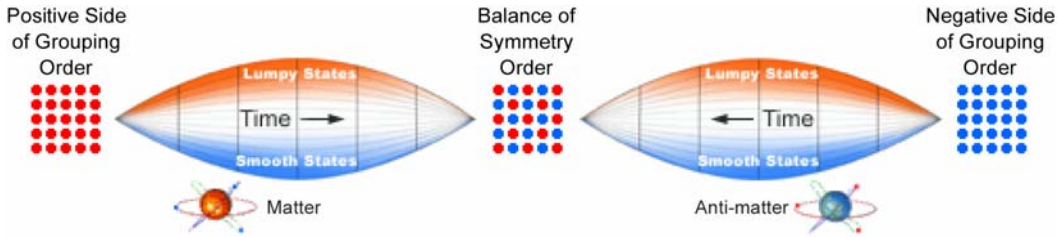


Figure 9 : Integrating Two Orders

What I would like to do now to further reinforce the unifying nature of symmetry order is introduce in part three an initially surprising switch in mathematical values. Ordinarily we see the world from a perspective derivative of the definition of grouping order. Much if not all of modern physics is based upon the axioms of grouping order. We gauge the universe according to grouping order and see the world from its *definition* oriented perspective. Grouping order is literally the order of finite objects or thingness and dictates how we presently acknowledge physical form. The absence of definition and multiplicity is to us zero things and we judge that zero, the uniformity of symmetry order, to be a nothing, even though in lesser measure we easily denote the chequered pattern, Einstein Bose Condensate, or the even distribution of galaxies, as order.

But there is another perspective of reality, another mode of perception, that we can shift into mentally. The universe and the integrity of form is defined altogether differently from the unique perspective of symmetry order. Rather than viewing the substantive world as magically arisen above nothing, there is a valid alternative, a perspective where matter is less than the balance and fullness of a seeming empty space. In this alternate view, what we ordinarily define as empty space transforms to become a composite of all conceivable possibilities. In extreme, perfect symmetry order is the nothing that is everything, a oneness of all times, all thought, all things, located not in our cosmological past but in our future. In part three we complete the perceptual shift by discovering an alternative mathematical system derived from combination over cancellation.

Part Three: The Mathematics of Symmetry Order

I. Zero as the Whole of All Numbers (stage five)

Most of us expect there to be some direct relationship between mathematics and reality, but what single number in ordinary math symbolizes the *everything* of numbers? We all are accustomed to using words such as *Universe*, *existence*, or *being,* and meaning them to symbolize the whole of all that exists. Why then, if it is so easy to refer to the universe as a whole, why is it impossible for a number to represent the whole of all numbers? What is so different about the nature of mathematics which makes all numbers impossible to represent as a whole?

We might conclude radically, that words such as Universe or being in fact have no meaningful application to nature, or perhaps it is more accurate to say that modern mathematics only represents the finite side of reality, and thus only partially represents reality. In the same way that the physical process of time could quite easily be secondary to a greater physical reality of timelessness, like a story in a book compared to the book itself, it is also possible that mathematics and even much of science conceptually models a sub-system of the primary whole.

There is actually a way to combine together or sum all real numbers into a single whole number. If we sum all positive numbers with all negative numbers, then the total combination of all in question would sum to zero, as shown below.

(1 + (-1)) + (2 + (-2)) + (3 + (-3)) +... = 0 + 0 + 0 + ... = 0

Except mathematicians recognize there is a problem in the consistency of the result of such equations. In fact several different equations sum all real numbers yet each yields a different product:

0 + 1 + (2 + (-1)) + (3 + (-2)) + (4 + (-3)) + ... = 1 + 1 + 1 + ...

next:

0 + (-1) + ((-2) + 1) + ((-3) + 2) + ((-4) + 3) + ... = (-1) + (-1) + (-1) + ...

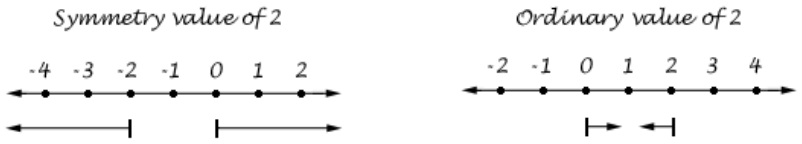
So we conclude in math that *the sum of all real numbers is undefined*, which solidly makes sense because if the sum of all numbers did indeed equal zero then we would be faced with the most complete of logical contradictions, since zero would simultaneously represent nothing and everything in the same system. Instead, zero represents nothing and there is no ultimate number that represents all numbers, and the logical consistency of mathematics is preserved.

However, one rather significant issue has obviously been overlooked here. It is said that the sum of all real numbers is undefined, but logicians and mathematicians must have made a mistake when investigating the simple idea that all real numbers sum to zero. They failed to consider switching the value of zero away from nothing. They failed to consider the option of assigning zero the value of everything, a value equal to the combination and whole of all numbers, and then considering the consequences.

