April 2012

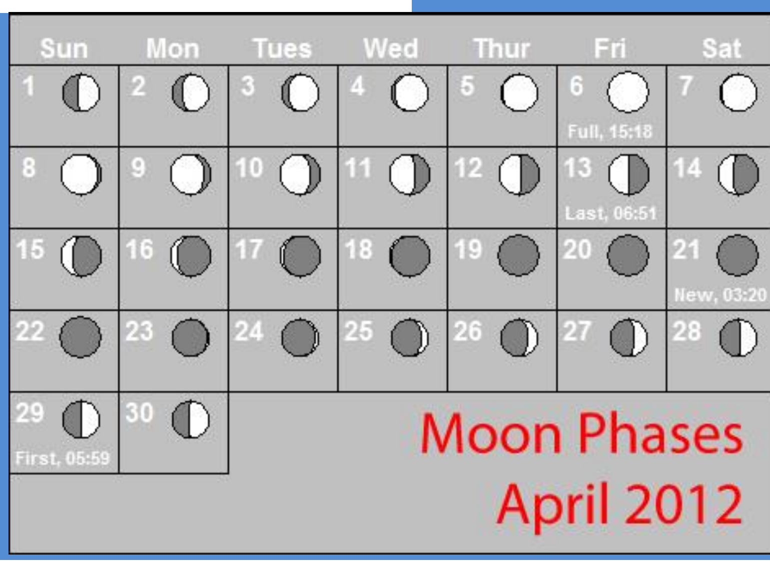
Inside this Issue:

April Meeting

The next meeting of S*T*A*R will be at 8pm on Thursday, April 5th, 2012. We have a terrific speaker for our meeting, club member Arturo Cisneros, who will present "Why does the Moon always show one side to the Earth? This, and other questions in basic astronomy." The meeting is at the Monmouth Museum at 8 p.m.

Calendar

- April 5th, 2012 – April meeting



May Issue

Please submit articles and contributions for the next *Spectrogram* by April 27th. Please email to fowler@verizon.net.

Are you a S*T*A*R Member?

S*T*A*R, The Society of Telescopy, Astronomy, and Radio, has promoted amateur astronomy since 1957 when it was organized by an energetic group of observers who participated in Project Moonwatch, a program in which a worldwide network of observers tracked the path of Sputnik among the stars of the night sky to obtain information on how the earth's atmosphere affects satellite orbits. This group soon evolved into an amateur astronomy club which was incorporated under its present name in 1969.

Today, S*T*A*R is the focal point for amateur astronomy in Monmouth County, NJ, attracting members of all ages, occupations and educational backgrounds. Its objectives are to promote the enjoyment of astronomy, and to increase the level of astronomical knowledge among its members and the public. The club achieves these goals through its regular meetings, observing nights, field trips, cooperation and exchange of information with other clubs, and special activities such as assisting Bayonet Farm in Holmdel and other park systems in conducting public astronomy programs.

S*T*A*R meetings are held on the first Thursday of the month from September to June, at 8 pm at the Monmouth Museum on the campus of Brookdale Community College, Lincroft, NJ. Programs generally consist of lectures and discussions by members or guest speakers on a variety of interesting topics on astronomy. Refreshments are served during the meeting and, weather permitting, a short observing session may occur afterwards.

The club owns 8" f/8, 13" f/4.5 and 25" f/5 Dobsonian telescopes which are available for use by members. Because of its large size use of the 25" requires the supervision of two qualified operators. To borrow a telescope or become a qualified operator of the 25", please contact the Vice President.

The current officers of S*T*A*R are:

President	Rob Nunn
Vice President	Kevin Gallagher
Secretary	Steve Fedor
Treasurer	Arturo Cisneros
Member at Large	Dave Britz

S*T*A*R is a member of United Astronomy Clubs of New Jersey (UACNJ), the Astronomical League (AL), and the International Dark Sky Association (IDA).

Memberships:
( ) Individual....$35
( ) Family...$45
( ) Student… $15

Name____

Address______________________________________

City______________________State___Zip________

Phone____

Email____

Make checks payable to: S*T*A*R Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701

The Transit of Venus

By Steven Seigel

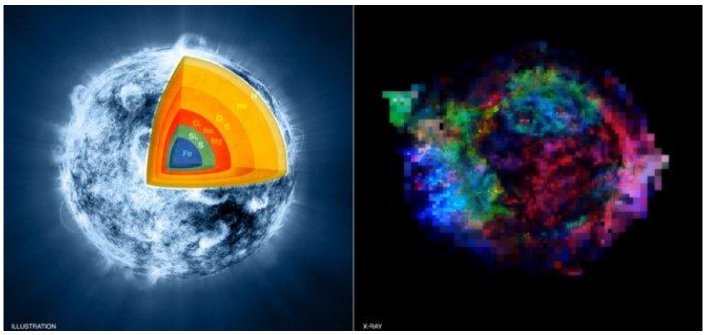
Comprehensive information concerning the transit of Venus can be found here: http://www.transitofvenus.org/

A video providing a brief history is found here: http://www.transitofvenus.org/education/video-new-media/325-trailer

After this video, other videos are offered.
Date-Time-Location (Calculator):
http://transitofvenus.nl/wp/where-when/local-transit-times/

A Star Explodes, Turns Inside-Out

A new X-ray study of the remains of an exploded star indicates that the supernova that disrupted the massive star may have turned it inside out in the process. Using very long observations of Cassiopeia A (or Cas A), a team of scientists has mapped the distribution of elements in the supernova remnant in unprecedented detail. This information shows where the different layers of the pre-supernova star are located three hundred years after the explosion, and provides insight into the nature of the supernova.



