

**Title:** Being, Becoming and Experience in Quantum Gravity

**Speakers:** Fay Dowker

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**Abstract:**

In causal set quantum gravity, spacetime is Being and the process of the birth of the atoms of spacetime is Becoming. This process coordinates with our experience of the passage of time.

# Being, Becoming and Experience

Fay Dowker

Abdus Salam Centre for Theoretical Physics,  
Imperial College London

Lee's Fest June 2025

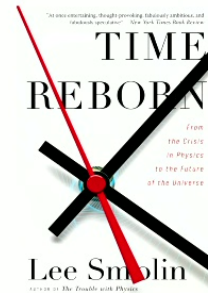
It's a great pleasure to be here to celebrate Lee's contributions to physics with so many friends and colleagues. Thank you Laurent, Francesca and the other organisers for inviting me.

I have enjoyed many many stimulating discussions about physics and philosophy with Lee over the years. Most recently, my conversations with Lee have been on the nature of time and consciousness.

I have found in Lee a kindred spirit on these subjects and so this is what I've chosen to talk about today. In my presentation, in the spirit of Lee, I will make some bold claims. I will sound more dogmatic than I feel just because there's no time to hedge around things.

## Time is Real

The passage of time is physical



The physics of the passage of time coordinates with conscious experience

- ▶ “Physics, time and qualia” Marina Cortés, Lee Smolin & Clelia Verde (2021) [[philsci-archive.pitt.edu/19364](https://philsci-archive.pitt.edu/19364)]

This view is a fruitful heuristic when building quantum gravity

- ▶ “Causal set quantum gravity and the hard problem of consciousness” FD (2022) [arXiv:2209.07653]

( For fun: try putting paper into "NotebookLM" ! )

## LIFE IN ONE DIMENSION



## Process and the concept of events

- ▶ Model your experience as a random walk on the integers
- ▶ There are two ways to conceive of this (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) Set of all completed histories (infinite sequences of integers)  $\Omega$ . The universe is one randomly chosen “Block Universe” history from  $\Omega$  (chosen according to a measure).
- ▶ An **event** is a measureable subset of  $\Omega$ . e.g.  $E_{5,13}$  = walker is at 5 at stage 13 =  $\{\gamma(t) \in \Omega \mid \gamma(13) = 5\}$ .
- ▶ In (a) there is a **process** of stepping. In (b) there is no process.
- ▶ In (a) there is occurrence of events **in the process**. In (b) there is no occurrence of events.
- ▶ Only (a) is coordinated with experience. The scientific empirical demand—i.e. due regard to experience—picks out (a) as physical

The passage of time in (a) is the **process**.

## (a)-type models

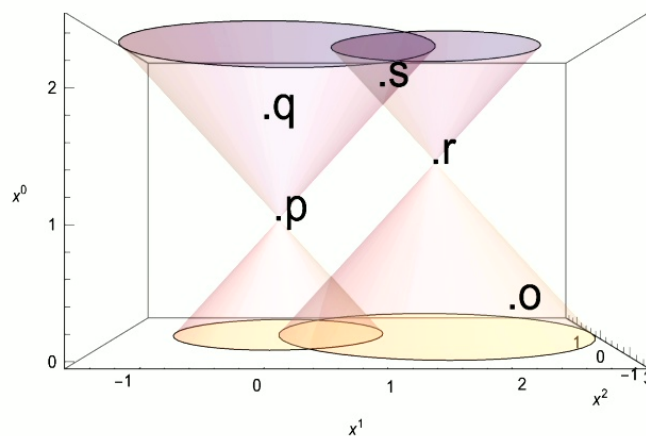
That was just a toy model of our Kafkaesque thought experiment. What about realistic physics?

Can't we just add an (a)-type process, a passage of time, to physics, GR say, in order that physics accord with our experience.

Three obstacles:

- ▶ Need a discrete process – beyond current physics (though, see Francesca's talk, possible experiments....)
- ▶ Physics is quantum – need a quantum process
- ▶ Relativistic order of events is a **partial** order: an obstacle but also an opportunity

## Events in GR and in Causal Set Theory

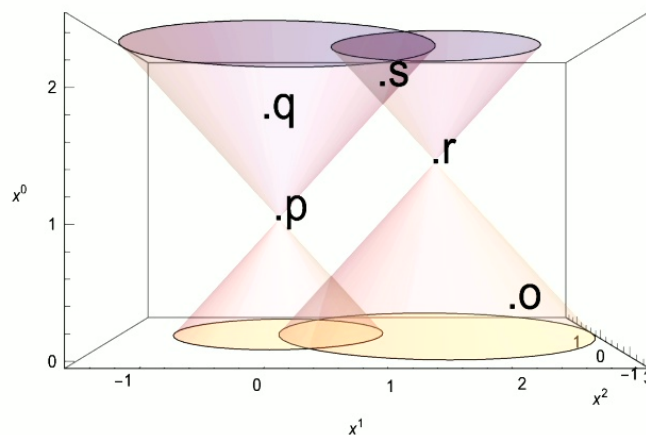


- ▶ The familiar lightcone structure of spacetime gives a partial order on spacetime point events, the **precedence order**: before and after.
- ▶ The order is a partial order:  $o \prec r$ ,  $r \prec s$ ,  $o \prec s$ ,  $p \prec q$ ,  $p \prec s$  and there are no other order relations between the selected points.

Now go discrete. In CST spacetime is a continuum approximation to a discrete order.



## A partially ordered birth process: Sorkin



- ▶ The **occurrence** of event  $E$  in CST is the **process** of the birth of its atomic events.
- ▶ The occurrence of  $E$  is not the same thing as  $E$ : 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 viewed as its objective, live, dynamical self from the outside (there's no god's eye view as Jenann puts it) **because the births are partially ordered** (contrast random walk).
- ▶ One **can** have an objective view of the process only if one is part of the physical system. That "internal view" is conscious experience.

## The hard problem

“[...] 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”

Eddington, 1928 Gifford Lectures

Though the birth process in causal set theory 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**.

Happy Birthday Lee, and looking forward to many more conversations on time and consciousness