Woods Hole Oceanographic Institution in Massachusetts. "It titillates the imagination." But she's not sure whether to call *Acaenoplax* an aplacophoran, because it is so different from modern ones. To Runnegar, that's part of the attraction. "It gives us a great deal of information about early molluscan evolution that cannot be retrieved from the living biota," he says. –ERIK STOKSTAD

DARK MATTER

Astronomers Glimpse Galaxy's Heavy Halo

Astronomers deal in light, so dark matter drives them a little crazy. For decades they have watched as the gravitational pull of an invisible hand twirls stars and gas around the fringes of galaxies like a ball on a string. And for decades they have failed to identify the source of the excess galactic gravity. With little to guide them, astronomers have fashioned dark matter candidates out of everything from underweight failed stars to massive subatomic particles that currently exist only in a theorist's imagination.

Now, they have something more to work with. In a paper published online today by *Science* (www.sciencexpress.org), an international team of astronomers claims to have directly spotted the source of at least 3% of all the dark matter in the galaxy: They have identified large numbers of fast-moving white dwarf stars that formed when the Milky Way first flickered to life several billion years ago. And that is just a cautious lower limit. "They could account for up to one-third of it," says team member Ben R. Oppenheimer, an astronomer at the University of California, Berkeley.

"The authors are to be congratulated," says astrophysicist Harvey Richer of the University of British Columbia in Vancouver. "This is a very nice piece of work."

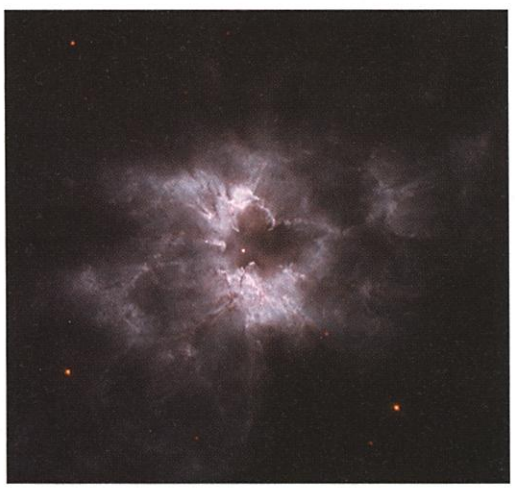
Most of the mass in a galaxy is invisible. The Milky Way's familiar sparkly pinwheel of relatively young stars sits amid an extended spherical halo of older stars and gas. Their combined gravity holds the galaxy together and keeps the stellar pinwheel spinning. Far enough from the center, the pull should eventually weaken and the stars slow down. But they don't. Stars and gas clouds as far as the telescope-aided eye can see continue to orbit at the same speed. The best explanation is that almost 90% of the total mass of the galaxy is an invisible substance spread throughout the halo called, for want of a better name, dark matter.

Tiny clumps of dark matter occasionally pass between Earth and distant stars. The gravitational field of the clump bends light from the star, causing a sudden brightening called microlensing. After spending the last 6 years counting these rare microlensing events, the Massive Compact Halo Object survey has concluded that between 8% and 50% of galactic dark matter is in clumps weighing about half the mass of the sun. But they never actually caught the culprit in the act.

White dwarfs in the halo have long been the leading suspects, says Richer. They are of the right mass, they move fast enough, and they should be quite common. Any star born weighing between one and eight times the mass of our sun sheds most of its mass as it evolves, eventually ending up as a dimly glowing, cold, half-solar-mass white dwarf. But are they common enough? The answer seemed to be no. When the number of nearby white dwarfs in the galactic disk—they can be seen directly because they are closer—was extrapolated to the halo, the total density came up short. Although isolated halo dwarfs had been spotted before, attempts to directly identify a large enough population to explain the microlensing had failed. Part of the reason, it turns out, is that astronomers were looking for the wrong color star.

Contrary to the popular images of red-hot peppers and cool blue ice, hot stars are blue and cold stars are red. So searches for white dwarfs in the halo targeted faint red stars. It was a mistake. The light radiated by a hot white dwarf starts off blue and turns red as the dwarf cools, as expected. But when the dwarf's temperature drops below 4500 kelvin, recent theoretical models by astrophysicist Brad Hansen of Princeton University and others show that molecular hydrogen in the dense, cold atmosphere absorbs the red light and reemits it at higher, bluer frequencies.

