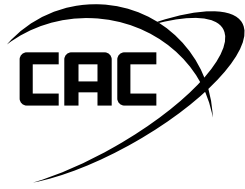


## Catskills Astronomy Club News

April, 2008



Catskills  
Astronomy  
Club

John Kocijanski.....Editor  
Jim McKeegan.....President  
John Kocijanski.....Vice-President  
Lisa Brody.....Treasurer  
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*4/1/08*

### *Club News:*

The latest of our “dinner and a movie” meetings was held on March 1<sup>st</sup> at Morgan Outdoors in Livingston Manor. The meeting was attended by about twenty people. The PBS/Nova documentary “Death Star” was shown. The film presented the mystery of gamma ray burst events and the theory that they may be related to the death of supermassive stars in distant galaxies. Two question and answer segments were moderated by Jim McKeegan. Alan Chao provided his laptop computer and projector to show the DVD. The film spurred numerous questions from the audience and was well received. Everyone seemed to enjoy the film as well as the pizza that was served for dinner. The image below shows Jim leading a discussion during one of the breaks.



The club has selection of astronomy books and DVDs in our library to lend to members. A Meade eight inch reflector and Edmund three inch reflector are also available for members to borrow. Please contact John at 791-5240 or [kocis@verizon.net](mailto:kocis@verizon.net) if you are interested in borrowing any of these.

### ***Astronomy News:***

Here are some articles from various NASA sources that might be of interest.

NEWS RELEASE: 2008-046

March 19, 2008

### **Astronomers Detect First Organic Molecule on an Exoplanet**

A team of astronomers led by Mark Swain of NASA's Jet Propulsion Laboratory, Pasadena, Calif., has made the first detection ever of an organic molecule in the atmosphere of a Jupiter-sized planet orbiting another star. The breakthrough, made with NASA's Hubble Space Telescope, is an important step in eventually identifying signs of life on a planet outside our solar system.

The molecule found by Hubble is methane, which under the right circumstances can play a key role in prebiotic chemistry - the chemical reactions considered necessary to form life as we know it.

This discovery proves that Hubble and upcoming space missions, such as NASA's James Webb Space Telescope, can detect organic molecules on planets around other stars by using spectroscopy, which splits light into its components to reveal the "fingerprints" of various chemicals.

"This is a crucial stepping stone to eventually characterizing prebiotic molecules on planets where life could exist," said Swain, lead author of a paper appearing in the March 20 issue of Nature.

The discovery comes after extensive observations made in May 2007 with Hubble's Near Infrared Camera and Multi-Object Spectrometer. It also confirms the existence of water molecules in the planet's atmosphere, a discovery made originally by NASA's Spitzer Space

Telescope in 2007. "With this observation there is no question whether there is water or not - water is present," said Swain.

The planet now known to have methane and water is located 63 light-years away in the constellation Vulpecula. Called HD 189733b, the planet is so massive and so hot it is considered an unlikely host for life. HD 189733b, dubbed a "hot Jupiter," is so close to its parent star it takes

just over two days to complete an orbit. These objects are the size of Jupiter but orbit closer to their stars than the tiny innermost planet Mercury in our solar system. HD 189733b's atmosphere swelters at 1700 degrees Fahrenheit, about the same temperature as the melting point of silver.

Though the star-hugger planet is too hot for life as we know it, "this observation is proof that spectroscopy can eventually be done on a cooler and potentially habitable Earth-sized planet orbiting a dimmer red dwarf-type star," Swain said. The ultimate goal of studies like these is to identify prebiotic molecules in the atmospheres of planets in the "habitable zones" around other stars, where temperatures are right for water to remain liquid rather than freeze or evaporate away.

The observations were made as the planet HD 189733b passed in front of its parent star in what astronomers call a transit. As the light from the star passed briefly through the atmosphere along the edge of the planet, the gases in the atmosphere imprinted their unique signatures on the starlight from the star HD 189733.

The astronomers were surprised to find that the planet has more methane than predicted by conventional models for "hot Jupiters." "This indicates we don't really understand exoplanet atmospheres yet," said Swain.

