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LARRY MACDOUGAL VIA ZUMA WIRE/ALAMY

Do aliens do physics?

Shaped by a different biology or culture, aliens – if they're out there – might understand the universe in a totally different way to us, says particle physicist **Daniel Whiteson**

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. 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 into universal reality and more of a mirror, reflecting the minds we happen to have.

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

This question sits at the heart of my book, *Do Aliens Speak Physics?* In developing it, I have come to realise that 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. But recently, 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 hugely successful.

Yet physics never describes the universe in full. 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.

Imagine that aliens arrive on Earth. 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. 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.

Alien approach

Hints of this already exist in our own theories. Quantum entanglement links distant particles so that measuring one seems to instantaneously set 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 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 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.

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?

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 often tolerates pluralism more than it admits. One example comes from classical mechanics. At school, we learn Isaac Newton's laws as a story about forces pushing and pulling objects through space. But the same motions can be derived in a 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, 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 crowning a single description as the truth.

Aliens and humans may have different concepts of time

LARRY MACDOUGAL/ZUMA PRESS, INC./ALAMY

"ALIENS MIGHT BUILD TECHNOLOGIES WITHOUT DEVELOPING RECOGNISABLE PHYSICS"

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.

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. 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 build technologies without ever developing anything recognisable as physics – not because they failed to take the next step, but because the step never seemed necessary.

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. ▮

This is an edited extract from our subscriber newsletter *Lost in Space-Time*. Sign up at newscientist.com/lost-in-space-time/

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