pattern of sidebands in the climate record, including a prominent 107,000-year oscillation. Frequency modulation "changes periodically the duration of the ice ages," says Rial. "It's a pretty idea."

He can't point to a particular physical mechanism that would translate the 413,000-year cycle into a lengthening and shortening of the 100,000-year cycle, although he says that the longer cycle of sunlight changes may interact with an oscillating part of the climate system, such as ice sheets. Even so, other climate specialists are taken with the frequency-modulation idea. "I like very much the ideas of Rial," says paleoclimatologist André Berger of the Catholic University of Louvain in Belgium. "Orbital forcing is certainly the pacemaker." The fit between the predicted pattern of oscillations and the climate record is "intriguing," says geodynamicist Bruce Bills of the Scripps Institution of Oceanography in La Jolla, California, but "it would be even better if you could point to an obvious physical mechanism that would explain why the system works that way."

How the glaciation in the north got started in the first place 2.75 million years ago is another enigma. Earth had been cooling for 50 million years, perhaps because waning carbon dioxide was reducing the atmosphere's greenhouse effect—although that idea has recently been questioned (*Science*, 11 June, p. 1743). Another push toward glaciation could have come when the Isthmus of Panama closed about 4.5 million years ago, shutting the passageway between the Atlantic and Pacific oceans and redirecting warm ocean currents into the North Atlantic. That would have increased the supply of moisture to high latitudes and hence fostered the snowfalls that built the ice sheets. But sizable ice sheets still failed to form in the north for another 2 million years, suggesting that at least one more factor was still missing. Candidates have included a surge in North Pacific volcanism (*Science*, 10 January 1997, p. 161), whose airborne debris would have further cooled climate, and a change in Earth's nodding.

Now a hint of an astronomical trigger for Northern Hemisphere glaciation has turned up beneath a field of sunflowers in central Hungary: a high-frequency climatic "buzz" apparently excited by Earth's orbital wobbling. The sunflowers grow over the bottom sediments of a now-vanished lake, where Willis and her colleagues retrieved a 320,000-year climate record spanning the onset of glaciation. It is largely made up of annual layers created by minerals that precipitated out of the lake in summer, alternating with wintertime algal blooms. So far, the researchers have sampled the core at 2500-year intervals, extracting pollen whose species composition varies as the climate changes. They found an abrupt increase in pollen from plants of the cold, boreal forest that began 2.75 million years ago, the same time that marine sediment isotope records show ice sheet formation accelerating.

The pollen also shows short warmings and coolings lasting just 5000 to 15,000 years. Such cycles, also known from other records, are shorter than any astronomical cycle, and climate researchers think some may be overtones of Milankovitch oscillations created in the climate system, like the squeaking of an overblown clarinet (*Science*, 14 January 1994, p. 174). In the lake record, the buzz intensifies 2.75 million years ago, when the orbital wobbling intensified. That's just when the boreal forest raced southward and the ice sheets swelled; Willis thinks the intensified buzz could have been the trigger. She suggests that the quick bursts of cold could have fostered ice buildup, while the intervening warm periods would have been too short to melt all the ice.

Berger and others are impressed with the detailed view of climate afforded by the Hungarian lake core. "They clearly see sub-Milankovitch [climate] periodicities," says Berger, but he says the connection between Milankovitch forcing, the climate buzz, and the onset of glaciation is not yet so clear. The answer may still lie in a closer look beneath the sunflowers. **–RICHARD A. KERR**

CREDIT: (TOP) GRANT HEILMAN

PHYSICS

DOE to Review Nuclear Grant

Cold shoulder. DOE is taking a second look at a grant to George Miley that critics say involves cold fusion.

The U.S. Department of Energy (DOE) is reconsidering a grant that critics say will fund "cold fusion" experiments. DOE officials this week announced that a special review panel will take a fresh look at the science underpinning the $100,000 project, which proposes to test a new method of transforming radioactive waste into harmless byproducts. The restudy represents a potentially embarrassing stumble for DOE's new $19 million Nuclear Energy Research Initiative (NERI), which DOE officials pledged would use top-notch external reviewers to pick the best projects (*Science*, 11 December 1998, p. 1980).

