TJO Newsletter

The Newsletter of the Theodor Jacobsen Observatory
University of Washington

SPRING/SUMMER 2007

In this newsletter:

This newsletter is published 2 or 3 times a year. Articles are written by undergraduates in the Astronomy Department.

Prof. Paula Szkody, supervising editor

For more information:

http://www.astro.washington.edu/observatory/

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UW Radio Astronomy Project — by Jim Davenport

Palen Radio Observatory at the University of Washington

The first thing one should understand about radio astronomy is that there are no headphones. The movie Contact with Jodi Foster gave many people the impression that radio astronomers simply sit around waiting for ET to whisper in their ears. Radio as we understand it in our daily lives, involves a simple antenna attached to the trunk of our car. Simply turn it on and music come spilling out. Radio astronomy must make use of more sophisticated equipment and computers, and of course there are no headphones. To that end, this is the story of a telescope (just a fancy antenna) and the students who have helped bring it to life.

Radio telescopes work in much the same way your satellite television works. Radio waves are just a form of low frequency light. Many things in the cosmos emit light at these radio frequencies, such as stars, galaxies, gas clouds, and planets like Jupiter. By pointing our dishes towards these distant sources, we can measure how much of this radio light they emit. We then use computers to decode the information from several radio telescopes to put together pictures of these objects.

In 2000, several undergrad students here at UW decided it was high time we had access to a radio telescope. No member of the faculty here has been involved in major radio telescope use in some time. Money was raised and supplies purchased, but the project never saw completion. These students graduated (and most have gone on to do very well in astronomy) and the radio telescope sat quietly, abused by the rain of Seattle.

Two years ago, a new group of students took up the reins, breathing life back into the project. The first order of business was to pick up where the original group left off. A new grant was written to fund the necessary parts to make the telescope operational. After about a year of work, the Palen Radio Observatory, or PRO, came online at the UW campus.

Sitting on a windy rooftop, PRO uses a remote-control computer system to operate. Students can access the telescope, record signals, and download the data from the site all on their personal computers at home. This convenient setup allows PRO to be used to edu-

The Brewster Radio telescope at Brewster, Washington

UW Radio Astronomy

cate students as well as for undergraduate research. Currently students are working on writing software for the telescope, completing a map of the whole sky in radio frequencies, and looking at the rotation of the Milky Way! The PRO project has given over 20 students from many departments a chance to learn about a unique and fascinating piece of astronomy.

For three years now, undergraduates have driven to the little town of Brewster, Washington for a radio telescope tour. Tucked away in the orchards and rolling hills of Brewster is one of the Very-Long-Baseline-Array (or VLBA) Telescopes. Towering at over 80 feet in diameter, the Brewster radio antenna is an impressive facility. Currently the VLBA is the world's largest radio telescope array, stretching from Hawaii to the Virgin Islands. The Brewster site is the northernmost one in the array.

Because of this interest, and the wonderful support from the faculty and staff in the Astronomy and Physics departments, radio has become a growing part of the atmosphere at UW. Next year a radio astronomy course will be taught for the first time in years. More trips to Brewster are scheduled for the newest generation of students using PRO. Radio astronomy is finally set to be a lasting part of the curriculum here at UW.

For more information, please visit:

http://www.astro.washington.edu/undergrad/radioastro/

Comet McNaught: a Glimpse of the Outer Solar System

by Shannon Schmoll

The University of Washington is no stranger to the beauty and richness of comets as shown by Don Brownlee's Stardust mission. However, Seattle was in for a rare and wonderful treat a few months ago when Comet McNaught flew through the skies. The comet drew crowds of amateurs, professionals, and astronomy enthusiasts into the winter cold at sunset around the world this past January.

For the several nights that McNaught was visible from Seattle, people gathered around the Physics/Astronomy Courtyard on the UW campus, eager to catch a glimpse of this comet with binoculars and small telescopes. When the temperature got to be too cold, many headed to the Physics and Astronomy Library to remain cozy.