In essence we have in the past tested the hypothesis that all numbers might sum to zero, against a mathematical system where the value of zero is already pre-set to be nothing. In ordinary math, all values are relative to zero as nothing, so of course we would discover that all real numbers do not sum to zero. If it were not so, the logical consistency of mathematics would be destroyed. Yet we can as an alternative allow zero to transform into the sum and whole of all numbers, it just can't be done half way. As the saying goes, it's all or nothing. The proper test of zero as the sum of all numbers requires that we allow the value of zero to transform into a value greater than all other numbers. At first this seems nonsensical, because we are switching into an entirely different set of axioms.

If zero contains all other numbers, and becomes the largest value in a mathematical system, what then is the value of number one, or two? Which is greater, one or two, *if zero is greater than both*? If zero is the largest value, the sum of all numbers, the only way there can be lesser values is if we remove some measure of value from the whole of zero. For example, suppose that we take away a (-1) from zero. What remains? Zero is suddenly no longer an absolute value containing all other numbers. Something has been removed from it. But what value does the zero whole transform into to show that loss? The answer is simply that a now slightly downsized zero transforms into the value 1, which in this value system contains all numbers, except (-1). The principle here is simply that if we remove a negative one from the whole the value of zero records that loss by becoming a positive one. And likewise, as shown below, the number two is the sum of all numbers except (-2) is removed, and so on, and so on.

Figure 10. The value of 2 can be drawn on a number line as shown below:



Just for the sake of clarity, switching to the negative, the number (-1) is a combination of all numbers except that a positive 1 is removed. In removing a positive two the whole shows that loss by becoming the number (-2), and so on, and so on. The larger the number, the more is removed and set apart, and thus larger numbers have ever smaller values. Of course this feels odd to anyone at first exposure, and to a mathematician who is learned and naturally entrenched in the extensive field of mathematics, all this likely seems absurd and perhaps useless. Hopefully everyone is interested in and fascinated by logical consistency, and maybe wise enough to not expect to immediately see how a logically consistent set of ideas can be applied for some practical purpose.

All we are really doing is considering a system of values where positive and negative values combine rather than cancel. But because values on either side of zero in such a system decrease rather than increase, as we count into ever larger numerics, the numerical value diminishes. So the value of ever larger numbers moves toward becoming infinitesimally small in both directions away from zero. In fact the values of this system converge toward two points of

infinitesimal value, an infinitely small positive value, and an infinitely small negative value, which we can denote as 'numbers'. Indeed this is a very different mathematical system.

What makes this system relevant and easily related to the SOAPS and pattern space models presented, is that the content and subsequent value of numbers decreases as we count toward greater numerics. In what I shall refer to as *Symmetry Math*, there are three extreme values, or three ultimate numbers. First there is zero, the number representing the sum of all numbers, which we should of course name *Omega*, or Omega zero. Then in the same way the number one in ordinary math bounds the infinite decimals that exist between zero and one, there is a value of positive infinity in this system which I refer to as the number *Proto*, and a value of negative infinity which I refer to as the number *Eleat*.

In symmetry math, zero and the entire spectrum of values are infinite and yet entirely definitive. Infinity in this system is not merely a series or a process. As we remove a part from the whole, we can only create other values which are themselves infinite and definitive as well. We still have a logically consistent system of values, but unlike the finite system of values embedded in this system, all values in symmetry math are infinite, because every positive value contains all positive numbers, and every negative value contains all negative numbers. For example, a positive one contains all the positive numbers and also all the negative numbers except a (-1). The number one million contains all positive numbers, it merely contains fewer of the negative numbers than does the near zero and so nearly whole 'positive one'.

The absolute smallest positive value that is possible in this system is produced by removing all negative numbers from zero, by grouping separately the positive from the negative (the extreme of grouping order). In removing all the negative numbers all the positive numbers remain. This is the smallest possible value in symmetry math. Nothing more can be removed. One of the more elegant features of this system is that although the two smallest numbers are points of infinitesimal value, Proto and Eleat are themselves each half of the whole.

$$+\infty + (-\infty) = \infty = \mathbf{\Omega} = \mathbf{0}$$

Earlier in this essay I broke away just before exploring the general probabilities of pattern space. I wanted to present grouping order and symmetry order and also this mathematical system based upon synthesis over cancellation with the goal of strengthening the readers appreciation for the theoretical model being presented, to give full weight to the conclusions drawn in exploring the probabilities of pattern space. It should be noted that the state space model presented in part one could be derived from two orders and also from this mathematical system. After exploring the probabilities of pattern space, in this final section, several other major conclusions are drawn by collectively considering the previous three models of understanding.

Conclusions

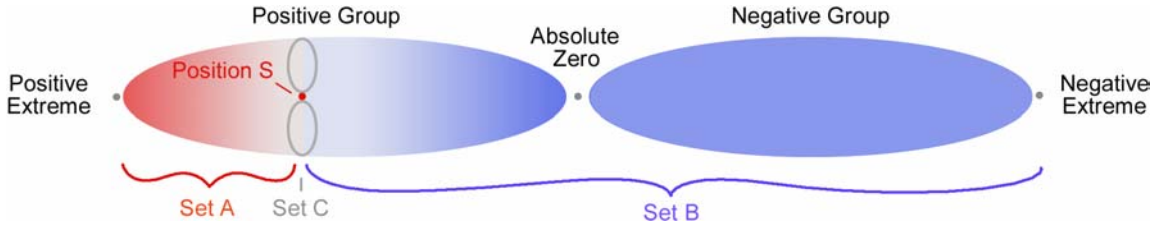
I. The General Probabilities of Pattern Space

We can now begin to study the general probabilistic features of the pattern space model to consider how all identifiable sets would influence temporality, perhaps establishing the partition of a many-worlds universe. Utilizing here exactly the same rational as it has been held that a greater number of disordered states influences the entropy and temporal direction of a system, we are attempting to understand the *why* of cosmological expansion, gravity, electromagnetism, the strong and weak forces, in the same way we understand the *why* of entropy, by viewing the probabilities of all conceivable states.