"These measurements are an important step to our ultimate goal of determining the conditions, such as temperature, pressure, winds, clouds, etc., and the chemistry on planets where life could exist. Infrared spectroscopy is really the key to these studies because it is best matched to detecting molecules," said Swain.

More information on the discovery and artist's concepts are online at:

<http://hubblesite.org/news/2008/11> . Swain's co-authors on the paper include Gautam Vasisht of JPL and Giovanna Tinetti of University College, London.

The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency and is managed by NASA's Goddard Space Flight Center in Greenbelt, Md. The Space Telescope Science Institute conducts Hubble science operations. The institute is operated for NASA by the Association of Universities for Research in Astronomy, Inc., Washington, DC. Scheduled for launch in 2013, the James Webb Space Telescope is an international collaboration between NASA, ESA, and the Canadian Space Agency (CSA). GSFC is managing the development effort. The prime contractor is Northrop Grumman Space Technologies. STScI will operate JWST after launch.

JPL manages the Spitzer Space Telescope mission for NASA's Science Mission Directorate, Washington. Science operations are conducted at the Spitzer Science Center at the California Institute of Technology, also in Pasadena. Caltech manages JPL for NASA. Previous Spitzer dis-

coveries regarding HD 189733b from Swain and others can be read at <http://www.spitzer.caltech.edu/Media/releases/ssc2007-04/release.shtml> .

Read a profile about astronomer Mark Swain at <http://www.jpl.nasa.gov/news/features.cfm?feature=1641>

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News Release: 2008-048

March 20, 2008

### **Cassini Spacecraft Finds Ocean May Exist Beneath Titan's Crust**

PASADENA, Calif. - NASA's Cassini spacecraft has discovered evidence that points to the existence of an underground ocean of water and ammonia on Saturn's moon Titan. The findings, made using radar measurements of Titan's rotation, will appear in the March 21 issue of the journal *Science*.

"With its organic dunes, lakes, channels and mountains, Titan has one of the most varied, active and Earth-like surfaces in the solar system," said Ralph Lorenz, lead author of the paper and Cassini radar scientist at the Johns Hopkins Applied Physics Laboratory in Laurel, Md., "Now we see changes in the way Titan rotates, giving us a window into Titan's interior beneath the surface."

Members of the mission's science team used Cassini's Synthetic Aperture Radar to collect imaging data during 19 separate passes over Titan between October 2005 and May 2007. The radar can see through Titan's dense, methane-rich atmospheric haze, detailing never-before-seen surface features and establishing their locations on the moon's surface.

Using data from the radar's early observations, the scientists and radar engineers established the locations of 50 unique landmarks on Titan's surface. They then searched for these same lakes, canyons and mountains in the reams of data returned by Cassini in its later flybys of Titan. They found prominent surface features had shifted from their expected positions by up to 30 kilometers (19 miles). A systematic displacement of surface features would be difficult to explain unless the moon's icy crust was decoupled from its core by an internal ocean, making it easier for the crust to move.

"We believe that about 100 kilometers (62 miles) beneath the ice and organic-rich surface is an internal ocean of liquid water mixed with ammonia," said Bryan Stiles of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Stiles is a contributing author to the paper.

The study of Titan is a major goal of the Cassini-Huygens mission because it may preserve, in deep-freeze, many of the chemical compounds that preceded life on Earth. Titan is the only moon in the solar system that possesses a dense atmosphere. The moon's atmosphere is 1.5 times denser than Earth's. Titan is the largest of Saturn's moons, bigger than the planet Mercury.

"The combination of an organic-rich environment and liquid water is very appealing to astrobiologists," Lorenz said. "Further study of Titan's rotation will let us understand the watery interior better, and because the spin of the crust and the winds in the atmosphere are linked, we might see seasonal variation in the spin in the next few years."

Cassini scientists will not have long to wait before another go at Titan. On March 25, just prior to its closest approach at an altitude of 1,000 kilometers (620 miles), Cassini will employ its Ion and Neutral Mass Spectrometer to examine Titan's upper atmosphere. Immediately after closest approach, the spacecraft's Visual and Infrared Mapping Spectrometer will capture high-resolution images of Titan's southeast quadrant.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The mission is managed by JPL, a division of the California Institute of Technology in Pasadena. The Cassini orbiter also was designed, developed and assembled at JPL. The radar instrument was built by JPL and the Italian Space Agency, working with team members from the United States and several European countries.

