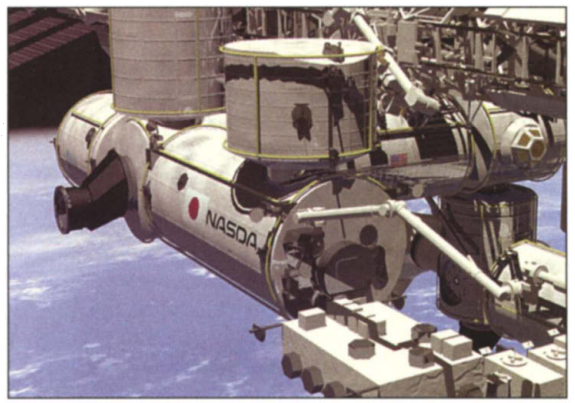
tion in 2004 and labeled "core complete"—imposed by the Bush Administration in 2001 after the discovery of $4 billion in cost overruns. "We have to plan further than core complete," NASA's new deputy administrator, Frederick Gregory, told *Science*.



Grounded. Japan's research module for the station will be launched up to 2 years later than planned.

NASA's new research plans have been heavily influenced by the recommendations of a recent independent panel (*Science*, 19 July, p. 316). Although its report won a lukewarm response from many researchers and from the advisory council, Mary Kicza, who leads NASA's biological and physical sciences program, says NASA agrees with its recommendation to phase out funds for those areas rated low priority, such as materials processing, environmental health, and structural and evolutionary biology. Areas that fell in the panel's set of highest priorities—such as clinical medicine, fluid dynamics, and cell and molecular biology—would receive roughly stable funding or some increase. NASA is also adopting the panel's suggestion to create the position of science officer aboard the station, which Kicza says "will make a difference in forging a scientific agenda." At the same time, Kicza plans to boost funding for radiation protection—which the panel ranked as a lower priority—because of its importance to astronaut safety.

Although the plan would eventually help set a new course for science on the station, two international contributions to that effort are now in question. Japan surprised NASA recently by announcing a delay of up to 2 years in the launch of its pressurized module, which is the centerpiece of Japanese space research. Although the laboratory is nearly complete, the country's space agency can't afford to launch the module in 2004 as planned. "NASDA [National Air and Space Development Agency] is being required to reduce its budget by about 10% in the next 3 or 4 years," says Masato Koyama, director of NASDA's Washington, D.C., office. The delay postpones delivery of a large chunk of research space, including an exposed work deck with a sophisticated robotic system.

Likewise, fiscal troubles have forced Brazil to cancel plans to develop a small research pallet that would have attached to the outside of the station for experiments that don't require precious pressurized space. NASA hopes that the U.S. Department of Defense will step in to fund the racks, says NASA's space station program manager, Bill Gerstenmaier, even though the military's involvement could draw objections from international partners.

At the same time, those partners are sure to be pleased with NASA's decision to lift its ban on a larger station design. Gregory says the agency has found ways to solve the $4 billion shortfall and provide for additional hardware beyond core complete. Although reports detailing station costs won't be released until the end of the year, NASA has asked the White House to include seed money for an expanded station in the president's 2004 budget request now being drawn up.

"It's a move in the right direction," says advisory council member John Logsdon, a political science professor at George Washington University in Washington, D.C., a feeling echoed by other council members. NASA managers will now take their show on the road, and not a moment too soon. This week the National Research Council and the National Academy of Public Administration issued a report harshly criticizing the core-complete design. Without more crew, the study warns, the station "can never achieve the status of a world-class research laboratory."

–ANDREW LAWLER

ASTRONOMY

Hubble Successor Finds Builder and New Name

The successor to the Hubble Space Telescope passed a major milestone last week when NASA announced that the company TRW in Redondo Beach, California, will lead construction of the $1.8 billion observatory. But it's not all plain sailing from here. TRW's competitor for the contract is considering whether to contest the decision, and delicate negotiations are going on with the European Space Agency over the exact nature of ESA's 15% contribution to the project. And NASA surprised everyone involved by breaking with tradition and naming the scope not after a pioneering scientist but after a former NASA administrator.

