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SATELLITE MAY CHECK RELATIVITY THEORY

From 250 million miles out in space, two spacecraft that flew by Mars last summer are giving scientists a rare chance to check Albert Einstein's theory of relativity.

The spacecraft are Mariners 6 and 7, managed for the National Aeronautics and Space Administration by the Jet Propulsion Laboratory, Pasadena, Calif.

Today, just before Mariner 6 swings behind the Sun, its radio signal will pass very close to the Sun before the signal is occulted (out of "sight"). That will give Dr. John D. Anderson of JPL and Dr. Duane O. Muhleman of the California Institute of Technology the opportunity to verify if the signal is slowed up by as much as two-tenths of a mile per second.

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If Einstein's 54-year-old theory is correct, the slow-up in the round trip signal from JPL's Goldstone tracking station on the Mojave Desert will be only 200 millionths of a second, yet it can be measured. Normal round trip time is about 45 minutes for the radio signal traveling at the speed of light (186,000 miles per second).

As radio signals are beamed to the spacecraft, they will pass within one million miles of the Sun's surface, a relatively short distance by interplanetary standards.

The present experiment, labeled "A Fourth Test of General Relativity," was first proposed in 1964 by Muhleman and Dr. Irwin Shapiro of the Massachusetts Institute of Technology.

Muhleman and Shapiro showed that, if one can measure precisely the time it takes for a radio signal to travel to a planet or spacecraft and back to Earth, the various theories of gravitation can be tested. In Einstein's theory, the velocity of light is slower in the gravitational field near the Sun than in interplanetary space where gravitational fields are weaker. Thus, as the radio signal passes near the Sun the waves are slightly slowed and the total travel time is a little longer.

The radio astronomers hope, by analysis of the Mariner signals, to learn whether Einstein was right when he proposed his gravitational theory or whether more recent observations are correct which indicate Einstein's predictions could be in error by as much as 10 per cent.

"Our experiment could settle this controversy," says Anderson, of JPL, principal investigator on this Mariner test. Muhleman, an associate professor of planetary sciences at Caltech, stresses that "final analysis of the data may take many months."

The experiment was made possible by the precise distance measuring system built by Warren L. Martin, JPL telecommunications research engineer and co-investigator, and by the 210-foot antenna built by NASA at Goldstone and operated by JPL.

Einstein's general theory of relativity is actually a geometrical theory of gravitation. Resolving any doubts about it is "of enormous importance to physicists and astronomers," say Muhleman and Anderson, "because of the fundamental importance of gravity to a better understanding of the universe."

Previously, there have been three methods of testing Einstein's relativity theory, all proposed by Einstein himself. One is that the frequency of spectral lines in the light from massive stars shifts toward the red side of the spectrum. Another is the bending of light rays from distant stars by the Sun's gravitational field.

The third test, measuring the slight change in Mercury's orbit about the Sun, was generally considered valid until recent years.

However, in 1966, Prof. R. H. Dicke of Princeton University made measurements indicating the Sun is slightly oblate, instead of round. He argued that this oblateness (flatness) causes perhaps 10 per cent of the shift in Mercury's orbit and suggested Einstein's theory may need further correction.

On May 10 the same experiment will be performed with Mariner 7 before it passes behind the Sun.

These measurements highlight a year-and-a-half series of radio signal observations of the two Mariners which will run through the end of 1970.

The Mariner radio measurements began on a once-a-week basis last September, a month or so after the spacecraft had completed their data-gathering tasks at Mars and settled into wide-ranging orbits around the Sun.

Radio signals from the 210-foot tracking antenna at Goldstone are shot in a narrow beam with up to 400,000 watts of power. Striking the spacecraft antenna, the signals trigger a transponder which amplifies and returns the signals to Goldstone.

The ranging performance of NASA's Deep Space Network has been improved in recent years so that the total elapsed time can be measured within less than a millionth of a second, say the investigators. They also can establish the actual distance to each spacecraft within 100 feet over the distance of a quarter of a billion miles.

The ultimate accuracy of the "fourth test" will be limited by the investigators' ability to remove the effects of interplanetary electrons which also slow the radio signals but by a much smaller amount. The experimenters say the continuing tests should enable them to determine electron density variations, and learn more about the solar corona and the flow of charged particles from the Sun, the so-called solar wind.

The Mariner program is managed by NASA's Office of Space Science and Applications and the Deep Space Network is managed by the Office of Tracking and Data Acquisition.

MARINER EINSTEIN THEORY TEST