PHYSICS

We Are Made of Waves

Everything in the universe, a playful new book argues, vibrates like a guitar string.

BY ASH JOGALEKAR June 6, 2024

Share

Reality often seems stranger and more dazzling than the most inspired fiction. Space, for instance, can warp, stretch, and ripple, like rubber, as Einstein taught us. And yet we travel through it, as passengers on Earth, at 150 miles per second—without feeling the slightest resistance. How can that be?

This is among the questions with which Matt Strassler, a theoretical physicist at Harvard University, opens his new book, *Waves in an Impossible Sea: How Everyday Life Emerges from the Cosmic Ocean*. His answer: Our tangible world—chairs and trees and dogs and human beings—exists not "within" the universe but is made "of" the universe itself, built from the same waves that constitute sp

Ho n field theory, which Strassler argues underlies all e is made up of fields, much like our familiar ele lectrons, and Higgs bosons are excitation these fields. How these fields are built and give rise to particles is at the heart of Strassler's b

The principle of relativity runs like Ariadne's thread through the narrative to keep us from getting lost.

These are weighty concepts, and yet Strassler writes with enviable conversational simplicity, drawing parallels between the waves and vibrations we know in our everyday lives—especially those in music (of which he is a connoisseur)—and the waves and particles of modern physics. In places, he coins delightfully pithy phrases that feel intuitive, for instance the "Higgsiferous ether" for the Higgs field which is at the heart of what imparts mass to certain particles in the universe. The law of inertia is the "coasting law." A scalar field—a field for a property, like temperature or pressure, which is defined only by a value at every point in space and not a direction—is "non-pointing."

Strassler also pitches frequent questions about physics in the form of conversations he has had with his students and non-scientist friends. This provides a fun narrative frame and an easy way to resolve any doubts a novice reader might have about the tricky concepts he's explaining. For instance, Strassler recounts a conversation he had in a coffee shop about the seemingly paradoxical notion that because all motion is relative, we can be both stationary and in motion at the same time: You don't feel the ground you stand on hurtling around the sun at 150 miles a second. Every fact of the physical universe has to be consistent with this deceptively simple-sounding principle of relativity, which runs like Ariadne's thread through the narrative to keep us from getting lost.

Strassler uses the relativity principle and the coasting law (law of inertia) to demolish a common misconception—a physics fib, or "phib" as he calls it—about the Higgs boson, an elementary particle that gets lots of time in the spotlight. The particle arises from the "Higgsiferous ether"—aka the Higgs field—and the phib is that it's a kind of treacly soup which, by virtue of its resistance to motion, "gives objects mass." If this phib were true, it would mean that the Higgs slows objects down, whereas in fact it allows them to coast, according to the coasting law. If the phib were true, the Higgs field would also slow moving objects but have no impact on stationary objects, a state of aff principle.

It's e Higgs field as a "stiffening agent" that interacts wi them from floppy to stiff, much like the gravitational field turns a floppy pendulum that's swinging all over a place into a bob swinging with

metronomic precision. The very things we call particles, in Strassler's vocabulary, should be called "wavicles"—wavy manifestations of fields, like the different harmonic modes of vibration on a violin or guitar string when it is plucked.

What the Higgs field does is interact with other fields' "resonant frequencies." (A resonant frequency is the natural frequency at which a field vibrates when set vibrating and left undisturbed.) The Higgs field interacts strongly with wavicle fields with high resonant frequencies—like those of the top quark and electrons—which are then stiffened, so that their masses can be said to come from the Higgs mechanism. By contrast, the Higgs field interacts negligibly with wavicle fields with low resonant frequencies, like those of gluons which hold together the quarks that make up protons and neutrons. The latter fact is why everyday objects like human bodies, which get almost all their masses from protons and neutrons, have scarcely anything to do with the Higgs boson: 99 percent of their mass comes from the energy of interaction between the quarks and the gluons.

Waves in an Impossible Sea seems mostly aimed at the reader who has read very little about physics. Strassler spends quite a bit of time explaining simple concepts, such as waves and inertia, which many readers of popular physics books should already understand, and may find tedious to revisit. But paradoxically, he omits much of the history of modern physics, which forces him to compress other key ideas. ("I, too, risk contributing to myth-making here," he concedes in one endnote. "... I am drastically abridging the complex prehistory of Einstein's ideas ...")

Take symmetry. It's intimately connected to the existence of conservation laws for energy and other fundamental properties. But the book does not dwell on why the breaking of this symmetry for the electromagnetic and weak forces gives rise to the Higgs mechanism. Historically this was a significant development leading to the discovery of the Higgs field, and touching on it would have illuminated an important principle.

Nevertheless, Strassler's efforts to illuminate fundamental aspects of the universe's makeup are co nd the dance of fields at work in our ordinary, ev ary about them. As Strassler writes, we are all "w here, in every thing."

