Growing block time structures for mathematical and conscious ontologies

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Abstract. A version of the growing block theory of time is developed based on the choice of both consciousness and mathematics as fundamental substances, while dismissing the reality/semantics distinction usually assumed by works on time theory. The well-analyzable growing block structure of mathematical ontology revealed by mathematical logic, is used as a model for a possible deeper working of conscious time. Physical reality is explained as emerging from a combination of both substances, with a proposed specific version of the Consciousness Causes Collapse interpretation. This leads to new solutions to old problems, including the epistemic problem and issues with Relativity.

Keywords Growing Block - Mathematical Platonism - Mathematical Logic - Foundations of physics - Libertarian free will - von Neumann-Wigner interpretation.

This article will defend the coherence of a growing block universe theory of time, by describing a detailed version of it where its old problems appear to find natural solutions.
This independently develops by other aspects, the concepts first introduced in the FQXI essay on mind/mathematics dualism (settheory.net/mind-math_dualism.pdf). See also the pages on the interpretations of quantum physics (settheory.net/physics).
The writing of this article started as a reaction to some related existing philosophical works on time theory, until a more extensive literature review was undertaken to feed more sections. The first sections so written, pertaining more to the general flaws of academic philosophy than to the specific topic of time theory, were then moved as an addition to a previously written page on such generalities (antispirituality.net/philosophy). This left here the following on-topic sections:

Section 1 argues that, for diverse physical reasons, a growing block view would be at odds with physicalism.

Section 2 briefly explains the growing block time order in mathematical reality revealed by mathematical logic, and announces its use as a model to better understand conscious time.

Section 3 starts applying this methodology by expressing this time structure in precise terms. Semantics appears as a real creative process.

Section 4 argues against the metaphysical concept of doomsday by pointing out why any reality relies on some potential future.

Section 5 describes the existing draft images of possible futures for mathematical reality.

Section 6 infers from articulations of the possible and the actual, a perspective on free will and divisions of consciousness into individuals.

Section 7 analyzes the epistemic objection, and invites to revise the concepts of time, presentness and their physical details, to provide a new solution and better fit relativistic invariance.

Section 8 argues the impossibility of time loops, and clarifies the structure of black holes to refute the presence of a Gödelian region inside.

Section 9 offers an account of physical reality and the nature of physical time, as emerging from a combination of consciousness and mathematics.

Section 10 defends the physical place of free will by critically reviewing usual arguments against the role

of consciousness in quantum physics, and providing some last clarifications.

Finally, section 11 invites to a Bayesian approach to compare the plausibilities of competing metaphysics.

(I submitted this article in the beginning of March 2022 to the one journal which seemed appropriate, with 3 criteria : on-topic (metaphysics and hard sciences), open-access without fees, and accepting articles of this size a bit long. About 6 weeks later, in lack of reply, I inquired and learned that the editorial board was under restructuration, thus not ready to accept submissions at the moment. I then gave up and just sent it to Philarchive instead.)

1. Thesis matchmaking

Assume you are a philosopher involved on a topic X with its list of popular thesis A_1, A_2,... but you are favoring and struggling to defend a minority thesis B. Then, you need to articulate it with another question Y, with its popular answers C_1, C_2,... but also a "largely discredited" view D. Which of these will you focus on ?

Credibility concerns may lead you to try to defend compatibility with a maximum of the C_n in hope to please their respective supporters, or by fear of making a wrong bet, disturbing the division of research by topics, or facing dismissal if you attempt to resurrect D.

However, this may be illogical for 3 reasons. First, the depth of arguments and the coherence of global views should always prevail over popularity concerns. Second, since you already oppose a majority about X, you should not be surprised if they were also mistaken on Y. Third, if the fear of opposing the majority on several fronts was common, B could be just suffering incompatibility with the C_n while D suffered incompatibility with the A_n, leaving open the unchecked possibility for B and D to match and resolve each other's troubles.

Consider X = time theory, and B = growing block time (GBT).
Before discussing substances (monism or dualism), consider

Y = interpretation of quantum physics;
C_1 = Many-worlds (MW);
C_2 = Hidden variables (HV), such as Bohmian mechanics;
C_3 = Objective Collapse (OC), such as GRW.

Yet, they all have heavy troubles. «*The Everett interpretation is advocated by a reasonable-sized constituency of physicists* (...) *but the other two "main interpretations" are largely ignored*» (Wallace 2020). One reason, developed in (Wallace 2016a) and more in-depth in (Wallace 2018), is that HV and OC usually focus on a toy model (non-relativistic particles systems) and are much harder to adapt to quantum theory as a whole (mainly QFT, which means relativistic invariance but not only). His (2018) arguments also undermine "causal sets", whose tentative physics is too fundamental to be relevant to the measurement problem: it should admit approximations as collapse models or anything precise for some known physics, but no clear link with such physics is available. Now, consider:

D = Consciousness causes Collapse (CC), or von Neumann-Wigner interpretation.

Both CC and OC feature a "collapse" process, candidate match with GBT's creation process, but differ by their recognized substances : CC is spiritualist (holding consciousness as primitive), while OC is physicalist. This gives CC the following physical and philosophical advantages over OC.

As known physical laws are local (even QFT somehow), the non-locality of collapse favors classifying it as a conscious event beyond physics. First, experimental violations of Bell's inequalities only clearly

involve a "distant action" if both sides undergo "collapse". Then, saying which one affects the other depends on their time order; but "events" without physical location escape relativistic invariance rules. Finally, seeing it also non-local for physical time can resolve further issues.

First, our deeply relativistic physics cannot reasonably emerge from non-invariant *physical* growing-block processes. The deep unity of physical space-time is better respected by a non-physical collapse process not using any time-slice (3D "simultaneity" surface).

Second, this avoids messing with physics, thus positively answering "*Does it provide a way to legitimate and make sense of the actual practice of quantum physics, across the various interrelated domains to which quantum theory has been applied?*" (Wallace 2018: p.23).

Third, only a non-physical consciousness outside space-time can escape "*the difficulties caused by the approximate and ill-defined nature of decoherence*" (Wallace 2007:40) (which is emergent, non-unique and progressive with no definite instant measure of its progress) to effectively see it as a completed process and use it as a condition for collapse.

This condition on a given collapse ensures the next outcome will stay "compatible" (non-orthogonal) with the previous one. Put as a general rule, it gives a non-destructive growing-block form to the perceptions history: collapses come as updates of a state of the universe defined from the growing block of past perceptions. This GBT structure is already well-known under labels of "no-collapse" interpretations: "relative state" (Everett 1957), "single mind", "many minds", or "relational" (Barrett 2018; Soltau's articles and references).

Equivalently, the resulting history stays among MW's reality branches. Thus, it inherits its (very subtle) exact respect of energy conservation, needed for compatibility with General Relativity, which time-local laws involved in OC are unlikely to fulfill (facing troubles defining energy in limited time for non-isolated systems).

A philosophical trouble with OC is "*...the superpositions should collapse before humans have a chance to observe them. But the motivation for this is open to question*" (Wallace 2007:39-40). The Slow Collapse (SC) variant of OC where observers stay in superposition for a while, resembles the UGH theory (Merrics 2006:8) which differs from GBT by defining "the present" as preceding the edge of the growing block by 10 years. But, while UGH is a purely dialectical issue, the move from OC to SC being a physical issue escapes the philosopher's hands : while some physical laws can give a collapse rate excluding SC, such causes being unrelated with the biological basis of consciousness according to physicalism, only achieve this result by coincidence, leaving the metaphysical possibility of SC on the shoulders of philosophers trying to support OC. Yet, the question to articulate whether and why it really is a problem, may be a still deeper problem for physicalism. Similar issues with OC are known as the tails problems (Wallace 2007: 5.2; McQueen 2015) and distributions of values (Myrvold 2018).

Then, philosophers trying to defend GBT over rival time theories contradict physicalism in two ways.

First, the recognition of intuition as a legitimate source of insights on the nature of time, is a spiritualist position : how could a consciousness emerging from effects of well-known physical laws which rather fit eternalism, experience an objective time hidden at a more fundamental reality layer ?

Finally, physicalism combined with the locality of physical laws, makes GBT indistinguishable from Presentism. Indeed, given 3 times $t<t'<t''$, it is ineffective to qualify the events at t as existing for those at t'', because events at t'' cannot access them due to shielding by the layer of events around t'. Only an indirect, encrypted trace of the events at t can cross this layer, with possible permanent information loss.

2. The GBT structure of mathematical ontology

Accepting spiritualism (like GBT founders Bergson and Whitehead), more details are needed. Both traditional versions are mind/matter dualism and idealism. I will explore a new option : taking mathematics as the other primitive substance, then explaining the physical as emerging from their combination. This is motivated as follows.

Mathematical Platonism sees mathematical systems as having an independent, timeless reality (the understanding of which usually makes one a mathematician rather than a philosopher). Let us express it as:

1. Mathematics is a kind of reality with its own ontology ;
2. It can be investigated but remains unaffected by this or any other familiar contingencies;
3. Its ontological structure is eternalistic.