The realization led the team to change strategies. First, team member Nigel Hambly of the University of Edinburgh scanned almost 200 digital



CREDITS: (LEFT TO RIGHT) H. BOND/STSCI, R. CIARDULLO/PSU, NASA; M. BALTER

Dim prospects. Invisible dark matter may have started out as hot white dwarfs like this one in the middle of planetary nebula NGC 2440.

ScienceScope

Bright Idea The French government may be rethinking plans to privatize a new materials research center after protests shut down two related devices for nearly a week. The scientists are unhappy with plans to operate as a private nonprofit the $172 million SOLEIL synchrotron (*Science*, 15 September 2000, p. 1859), which was also the subject of protests last year (right). The structure makes it easier for other nations to participate, but French scientists worry that it will make it harder for them to win jobs at government research centers. To make their point, nearly 100 scientists last week pulled the plugs on two machines, known as SUPER-ACCO and DCI. They also petitioned CNRS, France's basic research agency, to make SOLEIL a "mixed research unit" that can employ public-sector scientists.

The CNRS appears to be warming to the idea, says protester Pierre Lebasque of LURE, an x-ray lab in Saclay. One compromise would create a public research unit alongside a private management group, he says. Officials have time to mull: SOLEIL won't open until 2005.

No Comment In a rare public dispute, the National Science Board last week thwarted an attempt by its chair, Eamon Kelly, to chide the Bush Administration for neglecting the physical sciences in its 2002 budget proposal (*Science*, 9 March, p. 1882).

It wasn't the content that bothered the board, a presidentially appointed body that oversees the National Science Foundation (NSF). "It's a good statement, and inoffensive," said M.R.C. Greenwood, chancellor of the University of California, Santa Cruz, about a position paper that many board members saw for the first time at the meeting. But Greenwood and others argued that it would be better to wait at least until details of Bush's budget are released in early April. And some thought the less said, the better. "How often do we want to make such statements?" wondered Cornell University administrator Robert Richardson.

Kelly implored the board "to add one more voice to the chorus" calling for larger budgets for NSF and other agencies (see p. 2291). But Greenwood counseled that "voices raised on our behalf are more effective." In the end, the board deferred action until its May meeting.

Contributors: David Malakoff, Jeffrey Mervis, Alexander Hellemans

images covering 12% of the sky for fast-moving faint objects, turning up 126 candidate halo stars. Then the team checked for the blue color spectrum using four nights of follow-up observations from the 4-meter Blanco telescope at the Cerro Tololo Inter-American Observatory in Chile. In the end, the team plucked out 38 new cool white dwarfs orbiting in the galactic halo. By multiplying the density of the newfound cool dwarfs by the volume of the galactic halo, Oppenheimer's team estimated that white dwarfs make up at least 3% of the total galactic dark matter density.

There is only one catch, astronomers say: Some of the newly discovered dwarfs might not actually be from the halo. Physically, they are all inside the galactic disk. Because they are moving faster than typical disk stars, the white dwarfs are almost certainly just passing through as they circle the halo. "The gravity of the galaxy is not strong enough to confine such objects to a disklike geometry," Hansen explains. But even a small contamination of disk white dwarfs could reduce the estimated halo dwarf density, so Richer won't draw his final conclusions until several ongoing white dwarf surveys that probe farther into the halo start producing results in a year or two. "We are in the very early stages," he says. "Things haven't all shaken out yet." **–MARK SINCELL**

Mark Sincell is a science writer in Houston.

ECOLOGY

U.N. Report Suggests Slowed Forest Losses

A comprehensive survey of the world's forests, released last week by the United Nations (U.N.), suggests that global rates of forest loss decreased in the 1990s. But the ink was barely dry on the report before the World Resources Institute (WRI), a think tank in Washington, D.C., disputed that conclusion. "We need good news about the world's forests," says Dirk Bryant, who directs WRI's forest program. "But this is definitely not it."

Previous reports have been an important source of information for policy-makers, climate change scientists, and others. So WRI scrutinized the data as they were released on the Web over the last 6 weeks. It claims that the numbers are "out-of-date, patchy, and inaccurate." Moreover, the WRI says, changed baselines and methods invalidate the comparison of deforestation rates. The U.N. admits that the quality of data varies but says its methods and conclusions are sound.

