

The Possibility of Unification via a Global Adynamical Organizing Principle

I. Dynamism as a Failure of Self-Vindicating Unification

In the *Story of Your Life* by Ted Chiang⁽¹⁾, Earthlings encounter aliens from another planet and attempt to unravel their language and their physics. The aliens however experience the universe as a blockworld (BW), perceiving past, present and future as equally real. This BW perspective infects both the language and physics of the aliens, and the humans must overcome this difference in perspective in order to understand their new friends. This metaphysical conceit is not new in science fiction of course, perhaps most famously there are the Tralfamadorians from Kurt Vonnegut's *Slaughter House Five*⁽²⁾. Here is what one Tralfamadorian says to the protagonist Billy Pilgrim in response to his question "How did I get here?": "It would take another Earthling to explain it to you. Earthlings are the great explainers, explaining why this event is structured as it is, telling how other events may be achieved or avoided. I am a Tralfamadorian, seeing all time as you might see a stretch of the Rocky Mountains. All time is all time. It does not change. It does not lend itself to warnings or explanations. It simply *is*." The claim that "the BW perspective is correct, that the BW cannot be explained and it cannot *provide* explanation" is in conflict with the experience of becoming and change explicable *dynamically* via physics. We will suggest the possibility that the Tralfamadorian assumption, "explanation must be dynamical," is false and this fact might provide a novel resolution to the serious problems with dynamical attempts at "grand reductionism"⁽³⁾. We begin with a review of dynamical explanation in physics and the problems it faces today.

From very early on Western thinkers have generally assumed that everything can be explained. Perhaps the cosmological argument for the existence of God is the classic example of such thinking. In that argument Leibniz appeals to a version of the principle of sufficient reason (PSR) which states⁽⁴⁾ "no fact can be real or existing and no statement true without a sufficient reason for its being so and not otherwise." Leibniz uses the principle to argue that the sufficient reason for the "series of things comprehended in the universe of creatures must exist outside this series of contingencies and is found in a necessary being that we call God"⁽⁵⁾. While physics dispensed with appeals to God at some point, it did not jettison PSR, merely replacing God with fundamental dynamical laws such as those of some future Theory of Everything (TOE) and initial conditions (the big bang or some condition leading to it). Furthermore, at least in the theories of physics alleging to be relatively fundamental (relativistic quantum field theory, M-theory, loop quantum gravity (QG), causal sets, etc.), the assumption is generally maintained that the fundamental explanation will be a dynamical or causal one, e.g., particles carrying forces, dynamical laws evolving states of the system, etc. Such theories may deviate from the "manifest image" by employing radical new fundamental entities (wave functions, strings, loops, branes, etc.) evolving in counter-intuitive "spaces" (Hilbert, Calabi–Yau, Fock, etc.), but the basic game is always dynamical, it is a story involving boundary conditions plus some system whose state is to be evolved in time. In keeping with everyday experience a very early assumption of Western physics—reaching its apotheosis with Newtonian mechanics—is that the fundamental phenomena in need of

explanation are *motion* and *change in time* and that said explanation will involve dynamical laws.

In the quest to unify physics, it is the combination of PSR plus the dynamical perspective writ large (call it dynamism) that has in great part motivated the particular kind of unification being sought, i.e., the search for a TOE, QG and the like. This has led physicists to search for⁽⁶⁾:

a *unique* final theory of everything, a theory that permits only *one* universe [as opposed to a multiverse]... They are convinced that a unique theory describing a unique world, with all laws and parameters completely fixed by the theory, will eventually emerge... Einstein once remarked that what interested him most was whether 'God had any choice in the creation of the world.' If Gross is right, the answer is no: the universe *has* to be as it is. There is only one mathematically self-consistent universe possible.

Such a TOE, in order to be deemed a winner, would have to not only allow an in principle *ab initio* derivation of all other physical theories and phenomena, but also put an end to most of the fundamental WHY questions such as: why those fundamental laws, why the big bang (initial conditions), why those values for the constants, why that number of spatial and temporal dimensions, etc., etc. The quest for a TOE so envisioned is certainly an offspring of PSR. This is obviously quite a tall order, *is such an explanatory feat possible?* Let us explore that question in a little more depth.