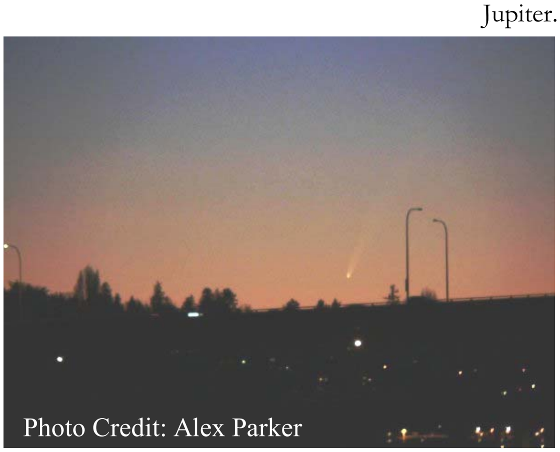


Photo Credit: Alex Parker

Comet McNaught was amazing in that it was the brightest comet to be seen in over 40 years. It was so bright, in fact, that it could be seen with the naked eye. Comets have highly eccentric orbits that carry them from the outer reaches of the solar system, to the inner regions and back out again. During its closest approach, Comet McNaught was a mere 0.17 Astronomical Units (1 AU is the distance between the Earth and Sun) away from the Sun, twice as close as Mercury, the planet nearest the sun. The close proximity to the Sun caused the comet to peak at a brightness of -3.0 magnitudes, ten times brighter than Jupiter.

The comet was first discovered on August 7, 2006 by Astronomer Rob McNaught at the Siding Spring Observatory in Australia. This particular comet marked the 29th comet found on that telescope and the 31st comet discovered by McNaught himself.

This comet will not return for many years to come. Another exciting green comet, Comet Lovejoy, was seen in early May from the Northern Hemisphere. There is almost always a comet in the sky, but usually in order to view them, you will need a telescope.

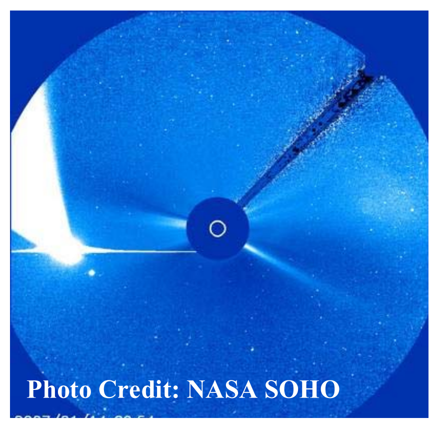


Photo Credit: NASA SOHO

Comet McNaught as seen by the SOHO satellite

http://sohowww.nascom.nasa.gov/

For More Photos of Comet McNaught:

http://www.spaceweather.com/comets/gallery_mcnaught.php

To check to see if there are any comets in the sky:

