

# The Stargazer

December 2008/January 2009

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**The Stargazer**  
**P.O. Box 12746**  
**Everett, WA 98206**

See EAS website at:

<http://everettastro.org>

## EAS BUSINESS...

### NEXT EAS MEETING – JANUARY 31ST 7 PM AT AURORA ASTRO PRODUCTS STORE AT SILVER LAKE.

#### ★★ Saturday January 31<sup>st</sup> 7:00 pm MEETING ★★

This month's program is **Dr. Ron Hobbs, NASA Solar System Ambassador**, speaking about **"The Great Martian Roadtrip" - a review of all of the main Martian exploration missions, including the upcoming Russian Fobos-Grunt/Yinghou 1 mission.**

#### Map/Directions to Aurora Astro Products store location -

[http://www.skyvalleyscopes.com/aurora\\_astro\\_products\\_silver\\_lak.htm](http://www.skyvalleyscopes.com/aurora_astro_products_silver_lak.htm)

Silver Lake Plaza, 11419 19th AVE. SE, Everett, WA 98208

#### If you are traveling northbound on I-5:

Take exit #186/128th St. and go east - to the right on 128th St. continue until you come to Murphy's Corner/Intersection with Highway 527/19th Ave SE/Old Bothell- Everett Highway (all one in the same) and turn left/north. Follow until you see Silver Lake Plaza (red brick construction) on your right with the lake is on your left.

#### If you are traveling southbound on I-5:

Take exit 187/ Everett Mall Way and at the top of the exit's hill turn right following signs for Highway 527. At the light turn right following the signs for Highway 527. Then stay on Highway 527/19th Ave SE/Old Bothell- Everett Highway until you have Silver Lake on your right and the Silver Lake Plaza on your left. You may also continue down I-5 until exit 186 and turn left onto 128th then follow previous directions. If you have a problem you can always call (425) 337-4384

The February Meeting will be February 28<sup>th</sup>.

#### ★ STAR PARTY INFO ★

Next scheduled EAS Star Party: None pre-planned until spring.

#### CAMP DELANEY SPRING STAR PARTY:

"The Olympic Astronomical Society will be hosting it's 6th annual spring Camp Delaney star party at Sun Lakes State Park April 23 - 26, 2009. We have enjoyed having your members join us in the past and I am extending a welcome again this year. The sign up form will be available on our website soon and can be found at [www.olympicastronomicalsociety.com](http://www.olympicastronomicalsociety.com). I hope this note finds your

respective clubs doing well. We are very excited about The year of Astronomy as I am sure you are as well."

- Cliff Mygatt, President, Olympic Astronomical Society

EAS member Ron Tam has offered a flexible opportunity to EAS members to come to his home north of Snohomish for observing on clear weekend evenings and for EAS starparties. Anyone wishing to do so needs to contact him in advance and confirm available dates, and let him know if plans change. "Our place is open for star parties any Saturday except weekends of the Full Moon. People can call to get weather conditions or to confirm that there is a star party. Our phone number is (360) 568-5152. They can e-mail me too ([tam1951@verizon.net](mailto:tam1951@verizon.net)) but I don't check my email daily. They can email me for directions if they never have been out here." Listed below are proposed dates for **planned EAS star parties** at my [Ron Tam's] place, depending upon the weather, of course. Call Ron about spur-of-the-moment observing.

Please also join the EAS mail list, and send mail to the mail list [everett\\_astronomy@topica.com](mailto:everett_astronomy@topica.com) to coordinate spur-of-the-moment observing get-togethers, on nights when the sky clears. We try to hold informal close-in star parties each month during the spring, summer, and fall months on a weekend near the New moon at a member's property or a local park. (call Jim Bielaga at (425) 337-4384 for info or check the EAS website.) Members contact Jim Bielaga for scope borrowing.

## EAS MEMBER NEWS

### Offices and Volunteer Roles in the EAS:

**President: (Mark Folkerts)** – Run the monthly EAS meetings, and introduce speakers, call EAS board meetings.

**Vice-President: (James Bielaga)** – Run EAS meetings if president is absent. Also store/maintain, and loan out the club telescopes.

**Treasurer: (Carol Gore)** – Collect club dues, pay club expenses, maintain club checking account bookkeeping, pickup and respond to mail sent to club.

**Librarian: (Mike Locke)** – Maintain the collections of books, tapes, videos, and software that has been donated to the club, and make available to members.

**Stargazer Newsletter Editor(s): (Mark Folkerts and Bill O'Neil)** – gather events and news and write articles to publish monthly newsletter.