The grant, to George Miley, a nuclear engineer at the University of Illinois, Urbana-

ScienceScope

To GM or Not? Scientists from around the globe are planning a joint statement on the potential risks and benefits of genetically modified (GM) agriculture. Representatives from seven scientific academies last week attended a London conclave organized by the U.S. National Academy of Sciences (NAS) and the U.K.'s Royal Society to ponder the issues surrounding GM foods, which have sparked controversy in many nations. The delegates—from the U.S., the U.K., China, Brazil, India, Mexico, and the 76-nation Third World Academy of Sciences—agreed that each academy will focus on a topic, such as environmental concerns, then report back. The full group hopes to issue a statement by November. Developing nations should "take the lead" in writing the document, urged NAS head Bruce Alberts, saying it is a chance "for their voices to be heard."

Meanwhile, in the wake of reports that corn engineered to carry pesticides might harm butterflies and other wildlife, U.S. Agriculture Secretary Dan Glickman last week announced plans for "an independent scientific review" of the U.S. Department of Agriculture's process for reviewing the safety of GM organisms. The department also plans to launch eight to 12 research centers to do long-term studies of biotech farm products.

Disaster Scenario? Physicists want to dispel worries that a new particle collider will destroy Earth. This week, the *Sunday Times of London* published an 18 July story suggesting that experiments at the soon-to-be-completed Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory in New York could create rare particles or mini–black holes that would devour the planet. Lab director John Marburger quickly took to the Internet to respond (www.pubaf.bnl.gov/pr/bnlpr071999.html). "There is no chance that any phenomenon produced by RHIC will lead to disaster," he wrote. Still, just to be sure, he has asked "experts in the relevant fields" to prepare a report on the disaster scenario, which was first aired in a letter in this month's *Scientific American*.

Contributors: Erik Stokstad and Jocelyn Kaiser, David Malakoff

Champaign, is intended to fund tabletop experiments to test the feasibility of treating nuclear waste using low electric fields and thin metallic films to produce "low-energy nuclear reactions." It's one of 45 awards, chosen from among 308 proposals and announced in May, for studies into everything from lightweight reactors to new radioactive waste cleanup technologies.

In an abstract (neri.ne.doe.gov/awardlist.html), Miley noted that preliminary experiments in which nickel, palladium, and titanium films were "highly loaded with protons" and then energized with electricity had produced reactions that appeared to transmute radioactive elements into safer byproducts and produce "excess energy." The approach, he told *Science*, "was motivated by a swimming electron theory," which suggests that high electron densities on the films can aid nuclear reactions. Further trials, he wrote, were needed to nail down "this breakthrough science." In particular, he requested funds to refine materials and to perform analyses designed to make sure the byproducts were produced by the reactions and not by accidental contamination.

The project's apparent similarity to controversial cold fusion experiments—which have unsuccessfully sought to use electrochemical reactions to spark energy-producing nuclear fusion at room temperature—raised eyebrows both within and outside DOE. An official at DOE's Germantown, Maryland, office first raised questions about the project in early June, according to NERI program manager John Herczeg. DOE officials decided that Miley's proposal should have been handled by the agency's Office of Science, which arranged reviews of NERI's basic research proposals, and not by the Office of Nuclear Energy, which oversaw the program's engineering grants. In late June, nuclear office chief Bill Magwood asked the science office to look at the grant, for which funds had not been disbursed. That office is recruiting three reviewers, who are expected to issue their opinion next month.

One group, however, says DOE should act immediately. "The credibility of DOE will be irreparably damaged unless funding for this cold fusion proposal is immediately withdrawn," Edwin Lyman, scientific director of the Nuclear Control Institute, a Washington-based arms control group, wrote in a 6 July letter to Energy Secretary Bill Richardson. The award, he told *Science*, "raises questions about the adequacy of DOE's peer review ... the whole [NERI] project needs to be looked at under a microscope." DOE officials, however, say that Miley's grant is the only NERI award scheduled for further scrutiny.

Miley says the turnabout "came as a complete shock." The proposal "is speculative but based on extensive experimental data," he says. And although his work has been identified as cold fusion, he say it is "radically different—we have trouble getting the cold fusion people to understand what we are doing." The difference, he says, is that whereas cold fusion experiments focus on fusing deuterium atoms, his work involves proton-metal reactions. He is also worried about the fate of three graduate students in his lab if DOE rescinds the award.

