A new place for consciousness in our understanding of the universe

To make sense of mysteries like quantum mechanics and the passage of time, theorists are trying to reformulate physics to include subjective experience as a physical constituent of the world

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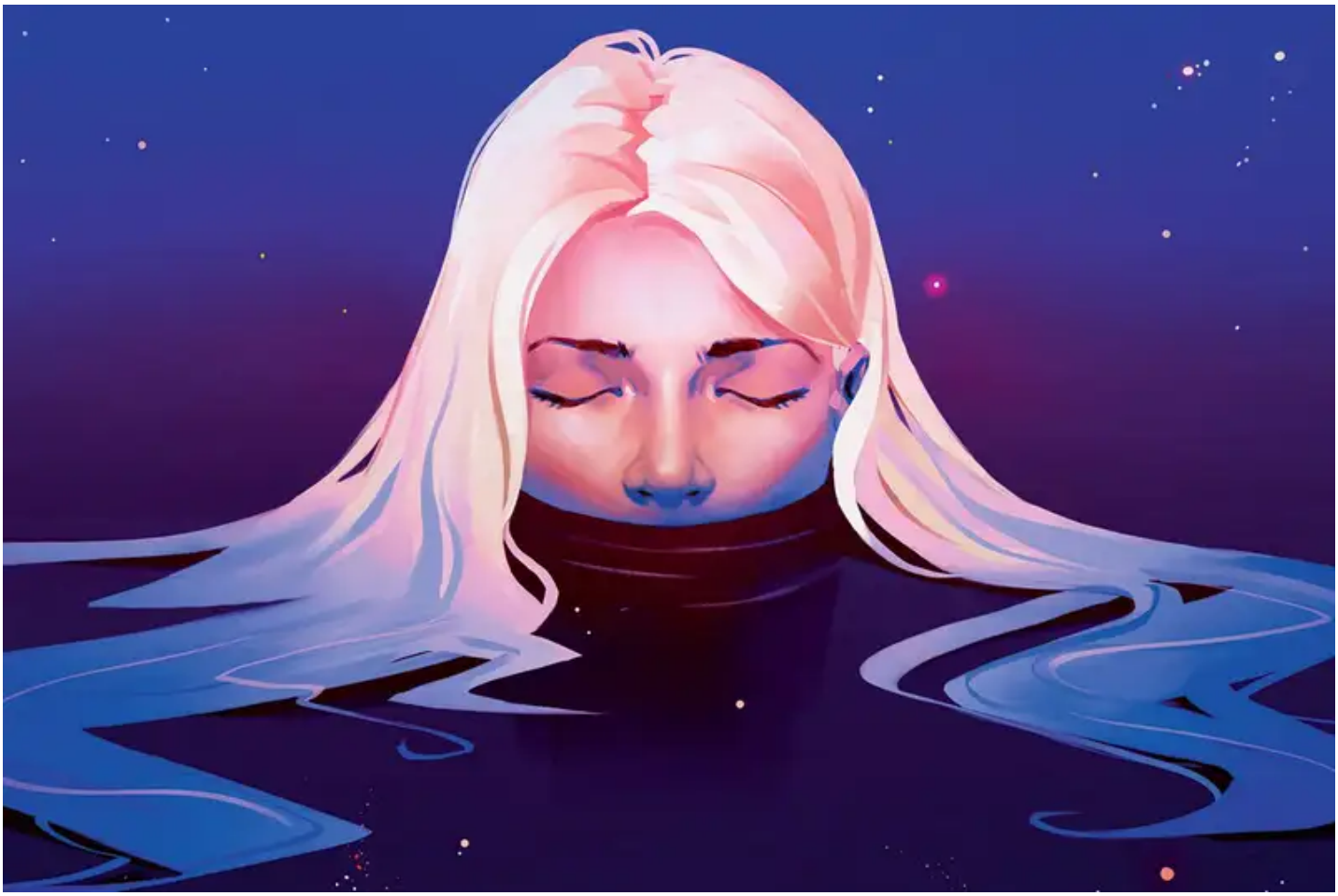
By **Thomas Lewton**



Pablo Hurtado de Mendoza

A WALK in the woods. Every shade of green. A fleck of rain. The sensations and thoughts bound in every moment of experience feel central to our existence. But physics, which aims to describe the universe and everything in it, says nothing about your inner world. Our descriptions of the wavelengths of light as they reflect off leaves capture something – but not what it is like to be deep in the woods.