**Webmaster: (Cody Gibson)** – design, update and support EAS website presence.

**ALCOR: (Joanne Green)** – Coordinate with the Astronomical League about EAS club membership info, announce AL ballots, review AL observing awards and distribute awards to members.

**Programs chairperson: (Mark Folkerts)** – Contact potential speakers and schedule them to come and speak to the EAS, send them directions and thank them for their contribution. Identify videos or other programs.

**Publicity / Astronomy-Day coordinator: (David Brodeur)** – Make reservations for venue (library), notify websites about EAS astronomy day events, create press releases and notify news organizations about EAS events, and promote new membership growth in the EAS.

**Star Party Host / coordinator: (Ron Tam)** – Offering the opportunity to members to view the sky from darker suburban/rural property location.

**Outreach chairperson: (currently vacant)** - Coordinate requests from public for EAS member volunteers to conduct star parties or presentations at visits to schools, senior centers, scout meetings, etc. We often have requests for members of the EAS to come and help with an 'astronomy night' event from local schools, scout groups, senior homes, or similar groups. Usually this would be in the form of a star party at their gathering, or perhaps a short slide show or night sky talk. Providing education and support to the community about interest astronomy is one of the main missions of the EAS. Please let club president know if you are interested and available to be on list of volunteers to handle these requests, so that we can say YES when people ask. A star party night can be a rewarding event for all involved. **Please email Mark Folkerts with your interest (or suggestions).**

**Sidewalk astronomy committee: (currently vacant).** – Plan and conduct urban/suburban sidewalk astronomy events to allow passers-by to experience astronomy. Needs 2-3 people for each event, and to schedule events. We are looking for volunteers who could do a series of Sidewalk Astronomy sessions this spring and summer, at a local park or public venue. For safety, moral support, and effectiveness, this should be done in teams of at least two people with telescopes. Special events like eclipse or comets especially draw the interest of the public.

**Secretary: (Carol Gore)** – Keep notes and photos of EAS meetings and events and speaker presentations, and publish them in the StarGazer newsletter, and send info to Night Sky Network.

**Other volunteers?** Find a way to help and contribute. Come up with a new idea to promote the EAS and astronomy in your community. Come to Astronomy Day or a star party and share your interest in the sky...

**Attention EAS Members – 10% Discount for all Everett Astronomical Society Members at Aurora Astro Products**

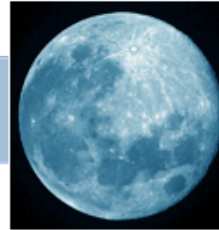
*"Show your club membership card at Jim Bielaga's new astronomy store 'Aurora Astro Products' and receive a 10% discount on all purchases. This is an exclusive discount to E.A.S. members only.*

*I am proud to be able to offer this discount to Everett club members, and thanks for the support you have shown me on*

*opening my new store. Also I have made great friends and learned a lot being a club member since 1991.*

*- Clear Skies, Jim Bielaga"*

**>> Members – please look at your EAS membership card to see when your membership dues are payable. If you are more than three months past due, the club will officially assume that you no longer wish to be a member, and remove you from the membership rolls. <<**



**Aurora Astro**

**Aurora Astro Products**

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Over 37 product dealerships, and growing

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Everett, WA 98208

[www.auroraastro.com](http://www.auroraastro.com)

425-337-4384

425-337-4758 fax

New hours:

Monday, Thursday, Friday – 9:00 am to 6:00 pm

Tuesday/Wednesday – Noon to 8:00 pm

Saturday – 10:00 am to 5:00 pm

Also, those who have subscriptions to Sky and Telescope can now pay their own subscription as long as they are EAS members in good standing. Members will now be able to renew directly via mail or phone and still obtain the club discount. The subscribers may mail in the renewal notices with their payment, or renew via phone at (800) 253-0245. Payment at the time of renewal is required. Once a year, Sky and Telescope will check with the EAS club treasurer to see that the subscribers are still members in good standing to qualify for the discount. New members will continue to subscribe through the club treasurer.

**\$\$ - FINANCIAL HEALTH - \$\$**

The club maintains a \$750+ balance. We try to keep approximately a \$500 balance to allow for contingencies.

**CLUB SCOPES**

**SCOPE**

10-INCH WARD DOBSONIAN

10-INCH SONOTUBE DOBSONIAN

8-INCH DOBSONIAN

**LOAN STATUS**

AVAILABLE

AVAILABLE

AVAILABLE

*EAS members: contact VP James Bielaga at (425) 337-4384 or jamesbielaga at aol.com to borrow a scope.*

**Does Anyone know about the history of the EAS ???**

The Northwest Region of the Astronomical League (NWRAL) is putting together a new website and needs the following information from each club of the NWRAL. The EAS is looking for any information from members about the early history.

