Name: ______________________

Class: ______________________

Session 1

Background Research

Directions:

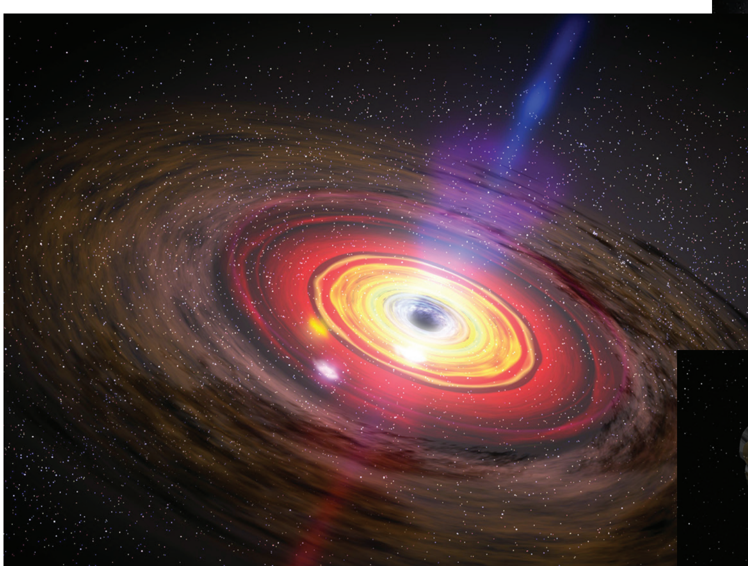
Your class will be researching information to help you understand a scientific discovery by the Swift and Suzaku satellites.

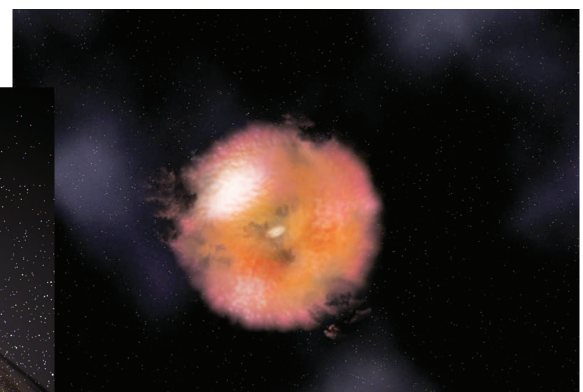
1. You will be placed in groups of three and each person will be assigned to research one of the following: black holes, active galactic nuclei (AGN), or the Swift and Suzaku satellites.
2. Your primary source of information will be the web pages provided on your research worksheet.
3. After your research is complete, your team will combine your information to prepare a presentation for your peers.

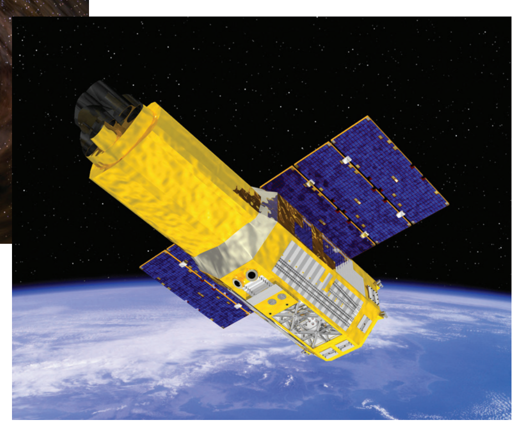
Black hole expert: ______________________

AGN expert: ______________________

Satellite expert: ______________________







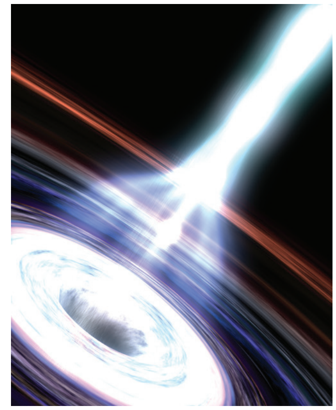
Session 1
Black Hole Research

Name: ______________________

Class: ______________________

Directions:

Today you are going to learn all about black holes. Use the links below to answer the questions about black holes. Be sure to note which web site(s) you've used to answer each question, in case you need to go back for more information.



Artist's conception of matter swirling around a black hole.

