

Amateur Sky Survey Keeps It Simple

At the other end of the spectrum from the \$54 million, 100-astronomer Sloan Digital Sky Survey is The Amateur Sky Survey (TASS): \$50,000 so far, and 10 to 12 people from varying professions. About all TASS shares with the new large surveys is a fondness for acronyms and astronomy.

TASS is a product of the imagination and bank account of Tom Droege, a semiretired engineer at Fermi National Accelerator Laboratory in Batavia, Illinois, who builds cameras out of 135-millimeter lenses and reject charge-coupled device (CCD) chips, then gives them away to anybody willing to operate them and, more important, collaborate on the software that links them into a survey. Droege advertised his offer over the Internet*—"where the programmers are," he says. So far, he has sent out 23 cameras to amateur astronomer-programmers in California, Maryland, Canada, and points between. The amateurs set the cameras out in their backyards, uncover the lenses at night, let the sky rotate over the lenses, then cover them up again in the morning. The sky's

* <http://p674p06.isc.rit.edu/tass/tass.html>

movement and the readout from the CCDs are synchronized, so the resulting image is sharp—a method also used by the Sloan.

TASS's amateurs, says Droege, come from the cadre of good scientists who can't find jobs doing research and are, he says, "just itching for an excuse to do science." The science is a survey of a 3-degree-wide strip of the sky in which, with any luck, TASS will find 1000 unmapped variable stars, which astronomers will study to fill out their theories of stellar life history. The observations will go into a digital database at the Rochester Institute of Technology in New York and will eventually be searchable over the Internet. When TASS gets all its talent trained, it will go on to watch for asteroids that might be aiming at Earth.

When Droege goes to meetings and hears astronomers lamenting the lack of funding for instruments and salaries, he says, "I just smirk inside." With cheap instruments and no salaries, he says, "we amateurs are setting out to take over the world." Such amateurs do "strong and competitive science," agrees Alex Szalay of Johns Hopkins University and the Sloan Survey. "They give us a run for our money."
—A.F.

Caltech, is "a little hard to say but within a couple of years definitely."

However they're designed, public databases with a common searching scheme will mean that astronomers and anyone else with access to the Internet can, in Szalay's words, dial up the sky in 14 wavelengths and ask it questions. Lonsdale, for example, would like to look for quasars that are hidden by dust, which would make them bright in the infrared but faint in

the ultraviolet where quasars are usually prominent. The question, she says, is, "Have we missed a large population of quasars because dust hides the nucleus?" Gunn wants to study star birth in nearby spiral galaxies by combining radio observations—sensitive to the compressed gas that spawns stars—with far-infrared, near-infrared, and optical observations that trace the stars' early lives. "You can get the whole history of star birth," he says.

A multiwavelength, publicly accessible universe is a couple of years off, says Szalay, "but it's gonna come, it's gonna come. All this information at our fingertips will change the way we do astronomy. It's going to be more democratic. It's a totally different world, and it's exciting to be there shaping it."

—Ann Finkbeiner

Ann Finkbeiner is a science writer in Baltimore.

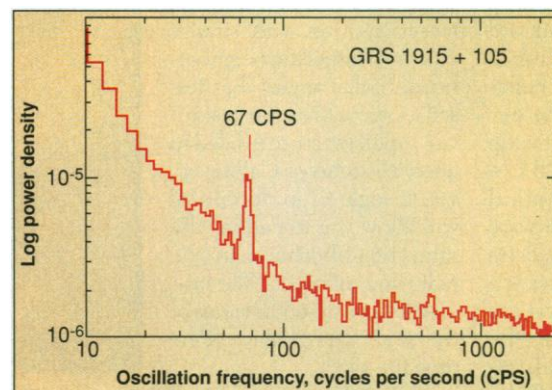
ASTROPHYSICS

X-rays Hint at Space Pirouette

If you spin in your office chair while holding a full cup of coffee, centrifugal force is likely to leave you wet—even if the entire office building and the surrounding city should somehow spin with you and hide any hint that you are moving. That's because, according to one of the more baffling concepts from Einstein's theory of relativity, the spin is measured against an abstract "frame of reference" determined by the average positions of all the stars in the universe—not a nearby speck of matter like a city. But if a chunk of matter is dense and massive enough—say, a planet or, better yet, a superdense star—all bets are off: Relativity predicts that such objects can "drag" reference frames right along with them.