Please contact Mark Folkerts if you have any info that could be of help. NRWAL would like a brief history of the club

- Club established date (approx 1986 ?)
- Who started the club (Terry Bacon, et. al.)
- When club joined the Astronomical League.

Sep 22 - Autumnal Equinox (21:18 UT)

### October 2009

Oct 09 - Draconids Meteor Shower Peak  
Oct 21 - Orionids Meteor Shower Peak

## ASTRO CALENDAR FOR 2008-2009

### January 2009

Jan 01 - International Year of Astronomy 2009  
Jan 03 - Quadrantids Meteor Shower Peak  
Jan 04 - Earth At Perihelion (0.983 AU From Sun)  
Jan 14 - Stardust spacecraft Earth Flyby  
Jan 14 - Venus At Its Greatest Eastern Elongation (47 Degrees)  
Jan 26 - Annular Solar Eclipse  
Jan 26 - Chinese New Year  
Jan 31 - EAS Meeting - 7:00 PM - Aurora Astro Products store

### February 2009

Feb 09 - Penumbral Lunar Eclipse  
Feb 17 - 50th Anniversary (1959), Vanguard 2 Launch  
Feb 28 - 50th Anniversary (1959), Discoverer 1 Launch  
Feb 28 - EAS Meeting - 7:00 PM - Aurora Astro Products store

### March 2009

Mar 08 - Daylight Saving - Set Clock Ahead 1 Hour (United States)  
Mar 08 - Saturn At Opposition  
Mar 20 - Vernal Equinox, 11:44 UT

### April 2009

Apr 02 - 50th Anniversary (1959), Selection Of Mercury 7 Astronauts  
Apr 12 - Easter Sunday  
Apr 22 - Lyrids Meteor Shower Peak  
Apr 23-26 - Camp Delany star party at Sun Lakes State Park  
Apr 29-May 03 - Astronomy Week

### May 2009

May 02 - Astronomy Day  
May 05 - Eta Aquarids Meteor Shower Peak

### June 2009

Jun 05 - Venus At Its Greatest Western Elongation (46 Degrees)  
Jun 21 - Summer Solstice, 05:45 UTC  
Jun 23 - Pluto At Opposition

### July 2009

Jul 04 - Earth At Aphelion (1.017 AU From Sun)  
Jul 07 - Penumbral Lunar Eclipse  
Jul 20 - 40th Anniversary (1969), 1st Man On The Moon (Apollo 11)  
Jul 22 - Total Solar Eclipse (China/Pacific)  
Jul 29 - South Delta-Aquarids Meteor Shower Peak

### August 2009

Aug 01 - Alpha Capricornids Meteor Shower Peak  
Aug 06 - Penumbral Lunar Eclipse  
Aug 06 - Southern Iota Aquarids Meteor Shower Peak  
Aug 12 - Perseids Meteor Shower Peak  
Aug 17 - Neptune At Opposition  
Aug 24 - Mercury At Its Greatest Eastern Elongation (27 Degrees)  
Aug 25 - Northern Iota Aquarids Meteor Shower Peak

### September 2009

Sep 04 - Saturn's Rings Edge-on From Earth  
Sep 17 - Uranus At Opposition

### UW Astronomy Speakers Colloquium Schedule

Astronomy Department weekly colloquium meets Thursdays at 4:00 pm in PAB A102 - the classroom part of the Physics/Astronomy Building complex.  
<http://www.astro.washington.edu/pages/colloquium.html>

### ON THE AIRWAVES - KSER 90.7 - 'IT'S OVER YOUR HEAD'

"Our group of radio script writers now consists of EAS and SAS members Jim Ehrmin, Greg Donohue, and Ted Vosk, who are now regularly writing and helping to produce our **astronomy radio show, "It's Over Your Head"** on radio station **KSER, FM 90.7**. The five-minute segment is broadcast **every Wednesday morning at approximately 8:20 A.M.** and gives a weekly look at what's up in the sky over Snohomish County, with other information. If you are a listener to the program, show your support by giving the program director of KSER a call!" Web page with lots of archives and other info is available at <http://www.celestialnorth.org/radio/index.php> and podcasts at <http://www.celestialnorth.org/radio/index.php>

**KPLU 88.5 FM National Public Radio has daily broadcasts of "Star Date"** by the McDonald Observatory of the University of Texas at Austin, Monday through Friday at about 6:05 pm. The short 2 minute radio show deals with current topics of interest in astronomy. The University of Washington TV broadcasts programs from NASA at 12:00 AM Monday through Friday, 12:30 AM Saturday, and 1:30 AM Sunday on the Channel 27 cable station.