Credits: Illustration: NASA/CXC/M.Weiss; Image: NASA/CXC/GSFC/U. Hwang & J. Laming

An artist's illustration on the left shows a simplified picture of the inner layers of the star that formed Cas A just before it exploded, with the predominant concentrations of different elements represented by different colors: iron in the core (blue), overlaid by sulfur and silicon (green), then magnesium, neon and oxygen (red). The image from NASA's Chandra X-ray Observatory on the right uses the same color scheme to show the distribution of iron, sulfur and magnesium in the supernova remnant. The data show that the distributions of sulfur and silicon are similar, as are the distributions of magnesium and neon. Oxygen, which according to theoretical models is the most abundant element in the remnant, is difficult to detect because the X-ray emission characteristic of oxygen ions is strongly absorbed by gas in along the line of sight to Cas A, and because almost all the oxygen ions have had all their electrons stripped away.

A comparison of the illustration and the Chandra element map shows clearly that most of the iron, which according to theoretical models of the pre-supernova was originally on the inside of the star, is now located near the outer edges of the remnant. Surprisingly, there is no evidence from X-ray (Chandra) or infrared (Spitzer Space Telescope) observations for iron near the center of the remnant, where it was formed. Also, much of the silicon and sulfur, as well as the magnesium, is now found toward the outer edges of the still-expanding debris. The distribution of the elements indicates that a strong instability in the explosion process somehow turned the star inside out.

This latest work, which builds on earlier Chandra observations, represents the most detailed study ever made of X-ray emitting debris in Cas A, or any other supernova remnant resulting from the explosion of a massive star. It is based on a million seconds of Chandra observing time. Tallying up what they see in the Chandra data, astronomers estimate that the total amount of X-ray emitting debris has a mass just over three times that of the Sun. This debris was found to contain about 0.13 times the mass of the Sun in iron, 0.03 in sulfur and only 0.01 in magnesium.

The researchers found clumps of almost pure iron, indicating that this material must have been produced by nuclear reactions near the center of the pre-supernova star, where the neutron star was formed. That such pure iron should exist was anticipated because another signature of this type of nuclear reaction is the formation of the radioactive nucleus titanium-44, or Ti-44. Emission from Ti-44, which is unstable with a half-life of 63 years, has been detected in Cas A with several high-energy observatories including the Compton Gamma Ray Observatory, BeppoSAX, and the International Gamma-Ray Astrophysics Laboratory (INTEGRAL).

These results appeared in the February 20th issue of *The Astrophysical Journal* in a paper by Una Hwang of Goddard Space Flight Center and Johns Hopkins University, and (John) Martin Laming of the Naval Research Laboratory.

Provided by JPL/NASA

Hubble Spies A Spiral Galaxy Edge-On

The NASA/ESA Hubble Space Telescope has spotted the "UFO Galaxy." NGC 2683 is a spiral galaxy seen almost edge-on, giving it the shape of a classic science fiction spaceship. This is why the astronomers at the Astronaut Memorial Planetarium and Observatory, Cocoa, Fla., gave it this attention-grabbing nickname.

While a bird's eye view lets us see the detailed structure of a galaxy (such as this Hubble image of a barred spiral), a side-on view has its own perks. In particular, it gives astronomers a great opportunity to see the delicate dusty lanes of the spiral arms silhouetted against the golden haze of the galaxy’s core. In addition, brilliant clusters of young blue stars shine scattered throughout the disc, mapping the galaxy’s star-forming regions.

Perhaps surprisingly, side-on views of galaxies like this one do not prevent astronomers from deducing their structures. Studies of the properties of the light coming from NGC 2683 suggest that this is a barred spiral galaxy, even though the angle we see it at does not let us see this directly.

NGC 2683, discovered on Feb. 5, 1788, by the famous astronomer William Herschel, lies in the Northern constellation of Lynx. A constellation named not because of its resemblance to the feline animal, but because it is fairly faint, requiring the "sensitive eyes of a cat" to discern it. And when you manage to get a look at it, you'll find treasures like this, making it well worth the effort.

This image is produced from two adjacent fields observed in visible and infrared light by Hubble's Advanced Camera for Surveys. A narrow strip which appears slightly blurred and crosses most the image horizontally is a result of a gap between Hubble's detectors. This strip has been patched using images from observations of the galaxy made by ground-based telescopes, which show significantly less detail. The field of view is approximately 6.5 by 3.3 arcminutes.

Provided by JPL/NASA

Hubble Views Grand Star-Forming Region

This massive, young stellar grouping, called R136, is only a few million years old and resides in the 30 Doradus Nebula, a turbulent star-birth region in the Large Magellanic Cloud, a satellite galaxy of the Milky Way. There is no known star-forming region in the Milky Way Galaxy as large or as prolific as 30 Doradus.

Credit: NASA, ESA, and F. Paresce (INAF-IASF, Bologna, Italy), R. O'Connell (University of Virginia, Charlottesville), and the Wide Field Camera 3 Science Oversight Committee

Many of the diamond-like icy blue stars are among the most massive stars known. Several of them are 100 times more massive than our sun. These hefty stars are destined to pop off, like a string of firecrackers, as supernovas in a few million years.

The image, taken in ultraviolet, visible and red light by Hubble's Wide Field Camera 3, spans about 100 light-years. The nebula is close enough to Earth that Hubble can resolve individual stars, giving astronomers important information about the stars' birth and evolution.

The brilliant stars are carving deep cavities in the surrounding material by unleashing a torrent of ultraviolet light, and hurricane-force stellar winds (streams of charged particles), which are etching away the enveloping hydrogen gas cloud in which the stars were born. The image reveals a fantasy landscape of pillars, ridges, and valleys, as well as a dark region in the center that roughly looks like the outline of a holiday tree. Besides sculpting the gaseous terrain, the brilliant stars can also help create a successive generation of offspring. When the winds hit dense walls of gas, they create shocks, which may be generating a new wave of star birth.