Measurements announced this week may back up that claim. At a meeting of the American Astronomical Society's High Energy Astrophysics Division in Estes Park, Colorado, two teams announced their analyses of data from the 2-year-old Rossi X-ray Timing Explorer, a satellite carrying sensitive detectors that allow it to observe faint, rapidly varying x-ray signals. They found

that tiny wobbles in the x-rays from matter being sucked into stellar cinders called neutron stars, and perhaps into even denser black holes, appear to be signs of "frame drag-



What a drag. The jump in x-ray intensity at 67 CPS may reveal a spinning black hole dragging the space surrounding it.

ging"—as if space, like black coffee, were a substance that could be stirred and swirled.

"It's an intriguing interpretation," says

Mitchell Begelman, an astrophysicist at the University of Colorado, Boulder. "It would be very important if it turns out to be the correct one." If so, he says, it could mean that reference-frame dragging might serve as a tool for studying black holes, objects now observed only indirectly.

In one presentation, Luigi Stella of the Astronomical Observatory of Rome gave an analysis of x-rays from matter spinning around several neutron stars. As this matter—probably torn from a companion star by each neutron star's powerful gravity—spirals into a spinning accretion disk and sporadically plunges toward the neutron star, fluctuations in its x-ray glow tip off astronomers to how fast the matter in the accretion disk is moving and even how fast the neutron star is spinning.

But the Rossi's sensitive detectors have also picked up much slower jitters, explains Stella. That got him and his colleague Mario Vietri of the University of Rome thinking about frame dragging.

GENETICS

Fast-Forward Aging in a Mutant Mouse?

The effect had been seen indirectly in the 1970s, through its influence on the way a pair of pulsars—neutron stars that emit beams of radio waves—orbit each other. And in a paper soon to appear in the journal *Classical and Quantum Gravity*, a team led by Ignazio Ciufolini of the University of Rome reports detecting the minute effects of frame dragging by Earth's own gravity in the orbits of the so-called LAGEOS satellites. While that detection remains controversial, the Gravity Probe B satellite, to be launched by 2000, will attempt to measure Earth's frame dragging precisely using gyroscopes.

Stella and Vietri thought that a neutron star's powerful magnetic field might create the conditions needed to see frame dragging in the x-ray signal. Like the whirling blades of an egg beater, the magnetic field punches a hole in the middle of the accretion disk. Because the field's north and south poles are generally out of line with the neutron star's spin axis, its whirling lines of force fling matter from the accretion disk out of the disk's plane. There, like a tilted toy top, the material should wobble, or precess, at the same frequency that the reference frame—and therefore the very space in which it exists—is being dragged around the star. Being off kilter is crucial to detecting frame dragging: Within the plane, dragging would produce only undetectable changes in the disk's speed. The wobble frequencies measured by the Rossi satellite are broadly consistent with the amount of dragging expected from the neutron stars' spin rates and the distance at which the material is whirling around them.

Other experts are cautious. "All we can say is that the order of magnitude is right," says Sharon Morsink, a relativity expert at the University of Wisconsin, Milwaukee. The uncertainty stems from a lack of knowledge about the internal structure of neutron stars, which are about 20 kilometers across and roughly as dense as atomic nuclei. Astronomers don't know how that density varies with depth in the star, says Morsink, which would affect the distance of most of the star's matter to the accretion disk and the magnitude of the frame-dragging effect.

Still, a second team, led by Wei Cui of the Massachusetts Institute of Technology, reported that Rossi's measurements of low-frequency x-ray oscillations might have also detected frame dragging around far denser objects: black holes (see graphic on p. 1012). In this case, the researchers don't have a direct measure of the black holes' spins. But if the result is correct, notes Colorado's Begelman, then the whirling of space could be used to measure how fast other black holes are spinning. And that, in turn, could provide clues as to whether spinning black holes are the engines behind such spectacular displays as quasars, plasma jets, and gamma-ray bursts.

