

Overview

- A multifaceted Public Communications & Engagement program encompassing press relations, public engagement, and education
- Reaches a large and diverse audience of national and international scope
- Direct connection and established working relationships with the astrophysicists whose research forms the basis for all products
- Products and activities evolve from an integrated pipeline design, encourage users toward deeper engagement
- Products target underserved audiences such as women, Spanish speakers, sight and hearing impaired



Overview

- Program conducts research into best practices which inform subsequent programs and products
- Products use emerging technologies and track user trends
- Education products undergo NASA evaluation and align with national standards
- Program undergoes comprehensive outside evaluation
- Work supported by ~11.25 FTE: 1.5 press scientists, 1 press officer, 1 lead coordinator, 1 multi-media coordinator, 1 scientific image processor, 1 web developer, 1 apps/social media developer, 1 animator/podcast producer, 1 scientific illustrator, 1.25 educators, .5 staff assistant



Publicizing Chandra Science: From science papers to the public

3

Cornell University Library
arXiv.org > astro-ph > arXiv:1309.6792
Astrophysics > High Energy Astrophysical Phenomena
The long helical jet of the Lighthouse nebula, IGR J11014-6103
L. Pavan, P. Bordas, C. Puehlofer, M. D. Filipovic, A. De Horta, A. O'Brien, M. Balbo, R. Walter, E. Bozzo, C. Ferrigno, E. Crawford, L. Stella
(Submitted on 26 Sep 2013 (v1), last revised 17 Feb 2014 (this version, v2))
Jets from rotation-powered pulsars have so far only been observed in systems moving subsonically through their ambient medium and/or embedded in their progenitor supernova remnant (SNR). Supersonic runaway pulsars are also expected to produce jets, but they have not been confirmed so far. We investigated the nature of the jet-like structure associated to the INTEGRAL source IGR J11014-6103 (the "Lighthouse nebula"). The source is a neutron star escaping its parent SNR MSH 11-61A supersonically at a velocity exceeding 1000 km/s. We observed the Lighthouse nebula and its jet-like X-ray structure through dedicated high spatial resolution observations in X-rays (Chandra) and radio band (ATCA). Our results show that the feature is a true pulsar's jet. It extends highly collimated over > 11pc, displays a clear precession-like modulation, and propagates nearly perpendicular to the system direction of motion, implying that the neutron star's spin axis is almost perpendicular to the direction of the kick received during the supernova explosion. Our findings suggest that jets are common to rotation-powered pulsars, and demonstrate that supernovae can impart high kick velocities to misaligned spinning neutron stars, possibly through distinct, exotic, core-collapse mechanisms.
Comments: 8 pages, 6 figures, 1 table. Discussion (sec.3) expanded and typos fixed; results unchanged. Published on A&A

CHANDRA X-RAY OBSERVATORY
NASA's flagship mission for X-ray astronomy.
Home About Chandra Education Field Guide Photo Album Press Room Resources Multimedia Podcasts Blog Research
IGR J11014-6103: Runaway Pulsar Firing an Extraordinary Jet
The Basics
What is it?
How Far Away is it?
How is it Made?
How Big is it?
What do the Colors Mean?
Where is it Located?
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THE ART OF BEING MINDFUL
Billion Dollar Bracket Challenge with YAZOO SPORTS
Home NewsFeed U.S. Politics World Business Tech Health Science Ent
SPACE
Caught on Camera: Supernova Spits Out Pulsar
of a stellar explosion zips through space—and sends us signals as it goes
Lentrick Feb. 19, 2014 8 Comments
For a cosmic adrenaline rush, it's hard to beat a supernova. It happens when a star detonates at the end of its life, blasting gases and other debris outward with unimaginable violence. The explosion is so powerful that for a few days at least, a single supernova can outshine an entire galaxy of 100 billion stars or more. And when the dust finally settles, so to speak, what's left behind (depending on the original star) might be a neutron star—an object so dense that a teaspoon's worth would weigh 10 million tons—or even a black hole.

Press and image releases:

- New release every other week
- *Includes:* Text, images, background info.

Also: illustrations, podcast, blog posts, press conference

Promoted with:

- Chandra webpage, NASA and AAS press lists, social media, email


Goals include:

- Be *accurate, clear, concise and engaging*, and reach a large audience

Quality, clarity and reach:

- Include reviews by authors, CXC, NASA
- Well-designed webpage:

IGR J11014-6103: Runaway Pulsar Firing an Extraordinary Jet



[View Wavelengths](#) [Composite](#) [X-ray](#) [Radio](#) [Optical](#)

The Basics

- [What is it?](#)
- [How Far Away is it?](#)
- [How is it Made?](#)
- [How Big is it?](#)
- [What do the Colors Mean?](#)
- [Where is it Located?](#)

Rate This Image

★ ★ ★ ☆ ☆
Rating: 3.7/5
(179 votes cast)

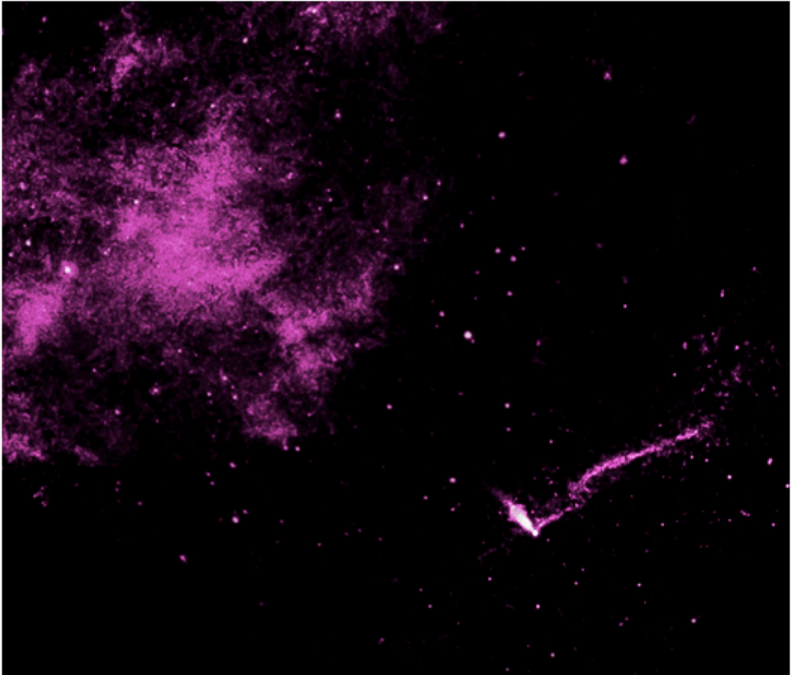
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Quality, clarity and reach:

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IGR J11014-6103: Runaway Pulsar Firing an Extraordinary Jet






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View Wavelengths Composite X-ray Radio Optical

Quality, clarity and reach:

- Include reviews by authors, CXC, NASA
- Well-designed webpage:

IGR J11014-6103: Runaway Pulsar Firing an Extraordinary Jet



The Basics

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- How Far Away is it?
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Rate This Image

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View Wavelengths Composite X-ray Radio **Optical**

Quality, clarity and reach:

- Include reviews by authors, CXC, NASA
- Well-designed webpage:

IGR J11014-6103: Runaway Pulsar Firing an Extraordinary Jet



X
A pulsar found racing away from a supernova remnant about 15,000 light years from Earth.




The Basics

- What is it?
- How Far Away is it?
- How is it Made?
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- What do the Colors Mean?
- Where is it Located?

