Lunar laser data uphold Einstein

Physicists have been concerned about the validity of the principle of equivalence at least since the time of Ioannes Grammaticus in the fifth century. The principle of equivalence states that the property of a material body that causes it to generate gravitational forces (which one might call gravitational charge) and the property that causes it to resist the action of any kind of force, commonly called inertia, are one and the same in quality and quantity. Both properties are usually called mass, or as Isaac Newton used to put it, "quantity of matter."

Really serious doubt of the principle of equivalence came when physicists began to study other forces than gravity. The doubt led to the formulation of theories of gravitation that deny the principle. Such theories are generally considered rivals to Einstein's general relativity, because Einstein explicitly accepted the principle of equivalence.

The debate has led to ever more stringent tests of the principle. Two independent analyses of the most ambitious experiment yet, the laser ranging of the moon, called the LURE program, yield data that support the principle rather strictly. The papers follow one another in the March 15 PHYSICAL REVIEW LETTERS. The first is by J. G. Williams and 16 others from a host of institutions ranging from the Air Force Cambridge Research Laboratories to the University of Hawaii. The second is by Irwin I. Shapiro and Charles Counselman III of the Massachusetts Institute of Technology and Robert W. King of AFCRL.

Serious reason for doubting the principle of equivalence usually arises because it makes gravity a special case among natural forces. The property of a body that generates electric forces, electric charge, is not the same as inertia. (And so far as we can tell, the same is true for the two classes of subatomic force, the strong interaction and the weak interaction.) Thus, Galileo's famous experiment works in a gravitational field: Two bodies with different masses fall with the same acceleration and hit the ground at the same time. Their masses cancel out of the relevant equations. In an electric field, two bodies with different masses (but the same charge) do not fall toward the center of the field with the same acceleration, because their masses do not cancel out. This seems to make gravity more intimately connected with the essence of matter than the other three kinds of force.

There are minds in theoretical physics that abhor privileged positions, and more than one attempt to dethrone gravity by formulating a theory that denies the principle of equivalence is current. If the principle is in error, that will show up in the motion of large orbiting bodies, especially the earth-moon-sun system. (The bodies have to be large because, as previous experiment indicates, any deviance is numerically extremely minute even if philosophically very important.)

In practical terms, the difference is that the moon's orbit will not be exactly as Newtonian theory predicts. There will be a slight deviance in the earth-moon distance, a kind of polarization of the moon's orbit toward the sun. This is called the Nordtvedt parameter after Kenneth Nordtvedt, a professor at Montana State University, who first figured it out. The LURE experiment was intended to check the Nordtvedt parameter by continually measuring the moon's distance with laser beams reflected from mirrors that the Apollo astronauts had left there. The results of both analyses indicate, essentially, that the Nordtvedt parameter is zero.

The case is not 100 percent settled. (No case ever seems to be in physics.) R. H. Dicke of Princeton University, one of the signers of the first paper, is one of the formulators of a prominent anti-Einsteinian theory. He is reportedly still somewhat disturbed at the adjustments that had to be made for terrestrial environmental and equipment effects in the data analysis. Possibly further experiments will be attempted, but for now most physicists are likely to bet even more strongly on Einstein and Newton. □

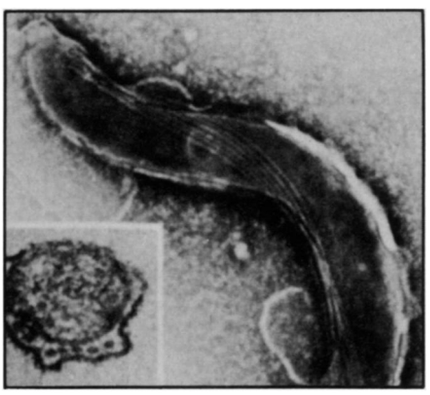
Progress toward a syphilis vaccine

The key to making a vaccine against the venereal disease syphilis is to first grow in the test tube the bacterium that causes it. Although scientists have tried to achieve this goal for many years, they've failed. Now a team of researchers at the Medical Research Institute of the Florida Institute of Technology in Melbourne, headed by Ronald H. Jones, claim that they have finally managed to bring it off. What's more, they've already developed a syphilis vaccine from their test-tube organisms and report that it shows promise in preventing syphilis in experimental animals. Their findings are published in the February issue of the BRITISH JOURNAL OF VENEREAL DISEASES.

They were able to grow the bacteria in the test-tube environment whereas other researchers failed by altering certain highly critical laboratory conditions, Jones explained to SCIENCE NEWS. For example, the syphilis organisms other researchers used were usually derived from animals that had been infected for 30 days. The organisms Jones and his colleagues used were from animals that had been infected for 8 to 11 days. Other investigators used fetal calf serum as a medium in which to grow cell lines infected with the syphilis organisms. Jones and his colleagues dispensed with the serum. Thanks to these and other environmental changes, they finally managed to culture cell lines containing syphilis organisms.

"This is the first definitive record of subcultivating pathogenic syphilis organisms outside of an animal body in the 70-year-plus history of syphilis research," Jones declares. "The growth of this organism in a test tube has provided the necessary first step upon which to develop an effective vaccine against syphilis."

Jones and his colleagues then found that the presence or absence of a slime layer, or capsule-like raincoat, on the syphilis organism apparently correlates with its ability to produce infection. The forms



Electron micrograph of syphilis organism.

that trigger disease have the capsule; the forms that are harmless don't. This recognition led to their learning how to preserve the capsule on the organisms so that they would remain infectious and, hence, be of use for vaccine production. Past methods by other researchers had apparently washed the capsules off.

Then the research group developed a vaccine with preserved capsules from their test-tube syphilis organisms. They gave rabbits one injection of the vaccine and challenged them with a massive dose of live syphilis organisms. The vaccine partially protected the rabbits; they developed far-less-severe infections than did rabbits not receiving the vaccine. Jones and his colleagues are now working on a more effective vaccine. They hope to test it on chimpanzees in two years and to start trials in humans in three to four years.

If a syphilis vaccine is ultimately perfected, Jones foresees that the general population would receive it along with other vaccines given during childhood. Some 25,000 new cases of syphilis are reported in the United States each year, according to the U.S. Public Health Service. Although penicillin can cure patients of syphilis in its earliest stages, many cases go undetected. Victims of advanced cases of syphilis suffer serious damage to their brains, bones and other organs. □

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