Image Credit: NASA

Links:

- What is a black hole?
  http://cosmology.berkeley.edu/Education/BHfaq.html#q1
- Black Holes
  http://imagine.gsfc.nasa.gov/docs/science/know_l2/black_holes.html
- How many types of black holes are there?
  http://hubblesite.org/reference_desk/faq/answer.php.id=62&cat=exotic
- If nothing can escape a black hole, why do they still emit X-rays?
  http://www.astronomycafe.net/qadir/q385.html
- Black Hole Bipolar Jets
  http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/990923a.html
- Jets from neutron star rival those made by black holes
  http://www.news.wisc.edu/13894
- Black Holes
  http://nasascience.nasa.gov/astrophysics/Black%20Holes
- X-rays and Black Holes
  http://www.astro.umd.edu/~chris/Research/X-rays_and_Black_holes/x-rays_and_black_holes.html

Questions to answer:

1. What is a black hole?
2. How do we "see" black holes?
3. There are two kinds of black holes: stellar-mass (or galactic) and supermassive. What's the difference between the two?
4. How do stellar-mass black holes form?
5. Do all stars become stellar-mass black holes? Why or why not?
6. How do supermassive black holes form?
7. Why do black holes create streaming jets of matter?
8. How does X-ray radiation help scientists better understand black holes?

Name: ______________________

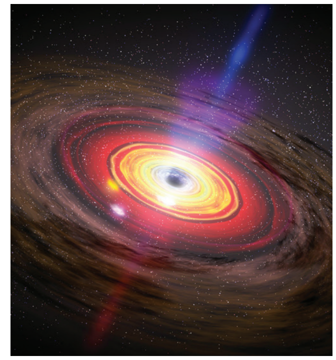
Class: ______________________

Session 1

AGN Research

Directions:

Just like a nucleus is the center of a cell, a galactic nucleus is the center of a galaxy. Use the links below to answer the questions about active galactic nuclei (AGN). Be sure to note which web site(s) you've used to answer each question, in case you need to go back for more information.



Artist's conception of the central engine of an active galactic nucleus.

Image Credit: NASA/ Dana Berry/SkyWorks Digital

Links:

- Active Galactic Nuclei
  http://heasarc.gsfc.nasa.gov/docs/objects/agn/agntext.html
- AGN Introduction
  http://aether.lbl.gov/www/projects/neutrino/agn/disk.html
- Accretion Disks
  http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/001106a.html
- Galaxies
  http://herschel.jpl.nasa.gov/galaxies.shtml
- Active Galaxies
  http://imagine.gsfc.nasa.gov/docs/science/know_l2/active_galaxies.html
- Active Galaxies (Lecture Notes)
  http://www.astronomy.ohio-state.edu/~ryden/ast162_9/notes37.html
- NASA's Spitzer Finds Hidden, Hungry Black Holes
  http://www.nasa.gov/vision/universe/starsgalaxies/spitzer-080305.html

Questions to answer:

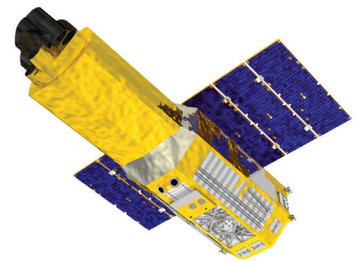
1. What are active galactic nuclei (AGN)?
2. What is an accretion disk?
3. Accretion disks in AGN are hard to image because they are very small and far away. How, then, do astronomers study accretion disks in AGN?
4. What does the "doughnut shaped ring" refer to?
5. Draw and label a sketch of an AGN complete with accretion disk, black hole, torus and jets.
6. What is the difference between a quasar, blazar, and a Seyfert galaxy?
7. What is a "shrouded" AGN or quasar? Why can't we observe the shrouded AGN in the infrared?

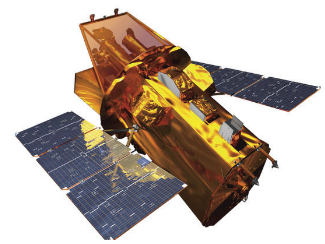
Name: ______________________

Class: ______________________

Session 1

Swift & Suzaku Research





Artist's conception of the Suzaku (top) and Swift (bottom) satellites.

