1440 Crunch time for cell phone suits

1443 Strong medicine for Imperial College

1444 Restoring the Danube delta

hike annual stipends for three graduate research and teaching fellowship programs from $18,000 to $21,500. That's $1000 above the agency's request and in line with Colwell's goal of making them more competitive (*Science*, 30 March, p. 2535).

Appropriators also took the rare step of committing hard cash—$5 million apiece—for two proposals to bolster undergraduate science and engineering that are still working their way through Congress. One, for scholarships to undergraduates who agree to be science teachers, is described in a bill (H.R. 1858) by Representative Sherwood Boehlert (R–NY), chair of the House Science Committee; the other (S. 1549), championed by Senator Joe Lieberman (D–CT), would reward universities that promise to produce more science and engineering majors. The Administration's new science and math partnerships program to link universities and local public schools was funded at $160 million rather than the $200 million requested.

–JEFFREY MERVIS

SPACE STATION

Partners Protest U.S. Plans to Shrink Crew

A U.S. plan to scale back the international space station has triggered a revolt among the project's foreign partners, who fear the cuts would ruin their research programs. Led by Canada, the partners are demanding a meeting with U.S. officials to try to reverse cost-saving moves that could leave the station with half its planned six-member crew.

A scaled-back station "would virtually eliminate the partners' collective ability to use" the station, declares a diplomatic note sent on 1 November by Canada to the U.S. State Department. A three-person crew would limit Canada to "30 minutes per week—which is not enough time to conduct any meaningful science," according to notes accompanying the message.

The outcry came as key lawmakers and a senior White House official tacitly agreed at a 6 November congressional hearing to support—at least temporarily—a less capable station with half the planned crew. The idea was put forward earlier this month by a panel led by retired aerospace executive Thomas Young (*Science*, 9 November, p. 1264). Meanwhile, lawmakers last week also approved a 2002 space station budget that cuts $75 million from the station's $2 billion annual budget and leaves little room for additions to reach its planned design (see previous page).

The partners, whose allocation of research time is based on the size of their investment in the station, say that the idea for a less capable version was hatched without their participation. In its note, Canada proposes a meeting of all the station participants to express their concern. That meeting, which has the backing of European and Japanese officials, likely won't take place until January.

The timing of the Young report is particularly awkward for the European Space Agency (ESA). Ministers from 15 states—including 11 that are members of the station effort—are meeting this week in Edinburgh to approve a $900 million research program for the station from 2002 through 2006. ESA's Columbus laboratory is slated to be launched at the end of 2004. But with routine maintenance and operations taking up more than 80% of the time of a three-member crew, there will be little opportunity for research. That's why the original plan to have six or seven astronauts on board is "an essential requirement," says Hebert Diehl, chair of the European partners' coordinating committee, in a 2 November letter to a senior State Department official.

Japanese officials were working on a similar statement. Japan is preparing to launch a laboratory module that will require a significant crew to conduct experiments in a wide range of materials and life sciences areas.

U.S. officials testifying last week assured Congress that the cuts need not affect the station's ultimate role as a research platform. The Young plan is "a good course of action" that the Bush Administration could endorse, says Sean O'Keefe, deputy director of the Office of Management and Budget. If NASA comes up with a credible way to complete the original version in the next 2 years, he added, "then there will be no diminution" of the space station's capability. House Science Committee Chair Sherwood Boehlert (R–NY) also expressed cautious support for the Young panel's suggestions, noting later that Congress was "in no mood" to boost spending on the station until NASA demonstrates better management oversight.

–ANDREW LAWLER

CREDIT: D. DUCROS/ESA

Goodbye Columbus? European scientists hope that U.S. cuts won't cramp their use of the Columbus lab module.

