Cosmic Cornerstone

WAS EINSTEIN RIGHT?

Putting General Relativity to the Test.
By Clifford M. Will.
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By Marcia Bartusiak

MANY who fall under the spell of Albert Einstein's vision often feel a little like Alice in Wonderland: The universe begins to look "curiouser and curiouser." Matter turns out to be frozen energy ($E = mc^2$); objects shrink as they accelerate toward the velocity of light, the speed limit of the universe; and gravity is no longer a mysterious force, but rather a curvature in the four dimensions of space and time. Space, Einstein told us in 1915 with his general theory of relativity, is like a boundless rubber sheet, and large masses indent this flexible mat, causing any passing rocket, planet or light beam to follow the natural depression.

General relativity was a geometric interpretation of gravity, and it was verifiable. Einstein predicted beams of starlight that happen to graze the sun would get bent by a slight but detectable amount owing to the dimpling of space around the sun's enormous mass — twice the bending that had been postulated previously. When the calculated gravitational deflection was detected by British astronomers during a total solar eclipse in 1919, the name Einstein, to the physicist's great puzzlement, became a household word, a synonym for genius.

In "Was Einstein Right?" Clifford M. Will, a professor of physics at Washington University in St. Louis, reminds us that the story of general relativity, one of the greatest achievements in 20th-century science, did not end with that solar eclipse experiment. Indeed, experimental relativity has undergone a renaissance over the last 25 years, owing to advances in space-age technology that enable us to check Einstein's hypotheses with uncanny degrees of precision.

The entire solar system now serves as general relativity's laboratory. Modern-day tests of the theory, often not described in detail in books on the subject, deserve their own forum, and Mr. Will skillfully fills this gap. He acquaints us not only with the science and machinery of his specialty, gravitational physics, but with the people who practice it as well. He relates an engaging tale of planetary probes, radio telescopes, gravity-wave detectors and space-borne clocks.

For many decades, general relativity was a very isolated branch of physics, mainly because there were few direct applications. "General relativists," says Mr. Will, "had the reputation of residing in intellectual ivory towers, confining themselves to abstruse calculations of formidable complexity." But the discovery of pulsars and black holes within the Milky Way, as well as violent quasars situated at the edge of the visible universe, dramatically changed this situation in the 1960's. These exotic celestial objects, with their intense gravitational fields, could not be comprehended without the use of Einstein's theory. General relativity was, at last, linked to the real world — or should we say cosmos?

While newcomers to relativity will probably want to start with a more basic primer on the topic, devotees of physics will find "Was Einstein Right?" a welcome addition to the field — and one that has just enough of a popular touch to set it apart from other studies of the subject, with their heavy emphasis on mathematics. For example, the author discusses hydrogen maser clocks, with frequencies accurate to one part in 100 billion, that rocket 6,000 miles above the earth to monitor how time speeds up when a mass is cut loose from our planet's gravitational grip. "A misbehaving monitor designed to keep track of conditions in the rocket clock," we learn, "was brought into line ... by the elegant technique of dropping it on the floor."

EINSTEIN has not gone unchallenged since 1915. Theoretical advances have introduced alternate theories of gravitation throughout this century. With Mr. Will's discussion of the Brans-Dicke theory, at one time general relativity's toughest competitor, his story takes on the trappings of a sports competition. "Who will win?" we wonder, as clever tests are arranged to see if the strength of gravity is not constant, as Einstein predicted, but rather varies over time. The account beautifully illustrates how science usually advances — not by reconfirming well-established tenets, but by meeting the experimental challenges set up by rival theories.

Was Einstein right? By the end of his book, Mr. Will leaves no doubt that the time has arrived for general relativity to take its place as a cornerstone of modern physics. And in the process he makes us marvel, once again, at how Einstein was able to fashion this remarkable theory with mere paper and pencil more than 70 years ago. ❑

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