Boltzmann's order-disorder gradient, or the wedge model, allowed only an indeterminate estimate of probability influence on cosmological time from an ambiguous body of disordered states. This new model, in that the measure of states is bounded, leads to a new field of probabilistic study only here introduced. Improving the specificity of the wedge allows us to clearly recognize the influence of four distinct groups of states, allowing us to compare the percentage of probability influence between the four conditional directions of freedom in state space, expansion versus contraction, and lumpiness versus smoothness.

The diagram below considers the evolving location of a single system in the SOAPS model. Set A or the *Alpha set* includes all states which are more positive than the present state of the system, and represents an always growing counter influence of states related to the past. The larger set B includes all states which are less positive than the present state of the system, which we will refer to as the *Beta set*, and being the dominant attractor, relates to the future. Set C includes the two groups adjacent the position S of the system, the two groups more smooth and more lumpy than the state, which also includes those states which are near the average density and are thus more immediately available to the system.

Figure 11: Probability Groups



If we consider probabilities from the position of the positive alpha state, at no time is the probability to travel toward zero greater, since from that position in state space the beta set includes the total of all states minus alpha, while set A is empty. We would expect then an unconflicted probability without needing to escalate would drive or attract conditions (all spatial directions) toward becoming more negative, which inevitably involves expansion and the creation of a positive volume (matter space-time).

It is easily recognized that as a temporal system changes its location in an initially divergent state space environment, moving nearer to the position shown in figure 11, the rate of transformation relative to the superstructure of state space would decelerate at an ever decreasing rate in alignment with zero, gradually slowing as the measure of states in the alpha set increases, and the measure of states in the beta set decreases. The countering influence of the past-like conditions of set A, which are not normally considered due to our present failure to include an absolute zero boundary state in our modern conception of all states, are here recognized as having considerable influence upon the probabilistic flow of time, especially as a system approaches absolute zero where the competing sets approach equalization. The simple proposal is that the influence of past-like conditions in the alpha set can be equated with gravitation and the influence of the beta set can be equated with Hubble expansion (excluding late-time acceleration).

Generally, the measure and probabilistic influence of set A is always the lesser compared to the Beta set, with the influence of set A growing until the two sets become equalized as the system approaches zero. However it should be noted that as the system travels away from the alpha state the momentum of time would also be moderately influenced and so initially slowed by a growing measure of possible states adjacent to the contrast gradient's basin of attraction, specifically those states equal or near the average density of the system in set C, which naturally compete with the much broader axis of states along the density gradient. In fact the probabilities become increasingly more complex and predictive as we consider the grouping order of alpha in competition with the symmetry order of omega.

Once a space-time system enters the *Period of Convergence*, where the measure of states in group C begins to decrease, all previously divergent pathways of time crossover into a far different environment where the volume of state space narrows, so that all available temporal directions invariably become aligned into radial trajectories toward the single omega state of zero. During convergence the inevitable future begins to more directly influence the past. The specific destination of time also shapes the past or our present. In a very real sense a zero future being the neutral balance of all positives and negatives necessarily prepares the past in order to actualize itself. Convergence reaches deeply into the past, forcing temporal systems to become systematic and orderly in preparation for the collision of all temporal systems with zero.

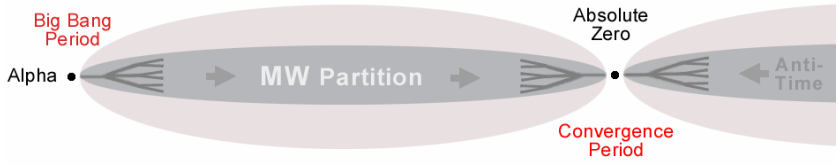


Fig. 12: Available paths initially diverge in state space then converge at zero.

An analogy we might consider of Omega's forceful ability to influence the past is if we deem some future event probabilistically inevitable in the life of a human being. Let's imagine a person living in the American continent who will inevitably be at the top of the Eiffel tower exactly at noon in one week's time. This single future state then dramatically changes the

potential events in this person's life, limiting the probability of more distant travel, eliminating the possibility of remote travel that would make the journey to the tower impossible, and dramatically increasing the probability of a method of travel toward the future goal of events. As the date of the event approaches faster modes of travel become ever more probable until finally some particular course toward the tower becomes inevitable. The inevitable future state does not dictate a specific means or specific time of travel, it maintains degrees of freedom although all have a common conclusion. We can imagine all the possible methods, and times, of how this person might travel to the tower, imagine this as a cloud of potential (each realized in the many worlds scenario), and beyond that cloud we can imagine seemingly normal events which are made impossible.

