



Causal set quantum gravity and the hard problem of consciousness:

An adventure between outer space and inner space

Fay Dowker

Imperial College London

March 2023

<https://arxiv.org/abs/2209.07653>

To frame the talk: part of Einstein's epistemology of science

Quotations from Einstein's Autobiographical Notes (AN) in "Albert Einstein: Philosopher Scientist" ed. P.A. Schilpp (Open Court, Chicago, 1949) and Einstein's 1952 letter to Maurice Solovine (LettS)

AN *I see on the one side the totality of sense-experiences, on the other side the totality of the concepts and propositions that are **laid down in books**.*

AN *The concepts and propositions acquire "meaning" and "content", respectively, only through their relation to sense-experiences. The connection of the latter with the former is purely intuitive, not itself of a logical nature. The degree of certainty with which this relation or intuitive connection can be made, **and nothing else**, is what differentiates empty fantasy from scientific "truth".*

LettS *What this all boils down to is the eternally problematical connection between the world of ideas and that which can be experienced (immediate experiences of the senses).*

My talk is on the connection between the world of communicable ideas ("outer space") and that which is experienced ("inner space").

So, it is going to be intuitive, nonlogical, and problematic.

The Hard Problem of Consciousness

Suppose there is a theory of “Neural Correlates of Consciousness” (NCC) that says such-and-such an event in A 's brain, E_{neur} say, correlates with subject A having so-and-so conscious experience. Consider then “the argument from knowledge” (F. Jackson 1982):

- ▶ Suppose Mary grows up locked in a black and white room and learns everything there is to know about the NCC theory. When she steps outside the room and experiences colours for the first time she gains new knowledge about the world. The knowledge of *what it is like* to experience colours.
- ▶ Ergo there's *something missing* from any NCC theory.

Finding what is missing is what is called “solving the Hard Problem”.

There are two camps: 1. NCC-Sufficient and 2. NCC-Insufficient.

Camp 2 claims that something essential is missing. Camp 1 claims that the “something essential” is an illusion and/or a misapprehension.

This sounds familiar.....

A disagreement on the nature of time

- ▶ The flow of time is an illusion, and I don't know very many scientists and philosophers who would disagree with that, to be perfectly honest. [...] And presumably the explanation for this illusion has to do with something up here (in your head) and is connected with memory I guess — laying down of memories and so on. So it's a feeling we have, but it's not a property of time itself [...] Time doesn't flow. That's part of psychology. [Paul Davies FQXi website (2013)]
- ▶ It is common to dismiss the passage of time as illusory since its passage has not been captured within modern physical theories. I argue that this is a mistake. Other than the awkward fact that it does not appear in our physics, there is no indication that the passage of time is an illusion. [John Norton "Time Really Passes" (2010)]

There are two camps: 1. Being ("Block Universe") and 2. Becoming.

Camp 2 claims that something essential is missing. Camp 1 claims that the "something essential" is an illusion and/or a misapprehension.

There are two camps: 1. NCC-Sufficient and 2. NCC-Insufficient.

Camp 2 claims that something essential is missing. Camp 1 claims that the "something essential" is an illusion and/or a misapprehension.

Being vs Becoming

Consider these thoughts from Arthur Eddington's Gifford Lectures (1926-27) Chapter V "Becoming":

- ▶ Unless we have been altogether misreading the significance of the world outside us—by interpreting it in terms of evolution and progress, instead of a static extension—we must regard the feeling of "becoming" as (in some respects at least) a true mental insight into the physical condition which determines it.
- ▶ But if there is any experience in which this mystery of mental recognition can be interpreted as insight rather than image-building, it should be the experience of "becoming"
- ▶ The view here advocated is tantamount to an admission that consciousness, looking out through a private door, can learn by direct insight an underlying character of the world which physical measurements do not betray.

Idea: the two debates on time and on the hard problem are the same debates. The experience of becoming, i.e. the perception of time passing, is the aspect of experience to which the Hard Problem of consciousness pertains.

Then, to solve the Hard Problem we need to find a physical correlate of the perception of time passing.

Sorkin's Proposal and Plan of Rest of Talk

In his 2007 treatise on the nature of time “Relativity theory does not imply that the future already exists: A Counterexample” Rafael Sorkin states:

[The example of sequential growth models for causal sets] even provides an objective correlate of our subjective perception of “time passing” in the unceasing cascade of birth-events that build up the causal set, by “accretion” as it were.

