search—some from countries known to be sympathetic to the program's goals. For example, Sweden, formerly one of the biggest contributors to the program, has drastically cut its donation, and Denmark—another major donor—has cut its subsidy entirely. An official of the Danish foreign ministry told *Science* that Denmark would not increase its donations to WHO programs until a new director-general was elected.

WHO resources have been further stretched by the failure of many rich Western countries to pay their membership dues on time, while some of the poorest countries in the world, including Rwanda, have managed to do so. Thus, the United States, the single biggest contributor, was nearly a year late paying its 1997 allotment of $107 million and still owes money from 1996. (A few countries, including Costa Rica and Bhutan, paid their 1998 dues months in advance.) But perhaps of greater ultimate concern are inequities in the way WHO resources are distributed around the world. "There is definitely less money going to countries with the greatest need," says Walt.

A recent study of 12 countries by a team of public health experts including Walt—which was commissioned by Australia, Canada, Italy, Norway, Sweden, and the United Kingdom—found that some of the nations most desperately in need of help from WHO were receiving significantly less aid than others in a better position to help themselves. For example, Mozambique, which is recovering from a 16-year-long civil war that essentially destroyed its health infrastructure, was found to be receiving only about half the assistance given to Ecuador, which has a relatively well-developed health system and only one-tenth the population.

Physician Carlos Tiny, head of WHO's office in Maputo, Mozambique's capital, told *Science* that the office has a technical staff of only five people, including himself. Yet, since last August, Mozambique has been ravaged by a cholera epidemic that has racked up 7000 cases and more than 200 deaths—and this in a country that has only 400 doctors for its 15 million inhabitants. Fortunately, much of the gap is being filled by numerous other aid agencies also working in the country. "The WHO is a technical cooperation agency and not a funding agency," Tiny says. "But if we had more staff, we could be more instrumental in coordinating donor input. We will never receive all the funds we need, but there is room for improvement."

Indeed, some critics of WHO believe the organization has stretched itself too thin and should concentrate its resources on the neediest countries. "The WHO has tried to be all things to all people," says immunologist Barry Bloom of the Albert Einstein College of Medicine in New York City. "But it doesn't have the funds to control every disease in every country in the world. Most countries don't need the WHO in there to vaccinate their kids. The WHO should really focus on upgrading health care in the poorest countries, because no one else is going to do it."

Some go so far as to argue that the headquarters should move entirely out of Geneva, a city with one of the highest costs of living in the world. "The WHO should become an organization that spends far fewer resources bringing people to Geneva to discuss policy and more resources getting people to build real programs in communities in the developing world," says Joseph McCormick, a former virus hunter with the U.S. Centers for Disease Control and Prevention in Atlanta and now at the Pasteur Institute in Paris. "Perhaps moving to Abidjan or Lagos or Karachi or Calcutta might reduce the bureaucracy and increase the amount of genuine commitment."

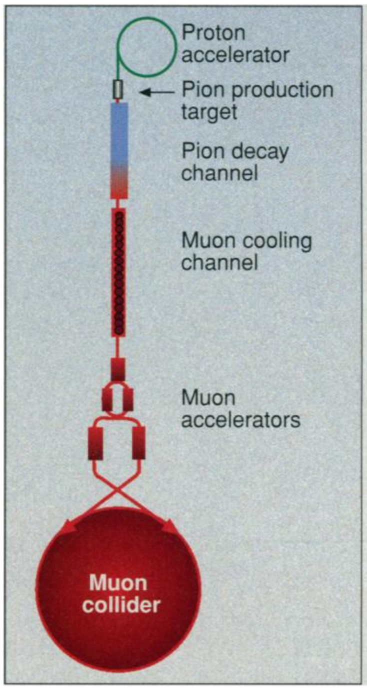
Such a dramatic step seems unlikely, at least at this juncture. But whoever is chosen as the organization's new director-general will clearly have to lead WHO in new directions if it is to retain its relevance into the next century. Says WHO's Holck: "To get us going along the right path at this crossroads, we need someone with guts and determination. And that person won't be easy to find."