However, a deep understanding of mathematical logic, developed in settheory.net (philosophical complements), leads to modify this, rejecting 3.: mathematical existence, though independent of *our* time, has its own GBT structure. Indeed, the necessary architecture of the foundations of mathematics has intuitive similarities with our time, thus can appear more familiar once clothed by the vocabulary and intuition of time.

Here are short hints. Discovering the necessities of mathematical ontology, is a matter of not postulating anything arbitrarily.

Mathematics needs expressions. Any meaningful expression (except tensorial ones) has a hierarchy of sub-expressions, representing the time order along which these can take values. To describe expressions and their semantics, requires first-order logic and model theory. But model theory, like all mathematics, also requires set theory as a foundation.

Then, endlessly many versions of set theory appear possible. Anyway we must not choose, but accept all reasonable ones. Generally, a mathematical time structure is the transitive closure of a given well-founded relation. While sub-expressions were partially ordered, ordinals form a total time order through all time scales, from finite steps, to large cardinals towards the end of eternity. The *strength* hierarchy of set theories, starting with Finite Set Theory, tracks the largest time scales.

We shall now re-use this analogy for the inverse purpose : using known features of mathematical ontology as a working model to approach consciousness. For this, some facts of mathematical logic clothed by a time language will be used as tentative descriptions of hidden aspects of conscious ontology. Yet for example, I consider the features of perfect symmetries and identical copies as specific to mathematics.

On the way, spiritual sources of hints such as the Seth Material will clarify strange aspects, confirming bold mathematical insights and inspiring new candidate solutions to old problems (while the physical, as an emerging reality, will illustrate the picture but cannot probe the foundations).

Such differences between appearances and deeper realities of conscious ontology, can be explained by biases from specific limitations of physical (human) life; beyond this life, some other forms of time experience are possible.

3. Some basic concepts

Let us dive into this metaphorical mix of times, or experience of mathematical time by the study of mathematical logic (hopefully more objective than usual time experience).

By definition, "the past" means the universe of all things, i.e. events, which currently happen to exist as available objects of meaningful discourse : those we can remember.

We say that *A* precedes *B* if *B* remembers *A*, thus if *A* is a part of *B*, needed to account for *B*'s creation. This relation is naturally transitive (or anyway its transitive closure can be restored by digging a little): if *C* remembers *B* which remembers *A*, then *C* indirectly remembers *A*.

An expression with proper syntax to be interpretable, is either

- *bounded* if only about specific objects, and possibly also their pasts (all quantifiers range over specified sets);
- *open* if some variable is under open quantifier : its range being unspecified, will be read as "the whole past" (or a class in it, not given as a set).

Then, it needs a semantics. Now comes a crucial point : *semantics is a creation process* like any other, and thus a possible model to understand the nature of all creation processes. It creates an *interpretation*, usually called a *token*, of a given expression.

The *memory* of a token, is the range of all objects it involves : the values it gives to all variables, either free or bound by quantifiers. Like any event, a token cannot belong to its own memory: its "creation time" escapes its past (section 8).

Re-applying semantics to an already interpreted open expression, will probably create a new token, with a larger memory. But, re-interpreting a bounded expression only restores an old token; then, semantics is no more creative, thus somehow, "the past is dead". If you remember having made an operation, then you will be bored repeating it.

4. Time Cannot Stop

Some arguments in the literature (Loss 2019) are concerned with GBT's inability to express doomsday. While this should not matter (Callender 2011a), another reply is possible. The possibility of a doomsday relies on the contingency of the physical, whose laws may not ensure the existence of a physical future (space-time extension). While the mentioned risk of Big Crunch is ruled out since 1998 (Wikipedia: Cosmological constant), others not mentioned remain (falling in a black hole; speculatively, a false vacuum decay, or a cancellation of reality branch in the Slow Collapse interpretation). However, these no more count as metaphysical doomsdays when rejecting physicalism to see time as a feature of consciousness, whose existence is more fundamental than matter.

Now, mathematical time cannot stop: a present event that "is" will necessarily become a past one that "exists". The *existence* of *x*, defined by the existential formula $(\exists y, y=x)$, is its role of object that can be named, irreversible expression of its reality. A definition is a form of tokening, naming the operational role of an expression by a new symbol, thus giving it existence; the general theory of semantics can describe any token, seeing it as past, thus giving it a future.

Oddly somehow, the future is the foundation of the past: to describe things, one needs to be in their future. Research takes time. The better we wish to understand events and why they occurred, and to elucidate this understanding, the more time it takes.

Mathematical logic reflects this as follows. By Tarski's Undefinability theorem, a "present" time only able to token any chosen expression about the past, is too short to define the infinite set of all tokens of possible expressions; this definition can only be tokened later, once all those tokens occurred and appear as past.

The strengths of set theories in terms of higher infinities (faraway futures), affect the ranges of arithmetical theorems (facts on the past) they can prove (understand). Thus, when trying to build a model of set theory on top of a non-standard model of arithmetic, the construction may run for a while across some non-standard ordinal hierarchy, until, at any later "time" (non-standard ordinal) without describable

limit (large cardinal), it suddenly breaks by uncovering its nonstandardness.

5. Ersatz worlds

Aside the necessary but elusive potential existence of some future, possible futures admit draft images called "ersatz worlds", known in mathematical logic as *non-standard models of set theories* since the 1930's, and re-invented for GBT by Briggs & Forbes (2012).

Then, "claims about the future" can be given the substitute meaning of being true in them all, which (by the Completeness theorem) is equivalent to provability: the "truth" of such a claim means its provability given the current state of affairs. As finite systems, proofs may be found and checked faster than the actual unfolding of events (which may involve actual infinity).

Another article by the same authors (2017) argues that GBT is incompatible with Humean Supervenience. Let us check their premises :

> "*9. There are not irreducible necessary connections between distinct existents (8, definition of Humean Supervenience).*"

Take two times $t<t'$, and distinct existents:

- A = an event which happened at t';
- B = a proof known at t that A would happen in a certain way.

That their necessary connection may contradict Humeanism, will not be my point. I doubt its irreducibility, which did not seem clearly defined there. Another premise is

> "*4. If some propositions about the future are made true by something (or things) not in the future, then there are irreducible necessary connections between distinct existents*".

The truth of a genuine proposition may have an irreducible necessary connection with its objects, as its token remembers them. However, our only meaningful "propositions about the future" are formed by emulation systems seeing them as abbreviating other propositions about either ersatz worlds or provability. In the provability case, the future tensed proposition P "about A" abbreviates a proposition about B. This is a syntactic connection of a familiar pseudo-proposition with a proper one. I also doubt its irreducibility, but more worryingly, its ability to connect A with B.

Tokening P over ersatz worlds, would connect its truth with A just through the copy of A in that ersatz world which will become actual, by the way they postulated ersatz worlds to work. In mathematics however, no ersatz world can become actual: the unfolding actual world will appear only approximated by some pre-existing ersatz worlds; it is genuinely created in the (potential) topological closure of their range. It differs from them neither in substance nor ontology, but only in quality : a "real" world is a *standard* one.

Intuitively, standardness is a kind of fullness, and equivalent to a kind of compatibility with endless, indescribably remote futures, as mentioned above. This ultimate quality cannot be anticipated nor formalized; it cannot be fully proven in finite time, but only eventually refuted. Any unfolding process is anyway a necessary part of any process of understanding its own *full* details.

Ersatz worlds are illustrated by Christian Sundberg's testimony repeated in diverse videos. Similarly, the Seth Material pictures evolution as going from the fuzziness of foreseen probable futures to the precision of their actualized versions (Roberts 1970 & 1979). Other excerpts mention "probabilities systems" featuring no clear linear ordering nor real vs ersatz distinction (Roberts 1972: 91), which I would compare with the study of other mathematical theories, where standardness does not apply.

6. Free will

These mathematical concepts of actuality and pre-existing possibilities, whose irreducible mysteriousness (standardness is undefinable, while all models of set theory are non-algorithmic) do not undermine their reality, can shed light on their conscious versions, ingredients of free will.

Both mathematical logic and the Seth material indicate that possibilities far exceed what can be actualized at a time, and any actualization creates even more new possibilities than it uses. In mathematics, the explosive indiscriminate actualization of all appearing possibilities into an inextricable mess is expressed by set theories; but consciousness needs to care selecting opportunities to optimize its development.

A version of this preference problem is featured by proof theory (whose finitism makes the standardness concept inapplicable). Indeed, from any given axiomatic theory, an explosive range of possible deductions appears, but not all are equally worthy: some statements (conjectures) appear as more valuable goals of deductive exploration, for which some possible short term deductions are more likely to be useful. Then, strategies are needed to make creative works more efficient towards given goals. Yet, their efficiency is often unpredictable: the only reliable way to find the shortest proof may be to try them all (or a huge amount of them), but that exploration would give up the concern for which shorter proofs were desired in the first place.

Then, the division of consciousness into individuals may come as a parallel undertaking of multiple exploration strategies, each protected from the cost and distracting noise of others. This division needs to be balanced with connections sharing the benefits of findings across individuals. For example, someone can benefit being directly given the shortest proof from someone else's extensive search, while ignoring the fruitless parts of that search.

