Orch-OR in a Process Ontology (a conjectural ode to Bourbaki)

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Abstract

Orchestrated Objective Reduction is viewed as the deposit on a full theory of nature and experience at fundamental scales; and subsequently, is elaborated into the context of a process ontology whilst retaining the key insights of objective reduction. This reframing also comes with consistent philosophical and physical layers provided by the actual entities/occasions of Whitehead, and Verlinde's approach to strings and gravity. Originally this chapter is intended to appear in a book. This article is part one of a two-part series.

The field of consciousness studies is due for another breakthrough. The first gauntlet was arguably thrown five years before the new millennium by David Chalmers with the "hard problem" and "easy problems" of consciousness, thereby providing the field with an initial structure and set of challenges. The easy problems involve "mechanistic analysis of the neural processes that accompany behaviour" e.g. binding problem; language and the mind (Mills, 1998), whereas the hard problem involves the nature of subjective experience and includes an appeal to the domain of quantum mechanics. While the "easy problems" have variously made considerable headway in recent years, the "hard problem" remains elusive. What is missing in consciousness studies and foundational physics is a formal theory of ontology that links nature and experience at fundamental scales. As Nobel laureate, Sir Roger Penrose proscribes, "in order to explain how we perceive the world to be within the framework of quantum mechanics, we shall need to have one (or both) of the following:

A. A theory of experience
B. A theory of real physical behavior" (NST, 128)

This chapter addresses the first of the two prompts by way of the process model of ontology—introduced and applied in chapters 5-7 in terms of philosophy, mathematical physics and cosmology (e.g. spacetime; string theory; black holes; gravity; QCD). With these layers, this process model is now applied to "the most specific scientific proposal for phenomenal experience ('the hard problem') yet put forth" (Hameroff & Penrose, 1996); namely, the Orchestrated Objective Reduction (Orch-OR) theory of subjective experience.

Orch-OR refers to a pioneering proposal by Roger Penrose and Stuart Hameroff that provides one of the strongest avenues to a testable theory of consciousness. Hameroff originally approached Penrose with the idea that microtubules could preserve quantum coherence and "might be able to function as quantum computers at the molecular level, which might be linked to Penrose's reduction process. This led to the orchestrated objective reduction view of consciousness" (Hameroff, 1997). The position advanced in this chapter, like the previous two, is that similar to Whitehead's description of actual entities/occasions, plus Verlinde's approach to modeling strings, spacetime, inertia and gravity, Orch-OR has pieces to a puzzle that stand to be reconfigured in a process logic. Also…like the other topics, this link is not entirely unexpected, given Penrose drafts his model in an effort to gravitize quantization (2014);

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plus, Hameroff explicitly nominates a Whiteheadian interpretation of "proto-conscious events" as exemplifying in microtubules.

Reframing Orch-OR into the geomodal process foremost involves a transposition of OR into the role of an "event-generator" or sampling mechanism ("snapshot"→"polaroid") based on some criteria of information-geometry/curvature begetting each new generative sequence of the process—and as variably rendered in microtubules. To the latter, research involving microtubules affirms: **a)** the ability to process quantum information; **b)** a link to consciousness; **c)** coherence and dissipative entanglement in the brain. Redressing these, microtubules can be interpreted as the receivers and distributors of quantum information representing/orchestrating "qualia" into a stream of subjective experience. While similar, the ontological process also triangulates the philosophical model of Whitehead's *actual occasions* in tandem with the physical/cosmological milieu of Verlinde's emergent gravity.

Key Highlights

1. OrchOR is the right kind of concept in an incomplete context that can be elaborated.
2. OrchOR is reframed into a generative ontology; yet, OR still involves gravity/XT akin to general relativity.
3. Einstein's general relativity describes gravity from the p.o.v. of an intrinsic model (ch7). In "modified OR," a tacit information-geometry threshold/range linked to curvature might involve certain properties of neural networks like information flow through the brain and characteristics of functional connectivity in neurons.
4. Phonons may influence dimer growth/catastrophe and induce dissipative synchrony in MTs, neurons, etc.
5. Application of fast/slow quantum processes in microtubules. Fast processes signify proto-conscious events that during slower processes refine structural/functional longevity & maintenance of quantum states.
6. In addition to events transpiring fast/slow in neuronal microtubules *in situ*, *de novo* nucleation might also be influenced by stable/refined products of the slower-processes. Two possible in-roads will be mentioned.

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1. Physical Ontology: from a Reductive model to a Process approach

As a model of consciousness combining mathematical-physics, cosmology, quantum gravity; quantum information theory; cognitive science; anesthesiology; subcellular biology; neuroscience; philosophy; Eastern wisdom; and biochemistry—Orchestrated Objective Reduction (Orch-OR) offers "a pivotally influential theory [...that] makes one of the most detailed attempts to sketch out a plausible theory of quantum consciousness" (King, 2012). This approach is admirable in overall interdisciplinary scope and ability to tie crucial topics together. My inclination is to view Penrose OR as a mechanism in search of a framework, and this requires a few modifications to the ontological foundations. The most ardent of these involves the growing trend to model the phenomena of Planck-scale physics and cosmology (e.g. spacetime, gravity, quantum gauge theory, string theory) as emergent. Yet, applying this logic to Orch-OR brings to the forefront a teensy-tiny issue. As Penrose and Hameroff explain, "it follows [from our position] that gravity cannot be regarded as some kind of 'emergent phenomenon', secondary to other physical effects, but is a 'fundamental component' of physical reality"

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(1997). While their position is tenable, given the specific formalism/role of OR, I contend it is precisely the update to a generative ontology that is overall needed to reconcile quantum gravity and subjective experience. Subsequently, to maintain their position, it is instructive to recall that the geometric XT of gravity (curvature) can also be linked to an information processing milieu qualified within a specific physical context—i.e., statistical mechanics and computational neurophysiology.

This presents an intriguing prospect where the OR mechanism can be recast into the process as a customized "sample-generator" (embedded in fundamental spacetime geometry/curvature of intrinsic neuro-topological models) that initiates each new run of the ontological process. In this way, what Penrose refers to as a non-computable quantum state reduction influenced by gravitational effects (GSE; curvature) may also be framed as an intrinsic optimization feature, similar to "curvature-aware" operations, whose (Planck) samples *create* spacetime as an "initial multiplicity of data" (Whitehead) i.e. "entangled source mass densities" (Verlinde) that evolve to induce gravity as a "real" force.[1] So, like a catcher framing a pitch for an umpire, OR can appear compatible with the process model. My core position is that Penrose's OR is a key insight into a specific feature of the process.

