legs, partial and missing limbs, fused skin, and other oddities was very close to that seen in the frogs in the field. Johnson thinks the cysts may cause deformities by changing the positions of cells in a developing limb, as Sessions's beads apparently did, and may also produce some chemical that mimics a hormone.

The Johnson team's findings don't mean that some chemical in the environment couldn't be at work too, but in the accompanying report, Sessions offers evidence that seems to rule out at least one type of chemical that has been linked to the frog deformities: retinoids. Sessions compared the abnormalities in 391 preserved, multilegged Pacific treefrogs from California and Oregon to those known to be induced in the lab by retinoids. More than 90% of the time, for example, the chemical produces a "proximal-distal duplication," such as a new limb coming out of the elbow rather than the shoulder. The retinoids also cause only certain mirror-image limb duplications. Although Sessions found many specimens with other kinds of mirror-image duplications, none had proximal-distal duplications. "Retinoic acid gives you particular morphologies, and we just don't see that with the frogs," says Sessions.

Developmental biologist David Gardiner of the University of California, Irvine, who has been studying retinoids as a possible cause, disagrees, saying they are still in the running. "What the published literature says retinoids do and don't give you," he says, isn't clear-cut. Other researchers say that differences in the abnormalities seen in midwestern and eastern frogs also point to other causes besides parasites. Few have the extra legs seen in California, for example. And although some of the animals have cysts, so far nobody has found *Ribeiroia* in the midwestern frogs. In addition, Carol Meteyer, a wildlife pathologist at the U.S. Geological Survey in Madison, Wisconsin, says she has dissected hundreds of metamorphosing tadpoles from the affected ponds, and the cysts she has found do not appear until after the frogs' limb buds had developed—too late to do the damage Johnson describes.

But Lannoo and many others think parasites should be looked at more closely, even in those locales where chemicals are also suspected. "I don't for a minute think this is going to explain everything," says David Wake, director of the University of California, Berkeley's Museum of Vertebrate Zoology. But he adds that it's "a warning not to put all of your eggs in one basket" when trying to pin down the cause of the frog deformities.

—JOCELYN KAISER

SCIENTIFIC COMMUNITY

Headhunters Stalk the Halls of Physics

Bidding wars are breaking out in academe as prestigious institutions vie for the top researchers in high-profile areas of physics and astronomy

Nothing is permanent but change, said the Greek philosopher and physicist Heraclitus. Academic physics departments are discovering this truth all over again. Like star athletes and top business executives, high-profile physicists and astronomers have become the object of bidding wars, leading to a chaotic mobility from which some academics believe only a handful of the most prestigious and best funded institutions can benefit. One shell-shocked department chair, Paul Langacker, quips that he has a new motto for enticing prospective faculty members: "The University of Pennsylvania—where Princeton and Harvard come to recruit."

THOMAS MASON

Toronto to Spallation Neutron Source, 1998

Langacker says that although researchers have every right to move, the accelerating pace threatens to destroy small groups that universities such as his own have carefully built up in emerging subfields—sometimes before the Princetons and Harvards saw the trend. Others think the aggressive recruiting actually has benefits, as it spreads ideas around and encourages collaboration. But there is one universal feeling when a star walks out the door, says Pekka Sinervo, chair of physics at the University of Toronto: "It hurts. There is no way that it can't hurt."

Sinervo and others at Toronto got a strong taste of that hurt in 1997 and 1998. First, Scott Tremaine—a former director of the Canadian Institute for Theoretical Astrophysics with joint appointments in physics and astronomy—left to become chair of the Astrophysical Sciences Department at Princeton. Long a force in areas ranging from celestial mechanics to cosmology, Tremaine, who turned down an initial offer from Princeton and then changed his mind 6 months later, says Toronto mounted a "very effective countercampaign" to keep him. It was not effective enough, however, and Sinervo was determined to do even better when the phone started ringing in late 1997 for one of his department's best young researchers: Thomas Mason, a materials scientist widely known for his studies of high-temperature superconductors.

Now 34, Mason was named one of "100 Canadians to watch" by *Maclean's* magazine in its 1 July 1997 issue for his structural studies of novel superconductors using neutron scattering. But he let it be known that he would entertain offers in the United States because of what he saw as insufficient support for such research in his department and because Canada's premier neutron facility—the Chalk River reactor—is aging and poorly funded. Interest materialized posthaste from the University of California, San Diego, and Los Alamos National Laboratory in New Mexico; but it was an offer to become scientific director of the planned $1.36 billion Spallation Neutron Source (SNS) at Oak Ridge National Laboratory in Tennessee that really grabbed his attention.

PAUL STEINHARDT

Pennsylvania to Princeton, 1999

Toronto quickly offered to bump Mason's salary up to six figures, to spend $400,000 on a new helium-liquefaction plant—crucial for Mason's work—and to hire a new faculty member in the same area. "It's by no means been a tradition at Toronto that we can react as nimbly as we did," says Sinervo. "In the end, the offer they made me actually addressed all of the concerns I had initially," says Mason. But by then, the once-in-a-lifetime chance to influence scientific priorities at SNS, along with a substantially more generous financial package and other benefits, induced him to leave the university just 5 years after he arrived. "I got tenure the week I left," he says.

In spite of Toronto's losses, the University of Pennsylvania's Langacker might envy the national boundary that separates Toronto from prestigious, deep-pocketed American

CREDIT: (LEFT) OAK RIDGE PHOTO; (RIGHT) PRINCETON UNIVERSITY

institutions. Located just a few miles down Interstate 95 from Princeton, his university has seen several of its biggest names alter their commutes recently. This year, in what Langacker calls a "devastating" loss, one of the world's most respected astrophysicists—Paul Steinhardt, who had been at Penn for 17 years—left the group of junior faculty he had been leading. In his move to Princeton, his family changed houses, but Steinhardt's wife, a professor of Chinese art history, was able to keep her position at Penn.