Since any choice is a kind of determination, the meaning of alternative possibilities needs clarification. Even determinism cannot mean full predictability: any complete "prediction" would be a real action encompassing the described events, and likely to disturb them away from their predicted course, thus obsolete. But free will brings the following differences:

- Apparently "deterministic" processes may have hidden indeterminations, by the ambiguities of standardness. The resistance of the undecidability of the continuum hypothesis to large cardinal axioms may be seen as a mathematical example.
- By their conscious nature, choices are inexpressible as any mathematical law, either deterministic or probabilistic;
- they can be genuinely attributed to individuals so conceived.

7. Answering the epistemic objection

GBT suffers this famous paradox: people's time intuition it relies on, includes the conviction of "living in some objective present", which is going to be false, like such beliefs held in the past which mistakenly subsist.

New answers will be provided. First, the geometrical definition of "the present" as the edge of existing space-time, tied with physicalism, is rejected. Then, the concept of "living in the present" needs a legitimate syntax. Let us first analyze "*This just happened*", or more formally

(*P*) "*There is hardly anything more than what this remembers*".

This still displays an unnoticed oddity of presentness : its negative form. It expresses a *disbelief* in the existence of later events than remembered ones. So, the paradox would be past people's mistaken disbeliefs.

Most people admit the possible existence of life on other planets, thus of many events they cannot remember, as these took place elsewhere. So, reading (*P*) literally, they correctly believe that they are *not*

living in the present. To distinguish claims, would require sorting unremembered events by the filter of "*being consecutive to this*"; that would be so complicated.

Mathematical logic has no concept of "objective present". Its time is purely relational, like in eternalism. Any token gives to the variables under open quantification, the range it happens to remember. Beyond specifying an event's memory, there is no sense asking when it occurred.

It has no objective simultaneity concept either (but tolerates conventional ones, such as the cumulative hierarchy and the constructible hierarchy, while a more objective one may emerge at large time scales where anything could collect a memory of everything else). Like in Relativity, "independence or equality" is not transitive.

Indeed, how can any fact about the present, exist and then get destroyed ? More precisely from previous insights:

1. The ultimate understanding of what is happening in the present, can only be approached later, because it takes time;
2. Then, it should work without our present being the objective one anymore, if that made sense.
3. Therefore, our perceptions of "the present" should be understandable without an objective present.

Yet, the eternalistic concept of complete totality is rejected:

- A maximal geometric extension of space-time would only form a physical totality, not complete beyond physicalism;
- The definition of "totality" is taken by "the past"; any interpretation of it would create a future beyond it, showing its incompleteness.

The Seth material, such as (Roberts 1970; Roberts 1972: 117-118 & Ch. XVI), describes physical reality by combining CC with MW, where only some of the possible reality branches from MW get actualized by free will. An absolute simultaneity appears partly defined, leaving the question of its full definiteness unclear. Interstellar psychic travel, not limited by the speed of light, is likened to travel between reality branches. I will try clarifying things by an example.

Consider two planets A and B in different galaxies. At one point, the time line of A splits into two branches A_1 and A_2, while that of B doesn't (its other branches are independent of A, thus can be ignored). Then, simultaneity can relate a time t_B on B, a time t_1 on A_1 and a time t_2 on A_2, where t_1 and t_2 can be physically quite different. This way, simultaneity between two planets is relative to the choice of a reality branch on each (only having to stay space-like to belong a common reality, while "reference frames" are mere artifacts of mathematical formalization). This can be expressed in terms of an hyper-time along which reality grows, but forming a mere partial order, and inessential to the actual processes: subjective time can run "at different speeds" with respect to it, leaving such "speed" differences unnoticed.

Indeed, consider the twin paradox in Relativity. The physical time interval between events of separating and meeting again, differs between twins. Now, if subjective time experience is relativistic invariant (following physical time, not usable as a non-physical instrument to measure absolute speed or gravitational potential), then it cannot measure any interval of hyper-time from a given past event.

In an extreme case, imagine God working to create the Earth, expanding its space-time block in week days until Saturday. As Sunday comes, God takes a one day rest, then resumes work on Monday. People waking up then, will think it is Sunday, neither remembering the real Sunday, nor feeling the hyper-time gap which occurred then. Hence a new challenge to the meaning of "*This just happened*" : God might have already rested for one day since then, and we would not know.

Finally, let us seriously answer the epistemic objection by conceiving "the present" as a matter of focus. Generally, *focus* is a choice of specific memory with which an action is processed. For semantics, it is a

choice of ranges for the quantified variables.

So, "living in the present" is an act of focus on our "immediate past", from which some consecutive events will follow. There is no question of when that "immediate past" really occurred, nor when the results will follow, as hyper-time cannot be measured. It is just necessary that results will follow.

To question the "validity" of this experience, requires to re-interpret it. However, this interpretation is not a matter of reading simple words, but of restoring a focus on this experience, similar to its own original focus. Humans seem unable to do that. Now, for anyone with this power, this action can lead to 3 possible results, illustrated by different excerpts of the Seth material:

- A re-checking of what already occurred, is a remembering, but can also apply to someone else's life (Roberts 1972: 14).
- A non-physical reading creates a non-physical reality extension from that physical experience (Roberts 1972: 92);
- A different but still physical choice, gives birth to a new reality branch from the given event, parallel to what already occurred (Roberts 1972: 135-136).

Then, compared to generally possible conscious experience, physical life appears singular by its rule of "focus on the present", which seemingly forms a single time thread (a body's physical extension) by always perceiving "the immediate past" much stronger, while quantum decoherence turns different choices of measurement results into separate, physically non-interacting "reality branches".

8. Time Cannot Loop

In this framework, only two physically effective psychic time travel models appear acceptable : one, between differently aged co-existing reality branches; the other, by creating a new branch from a past event. Existing reality branches persist. In a worst case scenario (Roberts 1972: ch. XV) anticipating quantum immortality (Squires 1986), a civilization which destroyed its planet may "reincarnate" in a parallel reality where they avoid destruction.

Conscious ontology can depart from our linear time structure; mystical experiences of timelessness should be no surprise when most mathematicians keep an eternalistic view of mathematical reality. Yet, time loops locally similar to our time, or any memory loops, cannot occur:

- In mathematical logic, time loops contradict the well-foundedness condition needed for actions (recursion) to proceed;
- Conscious time loops would fall under the famous time travel paradox, of which the liar paradox is a particular case. This excludes worlds with time loops, called *Gödelian worlds*, from conscious actuality which requires an open future.
- The laws of physics themselves collapse under the time travel paradox; details with quantum physics are given below.

This does not affect quantum gravity, whose relevant time scales are not related with conscious times.

I will reply the challenge "*to offer an explanation of why a Gödelian world is not possible*" (Le Bihan 2014), by refuting arguments for its possibility.

Writing down Gödelian metrics does not prove their physical possibility, any better than writing inconsistent theories could prove the existence of incoherently described mathematical structures.

The big bang is our only example of space-time not visibly coming from a dynamical evolution. It came without time loop, and nothing suggests it could have been otherwise. So, to argue that a Gödelian region can appear, requires a dynamical creation scenario.

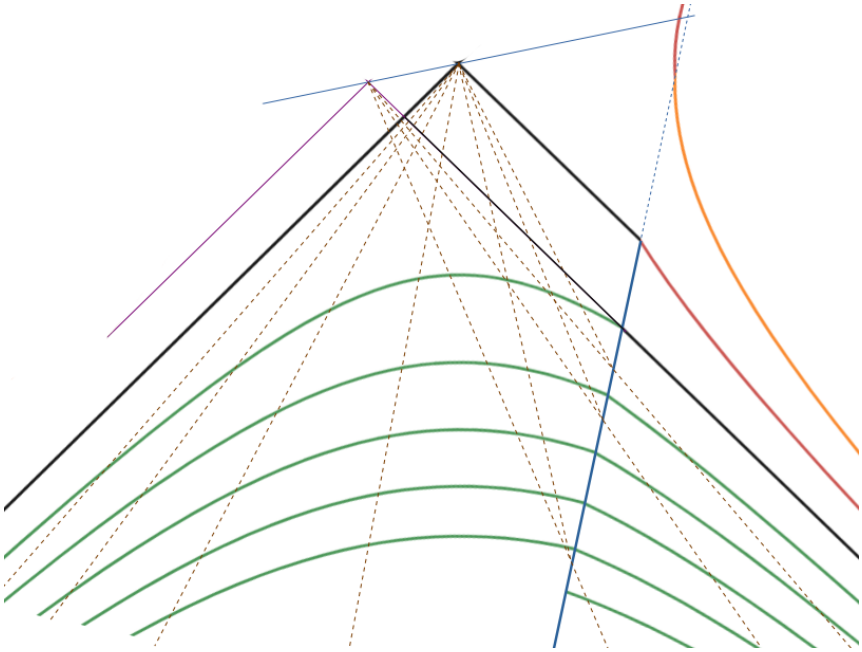
The main candidate scenario may be the collapse of matter into a rotating black hole. Precisely, in the

Kerr-Newman metric (Wikipedia) of a black hole, any time loop must meet one defined by ϕ being the only variable coordinate. This requires the coefficient of $d\phi^2$ in the metric to change sign, namely that $(r^2+a^2)(r^2+a^2\cos^2\theta) + a^2\sin^2\theta(rr_s-r_Q^2)$ turns negative. This only happens near the ring singularity ($r\simeq 0$, $\cos\theta\simeq 0$) with an electric charge ($r_Q\neq 0$). Then, the whole region below the inner event horizon would be Gödelian, as a time loop can be drawn from any point by first moving down to near the ring singularity, then following it (backwards to the rotation) until t decreases enough before going back up.