Credit: JAXA and NASA E/PO, Sonoma State University, Aurore Simonnet

Directions:

Astronomers use data from many satellites. Today you will learn about two of them: Swift and Suzaku. Use the links below to answer questions about these two satellites. Be sure to note which web site(s) you've used to answer each question, in case you need to go back for more information.

Links:

- Images - Introduction
  http://imagine.gsfc.nasa.gov/docs/science/how_l1/images.html
- X-ray Astronomy Introduction
  http://imagine.gsfc.nasa.gov/docs/science/know_l1/history1_xray.html
- Official NASA Swift Homepage
  http://swift.gsfc.nasa.gov/docs/swift/swiftsc.html
- Swift Frequently Asked Questions
  http://swift.sonoma.edu/about_swift/general_faq.html
- Suzaku Collaboration
  http://globalastro.gsfc.nasa.gov/?page_id=72
- Suzaku Overview
  http://globalastro.gsfc.nasa.gov/?page_id=101
- Suzaku Guest Observer Facility
  http://heasarc.gsfc.nasa.gov/docs/suzaku/astroegof.html
- Cosmology/Deep Fields/X-ray Background
  http://chandra.harvard.edu/xray_sources/background.html
- Chandra Resolves the Hard X-Ray Background
  http://apod.nasa.gov/apod/ap000114.html

Questions to answer:

1. How do we "see" X-rays?
2. What is the Swift satellite and what information can it provide?
3. What kinds of objects does Swift study?
4. What band of X-rays can Swift detect?
5. What is Suzaku and what information can it provide?
6. What kinds of objects does Suzaku study?
7. What band of X-rays can Suzaku detect?
8. What is the X-ray background?

Session 1

Presentation Tips

Name: ____________________

Class: ____________________

When preparing your group presentation, keep the following tips in mind.

Colors

- Use colors that are pleasing and easy on the eyes.
- Use contrasting colors: for a dark background, use light fonts; for a light background, use dark fonts.

Fonts

- Use common fonts – especially if you will show the presentation on a different computer.

Font Size

- Make sure your font is large enough to read from all ares of the room.
- Keep text to a minimum – keep it short and sweet.

Slides

- Keep slides attractive and professional. Distracting slides could take away from your content. Avoid too many transitions, animations, and clutter.
- When making a professional presentation, do not animate a long sentence "by letter."

Animation

- Less is more.
- Use visual effects in small doses – if you emphasize everything with animation, you emphasize nothing.
- Consistency is crucial for formal presentations. Stick with a familiar pattern so you don't jar your audience.
- Consider your audience and the tone you want to convey. Save the wackier animation and sound effects for less formal presentations.
- Experiment with the various effects until you understand what each one does, then use them selectively.

Remember

➔ Make presentations pleasing and interesting without over-using transitions, sound, and animations

➔ Preview your presentation on the presentation equipment you plan to use.

➔ Think of your audience – is this a presentation you'd like to sit through?

Name: ______________________

Class: ______________________

Session 1

Presentation Grading Rubric

Directions: Here are some guidelines on how your presentation will be graded. Include all elements to get a good grade. Also, be sure to follow your teacher's instructions.

Presentation Group:____

Scoring Criteria	5 Excellent	4 Good	3 Needs Improvement	2 Needs Much Improvement	1 No Information
Clearly and effectively communicates an introduction of the theme/ objective of the project					
Clearly and effectively communicates the content throughout the presentation					
Integrated a variety of multimedia resources to create a professional presentation (transition, graphics, and animations)					
Presentation holds audience attention and relates a clear message					
Timing between slides is sufficient for the viewer to read or observe content					
Each image and font size is legible to the entire audience					

Scale:

26 - 30 **A** Master Astronomer

21 - 25 **B** Astronomer

16 - 20 **C** Rookie Astronomer

11 - 15 **D** Stargazer

6 - 10 **F** Terrestrial Walker

Total =

Title: ____________________________

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

Session 2
Article Analysis

Name: ______________________

Class: ______________________

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.

