ASTROPHYSICS

Young X-ray Satellite Rattles Old Ideas

A year after its launch, Europe's XMM-Newton x-ray satellite is proving its mettle. Last week in Paris, scientists gave a sneak preview of findings that challenged cherished beliefs about what kind of material swarms around supermassive black holes in the middle of active galaxies, and how compact clusters of galaxies chill out. Those results and others, appearing next month as 56 papers in a special issue of the European journal *Astronomy and Astrophysics*, constitute what Roger Bonnet, director of science for the European Space Agency (ESA), describes as "monster astronomy."

Since the mid-1980s, scientists have believed that x-rays they detected in active galactic nuclei were partly absorbed by clouds of warm gas far from the black hole. When XMM-Newton trained its spectrometers on two such nuclei, astronomers expected to see the hallmarks of such a gas shroud: x-ray spectra riddled with gaps where the atoms in the gas absorbed radiation passing through it. But XMM-Newton had other ideas.

"The spectra didn't show the spiky absorption signatures that we expected on the basis of the [warm-absorber] model," says Masao Sako of Columbia University in New York City. Instead, as Sako was the first to realize, the spectra made much more sense if the spectral features originated from very hot gas orbiting extremely close to the black hole. What astronomers were seeing, Sako theorized, were not absorption lines but emission lines, distorted in ways that indicated that the gas must be moving close to the speed of light.

Material far from a black hole could not orbit so swiftly, says Jelle Kaastra of the Space Research Organization Netherlands (SRON) in Utrecht, the project scientist of the XMM-Newton spectrometers. That meant the gas had to be very close to the "edge" or event horizon of the black hole, just a few million kilometers from the center of the hole itself. The results also imply that the black hole is spinning, Kaastra says, because general relativity predicts that there are no stable orbits close to a stationary black hole. Physicists had long sought convincing evidence of such rotating black holes—called Kerr black holes, after the New Zealand physicist who predicted their properties mathematically. Now they have it.

"This is one of the outstanding results of XMM-Newton," says Johan Bleeker of SRON. "For the first time, we're studying emission from the accretion disk itself, very close to the central, rotating black hole." In principle, Bleeker says, observations like these should enable astronomers to derive the geometry, physical properties, dynamics, and chemical composition of the disk.

But Joachim Trümper of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, says discrepancies in the XMM-Newton data must be resolved before other physicists will accept them as conclusive. "This is certainly not the end for the warm-absorber model," Trümper says.

XMM-Newton's second challenge to conventional wisdom targets compact clusters of galaxies—enormous congregations of hundreds or thousands of individual galaxies, generally dominated by a giant elliptical galaxy in the core. Older x-ray observations showed that the space between galaxies in clusters contains hot, x-ray emitting gas. Astronomers have long believed that the hot gas slowly flows into the cluster core, cooling as it goes, says Andrew Fabian of Cambridge University in the United Kingdom, who led one of the groups that proposed the model in 1977. Because the gas in the cluster's core is denser than gas farther out, Fabian explains, it cools more efficiently, radiating its energy away in x-rays. As a result, the pressure near the core drops. Hotter gas from the outskirts of the cluster then starts to flow inward, where it cools in turn.

If the cooling-flow model were correct, XMM-Newton should detect signs of cold gas in the inner parts of the clusters. In particular, astronomers say, its sensitive spectrometers should find the spectral signatures of moderately ionized iron—atoms that have lost just a few of their electrons, an indicator of a low-energy environment. They don't. "The spectra provide us with a very significant [lower] limit on the temperature," says Bleeker. "This puts the cooling-flow model in jeopardy."

But Fabian thinks it's too early to write off the model. In a paper accepted for publication in the *Monthly Notices of the Royal Astronomical Society*, he describes five other possible explanations for XMM-Newton's results. Still, he admits the new observations have made things more complicated.

With so many intriguing clues emerging from just a few months' worth of observations, x-ray astronomers are confident that XMM-Newton will revolutionize the field. "This is not the end of the story," Bonnet says. "I expect the observatory will continue to send back such interesting science results for the next 10 years." **–GOVERT SCHILLING**

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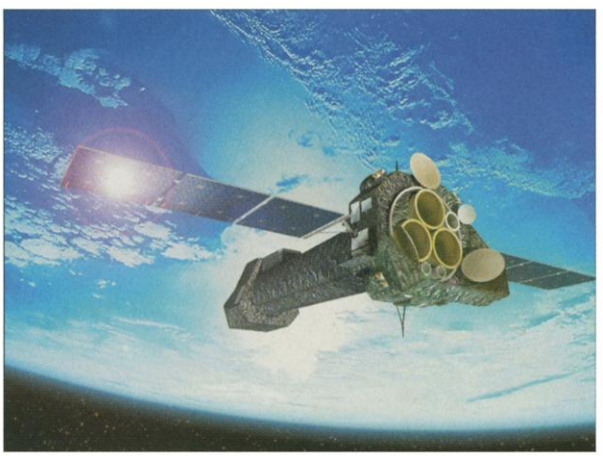

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Astro-monster. The 1-year-old XMM-Newton x-ray satellite is shaking up some of astrophysicists' pet theories.

GENE THERAPY

FDA Moves Against Penn Scientist

The U.S. Food and Drug Administration (FDA) has begun proceedings that could disqualify gene therapy researcher James Wilson of the University of Pennsylvania in Philadelphia from conducting any future clinical trials. Wilson, who is head of the university's Institute for Human Gene Therapy, oversaw the trial in which 18-year-old Jesse Gelsinger died after a genetically altered virus was injected into his liver (*Science*, 17 December 1999, p. 2244).

Under scrutiny. Penn's James Wilson.

Disqualification is the harshest penalty the FDA can impose on an investigator. It bars a researcher from receiving drugs for use in clinical trials—in effect, preventing that investigator from administering experimental drugs to patients. In a 30 November letter to Wilson, the FDA stated that Wilson had "repeatedly or deliberately violated regulations governing the proper conduct of clinical studies." The agency wrote that Wilson and his colleagues enrolled patients who were ineligible for the trial, did not monitor patients properly, did not halt the trial when patients experienced serious side effects, and failed to inform patients that a trial of a similar drug had severely sickened monkeys. The FDA has also issued warning letters to two of Wilson's collaborators in the study—Steven Raper of the Institute for Human Gene Therapy and Mark Batshaw of Children's National Medical Center in Wash-