But, just expressing a metric satisfying the field equations, does not mean physical space-time will follow it. The stability condition for convergence to this solution breaks at the inner event horizon, where material density suddenly diverges (Carballo-Rubio et al. 2021 ; Hamilton 2018; Hamilton & McMaken 2021), forming a wall of infinite energy abruptly ending space-time.

Inside a black hole, the external time coordinate t locally acts as space. Local time is directed by the r coordinate (intuitively the altitude, as oblate spheroids with equation r=constant are roughly of size r), decreasing from r_H^+ at the outer horizon (no return limit), to r_H^- at the inner horizon which locally appears as 2 fronts (surfaces) coming at light speed from different directions, and colliding: the lower front ($r=r_H^-$, $t=-\infty$) usually called "ingoing", comes "from the bottom" ; the upper one ($r=r_H^-$, $t=+\infty$), or "outgoing", comes "from the top".

Objects falling to the upper front contribute to the increase of r_H^-; those falling to the lower front contribute to its decrease. By symmetry, both cases can be represented by the same figure.



Green lines represent r; their black asymptotes are the fronts; dotted lines represent t; the falling object is blue; red and orange hyperbola branches, outside space-time, illustrate the figure's geometry : the object shifts the fronts orthogonally to it.

Actually, the lower front is the concentrated appearance of the matter which formed the black hole all the way from its birth, precisely all the part of it which fell on its upper front, thus contributing to its current size ; similarly, the upper front is the concentrated view of all the matter which will later fall on its lower front. (As the figure shows, any matter coming from the side of t one is approaching, to any target, shrinks the delay to one's collision with remaining front layers, compared to the front's location defined from empty space.)

Crossing a material layer gives an impulse to collapse in both lateral dimensions. The figure shows it with roles reversed: the front meeting the object then starts a decrease of r before colliding the other front. The closer to light speed a layer in it goes, the more sudden it feels this decrease.

This collapse (decrease of r) goes on across the successive infinitesimal layers of the front made of the matter which fell at successive ages of the black hole's history, and which similarly got those values of r as decreasing fractions of their respective r_H^-, being shot at increasingly collapsed stages by the same process.

The inner horizon of a black hole newly formed from a collapsing star is roughly similar, with its "north upper" and "south upper" fronts colliding onto the equatorial plane like a balloon collapses to the shape of a pancake (interrupting an incomplete material collapse if $r_H^->0$). Seen from other ages, this "birth stage" layer in the lower front is followed by more layers, of matter coming from all ages from this birth to the end of t on the opposite hemisphere.

So, no chance appears to escape anywhere beyond that firewall; for the same reason, "wormholes" conceived as slightly modified black holes cannot be traversed, while those requiring huge negative masses are ruled out by thermodynamics in QFT. Finally, if nothing can reach a Gödelian region, then nothing can create one either.

9. Physical time and ontology

The above risk of mistake illustrates a genuine division of physics in two kinds (orthogonal to the GR/QM division) treating physical time differently, which appears natural if physical reality emerges from of a combination of consciousness and mathematics, and *physics* is its mathematical component:

- *dynamical physics* is the full physics with its time asymmetry coming from conscious time;
- *theoretical* (or *fundamental*) *physics* is its pure, time-symmetric mathematical core.

To explain the role of theoretical physics, think of Euclidean geometry as a toy model. Like any mathematical theory, its syntax is made of finite systems, and has time orders, such as that of any successive deductions of theorems from its axioms. Unlike arithmetic and set theory, its semantics lacks a genuine time structure, a fact usually seen as supporting eternalism.

Yet, its other features of continuous symmetries and actual infinity are seldom read metaphysically. Indeed, physics describes information as locally finite by mathematics with a continuous semantics, even for the smallest information unit (the qbit). This contradiction between mathematical and intended semantics is unsurprising when mathematically describing a reality with a non-mathematical ontology (type of existence with structured contingencies).

Consider a space-time region with a "past" side and a "future" side. To each side is given some *configuration space* representing the possible states of systems there, respectively called "initial states" and "final states". Then, theoretical physics defines a time symmetric correspondence between both. Each physical theory defines these "configuration space" and "correspondence" precisely.

Dynamical physics introduces a causal view of this correspondence, ignored by theoretical physics. It proceeds by picking an initial state, then computing its impact on the future side. A physicist doing this may be imitating a process from another layer of consciousness, by which perceptions create physical reality. Hence the practical match between physical and computational times, absent from theoretical physics.

The numerical analysis algorithms for dynamical physics usually appear much more complex and unnatural than the abstract expression of the theoretical physics so processed. Yet, they must exist, and let in principle any effect be related, at any accuracy level, to a finite lot of distinct causes (approximating states by finite amounts of information), for physics to play its role of defining the kind of causality laws needed to form a proper universe.

The dynamical treatment of General Relativity brings time asymmetries and irreversibilities absent from

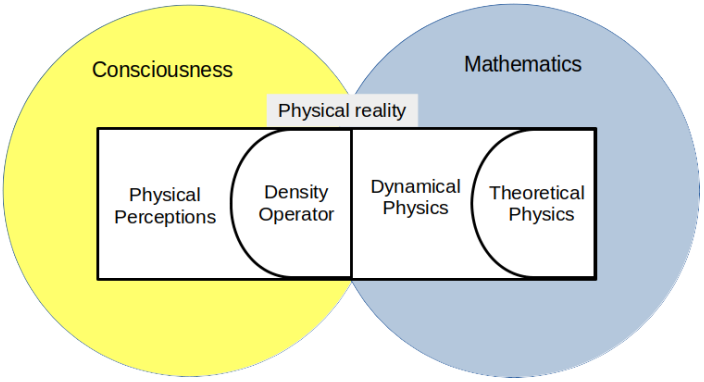
its main equations:

- Matter can collapse into black holes, but never spring out of them;
- Gravitational waves can be emitted but, in good approximation, never absorbed.

Quantum theory provides an evolution operator U mapping any initial state $|\psi\rangle$ to a final state $U|\psi\rangle$. From any initial state $|\psi\rangle$ and any final state $|\psi'\rangle$, it defines a number $p = |\langle\psi'|U|\psi\rangle|^2 \in [0,1]$. As p may depend on endlessly complex contexts, the continuity of its range [0,1] expresses the continuity of the semantics of quantum theory as a mathematical theory.

Then, its dynamical mode claims : "If the system was last found in initial state $|\psi\rangle$, the probably to find its final state as $|\psi'\rangle$ if measured in that sense is p". Here, the ambiguous and paradoxical concept of "probability" bridges the continuous and deterministic mathematical semantics of theoretical physics, to time asymmetric ontological claims of randomness for discrete physical possibilities, made effectively law-like (predictive) independently of actual mathematical infinities, by admitting computable approximations (while giving to computable facts a quantum complexity measure differing from classical complexity).

In a presence of time loops, quantum theory would respond (if it responds, which becomes questionable with a non-trivial first de Rham cohomology group, often involved by time loops, because of possible issues with gauge invariance when electric charges are allowed along such loops) by having the sum of its p over an exhaustive list of distinguishable final states, turn out to differ from 1 (on which it otherwise sticks), most likely with extremely low or large values. In clear, quantum theory ignores ontology, but a good ontology should exclude time loops in order for physical "probabilities" to be taken ontologically seriously (yet not too seriously as we shall explain).



The consciousness side of this metaphysics is known as *cosmic idealism* (Kastrup 2017 ; Chalmers 2017), specified with our GBT structure. Physical perceptions are a part of the block of conscious experience. A physical reality branch selected from these and abstracted from all other qualia than those felt by a Great Mathematician, defines a physical state (density operator). New perceptions update it as "wavefunction collapse", taking foot among the times of quantum decoherence (aspect of entropy creation) which *emerge* by quantum thermodynamics, only vaguely following physical times.

This ability of consciousness to collapse physical states, is no more mysterious than the possibility for these mathematical objects to exist beyond mathematics, as objects of perceptions. Both acts of perceiving and updating physical states (mathematical shadows of blocks of perceptions) are the same, and the chicken and the egg of each other.

This CC version uses MW as its zombie world. The claimed failure of the zombie argument (Mohammadian 2021) vanishes since "collapse does not occur" and "collapse occurs uncaused" respectively expressing the "bare theory" and "branching" descriptions of MW, do not differ empirically. The concept of "physical difference" makes no sense by lack of a physical substance, whose role is played by mathematical objects under conscious focus, and "collapse" only makes a subjective difference by moving the focus.

Finally, the physical can be understood as having a conceptual nature : mathematical concepts of timeless continuous systems and symmetries, induce formal evolution rules for discrete and time ordered physical states. Actually in mathematical reality, syntax and semantics are on par: the syntax may explain the semantics as well as the other way round.