I reframe it slightly into the following form:

The Proposal: the **process** of the partially ordered birth (= becoming) of the atomic-events that compose E_{neur} in causal set quantum gravity correlates with the subject A **having** the corresponding conscious experience in real time.

In other words, what is “missing” from the NCC theory is the birth **process**.

Rest of this talk: briefly flesh out this Proposal

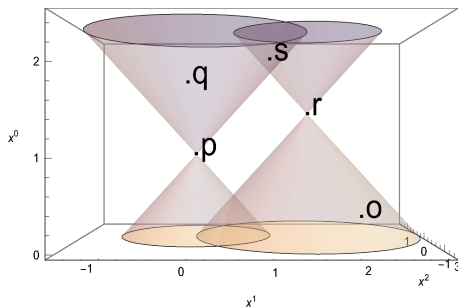
- ▶ Process and events (1 slide)
- ▶ Events and partial order in GR (1 slide)
- ▶ Causal sets: discrete atomic events are born in a partial ordered process (2 slides)
- ▶ Throw the light of the birth process on some Hard Problem issues (3 slides)

Throughout, I will assume that spacetime is a single causal set.

Process and the concept of **events** e.g. the random walk

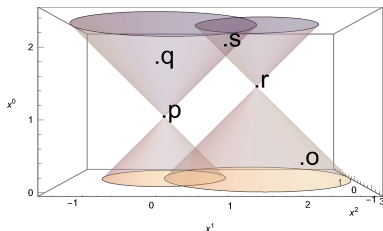
- ▶ There are two ways to conceive of a random walk on the integers: (a) as a *dynamic* process and (b) as a *static* measure theory
- ▶ (a) The walker steps to the left or right at each stage, with certain transition probabilities.
- ▶ (b) Consider all possible completed histories of the walker (infinite sequences of integers) in a big bag Ω . An **event** is a measurable subset of Ω . e.g. "walker is at 5 at stage 13" = $\{\gamma(t) \in \Omega \mid \gamma(13) = 5\}$.
- ▶ (b) Stochastic "process" in name only: choose one completed "Block Universe" history at random from the bag. That history is the world and each event either has occurred or has not occurred in the world.
- ▶ Mathematics favours (b). Theorems!
- ▶ **(a) and (b) are different physically.** In (a) there is the process of stepping and a physical order in which the steps occur. In (b) there is no stepping.
- ▶ In (a) there is a **difference** between an event and its occurrence. When I want to emphasise this I call an event, an event-as-such or an **occurable** (term suggested by David Reid, [U. of Chicago](#)).
- ▶ There is an **external** picture of both—(a) dynamic (movie) (b) static (on paper)
- ▶ The Proposal is built on (a): the dynamic conception of stochastic process.

Events in GR and partial order



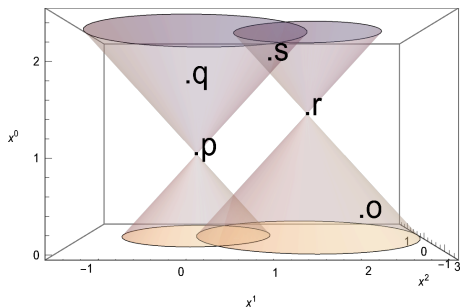
- ▶ In GR, an event (an occurrable) such as E_{neur} in A 's brain is composed of two material entities: a spacetime substrate and some matter degrees of freedom that are decorations on spacetime.
- ▶ Assume the spacetime substrate of E_{neur} is a piece of Minkowski space.
- ▶ The familiar lightcone structure of spacetime gives a partial order on spacetime points that I will call the **precedence order**: before and after.
- ▶ The order is a partial order: $o \prec r$, $r \prec s$, $o \prec s$, $p \prec q$, $p \prec s$ and there are no other order relations between the selected points.

Events in the Causal Set approach to the problem of quantum gravity



- ▶ In causal set theory (CST) this piece of \mathbb{M}^4 is a continuum approximation to a causal set, a finite set of spacetime atoms with a partial order of precedence.
- ▶ Evidence that this can work: David Malament ([U. Chicago](#)) 1976 Theorem.
- ▶ Typical neural event has very roughly 10^{120} spacetime atoms that compose the spacetime substrate (Planck scale discreteness).
- ▶ The spacetime atoms have a precedence order. The named points in the diagram now represent individual spacetime atoms: $o \prec r$, $r \prec s$, $o \prec s$, $p \prec q$, $p \prec s$.
- ▶ Matter = certain decorations on the spacetime atoms.
- ▶ A single spacetime atom with its matter decoration is an *atomic event*.

