Name: _____

Class: _____

SESSION 2

A NEW DISCOVERY

The following is an email excerpt from one NASA astronomer to another:

Date: Thu, 19 Jul 2007 16:07:22

From: Edwin Hubble <edwin.p.hubble.1@nasa.gov>

To: Arthur Clarke <arthur.c.clarke.1@nasa.gov>

Subject: Swift and Suzaku discover something new about AGN

Hi Art,

Late last night, the Suzaku and Swift astronomers released some preliminary findings that I think you will find very interesting. I have copied what they sent out. Let me know what you think.

Consensus is emerging that almost all large galaxies have a supermassive black hole at its center, a fraction of which are accreting, making them active galactic nuclei (AGN). AGN are broadly classified into Type I (AGN direct viewed with little absorption) and Type II (heavy line-of-sight absorption, AGN seen predominantly via scattered light). Suzaku observations show that two galaxies detected in the Swift/ BAT (hard X-ray, >keV, survey) to be neither. These are highly absorbed AGN, like traditional Type IIs, but show little sign of scattered light (hence missed by pervious surveys). This discovery may force a re-evaluation of the number of AGN in the local universe. Suzaku follow-up observations of newly discovered (with INTEGRAL or Swift/ BAT) hard X-ray sources are a highly effective method to evaluate the population of such highly absorbed AGN with little scattering.

—Ed

Name: _____

Class: _____

Session 2

Article Analysis

Directions:

Reporters tailor their text for specific audiences. You will be given a published article about the AGN discovery in the "A New Discovery" email. Read the article and answer the following questions.

Media Source:

1. What is the source of your article?

Author:

2. What is the author's name?

Title:

3. What is the title of your article?
4. Just by reading the title, what is the focus or main idea of the article?
5. What impression do you think the author is trying to give by using that title?

Audience:

6. Who is the intended audience of your article?
7. What details does the author include that allows you to determine who is the intended audience?
8. Are there any points that you think the author should have emphasized but did not?

Purpose:

9. The author must communicate with a purpose. What was the purpose of this article?
10. How did they get their point across?
11. Describe how the author's word selection (vocabulary) helped to meet their audience's needs. Provide examples.

Point of View:

12. What perspective did the author use?
13. How do you know which perspective the author used (notice the pronouns)?
14. Explain how using a different perspective (i.e., 1st or 3rd person) might alter the author's effectiveness.

SESSION 2

ARTICLE 1

Name: _____

Class: _____

Some Black Holes are 'Closet Eaters'

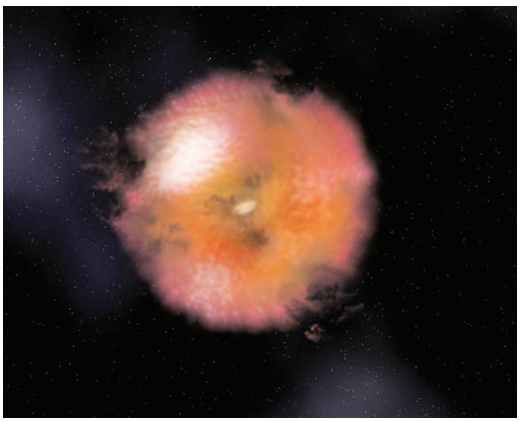
NewScientist.com news service; online article:

http://www.newscientist.com/article/dn12386

18:48 31 July 2007

By Maggie McKee

Black holes that are devouring their surroundings are among the brightest objects in the universe, shining like beacons from billions of light years away. But astronomers have found a strange new class of these objects that behave completely differently – 'closet eaters' that emit virtually no detectable radiation as they wolf down nearby matter.



Newly discovered 'active galactic nuclei' appear to be surrounded by a cloud of gas and dust that blocks most wavelengths of light from escaping

Image Credit: Aurore Simonnet/ Sonoma State University

The research may shed light on why the colossal black holes at the centres of some galaxies are gluttons, while others, such as the one inside the Milky Way, fast most of the time.

Until now, the enthusiastic eaters – known as active galactic nuclei, or AGN – were all thought to share the same essential structure. In this 'unified model', a doughnut-like disc of gas and dust, or torus, surrounds the supermassive black hole.

The AGN shine so brightly because matter from the torus is drawn towards the black hole, emitting radiation as it heats up and its magnetic fields twist and reconnect. Any differences in the nature of the radiation astronomers observe from the objects have been attributed to the angle at which they were viewed (see illustration below right).