–**Michael Balter**

HIGH-ENERGY PHYSICS

# Physicists Dream of a Muon Shot

When you plan to accelerate subatomic particles to astronomical energies and collide them to spawn new forms of matter, your choice of a projectile is critical. Hadrons—protons, for instance—shatter on impact into smaller pieces such as quarks and gluons, making their collisions messy and hard to interpret. Electrons are indivisible and yield cleaner collisions, but they emit energy-wasting synchrotron radiation when they are accelerated in circular machines. At a meeting last month in San Francisco, a group of physicists considering the next great collider—a hoped-for successor to the Large Hadron Collider (LHC) now being built at CERN in Geneva—pinned their hopes on the electron's chubby brother, the muon.




SOURCE: CERN COURIER

**Catching muon beams.** High-energy protons (green) collide with a target to produce pions (blue), which gradually decay to produce muons (red).

Pointlike, negatively charged particles 207 times more massive than the electron, muons generally have a fleeting existence in the debris resulting from particle collisions. Partly for this reason, they have never before been used as accelerator projectiles. But they and their positively charged antiparticles have some compelling advantages, promising the clean collisions of electrons without their wasteful synchrotron radiation. Although some researchers favor a hadron or electron collider as a successor to the LHC, the group that met at the 4th International Conference on Muon Colliders "is becoming more and more enthusiastic about muon colliders," says Andrew Sessler of Brookhaven National Laboratory (BNL) in Upton, New York.

Indeed, Sessler and his colleagues are now proposing a large-scale test of muon collider technology to see if they can generate and marshal these ephemeral particles into a coherent beam. "This is becoming more and more a real thing," he says. "And we expect that we can do it for less money."

The $5 billion LHC, which will begin colliding protons and antiprotons at an energy of 14 trillion electron volts (14 TeV) in 2005, may well offer a glimpse of the Higgs boson, a hypothetical particle that would help explain the varied masses of other particles. The machine may also reveal supersymmetric particles, heavier partners to known particles, which are predicted by a theory called supersymmetry. But to follow up on these clues, researchers will need a new machine that can produce Higgs and supersymmetric particles en masse and precisely measure their properties.

Proton-antiproton collisions are ill suited to making these precision measurements, says Howie Baer of Florida State University in Tallahassee: "You get lots of extra quarks and gluons, making the events very 'messy.'" And because electrons give off copious synchrotron radiation when a magnet bends their paths, a next-generation electron collider would probably take the form of a linear accelerator, or linac, tens of kilometers long.

Muons might offer the advantages of an electron collider without the expense of a huge linac. Because of their larger mass, they lose much less energy in the form of synchrotron radiation, so they can be accelerated in relatively small circular machines. "You don't have to build full-energy linacs," says Sessler. A 1-TeV muon collider "can fit on an existing laboratory site and use some of the existing infrastructure, and that is a tremendous advantage," adds William Marciano of BNL. What's more, because of muons' mass, their collisions spark physical processes that should generate Higgs particles far more efficiently than electrons can. "We can build a Higgs factory," says Sessler.

But producing and handling muons are still largely terra incognita, says Alvin Tollestrup of the Fermi National Accelerator Laboratory near Chicago, one of the proponents of the muon-collider idea. Muons are scarce in nature because they survive for only a few microseconds before decaying into electrons and neutrinos. In current designs, the first step toward making them is to collide an intense proton beam with a liquid metal target, producing quark-antiquark pairs called pions. The pions then decay into muons. In what Tollestrup calls "the critical part of that sequence," these muons have to be "cooled"—marshaled into a beam in which they all move at the same velocity. Only then can they be accelerated to nearly the speed of light, which extends their lifetime through Einstein's time dilation.

Sessler and his colleagues are now hoping to test muon-cooling schemes, which would rely on arrays of magnets and energy-absorbing materials. "We are proposing a $30 million experiment to be put in Fermilab," says Sessler. They expect to complete the final proposal early this year and hope to win funding in the fiscal year 2000 science budget.

Still, any push for a muon collider will encounter plenty of skepticism. Alvaro de Rújula, a theoretical physicist at CERN, acknowledges that the "clean physics" of a muon collider would be attractive. But he thinks the technical problems with these machines are daunting. "There are two types of machines of the future: the hadronic machine, where the experiments are extremely difficult, and the muon machine, where the machine is difficult."

