<< previous article News for October 2004

Relativity passes latest test

20 October 2004

Einstein's general theory of relativity has survived its latest encounter with experiment. Ignazio Ciufolini of the University of Lecce in Italy and Erricos Pavlis of the University of Maryland in the US have measured a value of the Lense-Thirring effect -- also known as frame-dragging -- that is 99% of that predicted by general relativity (*Nature* 431 958). However, the uncertainty in the result could be as high as 10%, and a number of researchers have pointed put that there might be other sources of error in what is an extremely difficult measurement.

General relativity predicts that massive bodies, like planets and stars, actually distort the fabric of space and time by their presence and also when they move. In particular the theory predicts that large rotating bodies, such as the Earth, will "drag" space-time with them as they turn about their axis.

"The Lense-Thirring effect we have measured is tiny, about two meters per year," Ciufolini told *PhysicsWeb*. "However, frame-dragging effects could be huge around a spinning black hole and they may have important dynamical consequences on the accretion disk of matter by rotating black holes and rotating neutron stars."


LAGEOS 1

Ciufolini and Pavlis analyzed how the orbits of two small satellites, LAGEOS and LAGEOS 2, changed as a result of frame dragging by the Earth. The surfaces of these satellites, which orbit at a distance of about 5900 kilometres, are covered with retro-reflectors that can bounce laser beams from Earth back to the exact position they were sent. By measuring the time it takes for a laser beam to come back from one of the satellites, its position can be calculated with a precision of just a few millimetres. Ciufolini and Pavlis analysed 11 years' worth of data -- a total of about 100 million laser ranging observations -- to obtain their results.

However, the Earth's gravity field is not uniform because of variations in the distribution of mass, and this lack of uniformity has a much bigger effect on the motion of the satellites than the Lense--Thirring effect. To remove these variations -- which are purely Newtonian in origin -- from their calculations Ciufolini and Pavlis relied on preliminary data from the Gravity Recovery and Climate Experiment (GRACE) mission. This mission consists of a pair of satellites that are making detailed measurements of the Earth's gravity field.

Ciufolini and Pavlis say the total uncertainty in their measurements is plus or minus 10% if they allow for unknown sources of error, and they hope to improve on this accuracy with a new satellite called Weber-sat. Meanwhile results with an accuracy of 1% are expected when the Gravity Probe B mission publishes its first results in early 2006.

"The work of Ciufolini and Pavlis is a relatively straight-forward test of frame-dragging, although it depends on error analyses that are difficult to verify," says John Ries of the University of Texas. "I would say I am cautiously optimistic about the results. However, a big danger in this experiment is that the analysts already know the answer they expect to get -- agreement with general relativity -- so there is a real possibility of a bias towards that result."

About the author

Belle Dumé is Science Writer at *PhysicsWeb*

E-mail to a friend

Links

Related Links

Department of Engineering and Innovation at the University of Lecce

Joint Center for Earth Systems Technology at the University of Maryland

LAGEOS 1 and 2

GRACE

Restricted Links

Nature **431** 958

Related Stories

Gravity Probe B takes off

General relativity passes Cassini test

Relativity passes the pulsar test

Slingshot test for general relativity

Author

Belle Dumé