Space Reactors Hinder Gamma-Ray Astronomy

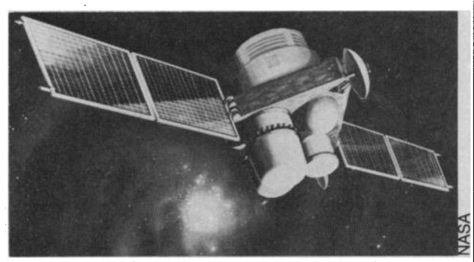
Soviet nuclear spy satellites are hurting gamma-ray astronomy; so why was that fact classified for 8 years?

FOR 8 YEARS NOW, many of the astronomers who monitor the sky with satellite-borne gamma-ray detectors have known that their data are being corrupted by Soviet intelligence satellites powered by unshielded nuclear reactors. Indeed, "the situation has become completely unlivable in the last couple of years," says University of New Hampshire astrophysicist Edward L. Chupp, a principal investigator for the gamma-ray instrument on the Solar Maximum Mission satellite.

And yet for 8 years, those same astronomers have been reluctant to talk about the problem: no sooner was the interference discovered by Solar Max in 1980 than it was classified as secret. The classification was finally lifted this past summer. But in the meantime the atmosphere of secrecy and uncertainty has been such that the Japanese Ginga satellite was designed without adequate knowledge of the threat, so that one of its most important gamma-ray instruments is now crippled. And National Aeronautics and Space Administration (NASA) scientists and engineers have been left scrambling to find a fix for a similar instrument that is scheduled to fly just 2 years from now aboard the $500 million Gamma-Ray Observatory.

According to astronomers and NASA officials contacted by *Science*, the interference was discovered not long after the February 1980 launch of Solar Max, which carried a gamma-ray detector capable of looking both at the sun and at more distant objects such as supernovas and neutron stars. Every so often the instrument would show a burst of gamma rays at 0.511 million electron volts (MeV), precisely the energy of photons produced by the annihilation of electrons and positrons. The bursts would last anywhere from a few seconds to 100 seconds or so, and would typically be accompanied by an enhanced flux of charged particles striking the spacecraft. "They just didn't make sense as extraterrestrial events," says New Hampshire's David Forrest. "So we decided the sources were in orbit."

It took little imagination to guess what those sources might be. The Soviet practice of hoisting nuclear reactors into orbit had been public knowledge since at least 1978, when Cosmos 954 reentered the atmosphere out of control and scattered radioactive debris across the Canadian Arctic. Indeed, the practice continues today. The reactors provide power for the Soviet military's Radar Ocean Reconnaissance Satellites, or RORSATs, which are used to track Western fleet movements. They have been launched at the rate of 2 or 3 per year since the late 1960s—the satellites rarely operate for more than a few months apiece—and their population now stands at 34.



The Gamma Ray Observatory. *Will it be partially blinded by nuclear-powered satellites?*

The gamma-ray interference arises from the fact that none of these reactors is shielded, presumably because the Soviets find it pointless to lift so much extra weight when no human being is ever going to come near the things (barring accidents, of course: Cosmos 1402 followed Cosmos 954 back to Earth in 1982, and Cosmos 1900 very nearly came down this year). One problem is the direct emission of gamma rays from fission fragments in the reactor core—a lesser problem, says Forrest, because satellites such as Solar Max orbit well above the active RORSATs. Much more serious are the indirect emissions: electron-positron pairs that stream from each reactor and then spread out along the earth's magnetic field to form vast, tenuous clouds. Indeed, it is almost impossible for any other satellite to escape such a cloud. Thus the Solar Max episodes: an enhanced flux of charged particles (the electrons), plus a pulse of 0.511-MeV gamma rays (positrons annihilating in the detector.)

None of this was clearly understood back in the early 1980s, says Forrest, but he and his colleagues reported their findings to NASA nonetheless. And in due course, the word came back down: keep it quiet. This subject was classified.

The question that Chupp, Forrest, and their colleagues still find baffling is "Why?" The existence of the Soviet RORSATs was hardly a secret after Cosmos 954. The Solar Max data were in the public domain. The capabilities of the gamma-ray detector had already been published. So, precisely what compelling national security need did this action fulfill? No one contacted by *Science* seems to have any idea.