Now, about eight AGN have been found that do not fall into this unified model. They were initially discovered using the Burst Alert Telescope on NASA's Swift space observatory, which observes high-energy X-rays. Follow-up observations with Japan's Suzaku satellite, which detects a wider range of X-rays, then confirmed that the objects did not radiate X-rays at lower energies.

'Filled doughnut'

Only AGN can emit X-rays at the energies Swift observed, suggesting the new objects are indeed ravenous black holes. But the fact that Suzaku did not detect them at lower energies suggests they are completely surrounded by gas and dust – which absorbs lower-energy X-rays – rather than a relatively flat, dusty torus.

"We're finding objects that don't have the shape of a doughnut . . . that don't have this hole in the middle," says team member Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Maryland, US. "The dust and gas is in a big mish-mosh in the centre. This is unexpected."

ARTICLE 1 (CONTINUED)

Name: _____

Class: _____

Jack Tueller, another team member at Goddard, suggests several explanations for this structure. The black hole may in fact be surrounded by a torus, but the torus-black hole combination may be embedded in a huge cloud of dust and gas that absorbs most wavelengths of light.

Another possibility is that the particles of gas and dust surrounding the black hole are heated in such a way that they have random velocities, producing a very thick disc of material that does not have a hole in its centre. "It's like a filled doughnut," Tueller told New Scientist.

High-energy glow

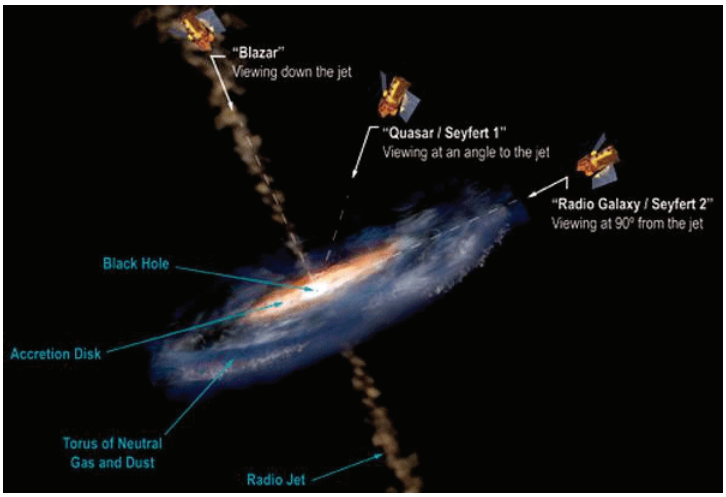
The discoveries of these black holes – which have evaded detection till now because they do not radiate at most wavelengths of light – suggest astronomers have underestimated the number of AGN in the universe by perhaps 20%, says Mushotzky. This could help astronomers better account for the source of diffuse, energetic radiation that pervades the universe, called the cosmic high-energy background, agrees Tueller.

"Another big mystery we don't understand is why are some black holes radiating and others not?" says Mushotzky. "If you don't observe all the objects that are radiating – and we are finding hidden ones – we can't test these ideas out properly."

Current theories suggest mergers between galaxies push gas into their cores, igniting the black holes there as AGN. "If that idea is correct, as we do our survey, we should find that many of the objects we're detecting also have the signature of mergers about them – they'll have either close companions, or be highly distorted, or have tidal tails," he says.

The team hopes to get clues about the structure of the objects by observing their spectra with the Spitzer Space Telescope, which detects infrared light. The dust and gas around them should absorb the objects' high-energy radiation and re-emit it at infrared wavelengths that would be more energetic in warmer regions close to the black hole and less energetic at greater distances.

Journal reference: Astrophysical Journal Letters (vol 664, L79)



In the 'unified model' of AGN, all share a common structure and only appear different to observers because of the angle at which they are viewed. The newly found black holes do not fit into this model, however, since they do not appear to be surrounded by a doughnut-like "torus" of gas and dust

Image Credit: Aurore Simonnet/Sonoma State University

Session 2

Article 2

Name: _____

Class: _____

Gas and Dust Hide Massive Black Holes

USA Today; online article:

http://www.usatoday.com/tech/science/space/2007-07-31-study-hidden-black-holes_N.htm