The following passages make clear what is expected of fundamental physics (a TOE) if it is to be truly explanatory:

In recent decades there has been quite general agreement that science can tell us not only *what*, but also *why*. At present, virtually all philosophers of science of widely diverse persuasions agree that science can teach us, not only *that*, but also *why*. It is now generally acknowledged that one of the most important fruits of modern science is understanding the world. We do not have to go outside of science to find it⁽⁷⁾.

A recourse to [fundamental] laws is indispensable for scientific explanation, because this feature of nomic necessity makes it possible for scientific explanations to achieve their task of showing not just *what* is the case, but *why* it is the case. This is achieved by deploying laws to narrow the range of possible alternatives so as to show that the fact to be explained 'had to be' as it is, in an appropriate sense of this term⁽⁸⁾.

Of course the sentiments expressed here by Salmon and Rescher, respectively, are just modern day echoes of PSR. Thus, the game of fundamental physics is to provide the WHY answers (as opposed to merely HOW) and this means showing that the fundamental laws, etc., were truly necessitated, meaning that they (and all the other fundamental facts that logically entail everything else) could not have been otherwise in some strong metaphysical or logical sense of modality. There have been those who expressed skepticism about the very possibility of such a project, as Redhead puts it⁽⁹⁾:

The ideal of scientific explanation is a matter of logical deduction, given a unified set of deep explanatory principles that are themselves accepted, for the time being, without explanation. But of course the ideal of scientific explanation is one for ongoing improvement. Perhaps from the fundamental laws of microphysics, by some consistency criterion, it will turn out that the constants of nature are tightly constrained or even uniquely determined. But even then we would still have the task of explaining the laws themselves at a still more fundamental level. At some stage scientific explanations always turn into descriptions—‘that’s how it is folks’—there is no ultimate terminus in science for the awkward child who persists in asking why! I do not believe the aim of some self-vindicating a priori foundation for science is a credible one.

Redhead is not alone, Smolin⁽¹⁰⁾ has argued that when it comes to explaining sub-systems of the universe an absolute division between dynamical laws and initial conditions is fine, but when it comes to explaining the universe as a whole such a division lands us in intractable problems; namely, to uniquely explain why the fundamental laws, initial conditions, values of constants, etc., are strongly necessitated. In his diagnosis, this is one of the main reasons for the failure of string theory as originally conceived, e.g. the failure of string theory to uniquely derive the values of constants, etc., and the rearguard action motivating the defeatist acceptance of the multiverse implications of string theory. His point is that the game of dynamical explanation, driven by PSR, seems to lead to absurdity when applied to the fundamental laws and other fundamental facts that are supposed to explain everything else dynamically—how can the bedrock facts themselves (for which by definition there are no boundary conditions, since the universe itself is at issue) be explained in a dynamical fashion without leading to an infinite regress or worse; a multiverse is exactly where such thinking inevitably leads. Note that Leibniz does not have this problem because he has a *necessary* being as a first cause (God) at the base of his axiomatic system and thus God requires no explanation dynamical or otherwise. In any endeavor of axiomatic unification how can one but fail to *explain* the fundamental axioms (that which is by definition the brutes fact of all) unless you could somehow show that said axioms really could not have been otherwise in some strong metaphysical or logical sense, good luck. Note also that Leibniz takes it for granted that modulo God, the explanation of everything else is dynamical or causal.

Smolin further notes that the problem of discharging fundamental WHY questions *dynamically* is greatly exacerbated by the fact that, in spite of the dynamical bias at work in physics, relativity theory by itself suggests a BW (per the relativity of simultaneity and lack of a preferred foliation)⁽¹¹⁾:

There is no dynamics within space-time itself: nothing ever moves therein; nothing happens; nothing changes. In particular, one does not think of particles as moving through space-time, or as following along their world-lines. Rather, particles are just in space-time, once and for all, and the world-line represents, all at once, the complete life history of the particle.