This resembles the role of set theory as a source of truths on arithmetic. The criterion of set theoretical provability for the truth of arithmetical formulas, can be expressed as an algorithm, which will look complex and arbitrary. Then, to validate this algorithm as a genuine truth criterion, namely to believe the formulas so checked, involves making sense of set theory with its concepts of infinity.

10. The physical place for free will

Our last two sections will examine the lack of proper reason for the unpopularity of CC (Arroyo 2020: ch.6). The only good excuse (Arroyo 2022: 3.2.3), is the lack of a famous clear and suitable expression of CC to argue about.

"*...philosophers reject interactionism on largely physical grounds... while physicists reject an interactionist interpretation of QM on largely philosophical grounds... This sort of interpretation needs to be formulated in detail to be assessed... Only Stapp goes into much detail, with an interesting but somewhat idiosyncratic account*" (Chalmers 2003: pp.31-32)

Kastrup (2017 & 2019) gave good arguments for CC, as recognized by (Sepetyi 2018), who still could not see the advantages of cosmic idealism, left unclear by Kastrup's tentative expression in another article.

The decoherence pre-condition for collapse, defended here, only appears elsewhere as implied by different interpretations : London & Bauer's "Consciousness recognizes the collapse" (Arroyo 2020: ch.7); "single-mind" and "many-minds" in (Barrett 2006) which supports these with strong arguments (ignored in Barrett's later article, maybe due to the oddity of such Mind Makes No Collapse interpretations).

It leaves "random outcomes" as the only avatar of free will by ruling out the role of other quantum effects. This non-literal reading of "randomness" is considered by some authors (Durieux 2021) and micro-PK experimentalists (Burns 2012), but leaves others shy or doubtful (Runyan 2018; Stapp).

Specialists in quantum foundations usually focus on physicalist interpretations, all known to have heavy troubles: each one's relative plausibility relies on the implausibility of others (Wallace 2007; Callender 2018). This would logically lead to reject physicalism and accept CC as the only plausible interpretation, if only it looked clear.

The philosophical consensus stays disconnected from modern science, either dreaming of quantum gravity, or exploiting the artifacts of non-relativistic QM as basis for metaphysical debates, leaving to future physicists the subordinate task of extending to QFT the validity of this non-relativistic discourse.

Remaining debaters about CC are even more direly left to float free from science and reason: aside caricatural trends of academic philosophy (Callender 2011b; Bryant 2020), flaws remain pervasive, when calling "arguments":

- For physicalism, some mindless proclamations of physicalist tenets like "causal closure" (refuted by QM) or "exclusion argument" (as if the exact causes of any effect always had to be clear);
- Against libertarianism, the humor of physicalists who stole this label and cannot defend it (Moore 2021), criticized by (Duncan 2011);
- Against CC, a presumed lack of observers during the Big Bang (as if they needed a biological basis), a challenge to tell if any ghost could observe stuff in our absence, and the failure of QM to fit the physicalistic intelligibility requirement to be worth taking seriously (Sepetyi 2018).

CC is known as the only interpretation whose main trouble is that other interpretations disagree with it: «*"Is this uncertainty ontological or epistemic?" The problem is that, absent an interpretation of quantum*

mechanics, there is no way of answering this question. This objection is devastating...» (De Caro & Putnam 2020) who then reduce the analysis to those two interpretations (HV and OC) rejected by physicists.

Some philosophers even try to justify their infamous (Arenhart 2019) "floating free from physics" (Arroyo & Arenhart 2020):

1. Physics equations do not literally dictate their metaphysics, for which each trivial deduction should give jobs to philosophers;
2. Our metaphysical literature is so great, it deserves writing many pages before excusing an interpretation of QM from the lack of famous thesis perfectly matching it (Arroyo 2020: ch.8);
3. This literature floats free from science;
4. Philosophers are jealous of mathematicians doing valid research in their bubble.

Once 2. is rejected, facts 3. and 4. miss a legitimacy.

Discussions on topics like free will or Hempel's dilemma, stay hopeless by not clarifying if expected substances, structures, properties, laws, ontologies or explanations are meant to be mathematical (either finite or infinite), or how they articulate with such (as if disbelief in mathematical Platonism could excuse this silence).

The vacuity of usual physicalist arguments is widely recognized (Diley 2004; Lycan 2009; Rodrigues 2014; Smythe 2017; Goetz 2021; Bennett 2021). Some physicalists like Bennett here, challenge spiritualists to describe minds like physical systems, by any mathematical laws or quasi-mathematical forms of understanding suitable to their brain. Some spiritualists have the weakness of endorsing that duty (Hoffman 2018; Chalmers 2021), missing the spiritualism which answers "Can you mathematically describe consciousness" by "No". As we saw, this answer does not prevent understanding and investigation.

Many scientists in the debate don't understand QM. The widely referenced claimed experimental refutation of CC is ridiculous nonsense (Reason 2017).

According to engineers Malozemoff & Mroczkowski (2019), "*quantum collapse is now understood to be able to occur without a conscious human observer*". Indeed, conscious animal or ghost observers should suffice (hardly anyone sees afterlife as an exclusivity of humans). Seriously, they present OC as the generally accepted understanding of physicists, though OC is neither widely accepted, nor anyhow understood by lack of a QFT version. They misrepresent science in other ways (van Lommel 2019).

Vervoort (2020) argues "*the possibility of an immaterial substance choosing among quantum states—contradicts one of the most fundamental laws of nature, namely the energy conservation principle*". Now, if this law is fatal to any interpretation violating it, then the dead one is OC, leaving after-decoherence CC safe with less competition. He first insisted that "Spike currents are constituted of the combination of many thousands of (...) ionic currents [which are] stochastic" (2.1), which "corresponds to classical randomness... *usually seen as deriving from deterministic, even if unpredictable, processes*."(2.4)

This widespread misconception of thermal randomness has both historical and philosophical roots : Statistical Mechanics (SM) was first expressed by Boltzmann on classical foundations (BSM), later superseded by Gibb's approach (GSM), but kept as the reference by philosophers protecting their physicalism from the challenges of modern physics, by a *Good Bye, Lenin!* attitude to the quantum revolution.

For example, Anta (2021) who "*Due to extension reasons...will focus exclusively on classical statistical mechanics, and not on its quantum counterpart*" (footnote 1), presents SM as "*a counterexample to Hempel's symmetry thesis, where the predictive capacity of a theory is directly correlated with its explanatory potential*", so as "*to understand in depth why* [GSM] *is hegemonic within real predictive*

practices... and [BSM] *is constantly claimed in philosophical domains... for its conceptual coherence in providing explanations*" (p. 418), like the highly predictive parents-giving theory of Christmas presents is hegemonic among adults, while children prefer the more powerful Santa Claus explanation:

«*...GSM descriptions ... have no explanatory capacity regarding equilibration, a fact agreed in the SM community... In Wallace's words: "...the Boltzmannian offers the true explanation of the success of statistical mechanics*"» (p.410)

Here, Wallace (2020) was expressing the misconception he meant to refute, not only tediously in that article "*under the (of course false) assumption that the underlying microphysics is classical mechanics... to make contact with the contemporary literature rather than out of a belief that quantum theory is irrelevant here*", but also radically based on QM, briefly "*at the end (section 12)*", and more fully in his previous article (2016b) showing that "*statistical-mechanical probabilities reduce entirely to quantum-mechanical ones*".

So, Gibbs distributions come as the limits of quantum states (the real microstates) in the SM classical limit of QM; the meaning of their probabilistic syntax is a matter of interpreting QM. Standard interpretations (Copenhagen, MW, Qbism, CC) give GSM as their classical limits. Others (HV, OC...) don't, but still cannot match BSM anyway.

Considering an SM system with a detector giving some random output, let us compare diverse interpretations. In standard QM interpretations, this output is created by measurement.

In BSM, it is extracted from an infinite pool of pre-existing data : the decimals of coordinates of the initial configuration. So, this output will be as truly random as this data pool was, and more precisely an absolute mystery by lack of any law specifying where this pool might come from. This big question mark stands as the usual definition of "determinism". Yet, authors exist who question this definition and explore other interpretations of classical SM (Del Santo 2020).

Another conceivable interpretation of SM consists in a computer simulation of a supposedly isolated system. The computer's memory limits will let random outputs become pseudo-random after a while. This interpretation has two unrealistic aspects: its coarse-graining forms an empirically unsupported asymmetry; and natural systems are not isolated. A more realistic simulation requires infinitely many computers working in parallel to describe respective regions in the universe. Finally, the output will be as random as its source: the infinite pool of initial data distributed across this infinity of computers, that is precisely a total mystery by lack of any law specifying it.

Like with QM, all such interpretations of SM are empirically equivalent. Thus, experimentalists could pick any interpretation, including a big question mark, to succeed. Yet, troubles come when proclaiming that they got the right metaphysics by Hempel's symmetry, while they did not start analyzing and comparing interpretations in the light of QM.

The brain's chaotic evolution f from states x defined near Heisenberg inequalities scales, through thermal fluctuations, up to macro-outcomes $y=f(x)$ microseconds later or so (Neunhäuserer 2010), transforms the (quite dispersed) quantum probability law for x, into a classical probability law for y. The CC interpretation I consider, sees y coming so undetermined, then its value directly picked by perception among not too unlikely possibilities, ignoring the details of x and f it may come from.