Posted 7/31/2007 12:35 PM

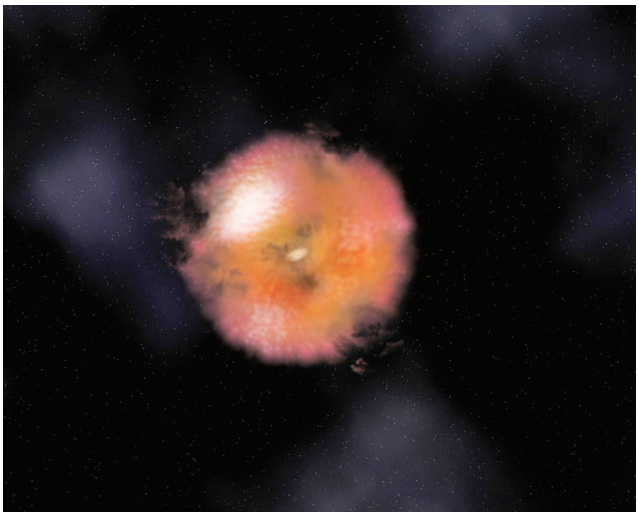
By Ker Than, SPACE.com

Some galaxies hide the normally bright output of supermassive black holes at their centers behind thick veils of dust and gas, a new study finds.

This phenomenon occurs in a type of galaxy called active galactic nuclei, or AGN, which that have active supermassive black holes at their cores. The black holes feed on infalling gas and many emit powerful beams of radiation from their poles that shine with the energy of billions of stars, making them some of the most luminous objects in the universe.

In the newly discovered type of "hidden" AGN, the central black hole is so heavily shrouded by gas and dust that no visible light escapes. As a result, these galaxies are difficult to detect and were missed by previous AGN surveys.

"This is an important discovery because it will help us better understand why some supermassive black holes shine and others don't," said study leader Jack Tueller of NASA's Goddard Space Flight Center in Maryland.



In the newly discovered type of AGN, the disk and torus surrounding the black hole are so deeply obscured by gas and dust that no visible light escapes, making them very difficult to detect.

Image Credit: Aurore Simonnet/Sonoma State University

The finding, detailed in the Aug. 1 issue of Astrophysical Journal Letters, could also force scientists to reconsider the role they think supermassive black holes play in the evolution of their host galaxies.

Hidden black holes

Scientists have been steadily gathering evidence for this new type of AGN for the past two years. Using NASA's Swift Telescope, Tueller and his colleagues spotted about 40 relatively nearby AGNs that were previously overlooked because their visible and ultraviolet light was dimmed by gas and dust.

Swift uncovered the AGNs because the telescope can detect high-energy X-rays, which can pierce through the dust and gas.

"These are the same energies as the X-rays used in the doctor's office," Tueller told SPACE.com. "They're very penetrating. They can go through the human body. They can go through that accreting torus of matter."

ARTICLE 2 (CONTINUED)

Name: _____

Class: _____

The discoveries were followed up by American and Japanese astronomers using the U.S./Japanese Suzaku X-ray observatory.

Scientists think AGNs are surrounded by donut-shaped rings of swirling material, which provide the fuel for the black holes. AGNs are divided into several types depending on the viewing angle at which this ring is angled toward Earth. A "blazer," for example, is an AGN whose ring, or "torus," lies roughly perpendicular to us. As a result, one of its twin jets points directly at us.

Shells, not rings

Richard Mushotzky, an astronomer also at NASA Goddard and a member of Tueller's team, thinks the new AGNs are surrounded by a shell of gas and dust, instead of a typical ring. This would have the effect of hiding nearly all of the visible and ultraviolet light produced by the AGN.

"We can see visible light from other types of AGN because there is scattered light," Mushotzky explained. "But in these two galaxies, all the light coming from the nucleus is totally blocked."

The researchers estimate that hidden AGNs could provide up to 20% of the X-ray background, a glow of X-ray radiation that pervades the universe.

Factoring in these new types of objects help scientists better understand how supermassive black holes and their host galaxies co-evolve, the researchers say.

"We think these black holes have played a crucial role in controlling the formation of galaxies, and they control the flow of matter into [star] clusters," Tueller said. "You can't understand the universe without understanding giant black holes and what they're doing.