2. Objective Reduction (OR) as Pico

Referring to "objective reduction" as Pico is my way of saying it is the right kind of idea in a mildly precarious (or incomplete) context; e.g., OR is part of a larger process. This topic coordinates in the terrain of a transition known as wave-function collapse, which involves the open question how the linear dynamics of a quantum wave—in the geomodal model, a *strand*; or what Whitehead calls a "continuous potentiality"—reduces in measurement via collapse/reduction to a singular state-value of "discrete actuality"—or what in physics is called an "eigenstate" of some operator (e.g. Krips, 1987).[2] In quantum mechanics this is called *the measurement problem,* first introduced by Werner Heisenberg and Niels Bohr.[3]

Rethinking this topic, Roger Penrose introduces a novel version of wave-function collapse that he calls Objective Reduction (1989)—i.e. *objective-threshold quantum state reduction* (see Hameroff, 2024). This concept "appeals to a form of quantum gravity" (Penrose, 1994; 1996) that models the collapse of a superposition as a real physical process initiated by a non-computable influence embedded in fundamental spacetime geometry at the Planck scale (Penrose & Hameroff, 2011). Specifically, Diósi-Penrose objective reduction models the spontaneous collapse of a superposition to classical states as "due to an objective threshold in the fine-scale structure of the universe at time $t = \hbar/E_G$, where $\hbar$ is the Planck-Dirac constant, and E_G is the gravitational self-energy of the superposition" (Hameroff & Penrose, 2014). Rather than random or algorithmic, "this type of objective self-collapse introduce[s] non-computability [as] an essential feature of consciousness… that might occur outside quantum measurement through gravitational interaction" (Penrose & Hameroff,

[1] "In Einstein's original Machian ontology, matter is fundamental, and the spacetime metric and gravitational field are derivative and equal. In Whitehead's ontology, actual occasions are the ultimately real entities. Spacetime metric, matter, and gravitational field, are all abstracted from the relatedness of actual occasions." (Desmet, 2012)

[2] "This would be one out of many possible alternative eigenstates relevant to the quantum operator" (Collins, 2015).

[3] "The postulate of collapse seems to be right about what happens when we make measurements, and the dynamics seems to be bizarrely *wrong* about what happens when we make measurements, and yet the dynamics seems to be *right* about what happens whenever we *aren't* making measurements." (Albert, 1992)

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2011).[4] As Collins explains, "superposed quantum states each have slight differences in their space-time geometry, and the quantum state uses a gravitational criterion to choose between one of these two sections of space-time, which results in a moment of proto-consciousness" (Collins, 2015). This is to say, "some objective threshold, probably related to space-time configurations, causes quantum state reduction" (*ibid*).[5] I say, what if this scenario describes the interval from a snapshot to a polaroid? In this case, superposition is between strands momentarily frozen in a manifold and where they would be in flow. Thus, there is no "choice between states" so much as an axiom that the action principle follows the polaroid, given it marks the initiating event of the generative process.

To lay it out, the main ingredients of OR comprise **A)** a superposition of spacetime, like a blister (*in ♪ the ♪ sun ♪*), which exhibits; **B)** quantum coherence of states in dimers of microtubules that; **C)** collapse via OR into; **D)** a conscious event. I say the order may be more like A,C,D,B; yet I say it with alacrity, because it means most of the pieces are there.

In what follows, let me attempt to make a persuasive case for reframing Penrose's model based primarily on an appeal to the conceptual framework forwarded in this book, emphasizing that I consider OR to entail the interval between a snapshot and a polaroid.

3. Objective Reduction recast in the Process Model (Fumi)

Another alternative to the measurement problem in quantum mechanics is called the De Broglie-Bohm theory, which suggests the wave-function may not actually collapse; and instead, "interaction with the environment during a measurement procedure separates the wave packets in configuration space, which is where apparent wave-function collapse comes from, even though there is no actual collapse" (Bohm, 1952).[6] This approach also evokes the geomodal portrait where a generative sequence begins when *strands* streaming through a manifold "decohere" in a snapshot into the appearance of *strings* on a polaroid.[7]

Rather than a collapse, the strands in a manifold at the moment of a snapshot are momentarily held-up while the rest of the ocean flows-on, before a decoherence between the superposed states of strands delocalizes to generate a Planck-scale polaroid (D2-brane of open strings) whilst releasing strands back into flow. The part in Outkast's song where you "shake it, shake, shake it" refers to the superpositional instability-blister that precedes formation of the polaroid *pi-i-cture*. It is this instantiated individuation of a polaroid off the manifold that can be linked to what Penrose calls the collapse of a superposition.

Perhaps the easiest way to visualize and intuitively comprehend these preliminary distinctions is by laying out OR in the context of the initial steps of the geomodal model.

[4] Roger: there is "some effect going on in the brain where gravity comes in." The process model elaborates his view.

[5] Such a threshold could also be dynamic, extending models where the growth and persistence of superposed states could reach a critical (optimization) threshold where collapse rapidly occurs (e.g. Pearle, 1989; Ghirardi et al, 1986).

[6] Joos/Zeh (1985) consider the De Broglie/Bohm view to be validated by the phenomenon of quantum decoherence where, instead of wavefunction collapse there is a "conversion of the quantum probabilities (that exhibit interference effects) to the ordinary classical probabilities" (also Zurek, 2003), which are locally emergent (Schlosshauer, 2004).

[7] Rather than measurement of an object, it is a sample of a large collection of objects. For Whitehead, this involves the dJ2 & dG2 metrics in the instantiation of an "event-entity" of space-time and gravity (in ch6); and in Verlinde's emergent gravity it refers to an "entanglement entropy," as also the instantiation of space-time and gravity (in ch7).

	GEOMODAL PROCESS (pt.1 of 3)	**ORCHESTRATED OBJECTIVE REDUCTION**
1	**Sea of Strands (**Ocean of Brahman)	n/a (*note: in geomodal, this includes QBism layer*)
2	**Manifold** (associated with Atman)	fine-scale structure of spacetime; **moduli** space
3	**Snapshot** of strands in a Manifold → **Polaroid** of (open) strings	**superposition**→quantum instability→ORCH → curvature-induced gravitational **collapse**
4	**Ingression** of Polaroid Contents	n/a (*note: in string theory this is modeled by Sen*)
5	**Phonon** bursts as collective valued quasiparticle of polaroid contents	OR/collapse creates a **proto-conscious event**; "bing" (Hameroff); microtubules (fast process)

Through this lens, Orch-OR appears like a metaphysically-truncated and conceptually compressed variation of steps 1-5 of the geomodal model, and from a different paradigm of ontology. Still, the concepts in OR can be effectively transliterated into the initial action sequence of this process, while "Orch" is reserved for steps 6-9 in a renormalization phase. Before diagramming these, let us first zoom-in to review the underwriting concepts of OR; namely, wave-function collapse; superposition; instability/uncertainty; objective threshold quantum state reduction; decay of superposition & reduction to a proto-conscious event.