In any case, the situation began to change about 2 years ago in ways that made it very hard to keep the interference a secret anymore. To begin with, the frequency of spurious events escalated dramatically, for reasons that are not entirely clear, but that probably have to do with the orbits of the newer RORSATs. By a cosmic coincidence, this escalation came at the same time that astronomers were focusing intense scrutiny on gamma rays from Supernova 1987A.

Second, the Soviet reactors have been causing a drastic loss of data on the Japanese Ginga satellite, which was launched in February 1987. The particular victim is a detector built at the Los Alamos National Laboratory to study gamma-ray bursters—real ones. These bursts are known to be natural events because they have been detected simultaneously by multiple spacecraft. They occur randomly all over the sky, at random times. They consist of a bright flare of gamma rays only a few seconds long. And they are among the most mysterious phenomena in astrophysics. No one knows what they are. The challenge in observing the bursters is that the information comes into the instruments far faster than it can be relayed to the ground. The Ginga detector is therefore designed to store up millions of bits of data during the course of an event; and then to shut itself off for the next 90 minutes until its transmittal to the ground is complete and its memory is empty again.

But therein lies the problem: the Ginga detector is being triggered so often by spurious bursts from the Soviet reactors that it spends more than 40% of its available observing time transmitting garbage. The frustrating thing, says a Los Alamos astrophysicist working with the Ginga detector, is that the scientists on the ground can tell which event is which—the simultaneous pulse of electrons gives it away—but the on-board logic cannot. Things might have been different if they had known more about the reactor problem ahead of time, he says.

And finally, the Ginga experience has made it clear that the Soviet reactors pose a major threat to the Gamma Ray Observatory, which will carry a burst detector quite similar to the one on Ginga. According to Gerald J. Fishman of NASA's Marshall Space Flight Center, chief scientist on this instrument, the reactors could trigger the detector as often as five times per day. Unlike the Ginga instrument, fortunately, this detector will be programmable. "So I'm optimistic we can find a software solution" to reject the spurious events, says Fishman.

Nonetheless, it was the threat to the Gamma Ray Observatory that precipitated efforts by the NASA astrophysics division to get the classification lifted. The request was approved by an interagency intelligence council this past summer. A nonclassified memorandum from observatory program manager Arthur J. Reetz, dated 29 August, brought the subject officially into the open. Several technical studies of the problem are now being prepared for publication.

Meanwhile, there remains the issue of the Soviet reactors themselves. The gamma-ray interference issue has recently been taken up by such groups as the Federation of American Scientists and the Committee to Bridge the Gap, both of which are seeking an international ban on any kind of nuclear reactors in space. They are after bigger game, of course: by banning reactors in space they hope to hamstring the U.S. Strategic Defense Initiative, which would need reactors to power the weapons of its orbital missile shield. Nonetheless, says Steven Aftergood, executive director of the Committee to Bridge the Gap, "This is another compelling reason to ban nuclear power in orbit." ■ M. MITCHELL WALDROP

