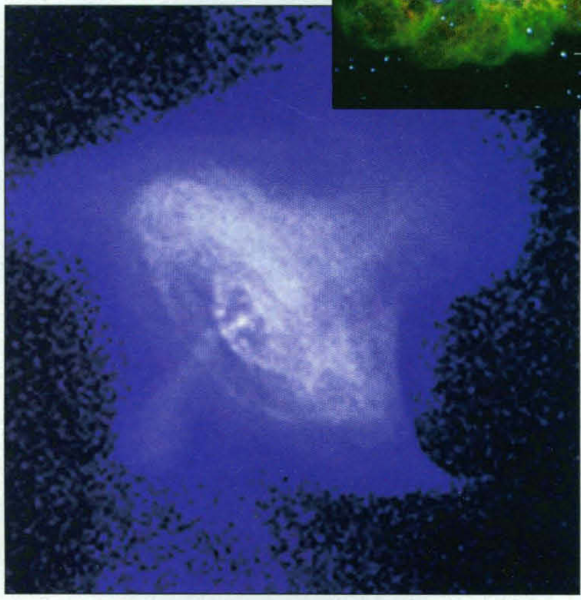
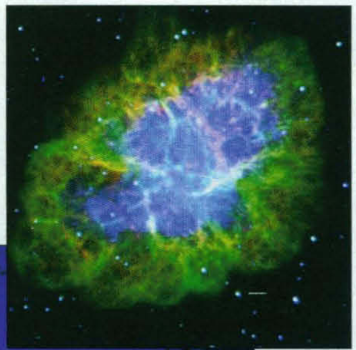
ASTRONOMY

# Peering at the Crab's Power Supply

The orbiting Chandra X-ray Observatory has opened a new and detailed look at the blazing heart of the Crab Nebula, the remnants of a star that exploded into view nearly 1000 years ago. The images reveal swirls of energetic material around the spinning stellar corpse in the nebula's center. The swirls, especially a bright inner ring, may trace the long-sought "power conduits" that pump energy from a pulsar at the center to the glowing nebula, according to researchers who spoke last week at NASA Headquarters in Washington, D.C.





**X-ray vision.** A ring, sharp jets, and other bright x-ray features surround the central neutron star in the Crab Nebula in this new image from the Chandra X-ray Observatory. The inner ring is about two-thirds of a light-year across. The entire Crab Nebula *(inset)*, seen in a ground-based photograph, measures about 6 light-years across.

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Chinese astronomers and Native Americans recorded the Crab as a new "star" in the year 1054. The celestial beacon was a supernova, the death blast of a giant star that had consumed all its fuel and collapsed. Astronomers have known since 1968 that an ultradense neutron star spins 30 times per second within the Crab's expanding cloud of debris, emitting a lighthouse beam of radio waves. But the chaos at the center of the nebula has shrouded the mechanisms by which this pulsar lights up the glowing cloud.

The new x-ray observations lift that shroud, says Chandra project scientist Martin Weisskopf of NASA's Marshall Space Flight Center in Huntsville, Alabama. Chandra, launched 2 months ago, peered at the inner 40% of the Crab Nebula and discerned a sharp ring of x-ray light encircling the pulsar at a distance of about one-third of a light-year, along with two jets shooting into space. Astrophysicists believe these structures are the x-ray signatures of electrons and positrons accelerated by the pulsar's intense magnetic fields to nearly the speed of light. The magnetic fields whip the charged particles in tight spirals, forcing them to emit synchrotron radiation in the form of x-rays.

The high-energy waves and jets also power the Crab's bright filaments of light. Chandra's images provide a roadmap that theorists will read to determine how that occurs, Weisskopf says. "These remarkable pictures may give us definitive clues about how the neutron star loses power and deposits it in the surrounding environment."

Astronomer Jeff Hester of Arizona State University in Tempe agrees, noting that the brightest x-rays in Chandra's images coincide with the most dynamic parts of the nebula as seen in 1996 by the Hubble Space Telescope. Hubble saw wisps, jets, and sprites that changed shape within days. "The ring is in exactly the right place to tie the pulsar with the larger nebula," Hester says.

–ROBERT IRION

DOE BUDGET

# Fusion Gains, Basic Science Takes a Hit

Battered by allegations of security breaches and lax worker safety controls, the Department of Energy (DOE) has been a popular target in Congress this year. But DOE's science budget has emerged from the rhetorical fire with only a few bullet holes. Last week, lawmakers approved a 4.3% increase for the agency's Office of Science, a move that is drawing generally good reviews from researchers.

It was not all that DOE was hoping for. The final figure of $2.8 billion for the office, part of a $21 billion bill that President Clinton signed on 29 September (P.L. 106-60), is $35 million less than the Administration requested. It will mean delays for several projects, including the $1.2 billion Spallation Neutron Source (SNS), and cuts in others, such as materials science. But given the battles still raging over other science budgets and the difficult year that DOE has had, lobbyists feel that the agency has held its own. "A lot of people associate DOE with dysfunctionality, but this is a big vote of confidence for [the agency's] science program," says physicist Michael Lubbell of the American Physical Society in Washington, D.C.

Fusion energy was the biggest winner: Congress approved $250 million—$27 million more than DOE requested and $20 million more than it spent in 1999. The hefty increase was due in part to the work of several DOE advisory panels, which labored to produce a plan for reinvigorating a field plagued by technical and political setbacks. Last year, for instance, Congress barred U.S. participation in the International Thermonuclear Experimental Reactor, a $10 billion prototype for producing energy from hydrogen and deuterium (*Science*, 8 May 1998, p. 818). House and Senate budget negotiators said that they were "pleased" by DOE's new fusion research roadmap, which calls for a greater emphasis on basic studies and less spending on potential commercial applications.


DOE's three largest basic research programs didn't fare as well. The $697 million high-energy physics program got a 1.6% boost, to $708 million, while the $809 million Basic Energy Sciences program—which supports materials, chemical, and other research—took a 3.2% cut, to $783 million. DOE's $444 million biology and environmental research budget, meanwhile, was trimmed by $2 million, although that's still $30 million more than the Administration asked for.

The high-energy physics number is $10 million higher than the Administration's request, but it comes with a warning about one of DOE's dream projects. Physicists hope to use a multibillion-dollar TeV linear collider, which would smash together electrons, to hunt the Higgs boson and other heavy particles also in the crosshairs of Europe's Large Hadron Collider, currently under construction in Switzerland. But while the legislators approved planning funds, they expressed "concerns about the early