progress. Over the past 2 years, Galione's team has shown that cyclic ADP–ribose helps control one calcium-dependent process: cardiac muscle contraction. Working with heart muscle cells isolated from the guinea pig, he has found that too little of the messenger can lead to inadequate contractions, while too much can make the heart beat out of control.

Other work has implicated cyclic ADP–ribose in glucose-stimulated release of insulin from the pancreas. "There is the intriguing possibility that defective signaling could be one way diabetes arises," says Galione. This messenger also seems to be part of signal-transduction pathways in the reproductive and immune systems, and in the regulation of smooth muscle cells by thyroid hormone.

To be sure, calcium levels in cells respond to many other signals besides cyclic ADP–ribose. "There are actually multiple mechanisms for the releasing of calcium," stresses Galione. In nature, these multiple mechanisms may cause calcium to be released from different storage sites and in different patterns, generating a calcium "signature" unique to each signaling pathway. Galione and Chua suggest that this may be how the cell can keep its signals straight even though the same ion, calcium, is involved in many different signaling pathways.

Even for the plant stress pathways that depend on cyclic ADP–ribose, many details remain to be ironed out. Researchers do not yet know, for example, how it leads to the activation of ADP–ribosyl cyclase, the enzyme that generates cyclic ADP–ribose. However, Chua's work provides a clue. He has found evidence that the activation step requires the addition of a phosphate group, possibly to the cyclase.

Chua now hopes to pin down the other details of this pathway. "It has tremendous agricultural implications," because it could be a key to designing hardier crops, he explains. But "in order to design methods to engineer plants to resist drought, you need to know about the signal to be transmitted."

Like Chua, Galione is working hard to identify all the components in the pathways between, for instance, the signal to contract and the heart contraction. Others are trying to understand the steps between glucose's arrival at a pancreatic β-cell and the release of insulin. And because molecular biologists are now able to make molecules that mimic or block cyclic ADP–ribose activity, Galione expects rapid progress. "We should really be able to nail these pathways down," he predicts—and explore an unexpected similarity between plants and people.

–Elizabeth Pennisi

ASTRONOMY

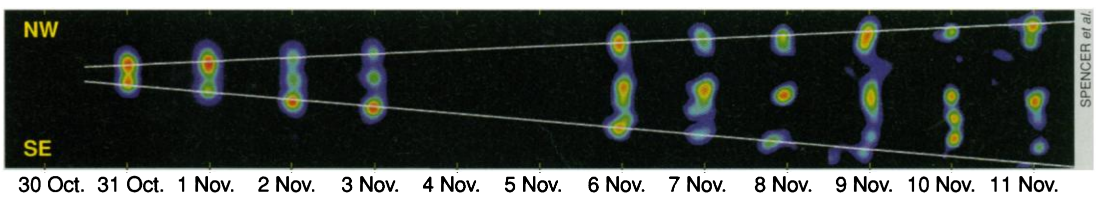
Black Hole Lurks in Miniature Quasar

Everything about quasars and active galaxies is outsized. These brilliant objects lie millions to billions of light-years from Earth and, at their centers, may harbor black holes with masses millions of times that of the sun. But astronomers are getting a closeup view of quasar behavior in a scaled-down model—a so-called microquasar in our own galaxy.

Like its full-sized relatives, the microquasar is thought to contain a black hole—in this case just a few times more massive than our sun—and it shows similar violent behavior, sometimes ejecting high-speed streams of ultrahot gas. Because of the microquasar's small size, its jets and flares develop and die out much faster than those of larger quasars, in minutes or hours rather than millions of years. This fast-forward view of quasar behavior is yielding new clues to how quasars work, including new evidence for the reality of the black holes at their centers. As Michael Garcia of the Harvard-Smithsonian Center for Astrophysics puts it, "You can actually see things happen in a minute" in the microquasar. "You can't see things like that happen in a [full-sized] quasar."

A team led by Felix Mirabel of France's Atomic Energy Commission at Saclay and Luis Rodriguez of the Institute of Astronomy in Morelia, Michoacán, Mexico, discovered the quasarlike behavior 3 years ago. With the Very Large Array radiotelescope in New Mexico, they observed jets of matter coming from a known x-ray source called GRS 1915, just 40,000 light-years from Earth. After other observers spotted radio outbursts from the same source, astronomers concluded they were seeing a system containing a small black hole—probably the legacy of a collapsed star—surrounded by an "accretion disk" of gas and dust dragged from a companion star. The interplay between the accretion disk and the black hole somehow powers the outbursts, just as in a full-sized quasar.

Last month, Ralph Spencer of the University of Manchester in the United Kingdom and several colleagues followed the evolution of GRS 1915's jets for 2 weeks using MERLIN, a set of six electronically linked radiotelescopes spaced across England. They found, reports Spencer's co-worker Rob Fender of the University of Amsterdam, that "the jets appear to be generated in less than a day, and we see the material speeding out over something like 2 weeks." Mirabel says that he observed the same event on 31 October with the Very Long Baseline Interferometer, which combines telescopes from Hawaii to the Virgin Islands. Once the data are processed, he says, "we will be able to see the blobs with a resolution equivalent to the size of the solar system."



Outburst. Probably driven by the spin of a central black hole, blobs of ionized gas fly outward from the microquasar.

By studying these fast-changing jets, astrophysicists are already gaining clues to their origin. In a paper scheduled to appear in the February issue of *Astronomy and Astrophysics*, Mirabel and his colleagues report that they traced jet formation by monitoring the microquasar at many different wavelengths—x-ray, infrared, and radio—sensitive to different parts of the accretion disk and jets. First, he says, "x-radiation from the inner accretion disk disappeared," presumably because superhot material fell into the presumed black hole. Then a new x-ray burst indicated that the inner disk was refilling with new material, and a dozen minutes later the first hints of a jet appeared. The findings, he says, support a picture in which the spinning black hole ejects the jets whenever material is building up in the inner disk.

The abrupt cutoff of the x-rays at the beginning of this process—often in a matter of seconds—is a strong hint that a black hole really is present, says Mirabel. The cutoff would not be so sudden if the material landed on the surface of a star, he says. Mirabel argues that the only explanation is that the globules of matter must suddenly be disappearing beyond the "event horizon" of the black hole. Garcia calls that picture "a very good model," although not "absolute direct evidence" for a black hole.

Still, says Martin Rees of Cambridge University in the U.K., further study of the microquasar is sure to cast more light on its shadowy heart and those of full-sized quasars: "In the next year or two, we [may] actually learn something about the nature of black holes."

–Alexander Hellemans

Alexander Hellemans is a writer in Naples, Italy.