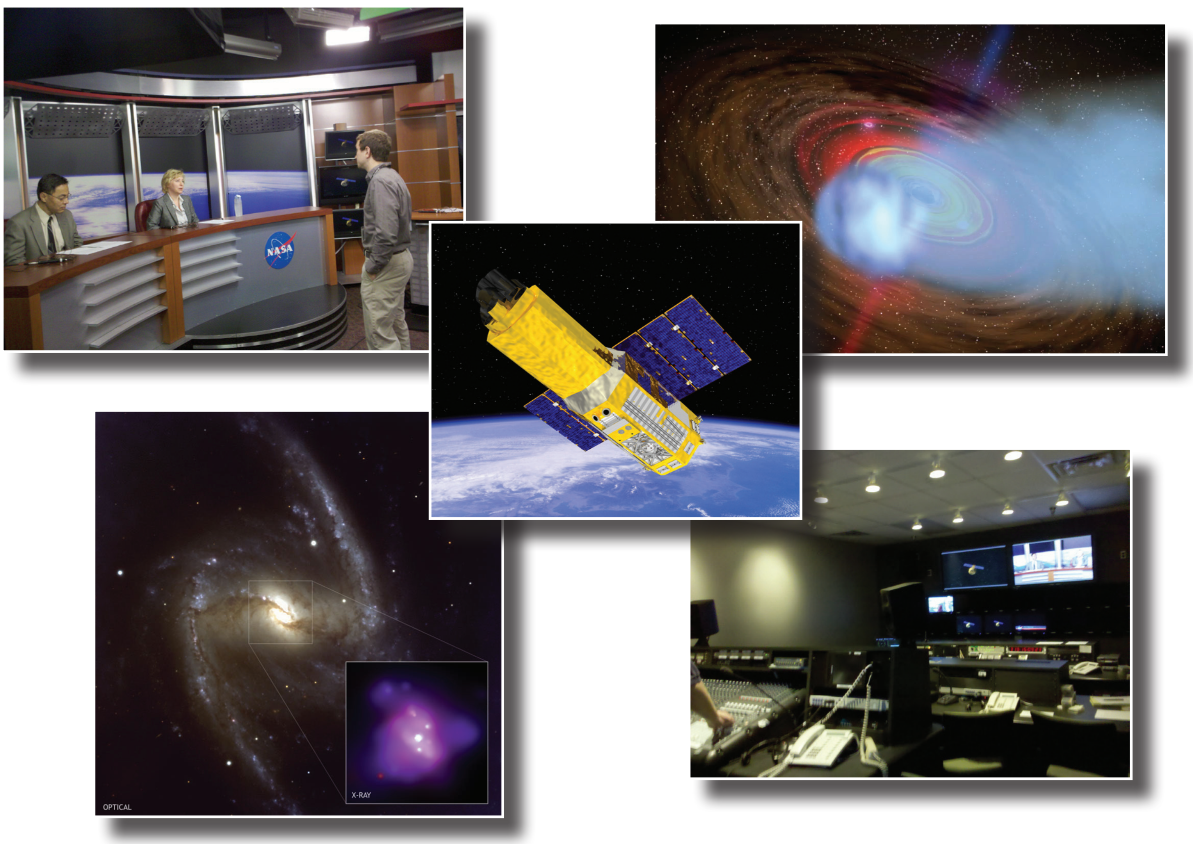
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

Science in the Media:

Bringing Cutting Edge Astronomy From Scientists to Students



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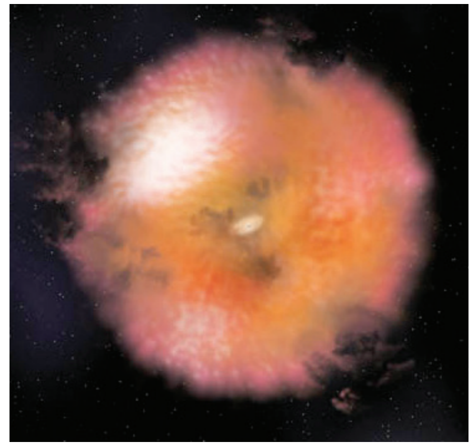
INTRODUCTION

Louis Pasteur discovered the first primitive antibiotic in 1887 which changed health care forever. Percy Spencer developed the first microwave oven in 1947 and changed human dining habits all around the world. Copernicus introduced us to a sun centered solar system, and Kepler discovered that the planets travel in elliptical orbits. All of these discoveries have changed either the way we conduct our everyday lives or how we conduct our scientific experiments to search for future discoveries.



Artist's conception of a newly discovered type of AGN.

Image Credit: Aurore Simonnet, Sonoma State University

How does the world find about new discoveries? What is the impact of these new discoveries in our daily lives and future discoveries?

NASA scientist Dr. John C. Mather answers questions during a press conference held at NASA Headquarters in Washington, DC. Dr. Mather was a co-recipient of the 2006 Nobel Prize for Physics on Oct. 3, 2006.

Image Credit: Bill Ingalls, NASA

These materials will address those two questions and will allow students to be journalists sharing a new discovery with the world.

Reporters do not know about every topic they report, so they must first research the new discovery before attempting to share it with others. Once they understand the discovery, they need to consider the intended audience of their article. For example, imagine that a company is going to introduce a new video game. If the reporter wrote about the game for a magazine aimed at middle-aged banking executives, it would be a very different article from one written for a gaming magazine aimed at teenagers.

Whatever audience or topic, nothing changes the basic rule for reporting: research the question, determine the audience, then write the article.

General Lesson Information

Objectives

- Students will learn about or enhance their knowledge in astronomical concepts: black holes, active galactic nuclei, and satellites.
- Students will reflect on how new knowledge and discoveries affect their view of the world and their future experiences.
- Students will learn how to effectively communicate with different audience groups.

Knowledge Prerequisites

- Students have a basic understanding of science and astronomy concepts.
- Students have the knowledge and basic skills of internet research and presentation software.
- Students have life experiences in viewing a televised or internet-produced news report.