Rate This Image

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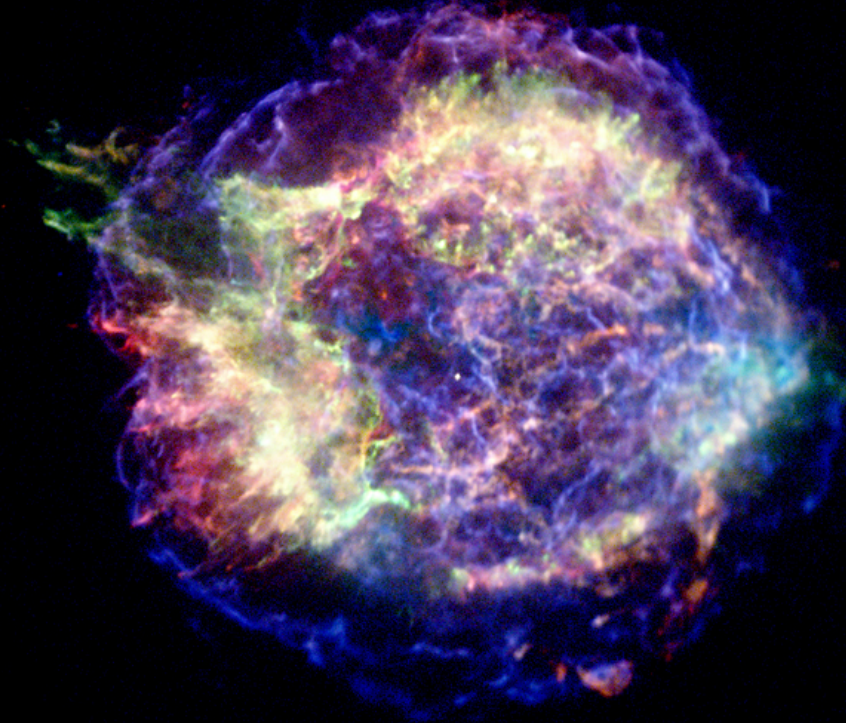
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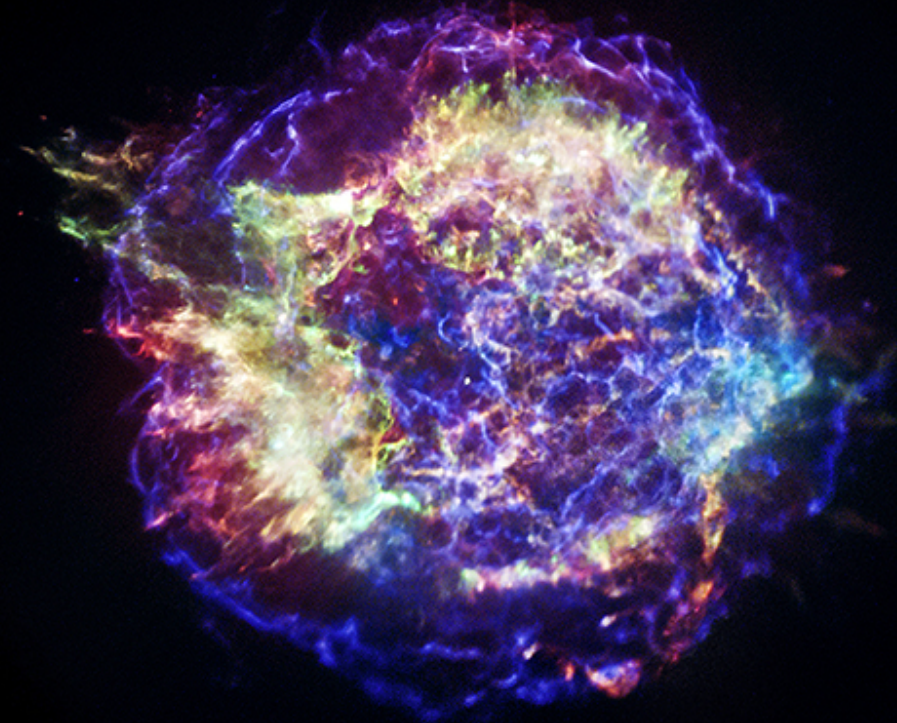
View Wavelengths Composite X-ray Radio Optical

Quality, clarity and reach (continued):

- Produce best possible images, applying advanced processing techniques
- 1st example: “tone mapping”



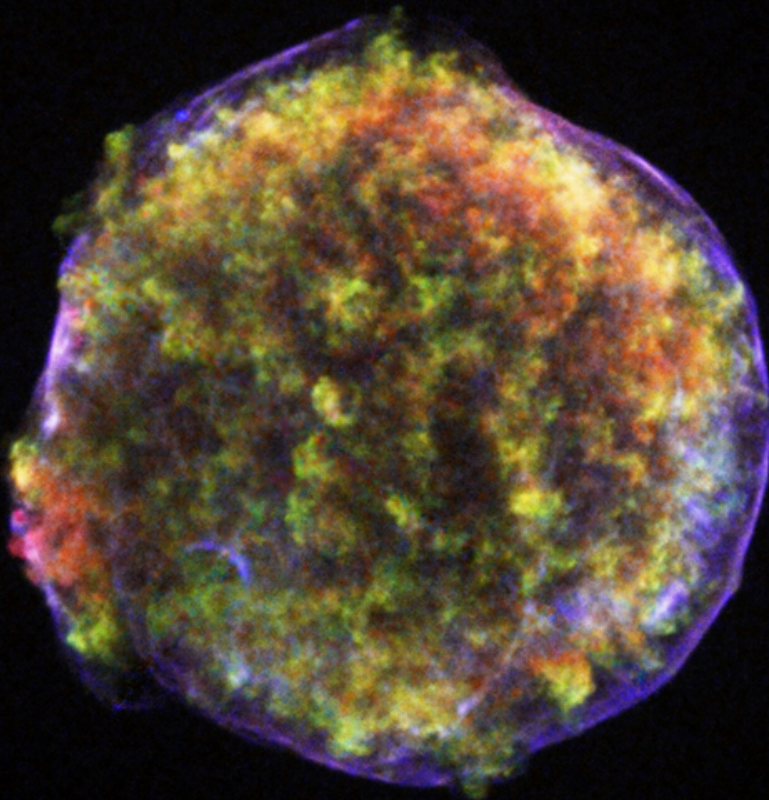
Before



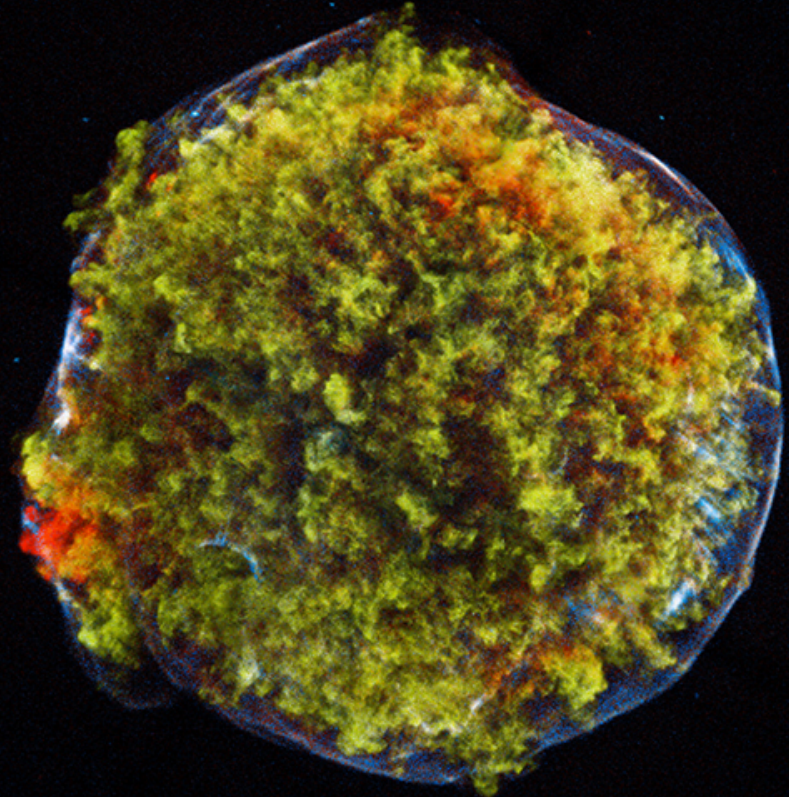
After

Quality, clarity and reach (continued):

