Stellar X-ray burst brings theory shock

A spectacular burst of X-rays from a compact star system has shattered a painstakingly assembled picture — based on a decade of observations — that astronomers thought accounted for the source's peculiar characteristics. The occurrence of such an outburst, detected by Japan's Ginga X-ray astronomy satellite, raises serious questions about how well astronomers understand what happens when a neutron star collects, or accretes, matter from an orbiting companion star.

The long and bright outburst was the first ever observed emanating from the X-ray source designated AC211, which lies at the center of the globular cluster M15, a region of densely packed stars on the Milky Way's edge. Tadayasu Dotani of the Institute of Space and Astronautical Science in Kanagawa, Japan, and his coworkers describe the surprising satellite data in the Oct. 11 NATURE.

"It's an important discovery," says astronomer Charles D. Bailyn of Yale University in New Haven, Conn. "It opens a whole can of worms . . . on which we had hoped we had put the lid."

X-ray bursts apparently occur when sufficient material collects on a neutron star's surface to initiate a runaway thermonuclear reaction. The newly arrived surface material periodically ignites, typically within about a second, and burns for a few hundred seconds, releasing copious quantities of X-rays.

Until the Ginga data showed otherwise, AC211 was the only one of nine known accreting neutron stars in globular clusters that had seemingly failed to exhibit this process. Astronomers theorized that AC211 collected matter so quickly that the material burned steadily as it landed, rather than building up and then exploding. And to explain why astronomers observed a low level of total X-ray emissions despite this steady thermonuclear activity, they assumed that the disk of material surrounding the neutron star obscured the view, in effect shielding Earth-based observers from the bulk of X-rays released.

"Now that this burst has been seen, essentially all such theories are pretty much out the window," Bailyn says.

If an accretion disk partially blocks the view, the intensity of any detected X-ray burst represents only a fraction of its true intensity. But the intensity of the X-ray burst observed by Ginga was already significantly higher than the theoretical level at which radiation pressure halts further accretion.

"The idea that the accretion disk blocks our view of the central neutron star must be wrong," says Michael R. Garcia of the Center for Astrophysics in Cambridge, Mass. "The only way to salvage it is to assume that the disk changes shape during the burst, or that the burst was from another, previously unknown source within a [short distance] of AC211."

But those possibilities and several other theories raise more questions than they answer. "Doubtless, theorists will soon provide us with theories about what can happen, but we don't have them at the moment," Bailyn says.

The peculiar behavior of AC211 "is yet another indication that this whole class of objects — accreting compact objects — is very complicated," he adds. "Although we have a basic understanding of what is going on, the details constantly surprise us."

— I. Peterson

A shady strategy for photosynthesis

"When faced with an adverse environment, animals in general have the option of moving away from it; plants cannot do that," notes plant biologist Anastasios Melis of the University of California, Berkeley. Yet plants have a molecular tactic that may be just as effective, he says.

In the October PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol. 87, No. 19), Melis and his colleagues report that an adaptive mechanism inside plant cells appears to sense the changing menu of light wavelengths and tune the light-hungry photosynthesis system to make best use of the available wavelength blend, which arrives in sunlight filtered through water, trees, overlying plants or other obstacles.

Plants feature molecular complexes called photosystem I and photosystem II, which reside in stacks of membranes within cell organelles called chloroplasts. Each photosystem has a certain blend of chlorophylls and other pigments that absorb specific wavelengths of photosynthesis-driving light.

Melis, working with Wah Soon Chow and Jan M. Anderson of the Commonwealth Scientific and Industrial Organisation in Canberra, Australia, observed that the relative amounts of photosystems I and II in pea plants change in response to incoming light whose wavelengths match the absorbance of one or the other photosystem. This enables pea plants and other higher plants, as well as photosynthetic bacteria and algae, to maintain nearly optimum photosynthetic efficiency as incoming wavelengths change over periods as brief as a few days, Melis says.

The researchers cite previous studies by others showing that many species maintain striking photosynthetic efficiency despite "diverse light habitats." They also cite their own earlier work, which indicated that the relative amounts of photosystems I and II in plants change in response to different light conditions during growth. The new work shows that these molecular changes permit plants to retain photosynthetic efficiency "near the theoretical maximum," they say.

Not so fast, warns John Whitmarsh of the U.S. Department of Agriculture and the University of Illinois in Urbana-Champaign. Whitmarsh calls the case for photosynthesis-preserving molecular adaptation "oversimplified" and argues that experimental uncertainties could account for the changes in photosystem ratio and photosynthetic efficiency measured by Melis' group.

— I. Amato

Chinese bird fossil: Mix of old and new

Documenting an important step in the evolution of avian flight, paleontologists have identified the 135-million-year-old fossil remains of a bird from northeast China. The sparrow-sized specimen is the earliest known example of a bird with modernized flying ability, reports Paul C. Sereno of the University of Chicago, who announced the find last week at the annual meeting of the Society of Vertebrate Paleontology, held in Lawrence, Kan.

The still-unnamed Chinese bird is about 10 million to 15 million years younger than the oldest known bird, *Archeopteryx*, and displays several flight features that the crow-sized *Archeopteryx* lacked. "This is the first bird with the capacity for a modern flight stroke," says Sereno. He studied the new specimen with Chenggang Rao of the Beijing (China) Natural History Museum.

The fossil shows an intriguing mix of modern avian features and primitive characteristics retained from reptilian ancestors. The bird had flight-specialized shoulders and a distinctly avian adaption called the pygostyle — a shortened set of tail vertebrae fused into one bone. The shorter tail allowed the bird's mass to center over the shoulders, aiding in flight. *Archeopteryx* and the dinosaurs from which it presumably descended had longer tails that balanced weight over the hind feet — a trait more useful for running along the ground. Many paleontologists believe *Archeopteryx* could not fly well, and they envision the creature flapping its wings while jumping after insects.

The Chinese specimen, however, displays adaptations for tree life. The claws of its feet were long and curved, allowing the bird to perch on a branch better than *Archeopteryx*, says Sereno. The "hand"