April 2011

Inside this Issue:

April Meeting

The next meeting of S*T*A*R will be on Thursday, April 7th 2011. Dr. William Gutsch has written and produced numerous programs for large format theaters and written for and directed many film legends in New York, Hollywood and at Lucasfilms. He started his career as a mountain top sitting astronomer but early on got bitten by the "teaching and popularizing bug". The result has been a unexpected but rich and fulfilling life long journey that has taken him on fun adventures around the world.

Calendar

- April 7, 2011 Lights, Camera, Universe! Presented by Dr. William Gutsch
- April 26, 2011 – Brookdale Star Party

Sun	Mon	Tues	Wed	Thur	Fri	Sat
					1	2
3 New, 10:34	4	5	6	7	8	9
10	11 First, 08:07	12	13	14	15	16
17 Full, 22:46	18	19	20	21	22	23
24 Last, 22:48	25	26	27	28	29	30

Moon Phases April 2011

May Issue

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

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

S*T*A*R is the proud owner of a monstrous 25" Dobsonian Obsession reflector – which members can gain access to!

Meetings are the first Thursday of each month, except July and August, at 8:00 PM at the Monmouth Museum on the Brookdale Community College campus. Meetings generally consist of lectures and discussions by members or guest speakers on a variety of interesting astronomical topics. 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....$25 ( ) Family...$35

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

Upcoming Star Parties!

Brookdale Community College Star Party
Tuesday, April 26, 2011
A Star Party is planned for the Astronomy Students and others from the college. Rain date is May 3rd. We are trying to get a good location on the campus as this will be the second half of their class for that evening. Sunset is 7:47, end of twilight 8:16. The moon will not be up. Please watch the board for any updates under "Events and Observing Plans" or a general e mail.

Messier Marathon Observing:

We will Reserve Dordrook Park for Messier Marathon Observing on the first weekend in March and the first weekend in April.

Please note by "clicking" on the Observing link on the top of our web site there is a Messier Marathon list and Telrad charts for the objects.

Thanks
Rich G.

Leo trio, M65,66, and NGC 3238. 4" Genesis f/5.4 refractor, Canon 40 D, iso 800, 10x 240 seconds, Leesburg, Fl.

Photo by: Ernie Rossi

President's Corner

Hi Folks:

If you remember, one of our club's primary reasons for relocating to the Monmouth Museum meeting site at Brookdale College was to be able to interact with the student and mix some new blood into our club.

Well here's our opportunity.

As you know, our last speaker was Dr. Marcos Puga who teaches astronomy at the college. We have made arrangements though him to have a hands-on observing session with his entire class of astronomy students and possible more students from some of the other classes. We are working on the location. We would prefer to have it on the campus so that the students will move right from their shortened Tuesday evening class out to the scopes so we can show them some "real universe" stuff! This time will be considered part of their class for the night and they must attend as per their professor. If the campus site (we are checking it out) will not be viable, we will hold it elsewhere (will keep you posted on location).

I would like for as many people as possible to bring scopes since we will have between 20-40 students there. But even if you are not bringing a scope, I would like as many as possible of you to attend since this is a major opportunity for all of us to network with the astronomy students (one of them has already inquired about joining the club).

The rain date for this would be Tuesday May 3rd.

Please let me know if you plan to attend and if you plan to bring a scope.

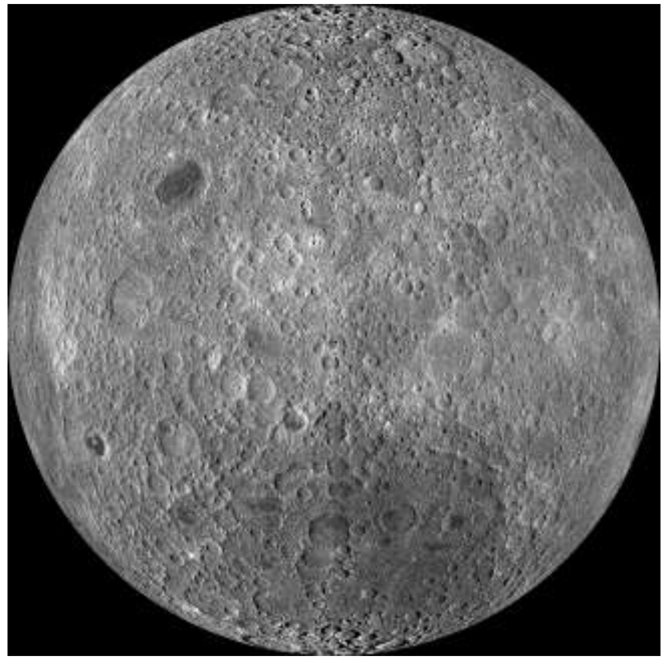
Best Regards,

Nancy

The Far Side of the Moon -- And All the Way Around

Because the moon is tidally locked (meaning the same side always faces Earth), it was not until 1959 that the farside was first imaged by the Soviet Luna 3 spacecraft (hence the Russian names for prominent farside features, such as Mare Moscoviense). And what a surprise -- unlike the widespread maria on the nearside, basaltic volcanism was restricted to a relatively few, smaller regions on the farside, and the battered highlands crust dominated. A different world from what we saw from Earth.