Of course it is not just special relativity that leads to this conclusion, there is the problem of time in canonical general relativity (GR) because⁽¹²⁾ “time-evolution is a gauge motion, and hence does not correspond to any change at all in the ‘physical’ degrees of freedom in the theory.” As Earman puts it⁽¹³⁾:

Taken at face value, the gauge interpretation of GTR implies a truly frozen universe: not just the ‘block universe’ that philosophers endlessly carp about—that is, a universe stripped of A-series change or shifting ‘nowness’—but a universe stripped of its B-Series change in that no genuine physical magnitude (= gauge invariant quantity) changes its value with time.

Of course this problem of timelessness and changelessness only gets worse in the case of the Wheeler-DeWitt equation which has no time dependence, the quantum state of the universe as a whole does not change whatsoever. The key point is this: how can one provide a *fundamentally dynamical* explanation for a frozen universe? It would seem that given relativity or Wheeler-DeWitt, whatever else dynamical laws are, they are not fundamental brute explainers bringing new events into existence that never existed before in some absolute sense. This would suggest something like a Humean regularity conception of laws rather than laws as event factories. Though Smolin does not put it this way, there is a certain irony in the fact that physics, historically driven both by PSR and dynamism, keeps being led to BW or worse. Smolin argues that currently some form of the multiverse interpretation is the only recourse to escape the explanatory failures of string theory and that is unacceptable, it is simply giving up the original explanatory project motivated by PSR and dynamism, it is a cheat. The problems facing this “Parmenidean project of unification” as he calls it, led Smolin to seek a radically “neo-Heraclitean” solution wherein change and becoming are fundamental such that fundamental dynamical laws, the values of constants that figure in those laws and configuration space itself evolve in time.

Though he does not frame it this way, he is advocating for a fundamentally Whiteheadian process conception of reality. As Smolin sees it, if we take seriously that the universe as a whole must be explained as the ultimate system in a complete cosmology or TOE, and we assume the standard dichotomy between initial/boundary conditions and eternal, universal dynamical laws, and we assume that time is either an illusion (Wheeler-Dewitt) or emergent (not fundamental), then we are left with the impossible task of *explaining* why the fundamental facts could not have been otherwise. While we applaud his brave insight that taking dynamism seriously means rejecting any theory as fundamental that implies BW or worse, it must be said that Smolin’s neo-Heraclitean solution is of course just a *multiverse in time* rather than space or spacetime and is therefore no less of a cop out. Just like the multiverse in space or spacetime, Smolin’s multiverse in time only pushes the fundamental WHY questions back one step. For example, will we need meta-laws to explain why the first-order laws and other fundamental facts change over time and so on ad infinitum?

While we think Smolin correctly diagnoses one of the major structural problems with the *dynamical* paradigm of unification, as we shall suggest, perhaps the solution is not ‘doubling down’ on dynamism as Smolin does, but looking for a fundamentally non-dynamical theory that is truly self-vindicating in some non-trivial fashion. To begin to see

how this might go let us return to the BW aliens of Chiang's story. The following is an episode from the story that nicely illustrates the different emphases in human physics and alien physics⁽¹⁴⁾:

That day when Gary [the human physicist] first explained Fermat's principle to me [the human linguist], he had mentioned that almost every physical law could be stated as a variational principle. Yet when humans thought about physical laws, they preferred to work with them in their causal formulation. I could understand that: the physical attributes that human found intuitive, like kinetic energy or acceleration, were all properties of an object at a given moment in time. And these were conducive to chronological, causal interpretation of events: one moment growing out of another, causes and effects creating a chain reaction that grew from past to future.

In contrast, the physical attributes that the heptapods [the BW aliens] found intuitive, like "action" or those other things defined by integrals, were meaningful only over a period of time. And these were conducive to a teleological interpretation of events: by viewing events over a period of time, one recognized that there was a requirement that had to be satisfied, a goal of minimizing or maximizing. And one had to know the initial and final states to meet that goal; one needed knowledge of the effects before the cause could be initiated. I was growing to understand that, too.

Humans had developed a sequential mode of awareness, while heptapods had developed a simultaneous mode of awareness. We experienced events in an order, and perceived their relationship as cause and effect. They experienced all events at once, and perceived a purpose underlying them all. A minimizing, maximizing purpose.

It's [the two worldviews] like that famous optical illusion, the drawing of either an elegant young woman, face turned away from the viewer, or a wart-nosed crone, chin tucked down on her chest. There's no 'correct' interpretation, both are equally valid. But you can't see both at the same time.