The oddity for us is of course that in our reference of time, the effect occurs before its cause, however, there is already an interpretation of quantum theory in place, the Transactional Interpretation[31] developed by John Cramer, which recognizes the influence of the future. Based upon absorber theory originated by Wheeler and Feynman and time symmetric Lorentz-Dirac electrodynamics, the Transactional interpretation describes all quantum events as a "handshake" executed through an exchange between future (advanced waves) and past (retarded waves), therein causing the collapse of both wave forms. As Cramer writes: "The absorber theory description, unconventional though it is, leads to exactly the same observations as conventional electrodynamics. But it differs in that there has been a two-way exchange, a "handshake" across space-time which led to the transfer of energy from emitter to absorber."

In convergence we discover the reason for the distinctiveness of the wave functions which shape space-time and the entire partition of Many Worlds. In that our inevitable zero future requires all space (beyond the collapsing event horizon) to stretch perfectly flat simultaneously, such a future necessarily reaches into its past (our present) and dictates particle structure (protons and electrons) as well as particle relationships or configurations necessary for that balance to occur, in the time allotted between the present state and omega. From our perspective within the product of past and future influences, we merely observe the retarded wave, but as Cramer states, "The transaction is explicitly nonlocal because the future is, in a limited way, affecting the past…When we stand in the dark and look at a star a hundred light years away, not only have the retarded light waves from the star been traveling for a hundred years to reach our eyes, but the advanced waves generated by absorption processes within our eyes have reached a hundred years into the past, completing the transaction that permitted the star to shine in our direction."

It is possible to recognize even at an intuitional level, that a zero future would influence matter in the specific ways that we observe forces presently influencing space-time. An increasingly neutral future would force like particles to repel and opposite particles to attract in order to balance the distribution of particles evenly. Such a force would be acting in opposition to the counter influence of the past toward grouping matter into dense bodies. This contrasting influence of the past is plainly visible first at the level of gravity slowing expansion, trying to re-collapse the universe, then at the level of the gravitational collapse of particle matter into

galaxies and stars, and finally visible at the particle level where the strong force bonds positive protons.

An inevitable zero future would also necessarily force complex particles to eventually decay into single particles, creating a sea of hydrogen atoms that can be distributed into orderly columns and rows, a symmetrical chequered pattern. This is the hidden role of the weak force, to counter the grouping order actions of the strong force, eventually forcing all complex particles to decay in preparation of distributing all particles evenly through space during a late-time Einstein-Bose condensation phase near absolute zero (note that the strong force appears here to be unifiable with gravitation over the electroweak interaction). We can further recognize a stringent necessity of positive and negative pairs built into a distant past.

So the general proposal then is that the *why* of electromagnetism and the weak force is an increasing symmetry built into the gradient of states approaching perfect flatness. Furthermore, the *why* of gravity and the strong force is a counter influence of all past-like states cast in the role of conservation of the past. Such forces maintain a precise measure of grouping order and positive density relative to the density gradient. Fundamentally we recognize here two forces, the future and the past. Note that the influence of a converging state space near zero is not considered in the big rip scenario but here we recognize that convergence requires a preparation process of increasing symmetry in the finality of time.

Eventually in this approach, in recognizing the fundamental struggle between the past and the future, between grouping and symmetry order, we depart altogether from a view of time as a dimension and recognize that time in our surrounding space travels in all available directions. In a complete quantum cosmology all forces of nature are probabilistic and the proposal here is that the superstructure of state space and an otherwise free flow of time actualizes all force in nature and all physical structure. In other words, what we think of as the direction of time is the sum of individual directions in space moving both forward and backward in state space, toward the past and toward the future[23]. The density of stars and galaxies, and also individual particles, are retarded time, while the cold and empty expanded space between the galaxies, and between particles, is advanced time. Gravity and the strong force are literally consequences of time moving backward while expansion, electromagnetism, and the weak force are time moving forward. This approach turns the world around us into a tapestry of time (space) directions.

Notably, this would seem to eliminate the possibility of temporal paradoxes. If an observer could somehow manage to intrude on a past-like state, all temporal evolution from the instant of the intrusion would proceed probabilistically free from the observer's expectations of the future. Simply the presence of the traveler changes the overall dynamics of probabilities, similar to the butterfly effect. But since the process of time travel would require that any time traveling observer re-establish a past-like macrocosmic state in their own evolved dynamic, such intrusions are more likely members of the temporally impossible or imaginary realm.

II. Infinities in Cosmology

The idea of Many Worlds existing in whole infinite form was until recently almost always treated with skepticism, in large part due to our confusion of zero with non-existence. The integrity and definition of the infinite has long been an unresolved mystery in both physics and mathematics, although there are a few tolerated infinities, such as electrons and black holes. However, any hope of ever discovering that the cosmos is purely finite vanished with the return of MBR data from the Boomerang and Maxima balloon born telescopes[32][33], and more recently the Wilkinson microwave anisotropy probe[34][35] further verified that the geometry of deep space is flat, indicating profoundly that if we could observe galaxies at a common age the universe would extend infinitely in all directions without end. It follows logically, and most cosmologists agree, that if the geometry of the universe is flat, then the first moment of time, the alpha state, is necessarily also flat and infinitely extended.