National Standards

National Science Standards:

NS.9-12.4 Earth and Space Science

NS.9-12.7 History and Nature of Science

National Language Arts Standards:

NL-ENG.K-12.4 Communication Skills

NL-ENG.K-12.6 Applying Knowledge

NL-ENG.K-12.7 Evaluating Data

NL-ENG.K-12.8 Developing Research Skills

Estimated Class Time

Entire Lesson Plan: 6-7 class periods

Session 1: 2-3 class periods

Class 1: Introduction, group formation, allocation of roles, and independent research

Class 2: Finish independent research, share research with group members, assimilate research into presentation

Class 3: Upload presentation to a sharing website, peer review, and wrap-up discussion

Session 2: 2 class periods

Class 1: Discussion about audience, group formation, begin group analysis of articles

Class 2: Finish group analysis of articles, share analysis results, wrap-up discussion

Session 3: 2 class periods

Class 1: Read Media Kit, formulate questions, watch press briefing

Class 2: Re-watch press briefing (if needed), work on student pieces

Session 1
Gathering Background Information

There are scientific concepts students must know before they will be successful in their attempts to communicate the scientific findings of the Swift satellite and the Suzaku X-ray observatory. This lesson will aid them in gathering background knowledge.

Timeline

Estimated class time: 2-3 class periods

Class 1: Introduction, group formation, allocation of roles, and independent research

Class 2: Finishing independent research, sharing research with group members, assimilating research into presentation

Class 3: Upload presentation to a sharing website, peer review, and wrap-up discussion

Key Concepts

- Electromagnetic spectrum: visible light, ultraviolet, X-ray
- Black holes: stellar-mass and supermassive
- Active galactic nuclei
- X-ray telescopes

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Session 1

Instructional Delivery

1. **Introduce background information.** Students will need some astronomical background information to interpret the scientific discovery of the Swift satellite and Suzaku X-ray observatory properly. The instructor should display the key concepts for the students to view and briefly take an oral assessment of the students' base knowledge prior to the assignment.
2. **Gathering background.** This is a group-based assignment with individual responsibilities. The students will be assigned to groups of three. Each member of the group will be responsible for one topic (black holes, active galactic nuclei, or satellites) and should be given a handout with their topic's title, list of the websites to be used to find the requested information, and questions to answer. (Note that some websites may have changed or become unavailable. If so keep a list of good websites for future classes.)
3. **Black holes, AGN and satellite presentations.** When the students have completed gathering information on their topics, each group will prepare a presentation to share their findings. The students then upload their presentations to the teacher's designated website, such as www.slideshare.net, for all students to review. Finally, the students review their peer's presentations using the Presentation Grading Rubric.
4. **Wrap up.** After the students have completed their peer reviews and summary worksheets, create a class discussion to prepare the students for Session 2. Ask the students what difficulties did they experience? Were the presentations directed to a specific audience? Would the presentations be different if they had to present to another audience? Who might be interested in this subject? Where might those who are interested in this topic learn of their research? If you had to present new information to various audience types and through different media publications, what should you as a journalist consider? Allow this to serve as a wrap up of Session 1 and a lead into Session 2.

Name: ______________________

Class: ______________________

Session 1
Background Research

Directions:

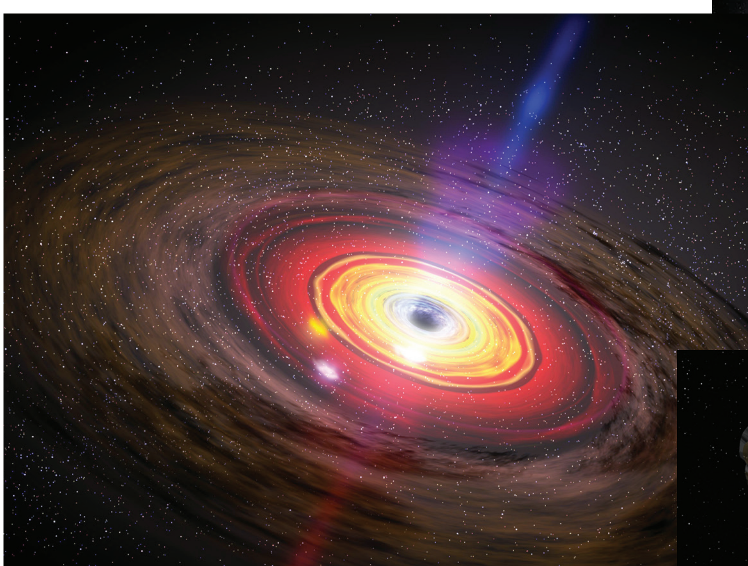
Your class will be researching information to help you understand a scientific discovery by the Swift and Suzaku satellites.

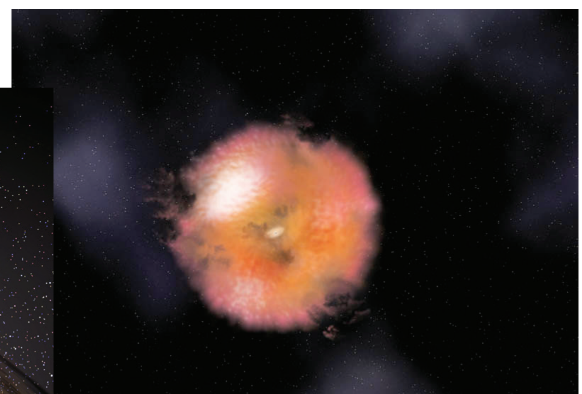
1. You will be placed in groups of three and each person will be assigned to research one of the following: black holes, active galactic nuclei (AGN), or the Swift and Suzaku satellites.
2. Your primary source of information will be the web pages provided on your research worksheet.
3. After your research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

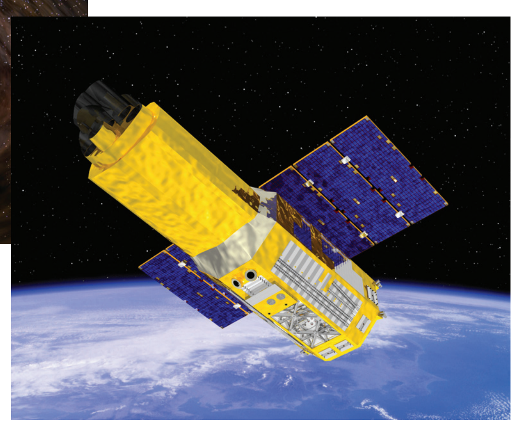
Black hole expert: ______________________