These observations were taken Oct. 20-27, 2009. The blue color is light from the hottest, most massive stars; the green from the glow of oxygen; the red from fluorescing hydrogen.

Provided by JPL/NASA

Observing The Moon

by Steven Seigel

Reasons we amateur astronomers give for not looking at the Moon:

1. Other objects are far more interesting.
2. The light will hurt my dark adapted eyes.
3. It's always there-I'll see it tomorrow.

I am sure you have your own for not observing our natural satellite but it is there and will always be there so why not embrace it? Why not visit its mountains, check out the craters that formed when the dinosaurs first roamed, or feel like an astronaut and walk across a "Sea?" You can do all this and more even in the smallest of telescopes. This article is designed to show you not to look at the Moon but rather to observe it like a masterpiece-with HEART!

Moon Calendar:
http://svs.gsfc.nasa.gov/vis/a000000/a003800/a003894/index.html

Put in month- date-hour and an accurate phase is presented for your location.

Moon Atlas:
http://www.inconstantmoon.com/atlas.htm

No download required
http://sourceforge.net/projects/virtualmoon/files/latest/download

Virtual Moon provides a wealth of information.

New NASA Video On History Of The Moon:
http://www.wired.com/wiredscience/2012/03/video-moon-history/

Very quick and interesting:

Moon Facts For Kids (Adults Also):
http://www.woodlands-junior.kent.sch.uk/time/moon/facts.htm

Moon Facts For Adults:
http://nineplanets.org/luna.html

Equipment:
Any telescope can see the Moon and its features. I have found a moon filter to be quite useful in observing the Moon and some of the planets. There are different types of Moon filters:
http://www.optcorp.com/ProductList.aspx?uid=105-156-840-1155-851

This site gives a good description of them. My preference is a polarizing filter because I can adjust the amount of light that I want which is done by turning the filter once it is attached to the eyepiece. I hold up the eyepiece to the Moon before installing on the telescope to get the right amount of light I want. One-half of a polarizing filter is a basic moon filter.

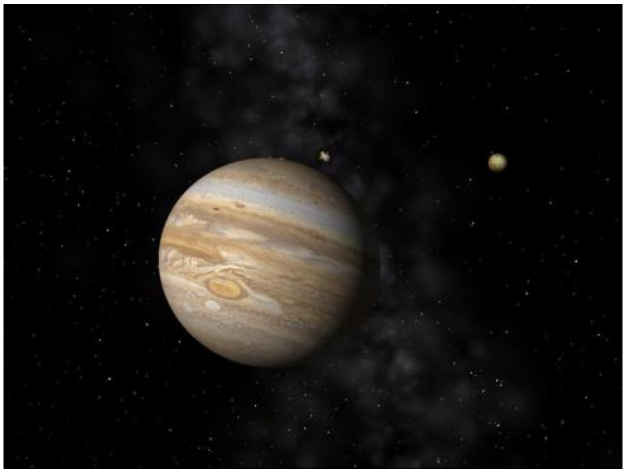
Drawing The Moon:

Drawing an object forces us to look for details that we would not notice at first sight and develops our appreciation of the objects. No artistic ability is required.
http://www.popastro.com/moonwatch/moon_guide/observing7.php
Learning to draw phases and craters can be found here.

Note On Observing:

When not using a filter, the best area to see features in detail is around the "terminator." That is the area where the light and dark sides meet.

Jupiter's Melting Heart Sheds Light On Mysterious Exoplanet



Scientists now have evidence that Jupiter's core has been dissolving, and the implications stretch far outside of our solar system.

Jupiter might be having a change of heart. Literally.

New simulations suggest that Jupiter's rocky core has been liquefying and mixing with the rest of the planet's innards. With this new data, astronomers hope to better explain a recent puzzling discovery of a strange planet outside of our solar system.

"It's a really important piece of the puzzle of trying to figure out what's going on inside giant planets," said Jonathan Fortney, a planetary scientist at the University of California Santa Cruz who was not affiliated with the research.

Conventional planetary formation theory has modeled Jupiter as a set of neat layers with a gassy outer envelope surrounding a rocky core consisting of heavier elements. But increasing evidence has indicated that the insides of gas giants like Jupiter are a messy mixture of elements without strictly defined borders.

This new research on a melting Jovian core bolsters a mixing model of gas giant planets and would provide another avenue for heavier elements to flow throughout the planet.

"People have been working on the assumption that these planets are layered because it's easier to work on this assumption," said Hugh Wilson, a planetary scientist at the University of California Berkeley and a coauthor of the new research appearing in Physical Review Letters.

Although scientists had previously toyed with the idea of melting cores in large planets, nobody sat down and did the necessary calculations, said Wilson.

Scientists have to rely on calculations of Jupiter's core environment because the conditions there are far too extreme to recreate on Earth. Wilson and his UC-Berkeley colleague Burkhard Militzer used a computer program to simulate temperatures exceeding 7,000 degrees Celsius and pressures reaching 40 million times the air pressure found on Earth at sea level.

Those conditions are thought to be underestimates of the actual conditions inside Jupiter’s core. Nonetheless, the authors found that magnesium oxide -- an important compound likely found in Jupiter's core -- would liquefy and begin drifting into Jupiter's fluid upper envelope under these relatively tame conditions.

Researchers believe that similarly-sized gas giant exoplanets -- planets found outside of our solar system -- probably have similar internal structures to Jupiter. Consequently, scientists were baffled earlier this year when they found a planet with approximately the same volume as Jupiter yet four to five times more mass.

Called CoRoT-20b, the new planet was announced in February, and its discoverers searched for a suitable explanation for its unusual density. Using conventional models, the astronomers calculated that the core would have to make up over half of the planet. For comparison, Jupiter's core only represents about between 3-15 percent of the planet’s total mass.