For information about Cassini visit: <http://www.nasa.gov/cassini> and <http://saturn.jpl.nasa.gov> .

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NEWS RELEASE: 2008-036

March 3, 2008

### **NASA Spacecraft Photographs Avalanches on Mars**

Pasadena, Calif. - A NASA spacecraft in orbit around Mars has taken the first ever image of active avalanches near the Red Planet's north pole. The image shows tan clouds billowing away from the foot of a towering slope, where ice and dust have just cascaded down.

The High Resolution Imaging Experiment (HiRISE) on NASA's Mars Reconnaissance Orbiter took the photograph Feb. 19. It is one of approximately 2,400 HiRISE images being released today.

Ingrid Daubar Spitale of the University of Arizona, Tucson, who works on targeting the camera and has studied hundreds of HiRISE images, was the first person to notice the avalanches. "It really surprised me," she said. "It's great to see something so dynamic on Mars. A lot of what we see there hasn't changed for millions of years."

The camera is looking repeatedly at selected places on Mars to track seasonal changes. However, the main target of the Feb. 19 image was not the steep slope.

"We were checking for springtime changes in the carbon-dioxide frost covering a dune field, and finding the avalanches was completely serendipitous," said Candice Hansen, deputy principal investigator for HiRISE, at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

The full image reveals features as small as a desk in a strip of terrain 6 kilometers (3.7 miles) wide and more than 10 times that long, at 84 degrees north latitude. Reddish layers known to be rich in water ice make up the face of a steep slope more than 700 meters (2,300 feet) tall, running the length of the image.

"We don't know what set off these landslides," said Patrick Russell of the University of Berne, Switzerland, a HiRISE team collaborator. "We plan to take more images of the site through the changing Martian seasons to see if this kind of avalanche happens all year or is restricted to early spring."

More ice than dust probably makes up the material that fell from the upper portion of the scarp. Imaging of the site during coming months will track any changes in the new deposit at the base of the slope. That will help researchers estimate what proportion is ice.

"If blocks of ice broke loose and fell, we expect the water in them will be changing from solid to gas," Russell said. "We'll be watching to see if blocks and other debris shrink in size. What we learn could give us a better understanding of one part of the water cycle on Mars."

Another notable HiRISE image released today shows a blue crescent Earth and its moon, as seen by the Mars Reconnaissance Orbiter. The west coast of South America is visible in the photo. Still other images allow viewers to explore a wide variety of Martian terrains, such as dramatic canyons and rhythmic patterns of sand dunes.

The camera is one of six science instruments on the orbiter. The spacecraft reached Mars in March 2006 and has returned more data than all other current and past missions to Mars combined.

"Our Mars program is the envy of the world," said Alan Stern, associate administrator of NASA's Science Mission Directorate, Washington. "We plan to launch a total of five more missions in the next decade, beginning with the Mars Science Lab rover next year and a Mars Aeronomy Scout mission in 2011."

The avalanche image, other selected images, and additional information about the Mars Reconnaissance Orbiter are online at <http://www.nasa.gov/mro>. All the newly posted and previously posted images from the High Resolution Imaging Science Experiment are available online at <http://hirise.lpl.arizona.edu>.

The MRO mission is managed by JPL for NASA's Science Mission Directorate, Washington. Lockheed Martin Space Systems, Denver, Colo., is the prime contractor for the project and built the spacecraft. The University of Arizona operates the High Resolution Imaging Science Experiment camera, which was built by Ball Aerospace and Technology Corp., Boulder, Colo.

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NEWS RELEASE: 2008-044

March 13, 2008

**Cassini Flies Through Watery Plumes of Saturn Moon**

NASA's Cassini spacecraft performed a daring flyby of Saturn's moon Enceladus on Wed., March 12, flying about 15 kilometers per second (32,000 mph) through icy water geyser-like jets. The spacecraft snatched up precious samples that might point to a water ocean or organics inside the little moon.