AGN expert: ______________________

Satellite expert: ______________________







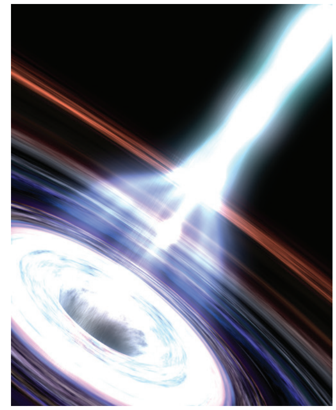
Session 1
Black Hole Research

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:

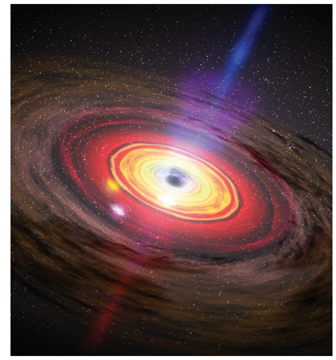
1. What is a black hole?
2. How do we "see" black holes?
3. There are two kinds of black holes: stellar-mass (or galactic) and supermassive. What's the difference between the two?
4. How do stellar-mass black holes form?
5. Do all stars become stellar-mass black holes? Why or why not?
6. How do supermassive 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?

Session 1
AGN Research

Name:	
Class:	

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?

Session 1

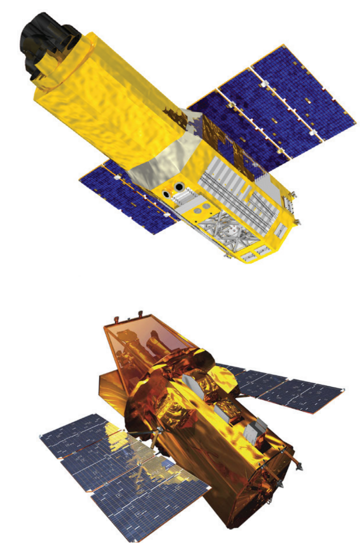
Swift & Suzaku Research

Name: ______________________

Class: ______________________

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.



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

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

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?

Name: ______________________

Class: ______________________

Session 1

Presentation Tips

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: ______________________

Session 1

Black Hole Research

KEY

Questions to answer:

1. **What is a black hole?**

From http://cosmology.berkeley.edu/Education/BHfaq.html#q1

A black hole is a region of space that has so much mass concentrated in it that there is no way for a nearby object to escape its gravitational pull.

From http://imagine.gsfc.nasa.gov/docs/science/know_l2/black_holes.html

Black holes are the evolutionary endpoints of stars at least 10 to 15 times as massive as the Sun.

2. **How do we "see" black holes?**

From http://imagine.gsfc.nasa.gov/docs/science/know_l2/black_holes.html

If a black hole passes through a cloud of interstellar matter, or is close to another "normal" star, the black hole can accrete matter into itself. As the matter falls or is pulled towards the black hole, it gains kinetic energy, heats up and is squeezed by tidal forces. The heating ionizes the atoms, and when the atoms reach a few million Kelvin, they emit X-rays. The X-rays are sent off into space before the matter crosses the Schwarzschild radius and crashes into the singularity. Thus we can see this X-ray emission.

3. **There are two kinds of black holes: stellar-mass (or galactic) and supermassive. What's the difference between the two?**

The mass is the main difference.

From http://nasascience.nasa.gov/astrophysics/Black%20Holes

On the one end, there are the countless black holes that are the remnants of massive stars. Peppered throughout the Universe, these "stellar mass" black holes are generally 10 to 24 times as massive as the Sun.

On the other end of the size spectrum are the giants known as "supermassive" black holes, which are millions, if not billions, of times as massive as the Sun.

4. **How do stellar-mass black holes form?**

From http://nasascience.nasa.gov/astrophysics/Black%20Holes

Most black holes form from the remnants of a large star that dies in a supernova explosion. If the total mass of the star is large enough (about three times the mass of the Sun), it can be proven theoretically that no force can keep the star from collapsing under the influence of gravity.

BLACK HOLE RESEARCH (CONTINUED)

KEY

5. **Do all stars become stellar-mass black holes? Why or why not?**

   Essentially, they do not have enough mass to collapse "all the way" to a black hole, but will end as a white dwarf or neutron star instead.

   From http://nasascience.nasa.gov/astrophysics/Black%20Holes

   Smaller stars become dense neutron stars, which are not massive enough to trap light.

6. **How do supermassive black holes form?**

   From http://hubblesite.org/reference_desk/faq/answer.php.id=62&cat=exotic

   We don't know exactly how supermassive black holes form, but it's likely that they're a by-product of galaxy formation. Because of their location in the centers of galaxies, close to many tightly packed stars and gas clouds, supermassive black holes continue to grow on a steady diet of matter.

7. **Why do black holes create streaming jets of matter?**

   From http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/990923a.html

   A fluid falling onto a small object usually cannot fall directly onto it – most of the matter will miss the object initially, rotate around it, and only gradually be able to hit the central object. Think of draining your bathtub: Accretion disks are the celestial equivalent of this phenomenon, and can be found around black holes, neutron stars, white dwarfs, or around ordinary stars.

   Accretion disks around a variety of objects seem to be able to produce jets (protostars certainly do, in addition to accreting black holes). It is just that the ones from an accreting black hole tend to be the fastest and the most spectacular. A general rule of thumb is that the speed of a jet is about the same as the escape velocity of the central object – so the jets from accreting black holes are at near the speed of light, while protostar jets are much more leisurely.

8. **How does X-ray radiation help scientists better understand black holes?**

   From http://www.astro.umd.edu/~chris/Research/X-rays_and_Black_holes/x-rays_and_black_holes.html

   As mentioned above, a large fraction of the energy released by the gas as it falls onto the black hole is converted into X-rays. It is thought that the X-rays come from material that is very close to the black hole (i.e. at distances of just a few times the event horizon size). Observations with X-ray telescopes allow astronomers to test and measure the conditions in this very interesting region of space.