Of course the difference in the human and the alien physics is truly only a matter of emphasis, since both have access to the same techniques. The path predicted by the equations of motion is exactly the path for which the action is extremal (*the principle of least action*). Richard Feynman generalized the least action principle to produce the path integral approach to quantum mechanics (QM); arguably another example whereby dynamism led to a more BW perspective in physics. In the least action approach, the particle "looks ahead" and chooses the path with the extremal action, whereas in the path integral approach for QM, the particle or quantum system uses all possible paths to produce the probability of its ending up in a certain place or configuration.

In part II, we will suggest that by taking heptapod thinking to its logical conclusion, there is a *possible* path to unification that is free of the aforementioned problems currently plaguing fundamental physics. Indeed, we will take this *integralist*

thinking to a new level by not only using path integral physics as fundamental, but also suggesting a fundamentally non-dynamical basis for the action; a non-dynamical basis that has spacetime as its foundation, i.e., a self-consistency criterion (SCC) between space, time and sources. The “teleology” in this case, i.e., global adynamical organizing principle, is the boundary of a boundary principle (BBP) that also generates self-consistency in Einstein’s equations of GR¹. Momentum, force and energy all depend on spatiotemporal measurements (tacit or explicit), so the stress-energy tensor (SET) cannot be constructed without tacit or explicit knowledge of the spacetime metric (technically, the SET can be written as the functional derivative of the matter-energy Lagrangian with respect to the metric). But, if one wants a ‘dynamic’ spacetime in the parlance of GR, the spacetime metric must depend on the matter-energy distribution in spacetime. GR solves this dilemma by demanding the SET be ‘consistent’ with the spacetime metric per Einstein’s equations. This self-consistency hinges on divergence-free sources², which finds a mathematical counterpart in the topological maxim, “the boundary of a boundary is zero⁽¹⁵⁾.” So, Einstein’s equations of GR provide an example of a self-consistency criterion in classical physics and, as we will suggest, it is the BBP that provides for a *self-consistency writ large* strategy of unification, i.e., a global principle that underlies fundamental physics and propagates formally to also underlie classical physics, even though the fundamental and classical formalisms and ontologies differ profoundly. Note that we are not suggesting giving up on the dream of PSR, we are merely suggesting that the key to a self-explaining universe might be just like the key to sorting out relativity: replacing space and time with spacetime. We need to go one step further and treat spacetime as a fundamental interdependent amalgam. Rovelli expresses it nicely as follows⁽¹⁶⁾:

GR altered the classical understanding of the concepts of space and time in a way which...is far from being fully understood yet. QM challenged the classical account of matter and causality, to a degree which is still the subject of controversies. After the discovery of GR we are no longer sure of what is space-time and after the discovery of QM we are no longer sure of what matter is. *The very distinction between space-time and matter is likely to be ill-founded....*I think it is fair to say that today we do not have a consistent picture of the physical world. [italics added]

The approach illustrated in part II avoids the preceding dilemma posed by Redhead because it admits *a priori* that the entire enterprise is one of self-consistency. Thus, the ultimate expression/explanation is not some THING or dynamical entity “at the bottom” conceived at higher energies and smaller spatiotemporal scales, begging

¹ There are major differences between the SCC at the fundamental level and Einstein’s equations of GR even though they are both based on the boundary of a boundary principle. Most importantly, in the SCC space, time and sources are inextricably co-defined so there is no empty spacetime while there are vacuum solutions to GR. Thus, again, one might term this fusion “spacetime matter.”

² Concerning the stress-energy tensor, Hamber and Williams write, “In general its covariant divergence is not zero, but consistency of the Einstein field equations demands $\nabla^\alpha T_{\alpha\beta} = 0$,” Hamber, H.W. and Williams, R.: Nonlocal Effective Gravitational Field Equations and the Running of Newton’s G. arXiv: hep-th/0507017 (2005).

for justification from someTHING at some yet “deeper” scale, but self-consistency writ large for the explanatory “process” as a whole. As we shall see, this goes well beyond consistency as typically conceived by physicists. Self-consistency writ large is just extremum thinking writ large, which truly transcends the dynamical perspective, it’s the heptapod’s TOE.