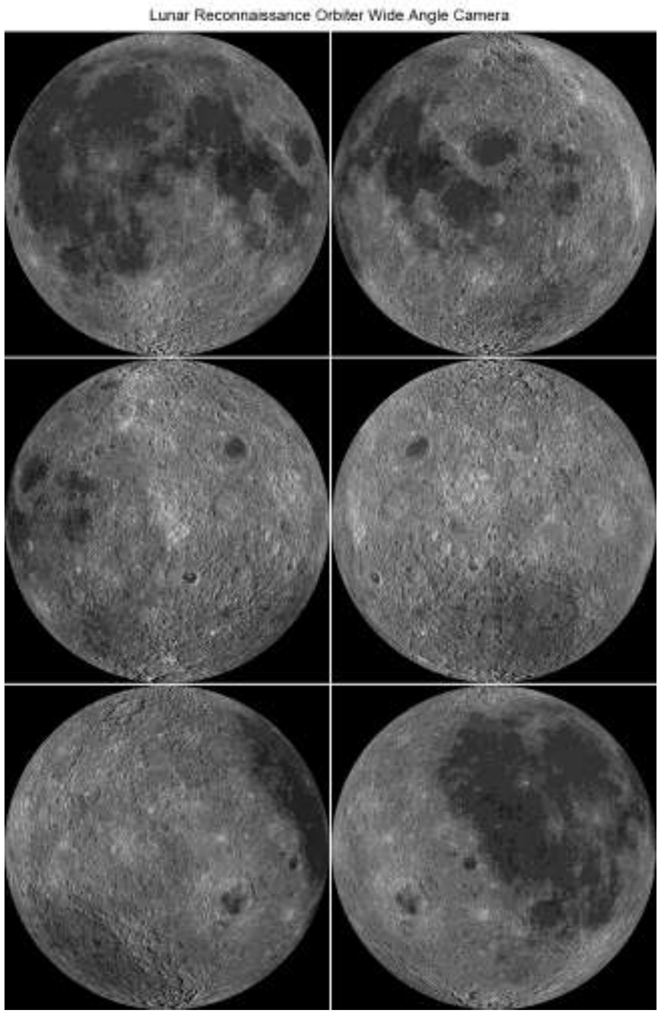
Of course, the cause of the farside/nearside asymmetry is an interesting scientific question. Past studies have shown that the crust on the farside is thicker, likely making it more difficult for magmas to erupt on the surface, limiting the amount of farside mare basalts. Why is the farside crust thicker? That is still up for debate, and in fact several presentations at this week's Lunar and Planetary Science Conference attempt to answer this question.



The lunar farside as never seen before! LROC WAC orthographic projection centered at 180° longitude, 0° latitude. Credit: NASA/Goddard/Arizona State University.

The Clementine mission obtained beautiful mosaics with the sun high in the sky (low phase angles), but did not have the opportunity to observe the farside at sun angles favorable for seeing surface topography. This WAC mosaic provides the most complete look at the morphology of the farside to date, and will provide a valuable resource for the scientific community. And it's simply a spectacular sight!

The Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) is a push-frame camera that captures seven color bands (321, 360, 415, 566, 604, 643, and 689 nm) with a 57-km swath (105-km swath in monochrome mode) from a 50 km orbit. One of the primary objectives of LROC is to provide a global 100 m/pixel monochrome (643 nm) base map with incidence angles between 55°-70° at the equator, lighting that is favorable for morphological interpretations. Each month, the WAC provides nearly complete coverage of the Moon under unique lighting. As an added bonus, the orbit-to-orbit image overlap provides stereo coverage. Reducing all these stereo images into a global topographic map is a big job, and is being led by LROC Team Members from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR). Several preliminary WAC topographic products have appeared in LROC featured images over the past year (Orientale basin, Sinus Iridum). For a sneak preview of the WAC global DEM with the WAC global mosaic, view a rotating composite moon (70 MB video from ASU's LROC website). The WAC topographic dataset will be completed and released later this year.



Six orthographic views of the Moon created from the new WAC global mosaic. From upper left to lower right the central longitude is 0°, 60°, 120°, 180°, 240°, 300°. Credit: NASA/Goddard/Arizona State University.

The global mosaic released today is comprised of over 15,000 WAC images acquired between November 2009 and February 2011. The non-polar images were map projected onto the GLD100 shape model (WAC derived 100 m/pixel DTM), while polar images were map projected on the LOLA shape model. In addition, the LOLA derived crossover corrected ephemeris, and an improved camera pointing, provide accurate positioning (better than 100 m) of each WAC image.

As part of the March 2011 PDS release, the LROC team posted the global map in ten regional tiles. Eight of the tiles are equirectangular projections that encompass 60° latitude by 90° longitude. In addition, two polar stereographic projections are available for each pole from ±60° to the pole. These reduced data records (RDR) products will be available for download on March 15, 2011. As the mission progresses, and our knowledge of the lunar photometric function increases, improved and new mosaics will be released! Work your way around the moon with these six orthographic projections constructed from WAC mosaics. The nearside view linked below is different from that released on 21 February.

Exploding Stars and Stripes

The discovery of a pattern of X-ray "stripes" in the remains of an exploded star may provide the first direct evidence that a cosmic event can accelerate particles to energies a hundred times higher than achieved by the most powerful particle accelerator on Earth.

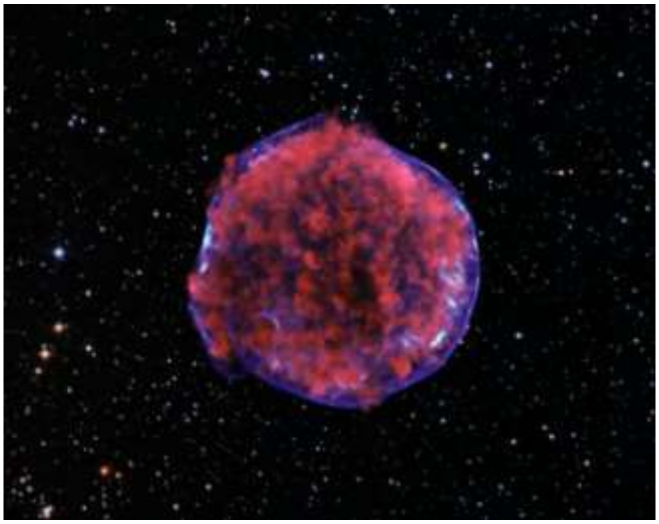
This result comes from a very long observation of the Tycho supernova remnant with NASA's Chandra X-ray Observatory. It could explain how some of the extremely energetic particles bombarding the Earth, called cosmic rays, are produced.

"We've seen lots of intriguing structures in supernova remnants, but we've never seen stripes before," said Kristoffer Eriksen of Rutgers University, who led the study. "This made us think very hard about what's happening in the blast wave of this powerful explosion." This latest study from Chandra provides support for a theory about how magnetic fields can be dramatically amplified in such blast waves.

In this theory, the magnetic fields become highly tangled and the motions of the particles very turbulent near the expanding supernova shock wave at the front edge of the supernova remnant. High-energy charged particles can bounce back and forth across the shock wave repeatedly, gaining energy with each crossing. Theoretical models of the motion of the most energetic particles -- which are mostly protons -- are predicted to leave a messy network of holes and dense walls corresponding to weak and strong regions of magnetic fields, respectively.

The X-ray stripes discovered by the Chandra researchers are thought to be regions where the turbulence is greater and the magnetic fields more tangled than surrounding areas, and may be the walls predicted by the theory. Electrons become trapped in these regions and emit X-rays as they spiral around the magnetic field lines.