AGN RESEARCH

KEY

Questions to answer:

1. **What are active galactic nuclei (AGN)?**

   From http://heasarc.gsfc.nasa.gov/docs/objects/agn/agntext.html

   In some galaxies, known as "active galactic nuclei" (AGN), the nucleus (or central core) produces more radiation than the entire rest of the galaxy! Quasars are very distant AGN - the most distant quasars mark an epoch when the universe was less than a billion years old and a sixth of its current size. In some cases, the size of the AGN is smaller than the size of our solar system. Current theory suggests that there is a supermassive black hole (millions of times the mass of the sun) at the center of AGN.

2. **What is an accretion disk?**

   From http://herschel.jpl.nasa.gov/galaxies.shtml

   A ring of dust and gas that may include matter drawn from nearby stars or even captured galaxies!

   From http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/001106a.html

   Accretion disks arise when material (usually gas) is being transferred from one celestial object to another. "accretion" means collecting of additional material.

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?**

   From http://imagine.gsfc.nasa.gov/docs/science/know_l2/active_galaxies.html

   An accretion disk forms, emitting huge amounts of light across the electromagnetic spectrum (infrared to gamma-rays)

   From http://herschel.jpl.nasa.gov/galaxies.shtml

   As the material spirals into the black hole, it heats up to enormous temperatures and emits radiation.

4. **What does the "doughnut shaped ring" refer to?**

   From http://herschel.jpl.nasa.gov/galaxies.shtml

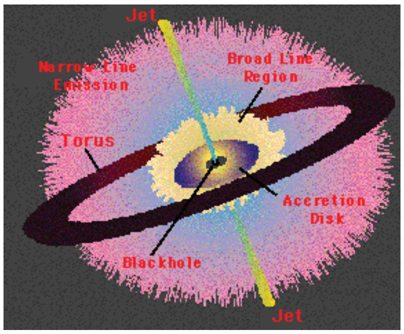
   AGNs shoot vast amounts of energy out into space in two enormously powerful jets, one at each pole. In the vast majority of observed cases, a donut-shaped ring, or torus, of orbiting gas and dust lies perpendicular to the jets.

Session 1
AGN Research (continued)

KEY

5. **Draw and label a sketch of an AGN complete with accretion disk, black hole, torus and jets.**

   From http://heasarc.gsfc.nasa.gov/docs/objects/agn/agntext.html



6. **What is the difference between a quasar, blazar, and a Seyfert galaxy?**

   From http://www.astronomy.ohio-state.edu/~ryden/ast162_9/notes37.html

   Quasars are a type of active galaxy. The luminosity of a quasar's "quasi stellar" nucleus can be from 10 to 100,000 times the luminosity of our galaxy (which is an ordinary galaxy, by the way). Quasars are powered by gas falling inward toward a central supermassive black hole.

   Blazars are a type of active galaxy which are still present today. Blazars can vary significantly in brightness in less than a day, indicating that most of their light must come from a region less than one light-day across (about 200 AU). Blazars are elliptical galaxies with highly luminous central nuclei.

   Seyfert galaxies are a type of active galaxy; they are spiral galaxies with extremely bright nuclei. About 2% of spiral galaxies are Seyferts. Within the nuclei of Seyfert galaxies, then, there exists very hot gas which is swirling around very rapidly. The luminosity of the nucleus of a Seyfert galaxy can vary wildly on time scales of less than a month. This implies that the size of the nucleus is less than one light-month (= 5000 A.U. = 0.025 parsec).

7. **What is a "shrouded" AGN or quasar? Why can't we observe the shrouded AGN in the infrared?**

   From http://www.nasa.gov/vision/universe/starsgalaxies/spitzer-080305.html

   They proposed that some quasars are positioned in such a way that their dusty rings hide their light, while others are buried in dust-drenched galaxies.

   Spitzer appears to have found both types of missing quasars by looking in infrared light. Unlike X-rays and visible light, infrared light can travel through gas and dust.

Swift and Suzaku Research

KEY

Questions to answer:

1. **How do we "see" X-rays?**

   From http://imagine.gsfc.nasa.gov/docs/science/how_l1/images.html

   We do the same thing with stars and galaxies and such. We use a detector that can see the X-rays they emit and then, in a very clever way, interpret what we have measured so that we can produce an image of what the objects would look like if our eyes could see X-rays.

2. **What is the Swift satellite and what information can it provide?**

   From http://swift.gsfc.nasa.gov/docs/swift/swiftsc.html

   With Swift, a NASA mission with international participation, scientists will now have a tool dedicated to answering these questions and solving the gamma-ray burst mystery. Its three instruments will give scientists the ability to scrutinize gamma-ray bursts like never before. Within seconds of detecting a burst, Swift will relay a burst's location to ground stations, allowing both ground-based and space-based telescopes around the world the opportunity to observe the burst's afterglow.

3. **What kinds of objects does Swift study?**

   Gamma-ray bursts (GRB)

   (From http://swift.sonoma.edu/about_swift/general_faq.html)

4. **What band of X-rays can Swift detect?**

   Energy Range: 0.2-10 keV

   (From http://swift.sonoma.edu/about_swift/general_faq.html)

5. **What is Suzaku and what information can it provide?**

   From http://globalastro.gsfc.nasa.gov/?page_id=101

   Suzaku is a joint Japanese-US satellite whose mission is to study X-rays emitted by objects in the universe, such as stars, galaxies, and black holes.

6. **What kinds of objects does Suzaku study?**

   From http://globalastro.gsfc.nasa.gov/?page_id=101

   Suzaku is a joint Japanese-US satellite whose mission is to study X-rays emitted by objects in the universe, such as stars, galaxies, and black holes.

Swift and Suzaku Research (continued)

KEY

7. **What band of X-rays can Suzaku detect?**

   From http://heasarc.gsfc.nasa.gov/docs/suzaku/astroegof.html

   Suzaku covers the energy range 0.2 - 600 keV with the two instruments, X-ray CCDs (X-ray Imaging Spectrometer; XIS), and the hard X-ray detector (HXD).

8. **What is the X-ray background?**

   From http://chandra.harvard.edu/xray_sources/background.html

   Before Chandra, when X-ray telescopes observed the sky, it was not dark between the points of X-ray light. Rather, a uniform background glow was apparent, similar to the diffuse glow produced by the lights from a distant city.

