We might only see time because we can’t think in quantum physics

By Leah Crane

A glass is much easier to smash than to unsmash

Sohl/Getty

Predicting the future is easy, if you are a physicist. Break a glass, and you can boldly assert that it will fall into a number of shards, assuming you know the initial conditions. Knowing the past is more difficult – you need to store much more information to piece a pile of broken glass back together.

This “causal asymmetry” makes it easier to determine cause and effect and thus place events in order. But it doesn’t exist in the quantum world, say Mile Gu at Nanyang Technological University in Singapore. Quantum physics uses the same amount of information to trace an event backwards in time as forwards. This find could have implications for how we perceive time itself.

Gu and his colleagues found that when a quantum computer models a system that seems causally asymmetrical to a classical computer, the asymmetry can disappear. In some cases, the amount of memory you need to store information is the same in both temporal directions, so there is no concept of cause and effect.

Quantum movie

Gu describes modelling ordinary physics as watching a film. “If you watch the movie in the correct direction, it makes much more sense,” he says. But for a quantum movie, both directions make sense.

His team tested this idea with a simple system, a list of ones and zeroes. Imagine the ones and zeroes as tiles on a path running south to north. You are tasked with crossing out each zero that lies immediately north of a one.

If you walk forwards, south to north, this is simple – if the last tile you stepped on was a one and now you are on a zero, you can cross it out. But if you walk backwards, north to south, you need to know what the next tile south is before you reach it. That is why the classical system requires storing more information moving backwards than forwards.

In the quantum system, as you walk in either direction, you place all of the tiles with zeroes into entangled quantum states, both crossed off and not crossed off. The entanglement stores some of that information, meaning you use less memory, says Gu.

The weird properties of quantum physics means that once information on all the tiles has been gathered in a quantum state, measuring that state produces the correct answer, no matter which direction you travelled, he says.

“This is a big area in quantum computing – to see, once we’ve built these things, what they’ll be good for,” says Gu. “Systems with causal asymmetry are a class of problems where these quantum machines can have a significant advantage.”

A quantum model will always need less memory than a classical one, so using a quantum computer to model a process in reverse will take less information than using a classical computer to model the process forwards. Sometimes, a quantum computer will need the same amount of memory to run forwards or backwards, eliminating causal asymmetry all together.

That means that, in some cases, our perception of cause and effect may come from our inability to process information in a quantum way. “We perceive this asymmetry because we reason classically,” says Gu. “It is possible that if we evolved to reason quantum mechanically, we might not perceive time.”

Others are less convinced. “I would not draw any philosophical implications from this work,” says Howard Wiseman at Griffith University in Australia – after all, large objects like us can never perceive the quantum world directly.

Journal reference: *Physical Review X*, DOI: 10.1103/PhysRevX.8.031013

More on these topics:

- quantum science
- time