However, the regular and almost periodic pattern of the X-ray stripes was not predicted by the theory.



This image comes from a very deep Chandra observation of the Tycho supernova remnant, produced by the explosion of a white dwarf star in our Galaxy. Low-energy X-rays (red) in the image show expanding debris from the supernova explosion and high energy X-rays (blue) show the blast wave, a shell of extremely energetic electrons . These high-energy X-rays show a pattern of X-ray "stripes" never previously seen in a supernova remnant. Some of the brightest stripes can also directly be seen in the full color image, on the right side of the remnant pointing from the outer rim to the interior. The stellar background is from the Digitized Sky Survey and only shows stars outside the remnant.

These stripes may provide the first direct evidence that supernova remnants can accelerate particles to energies a hundred times higher than achieved by the most powerful particle accelerator on Earth, the Large Hadron Collider. The results could explain how some of the extremely energetic particles bombarding the Earth, called cosmic rays, are produced, and they provide support for a theory about how magnetic fields can be dramatically amplified in such blast waves.

The X-ray stripes are thought to be regions where the turbulence is greater and the magnetic fields more tangled than surrounding areas. Electrons become trapped in these regions and emit X-rays as they spiral around the magnetic field lines. Regions with enhanced turbulence and magnetic fields were expected in supernova remnants, but the motion of the most energetic particles -- mostly protons -- was predicted to leave a messy network of holes and dense walls corresponding to weak and strong regions of magnetic fields, respectively. Therefore, the detection of stripes was a surprise.

The size of the holes was expected to correspond to the radius of the spiraling motion of the highest energy protons in the supernova remnant. These energies equal the highest energies of cosmic rays thought to be produced in our Galaxy. The spacing between the stripes corresponds to this size, providing evidence for the existence of these extremely energetic protons.

Credits: X-ray: NASA/CXC/Rutgers/K.Eriksen et al.; Optical: DSS

"It was a big surprise to find such a neatly arranged set of stripes," said co-author Jack Hughes, also of Rutgers. "We were not expecting so much order to appear in so much chaos. It could mean that the theory is incomplete, or that there's something else we don't understand."

Assuming that the spacing between the X-ray stripes corresponds to the radius of the spiraling motion of the highest energy protons in the supernova remnant, the spacing corresponds to energies about 100 times higher than reached in the Large Hadron Collider. These energies equal the highest energies of cosmic rays thought to be produced in our Galaxy.

Because cosmic rays are composed of charged particles, like protons and electrons, their direction of motion changes when they encounter magnetic fields throughout the galaxy. So, the origin of individual cosmic rays detected on Earth cannot be determined.

Supernova remnants have long been considered a good candidate for producing the most energetic cosmic rays in our Galaxy. The protons can reach energies that are hundreds of times higher than the highest energy electrons, but since they do not radiate efficiently like the electrons, direct evidence for the acceleration of cosmic ray protons in supernova remnants has been lacking.

These results also support the prediction that magnetic fields in interstellar space are greatly amplified in supernova remnants, but the difference between the observed and predicted structures means that other interpretations cannot be ruled out.

"We were excited to discover these stripes because they might allow us to directly track, for the first time, the origin of the most energetic particles produced in our galaxy," said Eriksen. "But, we're not claiming victory yet."

The Tycho supernova remnant is named for the famous Danish astronomer Tycho Brahe, who reported observing the supernova in 1572. Scientists think the explosion occurred when a white dwarf star grew in mass and exceeded its weight limit, forming a so-called Type Ia supernova. The Tycho remnant is located in the Milky Way, about 13,000 light years from Earth.

"Supernova remnants are our best cosmic laboratories for understanding how nature accelerates the highest energy cosmic rays," said Roger Blandford of Stanford University, a noted expert in this field who was not involved with these findings. "These careful measurements provide a very strong clue as to what actually happens at these giant shock fronts."

These results were published in the February 20th, 2011 issue of The Astrophysical Journal Letters. The other co-authors are Carles Badenes from Tel-Aviv University and the Weizmann Institute of Science in Israel, Robert Fesen from Dartmouth College, NH, Parviz Ghavamian from Space Telescope Science Institute, Baltimore, MD, David Moffett, from Furman University, Greenville, SC, Paul

Plucinsky from Harvard-Smithsonian Center for Astrophysics (CfA), Cambridge, MA, Cara Rakowski from the Naval Research Laboratory, Washington, DC, Estela M. Reynoso from the Institute of Astronomy and Space Physics and University of Buenos Aires, Argentina and Patrick Slane from CfA.

NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory controls Chandra's science and flight operations from Cambridge, Mass.

Fortuitous Timing for NASA's New Space Weather App

NASA's new iPhone application couldn't have come at a better time.

A few hours before a gigantic bubble of electrified gas and charged particles erupted from the Sun, NASA officially released the new Space Weather App making images and other data almost immediately available to users. "The timing was perfect," said Antti Pulkkinen, a scientist at the Community Coordinated Modeling Center (CCMC) at NASA's Goddard Space Flight Center in Greenbelt, Md. The multi-agency organization researches and develops models to help scientists better forecast space weather.

NASA's new Space Weather App allows users to analyze active regions on the Sun using observations by Sun-observing satellites, including the Solar Dynamics Observatory. Credit: NASA

Luckily for Earthlings, the fast-moving coronal mass ejection (CME) that raced through space at 2,200 kilometers (1,242 miles) per second, did not strike Earth directly. It made a glancing blow, sparing satellites, power grids, and electrical-transmission lines from damage and disruption that can happen during particularly severe space-weather events.

However, the eruption did trigger a run at the iTunes store. Within just a couple days, 1,500 users had already downloaded the application, making it one of the store's 20 most popular in the weather category, said Marlo Maddox, CCMC's Deputy Director for Operations and one of the Goddard computer scientists who helped develop the program.

The application also provides a comprehensive pool of data and model products for all major space weather areas of interest. Credit: NASA

Developed jointly by Goddard's engineering and science directorates, and based on support from NASA's Heliophysics Division as well as the National Science Foundation, the application gives users real-time access to solar-event images, data, model simulations, and forecasts as they evolve and affect the near-Earth space environment. Currently, 200 products observed primarily by NASA missions or modeled at the CCMC are available. The easy-to-use application also allows users to customize the program so that it displays only information of interest to them.

