Supernova's light curve baffles scientists

More than four years after light from supernova 1987A first reached Earth, radiation remains the key tool for investigating the hidden energy sources powering this exploded star. Soon after the supernova appeared, emissions of ultraviolet, infrared and visible light grew steadily fainter, following a predicted decay curve. But changes in the supernova's "light curve" over the past year now leave astronomers puzzled.

The changes hint at two dramatic possibilities: the abundance of elements in 1987A may differ widely from that in our solar system, or a new energy source — perhaps a dense, spinning sphere of neutrons known as a pulsar — lies hidden at the core of the object.

"It's a very exciting time to observe the supernova," says Alistair R. Walker of the Cerro Tololo Inter-American Observatory in La Serena, Chile. "We're getting to the stage where we have no comparable data from other supernovas."

The object's brightness began declining 85 days after astronomers first witnessed its stellar outburst in the Large Magellanic Cloud galaxy. Since then, emissions from 1987A have matched the output expected from the decay of cobalt-56, one of many radioactive elements produced during the explosion of the object. As cobalt-56 decays, it emits energetic photons called gamma rays. Some of the gammas excite atoms in the cloud of debris surrounding 1987A, causing the atoms to emit infrared and visible light observable from Earth. Based on the abundance of cobalt-56 as well as its half-life, scientists believe that until recently it provided the supernova's chief fuel.

But as observations of 1987A hit the three-year mark, little cobalt-56 remained, and the light curve flattened, reports Walker, Nicholas B. Suntzeff and their colleagues in the September Astronomical Journal. The flatter curve matches the slower decay of another isotope, cobalt-57, which the supernova produced in smaller amounts, the group notes. Another team, at the European Southern Observatory in La Silla, Chile, reports similar results.

So far so good. But although the shape of the light curve mimics the decay of cobalt-57, the *magnitude* of the curve — indicating the amount of light now emitted by 1987A — exceeds that predicted by theory, both teams say. One way to explain the greater emissions, note Suntzeff and his colleagues, is to assume that the supernova produced a ratio of cobalt-57 to cobalt-56 five times the ratio typical in our solar system. They will report these results in an upcoming Astrophysical Journal Letters.

The unusual ratio may pose a problem, several astronomers assert, even though the turbulent environment of 1987A — located 160,000 light-years from Earth — differs from that of the solar system. While nuclear burning inside stars creates the lighter elements, researchers believe it requires the violence of a supernova explosion to produce the heaviest materials, such as radioactive nickel, which then decays to cobalt, and ultimately to iron. Over time, thousands of supernovas spew out their contents, thus determining the abundance of heavy elements in our galaxy and others. According to this model, the abundance of isotopes created by individual supernovas should not differ radically from the ratio found near Earth.

Suntzeff's team suggests another explanation for the new findings, one that no longer requires 1987A's ratio to conflict with our solar system's. A constant energy source lurking at the core of the supernova could also account for the larger light output — perhaps a pulsar, long sought but never observed in 1987A, or a black hole. While such sources generally produce a totally flat light curve rather than the slowly declining one observed, Suntzeff says the latest data indicate 1987A's curve appears to be flattening.

Many astronomers caution that the findings provide only sketchy evidence for a pulsar. And absorption of the supernova's far-infrared emissions by Earth's atmosphere complicates efforts to measure the supernova's total brightness.

A study last month with NASA's Gamma Ray Observatory (GRO) may answer the cobalt ratio question, says Mark Leising of Clemson (S.C.) University. GRO measured the spectra of gamma rays from 1987A, which should allow researchers to calculate the amount of cobalt-57 produced by the supernova. In 1988, the Solar Maximum Mission satellite precisely calculated 1987A's quantity of cobalt-56. Comparing both isotopes will directly determine the relative abundance of cobalt-57. Very early results, Leising notes, suggest that GRO did not find the large increase inferred from the ground-based measurements. — *R. Cowen*

Cocaine may piggyback on sperm into egg

Tiny specks of cocaine can attach to specific sites on human sperm, according to a newly reported laboratory experiment. The finding suggests that the dangerous drug could piggyback its way into a new embryo by hitching a ride on the fertilizing sperm, perhaps harming the embryo's development.

"This is the first time I know of that a substance that causes abnormalities in offspring has been shown to bind to sperm," says the study's leader, Ricardo A. Yazigi of Temple University School of Medicine in Philadelphia. The new data might also explain some animal and human studies showing developmental or neurological problems among the offspring of males exposed to drugs, alcohol or other environmental toxicants, such as lead, he adds.

Yazigi, who conducted the experiment while at Washington University School of Medicine in St. Louis, studied samples from non-drug-using donors to the university's sperm bank. He and his colleagues added increasingly larger amounts of radioactively labeled cocaine to the samples, and filtered them onto disks that the researchers could wash and analyze using a type of Geiger counter.

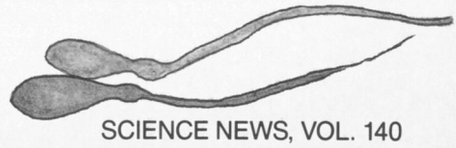
The samples initially became more and more radioactive as the researchers added in more cocaine. But after the cocaine reached a certain level, the radioactivity of the samples stabilized. This suggests that each sperm cell has a finite number of specific sites for binding cocaine, Yazigi says. His team also found that samples treated with a mixture of labeled and unlabeled cocaine were less radioactive than those treated with only labeled cocaine, further indicating that both compounds compete for a limited number of sites.

Cocaine levels normally found in the semen of cocaine-abusers did not kill the sampled sperm cells or slow their movement, the researchers report in the Oct. 9 Journal of the American Medical Association.

Yazigi acknowledges that no human studies have linked cocaine use by fathers with birth defects or developmental problems, although some have found that newborns whose fathers drank excessively weighed less at birth than did infants of men who did not consume alcohol. But he notes that other researchers have shown that some offspring of male rats given cocaine cannot perform basic tasks, such as successfully navigating a maze to find food.

Yazigi speculates that no one has observed the effects of paternal cocaine abuse in humans because it may cause "very subtle defects," such as learning disabilities and memory problems. In contrast, cocaine abuse by the mother may cause more severe disabilities, such as low birthweight, because the unborn child is exposed to the drug throughout pregnancy (SN: 9/7/91, p.152).

Yazigi's team made "a very interesting finding," says behavioral neuroscientist David F. Wozniak at Washington University. "People have been sort of skeptical of the effects of paternal drug use," he says, "but the evidence is mounting that there should be further studies." — *C. Ezzell*



Randy Fletcher