It can seem as if there is an insurmountable gap between our subjective experience of the world and our attempts to objectively describe it. And yet our brains are made of matter – so, you might think, the states of mind they generate must be explicable in terms of states of matter. The question is: how? And if we can't explain consciousness in physical terms, how do we find a place for it in an all-embracing view of the universe?

"There is no question in science more difficult and confusing," says Lee Smolin, a theoretical physicist at the Perimeter Institute for Theoretical Physics in Waterloo, Canada.

It is also one that he and others are addressing with renewed vigour, convinced that we will never make sense of the universe's mysteries – things like how reality emerges from the fog of the quantum world and what the passage of time truly signifies – unless we reimagine the relationship between matter and mind.

Their ideas amount to an audacious attempt to describe the universe from the inside out, rather than the other way around, and they might just force us to abandon long-cherished assumptions about what everything is ultimately made of.

Modern physics was founded on the separation of mind and matter. That goes back to Galileo Galilei, whose big idea, some four centuries ago, was to boil the world down to the interactions of moving objects that could be described by mathematical laws. Our senses, meanwhile, lived in the human soul – distinct, though still important. "Galileo said 'don't worry about consciousness for the moment, just focus on what you can capture in mathematics'," says Philip Goff, a philosopher at Durham University, UK.

To understand the universe, we might have to rethink the idea that objects are fundamental
NASA, ESA, K. Luhman and T. Esplin (Pennsylvania State University), et al., and ESO; Processing: Gladys Kober (NASA/Catholic University of America)

That philosophical sleight of hand changed everything. The material world became understandable as Newton and others created "universal laws" that describe how matter behaves. The achievements since have been stunning: precise, predictive models of all known elementary particles and forces, and of the evolution of the cosmos from just after the big bang until today.

These days, precious few scientists would claim to see the mind as inherently separate from matter. Modern neuroscience has left little room inside the brain for an immaterial soul. Instead, physicalism reigns – the idea that everything in nature must be derived from the basic stuff of physics. It follows that consciousness must somehow emerge out of particles, strings, information or whatever you take as fundamental.

But while neuroscience can explain with growing precision which kinds of brain activity map onto conscious states, it is far from understanding why this brain activity gives rise to conscious experience. This is what the philosopher David Chalmers called the "hard problem" of consciousness: the seemingly insoluble question of why matter inside your skull gives rise to personal, subjective experience of the world at all.

Some dismiss the hard problem as a red herring. They argue that consciousness is a useful illusion, or that we will explain consciousness in physical terms if only we have the patience. But philosophers and neuroscientists who think the hard problem is real see it as a reason to call physicalism into question. "The irony is that physicalism has done so well and explained so much precisely because it was designed to exclude consciousness," says Goff.

For physicists, the motivation to rethink matter and mind comes primarily from another direction – their ongoing attempts to make sense of quantum mechanics, the laws that govern the behaviour of the atoms and subatomic particles that make up the deepest layer of reality we know of.

Quantum mechanics was one of two theories that revolutionised physics in the early 20th century. The other was Albert Einstein's general relativity. This says that gravity is the result of mass warping space-time, and it ends up offering among the best examples of what physicists are striving for – an objective "view from nowhere" that has nothing to do with the individual perspective of observers.

Quantum theory was different. Experiments showed that subatomic particles manifest not in definite states – here or there, say – but as clouds of probabilities of many different possible states. That fuzziness is captured by a mathematical entity known as a "wave function". When we make a measurement of a quantum object, the wave function is said to collapse such that the object suddenly has definite properties. The classical world we see somehow seems to arise out of quantum uncertainty thanks to our intervention. We as observers bring reality into being.

Or at least that's one interpretation. Some argue that there is no need to invoke conscious observers to solve this "measurement problem" and instead advocate alternative interpretations. Perhaps the most notorious is that, when the wave function collapses, all possibilities play out in a near-infinite number of parallel universes. Critics of this many-worlds interpretation point out that the multiverse is an enormous price to pay to keep the mind and the observer out of the picture.