http://www.skyandtelescope.com/observing/highlights

Monster in the Milky Way: the Black Hole in the Galactic Center

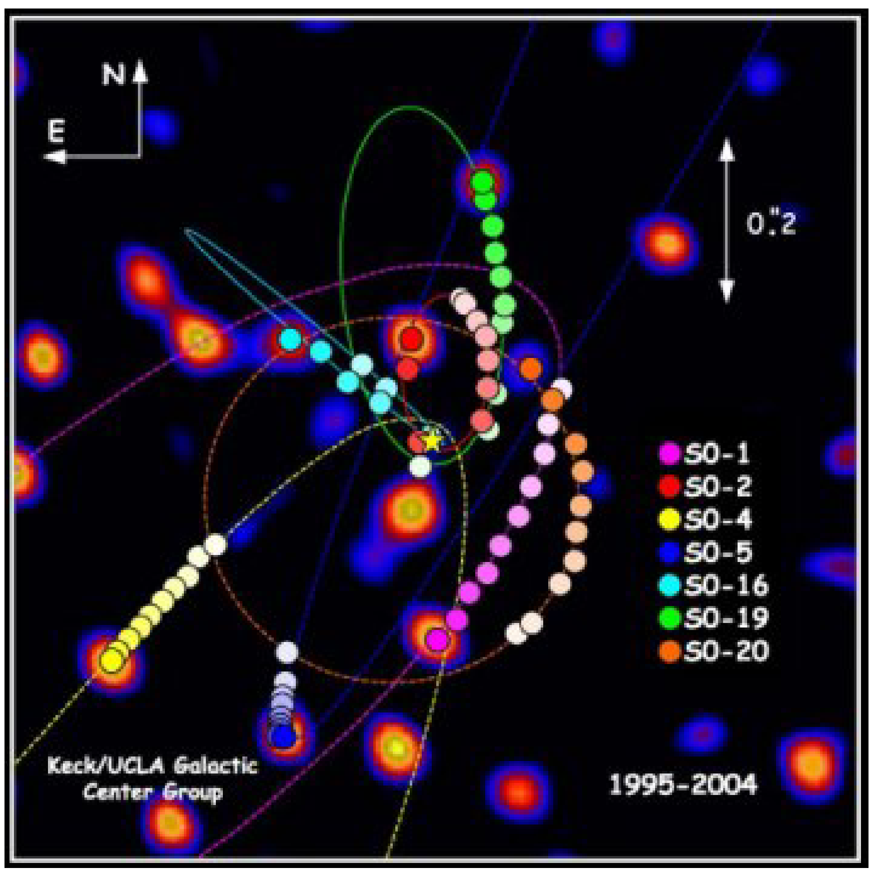
by Ben Cowin

In a similar fashion to how the Earth orbits the Sun, the Sun also orbits around the center of the galaxy. Once every 240 million years the Sun completes a single revolution, a period of time known as the galactic year. Last time the Sun passed through our part of the galaxy, the age of dinosaurs was just beginning and the Earth's continents were combined together to form one giant supercontinent. The Sun's orbit through the galaxy takes place on truly cosmic distance and time scales. One question that astronomers have pondered is what sort of object the Sun is actually orbiting. Is it circling some sort of single, supermassive central body, or is it orbiting around a cluster of stars at the center of our Sun's orbit? To answer these questions astronomers have studied the region at the very center of our Milky Way galaxy, known as the Galactic center (abbreviated as GC).

This center of the Sun's orbit is at a distance of 26,000 light years away (one light year is the distance that light travels in one year; for comparison the Earth's orbit around the Sun has a radius of 1/100000 of a light year). Studying the GC has provided astronomers with a unique set of challenges. Since it is in the very center of our galaxy, there is a great deal of dust, gas and stars between us and the GC. The dust absorbs light in the visual part of the spectrum (the portion that our eyes are adapted to see), making observations impossible with a normal telescope. Astronomers must instead work with other wavelengths of light, such as radio, infrared and x-ray. Using these tools, astronomers have built up a picture of the complex and dynamic region at the middle of our galaxy, which has many interesting features.

If you were living on a planet near the Galactic center, there would probably be a lot of bright stars in your sky. This is because the density of stars is much higher in the GC (by a factor of about 50 million!). There would be many nearby stars that you could see, but distant stars would be completely obscured by gas. If you looked in radio wavelengths, your sky would be filled with a myriad of different structures. Long, filament-like strands would be visible, which are believed to trace out the direction of the magnetic field. Many other radio sources could be identified as the shocks created by recent supernovae. Scientists predict that in about 200 million years, the density of gas will have reached a critical point, igniting a massive wave of star formation that will result in a huge number of supernovae in the GC region. In the center of this inferno can be found the most powerful and elusive object of all, a black hole with more than two million times the mass of our Sun.