Name: ______________________

Class: ______________________

Session 2
Article 1

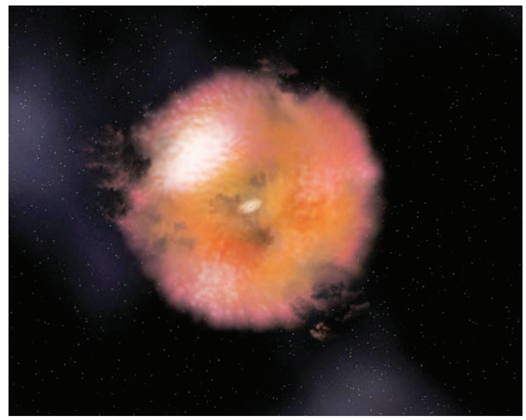
Some Black Holes are ‘Closet Eaters’

NewScientist.com news service; online article:

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

18:48 31 July 2007

By Maggie McKee



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

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.

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.”

SESSION 2
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

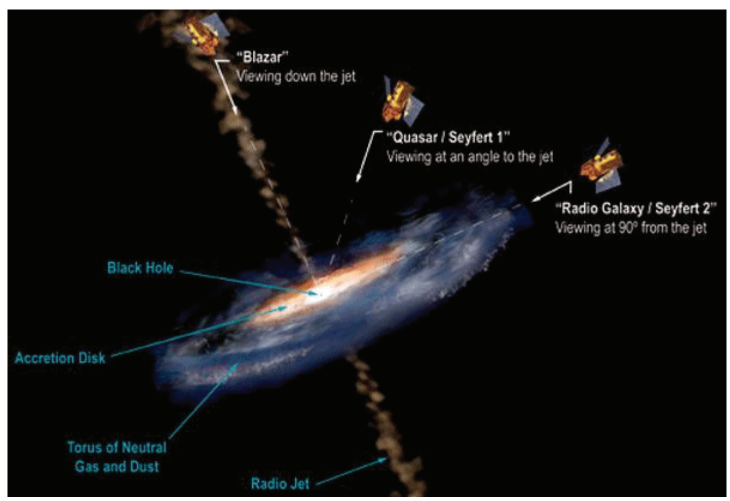
The discoveries of these black holes – which have evaded detection till now because they do not radiate at most wavelengths of light – suggest astronomers have underestimated the number of AGN in the universe by perhaps 20%, says Mushotzky. This could help astronomers better account for the source of 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

Name: ____________________

Class: ____________________

Session 2

Article 2

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

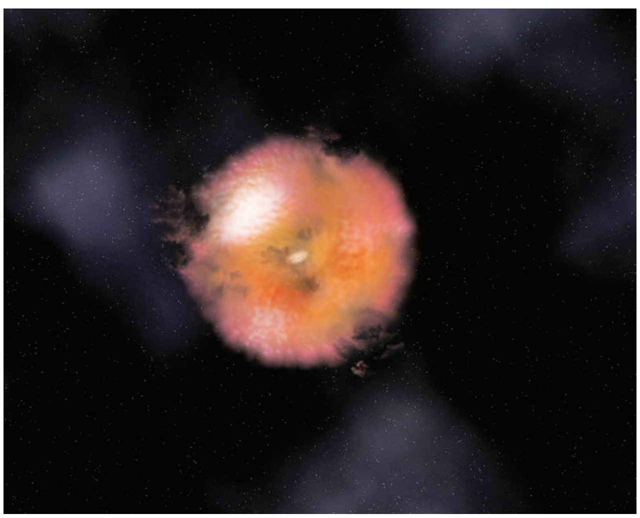
By Ker Than, SPACE.com

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.

Name: ______________________

Class: ______________________

SESSION 2

ARTICLE 3

Huge Black Holes Sighted Through Dust

Discovery News; online article:

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

August 1, 2007

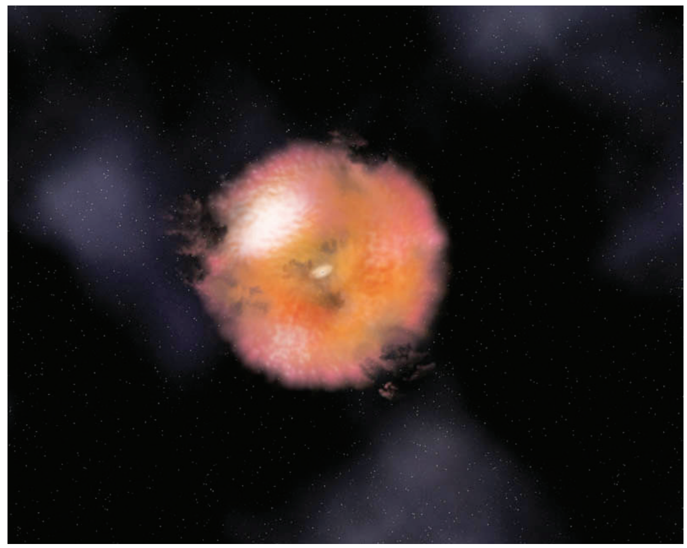
By Larry O'Hanlon, Discovery News

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

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.

NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

EDUCATIONAL PRESS RELEASE

Suzaku Probes ‘Comets’ Orbiting a Mega Black Hole

CONTENTS

Barbara Mattson
Goddard Space Flight Center, Greenbelt, MD

Koji Mukai
Goddard Space Flight Center, Greenbelt, MD

Educational Press Release

Suzaku Probes 'Comets' Orbiting a Mega Black Hole

WASHINGTON — Clouds of gas orbiting a black hole millions of light-years away have shapes and sizes similar to the tails of comets found in our own solar system, according to data from the Japan-U.S. Suzaku satellite. The evidence comes from the way the clouds dim X-rays emanating from hot gas near a giant black hole.

"We see a similar effect whenever a passing cloud dims the sun's light," said Roberto Maiolino at the National Institute for Astrophysics in Rome, the study's lead author. Detailed measurements of the sun's brightness would allow scientists to work out the shape and structure of the obscuring cloud. "That's essentially what we're doing, only with X-rays from a black hole in another galaxy," he added.

Using Suzaku, the researchers monitored a supersized black hole at the center of a spiral galaxy named NGC 1365. The galaxy is located about 60 million light-years away in the constellation Fornax.

The black hole contains about 2 million times the sun's mass. Gas orbiting the black hole gradually falls toward it and heats up as it gets closer. By the time the gas nears the black hole's event horizon – the point of no return – it has been heated to millions of degrees and emits vast amounts of X-rays. This intense radiation comes from a region so small that it would easily fit within the distance separating Earth and the sun – far too small to be resolved through a telescope at the galaxy's distance.

Optical and X-ray (inset) images of galaxy NGC 1365.

Image Credit: X-ray: NASA/CXC/CfA/INAF/Risaliti, Optical: ESO/VLT

Between Jan. 21 and 25, 2007, Suzaku maintained a steady watch on the galaxy, recording X-rays with energies between 2,000 and 5,000 electron volts. That's thousands of times greater than the energy of visible light.

On two occasions, Suzaku recorded that the X-ray emission dimmed in a peculiar way. It abruptly faded during the first 15 minutes and then dimmed more slowly over several hours. The researchers think that the sudden decline was caused by a dense sharp-edged gas cloud that quickly obscured Suzaku's view.

"To account for the fast fade-out, the edge of the cloud that first covers the X-ray source must be sharp and dense," Maiolino said. "For the slower dimming, we think Suzaku's observations are showing the effect of an expanding gas trail, much like the tail of a comet."

Suzaku Probes 'Comets' Orbiting a Mega Black Hole

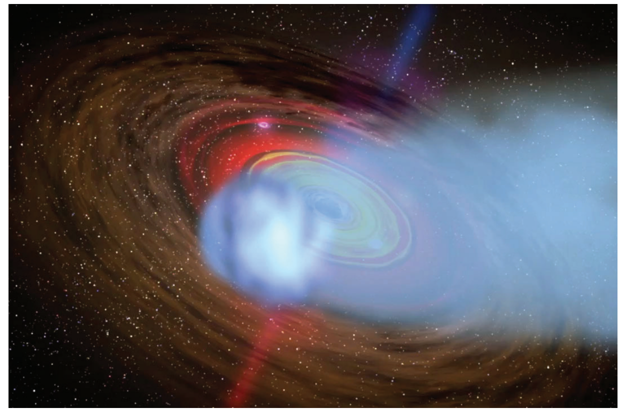
Maiolino and his colleagues estimate that the clouds are tearing around the black hole at speeds exceeding 2 million mph. Racing through a haze of hotter, thinner gas in their environment, the clouds slowly erode, and the lost gas creates the dissolving tail. In fact, the comet-shaped clouds erode so swiftly that they may be completely destroyed within a few months.