"We wanted to make this information more mobile," explained Michael Hesse, Chief of the Space Weather Laboratory and CCMC director. That way, scientists can access the information anywhere, anytime. "With tools like these, we also wanted to increase the public's awareness of space weather to the point where coronal mass ejections and solar flares are as familiar to most as hurricanes and tornadoes," Hesse added. "Users can be assured that they are accessing the same world-class, state-of-the-art information used by the professional space science community," Maddox added.

Work began on the iPhone application 18 months ago and was led by Goddard computer scientist Richard Mullinix, who has experience developing iPhone applications. However, the team doesn't intend to stop there. The group is now developing versions for Android mobile phones, the iPad, and other electronic tablets, said Goddard computer scientist David Berrios. Those releases are expected by the end of the summer.

The timing is fortuitous, team members agreed. The Sun undergoes an 11-year cycle that goes from a solar minimum, a period where the Sun produces few if any sunspots, which are areas of magnetic concentration that disrupt energy production on the Sun's surface and appear as dark spots, to solar maximum, a period of intense activity distinguished by giant blasts of energy and material into space. Based on recent solar events, it appears that the Sun is emerging from a long solar minimum and headed into a solar maximum, distinguished by the growing number of CMEs and energetic X-ray outbursts, Pulkkinen said.

To stay abreast of these events, the public may download the free application from iTunes or the App store on iOS devices. To improve the application, the team invites feedback from users. To weigh in, users may leave comments at swxapp@ccmc.gsfc.nasa.gov.

For those who do not own an iPhone, space weather information can be obtained via CCMC's integrated Space Weather Analysis system at http://iswa.ccmc.gsfc.nasa.gov.

NASA's Hubble Rules Out One Alternative to Dark Energy

Astronomers using NASA's Hubble Space Telescope have ruled out an alternate theory on the nature of dark energy after recalculating the expansion rate of the universe to unprecedented accuracy.

The universe appears to be expanding at an increasing rate. Some believe that is because the universe is filled with a dark energy that works in the opposite way of gravity. One alternative to that hypothesis is that an enormous bubble of relatively empty space eight billion light-years across surrounds our galactic neighborhood. If we lived near the center of this void, observations of galaxies being pushed away from each other at accelerating speeds would be an illusion.

This hypothesis has been invalidated because astronomers have refined their understanding of the universe's present expansion rate. Adam Riess of the Space Telescope Science Institute (STScI) and Johns Hopkins University in Baltimore, Md., led the research. The Hubble observations were conducted by the SHOES (Supernova Ho for the Equation of State) team that works to refine the accuracy of the Hubble constant to a precision that allows for a better characterization of dark energy's behavior. The observations helped determine a figure for the universe's current expansion rate to an uncertainty of just 3.3 percent. The new measurement reduces the error margin by 30 percent over Hubble's previous best measurement of 2009. Riess' results appear in the April 1 issue of The Astrophysical Journal.

The value for the expansion rate is 73.8 kilometers per second per megaparsec. It means that for every additional million parsecs (3.26 million light-years) a galaxy is from Earth, the galaxy appears to be traveling 73.8 kilometers per second faster away from us.

Every decrease in uncertainty of the universe's expansion rate helps solidify our understanding of its cosmic ingredients. Knowing the precise value of the universe's expansion rate further restricts the range of dark energy's strength and helps astronomers tighten up their estimates of other cosmic properties, including the universe's shape and its roster of neutrinos, or ghostly particles, that filled the early universe.

"We are using the new camera on Hubble like a policeman's radar gun to catch the universe speeding," Riess said. "It looks more like it's dark energy that's pressing on the gas pedal."

Bursting the Bubble

Dark energy is one of the greatest cosmological mysteries in modern physics. Even Albert Einstein conceived of a repulsive force, called the cosmological constant, which would counter gravity and keep the universe stable. He abandoned the idea when astronomer Edwin Hubble discovered in 1929 that the universe is expanding. Observational evidence for dark energy didn't come along until 1998, when two teams of researchers (one led by Riess) discovered it.

The idea of dark energy was so far-fetched, many scientists began contemplating other strange interpretations, including the cosmic bubble theory. In this theory, the lower-density bubble would expand faster than the more massive universe around it. To an observer inside the bubble, it would appear that a dark-energy-like force was pushing the entire universe apart. The bubble hypothesis requires that the universe's expansion rate be much slower than astronomers have calculated, about 60 to 65 kilometers per second per megaparsec. By reducing the uncertainty of the Hubble constant's value to 3.3 percent, Riess reports that his team has eliminated beyond all reasonable doubt the possibility of that lower number.

The brilliant, blue glow of young stars trace the graceful spiral arms of galaxy NGC 5584 in this Hubble Space Telescope image. Thin, dark dust lanes appear to be flowing from the yellowish core, where older stars reside. The reddish dots sprinkled throughout the image are largely background galaxies. Credit: NASA, ESA, A. Riess (STScI/JHU), L. Macri (Texas A&M University), and Hubble Heritage Team (STScI/AURA)

"The hardest part of the bubble theory to accept was that it required us to live very near the center of such an empty region of space," explained Lucas Macri, of Texas A&M University in College Station, a key collaborator of Riess. "This has about a one in a million chance of occurring. But since we know that something weird is making the universe accelerate, it's better to let the data be our guide."

Using stars as "cosmic yardsticks" measuring the universe's expansion rate is a tricky business. Riess' team first had to determine accurate distances to galaxies near and far from Earth. The team compared those distances with the speed at which the galaxies are apparently receding because of the expansion of space. They used those two values to calculate the Hubble constant, the number that relates the speed at which a galaxy appears to recede to its distance from the Milky Way. Because astronomers cannot physically measure the distances to galaxies, researchers had to find stars or other objects that serve as reliable cosmic yardsticks. These are objects with an intrinsic brightness, brightness that hasn't been dimmed by distance, an atmosphere, or stellar dust, that is known. Their distances, therefore, can be inferred by comparing their true brightness with their apparent brightness as seen from Earth.

Among the most reliable of these cosmic yardsticks for relatively shorter distances are Cepheid variables, pulsating stars that dim and fade at rates that correspond to their intrinsic luminosity. But Cepheids are too dim to be found in very distant galaxies. To calculate longer distances, Riess' team chose a special class of exploding stars called Type Ia supernovae. These stellar explosions all flare with similar luminosity and are brilliant enough to be seen far across the universe. By comparing the apparent brightness of Type la supernovae and pulsating Cepheid stars, the astronomers could measure accurately their intrinsic brightness and therefore calculate distances to Type Ia supernovae in far-flung galaxies.