PALEOCLIMATE

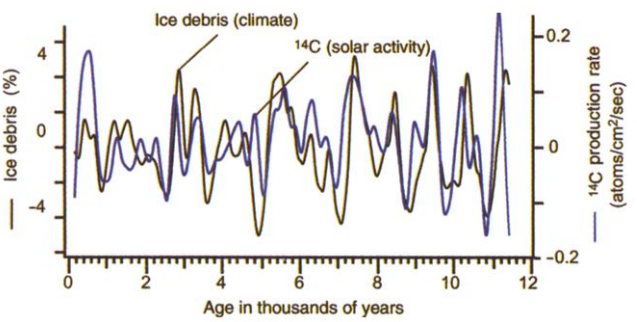
A Variable Sun Paces Millennial Climate

Most scientists have long assumed that the sun shone steadily, its unvarying brightness the one constant in a climate system that seemed to lurch willy-nilly from one extreme to another over the millennia. From time to time, a few brave souls would suggest that the sun actually waxes and wanes with a steady beat, driving earthly weather or climate in predictable cycles. But the proposed correlations between sun and climate would usually collapse under closer scrutiny. Now, prospects are brightening for the putative connection between a varying sun and climate change on the scale of millennia.

In a paper published online this week by *Science* (www.sciencexpress.org), paleoceanographer Gerard Bond of the Lamont-Doherty Earth Observatory in Palisades, New York, and his colleagues report that the climate of the northern North Atlantic has warmed and cooled nine times in the past 12,000 years in step with the waxing and waning of the sun. "It really looks like the sun has mattered to climate," says glaciologist Richard Alley of Pennsylvania State University, University Park. "The Bond *et al.* data are sufficiently convincing that [solar variability] is now the leading hypothesis" to explain the roughly 1500-year oscillation of climate seen since the last ice age, including the Little Ice Age of the 17th century, says Alley. The sun could also add to the greenhouse warming of the next few centuries.

The new sun-climate correlation rests on a rare combination of long, continuous, and

highly detailed records of both changing climate and solar activity. The climate record is a newly enhanced version of Bond's laborious accounting of microscopic rocky debris dropped on the floor of the northern North Atlantic during cold periods (*Science*, 25 June 1999, p. 2069). Ice on or around Canada, Greenland, and Iceland picked up these bits of rock and then floated into the North Atlantic, where the ice melted and dropped its load of debris. Bond and colleagues had found that the debris jumped in abundance every 1500 years (give or take half a millennium) as the ice surged farther out into a temporarily colder Atlantic. During spells of exceptional cold in the last ice age, huge amounts of ice crossed the Atlantic as far as Ireland, but even during the current warm interglacial interval a weaker millennial climate pulse continued across the Atlantic.



Well-matched wiggles. The synchroneity of fluctuations in ice-borne debris (black) and carbon-14 (blue) suggests that a varying sun can cause millennial climate change.

Records of solar activity are found in both carbon-14 in tree rings and beryllium-10 in cores of Greenland ice. Both isotopes are the products of cosmic rays striking the upper atmosphere. The solar wind of a brighter and more active sun would magnetically fend off more cosmic rays, decreasing production of carbon-14 and beryllium-10. Trees take up the carbon-14 to add new growth rings, and the beryllium-10 falls on Greenland snow that then forms annual ice layers.

The test for a sun-climate connection comes when the two types of records are put together for comparison. The more in synch the sun and climate are, the more it looks like the sun is driving climate change. "It's a strong result," says Bond. "You can do statistics on it," but what really persuades him is "what you see" in a plot of the two records: the close match between the peaks and troughs of the climate record and those of the solar record. Simple analysis gives correlation coefficients between 0.4 and 0.6. "That's a very high correlation" for separate geologic records, says geophysicist Jeffrey Park of Yale University. "It's not on the margin. It shows that the connection is real." Time series analyst David Thomson, soon to be at Queen's University in Kingston, Ontario, agrees that the statistics are good, "but their experiment may be good enough even without statistics. I think they've got a fairly convincing case."