We no longer need question whether the universe is infinite or not. Once we separate nothing and non-existence we can reasonably conclude that existence is fundamental and ultimately timeless because there is no alternative to existence. The case for a mode of timelessness[36][21][22][9][37][20][2][38] is no less compelling than the case for a many-worlds universe, and without question only the profound nature of both positions have delayed their inclusion into science.

So in this golden age of cosmology we have arrived at a question that seems less scientific or at least far more difficult to answer. How infinite is the Universe? Is the existence of universes bounded in some way? Evidence for an infinity of galaxies or space-time bubbles was not entirely unexpected, but what of the utter chaos of possibilities, all conceivable temporal universes and beyond, the majority being completely unlike our own. Are there any identifiable boundaries to what exists?

I would suggest, based on this work, that the physical existence of all possible states may be the extent to which existence is radically infinite, satisfying an existential requirement of nature that all possibilities exist. The success if this initial work in finding a relationship between the aggregate possible realm and the structure of space-time and the many worlds of quantum theory, suggests the SOAPS in serving as a timeless foundation, limits the dimensions of temporality to a macrocosmic system of space-time bubbles all similar to our own.

To understand the whole we must switch into a different mode. In symmetry math the values of the smallest numbers, Proto and Eleat are themselves infinite, which I suggest represent in mathematical form the positive and the negative alpha states. The alpha state in our past is a positive singularity, a body that is spatially flat and infinite, yet it is the smallest value possible in nature. Internally alpha is smooth and uniform, due to being all positive, and from our perspective is definable as a false vacuum innately in a constant state of inflation, yet because macrocosmically it contains merely half of the whole, it is the smallest value in our reference of values, a tiny point in our past, that expands only as negative values are added to it.

The science fiction writer and doctorate of chemistry Isaac Asimov, in an article, *What is Beyond the Universe?* wrote: "Where did the substance of the universe come from? . . If 0 equals (+ 1) + (-1), then something which is 0 might just as well become + 1 and -1. Perhaps in an infinite sea of nothingness, globs of positive and negative energy in equal-sized pairs are constantly forming, and after passing through evolutionary changes, combining once more and vanishing. We are in one of these globs between nothing and nothing and wondering about it."[39]

The process of transformation from the alpha state to zero is indeed similar to the phenomenon of virtual particles, if they are viewed as combining into a uniformity rather than canceling, and also there is no need of the creation phase. The alpha state itself, the first moment of time, like all other states, simply exists, and time is a product of directions away from that state. As Richard Feynman remarked, *time is a direction in space*[23], and in fact the progression of time can be understood as a fourth dimension of spatial directions that due to backward causality (zero being the great attractor) inevitably originate from either of the charged alpha states. This interaction between past and future is already described by the Transactional interpretation of quantum mechanics.

To complete the virtual particle scenario, we place ourselves within the positive virtual particle, while the identical negative particle (anti-spacetime) integrates slowly and invisibly from within, expanding our positive volume and moving us ever nearer toward neutrality. Of course the reverse process synchronically expands the negative volume of our parallel anti-spacetime. The two worlds manage definitive form only by being grouped separately, and seemingly annihilate one another in the cosmic evolution of grouping to symmetry order. The existence of separate positive and negative volumes can explain why negatively charged electrons are point particles, since the intrusion of negative density cannot exist spatially extended in a positive volume.

The evolution and expansion of our universe is equally analogous to counting from the number Proto to the number Omega, traveling probabilistically through the body of all possible states, initially diverging into an expanding state space, but finally converging in state space toward the omega state, which is also in a constant state of inflation relative to our position in space-time. In the same way the number Proto grows in value toward zero as negative numbers are added to it, the universe grows spatially because of a finely controlled influx of negative density into a positive density. The values of symmetry math also reflect our large-scale reference of space and volume, which is not the internal infinite volume of the alpha state, but rather our sense of volume is in reference to the space and form that is born of the growth of alpha due to the influx of negative density. The flat infinite extension of alpha is merely an infinitesimal point to us.

III. The Relativity of Space-time

In any study of space-time, it is self evident that time includes two distinct components, physical existence and change. Any physical system must primarily exist, and so the component of change could conceivably be a secondary component which is no less real than the first

component, but merely relative. Assuming this secondary time is embedded in a four dimensional existence, we have two evident components also. One is the necessity of a linear string-like path extended across the permanent landscape. The path of a dynamic system, like a story in a book, could conceivably be solidly imprinted into a static existence. However, like any story in a book, there must be a sort of binding which fuses the multiplicity of pages. The momentary states of a system must be fused into linear form, that form being at very least our temporal experience. I shall refer to this as the linear component or as *linear time*.

Simultaneously, the time of change requires a transition through unique states or patterns. Differences must exist between points A and B necessarily lateral to the linear evolution of time. Each state must possess a distinct identity apart from others along the linear path. Without an independent identity there could not be the temporal experience of a singular present so there would not be for us the illusion that existence evolves, as is commonly assumed. We can make reference to the necessary transition from state to state as the lateral component of time. It should be noted that like the four dimensional existence itself, each quiescent state is without beginning or end, and is thus unable to contribute any measurable time duration, but rather only offers change. I shall refer to this as the lateral component or as *lateral time*.

