program that allows doctoral students to earn up to $900 a month working part-time as research assistants. The program, says Fujiwara, will allow some students to get paid for laboratory work they are now doing for free. Monbusho has requested $6 million in its 1996 budget to fund 540 research assistant positions for graduate students, with the number growing to 8000 in 5 years.

Despite the increased opportunities, Japanese students may still need to be convinced that an advanced degree is a good investment of their time and money. Students who remain in school into their late 20s to attain advanced degrees are seen as shirking adult responsibilities. And corporations still prefer to hire masters'-degree holders and give them additional training in-house.

New Ph.D.s and postdocs also face the challenge of finding a permanent position in a sluggish economy. Take the case of Shinya Sawata. Sawata, who entered graduate school at the beginning of the government's push to increase enrollment, was awarded a Ph.D. in biochemistry in March from the University of Tsukuba. Now he has a postdoctoral research fellowship to study the chemistry of DNA at the University of Tokyo's Research Center for Advanced Science and Technology. Although his position runs until the end of next year, Sawata is already worrying about what will happen when his fellowship is up and he enters Japan's sluggish job market. In fact, he is close to despair when thinking about his career prospects. "I'd like to get out of research [because the future is so dim]," he says. "But I don't know what else I can do."

His plight is a familiar story to Saburo Nagakura, chair of the Kanagawa Academy of Science and Technology, a public-private research organization in Kawasaki. Nagakura chaired a subcommittee of a Monbusho advisory council that recommended increases in graduate and postdoctorate positions in a report earlier this year. "The biggest problem is that there are simply insufficient opportunities for younger scientists to conduct research," he says. The increases are a step in the right direction, he adds, but more must be done. For young scientists like Sawata, that next step—creating good jobs—can't come soon enough.

**–Dennis Normile**

*With additional reporting by free-lance writer Marc Lamphier in Tokyo.*

ASTRONOMY

# First Light From a Space Laser

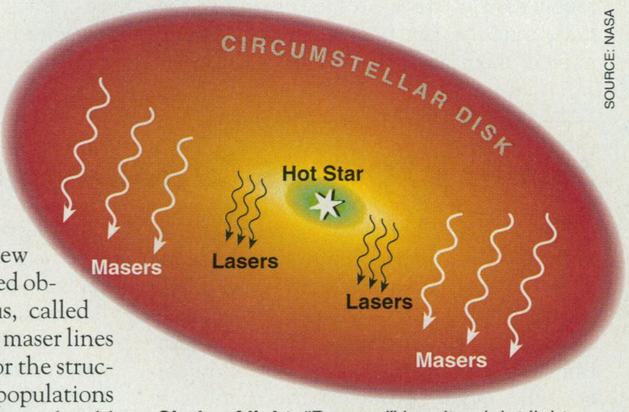
It seems to be a rule of nature, says Vladimir Strelnitski of the National Air and Space Museum (NASM) in Washington: "Masers anticipate lasers." Six years after the 1954 demonstration of the first laboratory maser—which draws on the energy of excited atoms to produce intense, coherent microwaves—its optical counterpart, the laser, was introduced. But for the past 30 years, researchers have been waiting to see if the same law applies in space. In the 1960s, researchers including University of California, Berkeley, physicist Charles Townes, the developer of the laboratory maser, found masers in the gases of deep space. But no single, unambiguous detection of a space laser followed.

Now the wait is over. In a measurement that Townes calls "quite convincing," a team led by Strelnitski has detected amplified infrared light coming from a disk of hydrogen gas whirling around a young star 4000 light-years away in the constellation Cygnus. The intensity of the emission at one wavelength compared to its neighbors shows that it is generated as crowds of energetic atoms in the disk emit photons in concert—the essence of laser action. The detection not only fulfills a long-standing prediction of lasers in space, say Strelnitski and his colleagues; it also gives astronomers a window into such disks, thought to be the precursors of planetary systems.

By now, radio astronomers have spotted several hundred masers in space, and theorists saw no reason why an occasional dense, energetic gas cloud in space shouldn't act as a laser. Space lasers should tend to be rarer than masers, because atoms excited up the large energy steps corresponding to photons of visible light have shorter decay times than atoms excited across microwave transitions. As a result, these highly excited atoms tend to emit light spontaneously, in all directions, reducing the energy available for lasing. What's more, most infrared light—the region of the spectrum where space lasers would most likely be—doesn't reach the ground.

But Strelnitski thought he knew a good place to look. Ground-based observations of the star in Cygnus, called MWC349, had picked up intense maser lines from the disk. And his scenario for the structure of the whirling disk and its populations of excited atoms predicted that lasing should also occur, in regions of the disk closer to the star. So he and his colleagues—Edwin Erickson and Michael Haas of the National Aeronautics and Space Administration's (NASA's) Ames Research Center, Howard Smith of NASM, and Sean Colgan of the SETI Institute in Mountain View, California—took to the air in NASA's Kuiper Observatory, a C141 Lockheed Starlifter jet that carries a 0.9-meter infrared telescope to an altitude of 12,500 meters.

Aiming the telescope at MWC349, the team saw a prominent infrared line at 169 micrometers that was six times more intense than it should have been if lasing weren't occurring. Strelnitski and his colleagues think this laser line is produced in hydrogen atoms that have been ionized by intense ultraviolet radiation—either from the star itself or from a shock wave at the disk's inner edge. After the freed electrons recombine with the ions, they cascade down atomic energy levels, emitting photons as they go. Much of the emission is spontaneous, but it can also be triggered when another photon passes by, "tickling" an atom into emitting an identical photon. Each of these photons can repeat the process, and over long paths through the gas, an intense beam results. The same process produces masers elsewhere in the disk, but in the inner disk it yields a laser, in part because the gas is denser and the ultraviolet light more intense.



SOURCE: NASA

**Circle of light.** "Pumped" by ultraviolet light, hydrogen atoms emit amplified microwaves from the outer part of this circumstellar disk and laser beams from the inner part.

Because MWC349's disk is oriented almost edge-on, some of the lasing paths aim toward Earth, which opened the way to the discovery. The result, says Erickson, "is like having a picture of a source we could never visit"—a picture that is especially valuable because the laser originates from a part of this planetary nursery that lies as close to the star as Earth does to the sun.

The measurements, obtained in mid-August, could be Kuiper's last hurrah, as it is due to be decommissioned this fall. But the researchers hope its success will induce Congress to fund a new high-flying observatory called SOFIA, for Stratospheric Observatory For Infrared Astronomy, which could be flying aboard a 747 by the end of the century. If Congress doesn't buy that argument, though, it could take longer to find the second laser in space than it did the first one.

**–James Glanz**