   From http://apod.nasa.gov/apod/ap000114.html

   It is everywhere but nobody knew why. In every direction at all times, the sky glows in X-rays. The X-ray background phenomenon was discovered over 35 years ago, soon after the first X-ray satellites were launched, and has since gone unexplained. Yesterday results were released using data from the recently launched Chandra X-Ray Observatory that appears to have resolved much of this mystery. The above photograph shows that about 80 percent of the apparently diffuse hard X-ray background can be resolved into very many very faint sources.

SESSION 2
A SCIENTIST MAKES A DISCOVERY!

When a scientist makes a discovery, he or she must inform others. In this lesson, students will take a close look at the scientific discovery and how it is communicated to the public. Students will also note how the various media outlets present the same information differently based on their intended audiences. It should be noted the intent is not to instruct students on the intricacies of fine writing, but rather to explore writing styles as it relates to the presentation of information through group work and class discussion.

Timeline

Estimated class time: 2 class periods

Class 1: Discussion about audience, group formation, begin group analysis of articles

Class 2: Finish group analysis of articles, share analysis results, wrap-up discussion

Key Concepts

- Active Galactic Nuclei (AGN)
- Audience
- Black Holes
- Media Source
- Point of View
- Purpose
- Swift Satellite
- Suzaku X-ray Observatory

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Session 2
Instructional Delivery

1. **Scientific Discovery!** X-ray telescopes on Swift and Suzaku have shown scientists some new things about active galactic nuclei (AGN).

   Distribute the introductory email, "A New Discovery," to each student and have them read it.

   As a class, brainstorm a list of different media sources (i.e., magazines, newspapers, web pages, journals, etc.) where such information might be conveyed to the general public. Post the class' ideas on the board for all to view.

   Next, have students brainstorm different audience groups who might want to know about this information. List these on the board, as well, and align them to any possible media sources just identified.

   Ask the class, why is it important to know the audience? Students should realize that knowing the intended audience helps to establish a purpose and focus for a writer. For example, a newspaper would have a general public audience; a science magazine would have a science-interested audience; and an astronomy magazine or journal would have an astronomy-interested audience.

   Have students put themselves in the place of a writer employed by any one of the media sources the class identified. What questions might they ask if they are write about the new AGN discovery by Swift and Suzaku? Post the questions on the board for all to see.

2. **The Media.** Now students will look at published articles talking about the AGN discovery. Students will note the type of media source and examine how this audience choice affects the writing style and vocabulary.

   Divide the class into three groups. Each group will be assigned one of the three specific articles to review. If need be, larger groups can be divided into smaller groups for the same article.

   Hand each student a copy of the "Article Analysis" handout, a copy of the article (for whichever group they are in), some butcher paper for the group and markers. Students are to work collaboratively in answering the "Article Analysis" questions by recording the answers onto the butcher paper. Once all questions have been answered, post each group's butcher paper around the room.

   General concepts students will consider as they complete the "Article Analysis"

   - Title (the first impression for the reader)
   - Audience (the intended person of interest)
   - Purpose (the focus of the topic)
   - Point of View (the perspective the author conveys the purpose)

   Take turns sharing each group's information and note any similarities and differences (between different groups of the same article and among the three separate articles). These are the things that writers must consider when they write for specific audience.

INSTRUCTIONAL DELIVERY (CONTINUED)

Wrap up this activity with a class discussion. Make sure to emphasize important points on the differences between how the discovery is handled by different media types – going over differences in vocabulary and the degree to which the article gives specifics about how the discovery was made.

3. **Grading Rubric.** The purpose of this section is not to teach students about the specifics of writing but rather to introduce them to the different media sources and analyze how various audiences influence writing styles of writers when presenting information. The session is based on students' participation in the form of a whole class discussion and group work. Therefore, an informal assessment can be used based upon students' verbal responses or points could be offered based upon correctness and/or completion of analysis questions. The following is a sample rubric one could use for very simplistic grading purposes.

Questions	Points
13-14	4
10-12	3
6-9	2
1-5	1

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.

ARTICLE 1

Name: ______________________

Class: ______________________

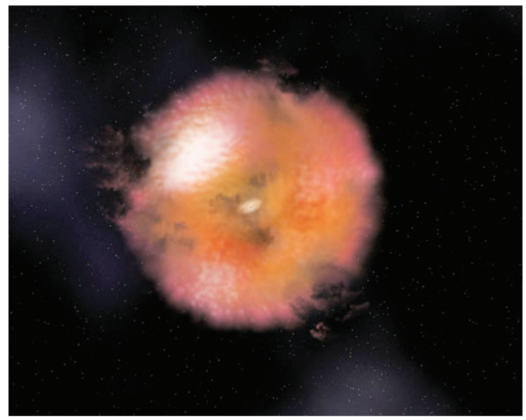
Some Black Holes are 'Closet Eaters'

NewScientist.com news service; online article:

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

18:48 31 July 2007

By Maggie McKee



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."

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

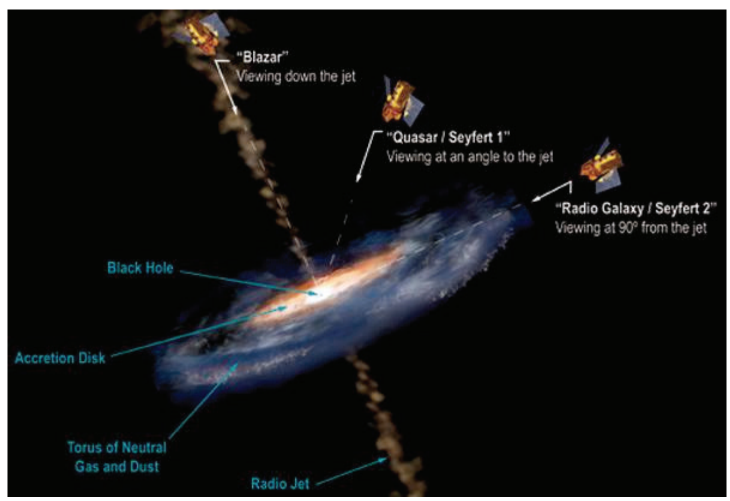
The discoveries of these black holes – which have evaded detection till now because they do not radiate at most wavelengths of light – suggest astronomers have underestimated the number of AGN in the universe by perhaps 20%, says Mushotzky. This could help astronomers better account for the source of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