Scientists believe the geysers could provide evidence that liquid water is trapped under the icy crust of Enceladus. The geysers emanate from fractures running along the moon's south pole, spewing out water vapor at approximately 400 meters per second (800 mph).

The new data provide a much more detailed look at the fractures that modify the surface and will give a significantly improved comparison between the geologic history of the moon's north pole and south pole.

New images show that compared to much of the southern hemisphere on Enceladus--the south polar region in particular--the north polar region is much older and pitted with craters of various sizes. These craters are captured at different stages of disruption and alteration by tectonic activity, and probably from past heating from below. Many of the craters seem sliced by small parallel cracks that appear to be ubiquitous throughout the old cratered terrains on Enceladus.

"These new images are showing us in great detail how the moon's north pole differs from the south, an important comparison for working out the moon's obviously complex geological history," said Carolyn Porco, Cassini imaging team leader, Space Science Institute, Boulder, Colo. "And the success of yesterday's daring and very low-altitude flyby means this coming summer's very close encounter, when we get exquisitely detailed images of the surface sources of Enceladus' south polar jets, should be an exciting 'next big step' in understanding just how the jets are powered."

This week's flyby and another one planned for Oct. 9, 2008, were designed so that Cassini's particle analyzers could dissect the "body" of the plume for information on the density, size, composition and speed of the particles. Among other things, scientists will use the data gathered this week to figure out whether the gases from the plume match the gases that make up the halo of particles around Enceladus. This may help determine how the plumes formed.

During Cassini's closest approach, two instruments were collecting data--the Cosmic Dust Analyzer and the Ion and Neutral Mass Spectrometer. An unexplained software hiccup with Cassini's Cosmic Dust Analyzer instrument prevented it from collecting any data during closest approach, although the instrument did get data before and after the approach. During the flyby, the instrument was switching between two versions of software programs. The new version was designed to increase the ability to count particle hits by several hundred hits per second. The other four fields and particles instruments on the spacecraft, in addition to the ion and neutral mass spectrometer, did capture all of their data, which will complement the overall composition studies and elucidate the unique plume environment of Enceladus.

Cassini's instruments discovered evidence for the geyser-like jets on Enceladus in 2005, finding that the continuous eruptions of ice water create a gigantic halo of ice dust and gas around Enceladus, which helps supply material to Saturn's E-ring.

This was the first of four Cassini flybys of Enceladus this year. During Wednesday's flyby, the spacecraft came within 50 kilometers (30 miles) of the surface at closest approach, 200 kilometers (120 miles) while flying through the plume. Future trips may bring Cassini even closer to the surface of Enceladus. Cassini will complete its prime mission, a four-year tour of Saturn, in June. From then on, a proposed extended mission would include seven more Enceladus flybys. The next Enceladus flyby would take place in August of this year.

For more images and more information, visit: <http://www.nasa.gov/cassini> and <http://saturn.jpl.nasa.gov> .

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 was designed, developed and assembled at JPL.

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NEWS RELEASE: 2008-039

March 6, 2008

### **Saturn's Moon Rhea Also May Have Rings**

PASADENA, Calif. -- NASA's Cassini spacecraft has found evidence of material orbiting Rhea, Saturn's second largest moon. This is the first time rings may have been found around a moon.

A broad debris disk and at least one ring appear to have been detected by a suite of six instruments on Cassini specifically designed to study the atmospheres and particles around Saturn and its moons.

"Until now, only planets were known to have rings, but now Rhea seems to have some family ties to its ringed parent Saturn," said Geraint Jones, a Cassini scientist and lead author on a paper that appears in the March 7 issue of the journal *Science*. Jones began this work while at the Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, and is now at the Mullard Space Science Laboratory, University College, London.

Rhea is roughly 1,500 kilometers (950 miles) in diameter. The apparent debris disk measures several thousand miles from end to end. The particles that make up the disk and any embedded

rings probably range from the size of small pebbles to boulders. An additional dust cloud may extend up to 5,900 kilometers (3,000 miles) from the moon's center, almost eight times the radius of Rhea.