This clear but seldom recognized possibility, leaves comparatively unattractive other mind/brain quantum links proposals, usually involving quantum coherence, which moreover lack empirical support (Sánchez-Cañizares). Beyond the fascinating mysteriousness of QM for those lacking expertise, these may be of two kinds. The ones see mind as a quantum computation, as if this substantially differed from classical ones; but complexity measures are the only real difference. Others like Stapp expect quantum interference terms to serve as targets of perceptions by the projection postulate; but this cannot rival the impact of a

direct choice of measurement result.

Thus, neurologists should take GSM as a foundation, to search for the expression of free will in its probabilistic predictions, these being the main form of quantum probabilities relevant for biology. This interpretation of GSM is unpopular, as its classical probabilistic formal structure (of mainly deterministic evolution of random states) suggests a classical realistic interpretation.

A probabilistic theory like GSM being mathematical, poorly represents, and cannot explain or generate, an ontological semantics of potential or actual randomness, which is a conscious experience. Such an interpretation requires pareidolia by a conscious reader, and careful comparative likeliness analysis. While admitting this substantial divide, (Epperson 2009) still claimed the randomness semantics was dictated by the probabilistic syntax (decoherence makes collapse). This assuming physicalism, sounds as if the existence of stories encoded in the decimals of π ensured their reality without the help of any conscious reader. Now, this "decoherence interpretation" is generally rejected, since the emergent and ambiguous nature of decoherence makes a systematic collapse by decoherence inexpressible as a mathematical law (Romano 2021; Sánchez-Cañizares).

Concerns for "realism" drives many philosophers and experimentalists towards non-standard interpretations. Presuming this to be a purely philosophical matter in their hands, they fail to see what else than raw instrumentalism and poor philosophy could be pushing physicists to standard ones instead.

Yet, they may be projecting onto these their own instrumentalist view of mathematics: the philosophy gazed from the grand book written in mathematical language (Galileo; Woit: blog articles), could actually confirm the need to "shut up" and "investigate [the world] *without* defining it!" (Feynman 1999), i.e. without prejudices, to avoid wandering about in dark labyrinths of hopeless research, or vain disputes in philosophical circles playing with labels of "scientific realism" offset from the real intellectual adventure of modern science.

Indeed the following briefly summed up mathematical hints may have been overlooked, even by some physicists whose physicalistic expectations could have overwhelmed, in their mind, the actual voice of Nature.

As mathematical theories, statistical equilibrium and QFT only differ by replacing real exponentials with complex ones (McCoy, B.M. 1994). Yet, no ontological semantics can be carried by this correspondence either way (Fraser 2020). This illustrates how mathematical theories involved in physics are coming without ontological semantics attached.

Quantum thermodynamics (QSM, with unitary evolution and entanglement) only differs from its classical limit (GSM, with Markov chains and correlations), by relaxing some inequalities, such as Bell's inequalities. This difference prevents the possibility of a "realistic" explanation by the classical SM ontology initially expected by physicalists.

The classical view of probabilities starts with a set S of "possibilities". Then, a probability law $p:S\to[0,1]$ is mathematically constructed over it. Finally, an event affected by p gives existence to a single element $x\in S$, and makes p obsolete. But the existence of S before its element x is illogical.

QSM cleans this classical SM picture by removing S : first comes a density operator p; then random events x may follow in the GSM limit of future physical times, but in unclear circumstances by lack of a specific S.

Supporters of non-standard interpretations dislike this. They want to mathematically rebuild some S, and cannot admit how far-fetched it is. The classical picture being basically missing, this reconstruction

requires an unnatural reinterpretation of *p* as a probability law over *S*. The coincidence (hiding the random source) between the primitive quasi-probabilistic properties of *p* and its reconstructed probabilistic role, would be a kind of miracle or conspiracy; the extreme case of superdeterminism has been dubbed "conspiracy theories" (Lewis 2006 ; Chen 2020).

Only CC can naturally explain random events *x* (without *S*), as results of conscious acts of interpretation of probabilities computed from the given memory (physical state).

Still, how could philosophers ignore the philosophical nonsense of fundamental probabilistic laws (unless probabilities were fractions, with denominator the number of branching realities from that event, while leaving no way to control branching numbers...) ? Already, the concept of absolute randomness is verificationally unclear (Barrett & Huttegger 2020). Probabilistic laws being shown fundamental for physics by mathematical insights, their metaphysical nonsense then suggests to dismiss the primitiveness of physics itself, and trace its "randomness" to a non-physical source.

Now, the consensus for the necessary acceptance of absolute randomness as evidence against free will in CC, is rivaled by the popularity of its necessary rejection as an argument for HV: in its name, random outputs described by standard QM as created in some nowhere located near measurement events, need an explanation as extracted from some pre-existing infinite random data pool (decimals of hidden variables) fancied from nowhere (without empirical or mathematical guidance), located really nowhere (fully non-local), and created at no time (to save its randomness from the label of indeterminism), namely at the birth of the universe where the breakdown of physics removes the need to explain the origin and meaningfulness of this deterministic fundamental randomness. It may not be hard to fill this pool with the decimals of π or a Chaitin constant, but it would still increase this picture's under-determined complexity.

11. A Bayesian check for metaphysics

Admittedly, physics is not killing people's freedom to believe that free will does not exist if they really want to, insensitive as they may be to any less than trivially absolute evidence from a mathematical physics foreign to their minds. Philosophers appear unclear with arguments, skeptically reviewing buzzwords like "simplicity" given their own failures misapplying such criteria.

Let us complete our initial questions list (*X*= time theory, *Y*= full laws) with:

H= fundamental substances list, selected from candidates : two understandable ones (consciousness and mathematics); some mysterious other, "physical" or anyhow "neutral".

Z= visible laws, with answer QM+RG. Generally, either *Y*=*Z*, or *Y* completes *Z* by hidden details.

Assessing the likeliness of answers involves studying their links, which needs to start by picturing their expected causal order.

The randomness argument against free will seems to treat *Y* as caused by *Z*. Similarly, the causal closure argument seems to treat *H* as causally affected by *Y*. Such causalities would look very strange. Now, if *H* comes as a primitive independent fact, which then drives its likeliness-ordered list of possible *Y*, from which *Z* is finally extracted, then neither argument seems logical anymore.

Bayesian inference allows to assess the posterior probability $P(H|E)$ of an hypothesis *H* coming as a cause of a known fact (evidence) *E*, as proportional to $P(E|H).P(H)$, where the prior probability $P(H)$ of *H* is a matter of taste, and arguments should focus on assessing the probability $P(E|H)$ of *E* given *H*.

Our findings on the ontological structures (*X*) of mathematics and consciousness, coincide with the expectable picture if both are primitive: they are similar but independent. Physics confirms this by providing theoretical physics as a no time's land between them (its "time" not being ontological).

It seems hard to choose a *H* without consciousness, with either the mathematical, the physical or both, and to explain their difference. Mathematical Platonism seems hardly resistible, both a priori (Duncan 2014), and a posteriori by the indispensability argument (Schneider 2017), given the high-level style of mathematics involved in theoretical physics (Woit 2015).

Since physical structures appear contained by mathematical ones, a mathematical monism can be tried. Our world would then appear as an emerging tower of multiple ontological concepts with different structures over the same substance. On top of the mysteriously downplayed set theoretical ontology, the physical would emerge first, then generate the strangely prominent conscious ontology over finite mathematical systems. Brain states being finitely complex like any local physical state, can in principle be encoded as natural numbers. Then, morality consists in giving conscious existence to more happy numbers than sad ones.

But, starting with a pure concept of physical or mathematical reality, how natural and plausible would be the spontaneous emergence of this ontological tower ?

In science, simplicity criteria usually either compare well-understood theories, or favor clearer ones. There is no simplification in reducing the number of primitive elements while moving difficulties into their postulated outcomes, fancied as needed to match empirical facts (the presence and value of consciousness), when the possibility of such outcomes is not intelligible. It would be like answering "why is the world like this" by "God wanted it so" without understanding God's motives but assuming this to be the simple case just because the world happens to be in this familiar way; expecting a future scientific elucidation helps no better than prophesying a coming Revelation.

The *Z* evidence is famously puzzling for physicalism. It complicates this ontological tower by dividing the physical into 3 kinds: the structures of theoretical physics, of dynamical physics (quantum states), and any fancied solution to the measurement problem (which for MW is how to make sense of Born's rule).

While the former two exhaust the physicists' physics, which accounts for all known empirical facts of physics, Allori (2016) argues that only the latter (some unrelated, free range "physics" designed by philosophers to be "compatible with scientific realism") should be taken to "represent matter" ("microscopic reality"), to avoid the "need to invoke a paradigm shift, or a quantum revolution". The form of this "matter" remains undetermined once required to be "defined in three-dimensional space" and ensure a "continuity between quantum and classical theories", supposedly helpful to "derive the properties of macroscopic objects in terms of their microscopic constituents".

The realistic motivations for this requirement look unclear if macroscopic appearances are cerebral reconstructions ("illusions") from abstract nervous data, through effective processes of standard physics. Nevertheless, she believes "the difficulties are technical rather than conceptual" for this mysterious "matter" to explain classical appearances, "in contrast with the alternative approaches" from the quantum state.

