‘Space Oddities’ Review: Forces Unknown

Strange findings at the forefront of physics and cosmology could be flukes. Or they could portend a new understanding of the universe.

By Marcia Bartusiak

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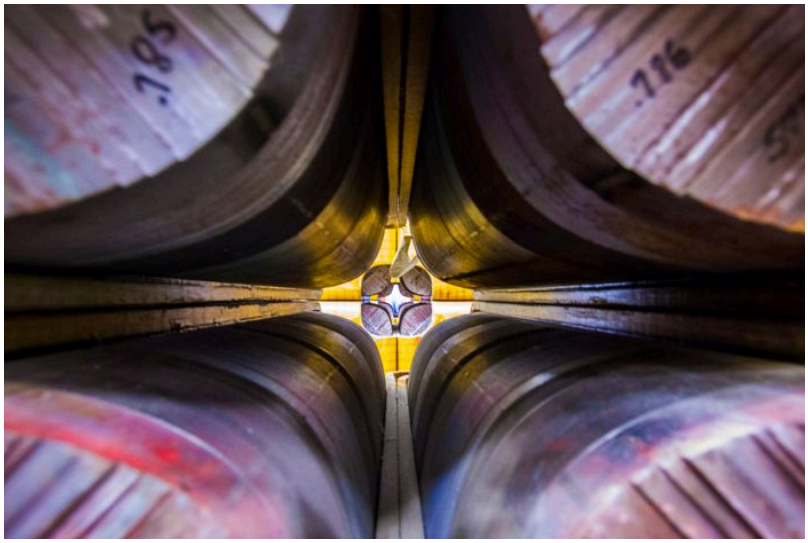

The muon g-2 experiment at Fermilab. PHOTO: CINDY ARNOLD/FERMILAB

It’s what scientists crave—that one piece of the puzzle that doesn’t quite fit. In the 1910s, Vesto Slipher at the Lowell Observatory in Arizona discovered that many spiraling nebulae were racing away from us at astonishing speeds, far faster than any other celestial object. This freakish behavior ultimately led to an entirely new vision of the universe. Those nebulae were other Milky Ways, galaxies surfing outward on the expansion of space-time.

In “Space Oddities,” Harry Cliff informs us that a similar transformation may now be under way, based on some peculiar measurements popping up in both

particle physics and cosmology. These findings could simply be due to statistical flukes or glitches in the equipment—a misconnected cable once made it look as if some neutrinos were disobeying Einstein and traveling faster than light. Or, Mr. Cliff writes, “these anomalies could be the answers to all our prayers, lifting the veil on nature’s best-kept secrets and leading to a revolutionary new scientific age.”

Mr. Cliff should know—he is a particle physicist at the University of Cambridge caught up in this cutting-edge research. He is also an engaging writer, with a keen ear for the fun metaphor and an observant eye when describing the scientific milieu in which he operates. His book provides the reader with a firsthand look at the challenges he and his colleagues face.

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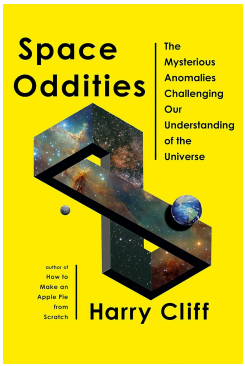
Space Oddities: The Mysterious Anomalies Challenging Our Understanding of the Universe

By Harry Cliff

Doubleday

288 pages



Mr. Cliff takes us to Antarctica, where a giant helium balloon floats in the stratosphere above the continent. Its payload is designed to receive blasts of radio waves coming up from below when ultra-high-energy neutrinos from distant supermassive black holes race through our planet and generate the radiation. Over the years, two odd signals have popped up. In each case, it appeared that a charged particle had traveled straight through the Earth—something current physics holds impossible—and burst out of the ice sheet itself.

Theorists went wild coming up with potential explanations: Could it be the sign of a new type of neutrino, or perhaps a particle derived from theories that go beyond the standard model of physics? During the 20th century, experimentalists mostly searched for particles that theorists had already predicted, from antimatter to quarks. Now the tables have turned: Theorists, starving for new physics after confirmation of the Higgs boson, are laser-focused on these rare anomalies. In the end, the Antarctica measurements were inconclusive, leaving the mystery for future detectors to resolve.

In 2013, Mr. Cliff relates, a 50-foot-wide magnetic ring began a very careful 3,200-mile journey from Brookhaven National Laboratory, on Long Island, to the Fermi National Accelerator Laboratory, near Chicago. It would be transported via land, sea and river in conditions that would protect it from flexing more than a few millimeters. Some Long Island residents were sure it was a UFO. "It probably didn't help that the team from the moving company," Mr. Cliff wryly notes, "had stuck a life-sized green alien to the bulge of the ring's cryogenic infrastructure, which looked for all the world like the cockpit."

In reality, this ring was the superconducting heart of a multimillion-dollar project to decipher a strange finding involving the muon, a heavy relative of the electron. Ten years earlier, the Brookhaven lab had detected that the muon's magnetism was a tad different from that predicted by the standard model of particle physics—possibly making it the smoking gun for an unknown quantum field. The superconducting magnet was transported to Fermilab to set up a more sensitive test. Two competing theoretical calculations created a stalemate: In one, the additional experimental data confirmed a new model of physics; in the other, Mr. Cliff writes, "there was no evidence for unknown particles in the muon's mechanical wake and experimenters have spent decades chasing a phantom."

Mr. Cliff may be chasing his own phantom. He's a member of a small army of theorists, physicists and engineers working at the Large Hadron Collider on the French-Swiss border, where atomic particles are smashed into one another. Sifting through the resulting debris, the scientists came to suspect that a new force was subtly altering the interactions of one of the heavier quarks, the unstable bottom quark. Separate teams came up with separate tests, and, like magic, the anomaly appeared and then disappeared with each new investigation. Mr. Cliff splendidly captures the behind-the-scenes experiences that are rarely reported on—the painstaking preparations, the months of data analysis and the theoretical flights of fancy undertaken to explain the unexplainable.

Why go to all this bother? Because our very understanding of the universe at large is at stake. Cosmology has its own anomalies. For a few decades we've known that ordinary matter makes up only about 5% of the universe. The rest is made up of other entities, known as dark energy and dark matter, which are pushing and pulling on space-time. "When you hear the word 'dark' being used

by physicists," notes Mr. Cliff, "you should get very suspicious because it generally means we don't know what we're talking about."

But new particles found within an accelerator could be the key to unmasking those mysterious forces, leading us to rewrite our current cosmological models. "We might find that these forces allow dark matter to form structures, perhaps even akin to stars or planets," writes Mr. Cliff whimsically. "Just imagine what that would mean: parallel dark galaxies populated by billions of dark stars, living alongside our own: invisible, untouchable, and just out of reach." If and when that revelation happens, I eagerly await Mr. Cliff's book on the discovery.

Ms. Bartusiak is a professor emeritus at MIT. Her books include "Einstein's Unfinished Symphony" and "The Day We Found the Universe."

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