In a universe viewed from a perspective of timelessness, it is not easy to reconcile how we so convincingly experience a distinct moment of now and clearly perceive change, be it illusion or not. One of the problems with the block universe view[20] or the existence of a multispatiality[40] has been concerned with how it is possible that many individual blocks of space which are necessarily distinct dimensional frames can simultaneously be spatially linked to form a fourth dimension of space which we refer to as time. Any fused series of distinct spaces form a whole space and thus would seem to forfeit the original separateness. If we then maintain each state as an individually distinct dimension, like a series of photographs, there is no indication of why we experience continuity and order between multiple frames of time.

The problem of trying to reconcile the two components and the problem of trying to reconcile our experience of time with a timeless existence is the same paradox faced in resolving the distinction between quantum theory and the general theory of relativity. At the macro-scale we observe objects to move along linear and continuous paths, and in knowing the position and momentum can predict the future or past. At the micro-scale it is not possible to decipher both position and momentum, and we conclude that particles travel as a wave from one position to the next without having a definite position between two definite points A and B[5].

My suggestion here is that the focus should not be upon how such spaces are linked, but instead how such spaces are maintained discretely in nature as individually distinct. If we assume a spatial holism and then ask what separates one state from another, the question is then not unlike other spatial issues regarding the relationship between two locations in space or different references of time. Note that there has never been an intuitive rejection to the integration of two dimensional slices of space into a three dimensional continuum, and likewise there is no reason

to expect that three dimensional blocks would not be linked naturally to form a four dimensional spatial continuum.

The last conclusion from inducting absolute zero into state space, primarily based on the new construct of symmetry order, is that in addition to all the ordinary expected directions embedded within and constructing the continuity of a three dimensional block of space, there also exists directions in space which travel across or through the existing multiplicity of all possible states. The proposal here is that directions in the fourth dimension travel probabilistically and thus dominantly pass through particular configurations in the superstructure of states, forming a four dimensional matrix which we refer to as many worlds. These directions in space are no less natural and inevitable than those which build a three dimensional continuity, *except for the critical feature that each single direction contributing to four dimensional space probabilistically constructs the lateral component of its surrounding conditions relative to itself*. In essence, each linear direction in four dimensional space constitutes a unique space-time bubble, and since each observer invariably surrounds a linear path in the four dimensional matrix, the lateral component is composed relative to each observer. This multi-spatial construction would explain why an observer in a four dimensional system simultaneously experiences quantum mechanical and relativistic properties, and in that such properties arise from the physics of space may indicate that such properties are not exclusive to observers.

The resulting four dimensional volumes are structured systematically in reference to configuration space, or a superspace[1], and each volume is unique from any contributing three dimensional volume and also unique from the matrix superstructure. Each linear path, rather than traveling freely instead encounters the inherent probabilities that exist within state space relative to its present state. Applying the model of pattern space proposed, each linear path inevitably begins confined by grouping order in a state denotable as positive or negative, and in escaping is probabilistically directed toward becoming neutral. As mentioned, the overall cosmology of this model predicts there are two opposing cosmological arrows of time, one producing positive volumes of space-time containing matter and the other producing negative volumes containing stable anti-matter, and of course each system is inseparably connected to the evolution of the other and the sum of the pair equals the greater whole zero.

This formula should be particularly enticing because if we can adequately describe space-time as a fourth dimension of space it would explain *why* we experience physical reality as we do, since this particular finely tuned universe we live in is the fourth spatial dimension. This would eliminate most multiverse scenarios with different constants that otherwise might exist, excepting the fifth, sixth, seventh spatial dimensions and so on. It would greatly lessen our reliance on the anthropic principle to explain why we experience this particular universe.

However, deeper questions concerning the relationship between our consciousness and a recognition of omega as a supreme state of being may not allow us to eliminate anthropic influences altogether. Seemingly arbitrary constants and a measure of the complexity of space-time may only be explainable as future influences, what we might literally refer to as intelligent

design. Simply in considering that space, and temporal evolution in general, is a product of synthesis rather than cancellation, we then must consider Omega as a synthesis of all life, all experience, all thought, probabilistically available throughout the infinite expanse of galactic and planetary systems in a geometrically flat universe. We know such variations of life exists regardless of how rare life is within any limited region, given that life exists on this planet in our region of the Many Worlds partition. And we must integrate all such life, our own experiences, into the Omega state. The most reasonable conclusion is that the final state of time is innately self aware, even supremely conscious (no correlation meant to any supreme consciousness as portrayed by any one religion), and that the existence of life is directly attributable to an evolution of consciousness invariably built into the process of reaching zero.

Two orders ultimately indicates that our intelligence and consciousness, the human desire to understand and model reality, exists relative to a predestined cosmological evolution toward a supreme state of intelligence and consciousness, the sum of all life. This conclusion was also made by Frank Tipler in his Omega point theory[41]. Tipler states, "quantum mechanics says that it is completely correct to say that the universe's evolution is determined not by how it started in the Big Bang, but by the final state of the universe. Every stage of universal history, including every stage of biological and human history, is determined by the ultimate goal of the universe. And if I am correct that the universal final state is indeed God, then every stage of universal history, in particular every mutation that has ever occurred, or ever will occur in any living being, is determined by the action of God."[42]

Of course the view suggested is not that Omega is dependent upon the summing of life, nor is the existence of life, systemization, form, dependent upon the uniform whole, but rather there is an interdependence between both states. Living systems are ultimately timeless and embedded in the whole, yet the summation of all life, information, or the term I prefer is meaning, exists inseparable from its finer content. There are no parts without the whole, and no whole without the parts, all of which would seem to dramatically elevate the role of life in cosmological development.

