SCIENCE NEWS of the week

Evidence for New Force — May Be No. 6

This should be a time of respect for Sir Isaac Newton, what with the 300-year anniversary of his masterwork, the *Principia*. But part of his legacy, the theory of gravity, is certainly taking a beating.

In 1986, physicists reported on experiments that found gravity to be slightly weaker than the value predicted by Newton's theory — a discrepancy they took as a sign of a previously unnoticed fifth universal force. Now a team of Air Force physicists has detected minute *additions* to gravity, which may be manifestations of a sixth force, they reported last week at the American Geophysical Union's fall meeting in San Francisco.

"This is the first indication that there is an additional, attractive force," says Andrew Lazarewicz of the Air Force Geophysical Lab in Hanscom, Mass. "We see more gravity than there should be according to Newtonian law."

The Air Force team had originally set out to detect the controversial fifth force by making precise measurements with a gravity meter on and around a 2,000-foot television tower in Garner, N.C. Earlier experiments had suggested that this force causes objects to repel each other and that the strength of the effect depends on the composition of the material involved (SN: 1/3/87, p.6; 10/3/87, p.212). But the TV tower experiment detected an opposite, attractive force.

It isn't every day that scientists discover a new force. In fact, for the half-century before 1986, physicists confidently believed they could describe the universe in terms of four forces: electromagnetism and gravity, both of which can function over infinite distances; and the subatomic strong and weak forces, which cannot be felt outside the nucleus of an atom. The fifth and sixth forces, if they exist, differ from the others by acting over intermediate distances ranging between a few feet and hundreds of yards.

While these potential forces may become recognized additions to the four-member family of fundamental forces, many scientists believe the recent experiments are revealing a side of gravity, says Lazarewicz, who worked with Christopher Jekeli, Anestis Romaides, Roger W. Sands and group leader Donald H. Eckhardt. In this case, the new "forces" would not exist on their own but would be correction terms to the standard theory of gravity.

If so, they would be small corrections, much weaker than the main Newtonian component. As the Air Force researchers moved up the tower, they measured departures of 0.00005 percent from what Newton's theory predicted the gravity should be. Though minuscule, these discrepancies are 10 times greater than the smallest detection limits of the instruments, giving the group confidence in its results, says Romaides.

To be accurate in their calculations, the researchers had to include the gravitational attraction of the sun, the moon, the air surrounding the tower and even the water table below the earth's surface.

Other physicists were impressed by the experiment. "This is very compelling evidence that there have to be two additional terms [to gravity]," says Mark E. Ander of Los Alamos (N.M.) National Laboratory (LANL).

The Air Force results may seem to contradict the findings of previous fifth-force experiments, but theoretical physicists can explain why this new experiment detected the attractive rather than the repulsive force. "We have two effects that look incompatible but are, in fact, compatible with the only theory that we're taking seriously," says Frank Stacey of the University of Queensland in Australia.

Stacey and others believe that both attractive and repulsive forces fit neatly into new theories that have predicted two additions to standard gravity.

These theories have emerged from attempts to combine all the forces of nature into one Grand Unified Theory. In this work, theoretical physicists have always stumbled when they reached the standard theory of gravity. One of the main problems is that the gravity described by Newton and Einstein simply will not mix with quantum mechanics.

Undaunted, some theoreticians have constructed their own hypothetical force of gravity, molded to be amenable to quantum mechanics. To succeed, they have had to add new terms to the standard equations. Says theorist Mike Nieto of LANL, "It is a generic conclusion of quantum gravity that there will be new aspects to gravity, in particular that there will be a new repulsive force and a new attractive one."

To explain their results, the Air Force physicists hypothesize that the new repulsive force is stronger than its attractive counterpart at close range; but at a longer range, the attractive force can outdistance the other and dominate.

Therefore, the gravity experiments conducted deep within a mine measured the repulsive force, because the instruments were surrounded by dense matter. But these researchers made their measurements on the surface of the earth and on the TV tower. With their instruments removed from the dense earth, they could detect the longer-range, attractive force, says Romaides.

Though the Air Force observations conveniently match some of the predictions of quantum gravity theory, all involved caution that convenience does not constitute scientific proof.

Moreover, several gravity experiments in the last year have failed to measure any departures from standard gravity, and most scientists are unconvinced that there are any new forces at all.

But as more experiments turn up with positive results, scientists are beginning to take notice, says Nieto. "There have been many times in the history of physics where people have thought they've seen important things and they haven't; it was experimental error," he says. "The point is that there are so many people seeing funny things now. It sure looks interesting." — *R. Monastersky*

Solar cycle linked to weather

Atmospheric scientists have discovered a strong statistical link between the 11-year solar cycle and the weather here on earth — a finding that may eventually help explain why some winters are mild while others are unrelentingly harsh. The report was presented last week at a meeting of the American Geophysical Union in San Francisco.

Scientists have known about the solar cycle for more than a century and have long attempted to associate it with weather and a host of other phenomena. "The number of polar bears, the length of women's skirts, the stock market: Everything imaginable has been correlated with the solar cycle," says Harry van Loon of the National Center for Atmospheric Research (NCAR) in Boulder, Colo. "The field has been in ill repute."

The cycle is actually a minute variation in different properties of the sun. During the cycle maximum, ultraviolet and X-ray radiation increase, more sunspots appear on the surface of the sun and the total solar output is greatest.

Previous attempts to find a link between the cycle and the variations in weather have failed. When scientists look at the weather from one year to the next, temperature and air pressure and other aspects vary wildly, with no connection to the cycle. But Karin Labitzke, of the Free University in West Berlin, discovered in March that if she included only certain years, the stratospheric winter temperatures over the North Pole closely followed the solar cycle.

Labitzke grouped years according to a pattern of stratospheric winds over the