A partially ordered process



- ▶ The **occurrence** of E_{neur} in CST is the **process** of the birth of its atomic events.
- ▶ The occurrence of E_{neur} is not the same thing as the occurable E_{neur} : the birth of an atomic event is not an atomic event just like **the birth of a baby is not a baby**.
- ▶ **BUT**—and this is the crucial point—the birth process cannot be pictured as its objective, live, dynamical self from the outside **because the births are partially ordered** (contrast random walk).
- ▶ One can have an external picture of the process if one sequentially labels the atomic events. But that is a gauge choice and not entirely physical/objective.
- ▶ The Proposal says one **can** have an objective view of the process **if** one is part of the physical system. That “internal view” (cf Eddington’s “insight” and “private door”) is conscious experience.

Explaining qualities of experience using properties of the birth process

The Proposal again: The birth of the atomic-events that compose E_{neur} in Causal Set Theory correlates with *A having* that conscious experience live, in real time.

- (1) **Conscious experience is momentary, fleeting and of the now.**
In the birth process each atomic-event occurs once. The occurrence of an atomic-event is momentary. Immediately an atomic-event is born, it becomes part of the past.
- (2) **Conscious experience of time passing is inexorable.**
The birth process is unceasing.
- (3) **Conscious experience is live.**
The birth process can only be objectively viewed from inside the world, as it happens.
- (4) **Conscious experience is internal and private.**
The birth process can only be viewed from inside the world. The entity having the experience in the world cannot copy and communicate that experience, cannot share it with another entity since to do so would be to create a picture of the process that is external and objective.
- (5) **Conscious experience is indubitable.**
The birth process is objective.
- (6) **Conscious experience is immediate (un-mediated).**
The birth process is the experiencing.

Various Hard Problem Issues in the light of the Proposal: I

▶ Consciousness in the Block

A Block Universe is an completed causal set, the result of the process having run to infinity. Then, the answer to the question, “What would it look like if it looked as if our world were a Block Universe?” is, “It wouldn’t look like anything because it would all be over and we would be dead.”

▶ Something is missing

The NCC theory is a theory based on concepts of NCC occurables. Live experience is the occurrence of NCC events. The “something missing” from the NCC theory is the dynamic birth process.

▶ The knowledge argument

Anyone who knows the NCC theory knows the full physical account of the **occurable**, the event that is “A had a conscious experience of seeing a red ball”. But one cannot know the physical correlate of *A having* the experience, live and in real time, because the correlate of the having is the partially ordered birth process. Only *A* can view it, experience it, from within, live and as it happens.

Various Hard Problem Issues in the light of the Proposal: II

▶ Panpsychism

The Proposal is sympathetic to panpsychism only to the extent that the birth process is universal to the whole physical world. The question, “Which entities have conscious experience?” is the question, “Which events are NCC-events?” and defines the quest for an NCC theory. For example, a supernova is an event and is composed of atomic-events. The partially ordered birth of the atomic events composing the supernova-event is the occurrence of the supernova-event. The question “Was the supernova that occurred conscious?” is a question that the NCC theory should answer.

▶ Fundamentalism about consciousness (and time)

The partially ordered birth process is fundamental and not emergent in Causal Set Theory (“time” in the sense of Becoming is fundamental and not emergent in Causal Set Theory). The process cannot be recovered from anything more basic. The NCC theory on the other hand will be constructed using concepts in biology, neuroscience and cognitive science such as neurons, information processing and superfast model fitting.

▶ How does consciousness interact with physical stuff, particles fields etc?

Conscious experience is the birth process (in the brain) so this question makes as much sense as “how does the birth of a baby interact with a baby?” The **process** is the creation of the **stuff** (4D-spacetime-stuff).

End where we started

Returning to Einstein's epistemology: the partially ordered birth process in causal set theory blurs the boundary between the world of ideas and the totality of sense-experiences. The birth process in CST as its live, dynamic self cannot be situated fully in the world of objective, communicable physical concepts because the births are partially ordered.

Though the process is a concept in the theory, it can only be fully apprehended as its dynamic self in the manifold of sense-experiences. It can only be objectively viewed from within. It has to be lived, it has to be experienced to be apprehended. One cannot know, from the outside, **what it is like**.

Thank you Rocky and Happy Birthday!