STRANGE UNIVERSE

9 Cosmic Conundra That Keep Scientists up at Night

We humans are an inquisitive lot. We want to know the how and the why of things, and so far we've done a pretty good job of sussing out the mysteries of the universe. But every solved question begets an unanswered enigma—and some of them are real doozies:

DARK ENERGY

Maybe it's an unknown force or energy, comprising about 70% of the universe. Possibly it's a mysterious property of gravity. Might even be the influence of unseen dimensions or universes. Oh, and it seems to be causing our universe to accelerate its expansion. Curiouser and curiouser...
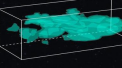
WFIRST
Mid-2020s
NASA's Wide Field Infrared Survey Telescope is a proposed space telescope that will investigate whether cosmic acceleration is truly an energy or is a gravitational phenomenon.

DARK MATTER

Like dark energy, it inhabits the shadows of perception—its presence is inferred from its gravitational effects and nothing more. To explain it, physicists invoke WIMPs and MACHOs, axions and extradimensional matter, topological defects in spacetime and even the insufficiency of general relativity. But we're still in the dark...

Euclid
2020 (?)
The ESA's proposed Euclid mission will investigate the nature of dark matter by accurately measuring cosmic expansion.

THE ARROW OF TIME

We all know, intuitively, that time is directionally asymmetric—it only moves forward, and a broken egg never spontaneously reassembles. Some blame the Second Law of Thermodynamics ("disorder must increase"); others chalk it up to dark energy (a favorite whipping boy). And some whisper of a time *before* time, an epoch preceding the Big Bang when time actually ran backwards...

Space-Based Gravitational Wave Observatories
2030s
Super-sensitive space arrays may allow us to study ripples in space that emanate from before the Big Bang itself—precosmic fossils encoding information about conditions before our universe began.

NEW WORLDS TO CONQUER

Ever had the feeling you've done all this before? Could be truer than you think. Our universe may be merely one in an endless series of repetitions; or perhaps our familiar spacetime is but one of many, floating like jellyfish in a hyperspatial sea called the "Bulk." And who knows what permutations the life principle has explored in our sister universes...

Galaxy

Multiverse

Universe

PRISM
Future missions like ESA's Polarized Radiation Imaging and Spectroscopy Mission will map the cosmic microwave background with unprecedented resolution, and possibly detect the radiation signature of universes beyond our own.

A SCHIZOID COSMOS

Why does matter predominate over antimatter? They're equal but opposites, and during the early universe should have destroyed each other and left nothing behind. But enough matter was left over to form billions of galaxies, stars, planets and carbon-based lifeforms. What gives?

proton

anti-proton

electron

positron

LHCB
The "Beauty Experiment" at the Large Hadron Collider will seek in coming years to understand the enigma of the matter-antimatter disparity by studying the interactions of b-hadrons.
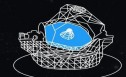
STRINGS ATTACHED

10 to 26 extra dimensions. D-branes and S-dualities, Calabi-Yau manifolds and M-theory. Welcome to the weird world of string theory, where the harmonics of one-dimensional strings create the universe of our experience. Problem: how do you prove something you can't conceivably fathom...?
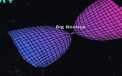
Astronomical Measurements
Precise measurements of outer Solar System bodies, conducted by future generations of ultrasensitive telescopes, may detect violations of Einstein's equivalence principle—a hint, some say, that string theory is real.

WHERE DO WE COME FROM?

We know that spacetime began 13.8 billion years ago with the Big Bang. But is this really where the story begins? What, if anything, came before? Was our universe born from the collision of two parallel universes? The collapse of a 4-dimensional star in the Bulk? Random quantum effects? Honestly, it's unlikely we'll ever *truly* answer this question...

Big Bounce

Energetic X-ray Imaging Survey Telescope
Future space telescopes will better study the light from distant gamma-ray bursts, which may betray evidence for "Loop Quantum Gravity"—a theory that predicts the Big Bang originated in the collapse of a pre-existing cosmos.

WHAT ARE WE?

Life exists in the universe—our very existence proves that. But is it restricted to Earth, or has it evolved elsewhere? Are there other minds like ours out there, asking the same questions and seeking such solace as only another intelligence can provide? Or are we unique, an accidentally self-aware assemblage of electrons and protons...?

Breakthrough Listen
This $100 million project, financed by Russian billionaire Yuri Milner, aims to scan the nearest stars and even galaxies for radio or optical signals of intelligent origin. It will be the most comprehensive SETI survey ever conducted.

WHERE ARE WE GOING?

How's it all going to end? Will spacetime be torn asunder in a Big Rip? Implode in a Big Crunch? Achieve maximal entropy over incalculable eons in the Heat Death? Quantum tunnel into another universe altogether? Maybe we—or our successors—will have evolved such powers that we can manipulate the fate of spacetime itself. Only time will tell...

Big Crunch

Indefinite expansion

Big Rip

Future Telescopes
New telescopes, like the James Webb Space Telescope, and gravitational wave detectors, like ESA's eLISA, will help to narrow down the rate of cosmic expansion, and may allow us to determine the destiny in store for our universe.

"And when [man] has conquered all the deeps of space and all the mysteries of time—still he will be beginning."

H. G. Wells

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