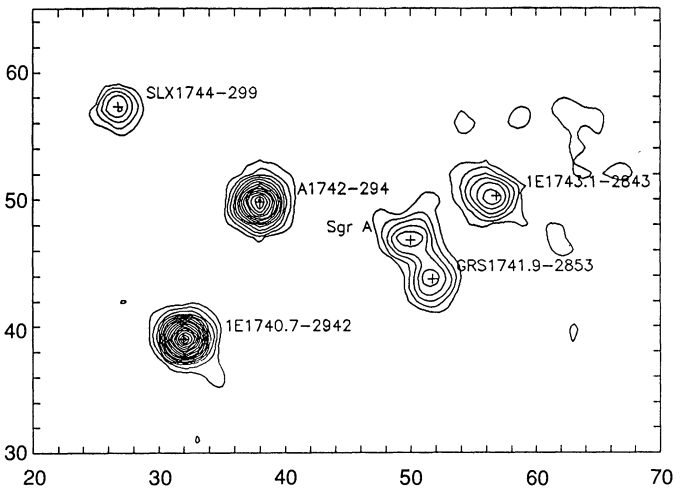
Black Holes Swarming at the Galactic Center?

The mysterious gamma ray emissions seem to come from a black hole some 100 light-years out; is there more than one?

THE CENTRAL REALM OF OUR MILKY WAY galaxy is turning out to be an exceedingly strange place. Not only have more and more astronomers become convinced in recent years that the center point is occupied by a black hole roughly one million times the mass of the sun, but now they have compelling reason to think that this black hole may not be alone. Just announced data from the Soviet-French gamma-ray satellite GRANAT strongly suggest that the central behemoth is accompanied by at least one "small" black hole with perhaps a few hundred times the mass of the sun. Moreover, the GRANAT observations have fingered this companion object, located about 100 light years out from the center, as the source of erratic and mysterious gamma-ray emissions that have been tantalizing astronomers for nearly two decades.

"I think that they [the Soviets and the French] have made a major scientific discovery," declares Bell Laboratories astrophysicist Marvin Leventhal, who first observed the emissions with a balloon-borne gamma-ray detector in 1977, and who sees the GRANAT findings as something of a vindication.



At the core. *GRANAT's gamma-ray image shows the positron source (lower left) and the galactic center (Sgr A).*

Those 1977 results were as frustrating as they were intriguing, Leventhal explains. The flux of gamma rays peaked at the telltale energy of 511 thousand electron volts (keV), which is precisely the energy of the gamma rays produced when an electron annihilates its antiparticle, the positron. Somehow, something was producing antimatter in huge quantities at the galactic center, which lies about 30,000 light years from Earth in the direction of the constellation Sagittarius. But what?

Unfortunately, it was beyond the capabilities of Leventhal's detector to pinpoint the source of the emissions. Worse, when he and several independent observers flew follow-up balloon missions in the 1980s—gamma rays are absorbed in the atmosphere and cannot be observed from the ground—they found that this mysterious antimatter source was switched off as often as it was switched on. Skeptics were constantly wondering aloud whether the signals were just some instrumental glitch. So, having GRANAT finally identify the source is, says Leventhal, "a real triumph."

The new observations are likewise a coup for the Soviet Union's space science program, whose future is increasingly clouded by that country's political and economic upheaval. At an international astrophysics meeting* held this past December in Brighton, England, just a week after the observations were first announced in France, GRANAT chief scientist Rashid Sunyaev of the Space Research Institute in Moscow rarely stopped beaming.

Pinpointing the annihilation radiation was largely a matter of luck and perseverance, he told the Brighton audience. In the spring of 1990, shortly after launch, GRANAT took its first look at the galactic center with its Sigma instrument, a gamma-ray imaging telescope built by a French team working under astrophysicists Jacques Paul and Pierre Mandrou. It did see a handful of gamma-ray sources, but none was emitting annihilation radiation. And in October, when the spacecraft turned that way again, it saw much the same: a handful of sources, but nothing very spectacular.

Nothing, that is, until the night of 13-14 October. Taking one last look before moving on to other targets, the Sigma telescope revealed that one source, which is offset from the center point of the galaxy by about 100 light-years, had flared up and was suddenly putting out gamma-ray energy at a rate some 10,000 times greater than the total luminosity of the sun. Moreover, most of that energy was coming out in the form of 511 keV gamma rays: the sure sign of annihilation.

The source of the flare bears the uninspiring designation 1E1740.7-2942. (The "E" refers to the catalog of x-ray sources complied by NASA's Einstein satellite in 1979.) At this point no one can know for sure what this object is, Sunyaev said. But the available evidence suggests that it is quite compact—much smaller than our own solar system, in fact—and very, very hot: making positrons requires a temperature of at least a billion degrees Kelvin.

These conclusions, in turn, suggest that the object is actually a smallish black hole, which presumably formed as the remnant of some long-ago supernova. Such an object would naturally tend to swallow interstellar gas and dust from its surroundings, said Sunyaev. And as the material swirled into the vortex, friction and pressure could easily generate those billion-degree temperatures.

In any event, the prospect of having one auxiliary black hole in the galactic center opens up a raft of new questions—starting with the question of how many others are floating around in there. If there is one, couldn't there be more?

And then there's that million-solar-mass black hole in the middle. If smallish black holes can generate bursts of positrons, then shouldn't an enormous one do it even better? And where did this Brobdingnagian thing come from, anyway? Did it form from the coalescence of lots of smaller holes?

Clearly, notes Leventhal, answering such questions is going to take a lot more observation. GRANAT is scheduled to take another look in April and May. NASA's Gamma Ray Observatory will be conducting a regular monitoring program, assuming that it gets launched this year as planned. And Leventhal himself is deep in negotiations with Sunyaev and his colleagues to launch one of his own detectors aboard a Soviet satellite. This mission is still in a preliminary stage, he says, but everyone from NASA officials to the Soviet scientists seem very supportive. No one has much money, so Leventhal says, "They're very eager to cooperate." ■ **M. MITCHELL WALDROP**

* The Texas/ESO-CERN Symposium on Relativistic Astrophysics, Cosmology, and Fundamental Physics, 16 to 21 December 1990, Brighton, United Kingdom.