that their states might be frozen out.

Despite the setback, Texas A&M says it is ready to compete for the center. And congressional aides note that DeLay and other Texas lawmakers could still earmark money for the project in a spending bill. Says one Republican staffer: "The idea that this is going away is absurd." Adds another aide, who is opposed to the project, "This is like a horror movie: The creature takes a licking but somehow keeps on ticking."

–DAVID MALAKOFF

ASTRONOMY

X-rays Show a Galaxy Can Have Two Hearts

Astronomers have sighted evidence of two black holes spiraling toward an eventual collision in the center of a nearby galaxy. The discovery—made by an international team of astronomers using data from the orbiting Chandra X-ray Observatory—has confirmed astronomers' long-held suspicions, based on indirect evidence, that the black holes at the hearts of many galaxies might come in pairs.

"It was not a surprise. … We have been thinking about it for more than 20 years," says Astronomer Royal Martin Rees of the University of Cambridge, U.K. In 1980, Rees, together with Mitchell Begelman of the University of California, Berkeley, and Roger Blandford of the California Institute of Technology in Pasadena, proposed that the waltz of binary supermassive black holes at the centers of some galaxies explains why jets of energy spewing from the galaxies sometimes wander, or precess. But their ideas have remained speculative until now.

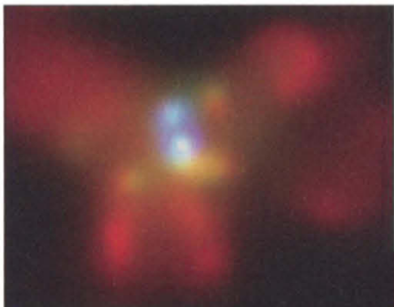
The galaxy that harbors the double black hole NGC 6240 lies 400 million light-years from Earth. "Ever since its discovery, it has received a lot of attention," says team member Stefanie Komossa, an astronomer at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. In 1983, astronomers observing NGC 6240 in visual light found that its shape is strongly distorted—an indication that it consists of two galaxies that have collided. What really piqued their curiosity, however, was that the galaxy radiated enormous amounts of power at longer wavelengths, in the infrared part of the spectrum.

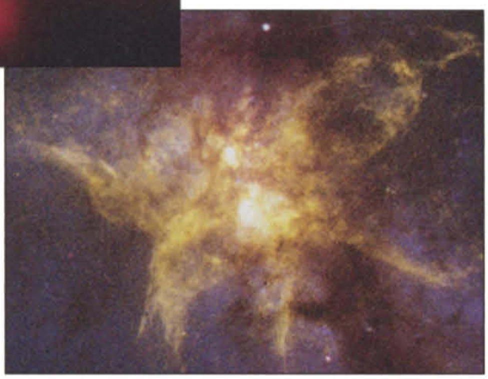
Astronomers knew of only two mechanisms that might explain such huge infrared emissions. NGC 6240 might be alive with starbursts, swarms of newly forming stars. Alternatively, like many other galaxies, it might contain an active galactic nucleus (AGN): an enormous engine that blasts out x-rays as matter falls toward a black hole in the galaxy's center. Dust clouds near the core of the galaxy would absorb x-rays and reradiate the energy in the infrared.

When Chandra was launched in 1999, its high-resolution x-ray imaging made NGC 6240 an obvious target, Komossa says. She and her colleagues set out to find the galaxy's x-ray powerhouse. Earlier observations by the ROSAT x-ray observatory, which Germany, the U.K., and the U.S. operated during the 1990s, had hinted that the galaxy's central x-ray source was oblong rather than spherical. In 10 hours of observations made in July 2001, Komossa's team found that the elongated source was actually two sources, thousands of light-years apart.

Several telltale signs show that the x-ray sources are black holes, Komossa says. First, they are very intense and concentrated, and they are emitting extremely high-energy x-rays—hallmarks of AGNs but not of starbursts. What's more, the spectrum of x-rays from the galaxy's center shows a strong emission line caused when cold, nonionized iron atoms absorb and release energy. Starbursts don't make iron fluoresce that way, but highly energetic x-rays from AGNs do.

The researchers estimate that each black hole has a mass between 10 million and 100 million times that of our sun. The distance between them, 3000 light-years, means that they must rotate around their common center over a period of millions of years. Over hundreds of millions of years, the two bodies will spiral toward each other, giving off energy in the form of gravitational waves, and ultimately merge. Such mergers might explain why some galaxies don't show an increased concentration of stars toward the center, Rees says: "In the process of merging, the binary would have kicked out the stars from the center."