- Produce best possible images, applying advanced processing techniques
- 1st example: “tone mapping”



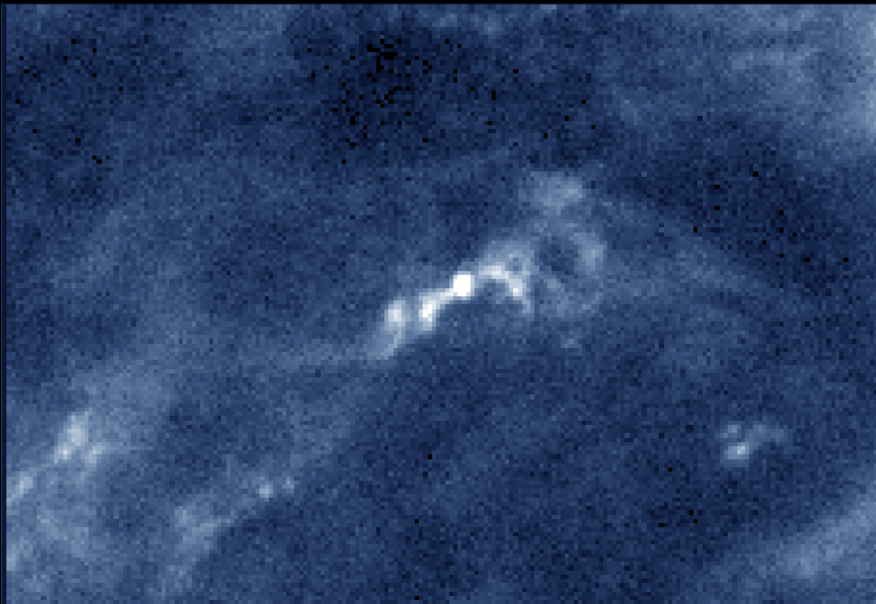
Before



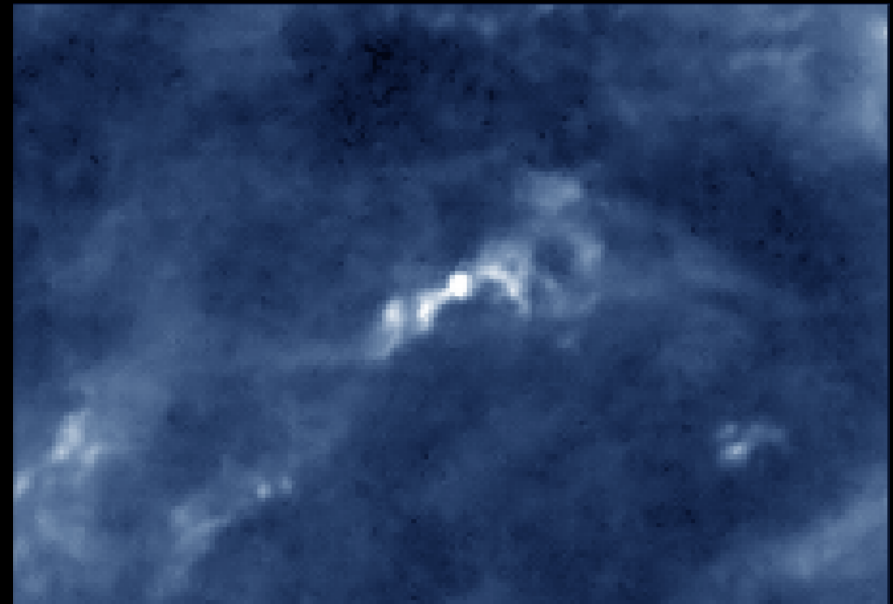
After

Quality, clarity and reach (continued):

- Produce best possible images, applying advanced processing techniques
- 2nd example: “Greycstoration”



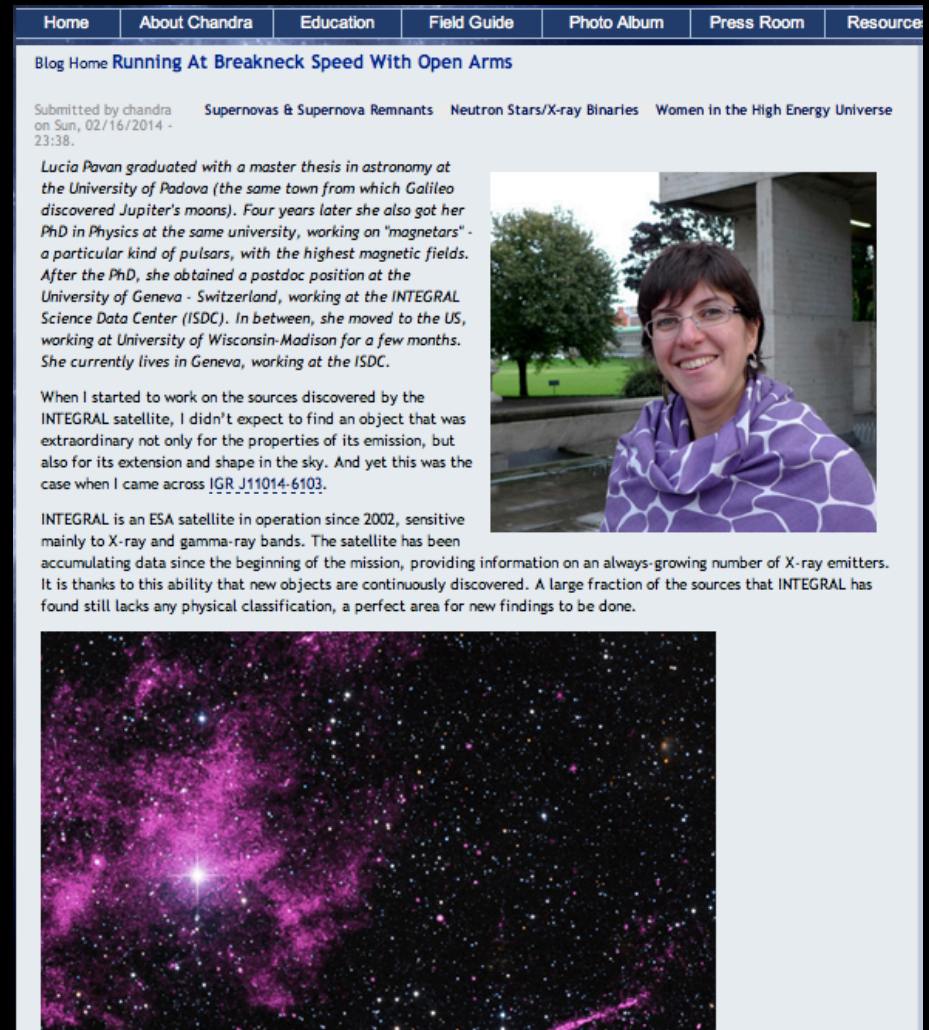
Before



After

Also crucial to be open, transparent, accountable:

- Blog post by 1st author
- Obvious, multiple links to text of science paper
- Show separate wavelength images
- I tweet about releases under my own name
- Maintain close interactions with science writers



The screenshot shows a blog post from the Chandra Science Center website. The navigation bar includes links for Home, About Chandra, Education, Field Guide, Photo Album, Press Room, and Resources. The post title is "Running At Breakneck Speed With Open Arms". It was submitted by chandra on Sun, 02/16/2014 at 23:38. The post includes a bio for Lucia Pavan, a photo of her, and text describing her work on magnetars and the INTEGRAL satellite. A large image of a star-forming region in purple and pink is at the bottom.


