X rays reveal black hole dining habits

From arsenic to zinc, black holes gobble up every element within their grasp. Even among such undiscriminating diners, some have bigger appetites than others. Researchers report that for the first time they have found an indicator of how rapidly these gravitational monsters devour their surroundings.

The indicator consists of X rays emitted by iron atoms after they fall onto a swirling disk of matter around a black hole. This emission, first detected in the early 1990s in a group of nearby galaxies that are relatively dim but have bright centers, is shifted in wavelength by a strong gravitational field—a tip-off that these galaxies house black holes.

In the new study, researchers used the sensitive ASCA satellite to study the same X-ray emission from 39 new sources, including 21 highly luminous, but distant, quasars. Quasars are thought to be powered by massive, central black holes.

In the Oct. 20 ASTROPHYSICAL JOURNAL LETTERS, Paul Nandra and Richard F. Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Md., and their colleagues report a striking correlation: The X rays generated by iron atoms in quasars have a much lower intensity than those produced by iron atoms in less luminous galaxies. Indeed, in the most luminous quasars, the X-ray signal vanishes altogether.

The astronomers suggest that iron atoms at the cores of the brightest galaxies and quasars are bombarded by a much higher dose of radiation than those in the less luminous galaxies. The intense bombardment strips the atoms of their electrons, the charged particles that generate the X rays. Therefore, the ionized atoms do not emit X rays when they fall onto the disk of matter circling the central black hole.

There are two reasons why some galaxies that house a black hole are brighter than others, Nandra notes. Either the black hole in the brighter galaxies is more massive, or it is feasting on matter at a higher rate. The second possibility is more likely, Nandra says. Theoretical calculations indicate that the most voracious black holes can most easily ionize atoms.

"As black holes swallow material at a greater rate, the X-ray emissions become dimmer," he notes.

The new report, says Christopher S. Reynolds of the University of Colorado at Boulder, draws together the suspicions of several observers who have examined X-ray emissions from individual galaxies.

If additional data corroborate this interpretation, Reynolds says, it could prove a milestone for probing the twisted, Alice-in-Wonderland world around black holes. —*R. Cowen*

New method speeds material discovery

An artist searching for the perfect tint blends daubs of color together on a palette, varying the mix to get the desired hue. Now, scientists are adopting the same technique in their search for new materials, using palettes that are disks of silicon only 3 inches in diameter.

By mixing together tiny amounts of chemical ingredients in varying proportions on these silicon wafers, researchers at Symyx Technologies in Santa Clara, Calif., can synthesize and screen up to 25,000 different compounds at one time. "It makes the discovery process much shorter and cheaper," says Xin Di Wu, director of electronics materials at Symyx. Pharmaceutical companies already use a similar approach, known as combinatorial chemistry, to find candidate drugs.

The group chose to demonstrate the technique by creating phosphors, glowing substances used in color display screens. First, the team deposited one phosphor component on the silicon in columns, then crisscrossed it with rows of another component. The group layered on additional ingredients in thinner stripes, masking areas of the chip to control the composition of the materials. The resulting grid contained squares of many different mixes, which could then be assessed for the color and intensity of their emitted light.

"It's easy to demonstrate whether phosphors are working," says Wu. "When you shine [ultraviolet] light on them, they give visible emissions." He and his colleagues describe their method in the Oct. 30 NATURE.

Their test turned up one promising substance that glowed red. When the scientists mixed up this material as a bulk powder, it proved better than the standard commercial red phosphor, which gives off a more orange-colored light. Testing the phosphor in bulk form was important, he adds, because the powder would ultimately be used to coat the back of a computer screen. Materials can exhibit very different properties as thin films on a chip.

In 1995, a group including Symyx cofounder Peter G. Schultz of Lawrence Berkeley (Calif.) Laboratory applied the combinatorial method on a smaller scale to superconductors. Symyx scientists plan to use the technique to look for new compounds with catalytic, magnetic, or thermoelectric properties. —*C. Wu*

Cocaine trips brain appetite suppressor

While the munchies triggered by smoking marijuana provide a rich vein of humor for comedians, the appetite suppression brought about by cocaine abuse is no laughing matter. People addicted to the drug can become dangerously thin.

Investigators have now found that cocaine-charged rat brains overproduce a small protein, or peptide, that seems to regulate food intake. This chemical may also play a role in other symptoms of cocaine use, such as frenzied motor activity.

A few years ago, Pastor R. Couceyro, now at the Yerkes Regional Primate Research Center in Atlanta, and his colleagues went looking for genes in the rat brain that become more active after cocaine or amphetamine use. "We were on a fishing expedition," says Couceyro.

The investigators reeled in one gene whose activity increases dramatically. The gene encodes a peptide, about 120 amino acids long, that they named Cocaine and Amphetamine Regulated Transcript, or CART. The researchers believe that cells cut CART into several pieces and that each has its own function in the brain.

CART's presence in vesicles at the tips of nerve cells suggests that the cells secrete the peptide to communicate with each other, says Couceyro.

Injecting specific fragments of CART into the brains of rats decreases the animals' appetites and increases their locomotor activity, Couceyro, Yerkes' Philip D. Lambert, and their coworkers reported at this week's Society for Neuroscience meeting in New Orleans. "This is the same thing that cocaine does," says Couceyro.

Since injections of even inert substances into the brain can induce behavioral changes such as loss of appetite, the investigators sought further proof that CART has a direct role in controlling food intake. They injected into rat brains blood serum containing CART-binding antibodies, which should block the peptide's function, explains Couceyro. "The antibody causes the animals to eat significantly more."

The investigators have also found that parts of the hypothalamus make CART. Couceyro notes that these same brain regions have been implicated in control of feeding behavior.

The peptide is synthesized elsewhere in the brain, which may help explain cocaine's addictive properties and other physiological effects. A fuller understanding of CART's role might ultimately suggest new ways to treat eating disorders as well as cocaine addiction, suggests Couceyro. —*J. Travis*