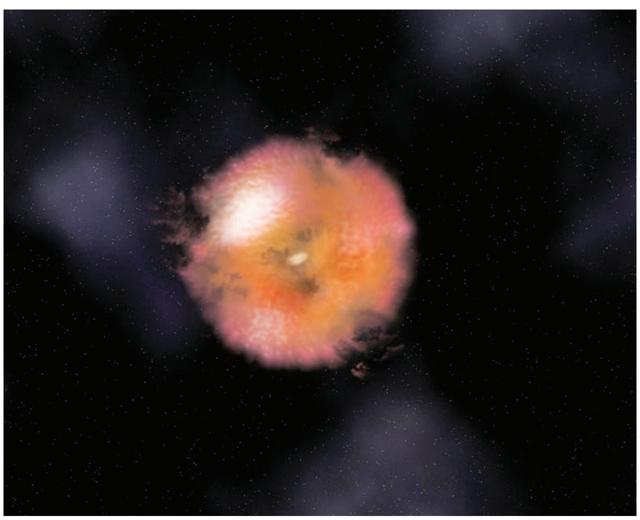
By Ker Than, SPACE.com

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.

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Name: ______________________

Class: ______________________

Huge Black Holes Sighted Through Dust

Discovery News; online article:

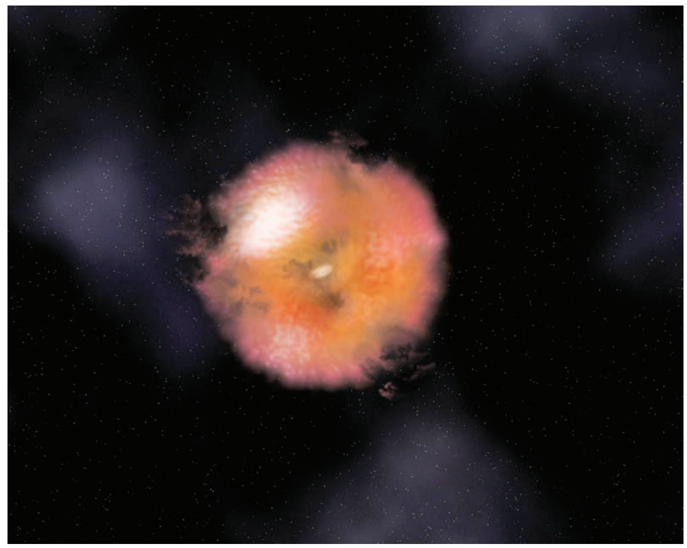
http://dsc.discovery.com/news/2007/08/01/blackholes_spa.html

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.



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 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.

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: ______________________

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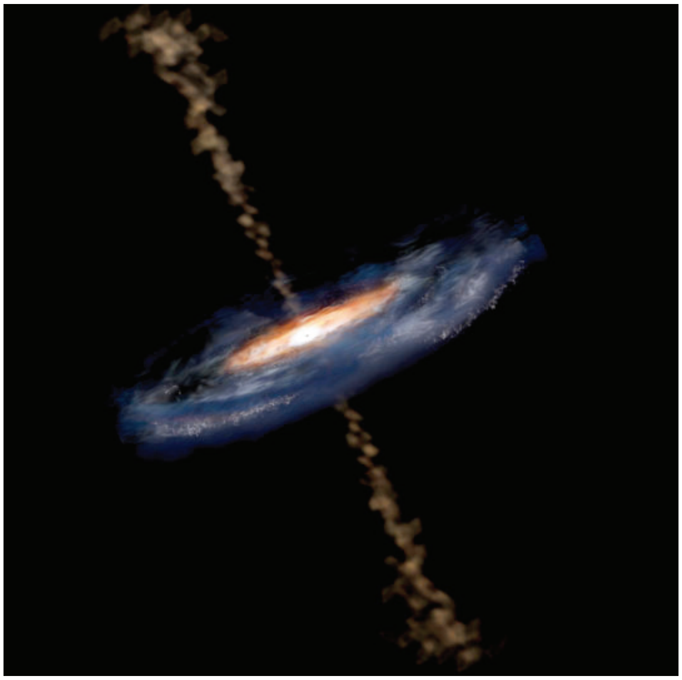

Up Close. This illustration shows the different features of an active galactic nucleus (AGN), and how our viewing angle determines what type of AGN we observe. The extreme luminosity of an AGN is powered by a supermassive black hole at the center. Some AGN have jets, while others do not.

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.

KEY

Session 2
Scientific Discovery! Answers

Media Source	Audience Group	Question
Newspaper or non-specialty magazine	General Public	What are the satellites mentioned? Suzaku, Swift, and Integral?
Newspaper or non-specialty magazine	General Public	How does the number of AGN in the universe affect me?
General science magazine or weblog	Science-interested	What are the different types of AGN?
General science magazine or weblog	Science-interested	Why is it important that a new type of AGN has been spotted?
General science magazine or weblog	Science-interested	What is the light scattering off of when we see an AGN?
Astronomy magazine or journal	Astronomy-interested	How many AGN of this type are there?
Astronomy magazine or journal	Astronomy-interested	How does this discovery change what we know about AGN and the universe?

SESSION 2

MEDIA COMPARISON ANSWERS

KEY

Article Analysis Question	"Some Black Holes are 'Closet Eaters'"	"Gas and Dust Hide Massive Black Holes"	"Huge Black Holes Sighted Through Dust"
1. Source?	NewScientist.com news service	USA Today	Discovery News
2. Author?	Maggie McKee	Ker Than	Lary O'Hanlon
3. Title?	"Some Black Holes are 'Closet Eaters'"	"Gas and Dust Hide Massive Black Holes"	"Huge Black Holes Sighted Through Dust"
4. Article focus/ main idea?	Black holes	Gas, dust and black holes	Black holes and dust
5. Title impression?	Black holes are consuming matter within our universe	They have found black holes behind the gas and dust that is in the universe.	They are now able to see black holes through the dust in the universe.
6. Intended Audience?	Science-interested audience, maybe astronomy-interested	Science interested, maybe general public	General audience
7. What details were provided?	Answers will vary, but the use of vocabulary helps to identify an intended audience.	Answers will vary, but the use of vocabulary helps to identify an intended audience.	Answers will vary, but the use of vocabulary helps to identify an intended audience.
8. Points not emphasized?	This will vary from student to student - based upon the proposed questions from "Scientific Discovery!"	This will vary from student to student - based upon the proposed questions from "Scientific Discovery!"	This will vary from student to student - based upon the proposed questions from "Scientific Discovery!"
9. Article purpose?	Describes how the discovery doesn't fit into the unification model. Also describes what the two satellites saw to lead to the confusion that some AGN are completely surrounded by dust.	Describes a possible new type of "hidden" AGN with the central black hole covered in dust. There are fewer specifics about what the X-rays showed and why two satellites were needed to confirm the discovery.	Describes the newly found AGN as completely hidden in shrouds of dust, and points out that we had not seen them in UV or visible light. Nothing about a new type of AGN, and few specifics about what the X-rays showed