A. Superposition

"The superposition principle [is] the building block of quantum theory" (Donadi et al, 2021). In OR, a superposition is modeled as a bifurcation of spacetime geometry, i.e., an object (dimer) in two places at the same time. "When a system is in a spatial quantum superposition, a corresponding superposition of two different space-times is generated" (Donadi et al, 2021). However, what initially causes a superposition is not clear. Hameroff considers it natural for dimers in neural microtubules to be in two states simultaneously; however, this hypothesis is not experimentally verified. In the process model, another derivation of a superposition stems from the ambient scenario of what Geoffrey Chew calls "pre-material strands" (2004) and I independently derive as fibers/strands (2002/3). Pinning this example for now—in the "spatial" case, the geomodal scenario denotes a "superposition" associated with the interval between a snapshot of strands in a manifold and the formation of a polaroid. During this infinitesimal interval, strands (otherwise streaming in the ocean) appear as if suspended all Hahn Solo style in a carbonite chamber until a polaroid forms and the strands are released back into flow. The growing blister of uncertainty, attributed to the "halting" effect of strands, cannot go on too long before they would not be able to catch up without runaway effects of turbulence; or as explained in OR, given the instability due to coexisting gravitational potentials would grow too large.

It is important to note, within this infinitesimal interval between a snapshot and the formation of a polaroid, GSE is not yet relevant (as portrayed in OrchOR). Instead, the polaroid generates the first object of the process—what Whitehead calls an "event-entity" comprising a "multiplicity of *initial* data," and what Verlinde refers to as an "entanglement entropy" associated with a holographic screen.

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In this scenario, GSE appears later in the process sequence. Another distinction is that rather than "reduction" as a "choice" linked to free will, the action principle axiomatically follows the individuation of a polaroid.[8] This is because each 'event-entity' precipitates another generative sequence of the process.

Returning to the pinned case of superposition, another feature of the Pilot-Wave model of De Broglie and Bohm is decoherence, which can be modeled as an "einselection" procedure (Zurek, 2003). "A good deal of the quantum-to-classical transition is explained by decoherence. Decoherence is the delocalization of the coherence of a subsystem over the environment entangled with it. It plays two roles: it selects the preferred basis through environment-induced superselection (*einselection*), which can eventually be measured, and it suppresses any superposition of states on this basis" (Tomaz et al, 2024).

In the geomodal model, quantum decoherence refers to delocalization of strands in the ocean when momentarily caught-up in a snapshot of a manifold, where "the phases of quantum wavefunctions are randomized [or *effectively* random, e.g. Peirce's tychism] to reduce quantum phenomena to classical processes" (Collins, 2015; also Jumper & Scholes, 2014). In this scenario, OR comes into play between the interval of a snapshot (linked to einselection) and formation of a polaroid, which also releases strands back into flow by a process like wave-trapping and release with turbulent mixing (e.g. An & Wang et al., 2018; Lakin & Noolandi, 1979; Mu & Liu et al., 2020). Strands seek to stay in their parcel within the Ocean of Brahman, so when halted in a snapshot, this status cannot persist very long.

B. Growing Instability/Uncertainty ("Blister") associated with a Superposition

"When two quantum superposed states are spatially separated, two spacetime distortions associated with each state should coexist" (Tomaz et al, 2024). In QM, this superposition causes uncertainty and instability, resembling a "blister." Per the Diósi–Penrose model, the "wave-function collapse ending a quantum superposition occurs due to the instability of coexisting gravitational potentials created by distinct geometric conformations of the system [dimers] in different states" (Tomaz et al, 2024). When the time interval of a growing quantum uncertainty/instability associated with a spatial superposition reaches a tacit, objective threshold, it causes a collapse to just one state. In the geomodal model, spacetime blisters arise from a halting of strands in a manifold for an infinitesimal interval between a snapshot and formation of a polaroid. Strands appear delocalized in position between being frozen in a manifold, and where they would be in flow. They 'catch back up' after release by a mechanism resembling wave-trapping & release with turbulent mixing.

C. Collapse/Decay of a Superposition

"The superposition must collapse within a specific time to avoid losing its quantum nature. This time is called the reduction time, and in Penrose's theory it is related to the gravitational self-energy of the difference in the mass distribution between states" (Collins, 2015). Penrose also refers to this as the decay of the superposition. In the geomodal model, the reduction-time/decay of a superposition refers to the interval from a snapshot to a polaroid. Specifically, this interval entails **1)** a snapshot—as a momentary pausing of strands in a manifold; **2)** the subsequent growing of a "blister" (re: uncertainty; instability) between frozen

[8] Choice still appears in terms of the initial snapshot sampling criteria, likely not as a strict threshold, and perhaps within a range. This is not a free-willed choice of a person so much as a non-computable autogenic imperative.

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positions of the strands, and as if still streaming in the ocean; and **3)** the individuation of a polaroid along with the releasing of strands back into flow.

In the Diósi–Penrose model, gravitational curvature induces collapse of a quantum superposition in terms of the uncertainty blister. As Collins explains, "the core axiom of Diósi-Penrose is [that] gravity actually only has an effect on the uncertainty of an energy, rather than the energy itself" (Collins, 2015).[9] Penrose suggests gravity exerts a force on these spacetime blisters, which become unstable above the Planck scale (10^{-35}) and therein collapse/reduce to one of the possible eigenstates in an average time of ħ/EG (*ibid*).[10] "A spatial quantum superposition collapses as a back-reaction from spacetime, which is curved in different ways by each branch of the superposition" (Donadi, Diósi et al., 2021).

Comparatively, in the process model, a curvature-induced "snapshot" of strands in a manifold induces (*something like*) spatial superposition in terms of a growing instability (uncertainty) between the strands—as momentarily "halted" in a manifold versus where they would be in position if still streaming in the ocean. This uncertainty cannot grow too large, leading to a threshold reduction. In this scenario, the reduction-to (formation-of) a polaroid (at Planck-scale) also releases *&* boosts strands "halted" in the manifold back into streaming flow in the ocean of Brahman (e.g., via wave trapping *&* release with turbulence mixing). Rather than a "choice," the action principle axiomatically follows the polaroid off a manifold, given a polaroid represents the initial event of a generative process sequence.

D. Collapse creates a proto-conscious event

While the three previous concepts in OR align pretty close with the geomodal model, a key divergence appears in terms of the order of operations regarding what happens upon "reduction." OR links reduction directly with a proto-conscious event, while the process model includes a key step between a polaroid and proto-conscious event that can also be articulated in the Whiteheadian context of "ingression" and in string theory by Sen (1998).

