

all particles, And the electrical force is weak compared to the extremely strong nuclear force that binds the particles inside an atomic nucleus.

The other known force is that of weak interactions, one example of which is the disintegration of radioactive atoms. This fourth force has a strength between electrical and gravitational forces.

Although the motion of an orbiting satellite is governed strictly by Newton's laws, scientists once proposed using a satellite to make another check of Einstein's relativity theory. Before this was done, however, the effect, called the gravitational red shift, was verified in the laboratory, confirming astronomical observations made on distant stars.

The reddening of light due to gravitation results from the slowing effect that strong gravitational fields have on time, whether time is clocked by the vibrations of atoms or by other rhythmic processes.

### Einstein's Influence

Einstein's concept of general relativity brought a revolutionary change in people's ideas about the world. He showed that time and space are not separate, but joined in a framework, and this mesh of space and time is distorted by mass.

One of the basic assumptions of the general theory is that no detectable difference exists between the force of gravity and the force produced by acceleration outside a gravitational field. Measuring the gravitational red shift has confirmed this assumption.

Scientists for the past few years have been investigating the possibility of "quantizing" general relativity, that is, treating gravitational radiation as if it were not continuous but consisted of tiny packets. This can be likened to the situation with light, which many years ago was thought to be continuous radiation but is now known to consist of tiny light packets, or photons.

The packet of gravitational energy is the graviton. Unlike light, which will interact only with charged particles, gravitons can interact with neutral particles.

### Detecting Gravity Waves

A device to detect gravity waves is in the final stages of construction by Dr. Joseph Weber and his associates at the University of Maryland. The existence of gravity waves, generated by any mass that is accelerated, is predicted by Einstein's general theory of relativity.

Dr. Weber's device is based on the small effect gravity waves are predicted to have on a relatively large mass. When a gravity wave penetrates the mass, small relative motions of different parts occur, setting up tiny internal oscillations.

These internal jiggings can be converted by crystals and low-noise amplifiers into an electrical output in the radio wave range.

Successful detection of gravity waves would be another proof of Einstein's general theory of relativity. Three effects have so far been verified:

1. Changes in the perihelion (the point closest to the sun) of the planet Mercury's orbit, which observations have shown come very close to prediction.

2. The bending of light from faraway stars by the sun's gravitational field, which

comes very close to the amount predicted by Einstein's theory.

3. The displacement, or reddening, of spectral lines due to the gravitational attraction of the sun and certain other stars; laboratory confirmation of this gravitational red shift by measuring the change in frequency of gamma rays given off by iron-57.

Bold experiments on gravitation are scheduled for the future. Some are now in the planning stages. It is, however, difficult to devise new tests because the specific effects of general relativity on matter and energy are very small and hard to measure.

### Paper and Pencil Experiments

Another way of attacking the problem of gravitational research is to use not apparatus but the human brain. Scientists with paper and pencil or chalk and blackboard can perform experiments.

Many are using their fertile imaginations to gain insight into how matter and energy are affected by gravitation.

Among these are Drs. Peter Bergmann of Yeshiva University, New York; Hermann Bondi and F. A. E. Pirani of King's College, London; Nobelist P. A. M. Dirac of St. John's College, Cambridge, England; V. A. Fock of the Academy of Sciences of the USSR; Leopold Infeld, director of the Theoretical Physics Institute of the University of Warsaw; Otto Heckmann of the University of Hamburg, Germany; Oscar Klein of the University of Stockholm; Andre Lichnerowicz of the College of France, Paris; Christian Moeller of the University of Copenhagen; A. Schild of the University of Texas; J. L. Synge of the Dublin Institute for Advanced Study, Ireland; and John A. Wheeler, Princeton University.

They are now turning their attention to the gravitational collapse of very large masses. Discovery of the vast energies released by the superexplosion of cosmic dust in objects 100 million times as massive as the sun at fantastic speed has called for a new analysis of the fundamentals of relativity.

• Science News Letter, 86:298 November 7, 1964

### MEDICINE

## Find Blood to Be Primary In Hardening of Arteries

► EVIDENCE that "fatty plaques" (or hardening of the arteries) are formed from the circulating blood was presented before the annual meeting of the American Heart Association in Atlantic City.

This finding contradicts the popular view that fatty plaques of atherosclerosis must start with initial changes in the artery wall itself, said Drs. I. Ernest Gonzalez and Fred Vermeullen, University of California Medical Center, San Francisco.

Dacron ribbons were suspended in teflon tubes inserted into the chest aorta of rabbits with high fat levels in their blood. The scientists discovered that fatty plaques developed on these ribbons in 150 days. Since the dacron ribbon was in contact only with the blood, it was concluded that these plaques were formed from the constituents of the circulating blood. Similar plaques have been observed by the scientists in synthetic blood vessels grafted into human arteries.

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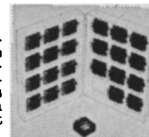
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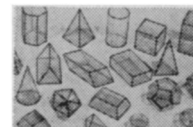
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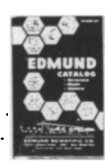
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