The flap could also jeopardize NERI's future. Despite backing from White House advisory panels and several well-placed lawmakers—including Senate Budget Committee chair Pete Domenici (R–NM)—DOE has had trouble building political support for its nuclear energy science budget, which Congress zeroed out in 1997 due to concerns about quality and other issues. NERI's commitment to peer review helped reverse the tide last year, and program officials were hoping for a $6 million increase to $25 million next year. But "the idea that DOE is spending money on questionable science could renew the doubts," says one Senate aide. Whether or not the grant is canceled, he says, the episode "will prompt a lot of questions."

–DAVID MALAKOFF

CIRCADIAN RHYTHMS

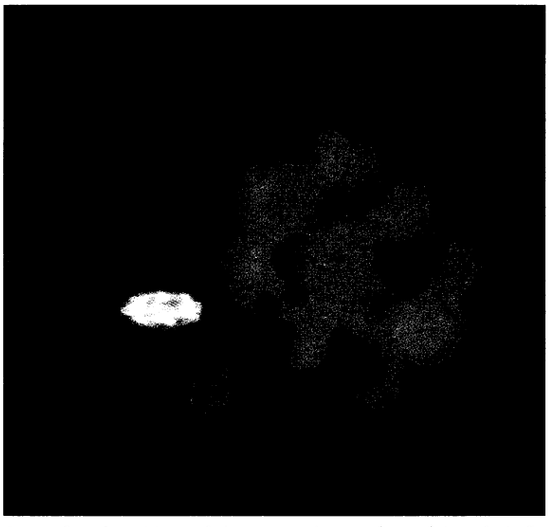
CRY's Clock Role Differs in Mice, Flies

A clock would be useless without a way to set it, and that's certainly true for the circadian clock that controls our daily biological rhythms. Several research teams reported last fall that the light-absorbing protein cryptochrome (CRY) seems to fill that role in plants and flies, synchronizing the clock to the 24-hour light-dark cycle. But research in mice raised the possibility that, in mammals, CRY might be a cog in the clockworks itself rather than the light receptor. Now two papers, one in this issue of *Science* and the other in this week's *Cell*, show how CRY interacts with the mouse and fly clocks, confirming that its roles in the two clocks are quite distinct.

In flies, Steve Kay's team at The Scripps Research Institute in La Jolla, California, reports on page 553, light triggers CRY to reset the clock by interacting directly with a clock protein called TIMELESS. But in mice, Steven Reppert of Harvard Medical School in Boston and his colleagues report in *Cell*, CRY is part of a group of proteins that make up the central clock mechanism and may not be a light receptor at all. "This is a clear difference between flies and mammals," says clock researcher Joseph Takahashi of Northwestern University in Evanston, Illinois. And that, Takahashi points out, has become a recurring theme in animal clocks, which use the same cast of proteins but often in different roles.

At the core of the fly's clock are two proteins, PERIOD (PER) and TIMELESS (TIM), whose levels rise and then fall over the course of a day. This oscillation is caused by a feedback loop in which PER and TIM accumulate, then team up to turn off their own genes. That causes PER and TIM levels to drop until they can no longer repress their genes, and the cycle starts again. Light can reset the clock by turning the genes on prematurely, and 3 years ago clock researchers found that it does this by inactivating TIM.

How that happens was a mystery until last fall, when Jeff Hall and Michael Rosbash of Brandeis University in Waltham, Massachusetts, along with Kay, found that light can't inactivate TIM in flies with a mutant *cry* gene (*Science*, 27 November 1998, p. 1628). That meant CRY is part of the light-resetting pathway, possibly the light receptor itself. But it didn't explain how CRY affects TIM.



Seat of action. Most of the cryptochrome (green) in a fruit fly cell exposed to light is in the nucleus. The cube shows the cell stained for cryptochrome alone (green), for a nuclear protein (red), and on the top face, the overlap of the two.

CREDIT: PALOMA MAS AND STEVE KAY

Now Kay's team has provided that explanation. They began with cultured fruit fly cells engineered to make PER and TIM but not CRY. The cells don't have a running clock, but the researchers follow PER and TIM activity in the cells by measuring their repression of a gene that contains the same control region as the *tim* gene. Light has no effect on that repression, so the researchers decided to add CRY to the system, Kay says, to see if that