"Like finding planets around other stars, and moons around asteroids, these findings are opening a new field of rings around moons," said Norbert Krupp, a scientist with Cassini's Magnetospheric Imaging Instrument from the Max Planck Institute for Solar System Research.

Since the discovery, Cassini scientists have carried out numerical simulations to determine if Rhea can maintain rings. The models show that Rhea's gravity field, in combination with its orbit around Saturn, could allow rings that form to remain in place for a very long time.

The discovery was a result of a Cassini close flyby of Rhea in November 2005, when instruments on the spacecraft observed the environment around the moon. Three instruments sampled dust directly. The existence of some debris was expected because a rain of dust constantly hits Saturn's moons, including Rhea, knocking particles into space around them. Other instruments' observations showed how the moon was interacting with Saturn's magnetosphere, and ruled out the possibility of an atmosphere.

Evidence for a debris disk in addition to this tenuous dust cloud came from a gradual drop on either side of Rhea in the number of electrons detected by two of Cassini's instruments. Material near Rhea appeared to be shielding Cassini from the usual rain of electrons. Cassini's Magnetospheric Imaging Instrument detected sharp, brief drops in electrons on both sides of the moon, suggesting the presence of rings within the disk of debris. The rings of Uranus were found in a similar fashion, by NASA's Kuiper Airborne Observatory in 1977, when light from a star blinked on and off as it passed behind Uranus' rings.

"Seeing almost the same signatures on either side of Rhea was the clincher," added Jones. "After ruling out many other possibilities, we said these are most likely rings. No one was expecting rings around a moon."

One possible explanation for these rings is that they are remnants from an asteroid or comet collision in Rhea's distant past. Such a collision may have pitched large quantities of gas and solid particles around Rhea. Once the gas dissipated, all that remained were the ring particles. Other moons of Saturn, such as Mimas, show evidence of a catastrophic collision that almost tore the moon apart.

"The diversity in our solar system never fails to amaze us," said Candy Hansen, co-author and Cassini scientist on the Ultraviolet Imaging Spectrograph at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "Many years ago we thought Saturn was the only planet with rings. Now we may have a moon of Saturn that is a miniature version of its even more elaborately decorated parent."

These ring findings make Rhea a prime candidate for further study. Initial observations by the imaging team when Rhea was near the sun in the sky did not detect dust near the moon remotely. Additional observations are planned to look for the larger particles.

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 was designed, developed and assembled at JPL. The Magnetospheric Imaging Instrument was designed, built and is operated by an international team led by the Applied Physics Laboratory of the Johns Hopkins University, Laurel, Md.

For information on the Cassini mission, visit: <http://www.nasa.gov/cassini> and <http://saturn.jpl.nasa.gov>.

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News Release: 2008-047

March 20, 2008

### **NASA Mission Finds New Clues to Guide Search for Life on Mars**

PASADENA, Calif. - NASA's Mars Odyssey orbiter has found evidence of salt deposits. These deposits point to places where water once was abundant and where evidence might exist of possible Martian life from the Red Planet's past.

A team led by Mikki Osterloo of the University of Hawaii, Honolulu, found approximately 200 places on southern Mars that show spectral characteristics consistent with chloride minerals. Chloride is part of many types of salt, such as sodium chloride or table salt. The sites range from about a square kilometer (0.6 square mile) to 25 times that size.

"They could come from groundwater reaching the surface in low spots," Osterloo said. "The water would evaporate and leave mineral deposits, which build up over years. The sites are disconnected, so they are unlikely to be the remnants of a global ocean."

Scientists used Odyssey's Thermal Emission Imaging System, a camera designed and operated by Arizona State University, Tempe, to take images in a range of visible light and infrared wavelengths.

Thermal infrared wavelengths are useful for identifying different mineral and rock types on the Martian surface. Osterloo found the sites by looking through thousands of images processed to reveal, in false colors, compositional differences on the Martian surface.

Plotted on a Mars map, the chloride sites appear only in the southern highlands, the most ancient rocks on Mars. Osterloo and seven co-authors report the findings in this week's issue of the journal *Science*.