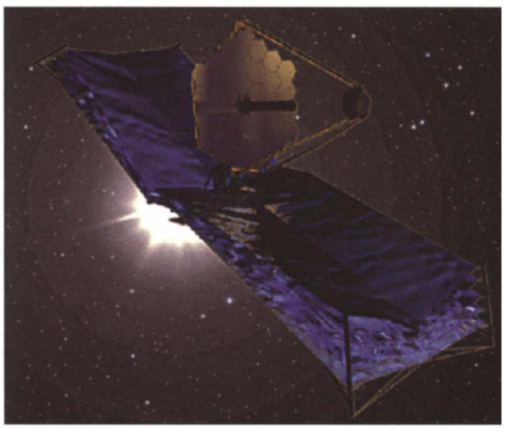
The James Webb Space Telescope (JWST), formerly known as the Next Generation Space Telescope and managed by NASA's Goddard Space Flight Center in Greenbelt, Maryland, is due to be launched in June 2010. To avoid infrared glare from Earth, it will be dispatched to a point in space 1.5 million kilometers distant, directly away from the sun. Once there, the scope's segmented 6-meter primary mirror will unfurl, along with a tennis court–sized sunshade. Working at near- and midinfrared wavelengths, JWST will peer into the very early history of the universe and study the formation of galaxies, stars, and planets.

TRW, which also built the Compton Gamma Ray Observatory (launched in 1991) and the Chandra X-ray Observatory (1999), will design and build the spacecraft and its revolutionary mirror, integrate the science instruments, and perform prelaunch and in-orbit tests and checks. NASA's JWST project manager Bernard Seery declined to reveal details of why the TRW design won the $824.8 million contract, but he suggested that the company's design for deploying the segmented mirror in space might have played a role.

Officials at the unsuccessful bidder, Lockheed Martin Missiles & Space in Sunnyvale, California, are "extremely disappointed and surprised" by NASA's decision, says spokesperson Buddy Nelson, pointing out that the company last year won an award from Goddard for contractor excellence. "We are confident we had a competitive proposal," he says. A meeting with the two bidders is imminent, says Seery, and Lockheed Martin will have 10 days after that to file an official protest.

Peter Jakobsen, ESA's project scientist for JWST, says the two agencies are still "heavily negotiating the exact nature of ESA's noninstrument contribution. It's a very delicate issue, which hopefully will be settled later this year." ESA had hoped to provide the main spacecraft module, but Seery says NASA would prefer ESA to launch the scope using Europe's Ariane 5 launcher: "That would make the negotia-

CREDITS: (TOP TO BOTTOM) NASA; TRW



Looking up. TRW's winning design for the $1.8 billion James Webb Space Telescope.

tions much simpler." As for JWST's instruments, the University of Arizona is building a near-infrared camera, ESA will provide a near-infrared spectrometer, and U.S. and European researchers will collaborate on a midinfrared camera-spectrometer.

The big surprise in NASA's announcement last week was the name. Like NASA's current Administrator Sean O'Keefe, James E. Webb (1906–1992) had a top position at the government's Office of Management and Budget (then called the Bureau of the Budget) before he led the space agency from 1961 to 1968, at the height of the moon race. NASA spokesperson Don Savage confirms rumors that the new name "originated from the current Administrator." NASA's senior JWST project scientist, John Mather of Goddard, says "this is certainly a surprising break with the tradition within NASA." But it might be no bad thing: "To me it's a clear sign that NASA is very committed to building and operating this telescope."

–GOVERT SCHILLING

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.

ASTROPHYSICS

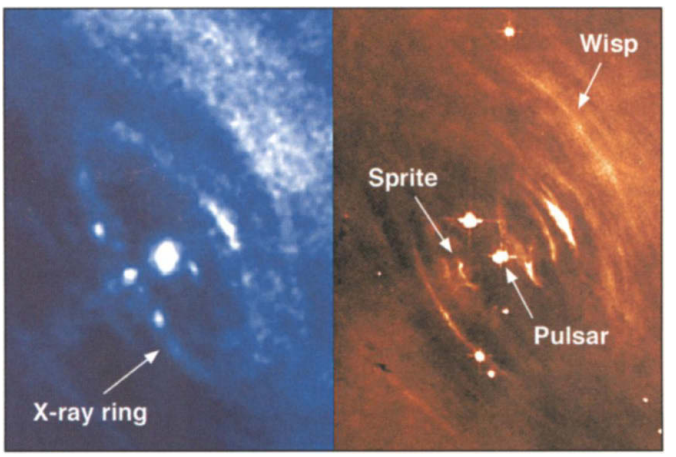
Orbiting Scopes Shoot 'Movie' of Crab Nebula

The Crab Nebula, a tangled web of cosmic debris cast off by a supernova nearly 1000 years ago, is starring in a new action-packed film. The hot fall release comes from the Hubble Space Telescope and the Chandra X-ray Observatory, which teamed up to take more than 30 images of the nebula's heart. The dynamic sequence, which spans about 8 months, is winning raves from astrophysicists who are accustomed to static snapshots or mere points of light. In the words of theorist Jonathan Arons of the University of California, Berkeley: "Wow!"