Twin peeks. X-ray image (*top*) reveals two black holes at the core of a galactic merger.

Gravitational waves unleashed by similar mergers should be detectable by the Laser Interferometer Space Antenna, a constellation of six spacecraft that the European Space Agency and NASA plan to launch later this decade (*Science*, 16 August, p. 1113). Because most galaxies are expected to contain supermassive black holes, and many galaxies merge, coalescent black holes might be common. "We may observe about one merger per year if we observe all the galaxies out to the limit of a big telescope," Rees says.

–ALEXANDER HELLEMANS

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PLANETARY ORIGINS

A Quickie Birth for Jupiters and Saturns

Talk about a major embarrassment for planetary scientists. There, blazing away in the late evening sky, are Jupiter and Saturn—the gas giants that account for 93% of the solar system's planetary mass—and no one has a satisfying explanation of how they were made. Of course, they formed from the infinitely more diffuse gas and dust of the solar nebula as the sun formed. But what could entice that much gas to condense into planets before it all dispersed in a million years or so?

On page 1756, a group of astrophysicists presents computer simulations of the nascent solar system that suggest a possible mechanism: runaway fluctuations in the disk's density. In their model, gas giants of about the right size, number, and orbit condense from a disk of gas to look like very young Jupiters. The trick was to simulate the process in fine detail so that the gas's own gravity could take over. "It's a beautiful calculation," says astrophysicist Richard Durisen of Indiana University, Bloomington. "It's a step along the way, but this is not the final answer." A next step is to work out whether some disruptive forces not yet included in this model might frustrate the disk's gravitational urge to collapse on itself and spawn planets.

Until recently, theorists assumed that, for a gas giant to form, a small core of rock with the mass of perhaps 10 Earths must accumulate bit by bit as kilometer-size planetesimals collide with one another. Only then would the core have the gravitational heft to begin pulling in the gas that would make up 99% of the planet. But in the meantime, the spinning protoplanetary disk is dispersing quickly. By current estimates, it's gone before a Saturn can grow, much less a Jupiter. But the alternative to accretion is even less appealing: Depend on a patch of slightly denser gas

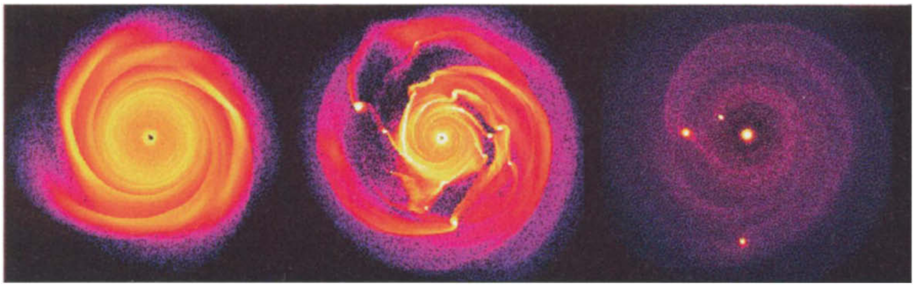
CREDITS: (X-RAY, LEFT) NASA/CXC/MPE/S. KOMOSSA *ET AL.*; (OPTICAL, RIGHT) NASA/STSCI/R. P. VAN DER MAREL AND J. GERSSEN forming—perhaps through random fluctuations—that is massive enough to pull in more gas, which could then pull in even more gas, leading to a runaway collapse into a planet. Such a gravitational instability mechanism had long appeared to require a disk 10 times as massive as expected. In 1998, astrophysicist Alan Boss of the Carnegie Institution of Washington revived gravitational instability by simulating gas clumping in a disk of reasonable mass, but he couldn't show that the growing clumps would survive to become planets.

Astrophysicists Lucio Mayer and Thomas Quinn of the University of Washington, Seattle, and their colleagues decided to throw more computing power at the gravitational instability problem. Using a model that they had previously built to study galaxy formation, they simulated a swirling gas disk with a million particles—10 times the number used in earlier efforts—orbiting a protosun. Run for several weeks on a massively parallel supercomputer, the model achieves an extra margin of realism, thanks to its inherent ability to automatically increase resolution where it counts the most: where mass is concentrating to form planets.