Home About Chandra Education Field Guide Photo Album Press Room Resources

Blog Home **Running At Breakneck Speed With Open Arms**

Submitted by chandra on Sun, 02/16/2014 - 23:38.

Supernovas & Supernova Remnants Neutron Stars/X-ray Binaries Women in the High Energy Universe

Lucia Pavan graduated with a master thesis in astronomy at the University of Padova (the same town from which Galileo discovered Jupiter's moons). Four years later she also got her PhD in Physics at the same university, working on "magnetars" - a particular kind of pulsars, with the highest magnetic fields. After the PhD, she obtained a postdoc position at the University of Geneva - Switzerland, working at the INTEGRAL Science Data Center (ISDC). In between, she moved to the US, working at University of Wisconsin-Madison for a few months. She currently lives in Geneva, working at the ISDC.



When I started to work on the sources discovered by the INTEGRAL satellite, I didn't expect to find an object that was extraordinary not only for the properties of its emission, but also for its extension and shape in the sky. And yet this was the case when I came across [IGR J11014-6103](#).

INTEGRAL is an ESA satellite in operation since 2002, sensitive mainly to X-ray and gamma-ray bands. The satellite has been accumulating data since the beginning of the mission, providing information on an always-growing number of X-ray emitters. It is thanks to this ability that new objects are continuously discovered. A large fraction of the sources that INTEGRAL has found still lacks any physical classification, a perfect area for new findings to be done.



KEY FEATURES OF PROGRAM

- High quality presence driven by science results
- Accessible to non-elite audiences
- Cross-cutting programs promote creative thinking, add relevance, support collaborative practices
- Cycle of research & evaluation informs practice at all points of program creation

HIGHLIGHTED IMPACTS

- Trusted, valuable science resource
- 10s of millions of participants served
- Learning gains, increased interest in astronomy
- Network of practitioners created and sustained

Goals: Opening access, sharing new discoveries with diverse audiences, engaging the imaginations of students, teachers, & the greater public, & increasing learning opportunities



Scaffolded Digital Presence Serves Multiple Audiences

USER - DRIVEN

INTERACTIVE

DYNAMIC

ACCESSIBLE

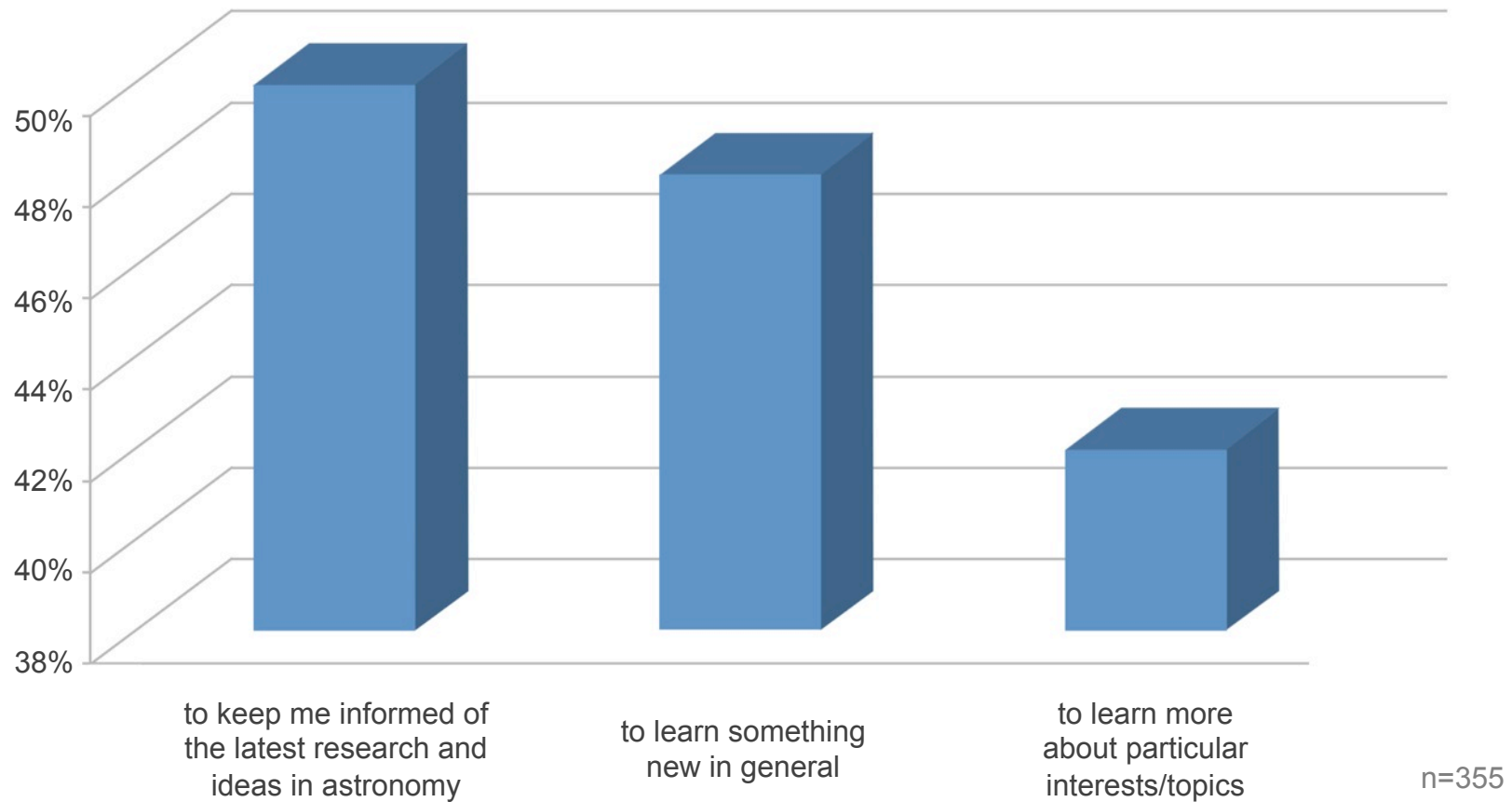
SOCIAL MEDIA INTEGRATION

The image displays a composite of digital content for the Chandra X-ray Observatory. At the top is the website header with the NASA logo and the text "CHANDRA X-RAY OBSERVATORY NASA's flagship mission for X-ray astronomy." Below this is a navigation menu with categories like Home, About Chandra, Education, Field Guide, Photo Album, Press Room, Resources, Multimedia, Podcasts, Blog, and Research. A secondary menu allows users to "Choose the type of information that interests you" with options for Everyone, Kids, Students, Educators, Planetariums, and Scientists. The main content area features a "SPACE SCOOP" banner with a satellite image and a featured article titled "CIRCINUS X-1: Supernova Blast Provides Clues to Age of Binary Star System". Below the banner are sections for "Learn About" (Stars, Light, Inertia, Speed, Height) and "Connect" (Chandra Mobile). A "Latest" section lists various resources like a podcast, interactive content, a handout, and a glossary. A "Space Fun" section includes infographics and "Hot Stories of Science". A "Photo Album" section offers images categorized by Science Category, Date, Photo Blog, and Sky Map. At the bottom, there are links for "Chandra mobile", "Help", "Site Map", and "Image".