IV. Fitting the pieces together

In ordinary math we count upward into an endless staircase of numbers, with no finality or boundary, and thus reality modeled by such a system has no ultimate or macrocosmic definition. In that ordinary math fundamentally counts things, there is naturally a number that represents *nothing* or no things, yet no number represents everything. If we instead switch into a mathematical mode that is able to represent the greater infinite universe as a whole, then naturally we find that the system represents reality in an entirely different way. We haven't merely reversed values, we have changed the very nature of our system of understanding.

In symmetry math, infinity is no longer constrained to a never ending process, but rather the infinity of mathematical values is whole, bounded only by infinite extremes. Engulfing the finite, the entire symmetry mathematical plane is real, complete, and consequently quiescent and timeless. In symmetry math, zero represents everything, and because the smallest values of this system still represent half of the whole, we no longer confuse the nothings in this system with non-existence. Nothings in this system are singularities.

In considering the new axioms of this system, we would ***not*** expect the values of the symmetry plane to be derived from an elementary first thing somehow emerging from nothing or an empty set. This world isn't magically arisen above nothing. There is no axiom of nothing implying non-existence, from which we question the existence of the rest. From the timeless Proto and Eleat singularities we can derive the single positive one and negative one from which all finite values and numbers of an abstract finite math unfold, like binary numbers that multiply into virtual worlds.

Symmetry math, *combination over cancellation*, is as logically consistent and as valid as common math, perhaps of no use within the abstract world of individual definitive things, yet immeasurably valuable in cosmology where a mathematical value for the universe as a whole is of critical importance in any attempt to understand for example, the implications of the many worlds theory, or how to conceptualize the realm of all possible states, or how to appreciate the evolution of a geometrically flat universe.

In a purely philosophical study of the three fundamental states, Omega is of course denoted as *everything* while interestingly the positive and negative outer poles can be related to *something* and *nothing*; two singularities annotated the simplest of any two meanings. This particular case of *nothing* is the negative of form or anti-form, which is itself form, just as anti-matter is matter.

In exploring the nature of the alpha states, the most interesting application I have found is in psychology toward understanding fundamental attitudes (states of mind). We can imagine the natures of Proto and Eleat as the core of masculine and feminine states of self identity, "*I am; you are not*" and "*I am not; you are*" (the absent element being *of relevance*). It can be recognized that each person assumes and oscillates between such states, more pronouncedly in forming identity during youth, then usually maturing toward a more generally respectful attitude of "*I am, you are*". Evolving from the necessity of establishing boundaries, distinction, identity,

our tendency is to mature toward a more spiritual state of becoming one with others and the world, in states of "*I am everything, you are everything*", or "*I and the universe are one*" and so a dissolving of boundaries between self and the universe.

Obviously in this approach we more lucidly recognize the conceptual switch that has been emerging for centuries, particularly in eastern philosophy. The void is not a simple nothing or a non-existence. The nothing of zero, of empty space, is the whole of form and not the absence of form. It may even be reasonable to refer to this mode as primary and consider our ordinary perspective of thingness to be secondary, as long as we respect the validity of either reality. It is not held here that time, or the definite world, is an illusion as some claim in metaphysical philosophy. Instead we should respect the two fundamental natures of being, the definition and form of the past, versus the formlessness of the future.

There are two fundamental forces of nature, what we might call the *Alpha Force* of grouping order and the past, and the *Omega Force* of symmetry order and the future. The prototype of alpha force is of course gravity, which holds back the expansion of the universe, slowing the cosmic evolution. With the aim of recreating the past, the alpha force serves the role of maintaining the past in the present. Without that force of conservation, without the influence of the past pulling at time, the story of the temporal universe would be a short one, over in an inflationary instant. Instead, the gravitational pull of the past slows time and change, producing the expanses of time and the variety of many worlds.

Fundamentally speaking, grouping order involves division, separation, distinction, individuality, density, pronunciation, opposition, and conflict. Symmetry order involves balance, integration, combination, uniformity, homogeneity, singularity, formlessness, symmetry, and unity. The two orders reflect two natures, and also two directions of increase that are opposite to one another. We can easily find these two forces as conflicting influences in nature, in society, in psychology, in politics.