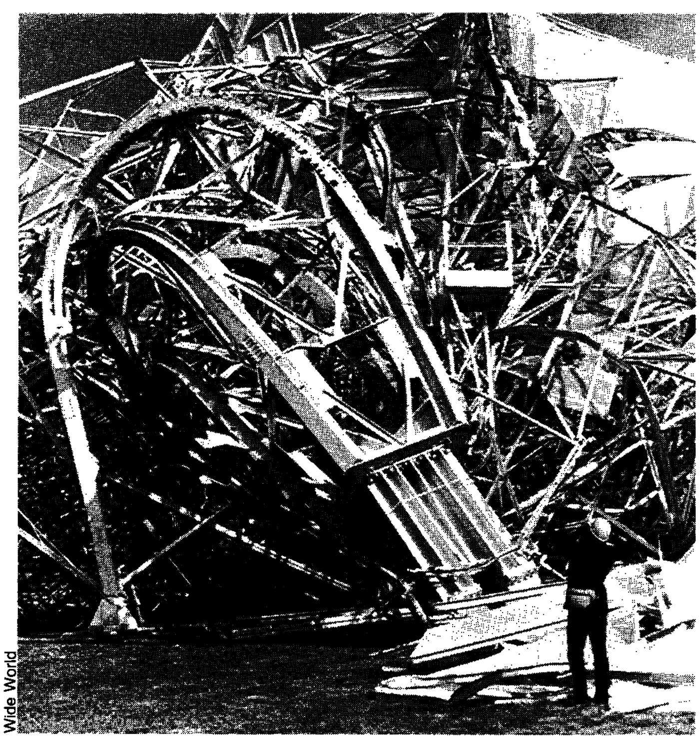
Collapse of a Radio Giant

"It was a very pretty telescope," says National Radio Astronomy Observatory (NRAO) director Paul Vanden Bout, with more than a trace of sadness in his voice. "It was light. It had a lacy structure." It rose out of a remote mountain valley near Green Bank, West Virginia, overshadowing its companions at the NRAO facility there. It was one of the largest radio dishes in the world.

And at 10 p.m. on the clear, calm night of 15 November, it collapsed. With no warning whatsoever, its two supporting pylons gave way. The great white mesh paraboloid, 300 feet (92 meters) in diameter, crumpled downward into a tangle of steel spaghetti. The falling debris tore open the roof of the control room underneath, sparing the computers and other equipment inside, and leaving the telescope operator frightened, but unscathed.

"We're baffled," Vanden Bout told *Science* shortly after his initial survey of the wreckage. "There are probably as many ideas around [about what happened] as there are astronomers."

One conjecture is that the telescope may have been shoddily built in the first place. Another is that the telescope may not have been properly maintained, particularly with NRAO's chronically tight budgets in recent years. Vanden Bout, however, does not subscribe to either conjecture at this point. It is certainly true, he says, that when the telescope was built in 1962 it was considered a stopgap instrument, a way to get the then-fledgling observatory up and running as quickly as possible. Construction was rapid and cost only $850,000—cheap even then. Contrary to an early report from the Associated Press, however, it was not a slapdash expansion of a smaller dish; the latter was actually a separate, 42.5-meter instrument of similar vintage that is still in operation.


Wide World

After the Big Bang.

As for deferred maintenance, says Vanden Bout, that is a real problem for the observatory. "But we confine it to things like roads," he insists, not items that would really matter to the science. In particular, he says, "the 300-foot got inspected regularly. We repainted a section of it in rotation every summer, like on a bridge. We kept the bolts in good condition. I can't say that because of lack of money we didn't do what we needed to do."

Whatever the final explanation, he says, it will probably have to await the results of a formal inquiry now being organized jointly by the National Science Foundation, which funds NRAO, and by the Associated Universities, Inc., the university consortium that operates the observatory on behalf of NSF.

Meanwhile, the 300-foot telescope itself will be sorely missed by the astronomical community. It is by no means the only large radio telescope in the world. The 305-meter radio telescope at Arecibo, Puerto Rico, for example, is more than three times larger. But it is the only one to combine such a large size and sensitivity with the ability to see all the sky in the northern celestial hemisphere. (Arecibo is immobile, and is thus comparatively restricted in what it can see.)

Perhaps its most dramatic finding came in 1967, shortly after pulsars were discovered: it was the first radio telescope to detect the furiously rotating pulsar at the center of the Crab nebula, which is the remnant of a supernova that exploded in 1054. But in the main, says Vanden Bout, "it was not an instrument for big breakthrough discoveries. It was a survey instrument, a road map instrument." Indeed, on the night of its collapse it was within a week of completing a new map of the entire northern sky at the 6-centimeter wavelength. It was much in demand for such activities as a survey of galaxies at high red shifts, or a survey of neutral hydrogen in our own galaxy and in other galaxies, or in one notable case, a survey of radio sources that might prove to be new gravitational lenses.

Ironically, at the time of the collapse, the NRAO had already embarked upon a study of possible replacements for the 300-foot telescope, as well as for the 42.5-meter instrument. Officials are hesitant to say what form the replacements might take—or how much they would cost—but the events of 15 November have clearly given them an incentive to complete their report.

■ M. MITCHELL WALDROP