The idea here is that, in addition to being BW, reality is *not fundamentally composed of dynamical entities* evolving in time (*things* with “primitive thisness” in metaphysical parlance), but rather of relations. This is ontological structural realism (OSR)⁽¹⁷⁾:

Ontic structural realists argue that what we have learned from contemporary physics is that the nature of space, time and matter are not compatible with standard metaphysical views about the ontological relationship between individuals, intrinsic properties and relations. On the broadest construal OSR is any form of structural realism based on an ontological or metaphysical thesis that inflates the ontological priority of structure and relations.

OSR claims that⁽¹⁸⁾ “The relata of a given relation always turn out to be relational structures themselves on further analysis.” Note that OSR does not claim that there are relations without relata, just that the relata are not individuals but always ultimately analyzable as relations as well³.

From the perspective of dynamism a reductive, unifying enterprise with something like the SCC at bottom might seem an Ouroboros-like cheat. We want to know why classical reality is the way it is. As Weinberg⁽¹⁹⁾ put it concerning his “grand reductionism,” “You have to ask, why is it the way it is? And it isn’t always in terms of something smaller, but in terms of something deeper.” The SCC is based on the same topological maxim (BBP) as classical field theory (CFT), so in what sense is it *explaining* the appearance of classical reality, rather than simply *positing* said appearance? And since the SCC isn’t dynamical, how can it be a “deeper explanation” per “grand reductionism?” In response, we can only ask those of dynamical persuasion to temporarily set aside this prejudice in order to consider an alternative account of grand reductionism, one in which a global adynamical organizing principle for the BW provides self-consistency writ large as a self-vindicating unification of physics.

II. Self-Consistency Writ Large as a Self-Vindicating Unification

Regarding the ultimate unification of physics, as we’ve seen, the dynamical approach is seriously challenged. Thus, we want to explore the possibility of a self-vindicating integral approach. Integral equations allow us to investigate fundamental global organizing principles for the mosaic of the BW that aren’t constrained by dynamical considerations. All we require is that the picture maps to experience, i.e., it is empirically testable, and human classical/dynamical perceptual experience is affirmed. So, while this

³ There is no infinite regress if one defines the relata of the fundamental relations via those same fundamental relations in a non-circular fashion. In the graphical example that follows, a boundary operator on the vector of links (fundamental relations) produces a very intuitive, but not tautological, characterization for the vector of nodes (relata for the links). Since components of the source vector correspond to nodes, this characterization of nodes in terms of links is used to define the source vector.

fundamental approach might not itself be classical, it must make correspondence in some limit with classical physics. Thus, whatever resides at the foundation of the methodological scheme must lead inexorably to the top, classical physics. Further, it must be self-vindicating otherwise, as Redhead notes, it's simply an infinite regress of another type. Redhead rejects the notion that "consistency" alone will provide self vindication and we agree, proposing instead *self-consistency writ large* provided by a global adynamical organizing principle for the BW.

To illustrate this idea mathematically, we use a path integral approach over graphs whereby the transition amplitude Z contains a discrete action constructed per the SCC for space, time and divergence-free sources. We codify the SCC using $\bar{\bar{K}}$ and \bar{J} , elements germane to the transition amplitude Z in the Central Identity of Quantum Field Theory⁽²⁰⁾,

$$Z = \int D\bar{\varphi} \exp \left[-\frac{1}{2} \bar{\varphi} \cdot \bar{\bar{K}} \cdot \bar{\varphi} - V(\varphi) + \bar{J} \cdot \bar{\varphi} \right] = \exp \left[-V \left(\frac{\delta}{\delta J} \right) \right] \exp \left[\frac{1}{2} \bar{J} \cdot \bar{\bar{K}}^{-1} \cdot \bar{J} \right]$$

We find that if $\bar{\bar{K}}$ is constructed from boundary operators on the graph so as to reproduce the action for coupled harmonic oscillators (where $V(\varphi) = 0$, i.e., simple Gaussian theory), and \bar{J} is constructed relationally (see footnote 3) so as to be divergence-free, i.e.,

