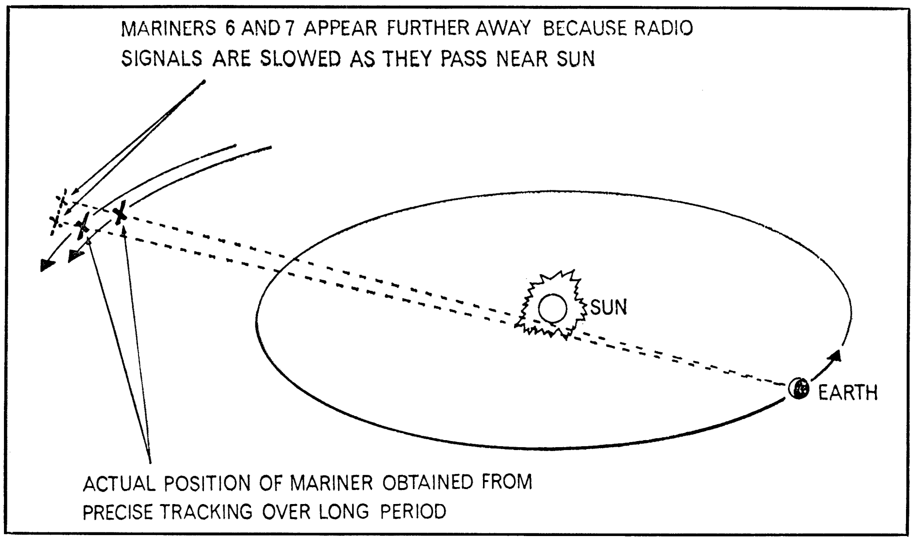
science news
OF THE WEEK

Space Age support for Einstein

Experimenters claim to distinguish between two rival theories of gravity



NASA

Radio signals reflected off Mariner craft were slowed by the sun's gravity.

Einstein's theory of general relativity is, in one of its aspects, a theory of the behavior of gravitational forces. It accounts for modern observations of the behavior of the planets that do not quite accord with the theory of gravity that Isaac Newton put forth in the 17th century, and that disturbed astronomers around the turn of the 20th century.

Einstein's theory also predicts a number of gravitational effects that Newton's did not, and provides an entirely new conceptual framework for cosmological speculations. A number of the Einsteinian gravitational effects, such as the bending of light rays by the gravity of a massive body or the existence of gravitational waves (SN: 6/21/69, p. 593), have been tested experimentally, and proof is claimed for them.

In spite of its experimental successes, a number of physicists have been unhappy with Einstein's theory on philosophical grounds. In the late 19th century the physicist and philosopher Ernst Mach proposed that the strength of gravitational forces should depend on the distribution of matter in the universe. As the universe expands and the total mass in it is spread thinner, gravity should weaken, he said. That is, the force between two bodies of constant mass at a constant distance from each other should weaken as the universe expands.

Einstein rejected this suggestion. In his theory, as in Newton's, the strength of gravity remains constant. Other physicists, however, have put forth theories in which Mach's idea is accepted.

The latest of these theories, proposed by Drs. Carl H. Brans of Loyola University and Robert H. Dicke of Princeton University, has been the subject of a number of inconclusive tests in recent years. The latest, most stringent test, reported at California Institute of Technology last week by Dr. John D. Anderson of Caltech's Jet Propulsion Laboratory, claims definitely to support Einstein over Brans and Dicke.

The test involves the prediction, contained in both theories, that the speed of a light ray passing a massive body will be slowed by the body's gravitational effect. The prediction was first tested two years ago using the sun as the massive body and looking for the slowing of radar beams reflected from planets on the other side of it from the earth (SN: 11/1/69, p. 397). The experiment showed that the slowing occurred, but was not accurate enough to distinguish between the rival theories, which predict slightly different amounts.

The experiment done by Dr. Anderson, with Dr. Duane O. Muhleman, Dr. Pasquale Esposito and Warren L. Martin, used radio signals reflected from Mariners 6 and 7 in the spring of 1970 as the spacecraft went behind the sun. The measured delay in the arrival of the signal at JPL's 210-foot antenna at Goldstone, Calif., was 204 microseconds in a maximum time of round-trip flight of 43 minutes. Einstein's theory predicts a delay of 200 microseconds, the Brans-Dicke theory 186 microseconds.

Dr. Anderson says the results are accurate to between 2 and 4 percent and claims they are a vindication of Einstein. So far Dr. Dicke is not giving up, although he concedes that later, more precise figures may force him to. Dr. Anderson says there is no reason to believe further analysis, to continue through 1971, will reverse the vindication of Einstein.

Dr. Dicke, however, points out that the spacecraft was buffeted about by light pressure, gas jets and solar wind pressure. The orbit varied considerably from its predicted position. The numbers presented by the JPL group were based on a limited part of the data when the spacecraft was relatively near the sun. If data from a wider range of points are included the results do not look as good, says Dr. Dicke, and he thinks that the data may not be as significant statistically as Dr. Anderson believes they are.

JPL

Goldstone antenna received signals.

Dr. Dicke says that he does not know exactly where the question stands at the moment. He is awaiting similar results from the observations of the positions of certain quasars and experiments that measure the bending of the quasar's rays as the sun passes in front of them. The experiments were first performed about a year ago but the results were not accurate enough to distinguish between the Einstein and the Brans-Dicke theory (SN: 6/13, p. 574). The observations were rerun in September, and, although data have not yet been reduced, Dr. Dicke says that the raw data look much better than those of a year ago. He is waiting to see what the reductions will show. □