After just 1000 years of simulated time, the runaway process had produced planets: The model's disk had clumped, clumps had merged, and two or three planets had emerged that bore some resemblance to the 100-plus gas giants found so far around other stars. The simulated planets had masses of two to 12 times that of Jupiter, orbited at between three and 20 times Earth's distance from the sun, and moved in elongated orbits. But the model's planets showed little sign of moving inward, as many extrasolar planets have presumably done. Nor does the model help explain the rounded orbits found in one solar system—our own.

The new modeling "is a very important step forward for the disk-instability mechanism," says Boss. "It shows that it is plausible that clumps could survive long enough to become gas giant protoplanets." But not even Boss thinks that disk instability is home free. "One has to be a little cautious," notes Durisen. Properly accounting for all the forces that work against gravity—including internal heating—must await future modeling, he says. Starting simulations with a realistic amount of instability is difficult, adds dynamicist Jack J. Lissauer of NASA's Ames Research Center in Mountain View, California; he thinks these runs started with far too much. And these simulations are "like a lab experiment that needs confirmation," says Durisen. It seems the gas giants will be glaring down a while longer.

—RICHARD A. KERR



Easy birthing. In a simulation, gas collapses on itself in less than 1000 years to form planets.

CREDITS: (TOP) L. MAYER ET AL.

CANADA

Universities Promise More Tech Transfer

TORONTO—Canadian university administrators hope they haven't struck a Faustian bargain. In return for a promise by the government to double research funding and create a permanent fund to pay the overhead costs of conducting federally funded research, universities have agreed to do a better job of turning academic research into commercial products. The deal gives each side something it badly wants, at a price both sides appear willing to pay.

The terms of the quid pro quo were announced here last week, at the National Summit on Innovation and Learning. The event, held despite a nationwide snowstorm, gave more than 500 members of Canada's academic, business, and financial elite a chance to offer final comments on the government's ever-evolving blueprint for doubling federal research spending (*Science*, 15 February, p. 1211). The doubling would raise the R&D budget to $9.2 billion by 2010.

Industry Minister Alan Rock says that the tradeoff, part of a proposed Framework Agreement on Federally Funded Research, marks the first time that academia has formally acknowledged its responsibility to generate economic wealth. "I wanted to commit them [academic institutions] in principle to a link between public funding and economic outcomes," he says.

At the core of the deal lies a government promise to roll a "one-time" allocation this year of $125 million for overhead costs associated with publicly funded research into

ScienceScope

To the Rescue French archaeologists are once again vowing to defend laws requiring digs prior to construction projects. Jean-Paul Demoule, president of INRAP, France's institute of "rescue archaeology," called on the group's 1500 members to go on strike this week to protest changes proposed by Parliament.

In 1997, the archaeologists took to the streets to successfully campaign for stricter enforcement of rescue archaeology laws and better funding from developers (*Science*, 7 February 1997, p. 746). Under the current rules, which require builders to negotiate dig payments on a case-by-case basis, archaeologists conducted about 4000 surveys this year. But lawmakers in the National Assembly and the Senate have recently added amendments to two bills that would loosen the requirements. If passed, Demoule says, the changes "would create chaos ... and throw a number of specialists out of work."

The Chirac administration opposes the amendments, saying it wants to complete a planned review next year before proposing any changes. Parliament must act on the matter by year's end.

Pulling Rank The National Science Board is about to tell scientists competing for big new research facilities exactly where they stand. Responding to an order from Congress, the oversight body for the National Science Foundation (NSF) agreed last week to assign a numerical ranking to each big project that it wants to fund. That's a big change from its previous policy of neutrality, which generated a growing backlog of projects deemed worthy of support and uncertainty about which ones the board preferred (*Science*, 14 September 2001, p. 1972).

"The new list will rank projects at the same time they are approved by the board," says Anita Jones, head of the board panel that drew up the new policy. "And that list will be public." Jones says the board also hopes to keep the list of approved projects as short as possible—"just a bit more than we think we can afford to do at any one time."

The board reforms are consistent with a bill Congress passed this month (H.R. 4664) reauthorizing NSF programs. It strengthens the board's ability to manage big projects with the goals of lowering costs, improving efficiency, and making the process more transparent.

Contributors: Dan Ferber, Andrew Lawler, Barbara Cassasus, Jeffrey Mervis