Below the website is a screenshot of the Chandra Observatory's Twitter profile. The profile name is "Chandra Observatory" with the handle "@chandraxray". The bio states: "Chandra's ongoing mission is to study the X-ray Universe. Operated for NASA by SAO. Privacy Terms: sl.edu/TermsOfUse In orbit - chandra.si.edu". The profile shows 68.3K tweets, 145 followers, and 49K following. Recent tweets include congratulations to the #BICEP2 team and a tweet about the "PROTONS/NEUTRONS/ELECTRONS" that make up stars/planets. A tweet image shows a jar of stars and a diagram of a star's internal structure.

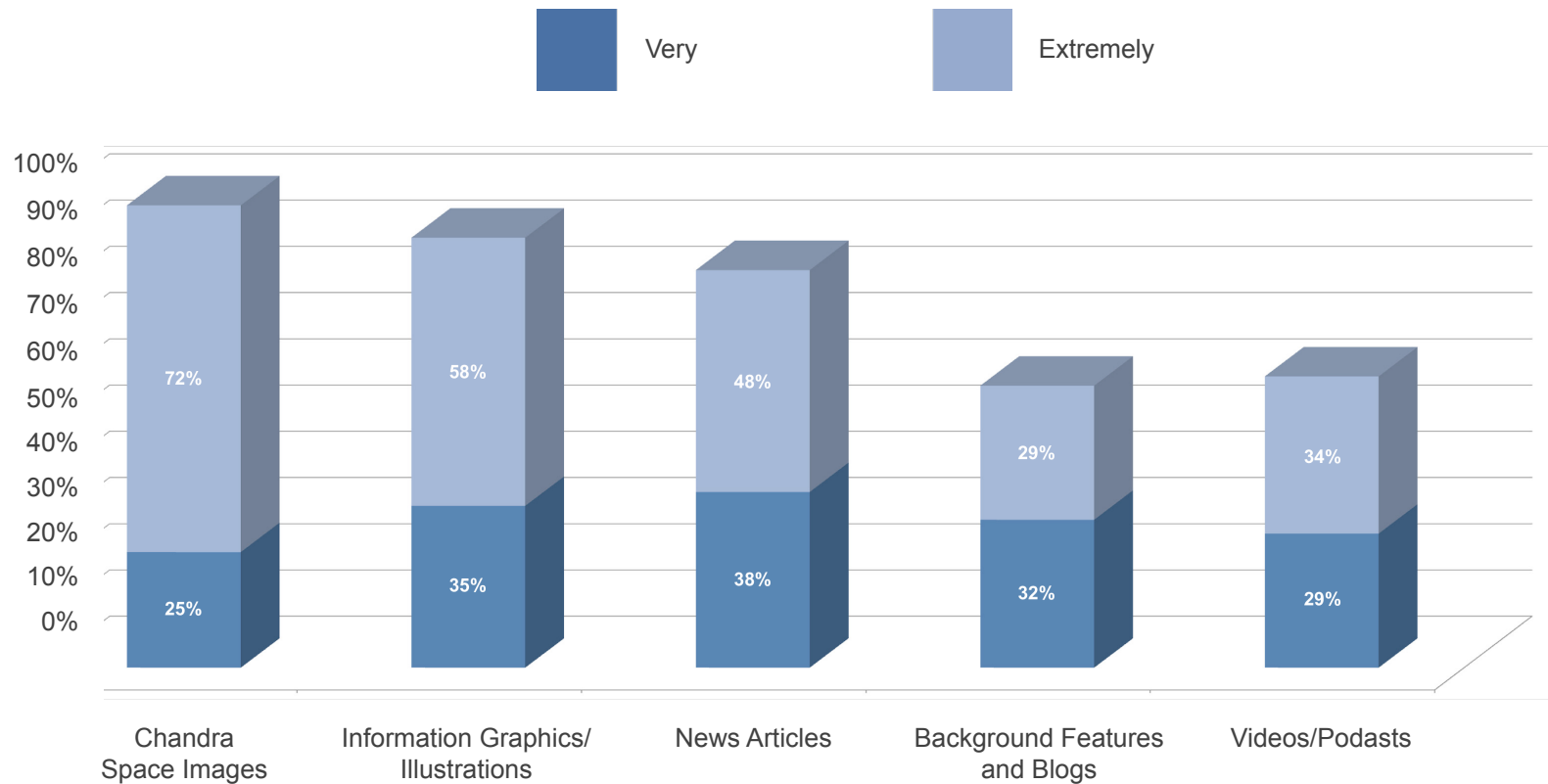
Why do you visit chandra.si.edu?

14a



“ I love your whole web site - news, videos - and the field guide stuff is the best. I have learned more here than I ever did in high school and college. Keep up the awesome work. Thank you.”

To what extent has your purpose of visiting the Chandra website been fulfilled?



“ This site really is a gem of the internet that continues to share the discoveries of this magnificent telescope.”

“ The pictures are stunning and the science is indispensable. Please share more.”



Neon Sign.

In a neon sign, an electric current runs through a tubular glass fixture that is filled with gas. This electric current causes collisions between the electrons and atoms in the neon gas. When various electrons relax, the energy released produces light that has a very specific color that invite us through the diner door.

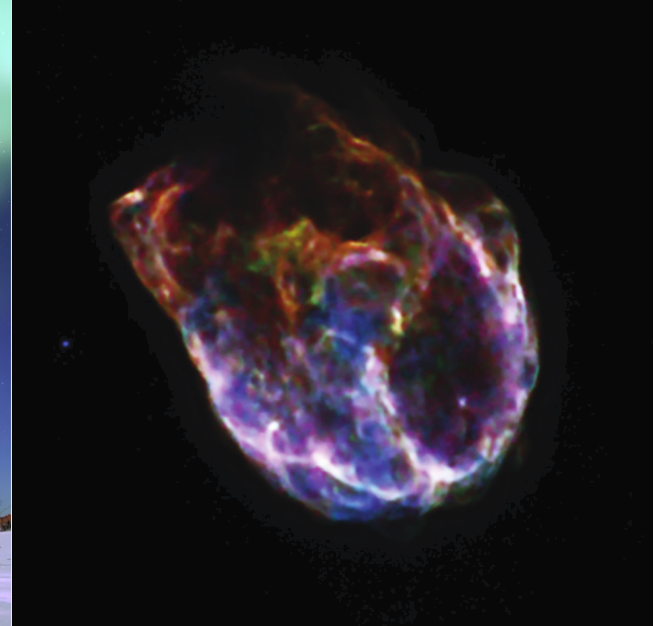
(Credits: Wikimedia Commons)



Aurora.