Now, if "matter" is so disconnected from effective physics, can any principle prevent processing thoughts from effective but "non-material" components of physical reality, or how real would such thoughts be ? Could our thoughts already be working that way, considering the lack of material dynamism in our brains ?

Spiritualism appears favored by Bayesian inference from *Z* :

"*In fact, one might argue that if one was to design elegant laws of physics that allow a role for the conscious mind, one could not do much better than the bipartite dynamics of standard quantum*

mechanics: one principle governing deterministic evolution in normal cases, and one principle governing nondeterministic evolution in special situations that have a prima facie link to the mental." (Chalmers 2003: 9, p.31)

To argue otherwise, requires to invent laws fitting better than QM all the needs for comfortable mind-matter interactions. Quantum macro-coherence would not be better. The famous "interaction problem" proceeds in the opposite way, defeating its claimed conclusion.

Precisely, if consciousness escapes mathematics, then mathematical laws for physics must provide clothes for the causal influence of "what cannot be described", either in choice of outcome or in time of intervention. Therefore, the literal muteness of physics about the source of measurement outcomes, is itself, on another level, the clearest expectable message, by its way of perfectly matching this requirement.

The one worthy objection I foresee, is to ask : under spiritualism, why does reality need to appear physical, following any mathematical law ? The answer, from spiritual sources, is that it doesn't : as big as our universe is, even with multiple reality branches, it is neither the first nor the main kind of reality system created by consciousness. As any individual is special, any reality system can also be special. Ours is special by its physical appearance, providing a kind of experience not found in other reality systems. But, it only needs to seem physical in practice; it neither needs nor happens to keep looking so all the way down under detailed analysis.

References

Allori, Valia (2016), "Primitive Ontology and the Classical World" In R. Kastner, J. Jeknic-Dugic & G. Jaroszkiewicz (eds.), *Quantum Structural Studies: Classical Emergence from the Quantum Level*. World Scientific. pp. 175-199, <https://philpapers.org/rec/ALLPOA-3>

Anta, J. (2021). "The epistemic schism of statistical mechanics". *THEORIA. An International Journal for Theory, History and Foundations of Science*, *36*(3), 399–419. <https://doi.org/10.1387/theoria.22134>

Arenhart, Jonas R. Becker (2019), "Bridging the Gap Between Science and Metaphysics, with a Little Help from Quantum Mechanics", *Proceedings of the 3rd Filomena Workshop* / João Daniel Dantas, Evelyn Erickson, Sanderson Molick (editores). – Natal: PPGFIL, 2019. ISBN: 978-85-66377-10-1. <https://philarchive.org/archive/ROCTSC>

Arroyo, Raoni Wohnrath (2020), "Discussions on physics, metaphysics and metametaphysics: Interpreting quantum mechanics", PhD thesis. <https://repositorio.ufsc.br/handle/123456789/216278>

Arroyo, Raoni Wohnrath & Arenhart, Jonas R. Becker (2020), "Floating free from physics: the metaphysics of quantum mechanics", <https://arxiv.org/abs/2012.05822>

Arroyo, Raoni Wohnrath (2022), "Consciousness and quantum mechanics: a philosophical approach". In Portuguese. To be published at NEL/UFSC. <arXiv:2201.09663>

Barrett, Jeffrey A. (2006), "A quantum mechanical argument for mind–body dualism", *Erkenntnis*, 65(1): 97-115, <http://www.socsci.uci.edu/~jabarret/bio/publications/quantum%20argument%20for%20dualism.pdf>

Barrett, Jeffrey A. (2018), "Everett's Relative-State Formulation of Quantum Mechanics", *Stanford Encyclopedia of Philosophy*, <https://plato.stanford.edu/entries/qm-everett/>

Barrett, Jeffrey A. & Huttegger, Simon (2020) "Quantum Randomness and Underdetermination" [Preprint] <http://philsci-archive.pitt.edu/16905/>

Bennett, Karen (2021), "Why I am not a dualist", *Oxford Studies in Philosophy of Mind* Volume 1,

<https://philpapers.org/rec/BENWIA>

Briggs, Rachael & Forbes, Graeme A (2012), "The Real Truth about the Unreal Future". *Oxford Studies in Metaphysics*, 7. <https://philpapers.org/rec/BRITRT-2> (The Real Truth About the Unreal Future, 2011)

Briggs, Rachael & Forbes, Graeme A (2017), "The Growing-Block: just one thing after another?", *Philosophical Studies* 174 (4):927-943,<https://kar.kent.ac.uk/55844/>

Bryant, Amanda (2020), "Keep the chickens cooped: the epistemic inadequacy of free range metaphysics", *Synthese* 197 (5):1867-1887, <https://philpapers.org/rec/BRYKTC-2>

Burns, Jean E. (2012), "The Action of Consciousness and the Uncertainty Principle", *Journal of Nonlocality* 1 (1), <https://journals.sfu.ca/jnonlocality/index.php/jnonlocality/article/view/9>

Callender, Craig (2011a), "Time's Ontic Voltage", in *Adrian Bardon (ed.), The future of the philosophy of time. London, UK: Routledge.* pp. 73-94, <https://www.craigcallender.com/publications>

--- (2011b), "Philosophy of Science and Metaphysics", *The Bloomsbury Companion to the Philosophy of Science*, French and Saatsi, <https://www.craigcallender.com/publications>

--- (2018),"Can We Quarantine the Quantum Blight?", *Scientific Realism and the Quantum* (OUP), 2020, edited by Saatsi and French. <http://philsci-archive.pitt.edu/15450/>

Carballo-Rubio et al., "Inner horizon instability and the unstable cores of regular black holes", *Journal of High Energy Physics* 2021(5), <https://arxiv.org/abs/2101.05006>

Chalmers, D. (2003), "Consciousness and its place in nature". In Stephen P. Stich & Ted A. Warfield (eds.), *Blackwell Guide to the Philosophy of Mind*. Blackwell. pp. 102--142 <http://consc.net/papers/nature.pdf>

--- (2017), "Idealism and the Mind-Body Problem", in (W. Seager, ed.) *The Routledge Handbook to Panpsychism* (Routledge, 2018), <https://philpapers.org/rec/CHAIAT-11>

Chalmers, D. & McQueen, Kelvin J. (2021), "Consciousness and the Collapse of the Wave Function", Forthcoming in (S. Gao, ed.) *Consciousness and Quantum Mechanics* (Oxford University Press), arXiv:2105.02314 [quant-ph].

Chen, Eddy Keming (2020) "Bell's Theorem, Quantum Probabilities, and Superdeterminism", *Eleanor Knox and Alastair Wilson (eds.), The Routledge Companion to the Philosophy of Physics*, <arXiv:2006.08609>

De Caro, Mario & Putnam, Hilary (2020), "Free Will and Quantum Mechanics", *The Monist*, Volume 103, Issue 4, Pages 415–426, doi: 10.1093/monist/onaa014 ,<https://www.researchgate.net/publication/346737990>

Del Santo, Flavio (2020), "Indeterminism, causality and information: Has physics ever been deterministic?", arXiv:2003.07411 [physics.hist-ph]

Dilley, Frank B. (2004), "Taking consciousness seriously: A defense of Cartesian dualism", *International Journal for Philosophy of Religion* 55:135–153, Kluwer Academic Publishers. <https://philpapers.org/rec/DILTCS>

Duncan, Steven M. (2011), "Determinism and Luck", <https://philpapers.org/rec/DUNDAL>

--- (2014) "Platonism by the Numbers", <https://philarchive.org/rec/DUNPBT>

Durieux, Jude Arnout (2021), "Freedom in a physical world", <https://philarchive.org/rec/DURFIA>

Epperson, Michael (2009), "Quantum Mechanics and Relational Realism: Logical Causality and Wave

Function Collapse", *Process studies* 38 (2): 340–367. <https://scholarlypublishingcollective.org/uip/ps/article/38/2/340/212404>

Everett, Hugh (1957), «"Relative state" formulation of quantum mechanics», *Reviews of Modern Physics* 29 (3):454--462, <http://www.weylmann.com/relative_state.pdf>

Feynman, R. (1999), *The Pleasure of Finding Things Out* ch.9 (interview by Omni), Perseus Books.

Fraser, Doreen (2020) "The Development of Renormalization Group Methods for Particle Physics: Formal Analogies Between Classical Statistical Mechanics and Quantum Field Theory". *Synthese* 197 (7):3027-3063. <https://philpapers.org/rec/FRATDO-31>

Galileo (1623), *The Assayer*.

