Physics

By the weight of the silvery moon

Scientists at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, have unmasked an unlikely culprit — the moon — in accounting for small, but significant fluctuations in the energy of particle beams circulating in the Large Electron Positron (LEP) collider. These tiny energy variations became apparent about two years ago as physicists steadily increased the precision of measurements of the mass of a subatomic particle known as the Z^0.

At the LEP collider, beams of electrons and positrons travel around an underground ring with a circumference of 26.7 kilometers. A radio frequency system keeps the particles circulating at a constant number of revolutions per second. However, tides induced by the moon's gravitational attraction not only make the oceans bulge, but also deform the Earth's crust. These deformations — which rise and fall over a period of roughly 12 hours — are enough to stretch or shrink the collider's circumference by nearly 1 millimeter. To keep circulating at a constant frequency, particles drift to slightly different paths around the collider at various times, depending on the moon's position. Such minute changes in path alter the beam energy by as much as 10 million electron-volts — enough to make the moon's gravitational effect the cause of the dominant error in determinations of the Z^0 mass. Thus, to calibrate the beam energy and keep improving measurement precision, it now pays to have an almanac or tide table handy.

Charmed at last

The "November revolution" of 1974 saw the dramatic discovery by two groups of a new subatomic particle — called either psi or J — that set the stage for wide acceptance of the idea that particles such as neutrons and protons are themselves made up of entities known as quarks. The psi/J particle consists of a charm quark paired with a charm antiquark to form a combination known as charmonium.

Just as a hydrogen atom — which consists of an electron and a proton — has various energy levels, charmonium has a so-called ground state and a number of excited states. In fact, the psi/J particle is actually charmonium in one of these excited states. Over the years, physicists have detected in the debris from electron-positron annihilations nearly all of the possible energy states of charmonium. Now, members of the E760 collaboration at Fermilab in Batavia, Ill., have finally observed charmonium in its fifth energy level — and they did it by sifting through proton-antiproton annihilations.

"This revolutionary technique of creating charmonium particles by proton-antiproton annihilations is also being used by the E760 collaboration to study the properties of other charmonium particles with unprecedented precision," says theorist Eric Braaten of Northwestern University in Evanston, Ill. Braaten recently contributed to theoretical work that makes possible the calculation of charmonium lifetimes consistent with the results of the E760 experiment.

Channeled particles in bent crystals

The spaces, or channels, between the planes of atoms in a silicon crystal provide a unique passageway for speeding subatomic particles. By slightly bending the crystal, researchers can even change the direction of high-energy beams. Members of the E761 collaboration at Fermilab have now confirmed that a silicon crystal 45 millimeters long and bent through just a tenth of a degree can cause a charged particle with spin, such as a proton, to precess, or rotate — just as gravity causes the axis of a spinning top to precess. This effect, reported in the Dec. 7 PHYSICAL REVIEW LETTERS, enables researchers to measure a charged particle's magnetic properties much faster than they can with conventional techniques.

Science & Society

Painful prospects for academic R&D

The Cold War's end warrants a reexamination of the nation's research and development (R&D) system — especially in light of today's slow economy, says White House science adviser D. Allan Bromley. Two groups have already offered assessments of the long-term prospects for the nation's 170 or so "research-intensive" universities. Their reports, released Christmas week, conclude that these and other research institutions face "painful decisions" if they hope to enter the next century robustly.

For instance, the President's Council of Advisers on Science and Technology (PCAST), a panel of experts largely from outside government, notes that because "we do not expect that the expansive days of the 1960s and of the early 1980s will be characteristic of the next decade . . . [research universities should exhibit] a sharp preference for quality over quantity." In simple terms, this means that many should consider "eliminating or downsizing departments rather than sustaining less than world-class quality," says Harold Shapiro, Princeton University's president and PCAST's vice-chairman. Indeed, the PCAST study argues against expanding the academic research system — at least not until the U.S. economy improves dramatically.

Among other controversial recommendations, PCAST suggests that many basic-research projects currently earmarked for national labs should in the future be open to competitive proposals from universities and industry. Bromley, who returns to Yale University following Clinton's inauguration, offered SCIENCE NEWS his own favorite recommendation: the development of a perhaps $4 billion competitive grants program to finance the modernization of existing academic research facilities over the next five to 10 years.

A new report of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) largely supports PCAST's findings and recommendations. However, as one might expect of a document drafted by representatives of 18 federal agencies, FCCSET's suggestions were worded much more vaguely.

Briefs: Help is on the way

• The Environmental Protection Agency has just set up a toll-free, 24-hour telephone hotline on lead, the first activity of its National Lead Information Center. Parents calling 1-800-LEAD-FYI (800-532-3394) will receive recommendations for reducing a child's exposure to the toxic heavy metal. In a few months, EPA plans to add a clearinghouse to disseminate technical data and information to professionals and the public.

• By May, manufacturers must begin phasing in new food labels. The Food and Drug Administration first announced plans in July 1989 to make "sweeping changes" in the nutrition data that labels provide. But the 2,000-page proposal it released in November 1991 unleased a flood of criticism. Last month, FDA unveiled its revised, final proposal — now 4,000 pages long — after President Bush resolved a major dispute between FDA and the Department of Agriculture. Key changes include a listing of per-serving quantities of saturated fat, cholesterol, fiber, and other key nutrients; identification of how those compare to a recommended daily amount; strict definitions of such previously vague terms as "light" and "high-fiber"; and permission to make certain health claims.

• Argonne (Ill.) National Laboratory has instituted an electronic bulletin board, called NEWTON, for science teachers and students "at any level." Teachers can retrieve ideas for classroom demonstrations, field trips, and on-line conferences. Students may be more interested in the service's "Ask a Scientist" feature, where researchers post answers to specific queries. Computers with modems can reach NEWTON at 1-708-252-8241 or log on through Internet.