Whatever their take on the measurement problem, many physicists agree that a better understanding of observers would be a boon, and not just for understanding the quantum world. Quantum mechanics and general relativity define observers in totally different ways, so thinking deeply about them could offer clues about how to reconcile the two to give us a unified, quantum theory of gravity.

The view from nowhere

And then there is time. Here, physics is once again at odds with our experience, in that [illegible]al relativity's view from nowhere holds that observers, including us, are just coordinates

or points in a static chunk of space-time called the "block universe" – a perfect, unchanging mathematical object in which past, present and future all exist at once. If that is true, our experience of flowing time, from the past through the present and to the future, is merely an illusion.

The problem is that "a view from nowhere is not something anyone's ever had", says Adam Frank at the University of Rochester, New York. We presume that there is some shared, objective reality out there, but we can never know for sure. "What quantum mechanics and what questions about time have both pressed on us is the absolute need to understand the observer, and to recognise it as a physical constituent of the world," says Jenann Ismael, a philosopher at Columbia University in New York. For centuries, we could ignore observers with little consequence, she says. Not any more.

One option is to suggest that some form of consciousness, however fragmentary, is an intrinsic property of matter. At a fundamental level, this micro-consciousness is all that exists. The idea, known as panpsychism, rips up the physicalist handbook to offer a simple solution to the hard problem of consciousness, says Goff, by plugging the gap between our inner experiences and our objective, scientific descriptions of the world. If everything is to some extent conscious, we no longer have to account for our experience in terms of non-conscious components.

But most physicists aren't buying that. Extending the fundamental stuff of physics to include micro-consciousness would disrupt our remarkably successful account of how the universe works, says Sean Carroll at the California Institute of Technology in Pasadena. We have little idea of what consciousness is, and so adding it directly into such precise and definitive equations could knock everything else off-kilter. "To start with the least-well-understood aspects of reality and draw sweeping conclusions about the best-understood aspects is arguably the tail wagging the dog," Carroll wrote in a recent issue of the Journal of Consciousness Studies dedicated to the mind-matter question.

Goff counters that the only way to make sense of our subjective experiences, or "qualia" – such as the redness of a sunset or the sharpness of a lemon – is to treat them as new data that science must include. This new approach complements rather than contradicts physics, he says.

Where to begin? We should be sceptical of attempts to amalgamate lots of little bits of micro-consciousness to create complex consciousness, says Eleanor Knox, a philosopher at King's College London, because it isn't how anything else in physics works. "That's the old-fashioned Lego brick view of how we build things up in the universe," she says. "What panpsychism doesn't take at all seriously is the complexity of the story that we already have about [illegible]gence in the world."

Emergence is the idea that behaviours and properties that don't seem to exist when we look at the individual components of a complex system suddenly take shape when we see the system as a whole. Emergent phenomena are, essentially, more than the sum of their parts. Individual water molecules aren't wet, for instance, and yet wetness is a property of water.

To create a picture of how things work at a higher level, we don't just simply combine particles from the bottom up. If we did, we would barely be able to explain how a kettle boils – never mind why our experience of time doesn't stack up with the timeless block universe. Instead, we have to add in top-down information. The same physical laws act on water molecules in a liquid and in a gas, but flipping the switch on your kettle changes the temperature and puts a new condition on the overall system so that the same laws have a different effect.

Emergence gives physics new explanatory powers, says Knox – but it is far from understood. "Even thinking that fundamental physics has something to say about my coffee cup is really complicated, and there are explanatory gaps", says Knox. Still, Carroll argues that if we can better understand the messy complexities of emergence, we might make sense of our role as observers in quantum reality. We may even find clues as to how Einstein's smooth space-time appears out of the grainy picture depicted by quantum theory. Physicalism could yet survive.

Others advocate a more radical approach. For Smolin and Marina Cortês at the University of Lisbon, the problems we have are related in a different way. We can gain a better understanding of quantum reality – but only by accepting that conscious awareness is tangled up with the nature of time.