**–Alexander Hellemans**

*Alexander Hellemans is a science writer in Naples, Italy.*

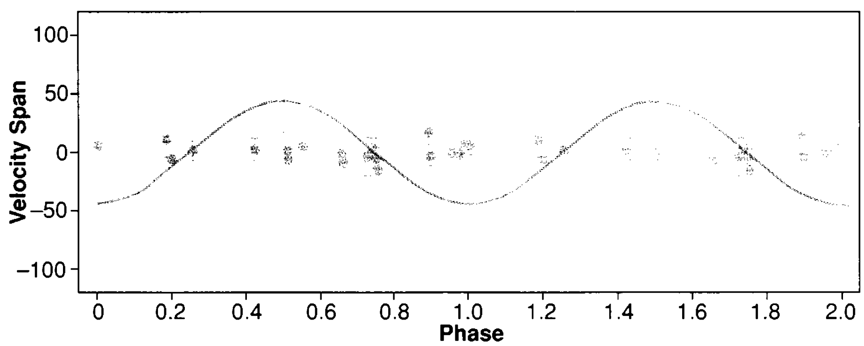
ASTRONOMY

# Far-Off Planet Makes a Comeback

"It looks like we're back to an ugly old planet," says David Gray. Nearly a year ago, the University of Western Ontario astronomer had issued a serious challenge to the case for an extrasolar planet—the first to be discovered around a sunlike star. He presented evidence that slow jitters in the spectrum of the parent star, thought to result from a planet's periodic tug, were actually due to a pulsation of the star's gases (*Nature*, 27 February 1997). The ensuing debate was at times less than civil. But harmony has been restored: Gray and at least three other groups say they have been unable to reproduce his earlier results. What looked like a planet killer may have been just a chance alignment of noisy data points.

One group, led by Artie Hatzes of the University of Texas, Austin, published its results in yesterday's issue of *Nature* alongside Gray's concession. A paper by another group, led by Timothy Brown at the High Altitude Observatory in Boulder, Colorado, has been accepted at *Astrophysical Journal Letters*. And a third group, at the University of Paris, is still finishing its analysis but also sees "no indication" of pulsations of the star, 51 Pegasi, says team member Jean Schneider. "The only reasonable explanation for the velocity wobble is [still] a planet," concludes Didier Queloz, who made the discovery with Michel Mayor at the Geneva Observatory (*Science*, 20 October 1995, p. 375).

Mayor and Queloz, who is now at the Jet Propulsion Laboratory in Pasadena, California, had monitored hundreds of dark absorption spikes carved into 51 Peg's spectrum by elements in the star's atmosphere such as iron and calcium, which filter out specific frequencies of light. In light from a stationary star, the frequencies would remain fixed. But the observed frequencies shifted up and down by small amounts over a 4.23-day period. Mayor and Queloz inferred that a roughly Jupiter-size planet was whipping around 51 Peg in an orbit much closer than Mercury's around the sun, causing the entire star to wobble and shifting the spike frequencies by the Doppler or train-whistle effect.




**Steady as a rock.** A measure of the shape of spectral lines from 51 Peg, expected to show regular variations (red) if the star is pulsating, reveals no changes.

SOURCE: HATZES ET AL.

Then came Gray's challenge. Using a spectrograph most astronomers describe as somewhat outmoded, he monitored a single absorption spike and found that asymmetries in its shape also changed over a 4.23-day period. A simple Doppler shift couldn't cause the distortion, but Gray believed that both the shape changes and the frequency shifts could be due to a bizarre type of "nonradial" oscillation never seen in a sunlike star: a slow sloshing of the star's surface gases. Because his 39 noisy data points were scattered over 7 years, however, Gray and others now emphasize that there was roughly a one-in-300 chance that a spurious 4.23-day signal might show up by chance.

That appears to be what happened. "I have to conclude that nature played a dirty trick on him," says Brown. In the most conclusive of the new measurements, Hatzes and co-workers made about 120 measurements of several absorption lines at more than twice Gray's spectral resolution and saw no changes in the line shapes. Neither did Gray when he made further observations with his original apparatus. His earlier results, he says, were either a fluke or a transient phenomenon that has since stopped.

But as the technical disagreement fades, the dispute has thrown light on the underside of a high-stakes field where new claims are followed like sports scores by the wider public. Astronomers grumbled privately about the attacks on Gray's work that appeared on an elaborate Web site—complete with links to corporate sponsors—maintained by the planet searcher Geoff Marcy of San Francisco State University. Gray responded in kind on his own Web site, calling some objections "arguments of ignorance." Tempers have since cooled, but Hatzes says: "I didn't like to see that. It should have been a more civilized debate."

**–James Glanz**