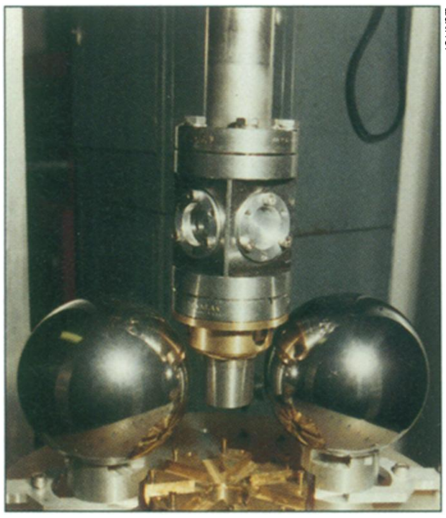
Gravity's force: Chasing an elusive constant

Determining the values of fundamental physical constants has long served as a test of both physical theory and measurement technology. Now, experiments by three independent groups have produced values for the strength of the gravitational force (G) that disagree significantly with the currently accepted number and with each other (see table).

The teams involved in these experiments reported their results at last week's American Physical Society meeting, held in Washington, D.C.

"Each of these groups has done a careful job, but G is an extremely hard number to nail down," says George T. Gillies of the University of Virginia in Charlottesville.

The problem stems from the fact that gravity is much weaker than the other



Luther

Apparatus for measuring G at Los Alamos.

forces of nature. Moreover, it's always attractive, and there's no way to shield an experiment from external gravitational influences.

Mark P. Fitzgerald and his coworkers at the Measurement Standards Laboratory in Lower Hutt, New Zealand, used a torsion balance, which consists of a copper bar dangling horizontally from a thin, tungsten wire fastened to the bar's midpoint (SN: 3/12/94, p.376).

Normally, the gravitational force of two large masses brought near the bar's ends causes it to rotate, slightly twisting the wire. To avoid complications due to wire twisting and bar oscillations, the researchers applied an electric field to attract the copper bar and balance the gravitational force, keeping the bar still at all times. By carefully measuring the compensating electric force, they could deduce the gravitational force and calculate G.

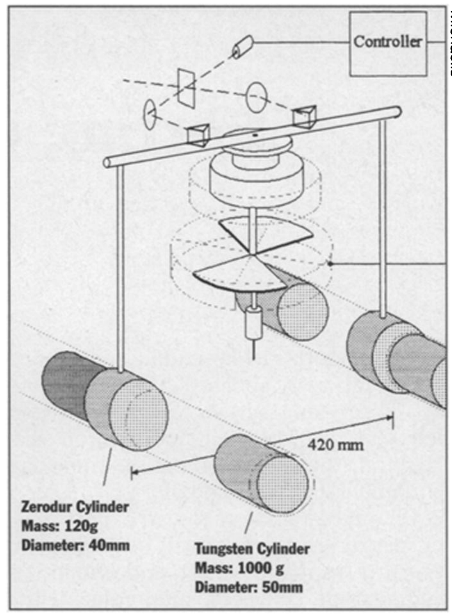
Winfried Michaelis and his group at the Physikalisch-Technische Bundesanstalt in Braunschweig, Germany, also used a torsion balance in which an electric force compensates for the gravitational force between pairs of masses (see diagram). In this case, the researchers eliminated the complicating effects of the wire by hanging metal cylinders from either end of a beam and letting the beam's support float in a mercury bath.

Hinrich Meyer and his colleagues at the University of Wuppertal in Germany adopted a different approach. This group used microwave technology to measure minute changes in the oscillation frequencies of a pair of pendulums disturbed by the movement of large masses in their vicinity.

The fact that these three, carefully performed experiments give different results "is truly a scientific mystery," comments Eric G. Adelberger of the University of Washington in Seattle. However, it doesn't necessarily imply that the physical theory is faulty.

"Each apparatus has its own idiosyncrasies," Gillies notes. "The differences among these numbers probably can be explained by extraneous gravitational effects that weren't properly accounted for." But no such confounding factors have yet been identified.

It remains unclear in what way the accepted value of G will change to reflect the new findings. Meanwhile, Gabriel G. Luther and his colleagues at the Los Alamos (N.M.) National Laboratory are preparing for a new measurement of this elusive constant. —*I. Peterson*



Michaelis

Torsion balance used by Michaelis and his colleagues.

New determinations of the gravitational constant, G

G	$\times 10^{-11}$ m^3/kg s^2
Currently accepted value	6.67259(85)
Fitzgerald *et al.*	6.6656 (6)
Meyer *et al.*	6.6685
Michaelis *et al.*	6.71540

Baby turtles journey across the Pacific

Off the coast of Baja California, 10,000 juvenile loggerhead turtles munch on the area's plentiful crabs and grow into adults. These young reptiles rest at the heart of a long-standing puzzle in marine biology: There are no known loggerhead nesting sites on the eastern side of the Pacific.

The nearest sites lie in Japan and Australia. Young turtles "head out into the water as 3-inch-long hatchlings," says Brian Bowen of the University of Florida in Gainesville, and researchers found it hard to accept that they could survive the 10,000-kilometer swim to Baja, a distance spanning more than one-third of the globe. The trek to Baja would rank among the longest documented marine migrations.

But fishermen often catch juvenile loggerheads in the North Pacific, causing scientists to rethink their disbelief in the voyage. And now a team led by Bowen appears to have proved that this incredible journey does take place.

Bowen's group obtained mitochondrial DNA samples from the loggerhead turtles at the Japanese and Australian nesting grounds and compared them to samples taken from 26 Baja juveniles and 34 ones caught inadvertently by North Pacific fishermen. Ninety-five percent of the juveniles carried the same distinctive genetic sequences as the baby turtles in Japan; the rest matched the DNA markers of the Australian turtles, they report in the April 25 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The case for a trans-Pacific migration is not completely nailed down, the authors acknowledge, since a remote possibility still exists of a hidden East Pacific nesting ground whose the turtles have the same DNA sequences.

Also unclear is whether the Baja turtles, after maturation, recross the Pacific and return to their nesting grounds. Knowledge of the migratory routes, the authors stress, will help in assessing the impact of commercial fishing on an already dwindling species. —*J. Travis*