Using the sharpness of the new Wide Field Camera 3 (WFC3) to study more stars in visible and near-infrared light, scientists eliminated systematic errors introduced by comparing measurements from different telescopes.

"WFC3 is the best camera ever flown on Hubble for making these measurements, improving the precision of prior measurements in a small fraction of the time it previously took," said Macri.

Using one instrument to measure the Hubble constant is like measuring a hallway with a tape measure instead of by laying a ruler from end to end. By avoiding the need to pick up the ruler and lay it back down, you can prevent mistakes. "The camera on Hubble, WFC3, is the best ever flown on Hubble for making these measurements, improving the precision of prior measurements in a small fraction of the time it previously took," Riess said.

The astronomer hopes that Hubble will continue to be used in this way to reduce the uncertainty in the Hubble constant even more, and thus refine the measured properties of dark energy. He suggests the present uncertainty could be cut in two before Hubble gives way to improvements out of Hubble's reach but within the scope of the James Webb Space Telescope, an infrared observatory scheduled to launch later this decade.

Chasing a runaway universe, Riess has been pursing dark energy for 13 years. He co-discovered the existence of dark energy by finding that distant Type Ia supernovae were dimmer than expected, which meant they were farther away than anticipated. The only way for that to happen, Riess realized, was if the expansion of the universe had sped up some time in the past.

Until that discovery, astronomers had generally believed that the cosmic expansion was gradually slowing down, due to the gravitational tugs that individual galaxies exert on one another. But the results implied that some mysterious force was acting against the pull of gravity, shoving galaxies away from each other at ever-increasing speeds.

Riess decided that one of the best ways to tighten the constraints on dark energy is to determine an accurate value for the Hubble constant, which he has been doing with the Hubble Space Telescope. That measurement, combined with others from NASA's Wilkinson Microwave Anisotropy Probe (WMAP), traces the universe's behavior from nearly the dawn of time to the present age. (WMAP showed the universe as it appeared shortly after the Big Bang, before stars and galaxies formed.)

Riess is just one of many astronomers who, over the past 80 years, have been measuring and re-measuring the Hubble constant. The Hubble telescope has played a major role in helping astronomers precisely measure the universe, expansion. Before Hubble was launched in 1990, the estimates for the Hubble constant varied by a factor of two. In 1999, the Hubble Space Telescope Key Project on the Extragalactic Distance Scale refined the value of the Hubble constant to an error of about 10 percent.

Suzaku Shows Clearest Picture Yet of Perseus Galaxy Cluster

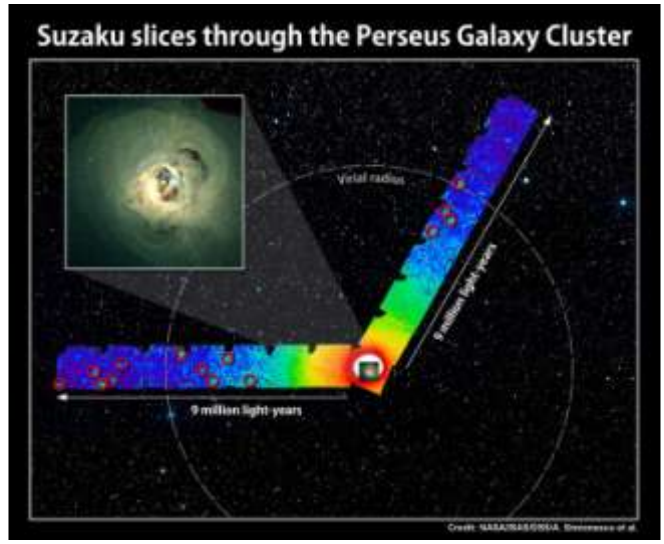
X-ray observations made by the Suzaku observatory provide the clearest picture to date of the size, mass and chemical content of a nearby cluster of galaxies. The study also provides the first direct evidence that million-degree gas clouds are tightly gathered in the cluster's outskirts.

Suzaku is sponsored by the Japan Aerospace Exploration Agency (JAXA) with contributions from NASA and participation by the international scientific community. The findings will appear in the March 25 issue of the journal Science.

Galaxy clusters are millions of light-years across, and most of their normal matter comes in the form of hot X-ray-emitting gas that fills the space between the galaxies.

"Understanding the content of normal matter in galaxy clusters is a key element for using these objects to study the evolution of the universe," explained Adam Mantz, a co-author of the paper at NASA's Goddard Space Flight Center in Greenbelt, Md.

Clusters provide independent checks on cosmological values established by other means, such as galaxy surveys, exploding stars and the cosmic microwave background, which is the remnant glow of the Big Bang. The cluster data and the other values didn't agree.



Suzaku explored faint X-ray emission of hot gas across two swaths of the Perseus Galaxy Cluster. The images, which record X-rays with energies between 700 and 7,000 electron volts in a combined exposure of three days, are shown in two false-color strips. Bluer colors indicate less intense X-ray emission. The dashed circle is 11.6 million light-years across and marks the so-called virial radius, where cold gas is now entering the cluster. Red circles indicate X-ray sources not associated with the cluster. Inset: An image of the cluster's bright central region taken by NASA's Chandra X-ray Observatory is shown to scale. (Credits: NASA/ISAS/DSS/A. Simionescu et al.; inset: NASA/CXC/A. Fabian et al.)

NASA's Wilkinson Microwave Anisotropy Probe (WMAP) explored the cosmic microwave background and established that baryons -- what physicists call normal matter -- make up only about 4.6 percent of the universe. Yet previous studies showed that galaxy clusters seemed to hold even fewer baryons than this amount.

Suzaku images of faint gas at the fringes of a nearby galaxy cluster have allowed astronomers to resolve this discrepancy for the first time.

The satellite's ideal target for this study was the Perseus Galaxy Cluster, which is located about 250 million light-years away and named for the constellation in which it resides. It is the brightest extended X-ray source beyond our own galaxy, and also the brightest and closest cluster in which Suzaku has attempted to map outlying gas.