With a core that large, CoRoT-20b presented a huge problem for traditional assumptions surrounding planet formation.

"It's much easier to explain the composition of this planet under a model where you have a mixed interior," said Wilson.

Even the team that discovered the planet noted that a mixing model could allow for a more palatable planet density. Wilson's simulations not only add credence to the mixing model of giant planets but also suggest that this specific exoplanet's core is probably melting just like Jupiter's.

This melting may help explain why the exoplanet's heavy elements are likely stirred up and distributed throughout its volume, said Wilson.

Santa Cruz's Fortney agrees that most of the exoplanet's heavy elements likely reside in the outer envelope. Nonetheless, he expects other factors played a larger role in how the planet's interior became mixed: "It's more of a planet formation issue."

Several other events, such as two gas giants colliding together, might explain the ultra-high density of this new planet, Wilson admits. Certain processes may also limit the effectiveness of the melting and mixing process.

Liquefied parts of a gas giant's core may have trouble reaching the outer envelope due to double diffusive convection -- a process commonly found in Earth's oceans. When salty water accumulates at the bottom of the ocean, its density keeps it from mixing thoroughly with the upper layers. In a similar fashion, the heavy elements in Jupiter's core may have trouble gaining enough energy to move upward and outward.

Scientists don't know how much this hindrance will affect potential mixing inside Jupiter, and many other questions remain to be answered about the melting process.

"The next question is, 'How efficient is this process?'" said Fortney.

Researchers will have more tools to answer this question once NASA's Juno probe reaches Jupiter in 2016. With the spacecraft's instruments carefully analyzing Jupiter's composition, Wilson believes that there will be signatures of mixing and core erosion.

Source: Inside Science News Service

New Finding Affects Understanding Of Formation Of The Solar System

A global collaboration including five University of Notre Dame researchers has revised the half-life of samarium-146 (146Sm), reducing it to 68 million years from 103 million years. The finding is published in the journal Science.

The revised half-life, which is 34 percent shorter than the previously adopted value, affects the understanding of processes leading to the formation of the solar system, and the dating of some major geological events in the mantles of Earth and other terrestrial planets in the early solar system.

Samarium-146 is one of the main tools for establishing the evolution of the solar system over its first few hundred million years. It is a radioactive atom that is used as a clock for dating the separation of mantles of the terrestrial planets — e.g., Earth, the moon, Mars and meteorite parent bodies — to regions with different chemical compositions, including the formation of crust from the mantle, in the early solar system.

Samarium-146, which is produced only in stars, does not occur naturally on Earth. It decays to neodymium-142 (142Nd), so the presence of excess 142Nd in the geological record indicates the previous presence of 146Sm. The researchers produced 146Sm samples in a reactor and used Accelerator Mass Spectrometry (AMS) to separate the isotope from other material with mass 146 (called isobars). Measurements were taken using the high-energy ATLAS accelerator facility at Argonne National Laboratory utilizing the gas-filled magnet technique. This technique was developed by a collaboration between Argonne physicists; Philippe Collon, professor of physics at the University of Notre Dame; and Michael Paul from the Hebrew University in Jerusalem.

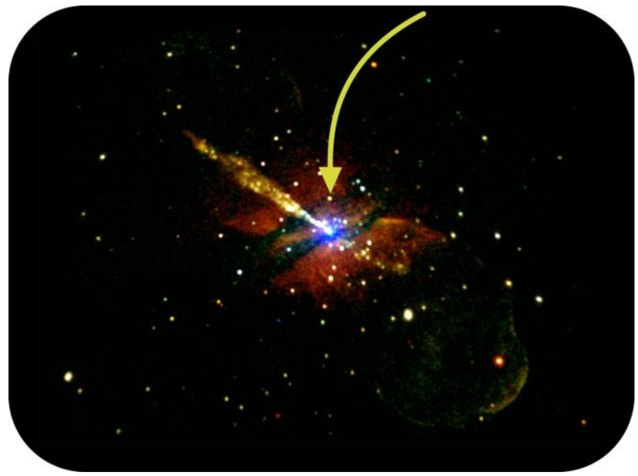
"Samarium-146 has a whole number of different applications that are specific to geological dating of these events. It goes back to the formation of the Solar System and the formation of Earth. That clearly changes some of the models and is an important piece of information. It is going to have implications on some of the models we have and our understanding of the formation of the Solar System and any extraterrestrial planetary system we are looking at," Collon said.

Collon along with Xiaodong Tang, a professor of physics; Yoav Kashiv, a visiting scholar who cowrote the paper; and graduate students Dan Robertson and Chris Schmitt were part of the research collaboration that involved groups from Israel, Japan and Argonne National Laboratory.

Provided by University of Notre Dame

'Ordinary' Black Hole Discovered 12 Million Light Years Away

An international team of scientists have discovered an 'ordinary' black hole in the 12 million light year-distant galaxy Centaurus A. This is the first time that a normal-size black hole has been detected away from the immediate vicinity of our own Galaxy. PhD student Mark Burke will present the discovery at the National Astronomy Meeting in Manchester.



The yellow arrow in the picture identifies the position of the black hole transient inside Centaurus A. The location of the object is coincident with gigantic dust lanes that obscure visible and X-ray light from large regions of Centaurus A. Other interesting X-ray features include the central active nucleus, a powerful jet and a large lobe that covers most of the lower-right of the image. There is also a lot of hot gas. In the image, red indicates low energy, green represents medium energy, and blue represents high energy light. Credit: NASA / Chandra

Although exotic by everyday standards, black holes are everywhere. The lowest-mass black holes are formed when very massive stars reach the end of their lives, ejecting most of their material into space in a supernova explosion and leaving behind a compact core that collapses into a black hole. There are thought to be millions of these low-mass black holes distributed throughout every galaxy. Despite their ubiquity, they can be hard to detect as they do not emit light so are normally seen through their action on the objects around them, for example by dragging in material that then heats up in the process and emits X-rays. But despite this, the overwhelming majority of black holes have remained undetected.