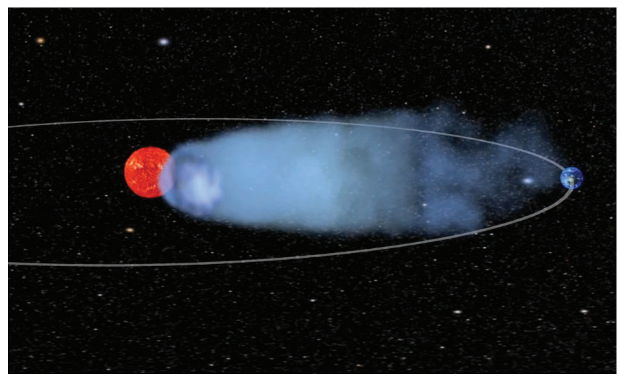
The team estimates that the tails of the clouds Suzaku detected extend at least 125 million miles – long enough to stretch from the sun to beyond Earth's orbit. For comparison, the tails of comets in our solar system, which are produced by gas evaporating from small icy bodies, can reach even greater lengths.

The astronomers also found that the comet clouds probably lie about 12 billion miles from the black hole, a distance equivalent to about three times Pluto's distance from the sun.

"This study and others like it take us to the very brink of a monster black hole – an incredible environment we can observe in no other way," Maiolino noted.

Suzaku ("red bird of the south") was launched on July 10, 2005, as Astro-E2 and was renamed once in orbit. The observatory was developed at the Japanese Institute of Space and Astronautical Science (ISAS), which is part of the Japan Aerospace Exploration Agency (JAXA), in collaboration with NASA and other Japanese and U.S. institutions.





Top: artist conception of the comet-shaped cloud eclipsing the view of the central black hole.

Bottom: illustration of the size of the comet-shaped cloud. The "tail" is long enough to reach from the Sun to just inside the Earth's orbit.

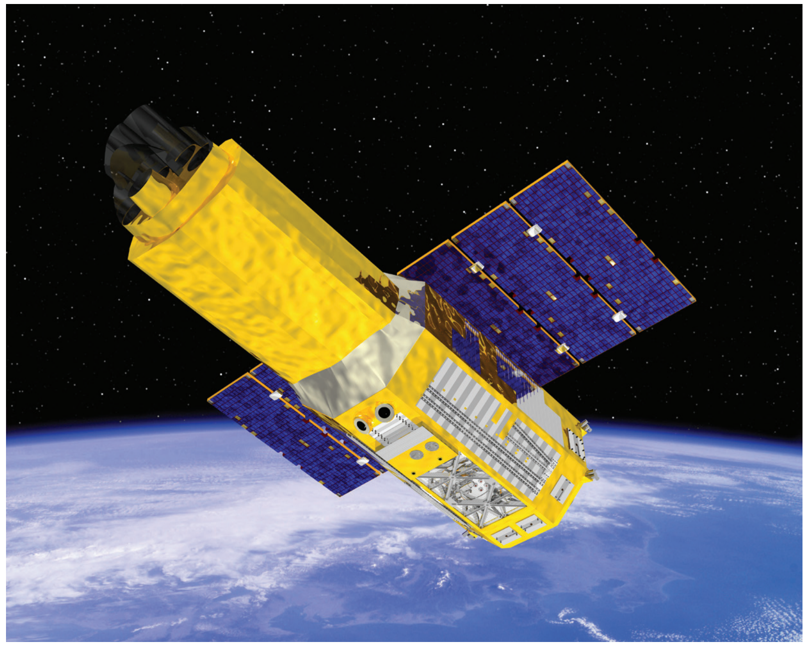
For more information about the mission, please visit: http://www.nasa.gov/astro-e2

-end-

Educational Press Release

Suzaku Information

Launched in 2005, Suzaku is the fifth in a series of Japanese satellites devoted to studying celestial X-ray sources. Managed by the Japanese Aerospace Exploration Agency (JAXA), this mission is a collaborative effort between Japanese universities and institutions and NASA's Goddard Space Flight Center (GSFC).