The spiky nebula is the famed remnant of a giant star that exploded when it ran out of fuel, seeding space with elements for new stars and planets. At the Crab's center a dense neutron star spins 33 times each second, unleashing pulses of radio waves, visible light, and x-rays. As it gradually slows down, this pulsar sheds energy along the axis of its intense magnetic field at a fantastic rate—equivalent to "a few thousand nuclear wars per square meter [of the pulsar's surface] per second," according to Arons. The rotation and magnetism combine to whip particles around the pulsar into a frenzy approaching the speed of light, but how that works is poorly understood.

Now, the new images have exposed jets, wisps, knots, and other features that roil the nebula's innermost cauldron, dramatically changing its shape from week to week. "This is relativistic astrophysics in action," says team leader Jeff Hester, an astronomer at Arizona State University in Tempe. "The Crab is the only object in the sky where we can watch these kinds of processes in real time."

Hubble aimed its Wide Field Planetary Camera at the nebula's core 24 times between August 2000 and April 2001, while Chandra took eight x-ray images during the same interval. Each Chandra observation consisted of about 15,000 exposures lasting an unusually short 0.2 seconds each, which prevented the bright nebula from saturating the detectors. And by gathering about five times more light per observation than previous images, Chandra revealed fainter x-ray features, says astronomer Koji Mori of Pennsylvania State University, University Park.



Heart of a crab. New images of the innermost Crab Nebula reveal fine structures in x-rays (*left*) and optical light (*right*).

CREDIT: J. HESTER *ET AL.*/CHANDRA X-RAY OBSERVATORY AND SPACE TELESCOPE SCIENCE INSTITUTE

The new images, released this week at NASA headquarters in Washington, D.C., and published in the 20 September *Astrophysical Journal Letters*, illuminate striking sets of shock waves near the pulsar. A blazing x-ray ring girdles the plane of the pulsar's equator. At that spot, says Hester, the violent but steady wind streaming from the pulsar careens into a frothy shock front of disordered electrons. The electrons emit synchrotron x-rays—as well as visible light—as they cascade around magnetic fields in the plasma. "It's no longer speculation that the synchrotron emission begins at this shock front," Hester says. "We can just see it."

Wisps of particles flit outward from the x-ray ring at half the speed of light. The wisps form crisp, narrowly defined arcs confined to the equatorial plane, probably held in place by tight lines of magnetic field whipping out from the pulsar. Meanwhile, at right angles to the plane, diffuse jets of particles blast into the nebula from the pulsar's rotation poles. The jets look like puffy plumes from industrial smokestacks on a windy day, buffeted to and fro by turbulence around them. The images show one jet plowing into slower material and triggering an amorphous shock that ebbs and flows, called the "sprite."

The different forms of the equatorial and polar shocks suggest that distinct mechanisms spew energy along those directions, says physicist Roger Romani of Stanford University in Palo Alto, California. "These structures and their variations will let us decipher or reverse-engineer the products of the particle accelerator at the center," he says. For example, Hester feels that a plasma consisting solely of electrons and positrons can account for the Crab's behavior, whereas Arons thinks that an underlying wind of charged atomic nuclei—mainly hydrogen and helium—plays a key role.

Settling such debates will take long hours of scrutinizing the rich images. "There is so much detail," says Chandra project scientist Martin Weisskopf of NASA's Marshall Space Flight Center in Huntsville, Alabama. "We all want to know how this pulsar converts its rotational energy into electromagnetic radiation with such amazing efficiency. It's a fascinating puzzle."

–ROBERT IRION

PHYSICS

CERN Team Produces Antimatter in Bulk

They're still a long way from powering the antimatter drive of Captain Kirk's *Enterprise*, but researchers are generating surprising quantities of antihydrogen. Scientists at CERN, the European laboratory for particle physics near Geneva, report in this week's issue of *Nature* that they have produced about 50,000 slow-moving atoms of antihydrogen, the antimatter doppelgänger of the most abundant element in the universe. Because such atoms are very cold and slow moving, the team hopes it will be able to study them long enough to probe the fundamental asymmetries between matter and antimatter.

"Previous attempts have used accelerators to make [antihydrogen] at high energy, so the atoms have flown away and annihilated," says CERN physicist Jeffrey Hangst. He and his colleagues on the ATHENA collaboration at CERN, however, used a series of magnetic traps to slow down antiprotons and antielectrons from thousands of kelvin to about 15