As Penrose and Hameroff posit, "we consider that consciousness occurs if an appropriately organized system is able to develop and maintain quantum coherent superposition until a specific 'objective' criterion (a threshold related to quantum gravity) is reached; [wherein] the coherent system then self-reduces" (Penrose & Hameroff, 2014).[11] In this scenario, superpositions disclose quantum information that is "absorbed by sensory neurons and … orchestrated – that is, synchronized among the many neurons" before objective reduction kicks-in at a tacit, gravitational threshold that "reduces the spatial superposition of quantum information into one state or the other, which results in a proto-conscious event" (Collins, 2015). "At each such OR moment…random (proto-) conscious moments of experience occur, composed of basic qualia" (Hameroff, 2021).

By comparison, in the process model, the "threshold mechanism" is elaborated while the essential result of a proto-conscious event remains the same. In particular, an initial threshold is related to some tacit information-

[9] Here, "the Killing vector is implicated as the source of uncertainty, and so the error is a measure of uncertainty in the d/dt operator needed for the Schrödinger equation" (ibid).

[10] Thus, collapse does not involve the wave-function; rather, the "choice" between states in a spatial superposition.

[11] "Quantum space-time effects, as described by non-critical string theory, [may also] trigger an organized collapse of the coherent states down to a specific or conscious state" (Mavromatos & Nanopoulos, 1995).

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curvature criteria that instantiates a "snapshot" and initiates a secondary threshold *a la* the time it takes to produce a polaroid. While the first case may evince a soft threshold, as a region, the second case observes a stricter sense of threshold in terms of time before "strands cannot catch back up in place."

Following the process scenario, the polaroid next undergoes an "ingression" leading to a closed string, not as a graviton—but instead, a collective-valued phonon; a quantum vibrational object localized and coupled in the brain via microtubules and subsequently orchestrated. This scenario appeals to Hameroff's position that microtubules are capable of quantum information processing. Mavromatos and Nanopoulos also note that "MTs are the microsites, in the brain, for the emergence of stable, macroscopic quantum coherent states, identifiable with the preconscious states" (Mavromatos & Nanopoulos, 1998).

While keen to aptly link their model with Whitehead's actual entities/occasions, their position renders an innocuous instance of conflation between these terms. As they portray, "OR is taken as an instantaneous event—the climax of a self-organizing process in fundamental space-time—and a candidate for a [proto-]conscious Whiteheadian 'occasion' of experience" (Penrose & Hameroff, 2014). However, this may be disambiguated by distinguishing between **a)** an *initial* "event-entity" at an "instant of time" (via OR as an "instantaneous event")—not as the climax, but beginning of a process *creating* spacetime; and which leads not to **b)** the *final* "satisfaction," i.e., an "actual occasion," but first…([12]) to **c)** an "*actual entity*" as a "feeling-tone" (James' "pulses;" Peirce's "bursts;"), i.e., a phonon as a form of gravity that is short-ranged, weak, and linked with a proto-conscious drop of experience. Let us now integrate these concepts (e.g. superposition, uncertainty, objective reduction, proto-conscious event) back into the initial sequence of the geomodal model.

4. Orch-OR recast in the Process Model

The process ontology of experience is primarily a visual logic that can be described in a compatible capacity by the foundations of physics and philosophy alongside comparative metaphysics in terms of ultimate reality and the soul. The ontological process takes place in the setting of a first-person "soular system" in ultimate reality (book I, ch4). This framework can be organized as follows into four general categories (sequences) of activity.

[12] Millennials and Genzies will get this footnote.

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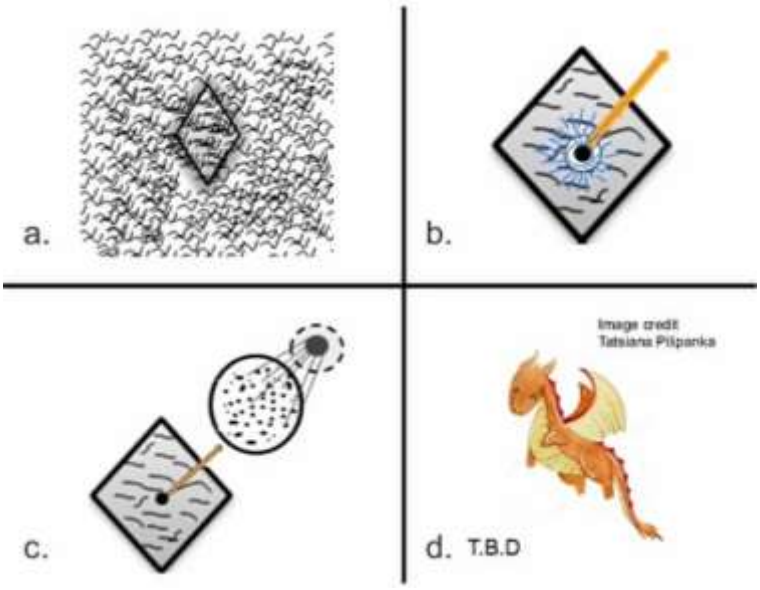

These four categories refer to the **setting**; **1st-generative sequence**; **2nd-generative sequence**; and **regenerative sequence** (from cosmos to cell; "where soul meets body"). Within this framework, a modified OR is conceptually coordinated to feature between the setting and first generative phase—as what triggers a snapshot to then form a polaroid. To unwrap & expound the layers in a visual logic comprising categories **a.** and **b.** is as follows.

From an ocean of strands streaming through background space, those that happen to be streaming through a manifold at the moment of a snapshot are momentarily halted and approximated as strings on a polaroid (hypersurface[13]; D2-brane). Immediately following, a D0-brane opens on the surface and creates a throat that swallows the (open) strings and induces the formation of a collective-valued phonon bursting (or radiating) off the brane.

Part I: Setting and Initial Phase

1. Strands of ultimate reality (cosmic background of vacuum), like tachyons, each describe a multiplex and adaptive, integrated nexus of strings in flux, as likened to coefficients that reflect probability amplitudes in a superposition (e.g. Susskind & Friedman, 2000; Nielsen & Chuang, 2010).[14] This is symbolized by the

[13] Notably, hypersurfaces and D-branes carry a charge on their surface, just as Diosi OR proposes a charged surface.
[14] Stock market numbers on an exchange board are each based on a number of invisible factors; confidence levels…

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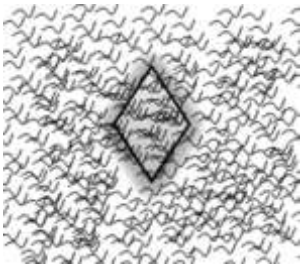
tails of each strand in constant, fast flux, where the entire strand up to the decimal core can be influenced by a given interaction.[15]

(*left*) Strands flow as if in a so-called Dirac sea of cosmic uniformity. (*right*) Each strand oscillates at the tail, and can be differentially influenced in any given interaction toward the decimal point depending on levels of impact. At (relativistic) embodied and enactive scales, strands can also resemble synaptic potentials and personalized probabilities re QBism (e.g Mermin, 2014). Strands fluctuate fastest at the tails (orange).