Artist's conception of the Suzaku satellite

Image Credit: JAXA

Suzaku is a satellite carrying telescopes for observing X-rays emitted by objects in the universe such as stars, galaxies and black holes. The name "Suzaku" means "vermilion bird of the south," originally from Chinese mythology. The satellite is a joint Japanese-U.S. collaboration, and was launched into orbit on July 10, 2005. Suzaku carries the X-ray Imaging Spectrometer (XIS) and the Hard X-ray Detector (HXD).

The Institute of Space and Astronautical Sciences (ISAS) in Japan, which is now part of JAXA, provided the rocket to launch Suzaku. In addition, scientists at ISAS built the HXD. Scientists and engineers at GSFC played key roles in building the X-ray Spectrometer (XRS, which suffered a catastrophic loss of coolant shortly after launch) and X-ray Telescopes (XRT). In addition, scientists at the Massachusetts Institute of Technology (MIT) contributed to the XIS instrument.

The science goals of the Suzaku mission are to help answer the following questions:

- When and where are the chemical elements created?
- What happens when matter falls onto a black hole?
- How does nature heat gas to X-ray-emitting temperatures?

Educational Press Release

Other Resources & Acronyms

Other Resources

Suzaku website: http://www.nasa.gov/astro-e2

Acronyms

GSFC	Goddard Space Flight Center
HXD	Hard X-ray Detector
ISAS	Institute of Space and Astronautical Sciences
JAXA	Japanese Aerospace Exploration Agency
NASA	National Aeronautics and Space Administration
XIS	X-ray Imaging Spectrometer
XRS	X-ray Spectrometer
XRT	X-ray Telescopes

Session 3

NASA Science Briefing

Name: ____________________

Class: ____________________

Directions: You are going to take on the role as reporter for a new discovery by the Suzaku X-ray satellite. To help you get facts for your article, you will get to listen in on a NASA Science Briefing about this discovery. Prepare for this briefing by first choosing the audience for your article and the type of media you will be writing for. Then read the NASA Press Kit for the discovery and brainstorm questions you'd like the science briefing to answer. Finally, take notes during the press briefing paying special attention to answers to questions on your list.

Intended Audience:

Media Source:

Questions for Science Briefing:

Session 3
Sharing the New Discovery

Name: ______________________

Class: ______________________

Directions: Now that you have learned about the new discovery, you have to tell the world. You should have already chosen an intended audience and media source, now you need to prepare to write your article (or script, if you are doing a podcast or video). Use the steps below to plan and write your piece.

Collect background Information:

- Intended Audience
- Media Source
- Key Vocabulary Words
- What words need to be defined for your audience?
- How will this discovery be important to your audience? Why will they want to know about this discovery?

Use the following guidelines to create an outline:

1. Start with a **headline**. The headline shouldn't be a summary of the article. Instead, it should get the reader's attention.
2. The first paragraph is your **lead paragraph**. In the first few sentences, answer the five W questions: Who? What? When? Where? Why? Do not tease or try to trick your reader; be simple and specific.
3. Next come **detail paragraphs**, where you will give amplification and explanation. These paragraphs are where you should indicate why the discovery will be important to the public and other astronomers. It is a good idea to include one or two quotes from people in these paragraphs as well.
4. In the **last paragraph**, try to round off your story with a quote or catchy phrase.
5. Add a **by-line** to the end of the story to state who wrote the article: "By ..."
6. Decide where **illustrations** will go, if any.

Finally, write your article or write and produce your podcast or video.

Name: ____________________

Class: ____________________

SESSION 3

ARTICLE GRADING RUBRIC

Directions: Here are some guidelines on how your article will be graded. Include all elements to get a good grade. Also, be sure to follow your teacher's instructions.

Article Title:____

Scoring Criteria	5 Excellent	4 Good	3 Needs Improvement	2 Needs Much Improvement	1 No Information
Clearly understands the new discovery and completely conveys it to the audience					
All vocabulary are appropriate to the audience and new terms are well defined					
No grammar or presentation errors - piece is ready to be published					
Images are included as appropriate and enhance the audience understanding of the new discovery					

Scale:

17-20 **A** Columnist

12-16 **B** Beat Writer

10-12 **C** Local Newspaper Writer

7-9 **D** High School Editor

4-6 **F** Job Applicant

Total =

Title: ____________________