In recent years, researchers have made some progress in finding ordinary black holes in binary systems, by looking for the X-ray emission produced when they suck in material from their companion stars. So far these objects have been relatively close by, either in our own Milky Way Galaxy or in nearby galaxies in the so-called Local Group (a cluster of galaxies relatively near the Milky Way that includes Andromeda).

Mr Burke works under the supervision of Birmingham University astronomer Dr Somak Raychaudhury and is part of an international team led by Ralph Kraft of the Harvard-Smithsonian Center for Astrophysics. The team used the orbiting Chandra X-ray observatory to make six 100,000-second long exposures of Centaurus A, detecting an object with 50,000 times the X-ray brightness of our Sun. A month later, it had dimmed by more than a factor of 10 and then later by a factor of more than 100, so became undetectable.

This behaviour is characteristic of a low mass black hole in a binary system during the final stages of an outburst and is typical of similar black holes in the Milky Way. It implies that the team made the first detection of a normal black hole so far away, for the first time opening up the opportunity to characterise the black hole population of other galaxies.

Mr Burke comments: “So far we’ve struggled to find many ordinary black holes in other galaxies, even though we know they are there. To confirm (or refute) our understanding of the evolution of stars we need to search for these objects, despite the difficulty of detecting them at large distances. If it turns out that black holes are either much rarer or much more common in other galaxies than in our own it would be a big challenge to some of the basic ideas that underpin astronomy.”

The group now plan to look at the more than 50 other bright X-ray sources that reside within Centaurus A, identifying them as black holes or other exotic objects, and gain at least an inkling of the nature of a further 50 less luminous sources.

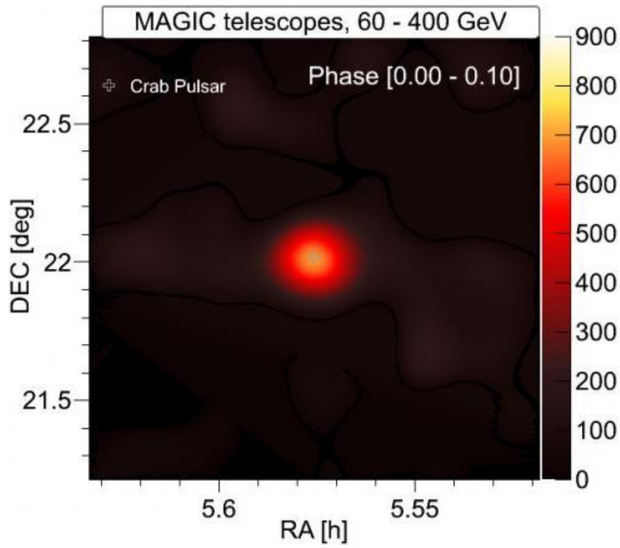
More information: The new work will appear in, “A Transient Sub-Eddington Black Hole X-ray Binary Candidate in the Dust Lanes of Centaurus A”, M. Burke et al, Astrophysical Journal. A preprint of the paper can be downloaded from http://arxiv.org/abs/1202.3149

Provided by Royal Astronomical Society

Powerhouse in the Crab Nebula

MAGIC telescopes measure the highest-energy gamma rays from a pulsar to date, calling theory into question.

The pulsar at the centre of the famous Crab Nebula is a veritable bundle of energy. This was now confirmed by the two MAGIC Telescopes on the Canary island of La Palma. They observed the pulsar in the very high energy gamma radiation from 25 up to 400 gigaelectronvolts (GeV), a region that was previously difficult to access with high energy instruments, and discovered that it actually emits pulses with the maximum measurable energy of up to 400 GeV – at least 50 to 100 times higher than theorists thought possible. These latest observations are difficult for astrophysicists to explain. "There must be processes behind this that are as yet unknown", says Razmik Mirzoyan, project head at the Max Planck Institute for Physics.

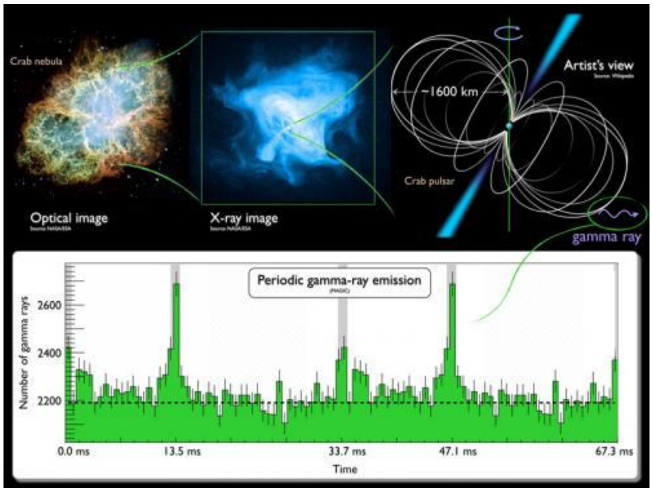


Cosmic lighthouse: The Crab Pulsar emits gamma ray pulses measuring up to 400 gigaelectronvolts (GeV); that is, at least 50 times higher than theorists thought possible. The animation shows the pulsed emissions as measured by the two MAGIC telescopes. Credit: S. Klepser, MAGIC Collaboration

The neutron star in the Crab Nebula is one of the best known pulsars. It rotates around its own axis 30 times every second and has a magnetic field of 100 million Tesla, over a trillion times stronger than that of Earth. The pulsar powers the surrounding famous Crab Nebula, located about 6000 light-years from Earth in the constellation of Taurus. Both the pulsar and the nebula are remnants of a supernova which exploded in July 1054 AD and was visible to the naked eye even by daylight for 23 days.