2. Within this ontological scenario, linked to the metaphysical domain of each living organism is a manifold of the soul, i.e. Atman—like Rih's diamond in the sky, whose walls are translucent and permeable, through which strands flow as if not there. This garners a Buddhist notion of not holding onto anything, which allows everything to flow through it.



Adopting Whitehead's phrasing, to transition from the mode of "continuous potentiality" to "atomic actuality" involves what (in the geomodal model) is called a "snapshot mechanism." It is this same mechanism that is essentially described by Penrose's objective reduction—so much so that it seems apparent we are attempting to describe the same phenomenon through differing lenses. Reciting the geomodal version of Penrose's scenario, a "snapshot" of values in a manifold induces an infinitesimal interval of superposition between the strands frozen in a manifold vs. where they would be if still streaming. The underlying premise is that such halting cannot go on too long before restoring it would cause disruptions by runaway turbulence effects, etc. As a result, this interval only persists for an infinitesimal moment before a polaroid forms and strands are released back into the flow of the ocean and restored/caught-up to their positions.

3. However, manifolds can sample contents by taking a snapshot that produces a polaroid. In a snapshot/sample, continuous values comprising "strands" in flow/flux are "reduced" (in dimension and representational form) to a single configuration state.[16] Here, the notion of "collapse" is modified to the

[15]From another perspective, qubits are like wannabe qudits, and qudits are wannabe strands.
[16] Supersymmetry is involved in that bosonic strands in one dimension take the form of fermionic strings in another.

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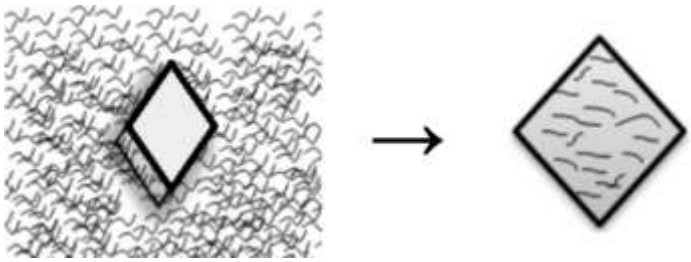
DeBroglie-Bohm model, where a snapshot can be thought of like a quantum state reduction of each element in the manifold—from a continuous value to a discrete approximation; e.g., the conversion of bosonic tachyons, like advanced/anticipatory waves (where any number of bosons can occupy the same ground state), into fermionic open strings, as discrete values on a D2-brane (or hypersurface) that together create an "entanglement entropy" (Verlinde, 2017). Distinctly from OR, this Planck-scale object generates/induces spacetime/gravity in a process model.

→

Caption: **(l)** a strand streaming through the vacuum with a tail in flux; **(r)** a strand frozen by a snapshot, resembling a string.

4. Taking half a step back—Penrose highlights how a wave-function cannot be sustained in superposition beyond a certain energy difference between quantum states. As he notes, "my own point of view is that as soon as a 'significant' amount of space-time curvature is introduced, the rules of quantum linear superposition must fail" (Penrose & Mermin, 1990). He gives an approximate value for this as a "Planck mass worth of matter," aka the "one-graviton level," as an objective criterion for wave-function collapse to a single state with a probability based on its amplitude in the original wave function (Penrose, 1989).

In the geomodal model, this limit-value or objective threshold for the interval of a spatial superposition is framed as an intrinsic tolerance-range between strands halted in a snapshot vs. where they "ought" to be in position—for the time it takes a snapshot to produce a polaroid. Here, referring to OR as a self-collapse/choice between states can be reframed into a positive statement about the instantiation of a polaroid—namely, that the action principle axiomatically follows (collapses/reduces-to) a polaroid. This is because a polaroid is the first-value/step initiating each sequence of the "implicate-order" process.



Upon the advent of a snapshot, strands are halted in a manifold until re-represented in momentarily-frozen forms as strings on a hypersurface (D2-brane). This interval describes what Penrose calls the decay time of a superposition, which results in the collapse of a wave-function to one state. Here, the uncertainty and instability arise from the interval between a snapshot that (like James Bay) "holds back the river" of strands until a polaroid forms, also releasing the strands back into flow along with a turbulence boost to catch back up.

In terms of phenomenal ontology, "according to Penrose, these superpositions collapse to form qubits" in microtubule dimers (Collins, 2015). Alternatively, in the geomodal model, the spatial superposition of

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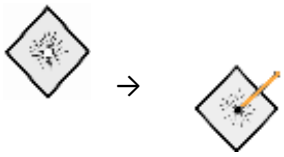
strands "reduces" to form a Planck-scale polaroid (D2-brane of open strings), as the basis of emergent spacetime, string theory and gravity. Linking his two major books, Whitehead refers to an event-entity (dJ^2) as "a *multiplicity of initial data*" in a *uniform background geometry* metric (dG^2), where the values are more essential than the space. Verlinde refers to this as "*entanglement entropy*" on a holographic screen (2016).

5. Rather than directly creating a proto-conscious event, the crucial next step in the geomodal process is that first a D0-brane (like a microscopic black hole) opens up on the polaroid/hypersurface (D2-brane), drawing-in the open strings (by a process Whitehead calls "ingression"), which only then induces the spontaneous formation and bursting of a phonon (as a "proto-conscious event"). This physical scenario is well-documented in Sen's "second model of tachyonic condensation" (1998). It is this radiating/resounding phonon (Peirce's infinitesimal burst; James' pulse of consciousness; Whitehead's actual entity) that is associated with qualia-laden proto-conscious moments, encoded by brain microtubules, and dissipating throughout entangled microtubules and neurons, etc. (Hameroff, 2024).[17]



Going deeper, as Hameroff explains, "consciousness depends on anharmonic vibrations of microtubules inside neurons" (2006). In the process model, phonons expressing in neural microtubules are patently atonal insofar as they represent collective-valued quasiparticles of an arbitrary collection (sample) of open strings (the contents on a polaroid); thus, raw. They go from raw to refined & orchestrated during the phase of renormalization. In their initial expression, phonons may express topologically in microtubules, where vibrational modes influence the dynamic instability of microtubule dimer assembly and catastrophe (Prodan & Prodan, 2009) like a VU meter or audio spectrum analyzer in recording studios, so too the temporal succession of phonons driving each stream of subjective experience.[18]

For another overlap, Hameroff and Penrose consider consciousness to arise from the orchestration of fast quantum processes (computations at higher frequencies involving the rapid oscillations of dimers in microtubules) by slower structural/functional and organizational dynamics of microtubules that influence how quantum states are maintained and information is processed over longer periods. In the process model, this slow, secondary mode of orchestration fittingly occurs during the renormalization phase. In the next section, GSE is shown to be applicable to renormalization in a quantum mode.