Streams of particles with electric charge are continually leaving the Sun and traveling through the Solar System. As these particles approach the Earth, some of them are channeled by the planet's magnetic field toward the North and South poles where they collide with atoms in the Earth's atmosphere. This produces the famous light shows we call auroras, or, more commonly in the Northern Hemisphere, the "Northern Lights."

(Credits: Wikimedia Commons)



Supernova Remnant.

When a massive star explodes, it generates an outgoing blast wave that travels through the space around the now-dead star. This wave heats the gas in this region to a temperature of several million degrees, making the molecules and atoms in the gas vibrate and collide. When the electrons in this superheated gas relax, they release their excess energy mostly in the form of X-ray light.

(Credits: NASA/CXC/NCSSU/K.J.Borkowski et al.)

ATOMIC LIGHT SHOW Atoms, the building blocks of matter, are constantly in motion, moving around at speeds that are thousands of miles per hour at room temperatures, and millions of miles per hour behind a supernova shock wave. In a collision of an atom with another atom, or with a free-roaming electron, energy can be transferred to the atom. This extra energy can then be released in the form of a light wave.

www.nasa.gov

<http://hte.si.edu/atoms>

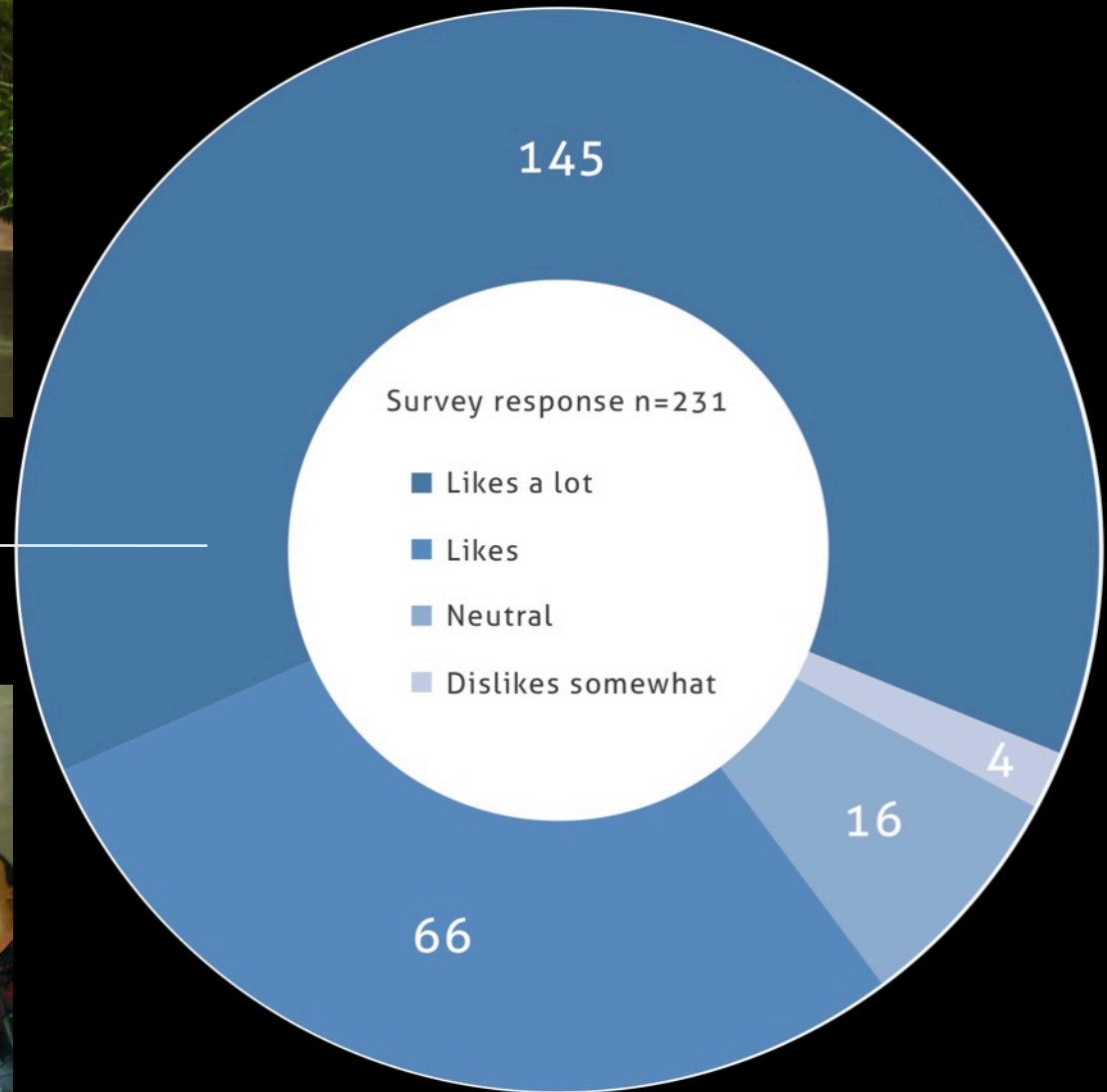
**BECAUSE WHAT HAPPENS HERE,
HAPPENS THERE,
HAPPENS EVERYWHERE.**



How Did Participants Feel About Their Public Science/FETTSS Experience



“Beautifully done.
Am coming back.”



Best Practices for Interdisciplinary Public Science with Multiple Audiences

Leadership in astronomy/science communications research, including creation and adaptation of "public science"

International research program conducting image and meaning studies

Results directly inform practice (see previous slides):

- 14 articles in peer-reviewed professional journals
- numerous conference proceedings, posters, invited presentations, articles/blogs

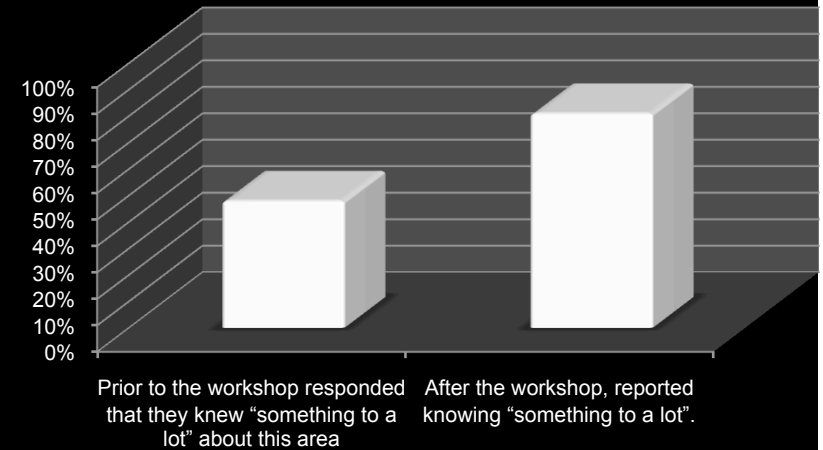
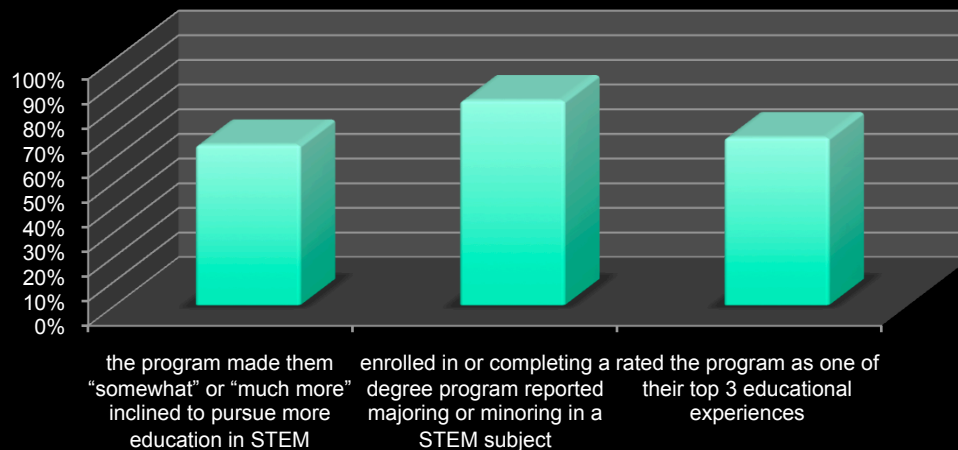


Goals

- Provide educators with the standards-based resources and knowledge to infuse NASA SMD content into their activities and classrooms.
- Develop materials and activities that give students authentic science experiences to understand the process of science including tools to analyze Chandra data
- Increase student interest in NASA SMD science and STEM subjects.