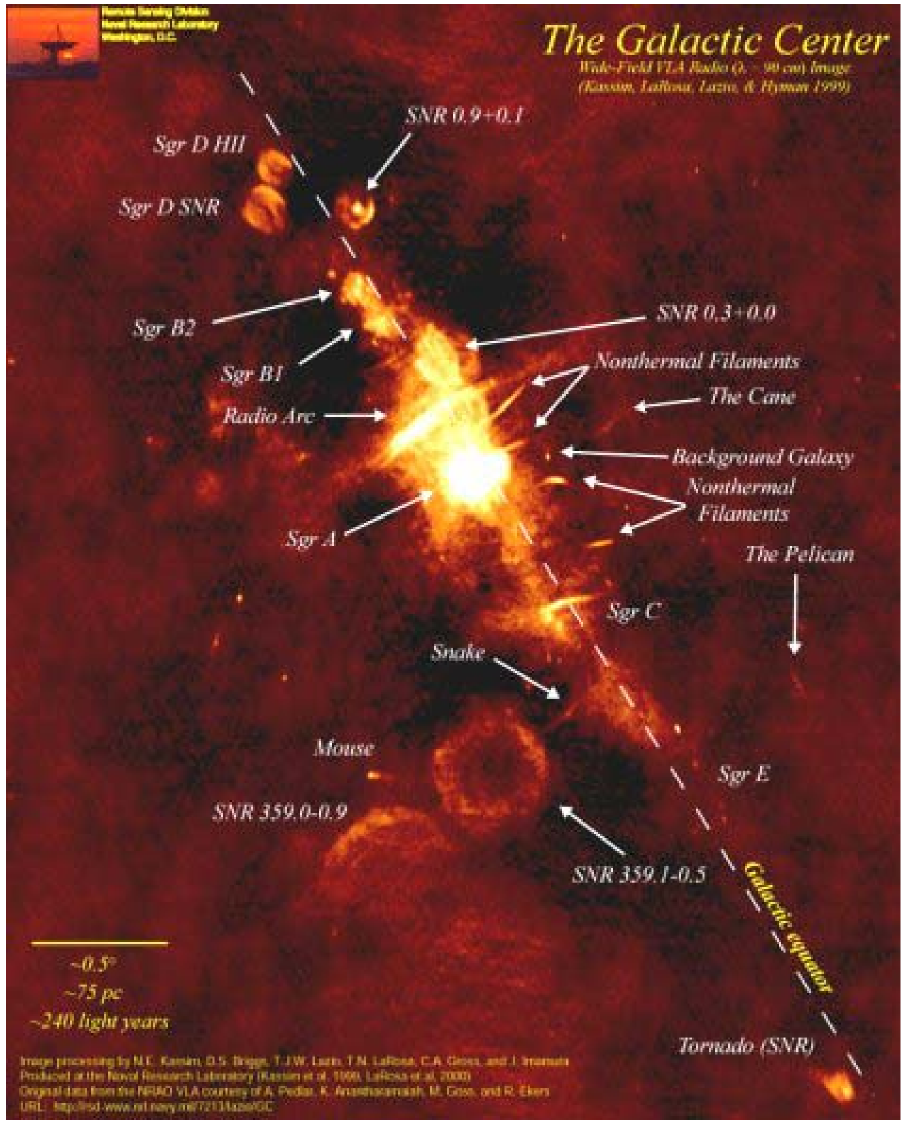
A black hole is an object whose mass is so large that it collapses into a single point from the strength of its own gravity. One of the most well-known properties of a black hole is that if matter gets too close to it, it will get "sucked in" to the black hole. In fact, even light can't escape from the gravity of a black hole. If black holes absorb light rather than emitting it like a normal stars, how can astronomers tell that there is a black hole at the center of our galaxy? There are typically two different ways to detect the presence of a black hole. First, astronomers can sometimes detect the matter that is being "sucked in" to the black hole, since it will emit light as it is accelerated inwards. Second, astronomers can also look for the intense gravitational effects of the black hole.



Above: The motion of stars in the Galactic center that provided evidence favoring the existence of a supermassive black hole. This image was created by Prof. Andrea Ghez and her research team at UCLA and is from data sets obtained with the W. M. Keck Telescopes. Source: http://www.astro.ucla.edu/~ghezgroup/gc/pictures/orbitsOverImage04.shtml

Galactic Center

In the case of the Galactic center, both methods were used. The most prominent radio source in the Galactic center region is known as Sagittarius A* (Sgr A*), whose image was used to determine that its size is much smaller than the size of our solar system. However, when astronomers looked for this source in other wavelengths, they couldn't find it. This eventually led to the proposal that the source was actually a black hole, emitting radio waves as matter falls in. In recent years, two groups have been observing stars in a cluster near the radio source. By observing in the near-infrared, they have been able to track the motion of these stars over a period of several years. The center of these orbits coincide with Sgr A*. From the motion of these stars, it is possible to determine the mass of the object that they are orbiting by using Kepler's law. From these observations, astronomers have concluded that the galaxy's central black hole is 2.6 million times as massive as our Sun. These observations have also allowed astronomers to gain a better understanding of other galaxies in the universe. We now know that there is a central black hole in our galaxy, and we have been able to detect supermassive black holes in other galaxies uch as M82 as well.



Above: A radio image showing some of the various structures in the Galactic center. "This image shows the central 4° x 4° of the Galaxy at a radio frequency of 330 MHz (wavelength 0.92 meters). (For comparison the full Moon is 1/2 degree in diameter.) It was produced from data acquired from the VLA's B-, C-, and D configurations…."