Lead image: orin / Shutterstock

Ash Jogalekar

Posted on June 6, 2024

Ash Jogalekar is a Bay Area-based theoretical chemist and writer interested in the history, philosophy, and sociology of science. He is fascinated by the logic of scientific discovery and by the interactions between science and society. Follow him on X @curiouswavefn .

The Internet Might Be Good for Us

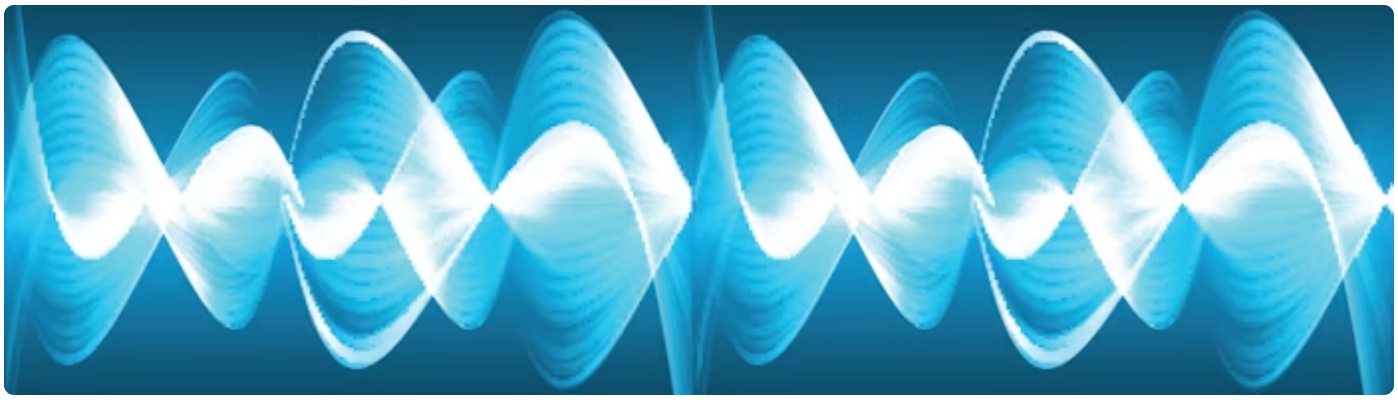
BY CHARLES DIGGES JUNE 7, 2024 **PSYCHOLOGY**

One study suggests that, on a global scale, it's associated with greater happiness.

How Schrödinger's Cat Got Famous

BY ROBERT P. CREASE JUNE 5, 2024 **PHYSICS**

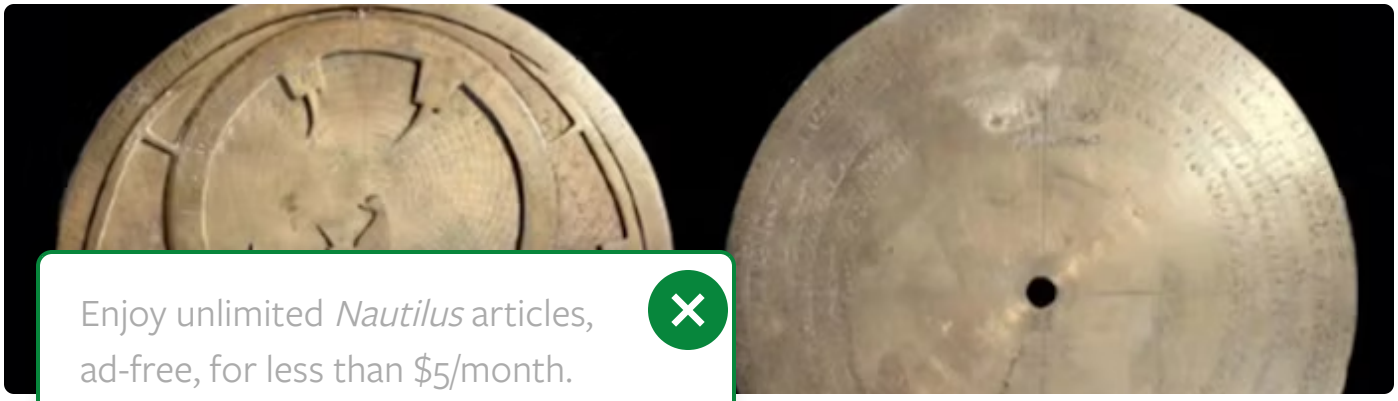
Fifty years ago, science-fiction writer Ursula K. Le Guin popularized physics' most enigmatic feline.



How Sound Rules Life Underwater

BY AMORINA KINGDON JUNE 3, 2024 **ENVIRONMENT**

Amorina Kingdon's 3 greatest revelations while writing *Sing Like Fish*.



T le Ages

BY

An accident of lighting uncovers Jewish, European, and Islamic origins.

Is Christianity Based on Psychedelic Trips?

BY STEVE PAULSON MAY 30, 2024 **HISTORY**

A radical theory that pagan cults gave rise to early Christianity.