$\sum_i J_i = 0$, then $\bar{\bar{K}}\bar{v} \propto \bar{J}$ follows tautologically due to the BBP. In this SCC, \bar{v} is a

vector of graphical entities, i.e., nodes, links or plaquettes, depending on the desired order of the resulting field theory, i.e., scalar, vector or tensor, respectively. Thus, the BBP is responsible for the SCC in the fundamental, non-classical realm and it also underlies GR and electromagnetism⁽²¹⁾, i.e., the classical limit. The SCC guarantees that \bar{J} is divergence-free and resides in the row space of $\bar{\bar{K}}$. Therefore it is always the case that $\bar{\bar{K}}$ will have a non-trivial eigenvector with eigenvalue zero, i.e., $[1, 1, \dots, 1]^T$. That $\bar{\bar{K}}$ has a non-trivial null space is responsible for gauge invariance, so the SCC is responsible for gauge invariance⁴. $\bar{\bar{K}}\bar{v} \propto \bar{J}$ constitutes what is meant by a self-consistent co-definition of space, time and divergence-free sources and thereby constrains $\bar{\bar{K}}$ and \bar{J} in the construct of the discrete action. This talk of "action" seems dynamical even though action is an integral quantity, but note that the action is not fundamental in this view because the field is an integration variable and Z is really a function of $\bar{\bar{K}}$ and \bar{J} alone. Thus, in this view, $\bar{\bar{K}}$ and \bar{J} provide the fundamental, adynamical, BW description of the phenomenon in question and Z provides a measure of their symmetry (strength of stationary points). In the simple Gaussian theory we have:

⁴ Such a relationship on discrete spacetime lattices is not without precedence. For example, Sorkin showed that charge conservation follows from gauge invariance for the electromagnetic field on a simplicial net. See section C of Sorkin, R.: The electromagnetic field on a simplicial net. Journal of Mathematical Physics 16, 2432-2440 (1975).

1. $\bar{\bar{K}} \cdot \bar{x} = \bar{J}$ co-defines space, time and divergence-free sources for BW description.
2. Transition amplitude $Z = \int_{-\infty}^{\infty} d\bar{Q} e^{-\frac{1}{2} \bar{Q} \cdot \bar{\bar{K}} \cdot \bar{Q} + \bar{J} \cdot \bar{Q}}$ measures symmetry of $\bar{\bar{K}}, \bar{J}$ combo, Σ .
3. Probability (relative frequencies) of realizing Σ among all possibilities is $|Z|^2$.
4. QM obtains in temporally continuous limit.
5. QFT obtains in temporally and spatially continuous limits.
6. Statistical limit given by $\delta\left(-\frac{1}{2} \bar{Q} \cdot \bar{\bar{K}} \cdot \bar{Q} + \bar{J} \cdot \bar{Q}\right) = 0$, i.e., $\bar{\bar{K}} \cdot \bar{Q} = \bar{J}$.
7. CFT obtains in temporally and spatially continuous limits⁵ of $\bar{\bar{K}} \cdot \bar{Q} = \bar{J}$.

For example⁽²²⁾, in the Maxwell action (basis for electromagnetism) one has the operator $K_{\alpha\beta} = \partial^2 \eta_{\alpha\beta} - \partial_\alpha \partial_\beta$ and the vector field A^β ($\eta_{\alpha\beta}$ is the metric in M4). Maxwell's equation $\partial_\alpha F^{\alpha\beta} = J^\beta$ results from $K_{\alpha\beta} A^\beta \propto J_\alpha$, which guarantees a divergence-free source, i.e., $\partial_\alpha J^\alpha = 0$, and is invariant under the gauge transformation $A^\beta \rightarrow A^\beta - \partial^\beta \Lambda$ since $K_{\alpha\beta} \partial^\beta \Lambda = 0$, i.e., $\partial^\beta \Lambda$ is a non-trivial eigenvector of $K_{\alpha\beta}$ with eigenvalue zero. The operator $-\eta_{\alpha\beta} \partial^2$ is then inverted to find the propagator in the Feynman gauge. Self-consistency writ large is given formally by $\bar{\bar{K}} \bar{v} \propto \bar{J} \rightarrow K_{\alpha\beta} A^\beta \propto J_\alpha \rightarrow \partial_\alpha F^{\alpha\beta} = J^\beta$, where divergence-free sources per the BBP are represented by $\sum_i J_i = 0$ at the

fundamental level and $\partial_\alpha J^\alpha = 0$ at the classical level. As another example, in the weak field expansion of the Einstein-Hilbert action⁽²³⁾ one has the operator