DAVID WEITZ
Pennsylvania to Harvard, 1999

"Penn was always extremely generous and supportive throughout my career there," says Steinhardt, "but they can't create an astrophysics department of the quality here out of the blue." Respecting Steinhardt's reasons for moving, Penn made no counteroffer, but it did swing into action when Princeton began recruiting materials scientist David Weitz. After a move from Exxon 3 years ago, Weitz had seen his reputation skyrocket as his research focus—the physical properties of biological materials, colloids, gels, and foams—became more familiar in academe.

The university put together a package worth more than $1 million, says Langacker, including a big salary increase, another faculty position in the field, and a center for "soft condensed matter" that Weitz would direct in exchange for a reduced teaching load. Ultimately, Penn lost out—when Harvard made "what I thought was a really outstanding offer," says Weitz, including a large amount of start-up money, a relocation package, and the chance to take all 10 of his students with him. "It's a job-seeker's market," says Weitz.

Just up the road, Rutgers University in New Jersey has seen its prized research group working on the high-profile topic of string theory—a mathematical quest for a unifying theory of particles and forces—become a hot commodity. Starting a decade ago, Rutgers built one of the premier groups in the field, luring four top theorists: Nathan Seiberg, Steve Schenker, Dan Friedan, and Tom Banks. But when string theory caught fire, other universities began eyeing this reservoir of talent. "What happened was they were successful—in some sense too successful," says Paul Leath, chair of the department of physics and astronomy at Rutgers. Seiberg has left for the Institute for Advanced Study in Princeton, and Schenker is at Stanford University. Banks is also considering leaving, says Leath. "We offered them everything you could imagine" to stay, says Leath, including sky-high salaries, new infrastructure, and fresh research funds.

Such bidding wars take a toll on universities, says one Nobel laureate. "I recognize that superstars can create real intellectual excitement and be a magnet so that a major new strength can be created," he says, but excessively lavish packages can "divert precious resources from others who could better use the money. I am not in favor of the 'free-agency' aspect of recruiting," adds this laureate.

Still, some physicists think the free agentry could be a sign of a broader stirring in the long-stagnant job market in physics, even though statistics compiled by the American Institute of Physics don't show any trend so far. "I was just in a committee meeting last week," says Tremaine, "and we realized that nine out of 10 people at the table either had moved in the last couple of years or were contemplating a move." Others note that the value of endowed academic chairs has risen with the stock market, increasing the odds that people can be attracted to fill openings that do exist.

For the departments on the losing side, there's another silver lining: the chance to recruit a new star. Toronto's Sinervo sweetened the package that had been put together for Mason and offered it to Louis Taillefer, a star materials scientist at McGill University in Montreal. Taillefer had no interest in leaving Canada, but "as soon as it became clear that Louis was mobile, other institutions moved in," says Sinervo, who then had the pleasure of outbidding McMaster University, Simon Fraser University, and the University of British Columbia. Taillefer now occupies Mason's former faculty slot in Toronto.

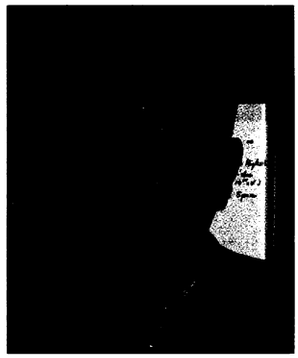
–JAMES GLANZ

GAMMA RAY ASTRONOMY

New Ground-Based Arrays to Probe Cosmic Powerhouses

Built at a tiny fraction of the cost of satellites, these telescopes should help unlock the mysteries behind these high-energy sources of photons

TOKYO—Gamma rays are a signature of the most powerful and puzzling phenomena in the universe—gamma ray bursts, supernovae, and the black hole–powered infernoes called blazars. But scientists' view of these high-energy photons has been blurry at best. Blocked by the atmosphere, they have been studied mainly from satellites, such as NASA's Compton Gamma Ray Observatory. But the satellite-based detectors have poor angular resolution, and the highest energy gamma rays elude them. To get a better view of the gamma ray sky, astronomers are going back to where it can't be seen directly—back to the ground.



CANGAROO kid. Japan's Tadashi Kifune leads new facility in Australia.

In a flurry of construction in deserts and on mountain peaks, they are building arrays of reflectors and light detectors designed to pick up the faint glow produced when gamma ray photons slam into the upper atmosphere. The University of Tokyo's Institute for Cosmic Ray Research (ICRR) has just gotten approval to expand its present single 7-meter telescope in the Australian outback, called CANGAROO, to an array of four 10-meter telescopes. The Max Planck Institute for Nuclear Physics in Heidelberg, Germany, is developing the components for an array of four 10-meter telescopes to be built in central Namibia. A second Max Planck physics institute, in Munich, leads a group including Spanish and Italian universities and institutes building a single 17-meter dish, called MAGIC, at the Roque de los Muchachos observatory on La Palma in the Canary Islands. And the Whipple Observatory of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, is expecting a funding decision within the next few weeks on a proposal to build seven 10-meter telescopes on Mount Hopkins in southern Arizona.

"This is a poor man's approach to gamma ray astronomy," says Trevor Weekes, principal investigator for the Whipple project, called VERITAS. VERITAS is the most expensive of the projects, but at $16.6 million, it is a fraction of the cost of a gamma ray satellite. Even at that bargain price, Weekes and his fellow gamma ray astronomers are

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