Antimatter takes a free gravitational fall

A hammer and a feather dropped simultaneously from a given height in an airless environment will hit the ground at the same time – as vividly demonstrated in 1971 by an astronaut who performed this experiment while standing on the moon's surface. In other words, influenced only by gravity, different objects fall with the same acceleration. But what would happen if one of the two test objects consisted entirely of antimatter? Would it fall in exactly the same way as ordinary matter?

According to Einstein's general theory of relativity, a particle and its antiparticle should accelerate identically in a given gravitational field, an idea enshrined in the so-called equivalence principle. But the tremendous technical difficulties associated with measuring the gravitational acceleration of an antiproton or positron in free fall have so far prevented experimenters from directly testing this prediction.

Two groups of researchers have now independently reinterpreted existing experimental data to provide indirect evidence that, within limits, antimatter really does fall with the same acceleration as ordinary matter. They report their conclusions in separate papers in the Feb. 18 PHYSICAL REVIEW LETTERS.

Richard J. Hughes and Michael H. Holzscheiter of the Los Alamos (N.M.) National Laboratory use the results of an experiment performed at Harvard University by Gerald Gabrielse and his team. It showed that a proton and an antiproton have the same mass to a precision of four parts in 100 million (SN: 7/21/90, p.38). The Harvard researchers determined the relative masses of the particles in that experiment by measuring the frequencies at which protons and antiprotons orbit around magnetic field lines.

Using the idea that gravity acts on energy as well as mass, Hughes and Holzscheiter argue that any differences between the frequencies observed for protons and antiprotons set an upper limit on the extent to which the gravitational behavior of antimatter can differ from that of ordinary matter. "These particles are in the gravitational field of the whole universe," Hughes says. "If the gravity of the rest of the universe pulls on the kinetic energies of particles and antiparticles with different strengths, then the two [types of] particles would orbit at different frequencies."

The Harvard results show that any such effect, if it exists at all, must be exceedingly small.

Eric G. Adelberger and his colleagues at the University of Washington in Seattle rely on the results of high-precision experiments originally designed to ferret out a nongravitational, "fifth" force (SN: 9/22/90, p.183). They argue that if antimatter falls with an acceleration different from that of ordinary matter because of the influence of additional, gravitational forces like those that arise in various theories of quantum gravity, this effect would show up in a special way in their experiments, even though they performed their experiments using ordinary matter.

"The very great precision achieved in our fifth-force type of experiments allows us to say something really quite significant about the predicted effects of antimatter," Adelberger says. The results suggest that additional gravitational forces, which would have anomalous effects on antimatter, can't exist unless they exert an influence over such short ranges – less than a few centimeters or so – that there are no measurable, macroscopic effects.

Despite these efforts to resolve the question of which way antimatter falls, some researchers believe the real test will come only with a direct measurement of an antiparticle's gravitational acceleration. "I don't feel completely comfortable with all this nifty theory," Gabrielse says. "As always in this business, you look for the unexpected. There could be surprises there that we don't know about."

– I. Peterson

New marker may aid Alzheimer's diagnosis

Discovery of an association between an important brain enzyme and Alzheimer's disease may help researchers understand the biological basis for this dementia and help physicians diagnose the illness sooner.

Most Alzheimer's victims – and some individuals suffering other forms of dementia – appear to carry a variant form of the enzyme acetylcholinesterase (AChE), a study in the Feb. 23 LANCET indicates. Normal forms of AChE break down acetylcholine, which acts as a messenger between individual nerve cells. The variant's function in the brain remains undetermined, says neuropharmacologist A. David Smith of Oxford University in England, an author of the new study.

Smith and his colleagues sampled cerebrospinal fluid from 61 people who died from various causes. Assays from 19 of the 23 individuals diagnosed with only Alzheimer's during an autopsy contained a form of AChE not found in the 19 people without dementia. The same variant AChE turned up in four of eight people who had suffered from other forms of dementia.

Though healthy neurons produce as many as eight discrete forms of AChE, scientists do not yet understand why, Smith says. The new variant might result from a genetic defect, or some later alteration of a normal enzyme.

Some form of AChE occurs in many of the neural pathways affected by Alzheimer's. As a result, Smith says, researchers have suspected that an AChE abnormality might play a role in the disease. Though previous research showed that AChE levels in brain tissues affected by the disease are lower than normal, researchers remain unsure of the enzyme's role in Alzheimer's, he notes.

The new AChE finding may eventually help researchers answer this question. But for now Smith plans to develop its potential as a marker to help physicians more accurately diagnose Alzheimer's in living patients, thereby offering the prospect of earlier treatment. Though other potential markers are being explored, physicians still confirm this disease only through postmortem exams.

A good Alzheimer's marker would be very important, agrees Israel Hanin, a neuropharmacologist at Loyola University of Chicago's Stritch School of Medicine in Maywood, Ill. However, he stresses the new findings must be confirmed elsewhere, because "different populations may [develop Alzheimer's] for different reasons." In the United States, Alzheimer's disease afflicts an estimated 4 million individuals, primarily aged 65 and older.

Smith's team has already begun follow-up work to determine the newly discovered AChE's frequency among people with various dementias and to study its potential as a marker for Alzheimer's.

– W. Gibbons

portrait of Venus

With each passage around Venus, the Magellan spacecraft's radar penetrates a blanket of acrid clouds to map a slightly different swath of this planet's surprising and splendidly varied terrain. The "radar-bright" mountains pictured here, called Freyja Montes, appear light colored because they reflect Magellan's radar signals well.

Planetary geologists say this may mean Freyja Montes is younger than the darker mountains to the north, or that they may contain different rock types, such as iron pyrites. Valleys within the darker mountainous region appear partially flooded by lava flows.

The smooth, dark plains at the image's bottom left represent the northernmost reaches of an area called Lakshmi Planum, which also shows signs of extensive volcanism. This mosaic image encompasses about 130,000 square kilometers in Venus' northern hemisphere.