Session 2
Media Comparison Answers

KEY

Article Analysis Question	"Some Black Holes are 'Closet Eaters'"	"Gas and Dust Hide Massive Black Holes"	"Huge Black Holes Sighted Through Dust"
10. How was the purpose conveyed?	The article says: "Now, about eight AGN have been found that do not fall into this unified model." . . . "Only AGN can emit X-rays at energies Swift observed, suggesting the new objects are indeed ravenous black holes. But the fact that Suzaku did not detect them at lower energies suggest they are completely surrounded by gas and dust."	The article describes the discovery by claiming: "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."	The article summarizes the discovery with: "All of the black holes found are the super-massive sort, which live at the centers of galaxies. But unlike others that have been detected by 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."
11. Describe the word selection (vocabulary). Examples.	The donut-like disk is called a "torus" after the first introduction of the term Mentions magnetic fields twisting and reconnecting Describes donut-disk as the "unified model" "Wavelength of light" instead of saying "visible", "UV", or "infrared "Diffuse, energetic radiation" Mentions "spectra", which is a scientific term general audiences might not get	AGN are explained in one of the first few sentences The dusty torus is described as a "donut-shaped ring", usually called "ring", not "torus" The word "light" instead of "radiation" X-rays are associated with the ones in the doctor's office "Swirling material" rather than accretion disk	"'cosmos' biggest monsters" to describe super massive black holes "doomed matter" to describe accretion "AGN" not even introduced until the 4th paragraph Explanation of why X-ray telescopes/satellites operate in space "galactic donut holes" to describe the dusty torus in AGN
12. Perspective?	3rd person	3rd person	3rd person
13. How do you know the perspective?	The article indicates what is being spoken or written about with the use of the pronouns – "it", "their", and "they"	The article indicates what is being spoken or written about with the use of the pronouns – "it", "their", and "they"	The article indicates what is being spoken or written about with the use of the pronouns – "it", "their", and "they"
14. Explain how a different perspective might alter the effectiveness.	1st person offers one perspective and although it does create a bond with the reader, it is rather limited because it is from one person's perspective. 3rd person is more versatile	1st person offers one perspective and although it does create a bond with the reader, it is rather limited because it is from one person's perspective. 3rd person is more versatile	1st person offers one perspective and although it does create a bond with the reader, it is rather limited because it is from one person's perspective. 3rd person is more versatile

Session 3
Communicating A New Discovery

What does it take to be a reporter? In this session, students will try their hand at writing a piece based on a new astronomical discovery. Students receive a NASA media kit that will introduce them to a new discovery which builds on the astronomy background they learned in Session 1. After choosing a target audience for their media piece, students brainstorm questions they would have for scientists involved in the discovery. Then students listen in on a NASA science briefing for answers to most of their questions. Finally, students present the discovery in a media format appropriate for a specific audience.

Timeline

Estimated class time: 2 class periods

Class 1: Read over Media Kit, formulate questions, watch press briefing

Class 2: Re-watch press briefing (if needed), work on student pieces

Key Concepts

- Audience
- Purpose
- Active galactic nuclei (AGN), black holes, material around the black hole in AGN

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NASA Science Briefing 39

Sharing the New Discovery 40

Article Grading Rubric 41

Session 3
Instructional Delivery

1. **New discovery about AGN.** The students become reporters with the job of sharing a new discovery with their audience. Students should decide what audience they will be reporting to (general, science-interested, or astronomy-interested) and what type of media they will be writing/presenting. Determine if you would like your students to work on a written piece or if they can explore other media, such as blogs, podcasts, or videos. If you allow them to report using other media, remind students that even podcasts and videos have scripts, so they will be writing no matter what media they choose. Provide students the Press Kit from NASA and have them complete the “NASA Science Briefing” worksheet.
2. **Listening in on a NASA science briefing.** Tell the students that they will now get to listen in on a NASA science briefing about the new AGN discovery. Some of their questions should be answered by the scientists in the briefing. Students will need to take notes during the press conference, paying special attention to answers to the questions they wrote in response to the Press Kit.

   The science briefing is available streaming on YouTube and TeacherTube:

   TeacherTube: http://www.teachertube.com/viewVideo.php?video_id=261245

   YouTube: http://youtu.be/3EBD0QI4xSg

   The briefing video is also available for download from our website:

   http://globalastro.gsfc.nasa.gov/?page_id=3865

   After watching the science briefing, ask if there were any questions not answered by the scientists in the video. There are likely to be many that were not answered. Take this opportunity to ask students if they think this happens in a real-life press briefing (it does!). And ask students how reporters handle it when they still have questions. Students should recognize that reporters will need to do further research, which may include calling scientists either directly involved in the discovery or familiar with the science discussed in the press conference.
3. **Sharing the new discovery with an audience.** Students now have the tools they need to write their piece. Hand out the “Preparing to Write” and “Write an Article About the Discovery” worksheets to students. These two handouts will walk students through the process of writing a newspaper article about the new discovery. Even if students are writing an audio or video podcast, they should fill out these worksheets because they will need to include the same information in their script. Also give the “Rubric for Sharing a New Discovery Article” handout to students, so they know how their final project will be graded. Finally, students produce their piece on this new Suzaku discovery.

NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

EDUCATIONAL PRESS RELEASE

Suzaku Probes 'Comets' Orbiting a Mega Black Hole

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Other Resources
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Barbara Mattson
Goddard Space Flight Center, Greenbelt, MD

Koji Mukai
Goddard Space Flight Center, Greenbelt, MD

EDUCATIONAL PRESS RELEASE

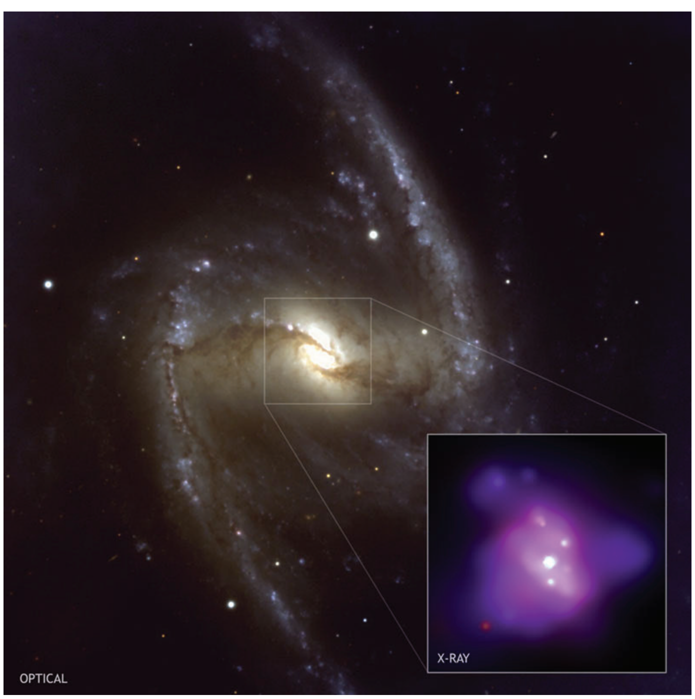
SUZAKU PROBES 'COMETS' ORBITING A MEGA BLACK HOLE

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."

EDUCATIONAL PRESS RELEASE
Suzaku Probes 'Comets' Orbiting a Mega Black Hole

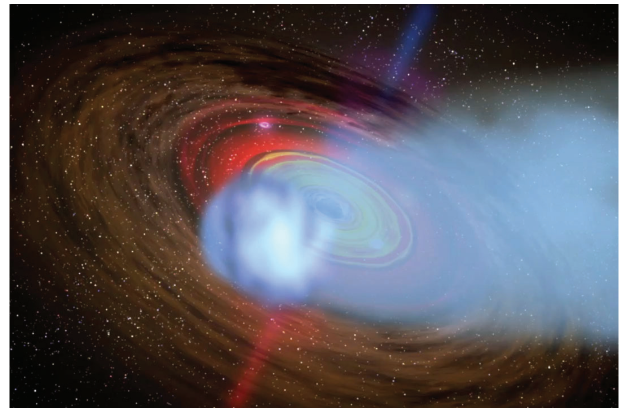
Maiolino and his colleagues estimate that the clouds are tearing around the black hole at speeds exceeding 2 million mph. Racing through a haze of hotter, thinner gas in their environment, the clouds slowly erode, and the lost gas creates the dissolving tail. In fact, the comet-shaped clouds erode so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

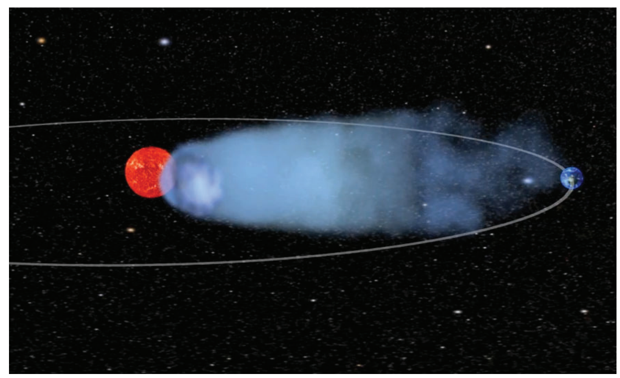
The team estimates that the tails of the clouds Suzaku detected extend at least 125 million miles – long enough to stretch from the sun to beyond Earth's orbit. For comparison, the tails of comets in our solar system, which are produced by gas evaporating from small icy bodies, can reach even greater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

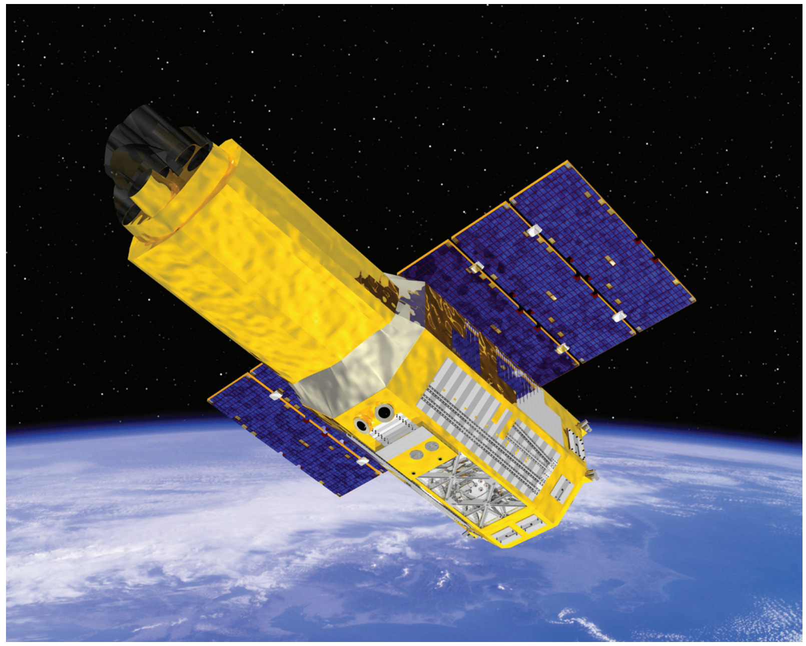
Bottom: illustration of the size of the comet-shaped cloud. The "tail" is long enough to reach from the Sun to just inside the Earth's orbit.

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

-end-

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?

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:

Name: ________________

Class: ________________

Session 3
Sharing the New Discovery

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: ______________________