### EAS MEMBERSHIP BENEFITS & INFORMATION

#### EAS Benefits -

Membership in the **Everett Astronomical Society** (EAS) includes invitations to all of the club meetings and star parties, plus the monthly newsletter, **The Stargazer**. Currently, a 10% discount is also being offered to EAS members for purchases at Aurora Astro Products in Everett

#### Magazine Discounts -

In addition you will be able to subscribe to **Sky and Telescope** for \$7 off the normal subscription rate, contact the treasurer (Carol Gore) for more information. <http://everettastro.org/application.htm> (When renewing your subscription to **Sky & Telescope** you should send your **S&T renewal form along with a check made out to Everett Astronomical Society to the EAS address**. The EAS treasurer Carol Gore will renew your **Sky and Telescope** subscription for you. **Astronomy** magazine offers a similar opportunity to club members.)

#### Membership in the Astronomical League -

EAS is a member of the **Astronomical League** and you will receive the Astronomical League's quarterly newsletter magazine, **The Reflector**.

#### EAS Club Telescope Borrowing -

Being a member also allows you the use of the club's telescopes, including an award winning 10 inch Dobsonian mount reflector, a second 10" dob, or and 8" Dobsonian. Contact Jim Bielaga (425) 337-4384 to borrow a telescope.

#### 10% Discount on Purchases at 'Aurora Astro Products' in Everett -

EAS members are currently offered a 10% discount for all purchases of any telescopes, accessories, or other items at Aurora Astro Products, when they show their EAS membership card.

#### EAS Library -

Membership will give you access to all the material in the lending library. The library, which is maintained by Mike Locke, consists of VCR tapes, DVDs, many books, magazines, and software titles. The EAS has a

library of books, videotapes, and software for members to borrow. We always value any items you would like to donate to this library. You can contact a club officer or **Librarian Mike Locke**, phone (425) 259-5995, email lockemi at comcast.net, to borrow or donate any materials. See list here: [http://everettastro.org/eas\\_library.htm](http://everettastro.org/eas_library.htm)

#### Joining or Renewing with the EAS -

EAS dues are \$25 / year per family. Funds obtained from membership dues allows the EAS to publish the Stargazer newsletter, pay Astronomical League dues, pay insurance, host a web site, and maintain our library. If it has been a year since you paid your dues, please re-subscribe to keep the club financially solvent, and to continue to receive membership benefits. <http://everettastro.org/application.htm>

Send your annual dues renewals to the  
**Everett Astronomical Society**  
 P.O. Box 12746, Everett, WA 98206.

## OBSERVER'S INFORMATION...

### LUNAR FACTS

Jan 04	First Quarter Moon
Jan 11	Full Moon
Jan 18	Last Quarter Moon
Jan 26	New Moon
Feb 02	First Quarter Moon
Feb 09	Full Moon
Feb 16	Last Quarter Moon
Feb 24	New Moon
Mar 04	First Quarter Moon
Mar 11	Full Moon
Mar 18	Last Quarter Moon
Mar 26	New Moon

### Digital Lunar Orbiter Photographic Atlas of the Moon

The Lunar and Planetary Institute has created a digital version of the Lunar Orbiter Photographic Atlas of the Moon, and Consolidated Lunar Atlas available online at:

<http://www.lpi.usra.edu/research/cla/menu.html>  
[http://www.lpi.usra.edu/research/lunar\\_orbiter](http://www.lpi.usra.edu/research/lunar_orbiter)

### UP IN THE SKY -- THE PLANETS (AND PLUTO)

Object	Rises	Sets	Con	Diam.	Mag
Sun	07:39 am	17:06	Cap	30'	-27.5
Mercury	06:30 am	15:43	Sag	09"	+1.0
Venus	09:15 am	21:29	Psc	16"	-4.5
Mars	07:04 am	15:43	Sag	04"	+1.3
Jupiter	07:32 am	16:37	Cap	32"	-1.9
Saturn	20:34	09:31 am	Leo	19"	+0.8
Uranus	09:15 am	20:40	Aqr	03"	+5.9
Neptune	08:17 am	18:15	Cap	02"	+8.0
Pluto	05:01am	14:23	Sag	--	+14.0

(times listed are in local time for Everett PST)