As warm as the reception for a sun–millennial climate link may be, researchers caution that much is left to be sorted out. "It remains a little hard to figure out exactly how the sun has mattered to [recent] climate," says Alley, "and why it has mattered so much." The dimming and brightening was too small to alter the climate directly with changes as dramatic as the Little Ice Age, especially in the high-latitude North Atlantic, where the chill seems to have been greatest.

Alley points to growing evidence that solar variations can gain leverage on the atmosphere by altering the circulation in the stratosphere, which in turn changes the circulation below in the lower atmosphere (*Science*, 19 October, p. 494). Once near the surface, the solar influence might induce a change in ocean circulation. A self-sustained oscillation in the rate at which far northern North Atlantic waters sink into the deep sea had been the leading alternative to a solar influence. Given the cooling pattern they find across the Atlantic during the last few cycles, Bond and his colleagues suggest that deep-water formation does in fact oscillate, but the timing of the oscillation would be influenced by the now seemingly inconstant sun. **–RICHARD A. KERR**

CREDITS: (LEFT TO RIGHT) G. BOND *ET AL.*; ICRR/UNIVERSITY OF TOKYO

HIGH-ENERGY PHYSICS

Neutrino Oddity Sends News of the Weak

Physicists are excited, once again, about a potential conflict with the Standard Model of Particle Physics. Measurements of the behavior of neutrinos, made by a team at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, suggest that the Standard Model may misgauge the strength of one of the fundamental forces of nature. Although not conclusive, the results might signify an undiscovered particle—or an experimental fluke.

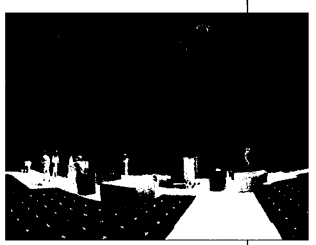
The Fermilab experiment measured θ_W ("theta-sub-w"), a quantity called the weak mixing angle. Although not an angle in the ordinary sense, θ_W smells like one to a mathematician. Roughly speaking, it measures the relation between the electromagnetic and weak forces: Different values of θ_W yield different pictures about the relative strengths of the forces at different energies.

ScienceScope

In the Dark In a major setback for neutrino observations, the Super-Kamiokande neutrino detector in central Japan has been knocked out of commission during repairs to the $100 million facility.

Buried a kilometer underground in a mine, Super-Kamiokande is a 39-meter-by-41-meter tank of water lined with 11,146 photomultiplier tubes that watch for a characteristic glow, known as Cerenkov radiation, from the statistically rare interaction of ephemeral neutrinos and atomic particles in the water. In 1998, it provided researchers with the first convincing evidence that neutrinos have mass.

The tank was emptied in August to replace 100 burned-out tubes and was being refilled on Monday when more than half of the tubes suddenly shattered in an apparent chain reaction. Yoji Totsuka, director of the University of Tokyo's Institute for Cosmic Ray Research, which heads an international collaboration operating Super-Kamiokande, says he has no idea what caused the accident or how soon the facility can be put back online. One scientist estimated that it could cost $10 million just to replace the tubes.



Deep Decision The underground science movement is still kicking. Congress last week included $10 million in a housing appropriations bill to prevent an abandoned gold mine from flooding. The money, for a skeletal crew and equipment to keep the mine dry, keeps alive scientists' hopes of transforming the Homestake gold mine in Lead, South Dakota, into the world's deepest underground laboratory (*Science*, 15 June, p. 1979). Scientists studying certain phenomena, such as neutrino signatures, need such sites to shield experiments from cosmic radiation.

Senator Tom Daschle (D–SD) and mine owners last month worked out environmental and liability issues that threatened to scuttle the plan. Ironically, Daschle aides were hammering out the final deal in the senator's Washington, D.C., office when they learned that a staffer had just opened the anthrax-bearing letter, according to *The Wall Street Journal*. While members of Daschle's staff wait to return to their shuttered building, researchers await word from the National Science Foundation on a $281 million proposal to build the underground lab.