—James Glanz

When the television or the toaster oven breaks down a week after its warranty expires, it's tempting to believe the manufacturer designed it to do so. Similarly, the infirmities and breakdowns that herald old age are so predictable that some scientists believe our genes evolved with their own kind of warranty, one that runs out shortly after reproductive age. These researchers speculate that if they could figure out which genes underlie this planned obsolescence, they might be able to delay it—in effect, extending the warranty. Now, by studying mutant mice that resemble senior citizens by the time they're only 60 days old, a team in Japan may have discovered what such a gene would look like.

Defects in the previously unknown gene, called *klotho*, cause mice to die prematurely with a skein of disorders commonly found in elderly humans, such as arteriosclerosis, osteoporosis, skin atrophy, and emphysema. The finding, reported by a team led by Makoto Kuro-o, a physician and molecular geneticist at the National Institute of Neuroscience in Tokyo, in this week's issue of *Nature*, suggests that a specific set of genes suppresses all these age-related conditions. The *klotho* gene, which appears to produce a protein that circulates in the blood, may be the signal that keeps this genetic program turned on while an organism is young, says Kuro-o. And because *klotho*—named after the Greek goddess who spins the thread of life—is also found in people, Kuro-o says he has high hopes "that this notion will be effective for understanding aging mechanisms in humans."

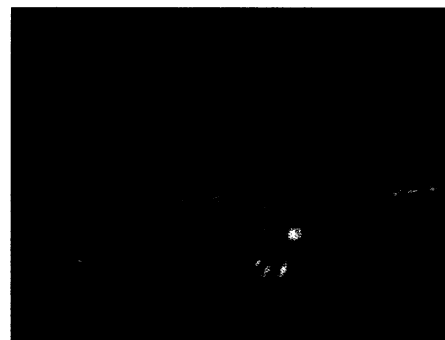
"A wonderful surprise" is how George Martin, a medical geneticist at the University of Washington in Seattle, describes the finding. Indeed, it's such a surprise that skepticism is called for, says Michal Jazwinski, a geneticist studying aging at Louisiana State University Medical Center in New Orleans. "They're fooling around with a gene that's normally expressed in the mouse and getting a syndrome that looks like aging in humans," Jazwinski notes. "That's a bizarre twist"—and a possible sign, he says, that the mutation doesn't accelerate the mice's own aging, but merely kills them prematurely.

Kuro-o started out looking for genetic changes that contribute to hypertension, not hoariness. To test whether one cause of high blood pressure in mice and humans might be

overproduction of a protein that plays a role in transporting sodium across cell membranes, Kuro-o injected one-celled mouse embryos with multiple copies of the corresponding gene. These new genes took up random positions in the embryos' DNA, sometimes landing in locations where they disrupted native genes.

Kuro-o noticed that mice belonging to one such strain stopped growing 3 to 4 weeks after birth and died after only 8 to 9 weeks instead of the usual 2 to 3 years. And when Kuro-o examined tissues from the mice under the microscope, he found further changes that, in humans, would be signs of aging: Their arterial walls and other tissues

had calcified, their bone density had decreased, the alveoli of their lungs had deteriorated, and they had lost hair follicles and skin thickness. Although these symptoms aren't normally part of the aging process in mice, they might at least make the *klotho* mouse a good laboratory model for the



Whiskered and wizened. Mice with a mutated *klotho* gene resemble elderly humans.

study of human aging, Kuro-o realized.

By homing in on the inserted transgene, Kuro-o's team cloned *klotho* itself and determined from its DNA sequence that it encodes a protein similar to β -glucosidase, an enzyme found in bacteria, plants, and mammals that can break apart fat-soluble molecules such as glycolipids. From its amino acid makeup, Kuro-o believes that the enzyme has an active portion that circulates in the blood, where it may break down glycolipids to generate ceramide, a compound known to help regulate programmed cell death. He's now testing mouse and human blood plasma for signs of the enzyme, and is also looking for variations in *klotho* carried by people with common age-related disorders, such as osteoporosis.

Other scientists will want to know those results, not to mention the enzyme's true function, before they'll fully believe Kuro-o's theory. The *klotho* mutants might be suffering from a metabolic disease rather than aging, says Jazwinski. "Are they seeing premature aging, or simply premature death? This is the essential question." But Kuro-o says he's found no metabolic abnormalities in the mutants. He sums up: "I think these mice died of old age."

—Wade Roush