"Many of the deposits lie in basins with channels leading into them," said Philip Christensen, co-author and principal investigator for the camera at Arizona State University. "This is the kind of feature, like salt-pan deposits on Earth, that's consistent with water flowing in over a long time."

Scientists think the salt deposits formed approximately 3.5 to 3.9 billion years ago. Several lines of evidence suggest Mars then had intermittent periods with substantially wetter and warmer conditions than today's dry, frigid climate.

Scientists looking for evidence of past life on Mars have focused mainly on a handful of places that show evidence of clay or sulfate minerals. Clays indicate weathering by water, and sulfates may have formed by water evaporation. The new research, however, suggests an alternative mineral target to explore for biological remains.

"By their nature, salt deposits point to a lot of water, which potentially could remain standing in pools as it evaporates," said Christensen. "That's crucial. For life, it's all about a habitat that endures for some time."

Whether life ever has existed on Mars is the biggest scientific question driving Mars research. On Earth, salt is good at preserving organic material. Bacteria have been revived in the laboratory after being preserved in salt deposits for millions of years.

"This discovery demonstrates the continuing value of the Odyssey science mission, now entering its seventh year. The more we look at Mars, the more fascinating a place it becomes," said Jeffrey Plaut, Odyssey project scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

"This is a wonderful and scientifically exciting result obtained from a relatively low cost NASA Mars orbiter mission which still has years of life left," said Alan Stern, associate administrator for NASA's Science Mission Directorate in Washington. "Hold on to your hats, more exciting results from Mars are sure to be coming."

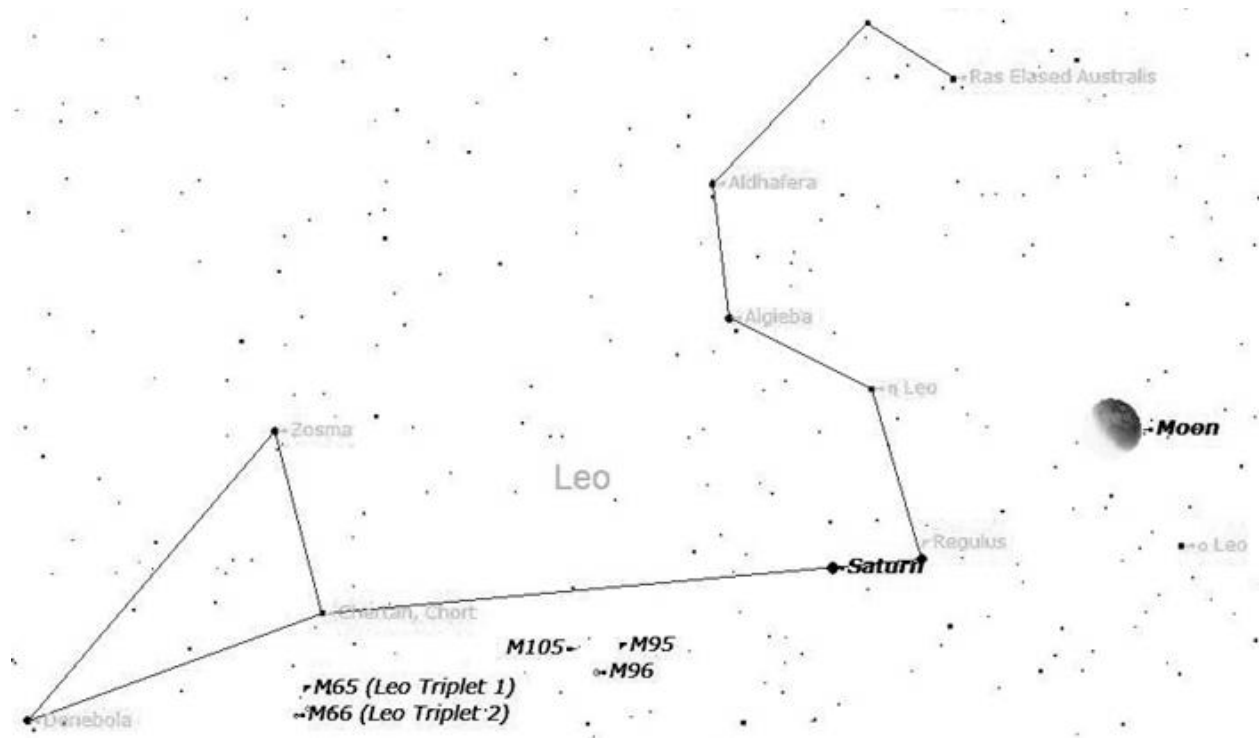
JPL, a division of the California Institute of Technology, Pasadena, manages Odyssey for the NASA Science Mission Directorate. Lockheed Martin Space Systems, Denver, is the prime contractor for the project and built the spacecraft. Additional information about Odyssey is at