Neutron stars are extremely dense spheres made of nuclear material. Their mass is similar to that of the sun, but they have diameters of just 20 kilometres. But what makes a neutron star a pulsar, of which astrophysicists have detected some 2000 in our Milky Way galaxy? Neutron stars have an extremely regular and very short rotation period or "day", ranging from one millisecond to ten seconds. While rotating, the star constantly emits charged particles, mainly electrons and positrons (positively charged electrons) and electromagnetic radiation.

These particles move along magnetic field lines that rotate at the same speed as the neutron star itself, giving off beams almost everywhere the electromagnetic spectrum, from radio wavelengths to gamma rays. If one of these beams crosses our line of sight, the star flashes up for a moment, just like the signal from a lighthouse.



In a different light: The illustration shows the Crab Nebula as seen through an optical telescope (left) and an X-ray telescope (middle), with a graphic representation of the pulsars magnetic field (right). The light curve (bottom) shows the regular emission of gamma rays at intervals of 0.0337 seconds, or two pulses per rotation. For clarity two periods are shown. Credit: NASA, ESA, J. Hester, A. Loll, CXC, SAO, F. Seward et al., MAGIC Collaboration

A few years ago, the MAGIC telescopes detected gamma rays of energy higher than 25 GeV from the Crab Pulsar. This was very unexpected since the available EGRET satellite data were showing that the spectrum ceases at much lower energies. However, at the very high energies MAGIC demonstrated to have few orders of magnitudes higher sensitivity compared to the satellite missions. At the time, scientists concluded that the radiation must be produced at least 60 kilometres above the surface of the neutron star. This is because the high-energy gamma rays are so effectively shielded by the star's magnetic field that a source very close to the star could not be detected. As a consequence that measurement ruled out one of the main theories on high energy gamma-ray emission from the Crab pulsar.

Now the data measured by MAGIC over the past two years show that the pulsed emissions by far exceed all expectations, reaching 400 GeV in extremely short pulses of about a millisecond duration. This finding casts doubt on existing theories, since it was thought that all pulsars had significantly lower energy limits.The recent measurements by MAGIC, together with those of the orbiting Fermi satellite at much lower energies, provide an uninterrupted spectrum of the pulses from 0.1 GeV to 400 GeV. These clear observational results create major difficulties for most of the existing pulsar theories that predict significantly lower limits for highest energy emission.

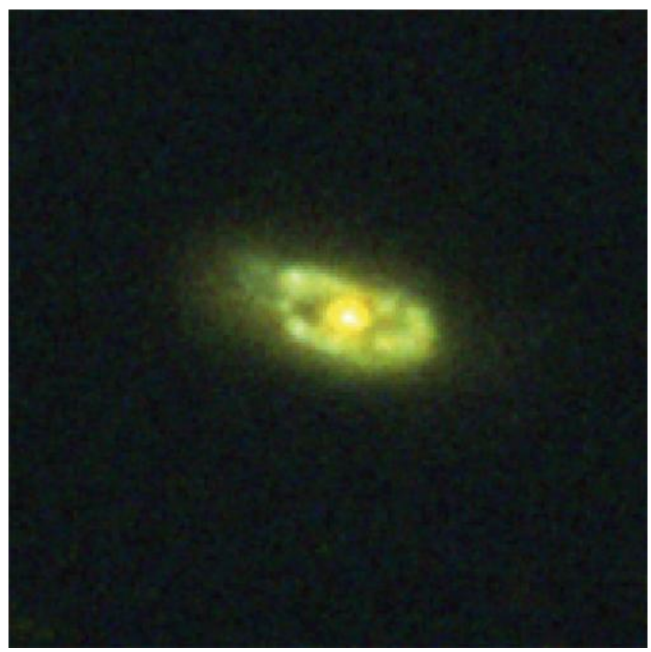
A new theoretical model developed by MAGIC team associate Kouichi Hirotani of the Academia Sinica, Institute of Astronomy and Astrophysics in Taiwan explains the phenomenon with a cascade-like process which produces secondary particles that are able to overcome the barrier of the pulsar's magnetosphere. Another possible explanation posed by Felix Aharonian of the Dublin Institute for Advanced Studies and other researchers links the puzzling emission to the similarly enigmatic physics of the pulsar wind – a current of electrons, positrons and electromagnetic radiation which ultimately develops into the Crab Nebula.

However, even though the above models are able to provide explanations for the extremely high energy and the shortness of the pulses, further refinements are necessary for achieving a good agreement with observations. Astrophysicists hope that future observations will improve the statistical precision of the data and help solving the mystery. This could shed new light on pulsars and on the Crab Nebula itself, as one of the most studied objects in our Milky Way.

More information: MAGIC Collaboration, J. Aleksic et al., Phase-resolved energy spectra of the Crab pulsar in the range of 50-400GeV measured with the MAGIC telescopes, Astronomy & Astrophysics, March 30, 2012

Provided by Max-Planck-Gesellschaft

Recycling Galaxies Caught In The Act

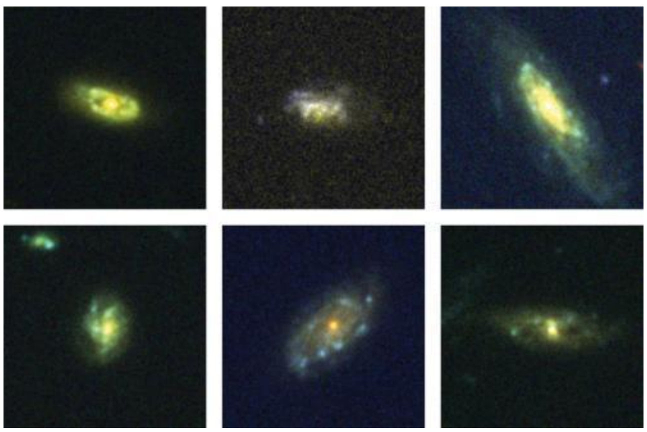


One of the six galaxies that has been found by the Keck I telescope to have significant inflows of gas, which together with outflows create a galactic juggling act. Credit: NASA/STScI

When astronomers add up all the gas and dust contained in ordinary galaxies like our own Milky Way, they stumble on a puzzle: There is not nearly enough matter for stars to be born at the rates that are observed. Part of the solution might be a recycling of matter on gigantic scales – veritable galactic fountains of matter flowing out and then back into galaxies over multi-billion-year timescales.

