High-Energy Summer for Astrophysics

With the well-known gamma-ray source at the center of our Milky Way galaxy suddenly flickering out, and with an otherwise obscure star in the constellation Cygnus suddenly producing an explosion of x-rays—both events coincidentally discovered on 22 May—the summer of 1989 has so far been a lively one for high-energy astrophysicists.

The discovery of the disappearing gamma rays came as something of a disappointment to University of California, San Diego, physicist James Matteson and his co-workers. On a 22 May balloon flight launched from Alice Springs, Australia, they flew a new gamma-ray spectrometer designed to pinpoint the galactic center emissions with unprecedented resolution. They found nothing above background.

On the other hand, even negative results can have their compensations. "This is a very exciting finding," declares Matteson. It provides yet another piece of evidence that stars and gas in the galactic center are being gobbled up by a huge black hole.

When the source is on, explains Matteson, it emits gamma rays at the 511-thousand-electron-volt (keV) energy of electron-positron annihilation. The positrons are presumably generated when a wandering star or clump of interstellar gas falls into the hole and says good-bye to the universe with a flash of thermonuclear radiation. Furthermore, the fact that the source has now flickered out—it flared in 1977 when it was first discovered, it vanished in 1980, and then flared again in 1988—is exactly what you would expect: if the gas supply is erratic, then the positrons will be erratic.

So, if the past is any guide, another clump of matter will eventually die and the 511-keV radiation will flare again. Until then, however, San Diego theorist Richard Lingenfelter is just as excited about the group's separate observation of gamma rays above the annihilation energy. "These hotter emissions come from the source that actually produced the positrons," he says. So a careful analysis could allow the researchers to look right at the monster in the middle, and perhaps come closer to answering a fundamental question: is it a galaxy-sized behemoth as big as a million times the mass of the sun, as some researchers have suggested? Or is it, as Lingenfelter suspects, just a baby of less than a thousand solar masses?

Meanwhile, even as the gamma-ray spectrometer was drifting over Australia, the Japanese Ginga x-ray satellite was detecting a flux of x-rays coming out of Cygnus. Ginga's angular resolution was not good enough to pinpoint the source. But on 26 May, astronomers Sumner G. Starrfield of Arizona State University and R. Mark Wagner of Ohio State University decided to take a quick look at the area during the last minutes of their observing run at the Lowell Observatory near Flagstaff, Arizona.

"I just saw it visually on the TV screen," says Wagner: fading rapidly into the dawn was a blip of light far brighter than anything recorded on the standard star charts in that position. The next night it was picked up again by the International Ultraviolet Explorer satellite, which made the identification certain. An obscure star known as V404 Cygni, located some 3000 to 4500 light-years from Earth, had suddenly brightened by a factor of about 2000.

As it happens, says Wagner, this was not the first time for V404. Astronomers had noticed it going through a similar flare back in 1938. But that was before radio telescopes, x-ray satellites, and the like. This time around V404's outburst has triggered a fairly large campaign, he says. In addition to Ginga and the International Ultraviolet Explorer, it has been observed by optical telescopes, by the Very Large Array of radio telescopes, and most recently, by the gamma-ray detector aboard the Soviet Union's Mir space station.

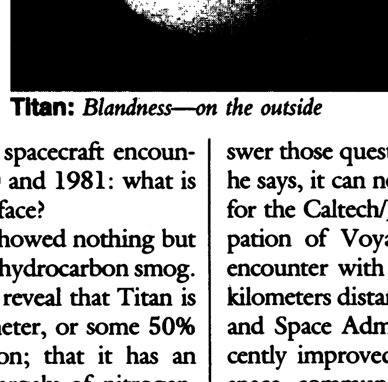
"Flares like this are certainly not common," says Wagner. The last such "x-ray transient" was in 1975. The general idea is that V404 is a binary system in which a compact object—a neutron star, or perhaps even a black hole—is orbiting around a more or less normal star and occasionally pulling off globs of matter. The matter then plunges across the gap to strike the compact object with an explosive burst of radiation. But understanding the details will not be easy, says Wagner, not with the fast-fading x-ray signal jumping up and down by a factor of 10 or so on a time scale of seconds.

■ M. Mitchell Waldrop

Titan: Continents in a Hydrocarbon Sea

Breaking all distance records for interplanetary radio astronomy, researchers from the California Institute of Technology and Caltech's Jet Propulsion Laboratory have bounced radar signals off the cloud-wrapped surface of Saturn's giant moon Titan, 1.25 billion kilometers from Earth. Encoded in the echo, moreover, are hints of a surprisingly rich, if frigid, geography: at least one Titanian "continent" of ice, rock, and solid carbon dioxide seems to be rising out of a satellite-wide ocean of liquid hydrocarbons.

"The radar echo from Titan is the weakest such echo that has ever been measured," says Caltech planetary scientist Duane O. Muhleman, leader of the group. Nonetheless, it has yielded the first direct information on a mystery that survived even the Voyager spacecraft encounters with Saturn in 1980 and 1981: what is the nature of Titan's surface?



Jet Propulsion Laboratory

Titan: *Blandness—on the outside*

The Voyager images showed nothing but a smooth orange haze of hydrocarbon smog. Other Voyager data did reveal that Titan is 5150 kilometers in diameter, or some 50% larger than Earth's moon; that it has an atmosphere composed largely of nitrogen, with an admixture of hydrocarbons such as methane and ethane (the action of sunlight on these compounds is presumably what produces the smog); and that its surface conditions—a pressure 1.3 times that of Earth and a temperature of 94 K—are sufficient to trigger showers of ethane and methane rain.

From these findings it was only a short step to hypothesize a satellite-wide ocean of methane and ethane. Indeed, many scientists began to think of Titan as a remarkably Earth-like body, despite the chill. On the other hand, says Muhleman, no one could say how deep the Titanian ocean might be—a kilometer, perhaps?—or whether any dry land might rise above its surface.

But if the Voyager program failed to answer those questions on the first go-around, he says, it can now take some indirect credit for the Caltech/JPL radar success. In anticipation of Voyager 2's upcoming August encounter with Neptune, some 4.5 billion kilometers distant, the National Aeronautics and Space Administration (NASA) has recently improved the sensitivity of its deep space communications antenna in Gold-