[http://www.nasa.gov/mission\\_pages/odyssey](http://www.nasa.gov/mission_pages/odyssey) . More information about the camera and the new findings is at <http://themis.asu.edu> .

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### ***Mid Evening Observing Highlights for April***

Saturn is high in the southeastern sky in the constellation Leo. Orion is setting in the west. The bright star Arcturus is rising in the eastern sky. The bright star Spica is rising in the southeast. The constellations Virgo, Coma Berenices, Ursa Major, and Leo have many observable galaxies within their boundaries. New moon will occur on April 5<sup>th</sup> and full moon will occur on April 20<sup>th</sup>. The image below shows the location of some of the galaxies located in Leo on the evening of the 14<sup>th</sup> when the moon is just to the right of Saturn and the bright star Regulus.



## **Tracking Wildlife from Space**

by Patrick Barry

It's 10 o'clock, and do you know where your Oriental Honey Buzzard is?

Tracking the whereabouts of birds and other migrating wildlife across thousands of miles of land, air, and sea is no easy feat. Yet to protect the habitats of endangered species, scientists need to know where these roving animals go during their seasonal travels.

Rather than chasing these animals around the globe, a growing number of scientists are leveraging the bird's-eye view of orbiting satellites to easily monitor animals' movements anywhere in the world.

The system piggybacks on weather satellites called Polar Operational Environmental Satellites, which are operated by the National Oceanic and Atmospheric Administration (NOAA), as well as a European satellite called MetOp. Sensors aboard these satellites pick up signals beamed from portable transmitters on the Earth's surface, 850 kilometers below. NOAA began the project—called Argos—in cooperation with NASA and the French space agency (CNES) in 1974. At that time, scientists placed these transmitters primarily on buoys and balloons to study the oceans and atmosphere. As electronics shrank and new satellites' sensors became more sensitive, the transmitters became small and light enough by the 1990s that scientists could mount them safely on animals. Yes, even on birds like the Oriental Honey Buzzard.

“Scientists just never had the capability of doing this before,” says Christopher O'Connors, Program Manager for Argos at NOAA.

Today, transmitters weigh as little as 1/20th of a pound and require a fraction of a watt of power. The satellites can detect these feeble signals in part because the transmitters broadcast at frequencies between 401 and 403 MHz, a part of the spectrum reserved for environmental uses. That way there's very little interference from other sources of radio noise.

“Argos is being used more and more for animal tracking,” O'Connors says. More than 17,000 transmitters are currently being tracked by Argos, and almost 4,000 of them are on wildlife. “The animal research has been the most interesting area in terms of innovative science.”

For example, researchers in Japan used Argos to track endangered Grey-faced Buzzards and Oriental Honey Buzzards for thousands of kilometers along the birds' migrations through Japan and Southeast Asia. Scientists have also mapped the movements of loggerhead sea turtles off the west coast of Africa. Other studies have documented migrations of wood storks, Malaysian elephants, porcupine caribou, right whales, and walruses, to name a few.

Argos data is available online at [www.argos-system.org](http://www.argos-system.org), so every evening, scientists can check the whereabouts of all their herds, schools, and flocks. Kids can learn about some of these endangered species and play a memory game with them at [spaceplace.nasa.gov/en/kids/poes\\_tracking](http://spaceplace.nasa.gov/en/kids/poes_tracking).

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