"Before Suzaku, our knowledge of the properties of this gas was limited to the innermost parts of clusters, where the X-ray emission is brightest, but this left a huge volume essentially unexplored," said Aurora Simionescu, the study's lead researcher at the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) at Stanford University.

This Hubble Space Telescope image shows NGC 1275, the galaxy located in the center of the Perseus Galaxy Cluster. The red threadlike filaments are composed of cool gas suspended by a magnetic field. (Credit: NASA/ESA/Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration)

In late 2009, Suzaku's X-ray telescopes repeatedly observed the cluster by progressively imaging areas farther east and northwest of the center. Each set of images probed sky regions two degrees across -- equivalent to four times the apparent width of the full moon or about 9 million light-years at the cluster's distance. Staring at the cluster for about three days, the satellite mapped X-rays with energies hundreds of times greater than that of visible light.

From the data, researchers measured the density and temperature of the faint X-ray gas, which let them infer many other important quantities. One is the so-called virial radius, which essentially marks the edge of the cluster. Based on this measurement, the cluster is 11.6 million light-years across and contains more than 660 trillion times the mass of the sun. That's nearly a thousand times the mass of our Milky Way galaxy.

The researchers also determined the ratio of the cluster's gas mass to its total mass, including dark matter -- the mysterious substance that makes up about 23 percent of the universe, according to WMAP. By virtue of their enormous size, galaxy clusters should contain a representative sample of cosmic matter, with normal-to-dark-matter ratios similar to WMAP's. Yet the outer parts of the Perseus cluster seemed to contain too many baryons, the opposite of earlier studies, but still in conflict with WMAP.

To solve the problem, researchers had to understand the distribution of hot gas in the cluster, the researchers say. In the central regions, the gas is repeatedly whipped up and smoothed out by passing galaxies. But computer simulations show that fresh infalling gas at the cluster edge tends to form irregular clumps.

Not accounting for the clumping overestimates the density of the gas. This is what led to the apparent disagreement with the fraction of normal matter found in the cosmic microwave background.

"The distribution of these clumps and the fact that they are not immediately destroyed as they enter the cluster are important clues in understanding the physical processes that take place in these previously unexplored regions," said Steve Allen at KIPAC, the principal investigator of the Suzaku observations.

Goddard supplied Suzaku's X-ray telescopes and data-processing software, and it continues to operate a facility that supports U.S. astronomers who use the spacecraft.

Suzaku (Japanese for "red bird of the south") is the fifth Japanese X-ray astronomy satellite. It was launched as Astro-E2 on July 10, 2005, and renamed in orbit. The observatory was developed at JAXA's Institute of Space and Astronautical Science in collaboration with NASA and other Japanese and U.S. institutions.

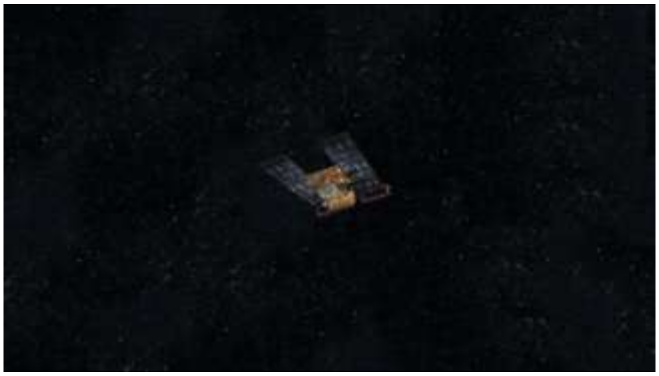
NASA's Venerable Comet Hunter Wraps up Mission

At 33 minutes after 4 p.m. PDT on March 25th, 2011, NASA's Stardust spacecraft finished its last transmission to Earth. The transmission came on the heels of the venerable spacecraft's final rocket burn, which was designed to provide insight into how much fuel remained aboard after its encounter with comet Tempel 1 in February.

"Stardust has been teaching us about our solar system since it was launched in 1999," said Stardust-NExT project manager Tim Larson from NASA's Jet Propulsion Laboratory in Pasadena, Calif. "It makes sense that its very last moments would be providing us with data we can use to plan deep space mission operations in the future."

The burn to depletion maneuver was designed to fire Stardust's rockets until insufficient fuel remains to continue, all the while downlinking data on the burn to Earth some 312 million kilometers (194 million miles) away. Mission personnel will compare the amount of fuel consumed in the burn with the amount they anticipated would be burned based on their fuel consumption models.

Fuel consumption models are necessary because no one has invented a reliable fuel gauge for spacecraft when in the weightless environment of space flight. Until that day arrives, mission planners can approximate fuel usage by looking at the history of the vehicle's flight and how many times and for how long its rocket motors have fired.



Space exploration's most traveled comet hunter, NASA's Stardust spacecraft, illustrated in this artist's concept, completed its 12 year mission on March 24, 2011. Image credit: NASA/JPL-Caltech

Mission personnel watched the final data from the burn come down at JPL's Space Flight Operations Facility and at the Stardust-NExT mission support center at Lockheed Martin Space Systems in Denver.

"Stardust motors burned for 146 seconds," said Allan Cheuvront, Lockheed Martin Space Systems Company program manager for Stardust-NExT. "We'll crunch the numbers and see how close the reality matches up with our projections. That will be a great data set to have in our back pocket when we plan for future missions."

The Stardust team performed the final burn to depletion because NASA's most senior comet hunter is a spacecraft literally running on fumes. Launched on Feb. 7, 1999, Stardust had completed its prime mission back in January 2006. By that time, Stardust had already flown past an asteroid (Annefrank), flown halfway out to Jupiter to collect particle samples from the coma of a comet, Wild 2, and returned to fly by Earth to drop off a sample return capsule eagerly awaited by comet scientists. NASA then re-tasked the spacecraft to perform a bonus mission to fly past comet Tempel 1 to collect images and other scientific data. Stardust has traveled about 21 million kilometers (13 million miles) in its journey about the sun in the few weeks since the Valentine's day comet Tempel 1 flyby, making the grand total from launch to its final rocket burn about 5.69 billion kilometers (3.54 billion miles).

With all that mileage logged, the Stardust team knew the end was near. Now, with its fuel tank empty and its final messages transmitted, history's most traveled comet hunter will move from NASA's active mission roster to retired.