Together with independent philosopher Clelia Verde, Cortês and Smolin are taking tentative steps towards a new theory of quantum gravity that folds in qualia. It starts with a conviction that the timeless block universe depicted by general relativity is wrong. Instead, Smolin says that we should take our experience of time seriously and recognise that things only exist in the present moment. Nothing persists, things only happen. "For me, time is absolutely fundamental," he says. "And there is one property that mathematical models don't have, which is that nature seems to be organised as a series of moments."

This leads to a very different cosmology, one rooted in present events and the relationships between them, rather than objects sitting in space-time. Each event has a view of the world that provides information about how it fits into the rest of the world – in particular, what its progenitor events in the past were and how it came to be formed from them. In this "causal theory of views", quantum mechanics and space-time aren't fundamental, but emerge out of this network of views of events. As events come to be, they make ambiguous possibilities definite; the unknown future becomes the present moment. And in this time-created world, physical laws aren't fixed like Galileo or Newton supposed, but evolve through time.

Intriguingly, this opens the door to qualia and conscious awareness. That is because in this picture, there are two types of events. Some events can be predicted, at least statistically, based on what has happened before. But if physical laws evolve, then there are other, rarer events whose outcome is not habitual. These totally novel events, free from precedent, allow the universe to dictate what happens next.

Near the big bang, novel events would have been very common. Consciousness would permeate the universe in a picture not unlike panpsychism. But as the universe ages, unprecedented events become much rarer. One potential wellspring of novelty today, however, is the highly complex human brain. Perhaps our brains evolved to make use of these novel events and their freedom to determine the future, says Cortês. The idea is that our awareness results from this creative freedom.

Taming qualia

"The universe often surprises itself. Qualia are expressions of the universe to surprise," Cortês, Smolin and Verde propose in their contribution to the special issue of the *Journal of Consciousness Studies*.

All of which is rather bold. "I'm willing to ask questions," says Smolin. "I don't claim to have an answer." But evidence may come by looking for parallels in the structure of views of events, on the one hand, and in the structure of qualia on the other – bridging the void between mind and matter opened by Galileo. A first step is to make qualia more hospitable to physics by describing, for example, how certain experiences are bundled together and enter our stream of consciousness.

Accepting qualia as scientific data is just what Goff has called for. He wants physicists to go even further than Smolin and Cortês, though. Rather than finding a home for consciousness in a physical theory, as in the causal theory of views, Goff reckons that consciousness comes first, and that it is networks of simple, conscious entities that ultimately realise the mathematical structures of physics. The challenge is to demonstrate how.

Yet Ismael sees no need for qualia, or indeed our experience of time, to take on a central role within physics. We can build up a satisfactory picture of reality, she argues, simply by examining the relations between ourselves and how we go about doing physics.

Neuroscience doesn't explain why brain activity produces conscious experience
Monty Rakusen/Getty Images

Humans have the ability to develop abstractions that are far from our actual experience, which helps when devising mathematical descriptions of nature. The mistake we make is when we try to reverse that process of abstraction – when we try to start from microscopic particles, like atoms and quarks, and recover our internal experience. "The closest that we get with an objective description is brain processes," she says. "We look at that and say: 'That has no connection with anything that's going on up here.' But that's partly because of this process of abstracting outwards."

In this way, physical theories will always seem to be at odds with our internal self and the language of experience. The hard problem of consciousness isn't something that physicists need to address, says Ismael. "Physics can move on without worrying about it."

Carlo Rovelli, a theoretical physicist at Aix-Marseille University in France, takes things further still. Much of the confusion arises, he says, because we forget that all phenomena, whether mind or matter, are related to one another. This relational view, rooted in Rovelli's research in quantum mechanics, demotes the physical objects that are usually the starting point for fundamental physics. "The best description we have about the world is in terms of the way ms affect one another," says Rovelli.

In which case, Galileo's distinction between subject and object is blurred, as everything is both a subject and an object – including observers and their minds. There is no view from the outside. In this way, Rovelli sees the relational universe as a "very mild form of panpsychism" in that there is something in common between mind and matter. "It is the realisation that nature is about things that manifest themselves to one another," he says. "This takes away much of the mystery of consciousness."

If Rovelli is on to something, it would leave us with an uncomfortable truth. The traditional stuff of physics – namely objects with absolute properties, to which Galileo devoted his life – can't exist alone. How does that feel?

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