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Medicine & Science

Proving Einstein was right

Satellite: Gravity Probe B orbits Earth trying to prove the theory of general relativity -- 44 years after the project was proposed.

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It took 44 years to build, and it's designed to resolve one of the most intriguing questions in science: whether Einstein was right about the universe.

Now circling the earth, Gravity Probe B is regarded by some knowledgeable researchers as the most precise scientific tool ever assembled.

The probe's four gyroscopes -- capable of measuring Earth's spin with unprecedented accuracy -- are based on the most perfect spherical objects ever built. Its instruments are encased in a helium chamber, chilled to 455 degrees below zero and can measure a change in angle the width of a human hair from 100 miles away.

"It really is an amazing beast," said C. W. Francis Everitt, 70, the Stanford University physics professor who has been working on the project for 42 years.

But since its launch April 20, the \$750 million probe has seen its share of glitches. Two of the probe's 16 thrusters have malfunctioned. A radiation belt in the earth's Southern Hemisphere created software problems, and unexpected levels of helium gas leaked out when scientists started up the gyros.

Scientists were supposed to spend two months adjusting the probe after launch -- aiming its telescope and blasting jets of helium at the gyroscopes to start them spinning. But with the glitches, those adjustments have taken twice as long as expected.

"Should we be further along by now? Yes. But are we ready now? Yes," said Everitt, the principal investigator.

"We were told that after launch we might expect problems, that things you spend time worrying about are going to be no problem and other things you don't worry about become problems," he said. "That's exactly what happened."

Scientists have corrected the problems by tweaking the gyroscopes and fine-tuning other equipment. So the probe is gradually beginning a year of collecting data, he said.

Researchers not connected with the Mission say glitches are common with satellite launches. "In many of these space missions, there are problems and adjustments early on, after launch. But they seem to have things ready to go," said Clifford M. Will, a Washington University physics professor and chairman of a panel advising NASA on the project.

Gravity Probe B is designed to prove Einstein's theory of general relativity (known in the business as GR), a concept that stunned the scientific world when it was first proposed in 1916.

Einstein theorized that huge objects, such as planets, distort the space and time around them, essentially "warping" or curving them the way a bowling ball placed on a bed would wrinkle the bedsheet.

Two years after Einstein's announcement, Austrian researchers Joseph Lense and Hans Thirring concluded that general relativity also means that as planets rotate, they drag space and time along with them, the way that stirring honey with a spoon creates swirls around the spoon. The phenomenon is known as frame dragging.

To prove Einstein's theory and frame-dragging, Gravity Probe B will orbit 400 miles above the Earth's two magnetic poles, with gyroscopes the size of pingpong balls bonded to a telescope that is trained on a relatively steady guidestar, IM Pegasi.

The probe weighs three tons and is 21 feet long. The gyroscopes operate at super-chilled temperatures in a magnetic field where their spin is carefully monitored. If the theories are correct, the earth's mass and rotation should shift the gyroscopes away from the guidestar alignment, as space and time curve around the Earth.

Researchers will take measurements for a year and spend about four months analyzing the data before announcing results, Everitt said.

Not everyone is convinced that Gravity Probe B is worth the cost. Some critics say it was a good idea when it was conceived 40 years ago, but that Einstein's theory has since been proved by other NASA findings.

"I thought it should have been terminated 15 years ago," said Kenneth Nordtvedt, a former physics professor at Montana State University who has worked on NASA projects.

Nordtvedt said scientists first found proof of relativity in the 1970s by studying radio signals detected from a binary neutron star system known as the Taylor-Hulse Binary Pulsar.

Later, GR was confirmed by fluctuations in laser pulses reflected off mirrors that astronauts planted on the moon, as well as by radio signals from beacons on Mars and sensors on board the Cassini probe, he said.

But other scientists disagree. Although data received by those signals may be consistent with Einstein's theory, they fall short of proving it, they argue. Gravity Probe B will be the first to prove general relativity through direct experiment and observation.

"I've heard both sides and I understand the arguments. But at the end of the day, it'll be a real triumph for our ability to take measurements in space and for establishing general relativity," said Will, who served on panels that reviewed the probe's relevance in 1993 and last year.

Will said that probe may rewrite modern physics -- particularly if it shocks scientists by shooting down the theory. "If it refutes GR, we'll all be falling on our swords," Will said.

Along with developing the technology for Gravity Probe B, backers expended a major effort in mustering support for it in a 40-year fight for funding.

Everitt has spent much of his career lobbying Congress for Gravity B funds. At the launch site last spring, at Vandenberg Air Force Base in California, he was elated. "When I started in physics, I didn't realize it would involve so many other things besides paper and machinery," he said. "It involves money."

Conceived by scientists in the 1950s, the Gravity Probe B mission was first proposed in a paper published by Stanford University physicist Leonard I. Schiff in 1960.

NASA provided the first research funds in 1964. But the project was killed seven times over the years, and the cost ballooned 20-fold, from \$35 million to \$700 million. Since its inception, an estimated 1,000 people have worked on Gravity Probe B. Some 95 scientists have earned doctorates by advancing some aspect of it, Everitt said.

Everitt sees a certain irony in spending so much time, manpower and money to prove a concept that was the brainchild of a single scientist.

"It takes one man about 10 years to come up with a theory, and it takes hundreds of people so much longer to prove it," Everitt said.

For the latest online information on Gravity Probe B, visit [www. gravityprobeb.com](http://www.gravityprobeb.com).

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