Now, a team of astronomers led by Kate Rubin of the Max Planck Institute for Astronomy in Germany has used the W. M. Keck Observatory to find evidence of just such fountains in distant spiral galaxies.

In the Milky Way, it's estimated that every year about one solar mass (an amount of matter equal to that of our Sun) worth of dust and gas is turned into stars. Yet a survey of the available raw materials shows that our galaxy could not keep up this rate of star formation for longer than a couple of billion years. Star ages and comparisons with other spiral galaxies show that one solar mass per year is a typical star formation rate. So the puzzle appears to be universal.



Images of the six galaxies with detected inflows, detected by the Keck I telescope. Most of these galaxies have a disk-like, spiral structure, similar to that of the Milky Way. Star formation activity occurring in small knots is evident in several of the galaxies' spiral arms. Because the spirals appear tilted in the images, Rubin et al. concluded that we are viewing them from the side, rather than face-on. This orientation meshes well with a scenario of 'galactic recycling' in which gas is blown out of a galaxy perpendicular to its disk, and then falls back at different locations along the edge of the disk. These images were taken with the Advanced Camera for Surveys on the Hubble Space Telescope. Credit: NASA/STScI

This means additional matter must find its way into galaxies. One possible source is an inflow from huge low-density gas reservoirs filling the intergalactic voids. There is, however, little evidence that this is happening.

Another possibility, closer to home, involves a gigantic cosmic matter cycle. Gas is observed to flow away from many galaxies, and may be pushed by several different mechanisms, including violent supernova explosions (which are how massive stars end their lives), and the sheer pressure exerted by light emitted by bright stars on gas in their cosmic neighborhood.

As this gas drifts away, it is pulled back by the galaxy's gravity, and could re-enter the same galaxy on timescales of one to several billion years. This process might solve the mystery. If so, then the gas we find inside galaxies may only be about half of the raw material that ends up as fuel for star formation. Large amounts of gas are caught in transit, but will re-enter the galaxy in due time. It's a gigantic juggling act, in other words, with some of the balls in the galactic hands and others in the air. Added all together, there is a sufficient amount of raw matter to account for the observed rates of star formation.

Until now, however, there was a great deal of uncertainty about the idea of cosmic recycling. Would such gas indeed fall back, or would it more likely reach the galaxy's escape velocity, flying ever further out into space, never to return? For local galaxies out to a few hundred million light-years in distance, there had been studies showing evidence for inflows of previously-expelled gas. But what about more distant galaxies, where outflows are known to be much more powerful? Would gravity still be sufficient to pull the gas back? If no, astronomers might be forced to radically rethink their models for how star formation is fueled on galactic scales.

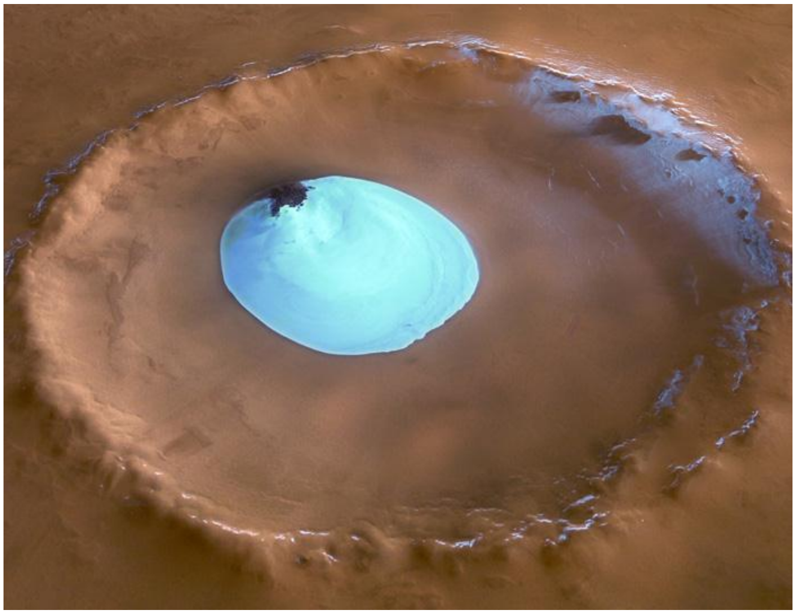
To sort this out, Rubin and her team examined gas associated with a hundred galaxies at distances between 5 and 8 billion light-years with the Keck I telescope's Low Resolution Imaging Spectrogtaph (LRIS). They found in six of those galaxies the first direct evidence that gas adrift in intergalactic space does indeed flow back into star-forming galaxies.

Even more encouraging, the inflow which can be detected by with the Keck I telescope might well depend on the angle at which we observe the galaxy. As Rubin and her team can only measure average gas motion, the real proportion of galaxies with this kind of inflow is likely to be higher than the six percent suggested by their data. It could, in fact, be as high as 40 percent. This is a key piece of the puzzle and important evidence that cosmic recycling could indeed solve the mystery of the missing star-making matter.