	GEOMODAL PROCESS (pt.1 of 3)	**WHITEHEAD's ACTUAL ENTITIES**
1	**Sea of Strands (**Ocean of Brahman)	"Continuous (or Pure) Potentialities"

[17] For one line of reasoning, "Condensates in microtubules in one neuron can link with microtubule condensates in other neurons and glial cells via gap junctions and thus generate an extensive quantum state suggested to be a Bose-Einstein condensate (Hameroff, 2006). For another layer of similarity, Georgiev, Papaioanou & Glazebrook (2007) investigates the rôle of solitons in microtubule-based processing, supporting conclusions of OR.

[18] Like fast/slow; high/low-freq. neurodynamics & laminar layers, raw=fast/local/surface; refined=distributed/deep.

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2	**Manifold** (associated with Atman)	"Uniform Background Geometry;" "DG^2 metric"
3	**Snapshot** of strands in a Manifold → **Polaroid** of (open) strings	"Instant of time" → "Multiplicity of Initial Data" that appears as the "DJ^2 metric" (of gravity)
4	**Ingression** of Polaroid Contents	"Ingression" of "Eternal Objects"
5	**Phonon** as collective-valued quasiparticle of polaroid contents	Formation of an "original datum;" or "**actual entity**" in its "feeling-tone" ("affective pole")

	GEOMODAL PROCESS (pt.1 of 3)	**STRING THEORY (incorporated w/ mOR)**
1	**Sea of Strands (**Ocean of Brahman)	Tachyonic Field; Advanced Waves; Dark Energy
2	**Manifold** (associated with Atman)	moduli space of M-theory; vacuum manifold
3	**Snapshot** of strands in a Manifold → **Polaroid** of (open) strings	*modified OR in information-geometry context* → D2-brane of open strings; tachyonic maximum
4	Polaroid contents down a **Drain**	Rolling tachyon; tachyonic condensation (Sen)
5	**Phonon** as collective-valued quasiparticle of polaroid contents	11-d Phonon with strings wrapped radiates off a D0-brane as a result of tachyonic condensation

Part II: Selection and Orchestration during Renormalization

The formation/expression of a phonon, as a Whiteheadian *actual entity*, is only the initial result of the process—and only one aspect of the phonon—which means neither is it the end of the story for microtubules. Where Whitehead specifies that *actual entities* have two modes—a *feeling-tone* and *physical-pole*—so too, a phonon has two roles, *expressive* and *analytic*. In the *former*, proto-conscious events localize-in and couple-to the brain via neuronal microtubules and other biomolecules driven by metabolic processes (Hameroff & Penrose, 2014). In this context, "pi resonance regions in microtubules and other biomolecules maintain coherent states, and a 'quantum underground' pervades the brain's neurons" (Hameroff, 2018). In the latter mode, a phonon serves as a coupling constant (Verlinde, 2011) and an assessor/selector, like a coach selecting players to train & perform as a team. This can also be seen as an objective process per strength of connection. This analysis occurs during a refining and orchestration sequence that Whitehead refers to as "prehension" and the "phases of concrescence;" and in physics, refers to renormalization. Verlinde's model entails the holographic renormalization procedures of "coarse graining" and "foliation." In these models, the phonon operates on the holographic dual of polaroid values projected into one-less dimension and a different representational form. Following the AdS/QCD duality, holographic renormalization in a quantum black hole can be duly modeled by **i)** open-string values in a string matrix (Verlinde) connecting 5d anti de Sitter space with **ii)** the paired mode of a strong-force regime, as a chiral bag of QCD matter (quarks, gluons, pions) e.g. inside the conformal boundary (4d-CFT) of a quantum black hole. One describes the emergence of gravity; the other, a "little Higgs" and YMT scenario.

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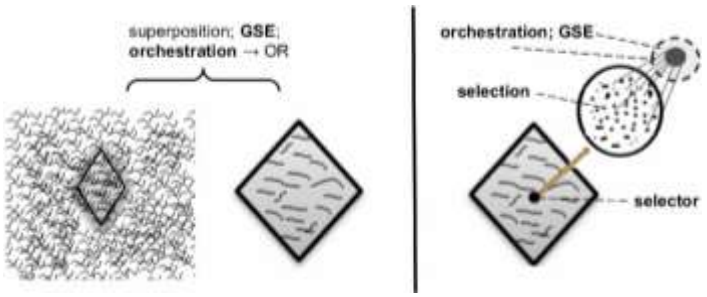
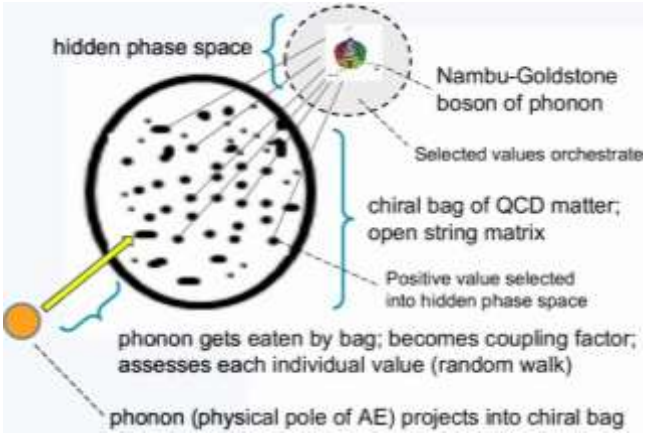


In (a sorta fairytale) of biological renormalization—Hameroff proposes that "a neuron can very rapidly alternate quantum computing with normal function by temporarily isolating the microtubules from the membrane through disassociating the linking MAP proteins (to avoid quantum decoherence effects). This would mean the quantum computation is isolated from the global brain state during the quantum computation cycle" (Hameroff, 2015). On this view, "quantum vibrational computations in microtubules are 'orchestrated' ("Orch") by synaptic inputs and memory stored in microtubules and other biomolecules" (Hameroff & Penrose, 2014). "This occurs primarily in dendrites and soma, thus being able to trigger, or not trigger axonal firings and control behavior" (Hameroff, 2015). Further, post-translational modifications of tubulin (e.g acetylation, detyrosination, glutamylation, which play key roles in regulating functions, organization and dynamics) could be seen as mechanisms that "renormalize" microtubular behavior to suit specific cellular contexts (for example, Wloga & Gaertig, 2010; Muroyama & Lechler, 2017; Skorentseva et al., 2025).

A. "Phonon-as-Coupling" & the "Little Higgs" Model of a "Composite Higgs" Boson

In addition to gauge-gravity models in AdS/QCD, a third approach to model holographic renormalization (in strong force QCD) is by way of a composite Higgs boson orchestrated by a "little Higgs" (phonon-coupling in string matrix) that selects aspects to stabilize the collective-valued/composite Higgs. Here, a chiral bag of QCD matter serves as fodder for orchestrating a stable, refined, composite Higgs. In Whitehead's model, a composite Higgs aligns to the "satisfaction" of an actual occasion, plus with a final expression of GSE.