Goetz, Stewart (2021), "Libertarian Free Will, Naturalism, and Science", *Journal of Philosophical Theological Research*, <http://pfk.qom.ac.ir/article_2034.html>

Hamilton, Andrew J. S. (2018), "Towards a general description of the interior structure of rotating black holes", arXiv:1108.3512 [gr-qc]

Hamilton, Andrew J. S. & McMaken, Tyler (2021), "Geometry near the inner horizon of a rotating, accreting black hole", *Phys. Rev.* D 103, 084014, arXiv:2102.10402

Hoffman, D.D. et al (2018), "Conscious agents networks: Formal analysis and application to cognition". *Cognitive Systems Research*, 47, 186-213. <https://www.cogsci.uci.edu/~ddhoff/CA-circuits-CSR-rev.pdf>

Kastrup, B. (2017), "On the Plausibility of Idealism: Refuting Criticisms", *Disputatio* 9 (44):13-34, <https://philpapers.org/rec/KASOTP-3>

--- (2019), «Reasonable Inferences From Quantum Mechanics: A Response to “Quantum Misuse in Psychic Literature”», *Journal of Near-Death Studies*, 37(3), <https://philarchive.org/rec/KASRIF>

Le Bihan, Baptiste (2014), "No-Futurism and Metaphysical Contingentism", *Axiomathes* 24 (4):483-497, <https://philpapers.org/rec/LEBNAM>

Lewis, Peter J. (2006), "Conspiracy Theories of Quantum Mechanics", *The British Journal for the Philosophy of Science*, Vol. 57, Nr 2, <http://philsci-archive.pitt.edu/2651/>

Loss, Roberto (2019) "No Ground for Doomsday". *Inquiry: An Interdisciplinary Journal of Philosophy* 62 (9-10):1136-1156. <https://philpapers.org/rec/LOSNGF>

Lycan, William G. (2009), "Giving Dualism its Due", *Australasian Journal of Philosophy*, 87:4, 551-563, DOI: 10.1080/00048400802340642

Malozemoff, Alexis P. & Mroczkowski, Jack A. (2019), "Quantum Misuse in Psychic Literature: A Rejoinder" (abstract), *Journal of Near-Death Studies*, Volume 37, Number 3, Spring 2019; University of North Texas Libraries, UNT Digital Library, Durham, North Carolina. <https://digital.library.unt.edu/ark:/67531/metadc1752581/>

McCoy, Barry M. (1994), "The Connection Between Statistical Mechanics and Quantum Field Theory", arXiv:hep-th/9403084

McQueen (2015), Kelvin J., "Four Tails Problems for Dynamical Collapse Theories", *Studies in the History and Philosophy of Modern Physics* 49:10-18, arXiv:1501.05778 [quant-ph]

Merricks, Trenton (2006), "Good-Bye Growing Block”, *Oxford Studies in Metaphysics* (vol. 2, Oxford University Press), <https://www.trentonmerricks.com/public/publications/Growing-Block.pdf>

Mohammadian, M (2021), "If Consciousness Causes Collapse, the Zombie Argument Fails", *Synthese*

199, 1599–1615 (2021), <https://philpapers.org/rec/MOHICC>

Moore (2021), D. "Libertarian Free Will and the Physical Indeterminism Luck Objection". *Philosophia*. https://doi.org/10.1007/s11406-021-00370-2, <https://philpapers.org/rec/MOOLFW>

Myrvold, Wayne C. (2018) "Ontology for Collapse Theories", in Shan Gao, ed., *The Collapse of the Wave Function* (Cambridge University Press, 2018), 97–123. <http://philsci-archive.pitt.edu/13318/>

Neunhäuserer, J. (2010), "Dynamics, Quantum mechanics and the Indeterminism of nature", <https://philpapers.org/rec/NEUDQM>)

Reason, Catherine M (2017), "Comment on the paper Quantum mechanics needs no consciousness by Yu and Nikolic (2011)", arXiv:1707.01346 [quant-ph]

Roberts, Jane (1970). *The Seth Material* (ch. 18, or Early Sessions book 9, sessions 426-427). Reprinted, 2001 by New Awareness Network. Quoted at <settheory.net/seth-creation>.

-- (1972), *Seth Speaks: The Eternal Validity of the Soul*. Amber-Allen Publishing (reprinted 1994), <https://stormwolfwords.files.wordpress.com/2014/05/seth-speaks.pdf>

--- (1979). *The Nature of the Psyche: Its Human Expression*. Prentice-Hall, Amber-Allen Publishing (Reprinted 1996), Session 797: "Your universe...beside the point", <http://lukaali.com/seth/THE%20NATURE%20OF%20THE%20PSYCHE.html>.

Rodrigues, José Gusmão (2014), "There are no good objections to substance dualism". *Philosophy*, 89, Issue 2, pp. 199-222 doi:10.1017/S0031819114000060

Romano, Davide (2021), "The Unreasonable Effectiveness of Decoherence", *Quantum Mechanics and Fundamentality* (V. Allori, ed.), *Synthese Library*. <http://philsci-archive.pitt.edu/19125/>

Runyan, Jason D. (2018), "Agent--causal libertarianism, statistical neural laws and wild coincidences", *Synthese* 195 (10):4563-4580 <https://philarchive.org/rec/RUNALS>

Sánchez-Cañizares, Javier (2014), "The Mind-Brain Problem and the Measurement Paradox of Quantum Mechanics: Should We Disentangle Them?" (removed from: *NeuroQuantology* 2014, Vol. 12, 1: 76-95), <https://www.researchgate.net/publication/262104515>; short version: "Is Quantum Physics Relevant for the Mind-Brain Problem?" (2015), <https://www.researchgate.net/publication/286623445>

Schneider, Susan (2017) "Does the Mathematical Nature of Physics Undermine Physicalism?" *Journal of Consciousness Studies*, 24, (9–10):7-39.

Sepetyi, Dmytro (2018), "Quantum Mechanics and Consciousness: No Evidence for Idealism", ISSN 2522-9338. *Філософська думка*, 2018, № 4, <https://www.researchgate.net/publication/327594187_Quantum_Mechanics_and_Consciousness_No_Evidence_for_Idealism>

Smythe, T. W. (2017). "Defending Dualism". *Advances in Social Sciences Research Journal*, 4(7) 51-58. DoI:10.14738/assrj.47.2964.

Soltau, Andrew (2009), "Times two: The tenses of linear and collapse dynamics in relational quantum mechanics", <https://philpapers.org/rec/SOLTTT>

--- (2010), "logical types in quantum mechanics", <http://philsci-archive.pitt.edu/5554/>

--- (2018), "The Quantum-Mechanical Frame of Reference Part 2: Logical Type in Time Evolution" sections 6-8, DOI:10.13140/RG.2.2.10990.87363, <https://www.researchgate.net/publication/330016514>

Squires, Euan (1986). *The Mystery of the Quantum World*. Hilger. pp. 72–73.

Sundberg, Christian, "PRE-BIRTH EXPERIENCE: Life Before Birth, The Spirit of God, Choice & The Veil" from 13:03, *Passion Harvest* Youtube channel, Mar 13, 2021, <youtu.be/sEYvYX7Tcmk&t=783s>

van Lommel, P. (2019), «Quantum Physics as Analogy: A Response to “Quantum Misuse in Psychic Literature”»; *Journal of Near-Death Studies*, 37(3); 174-184, <https://pimvanlommel.nl/wp-content/uploads/2020/11/Quantum-Physics-as-Analogy-response-article-JNDS-2019.pdf>

Vervoort, L., & Blusiewicz, T. (2020). "Free will and (in)determinism in the brain: a case for naturalized philosophy". *THEORIA. An International Journal for Theory, History and Foundations of Science*, *35*(3), 345–364. <https://doi.org/10.1387/theoria.21302>

Wallace, David (2007), "The Quantum Measurement Problem: State of Play", *D. Rickles (ed), The Ashgate Companion to the New Philosophy of Physics* (Ashgate, 2008), <https://arxiv.org/abs/0712.0149>

--- (2016a), "Lessons from Realistic Physics for the Metaphysics of Quantum Theory", *Synthese* 197, 4303-4818 (2020), <http://philsci-archive.pitt.edu/15293/1/quantum_metaphysics_revised%20v3.pdf>

--- (2016b), "Probability and Irreversibility in Modern Statistical Mechanics: Classical and Quantum", To appear in D. Bedingham, O. Maroney and C. Timpson (eds.), *Quantum Foundations of Statistical Mechanics* (Oxford University Press, forthcoming), arXiv:2104.11223 [cond-mat.stat-mech]

--- (2018), "On the Plurality of Quantum Theories: Quantum theory as a framework, and its implications for the quantum measurement problem" (2018), S. French and J. Saatsi, *Scientific Realism and the Quantum* (OUP, 2020), <http://philsci-archive.pitt.edu/15292/1/leeds_realism.pdf>

--- (2019), "Review of R. Healey, 'The Quantum Revolution in Philosophy'", *Analysis* 80 (2020),<https://sites.pitt.edu/~dmw121/papers/healey_review.pdf>

--- (2020), "The Necessity of Gibbsian Statistical Mechanics" In V. Allori (ed.), *Statistical Mechanics and Scientific Explanation: Determinism, Indeterminism and Laws of Nature* (World Scientific). <http://philsci-archive.pitt.edu/15290/>

Woit, Peter: blog articles
(2010) "Bohmian Spat" <www.math.columbia.edu/~woit/wordpress/?p=2914>
(2012) "’t Hooft on Cellular Automata and String Theory" <www.math.columbia.edu/~woit/wordpress/?p=5022>
(2018) "Beyond Weird" <www.math.columbia.edu/~woit/wordpress/?p=10522>

Woit, Peter (2015), "Towards a Grand Unified Theory of Mathematics and Physics", arXiv:1506.07576 [physics.hist-ph]