SESSION 2

ARTICLE 3

Name: _____

Class: _____

Huge Black Holes Sighted Through Dust

Discovery News; online article:

http://dsc.discovery.com/news/2007/08/01/blackholes_spa.html

August 1, 2007

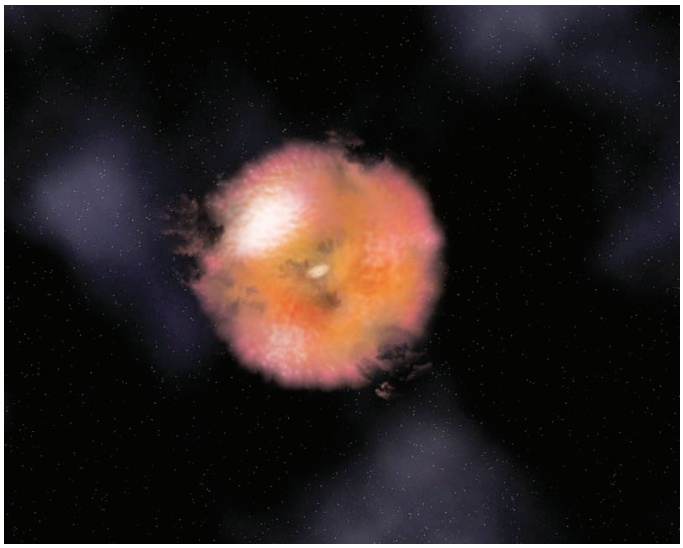
By Larry O'Hanlon, Discovery News

Some of the cosmos' biggest monsters have been hiding, say Japanese and U.S. X-ray astronomers who have now spotted several hundred super-massive black holes at the hearts of as many galaxies.

All of the black holes found are the super-massive sort, which live only at the centers of galaxies. But unlike others that have been detected by the visible and ultraviolet light streaming from doomed matter as it falls into oblivion, or from the infrared glow of hot gases heated by these screams, these gigantic black holes appear to be completely hidden in immense shrouds of dust. Only the highest-energy "hard" X-rays escape.

"The thicker the dust and gas is, the higher the energy needed to get through it," explained astronomer Richard Mushotzky of NASA's Goddard Space Flight Center.

It was NASA's Swift Burst Alert Telescope that started to detect the high energy X-rays leaking from what are called Active Galactic Nuclei (AGN) two years ago.



Cloaked Monster. In the newly discovered type of Active Galactic Nuclei, the disk and torus surrounding the black hole are so deeply obscured by gas and dust that no visible light escapes, making them very difficult to detect.

Image Credit: Aurore Simonnet/Sonoma State University

The discovery appears in a report in the August 1 issue of Astrophysical Journal Letters.

The confirmation of the newfound super-massive black holes came after taking aim with the Japanese/U.S. Suzaku X-ray telescope, which can detect and observe a broader range of X-ray energies than Swift. Both telescopes operate in space, since Earth's atmosphere blocks cosmic X-rays from reaching the ground.

Shrouded AGN were a surprise for astronomers and astrophysicists. According to standard AGN theory, the galactic super black holes are supposed to have a donut of dust surrounding them. This means they should be more visible from directly above and below — through the galactic donut holes.

Just what sort of emissions astronomers have seen from AGN was usually a function of the angle of

ARTICLE 3 (CONTINUED)

Name: _____

Class: _____

Up Close. This illustration shows the different features of an active galactic nucleus (AGN), and how our viewing angle determines what type of AGN we observe. The extreme luminosity of an AGN is powered by a supermassive black hole at the center. Some AGN have jets, while others do not.

Image Credit: Aurore Simonnet/Sonoma State University

view of any particular galaxy.

"What we learned from Suzaku is these [galaxies] don't have a hole," Mushotzky told Discovery News. "It's basically a change in our understanding of the geometry."

The discovery of fully shrouded AGN also implies there are a larger number of galaxies with black holes in the act of eating matter.

"The thing that is really surprising that's beginning to emerge from these surveys is how common [AGN] are," said astronomer Christopher Reynolds of the University of Maryland, College Park. "The numbers of truly inactive galaxies are falling."

It could be, perhaps, that half of all galaxies have actively feeding black holes at their centers, he told Discovery News.

This, of course, begs the question: Why are some galactic black holes active while others are not?

At the center of the Milky Way, for instance, is a black hole as massive as three million suns that's not eating much matter at all, and so it's not sending out X-rays, Mushotzky said.

One possibility is that the space around most super-massive black holes is usually clear of material, and they are usually quiet. It's only when galaxies collide with each other that dust is dragged through a galactic center and a black hole gets to eat.

If this is true, many of those thousands of AGN seen near and far in the cosmos could be road flares of galactic collisions.