Would aliens do physics, or is science a human invention?

Shaped by a different biology or culture, other intelligent civilisations – if they're out there – might understand the universe in a completely different way than we do. Physicist Daniel Whiteson explores what that could tell us about physics and ourselves

The following is an extract from our Lost in Space-Time *newsletter. Each month, we dive into fascinating ideas from around the universe. You can sign up for* Lost in Space-Time *here*.

Modern physics offers a remarkable lens on reality. In just over a century, it has decoded the architecture of atoms, traced the early history of the universe and produced laws that seem to hold everywhere, from Earth's crust to distant galaxies. It is tempting to believe that these theories aren't just accurate, but inevitable – that any sufficiently intelligent civilisation would eventually uncover the same truths.

I used to believe that, too. But lately I have started to wonder whether physics is less a window onto universal reality and more of a mirror, reflecting the particular kind of minds we happen to have.

That unsettling thought emerges when you ask a deceptively simple question: would alien scientists, shaped by a different biology or culture, arrive at the same physics that we have? Or might they develop something that works just as well, but looks utterly foreign – built on concepts and assumptions we would struggle to recognise?

The bold attempt to solve the toughest mystery at the heart of physics

This question sits at the heart of my book, *Do Aliens Speak Physics?*, which imagines various scenarios of first contact, each designed to probe a foundational assumption of modern physics. In developing it – often in conversation with philosophers of science – I have come to realise something surprising: many pillars of physics that feel hardwired may actually be contingent. But recognising that doesn't weaken science. It may be how we make it better.

I've spent my life doing physics. When I am not teaching at the University of California, Irvine, I work at the CERN particle physics laboratory near Geneva, Switzerland, analysing data from the Large Hadron Collider. But a few years ago, conversations with philosophers forced me to revisit a question I hadn't seriously considered since my student days: what is physics, really?

At its core, physics aims to explain how the universe works – not just what we observe, but what lies behind those observations. It looks for patterns, builds models that expose hidden structure and, ideally, distils everything down to a small set of rules from which the rest follows. By that measure, it has been spectacularly successful.

Yet physics never describes the universe in full. It describes carefully chosen versions of it.

Consider predicting the path of a comet. In principle, we could account for every gravitational tug, the slow loss of material as ice sublimates, even the way an irregular shape causes the comet to tumble. In practice, we must decide what to include and what to ignore. There is no single correct model – only models that are good enough for the question at hand.

This is true throughout physics. Even our most precise theories rely on approximations and assumptions that make the mathematics tractable. And it isn't clear that the theories we treat as fundamental really are. They may simply be effective descriptions that work at human scales. There is no guarantee that, by probing nature ever more finely, we will eventually strike bedrock.

If physics depends on choices – about simplification, representation and emphasis – then alien physicists might reasonably make different ones.

What if aliens don't experience time the way we do?

Imagine that aliens arrive on Earth. They have mastered interstellar travel and touched down near Paris. We send linguists and scientists to greet them, hoping for a technological windfall. The delegation returns empty-handed.

"They can't share their technology," the lead physicist explains. "Because of what will happen 74 years from today."

The implication is disturbing. These aliens don't experience time as a flowing sequence, but as a complete structure, something navigable rather than endured. Human physics, by contrast, is built on the idea that the present generates the future. Causes precede effects. The universe computes itself forward, moment by moment.

A new understanding of causality could fix quantum theory's fatal flaw

Quantum theory fails to explain how the reality we experience emerges from the world of particles. A new take on quantum cause and effect could bridge the gap

But what if that picture is a human convenience, rather than a cosmic necessity?

We know that any workable physics must obey certain constraints. A universe that allows unrestricted messages from the future quickly collapses into a paradox. But within those limits, the structure of time may be more flexible than we usually admit.

Hints of this already exist in our own theories. Quantum entanglement links distant particles so that measuring one appears to instantaneously fix the state of the other, despite the fact that there can be no information exchanged between them. This alone strains our intuitions. But matters become stranger when relativity enters the picture. Observers moving at different speeds disagree about the order of events. In some frames of reference, one measurement appears to influence another before it occurs.