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Caption: renormalization phase operations of selection and orchestration. This diagram depicts a chiral bag of QCD matter, as the holographic (AdS/QCD) dual of a polaroid of open strings, in a composite Higgs scenario. This is also depicted in Verlinde's open-string matrix, during renormalization. In QCD, a (*little Higgs*-like) "phonon-coupling" renders into the bag of free quarks and begins the selection and orchestration process during the enumerative phases of orchestration and coarse-graining, where the non-zero value of a phonon likens to a Nambu-Goldstone boson (in a Mexican hat model). Chosen values progressively orchestrate as new values are added, leading to a composite Higgs *&* GSE. Values integrated out might be thought of as protecting the composite Higgs from large radiative corrections.

B. Progressive Orchestration of the Elect → GSE of a collective-valued Higgs Boson

Two key topics come into play here for comparing between Orch-OR and the ontological process model; namely, "orchestration" and "**g**ravitational **s**elf-**e**nergy."[19] Penrose situates orchestration and gravitational self-energy within the initial phase of superposition; however, in the process model, both attributes appear in a later phase of renormalization that occurs after the generation of a proto-conscious event. A Whiteheadian reader will recall this means the process does not halt with the formation of an "actual entity." The reader familiar with Orch-OR will also note their model does not refer to renormalization. Interestingly, the reason for this may simply come down to the choice of model selection.

As generally defined, gravitational self-energy involves energy contributions due to gravitational interactions between different parts of a system (Jones, 1995). As Penrose explains, "the gravitational self-energy in a mass distribution is the energy that is gained in assembling that mass distribution out of point masses completely dispersed at infinity" (Penrose, 2005). However, this description applies to classical systems. In the quantum version of gravitational self-energy, infinities are found in renormalization.[20] Essentially, it appears that Dr. Penrose applies a classical interpretation of gravitational self-energy for attempting to resolve (what may instead be) a quantum involvement of this phenomenon.

Following the two previous exemplars of the geomodal process logic in philosophy and physics, "orchestration" is reframed to take place during the phase of holographic renormalization involving selection and orchestration of the selected; and it is only in the final orchestrated value ("*satisfaction;*" *AO*) that a gravitational self-energy appears (as linked to a composite Higgs: e.g Frandsen, 2023). Thus, in the Diosi-Penrose model, where "decay of a superposition is related to the gravitational self-energy of the difference in the mass distribution between states" (Collins, 2015)—which places it front-end; in Verlinde's theory, the difference in mass distributions between two states (initial value; final refined product) gives rise to the entropic/emergent[21] force of gravity as an (inertia-based; adiabatic) gravitational acceleration force appearing at the end of renormalization phase. Intriguingly, recent research in neuroscience suggests renormalization may be part of the learning process (Wenger et al., 2017). Essentially described by Whitehead's prehension in the same way I describe a coach selecting a team, so

[19] In OrchOR, the collapse of quantum states of dimers in microtubules is influenced by the gravitational self-energy associated with the separation of these (qubit-like) conformational states of dimers "in fundamental spacetime."
[20] "The gravitational self-energy is necessarily smaller than anything in the biological sphere, or there would be destructive interference resulting in noise" (Collins, 2015). This matches with my independent insight in 2003. The difference is in the application of GSE. Penrose puts it at the beginning of the generative phases; I put it at the end.
[21] The gravitational acceleration is motivated by the difference of information between the initial values and final rarefied product (Higgs). Adiabatic processes refer to those without transfer of heat, as distinct from the phonon.

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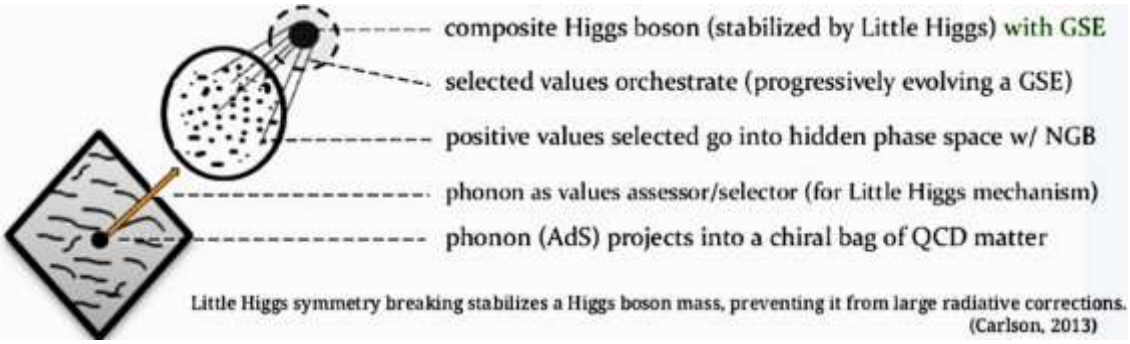
too, Wenger refers to an audition for the cast of a movie, where "numerous candidates are first progressively called in, then the best are selected, and the rest are sent home, that is, pruned away" (*ibid*).[22] In their "expansion–renormalization model," learning-related neural processes often follow a sequence of expansion, selection, and renormalization (also Fu & Zho, 2011; Kilgard, 2012).

Reciting the geomodal scenario, an "initial multiplicity" introduces an "expansion" of values into a phonon, first felt, that goes on to assess the dual-values of initial data one at a time, discarding or promoting each for participation in the phases of renormalization, where selected values progressively self-organize into optimized modes of orchestration. This process continues until all values have been assessed, at which point a final phase-product of orchestrated values certifies the configuration state. I suggest this final product may be modeled as a collective-valued (composite[23]) Higgs boson; i.e., a pseudo Goldstone boson also linked to a gravitational self-energy (Hill 2020). In a process lens, where OR links GSE to a snapshot→polaroid interval, here it is linked with a Higgs boson. This portrait can be described in the context of the Higgs Mechanism, as the cornerstone of the Standard Model of particle physics that explains how particles acquire mass (ch7).

Part III is reserved in this article, as it does not serve the initial focus of OrchOR.



Closing Remarks

> Consciousness drives evolution; and, as Penrose suggests, conscious quantum events intrinsic to the universe solve other problems like the 'anthropic principle', why the universe is perfectly tuned for life and consciousness [...]. Problems in evolution, brain science, quantum physics and cosmology all fade away with consciousness as an intrinsic feature of the structure of reality. (Hameroff, 2013)

[22] Specifically, "this resembles the audition process for the cast of a movie, where initially numerous candidates (i.e., computational circuits or ensembles of e.g., neurons, synapses, astrocytes, and glia cells) are called in (overall tissue expansion). These are then tested for suitability for the role (i.e., functional efficiency) and the best candidates (i.e., circuits) are then selected (selection), while the rest are sent home (i.e., pruned away; leading to renormalization).".