Up in smoke. Slash-and-burn agriculture, as shown here in Panama, destroys much tropical forest.

Every 5 to 10 years, the U.N.'s Food and Agriculture Organization (FAO) reports on the status of forests. For the current Global Forest Resources Assessment 2000 (FRA2000), it tabulated the latest data, such as forest areas and composition for 217 countries—a challenging task because few countries undertake regular inventories of their forests. To get estimates for 2000, FAO analysts sometimes had to use economic statistics and other information to project trends from older forest data. As a supplement, they examined satellite images that covered 10% of the world's tropical forests.

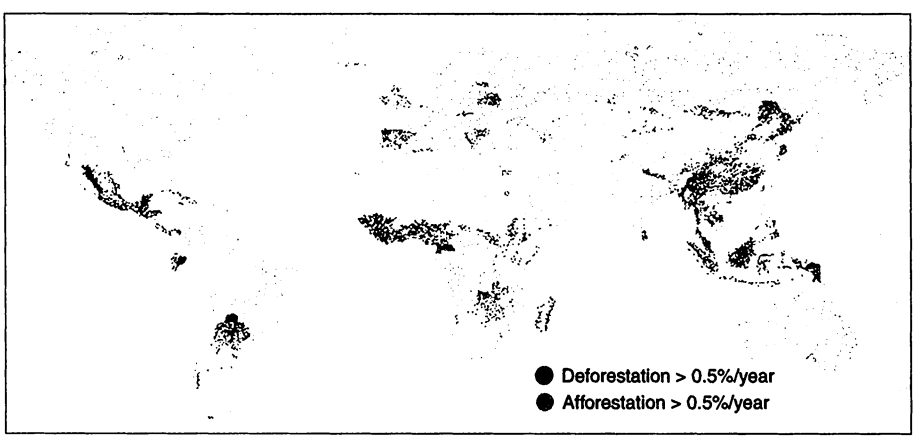
The report suggests that the average annual net loss of forests during the 1990s was 9 million hectares—0.2% of the global total—or an area roughly the size of the state of Maine. That rate is at least 10% lower than the one FAO calculated for the first half of the decade in a 1997 report, says Peter Holmgren of FAO's Forest Resources Assessment Program in Rome, Italy. The slowdown is mainly due to new tree plantations, particularly in India and China, and forest growth on disused farms. The rate of loss apparently remained the same in the tropics, however. Satellite images combined with data supplied by the countries themselves suggest a gross annual loss of natural forest of 14.5 million hectares, which Holmgren says differs little from figures from the 1980s.

The WRI disagrees with both of FAO's assessments. "I don't believe we can say deforestation is slowing down based on this report," says WRI's Emily Matthews, an environmental analyst. For the FRA2000 report, Matthews says, FAO revised many of the 1990 forest areas to be much larger than in the 1997 report. Although done partly to standardize worldwide forest definitions, this reduced, perhaps erroneously, the percentage of forest lost calculated in FRA2000 for the decade. Holmgren admits that the comparison is not straightforward, but he says that estimates using other FAO reports also indicate a slowdown.

Matthews also worries that the report will send a "damaging" message that natural forests are in less danger than before, although as Holmgren notes, the report makes clear that deforestation of tropical, natural forests has not declined. And still another criticism concerns FAO's sampling of satellite images.

The problem, remote-sensing experts say, is that deforestation in tropical forests is highly concentrated along roads and rivers. As a result, says Compton Tucker of NASA's Goddard Space Flight Center in Greenbelt, Maryland, a small and random sample—such as the 10% used by FAO—"will give you grossly inaccurate numbers." Holmgren responds that funding constraints prevented wider coverage, but that each sampling area—3.4 million hectares—did cover some roads and rivers. Even more important for an accurate assessment of forests, he says, is field sampling—something that most countries don't do systematically.

Indeed, everyone agrees on the need for better and more consistent forest data from almost all countries. To minimize such problems in the future, Holmgren says the FAO has proposed an initiative, called the Global Forest Survey, that would establish a global standard for data collection and support individual countries in monitoring their forest resources. **–ERIK STOKSTAD**



Extremes. Forests (yellow) are colored red where deforestation was especially high during the 1990s. Green shows new plantations and regrowth.

CREDITS: (TOP TO BOTTOM) DANNY LEHMAN/CORBIS; FAO