Source: http://rsd-www.nrl.navy.mil/7213/lazio/GC/

For more information on the Galactic center, check out these links:

http://antwrp.gsfc.nasa.gov/apod/ap001220.html

http://www.astro.ucla.edu/~ghezgroup/gc/?

http://www.mpe.mpg.de/ir/GC/index.php

The Bullet Cluster

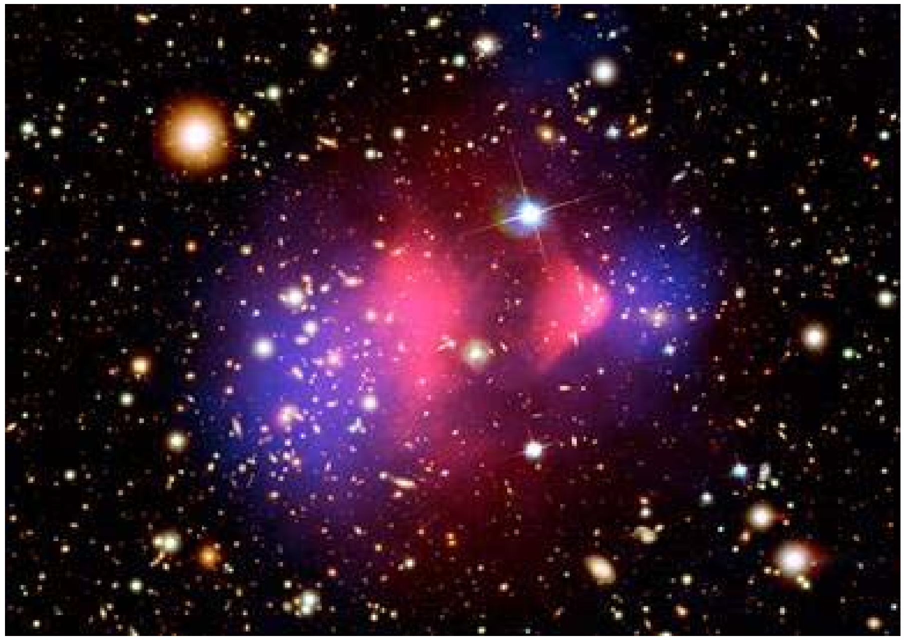
by Devin Silvia

At a distance of about 3.4 billion light years away, an astronomical object commonly known as the Bullet Cluster has recently provided scientists with the most direct evidence so far of the existence of dark matter. This discovery was first announced in August of 2006 with observations from NASA's Chandra X-Ray Observatory.

The question as to whether or not dark matter truly exists in our universe has been a topic of discussion in the world of astrophysics for several decades. The first scientists who argued for the presence of dark matter used it as a means to explain the extra gravitational forces necessary to hold together many of the structures in our universe. More simply put, when astronomers make observations of galaxies or clusters or galaxies and add up all of the mass that they can see, they come up short. Based on these observations, arguments have been made that there must be some form of additional matter contained within these astronomical structures that does not emit or reflect light, which is why we can't see it. Without this matter and its gravitational pull, galaxies and clusters of galaxies would come flying apart.

Over the years more and more studies have been carried out to figure out just how much of this mysterious dark matter exists in our universe, and from these efforts scientists now believe that roughly 22% of our universe is made up of dark matter. This comes across as an astounding amount when we are then told that normal matter, the "stuff" that you and I are made of, only accounts for 4% of the total.

Although dark matter provided a good explanation for what appeared to many as "missing matter", not everyone was immediately convinced. Additional theories were created to attempt to account for the effects of dark matter and so there arose a rift in the astrophysical world between competing theories. However, the dark matter theory took center stage when the observations of the Bullet Cluster hit the press.



A photo from NASA of the Bullet Cluster showing what is believed to be dark matter, which is represented in blue, while the hot x-ray gas in the middle, is represented in pink.