The daring idea that time is an illusion and how we could prove it

The standard response is to insist that nothing physically problematic has happened: no faster-than-light signals, no causal contradictions. But that reassurance relies on clinging tightly to a classical notion of causality that quantum mechanics has never fully respected.

Some physicists have taken a more radical approach. In so-called retrocausal interpretations of quantum mechanics, future events are allowed to help shape the present. Measurements don't merely reveal outcomes; they help define them, even backwards in time. The universe no longer computes itself strictly step by step.

If aliens had a radically different construct of time, they might adopt such ideas naturally, rather than treating them as unsettling exceptions. And perhaps we may eventually need to do the same.

What if aliens don't insist on a single theory of nature?

Now imagine the aliens invite us aboard their ship for a scientific conference. Earth sends its brightest minds. We present our best theories. The aliens listen politely, then respond.

One group describes a framework that reproduces all known experiments using unfamiliar concepts. A second presents another, incompatible approach. Then a third. Each works. Each is internally consistent. None can be reduced to the others.

Finally, someone asks the obvious question: which one is true?

The aliens seem puzzled. All of them, they say. Why choose?

Aliens' physics may look completely incomprehensible to human scientists, if they do physics at all

Larry MacDougal via ZUMA Wire/Alamy

Human science assumes that competing theories must ultimately fight it out, with only one surviving as the correct description of reality. When multiple explanations fit the data, we design experiments to eliminate all but a single winner.

This strategy is powerful and often effective. But it is a preference, not a logical necessity. Science today often tolerates pluralism more than it admits. Weather forecasting is a striking example. Modern meteorology relies on suites of models, each tuned to different assumptions and scales. These models routinely disagree, and experts decide which to trust depending on context. No single model is treated as the uniquely correct one.

Another example comes from classical mechanics. At school, we learn Newton's laws as a story about forces pushing and pulling objects through space. But the same motions can be derived in a very different way, by tracking how energy flows through a system, or by assuming that nature somehow "chooses" the path that minimises a quantity called "action". To most physicists, these are just alternative ways of doing the same sums.

Philosophers of science, however, would point out that each framework elevates a different concept to centre stage – force, energy, optimisation – and offers a different account of what, at bottom, is driving the motion. The fact that these pictures cannot be told apart by experiment shows that empirical success alone may not be enough to tell us which account, if any, deserves to be called the "true" one.

This suggests an alternative vision of science – not a march towards a single, final theory, but a toolbox of frameworks, each useful in different situations. Aliens might adopt such an approach from the outset, without ever feeling the need to crown a single description as the truth.

What if aliens never felt the need to do physics at all?

Finally, imagine that aliens arrive by opening a wormhole. The technology is astonishing. Surely they must possess deep insights into gravity, perhaps even quantum gravity.

But what if they don't?

What if their space-bending technology is the result of millions of years of trial and error rather than theoretical understanding? They know how to build it and how to use it, but not why it works – and they may not care.

Construction began on the Salisbury Cathedral centuries before the invention of calculus

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This sounds implausible only because we are used to thinking of technology as the offspring of science. Historically, the relationship often ran the other way. Humans made steel, glass and antibiotics long before understanding the underlying chemistry or biology. Cathedrals were built before calculus.

The tight coupling between science and technology that we take for granted is a recent and culturally specific achievement.

It is tempting to assume that any intelligent species would be driven to ask "why". But that urge may reflect human psychology rather than a universal feature of intelligence. Other species might value reliability over explanation, or usefulness over understanding. They could build extraordinary technologies without ever developing anything recognisable as physics – not because they failed to take the next step, but because the step never seemed necessary.

No space, no time, no particles: A radical vision of quantum reality

These scenarios are speculative. But they point to something easy to forget. Physics is the cumulative result of many human choices: about what counts as an explanation, which inconsistencies matter and which questions are worth asking at all. It reflects our history, our tools and our values as much as it reflects the structure of the universe.

Recognising that doesn't diminish physics. It does the opposite. The more aware we are of the assumptions baked into our theories and methods – about time, causality, truth and explanation – the more freedom we gain to rethink them.