More information: The results described here have been published as Kate H. R. Rubin et al., "The Direct Detection of Cool, Metal-Enriched Gas Accretion onto Galaxies at z ~ 0.5" in the journal Astrophysical Journal Letters, Vol. 747 (2012), p. 26ff. The co-authors are Kate H. R. Rubin (Max Planck Institute for Astronomy), J. Xavier Prochaska (MPIA and UCO/Lick Observatory, University of California), David C. Koo (UCO/Lick Observatory), and Andrew C. Phillip (UCO/Lick Observatory).

Provided by W. M. Keck Observatory

Year of the Solar System
Ice!



The Mars Express took this photo of a crater on Mars filled with water ice. Credit: ESA/DLR/FU Berlin (G. Neukum)

Ice is common in our solar system, from deposits at the poles of Mercury and the Moon to ice-covered moons and rings around distant Jupiter and Saturn, and comets made of ice and other materials streaming across the spaces between. And, of course, ice is present around our own world.

While the most common type of ice in our solar system is water ice, there are also many other types of ice. Mars' poles have abundant amounts of frozen carbon dioxide (also called dry ice), and comets have frozen ammonia and methane in addition to frozen water and other ices. Saturn's moon Titan is famous for its methane, which can exist as a solid, a liquid and a gas at Titan's surface temperatures and pressures.

The ice on continents contains about 75% of Earth's freshwater. Melting ice sheets on Greenland and Antarctica have the potential to raise global sea levels by 23 feet (Greenland) and 187 feet (Antarctica).

Scientists are studying water ice both on Earth and on other planets; snow and glaciers are a critical source of freshwater for many regions on Earth, and ice deposits can be a source of water for future explorers in the solar system. Given the apparent need all life has for water, the presence of frozen water may also provide clues to the possibility of life! Check out April 2011 for more about water in the solar system, and June-July 2012 for more about the search for life.

All types of ice play an important role in the characteristics and planetary processes throughout the solar system. Glaciers have eroded parts of the Earth and Mars, creating new features. Uranus and Neptune are filled with "icy" materials like water, ammonia, and methane, under incredible heat and pressure. Some moons in the outer solar system have volcano-like geysers that erupt ice! For more information about ice in the solar system, check out Background.

Join us this month as we explore ice and its properties, where it is located, and what it tells us about the planets and moons in our solar system. We will join the Earth Day celebrations this month! Check out the classroom and informal activities, resources, and further information.

April 2012 Celestial Events: supplied by J. Randolph Walton (Randy)

Day	Date	Time (EDT)	Event
Tue	3	Evening	**Venus 0.4 deg. SE of Pleiades (M45)**
		23:30	Venus Sets
Fri	6	15:19	**Full Moon**
		19:46	Moon rise
Sat	7	05:10	Mars Sets
		05:40	Mercury Rises
		06:34	Sunrise
		19:31	Sunset
		20:00	Saturn Rises
		21:02	Moon rise
		21:40	Jupiter Sets
		23:32	Venus Sets
Fri	13	06:50	**Last Quarter Moon**
		12:25	Moon Set
Sat	14	04:40	Mars Sets
		05:29	Mercury Rises
		06:23	Sunrise
		13:29	Moon Set
		19:30	Saturn Rises
		19:38	Sunset
		21:22	Jupiter Sets
		23:37	Venus Sets
Sat	21	03:18	**New Moon**
		04:10	Mars Sets
		05:20	Mercury Rises
		06:13	Sunrise
		06:20	Saturn Sets
		19:45	Sunset
		20:24	Moon Set
		21:00	Jupiter Sets
		23:35	Venus Sets
Sun	22	01:00	**Lyrid meteors (ZHR=20)**
Sat	28	03:42	Mars Sets
		05:15	Mercury Rises
		05:45	Saturn Sets
		06:03	Sunrise
		11:41	Moon Set
		19:52	Sunset
		20:43	Jupiter Sets
		23:30	Venus Sets
Sun	29	05:57	**First Quarter Moon**
		12:44	Moon rise
		21:00	**Lunar Straight Wall visible**
Mon	30	Evening	**Venus at greatest illuminated extent (m=-4.3)**
		23:29	Venus Sets

In the Eyepiece

Here is a list of objects for this month. This is reproduced from www.skyhound.com with the kind permission of its creator and author of SkyTools Greg Crinklaw.

Object(s)	Class	Con	RA	Dec	Mag
M 81 & M 82	Galaxies	Ursa Major	09h55m34.1s	+69°03'59"	7.8
NGC 3511	Galaxy	Crater	11h03m23.7s	-23°05'11"	11.5
The Spindle	Galaxy	Sextans	10h05m14.1s	-07°43'07"	10.1
Ghost of Jupiter/Eye	Planetary Nebula	Hydra	10h24m46.1s	-18°38'32"	8.6
NGC 2903	Galaxy	Leo	09h32m09.7s	+21°30'03"	9.6
M95	Galaxy	Leo	10h44m00.0s	+11°41'57"	10.5
M96	Galaxy	Leo	10h46m48.1s	+11°48'54"	10.1
The Leo I Dwarf	Galaxy	Leo	10h08m30.6s	+12°18'07"	11.2
Markarian 421	Galaxy	Ursa Major	11h04m27.4s	+38°12'34"	14.8
Arp 270	Galaxy Pair	Leo Minor	10h49m52.4s	+32°58'35"	12.4
NGC 2818	Planetary Nebula in Open Cluster	Pyxis	09h16m01.5s	-36°36'37"	13.0
The Twin Quasar	Quasar	Ursa Major	10h01m20.8s	+55°53'54"	17.0
Hickson 44	Galaxy Group	Leo	10h18m00.4s	+21°48'44"	10.0
Abell 33	Planetary Nebula	Hydra	09h39m09.2s	-02°48'35"	13.4