[23] "In composite Higgs models, the Higgs boson can be thought of as a bound state of fermions from a strongly interacting sector, and it arises as a pseudo-Goldstone boson. [So too], skyrmions can appear as topological solitons, similar to how they appear in quantum chromodynamics (QCD) as baryons" (Yun & Yoon, 2024; Gillioz, 2011).

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Einstein once said to make things as simple as possible but no simpler. This chapter highlights another way to interpret the ontological, mechanistic and physical scenarios of Orch-OR, where the essential concepts remain valid, yet subject to elaboration. To integrate this into the process sequence (plus Whitehead's actual entities/occasions) requires a few modifications.[24] For one—another thing Einstein said was that "space and time are modes in which we think, not conditions in which we live." I suggest we take this seriously and apply the spacetime of GR to topological information theory and neural models (e.g. Rovelli, 2013; Papadopoulos & Scardigli, 2019) regarding (a curvature-aware) autogenic optimization process for sampling information states at a certain range, like the ultimate Instagram boyfriend/paparazzo snapping pics that optimize best/salient angles.[25]

Following the insight from chapters 6/7 that Einstein & Whitehead's models of relativity conform to two distinct modes of experience and epistemology—i.e., the binate autogenic/agential construct (ch3)—the spacetime of Einstein's general relativity can also be interpreted as a model of gravity from the perspective of an autogenic (intrinsic) model linked to the soular faculty of logos/sākṣī; ch4,bk1. By contrast, Whitehead and Verlinde's approaches effectively derive a model of gravity as a real, emergent force. This suggests both versions are valid—one in a first-person agential mode, the other from a first-person autogenic mode—and it just so happens one context where both modes interface is in the "sampling" by a modified OR mechanism that initiates each generative process sequence.

Thus, where Hameroff refers to Orch-OR as "the most specific scientific proposal for phenomenal experience," the case laid out in this chapter suggests it may not be specific enough, and is actually a bit of a cartoon compared to the process model. If this sounds familiar, it is the same critique Hameroff astutely levies against neuroscience (re: neuron as a cartoon). In turn, I provide a cartoon accompaniment for my case. As initially surmised in 2014, Orch-OR is like the deposit on a full theory; the first and last month's rent; the opening and ending sequence. This is elaborated in the process sequence as what we might not call a modified objective reduction. That way, if someone were to ask "what's your take on OR" (or OrchOR), you can say, the concepts are good—it just needs mOR.

To reprise the main position, Penrose's "objective reduction" can be disambiguated into two specific features of the ontological process—namely, **1)** as the basis of a snapshot of strands in a manifold—by an autogenic computational operation that takes samples at an intrinsic threshold/region as an optimizational range; and **2)** as the interval between a snapshot and generation of a polaroid. Consequently, where Penrose claims there is "some effect going on in the brain where gravity comes in," in addition to the above, another instance of gravitational effect can be identified in the modified OR procedure with regard to the weak/short-ranged force of gravity associated with closed strings (as phonons rather than gravitons: Verlinde, 2011) in expressive & information-laden forms consistent with the expectations of proto-conscious events underwriting subjective experience.

Thirteen preliminary pivot points can be identified for translating OrchOR into the first two parts of the process model. **1)** ontological paradigm (fundamental v. emergent); **2)** the measurement problem (wave function collapse vs. sampling); **3)** Penrose objective threshold remains non-computable yet may entail a *region* or regime of "curvature-aware" optimization criteria involving the structure/dynamics of

[24] "The actual mechanisms underlying the production of consciousness in a human brain will be very much more sophisticated than any that we can put forward at the present time, and would be likely to differ in many important respects from any that we would be in a position to anticipate in our current proposals" (Penrose & Hameroff, 2014).
[25] "In information geometry, curvature is used to describe the geometry of statistical models. The curvature of a statistical model can provide insights into the behavior of the model (e.g. sensitivity to changes in parameters; how well it can approximate different distributions)." I-G concepts draw from differential geometry, such as Riemannian manifolds and the Fisher information metric, to study the properties of statistical models (Stavrov, 2020).

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neural manifolds/networks;[26] **4)** spatial superposition as qubits in neural dimers vs. the interval between strands halted in a manifold and where they would be if not frozen in the snapshot of a manifold; **5)** the classic notion of superposition can be applied to a characteristic of strands *&* involves the measurement problem in terms of the non-collapse variant (DeBroglie & Bohm); **6)** decay of a superposition as the interval between a snapshot of the manifold and the formation of a polaroid; **7)** polaroids are not the culminating feature (as in OR), rather, the actuating events of each process sequence; **8)** rather than selection/reduction directly resulting in a proto-conscious event, there is an additional step appearing in a string theory description; **9)** rather than a "choice," the action principle axiomatically follows the polaroid; **10)** "one graviton" polaroids produce phonons; **11)** phonons are expressed by microtubules, which integrate across neurons into a stream of proto-conscious subjective experience; **12)** rather than instructive of a free will, mOR is about the role of an autogenic operator (corollary to the free will: ch3) as what in 2004/5 i coin "the ultimate paparazzo" and **13)** a general appeal to the first-person subjective experience of "consciousness," as counterpoised with objective experience (i.e. what remains when microtubule flow is blocked by anaesthesia).

To elaborate point *four* on the topic of qubits in dimers, another alternative entails the nature of strands akin to quantum potentials. Given the role of localized synaptic potentials and QBism already function in a natural capacity, strictly speaking this suggests synthetic qudits/qubits may be an ontological redundancy that only apply to technology.

To elaborate the *tenth* point, where Penrose considers OR to occur at the "one graviton" limit, this may also explain why actual gravitons may not exist as such—if they serve as a limit for the polaroid formation; and instead, closed-string phenomena refer to phonons. To elaborate the *eleventh* point, it appears self-evident microtubules have a major cellular involvement in subjective experience. For example, anesthetic gases appear to exert their functional effects on cytoskeletal microtubules in neuronal interiors, making microtubules the target of anesthetic action. When the flow of microtubules is blocked, so too is subjective experience, although the body remains functional in objective operations. Unblock microtubular flow and subjective experience restores. As Craddock explains, "we now have excellent evidence this happens through preventing quantum dipole oscillations in brain microtubules (Craddock et al, 2015; see also Eckenhoff, cited in Elsevier, 2014).

This line of reasoning showcases a provisional case how metaphysics and ontology may converge in a framework of logic at the fundamental scales of experience and nature.

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[26] For instance, curvature can be used to quantify neural manifolds or enhance brain segmentation frameworks (Zhao et al, 2024). Curvature is also investigated in visual processing areas, e.g. re object & place recognition in the brain.

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