Source: http://chandra.harvard.edu/photo/2006/1e0657/1e0657.jpg

The Bullet Cluster is actually two separate clusters that collided with each other roughly 150 million years in the past. The name itself comes from the small sub-cluster that "shot through" the larger cluster. When the two clusters encountered each other the hot, x-ray emitting gas contained in the clusters ended up interacting electromagnetically, resulting in it being clumped mostly in the center while the stars passed through almost completely unaffected. However, as astronomers studied the structure, they discovered that the stellar matter wasn't the only thing that traveled through without colliding. Using a method of detecting mass called gravitational lensing, the researchers were able to determine that the majority of the mass in the clusters had not interacted, a clear sign of collisionless dark matter. Other theories that attempt to account for the influence of dark matter while arguing against its existence cannot explain the observational result of the Bullet Cluster and so dark matter theory seems to have won the battle.

Now that most are convinced that dark matter really does exist, the only question we have left to answer might be even more important. What *is* dark matter?

For more information on dark matter and the bullet cluster

http://map.gsfc.nasa.gov/m_uni/uni_101matter.html

http://www.darkmatterphysics.com/

http://chandra.harvard.edu/photo/2006/1e0657/

http://www.nasa.gov/home/hqnews/2006/aug/HQ_06297_CHANDRA_Dark_Matter.html

http://arxiv.org/abs/astro-ph/0608407 (for the more technically inclined)

The Newsletter of the Theodor Jacobsen Observatory

The Theodor Jacobsen Observatory is located on the north end of the University of Washington campus.

Enter through the gate at 17th NE and NE 45th. We're just east of the Burke museum.

For more information:
http://www.astro.washington.edu/observatory/

Observatory Volunteer Director::
Dr. Ana M. Larson
larson@astro.washington.edu
206-685-7856

Hours:

- March: 7 - 9 pm
- April through September: 9 - 11 pm
- October, November: 7 - 9 pm
- CLOSED: December through February

The talk is given about around 15 - 20 minutes after opening. If the sky is clear enough, the dome will be open for viewing objects through the ancient telescope. Additional exhibits are found in the "Transit Room" and "Pillar Room."

The Theodor Jacobsen Observatory is the second-oldest structure on the University of Washington campus. Built in 1895, the Observatory, with its 115-year old refracting telescope, is still offering views of the wonders of the Universe. The Observatory is now open to the public every first and third Wednesday, March 1 - November 30.

Upcoming Presentations

July 18 (9 - 11 pm)

9:15 pm Various Speakers -- Sci-Fi Night at the Observatory

We'll be reviewing a number of sci-fi movies and talking about the science or lack thereof. Space invaders, black holes, threatening asteroids, space trips to Jupiter and Mars, and more. As a special treat, we'll be featuring the new movie Sunshine that will be released in Seattle July 27. There will be a chance to win free movie passes and posters. We've seen only the trailer for this movie, and the imagery of the Sun is spectacular (note: This movie is rated R for violence and language. Guess we'd all swear, too, if we were in a spaceship heading towards the Sun!) We are adding a second presentation at 10 pm.

August 1 (9 - 11 pm)

9:15 pm Liz Williams -- Formation of the Solar System: How did our planets come to exist? When do scientists think the planets formed? What is the evidence supporting the theory?

Friends of the Observatory
Astronomy Department
University of Washington
Box 351580
Seattle, WA 98195-1580

You can make a difference in the undergraduate education and outreach programs at the U of W. Your donation to the University of Washington, Friends of the Observatory, will go a long way towards the educational programs provided at the Observatory. These funds are also used to support visits to local schools and organizations. Besides the Observatory, astronomy undergrads are active in radio astronomy, K-12 planetarium shows, an Astronomy Club (that is open to all undergrads at the UW), along with their individual research projects. Please make checks payable to the University of Washington, with "Friends of the Observatory" shown on the memo line.

Undergraduate Students in Charge

Every Autumn or Winter quarter, an outreach course is offered at the University of Washington where a new group of undergraduates are taught how to use the telescope and how to give great scientific talks on astronomy. Not only has the Observatory been an excellent venue for the educational growth of our undergraduates, it has also become an important outreach facility for the University of Washington, reaching around 2000 visitors a year. These undergraduates are the backbone of our outreach program here.

Seattle Astronomical Society

The Observatory would not be open today were it not for the generous donation of time, expertise, and money by members of the (SAS) Seattle Astronomical Society. The open houses will continue with their on-going support in the dome and with the maintenance and repair of the telescopes. http://www.seattleastro.org/