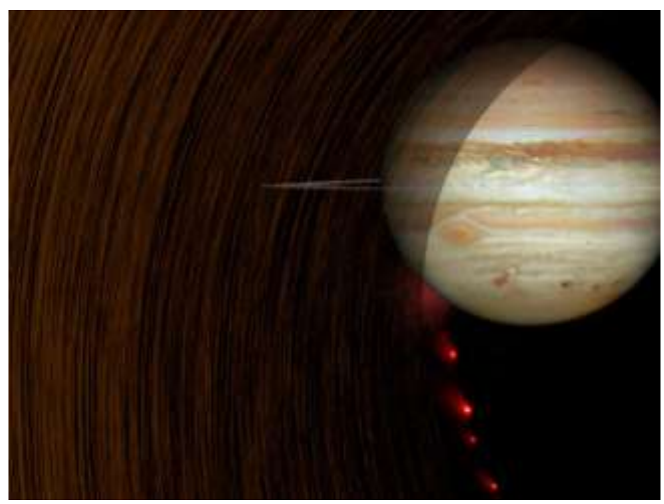
"This kind of feels like the end of one of those old Western movies where you watch the hero ride his horse towards the distant setting sun – and then the credits begin to roll," said Larson. "Only there's no setting sun in space."

Stardust-NExT was a low-cost mission to expand the investigation of comet Tempel 1 initiated by NASA's Deep Impact spacecraft. JPL, a division of the California Institute of Technology in Pasadena, managed the Stardust-NExT project for the NASA Science Mission Directorate, Washington, D.C., which was part of the Discovery Program managed by NASA's Marshall Space Flight Center in Huntsville, Ala. Joe Veverka of Cornell University, Ithaca, N.Y., was the mission's principal investigator. Lockheed Martin Space Systems, Denver, built the spacecraft and managed day-to-day mission operations.

Forensic Sleuthing Ties Ring Ripples to Impacts

PASADENA, Calif. – Like forensic scientists examining fingerprints at a cosmic crime scene, scientists working with data from NASA's Cassini, Galileo and New Horizons missions have traced telltale ripples in the rings of Saturn and Jupiter back to collisions with cometary fragments dating back more than 10 years ago.

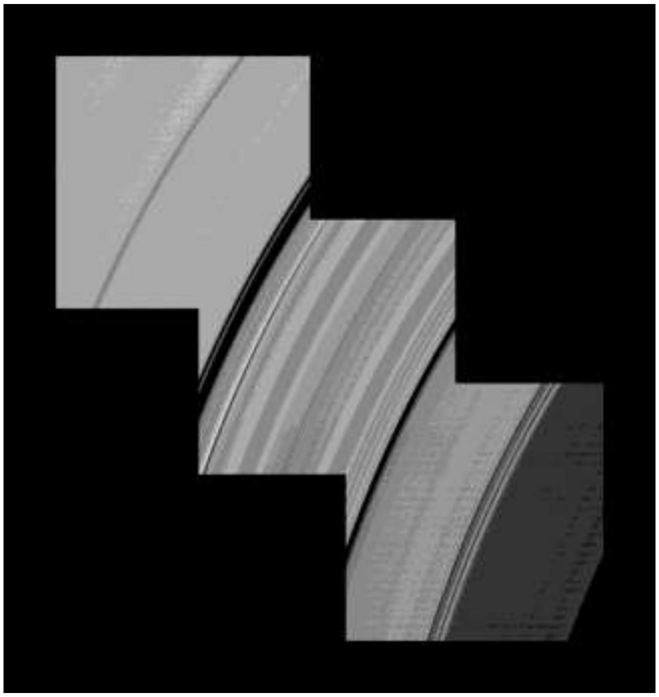
The ripple-producing culprit, in the case of Jupiter, was comet Shoemaker-Levy 9, whose debris cloud hurtled through the thin Jupiter ring system during a kamikaze course into the planet in July 1994. Scientists attribute Saturn's ripples to a similar object – likely another cloud of comet debris -- plunging through the inner rings in the second half of 1983. The findings are detailed in a pair of papers published online today in the journal Science.



This artist's concept shows comet Shoemaker-Levy 9 heading into Jupiter in July 1994, while its dust cloud creates a rippling wake in Jupiter's ring. Image credit: copyright M. Showalter

"What's cool is we're finding evidence that a planet's rings can be affected by specific, traceable events that happened in the last 30 years, rather than a hundred million years ago," said Matthew Hedman, a Cassini imaging team associate, lead author of one of the papers, and a research associate at Cornell University, Ithaca, N.Y. "The solar system is a much more dynamic place than we gave it credit for."

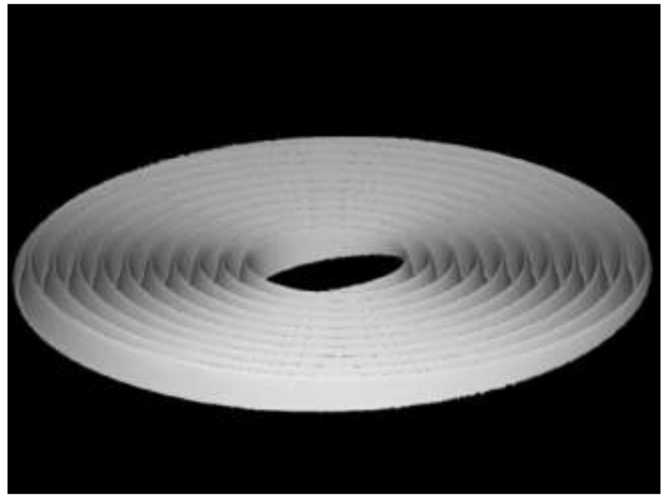
From Galileo's visit to Jupiter, scientists have known since the late 1990s about patchy patterns in the Jovian ring. But the Galileo images were a little fuzzy, and scientists didn't understand why such patterns would occur. The trail was cold until Cassini entered orbit around Saturn in 2004 and started sending back thousands of images. A 2007 paper by Hedman and colleagues first noted corrugations in Saturn's innermost ring, dubbed the D ring.



Alternating light and dark bands, extending a great distance across Saturn's D and C rings, are shown here in these Cassini images taken one month before the planet's August 2009 equinox. Image credit: NASA/JPL/Space Science Institute

A group including Hedman and Mark Showalter, a Cassini co-investigator based at the SETI Institute in Mountain View, Calif., then realized that the grooves in the D ring appeared to wind together more tightly over time. Playing the process backward, Hedman then demonstrated the pattern originated when something tilted the D ring off its axis by about 100 meters (300 feet) in late 1983. The scientists found the influence of Saturn's gravity on the tilted area warped the ring into a tightening spiral.