$K_{\mu\nu;\lambda\sigma} = \frac{1}{2} \partial^2 (\eta_{\mu\lambda} \eta_{\nu\sigma} + \eta_{\mu\sigma} \eta_{\nu\lambda} - \eta_{\mu\nu} \eta_{\lambda\sigma}) - \partial^2 \eta_{\mu\lambda} \eta_{\nu\sigma} + \frac{1}{2} \partial_\alpha \partial_\beta \eta_{\lambda\sigma}$ and the tensor field $h_{\lambda\sigma}$. The QFT counterpart to the SCC is then $K_{\mu\nu;\lambda\sigma} h^{\lambda\sigma} \propto T_{\mu\nu}$ which gives linearized gravity in M4, i.e., $\partial^2 h_{\mu\nu} \propto \left(T_{\mu\nu} - \frac{1}{2} \eta_{\mu\nu} T^\alpha_\alpha\right)$ in the harmonic gauge, and ensures a divergence-free source, i.e., $\sum_i J_i = 0 \rightarrow \partial_\alpha T^{\alpha\beta} = 0$. $K_{\mu\nu;\lambda\sigma} h^{\lambda\sigma} \propto T_{\mu\nu}$ is invariant under

$h^{\lambda\sigma} \rightarrow h^{\lambda\sigma} + \partial^\lambda e^\sigma + \partial^\sigma e^\lambda$ since $K_{\mu\nu;\lambda\sigma} (\partial^\lambda e^\sigma + \partial^\sigma e^\lambda) = 0$, i.e., $\partial^\lambda e^\sigma + \partial^\sigma e^\lambda$ is a non-trivial eigenvector of $K_{\mu\nu;\lambda\sigma}$ with eigenvalue zero. The operator

$-\frac{1}{2} \partial^2 (\eta_{\mu\lambda} \eta_{\nu\sigma} + \eta_{\mu\sigma} \eta_{\nu\lambda} - \eta_{\mu\nu} \eta_{\lambda\sigma})$ is then inverted to find the propagator in the harmonic gauge. Thus, $\bar{\bar{K}} \bar{v} \propto \bar{J}$ from the BBP at the fundamental level gives $K_{\mu\nu;\lambda\sigma} h^{\lambda\sigma} \propto T_{\mu\nu}$ in

⁵ That discrete spacetime is fundamental while “the usual continuum theory is very likely only an approximation” is, of course, an old idea. See, for example, arguments in Feinberg, G., Friedberg, R., Lee, T.D., and Ren, H.C.: Lattice Gravity Near the Continuum Limit. Nuclear Physics B245, 343-368 (1984).

accord with the BBP at the classical level which is the basis for GR⁶, i.e., self-consistency writ large.

III. Conclusion

Fundamental reality is not being described via some fundamental entity or entities evolving in time according to dynamical laws against a spacetime background per certain boundary conditions. Instead, the most fundamental *fact* of reality is the BBP which underlies the self-consistency of space, time and divergence-free sources at both the fundamental and classical levels to provide a self-explaining “grand reductionism.” Again, the dilemma posed by Redhead is avoided because we assume from the start that the entire enterprise is one of self-consistency. Therefore, we believe it is *ultimately possible* that a global adynamical organizing principle can provide the basis for a strategy of self-consistency writ large whence a self-vindicating unification of physics.

⁶ Miller showed the “boundary of a boundary” maxim applies to Regge’s discrete spacetime in Miller, W.A.: The Geometrodynamical Content of the Regge Equations as Illuminated by the Boundary of a Boundary Principle. Foundations of Physics 16, 143-169 (1986). In this example, Regge calculus would be the point of correspondence with GR, i.e., $\bar{\bar{K}}\bar{\bar{v}} \propto \bar{\bar{J}}$ is linear but nonseparable and its statistical (classical) limit is non-linear, separable Regge calculus.

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