Outcomes

- Educators have increased ability to use NASA SMD content in formal and informal education.
- Increased participation and retention of students in STEM subjects.



Selected programs

- Materials and activities give students authentic science experiences
- Teacher Professional Development workshops at National Science Teachers Association conferences: evaluations show participant satisfaction and learning gains.
- National Science Olympiad: teams starting at local levels in all 50 states. Over 100,000 participants yearly. Chandra educators include NASA content in astronomy competitions and study materials, hold coaches clinics.
- STOP for Science: in 250 schools distributed across 41 states, plus D.C and APO's; incl. 18 of lowest performing US school districts.

CHANDRA EDUCATION DATA ANALYSIS SOFTWARE AND ACTIVITIES

Chandra Ed. Home Page | Installation | Learning ds9 | Activities & Images | Evaluation

[Contact Help] [Chandra Public Page]

New Users

Before you access this system, you may want to read about the Chandra X-Ray Observatory Mission and science on the Chandra public outreach page. Helpful links are:

- [Chandra 101](#): a short summary of the mission
- [Chandra Mission](#): a detailed description of the mission.

If you are a new user of this system, follow the steps linked below, in the order listed, to install and familiarize yourself with the system software before going to the images and analysis activities.

Step 1: [Install the system](#)
Step 2: [Learning ds9](#)
Step 3: [Images & Analysis Activities](#)

Chandra Education Data Analysis Software And Activities

Welcome to the home page for the Chandra Education Data Analysis Software and Activities. The system linked from this page allows educators, students, amateur astronomers and the general public to perform X-ray astronomy data analysis using data sets from the Chandra X-ray Observatory, the "ds9" image display program, and astrophysical software analysis tools.

Our goal is to provide a system that allows you to experience much of the same analysis process that an X-ray astronomer would follow in analysing the data he or she has received from a Chandra Observation.

Experienced or returning users who have already installed the "ds9" imaging system on their computers should first check the [system update link](#) to see if any upgrades affect their installation. Then they may visit the section of their choice using the navigation bar above.

Note: If your version of ds9 is more than a year old, please upgrade at your earliest convenience. Details on how to do so can be found on the [Install the system](#) page.

Evaluation

After you have used this system, we would be very interested in your comments. We hope you will help us with suggestions for improvements and further developments, particularly ways to make the material more appealing and accessible to students. [Access the comment and evaluation form.](#)

openFITS

unlocking the mysteries of astronomical image processing

With a basic understanding of astronomical data and image processing software, you can create your own astronomy images from FITS files. "FITS" which stands for Flexible Image Transport System, is a digital file format used mainly by astronomers. Check out chandra.si.edu to download FITS files for some of our favorite Chandra images and learn how to compose your own versions of these high-energy astronomy images.

Data available at:
<http://chandra.si.edu/photo/openFITS>

Example data:
<http://chandra.si.edu/photo/openFITS/crab.fits> Software - GIMP v2.8
<http://www.gimp.org>

1 OPEN & CHANGE MODE
 Open your FITS file in GIMP using File>Open. GIMP has a built-in FITS reader and you should be able to use the default settings.

2 ADJUST LEVELS
 Your first view of the image will very dark. Even though GIMP automatically rescaled the FITS data, the image still needs to have its pixel levels adjusted.

Open the Levels dialog box by selecting Colors>Levels and feel free to adjust the small images under the histogram plot in "Input Levels" to your liking.

The trick with adjusting the levels at this stage is to bring out faint details in the object but maintain the amount of background "noise" in the image. Play around with the sliders and see how subtle changes in the levels affect the image.

COLOR IN ASTRONOMY

The colors we see with our eyes are the result of how the human eye and brain perceive different wavelengths of light in the visible part of the electromagnetic (EM) spectrum. The variety of the human eye is designed to be based on the varying availability of photons in the visible light of different wavelengths. The EM spectrum extends beyond visible light in both longer and shorter wavelengths which are not perceived by the human eye. X-ray light is light of a much higher energy than the eye can perceive, while infrared light has a longer wavelength than visible light. Much of what we see in astronomical images has been "translated" into light that we can see with our eyes. Typically referred to as "false color" the use of astronomical imagery are more coded to render their colors we can see.

Decoding Starlight: From Pixels to Images

Decoding Starlight is a classroom activity that helps students better understand the scientific practices associated with imaging. The activity combines data analysis with image creation and interpretation. Students work through the activity tasks without the aid of automation, thereby facilitating understanding of both how computers normally conduct the analysis and why scientists use computers for imaging. This article first discusses some fundamentals of how scientists and technicians create astronomical images and how imaging is a scientific process. The article then introduces the basics of the activity and how Decoding Starlight can be used in the classroom. Finally, the article concludes by presenting suggested next steps to further deepen student understanding of image analysis and evaluation.

Some Imaging Fundamentals

Astronomers, geophysicists, and many other scientists use imaging widely in their daily routines. Scientists employ images to achieve greater understanding of our universe, and also to engage students as well as the public in the scientific enterprise. In this way, imaging creates both scientific knowledge and increases scientific literacy. The Decoding Starlight activity uses data collected from NASA's Chandra X-ray Observatory, a spacecraft and telescope system that has been orbiting Earth since 1999, and helps students learn the fundamental processes of imaging that are common to many scientific disciplines.

Representative color

The Chandra X-ray Observatory gathers information about high-energy astronomical phenomena. From the data collected by the observatory, scientists and technicians have created literally thousands of images that are all available on the Chandra website (<http://chandra.harvard.edu>). The observatory collects information from X-rays, a type of light invisible to the humans. The question then arises: how are images of X-ray light made, and specifically, how are these images made so that they are scientifically meaningful?

THAT'S FAST!

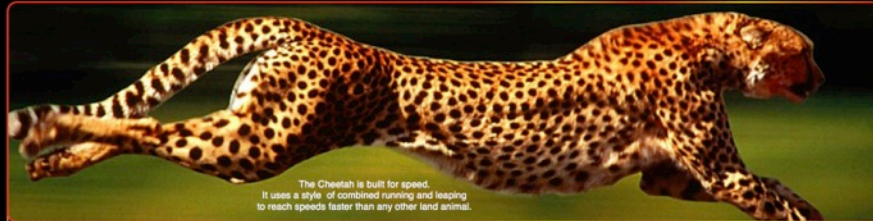


WHAT IS SPEED, AND HOW DO WE MEASURE IT?