The past ←	vs.	**→ The future**
Grouping into parts	vs.	Balance of the whole
Self	vs.	The Many
Identity	vs.	Selflessness
The individual	vs.	The group
Any Group	vs.	The Whole
State	vs.	Country
Country	vs.	Planet
Republican	vs.	Democrat
Conservative	vs.	Liberal
Racism	vs.	Integration
Selfishness	vs.	Compassion
Self Gain	vs.	Planetary Survival
Reductionism	vs.	Holism
Left brain	vs.	Right brain
Creativity	vs.	Teamwork

Ideally we fully appreciate the value and necessity of both sides of each dichotomy, understanding the necessary balance between selfishness or identity and the greater sense of self that is human society, the Earth, and the Universe. If imbalanced, either force of past or future can detrimentally dominate a person's mentality. The cosmic struggle between the two forces is the most common human theme in both fiction and non-fiction. Of course the key to health is balance. We can avoid extremes of selfishness or selflessness, and rather nourish fullness, meaning that we fully develop our personalities or self, yet also develop our function and place as a member of a community, country, as human beings or simply life, and finally it is essential that we become aware of our ability to dissolve all boundaries, to know that we are ultimately one with the universe. Understanding both our individual distinctiveness and our unity with one another and the world, even our connection to the timeless whole, may be an essential ingredient of our future survival on this planet.

V. Accelerating Toward the End of Time

As if the beginning of time were being swallowed by a cold black hole, accelerating cosmological expansion and the great seeming void sucks the majority of galaxies beyond an outer event horizon. Erasing the rich history of the universe we are now so fortunate to enjoy, eventually the volume of space-time shrinks inward to the local group then collapses inward to the gravitational curvature of our own Milky Way galaxy.

As to the final fate of the Milky Way universe, as if the cosmos has a sense of humor, again we find ourselves stonewalled by a deciding critical density, with the universe riding the line between two dramatically different futures. In the equation-of-state parameter $w = p/\rho$, the ratio of dark energy pressure p to energy density ρ required for acceleration is $< -⅓$ and has been generally assumed to be ≥ -1. Since the acceleration was discovered it has generally been maintained that gravity would hold off a final collapse to zero for an infinite period of time, in which case the galaxy would survive. Discussion on the dark energy density heated up this last year when Caldwell, Kamionkowski, and Weinberg introduced the Big Rip Scenario[7], where a dark energy density dubbed phantom energy[8] by Caldwell increases with time.

Even if w is only equal to -1 cosmic acceleration is exponential, however if w exceeds the critical value of 1, the future is no longer in question since neither gravity nor any other force will be able to restrain the collapse of the absolute cold event horizon. The density of ordinary matter and energy exponentially decreases with time, finally becoming zero in finite time.

As is presently thought, the source of accelerating expansion is a property of space itself and so not evident in the probabilities of state space. Some acceleration to expansion is built into the process of convergence occurring because the contrast gradient narrows. However, a fully independent acceleration force occurs more dominantly due to the nature of time itself.

Prior to the discovery of accelerating expansion, it was assumed that a state of absolute zero or a perfectly flat space, if entertained as being physically real, would initially be envisioned simply as a Euclidean space, a static three dimensional block of empty space in which ordinary properties such as distance have no meaning. As acceleration was integrated into this state space

model it gradually became evident that we in this discovery are simply witnessing the most innate property of a four dimensional existence, meaning that the most innate property of zero from our perspective is an ever constant inflation. In fact that conclusion is inevitably made of the discovery itself. The conclusion that time ends in either infinite or finite time in an inflated state has been made for us.

Symmetry order further indicates absolute zero as an integration of all possible states, as well as all four dimensional directions in space, and thus the four dimensional whole, meaning the composite of all the many worlds predicted of quantum theory, and also the composite of all life within that expanse. With our universe converging toward, joining with, and becoming a part of that matrix, the expansion of the universe is required to accelerate by the expansive conditions which exist at the end of time.

With the direction of time following the basin of attraction within the density gradient we can expect a more complex scheme for the end of time than the Big Rip scenario. The dominant quantity of isotropic patterns near flat space require a gradual *and increasingly uniform* transformation to zero more reminiscent of the beginning of time in reverse than a late-time shredding of whole galaxies. As space-time approaches absolute zero, stars and galaxies and all complex atoms will be systematically broken down into a supercooled condensate of protons and electrons stationed in orderly rows and columns.

In the final moments hyper-expansion stretches all remaining matter and energy flat. Not even virtual particles are able to compete with the inflation. Space-time collapses and in that instant our universe completes its integration with all other space-times including its inseparable parallel partner. The two opposite arrows of time become omni-directional and inflated, producing at time's end the ultimate singularity, a oneness of space and time and things, which is and always has been the native state of a timeless infinite Universe.

The question left then is to wonder at the influence of such a paradigm shift on society, given that such theories pass the test of time and are adapted to hard science. These theories were not developed from any spiritual belief system, and were always meant to conform to strict science, even experimentation. But the product of discovering symmetry order is obviously knowledge concerning a supreme state of being. How interesting if an advanced scientific cosmology can without difficulty be related to both religious and eastern philosophical cosmologies.

At the heart of all scientific discipline is a devotion to truth, although it is sometimes a naive expectation of scientists. There is an element of modern science, perhaps a product of limited awareness, that would prefer physics remain sterile of purpose, and so there is a danger that physicists may mask over the profound conclusions now available. It is hoped that science will gracefully adjust to implications of accelerating expansion, and here not consider the profound and even spiritual nature of symmetry order a basis for rejection. I must agree with Huxley who declared wisely “Follow humbly wherever and to whatever abyss nature leads, or you shall learn nothing”.

Correspondence: e-mail: dh@everythingforever.com
http://everythingforever.com

Scientists are encouraged to support and help develop this work.

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