Cassini imaging scientists got another clue when the sun shone directly along Saturn's equator and lit the rings edge-on in August 2009. The unique lighting conditions highlighted ripples not previously seen in another part of the ring system. Whatever happened in 1983 was not a small, localized event; it was big. The collision had tilted a region more than 19,000 kilometers (12,000 miles) wide, covering part of the D ring and the next outermost ring, called the C ring. Unfortunately spacecraft were not visiting Saturn at that time, and the planet was on the far side of the sun, hidden from telescopes on or orbiting Earth, so whatever happened in 1983 passed unnoticed by astronomers.



This graphic shows in a series of three images how Saturn's rings, after they became tilted relative to Saturn's equatorial plane, would have transformed into a corrugated ring. Image credit: NASA/JPL/Cornell

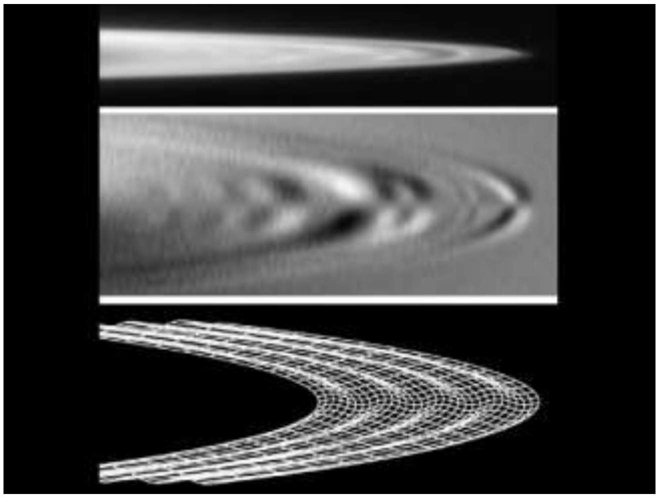
Hedman and Showalter, the lead author on the second paper, began to wonder whether the long-forgotten pattern in Jupiter's ring system might illuminate the mystery. Using Galileo images from 1996 and 2000, Showalter confirmed a similar winding spiral pattern. They applied the same math they had applied to Saturn – but now with Jupiter's gravitational influence factored in. Unwinding the spiral pinpointed the date when Jupiter's ring was tilted off its axis: between June and September 1994. Shoemaker-Levy plunged into the Jovian atmosphere during late July 1994. The estimated size of the nucleus was also consistent with the amount of material needed to disturb Jupiter's ring.

The Galileo images also revealed a second spiral, which was calculated to have originated in 1990. Images taken by New Horizons in 2007, when the spacecraft flew by Jupiter on its way to Pluto, showed two newer ripple patterns, in addition to the fading echo of the Shoemaker-Levy impact.

"We now know that collisions into the rings are very common – a few times per decade for Jupiter and a few times per century for Saturn," Showalter said. "Now scientists know that the rings record these impacts like grooves in a vinyl record, and we can play back their history later."

The ripples also give scientists clues to the size of the clouds of cometary debris that hit the rings. In each of these cases, the nuclei of the comets – before they likely broke apart – were a few kilometers wide.

"Finding these fingerprints still in the rings is amazing and helps us better understand impact processes in our solar system," said Linda Spilker, Cassini project scientist, based at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "Cassini's long sojourn around Saturn has helped us tease out subtle clues that tell us about the history of our origins."



These images, derived from data obtained by NASA's Galileo spacecraft, show the subtle ripples in the ring of Jupiter that scientists have been able to trace back to the impact of comet Shoemaker-Levy 9 in July 1994. Image credit: NASA/JPL-Caltech/SETI

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging team is based at the Space Science Institute in Boulder, Colo. JPL managed the Galileo mission for NASA, and designed and built the Galileo orbiter. The New Horizons mission is led by Principal Investigator Alan Stern of Southwest Research Institute, Boulder, Colo., and managed by the Johns Hopkins Applied Physics Laboratory, Laurel, Md., for NASA's Science Mission Directorate.

Some Parting Shots by STAR Members

Bodes Galaxy: C9.25 @f6 CGEM with autoguiding, Canon 50D, Light pollution filter.
6x 240 seconds @ ISO 1600
5x 160 seconds @ ISO 3200
2x 300 Seconds @ ISO 3200
Photo by: Joe Tillman

Saturn taken in b/w and color. C 11 at F/20 using a 2" 2x Powermate. Registax 5 and Image Plus, seeing a little above average. Leesburg, Florida around 11:30 PM, lots of Dew. Camera DBK21 1,000 AVI files. If you look at previus images of Saturn you can see that the storm has increased in size.
Photo by: Ernie Rossi

April 2011 Celestial Events

supplied by J. Randolph Walton (Randy)

Day	Date	Time (EDT)	Event
Sun	3	10:32	**New Moon**
		19:50	Moon set
Sat	9	05:20	Venus Rises
		06:05	Mars Rises
		06:25	Mercury Rises
		06:32	Sunrise
		06:40	Saturn Sets
		10:10	Moon rise
		19:05	Jupiter Sets
		19:32	Sunset
Mon	11	08:05	**First Quarter Moon**
		12:15	Moon rise
		21:00	**Lunar Straight Wall visible**
Sat	16	05:15	Venus Rises
		05:50	Mars Rises
		05:55	Mercury Rises
		06:10	Saturn Sets
		06:10	Jupiter Rises
		06:21	Sunrise
		18:18	Moon rise
		19:39	Sunset
Sun	17	19:35	Moon rise
		22:44	**Full Moon**
Fri	22	19:00	**Lyrid meteors (ZHR=20)**
Sat	23	05:05	Venus Rises
		05:25	Mercury Rises
		05:35	Mars Rises
		05:40	Saturn Sets
		05:45	Jupiter Rises
		06:11	Sunrise
		10:47	Moon set
		19:46	Sunset
Sun	24	11:50	Moon set
		22:47	**Last Quarter Moon**
Sat	30	05:00	Venus Rises
		05:10	Saturn Sets
		05:10	Mercury Rises
		05:20	Jupiter Rises
		05:20	Mars Rises
		06:02	Sunrise
		17:43	Moon set
		19:53	Sunset

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