A jet plane is fast, and a snail is slow. But what exactly does this mean? The **speed** of an object is defined to be the distance it will travel in a certain amount of time. If something travels 100 feet (or about 30 meters) in 10 seconds, its speed is 10 feet per second (ft/s), or 3 meters per second (m/s). We often talk about speeds in miles per hour (mi/hr, or mph) or kilometers per hour (km/hr).

STOP
for science

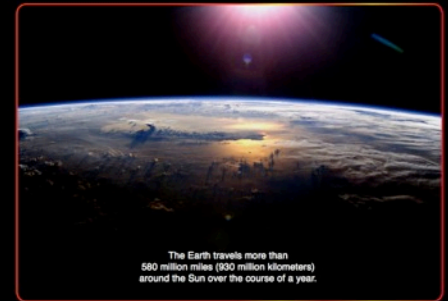
<http://chandra.si.edu/edu/stop/>



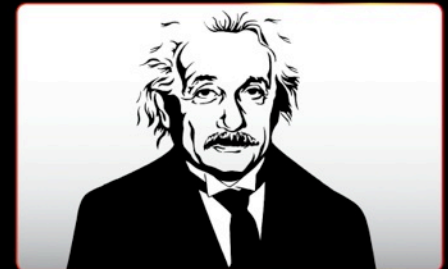
The Cheetah is built for speed. It uses a style of combined running and leaping to reach speeds faster than any other land animal.

HOW FAST, IS FAST?

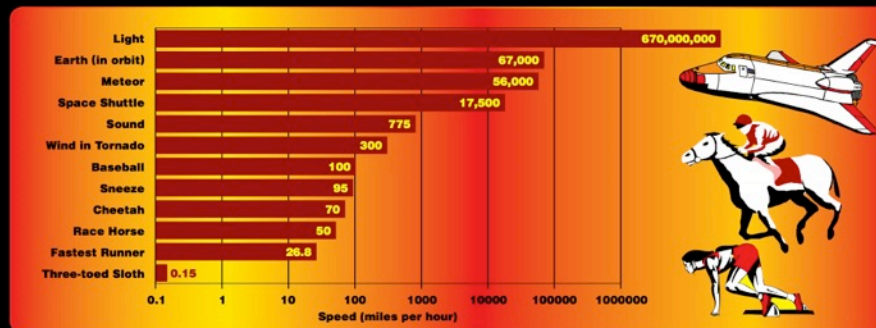
The fastest land animal is the Cheetah, which can reach speeds of 70 mi/hr (112 km/hr). This is fast, but not compared to how fast a pitcher can throw a baseball (100 mi/hr, or 160 km/hr). A Peregrine falcon is so fast that it could easily outrace a baseball; it can go up to nearly 200 mi/hr (320 km/hr). But this is a snail's pace compared to how fast the **Earth moves around the Sun!** Over the course of a year, the Earth travels more than 580 million miles (930 million kilometers). That's an average speed of about 67,000 mi/hr (107,000 km/hr)!



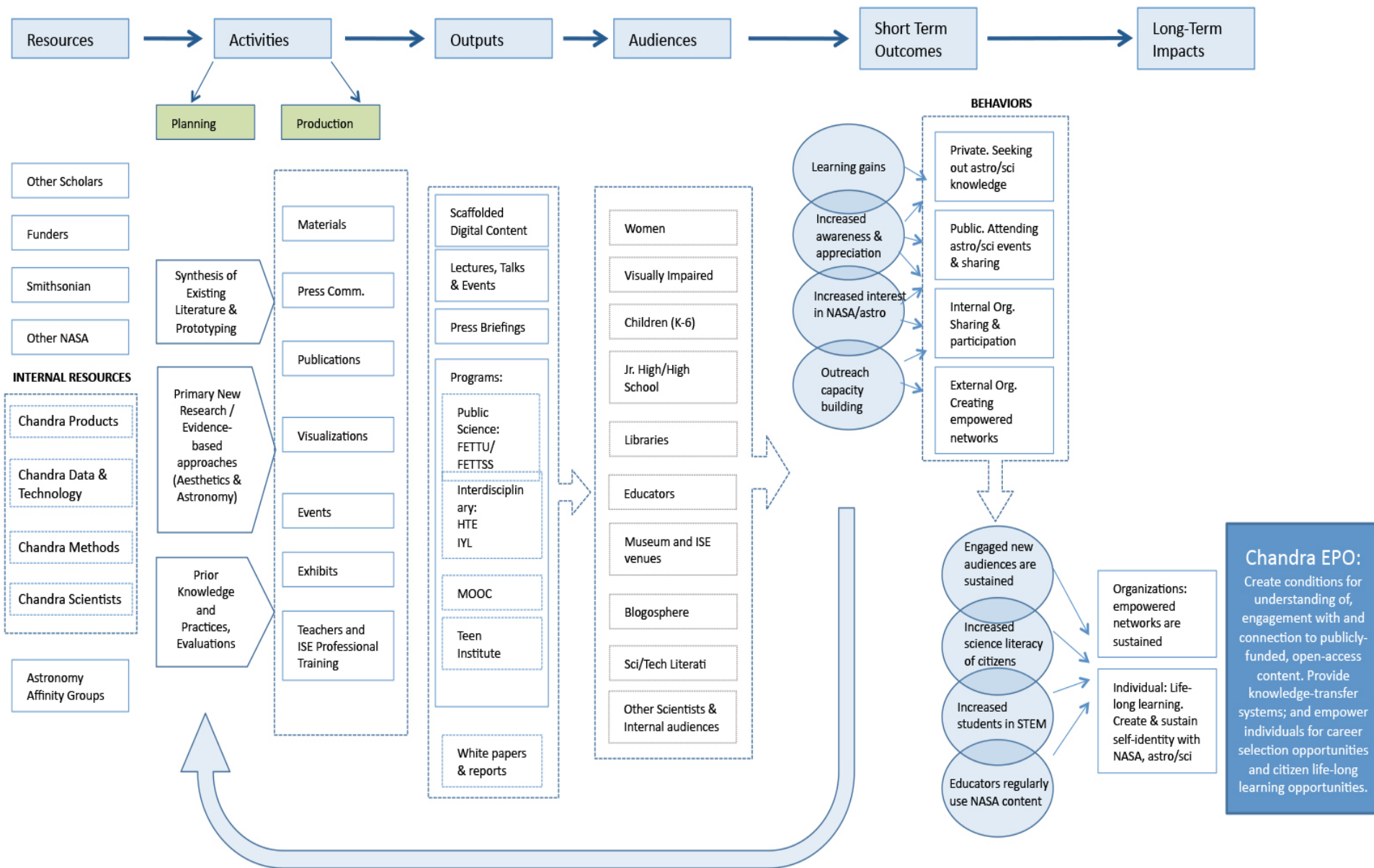
The Earth travels more than 580 million miles (930 million kilometers) around the Sun over the course of a year.



As part of his theory of relativity, Albert Einstein showed that nothing can be accelerated to speeds faster than the **speed of light** (186,000 miles/sec, or 300,000 km/sec); this is the speed limit for our Universe! This has been confirmed in many experiments. We can make things go fast, but only light (or other electromagnetic waves) can go this fast.



Creation Pipeline = Coordinated, Embedded Approach



Chandra EPO:

Create conditions for understanding of, engagement with and connection to publicly-funded, open-access content. Provide knowledge-transfer systems; and empower individuals for career selection opportunities and citizen life-long learning opportunities.

<http://chandra.si.edu/impact>