### Observing Jupiter's Moons – Java tool

<http://skytonight.com/observing/objects/javascript/jupiter>

### Transit times for Jupiter's Great Red Spot in 2008

<http://skytonight.com/observing/objects/planets/3304091.html>

### NOAA SUN CALCULATOR

Need to know exactly what time the sun will set on Sept. 26, 2065? Or when it rose in 565 BC? How about the length of daylight a week from Tuesday in Albuquerque, N.M.? Just go to NOAA's solar calculator, now available on the Web. <http://www.srb.noaa.gov/highlights/sunrise/gen.html>

## INTERNATIONAL SPACE STATION – VISIBLE SEATTLE PASSES

ISS Visibility – Heavens Above:  
<http://www.heavens-above.com/PassSummary.asp?lat=47.979&lng=-122.201&alt=0&loc=Everett&TZ=PST&satid=25544>

### YOUNG ASTRONOMER'S CORNER

#### Q: What is a neutron star?

A: A neutron star is the very dense remnant of a “dead” star. A pulsar is a rotating neutron star. After certain supernova explosions, a neutron star is formed. It is termed “dead” because no nuclear reactions are occurring in its core. With some supernova explosions, the core of the star survives, and this core begins to further collapse in upon itself. This results in a sphere only about 10 miles across: a neutron star. A very dense object, a teaspoon of material from a neutron star would weigh several million tons!!

#### Q: How long do stars live?

A: The size of a star determines how long it will live: the smaller the star, the longer it will live (or, another way of putting it, the bigger you are, the shorter your life!). Smaller stars combine hydrogen into helium very slowly; they can survive for trillions of years before all of the hydrogen in the core is used up. Medium sized stars like the Sun burn faster. The more massive the star, the greater the pressure in their cores, which causes nuclear reactions to occur more quickly. Such medium sized stars live for “only” a few billion years. The largest stars have the shortest lives. The burn the hottest and are also the brightest stars in our night skies; these die within “only” a few million years!

#### Q: What is the difference between a meteor and a meteorite?

A: Simply stated, it's all about location: one is up in the air and the other is on the ground!! A meteor is a (usually very small) space rock traveling through the Earth's atmosphere: these can be as small as grains of sand and still produce brilliant flashes of light as they are burned up in the Earth's atmosphere. A meteorite is the same material (a space rock), but usually big enough to have some remnant of it survive the atmospheric burning to actually make it to the Earth's ground (where some lucky rock-hound may find it some day!!). It's simple: once it hits the ground (if it is big enough to survive the atmosphere), a meteor becomes known as a meteorite!!

### ASTRONOMY AND TELESCOPE “LINGO

**ASTRONOMY “LINGO”:** **CLOCK STAR:** A bright star, usually located near the celestial equator, with positions and proper motion very accurately known: because of this precision, these stars can be use for the exact determination of time, for the determination of error of observatory time keeping instruments, and for the correction of positional observation of other stars.

**TELESCOPE “LINGO”:** **OPTICAL PATHLENGTH:** The distance (d), traveled by a light beam multiplied by the refractive index (n), of the medium through which the light has passed. If this light travels across more than one medium, then the pathlength is the sum (n1d1 + n2d2, etc.....) for each medium. This formula gives the effective pathlength in terms of the wavelength of light.

**ASTRONOMY “LINGO”:** **SUBLUMINOUS STARS:** Types of stars, such as high-velocity stars, white dwarfs, and sub-dwarfs, which are fainter than main-sequence stars; most are older Population II stars.

**TELESCOPE “LINGO”:** CRRES: A joint NASA/US Air Force satellite launched in 1990 to monitor the plasma in the magnetosphere. It does this by measuring mass, energy, and trajectory of flow of charged particles, and by checking radiation effects on certain instrumentation. CRRES was launched into a highly elliptical orbit.

#### ASTRONOMY “FUN FACTS”

★ ★ Total eclipses of the Sun are dying a slow death. Because of tidal influences, the Moon is gradually spiraling farther and farther away from Earth: some day, the Moon’s disk will be unable to completely block out the Sun’s disk (the requirement for a total solar eclipse). An annular eclipse will always be visible, but solar eclipses are dying a slow death: but we still have time to enjoy them, as this ability of the Moon to completely block out the Sun will only die out a few billion years from now!!

★ ★ If the massive amount of gamma ray energy generated in the Sun’s core reached the Sun’s surface (photosphere) unchanged, the Sun would radiate as a “dark” Sun, generating “death rays” (deadly gamma rays) throughout the solar system and making life impossible. Currently, most gamma rays generated at the Sun’s core are dissipated in their protracted journey to the photosphere, and become infrared, visible, and ultraviolet radiations that will heat, light, and burn us. These forms of electromagnetic radiation will not kill us (at least not yet... but who knows the ultimate consequences of unchecked global warming and ozone depletion??).

★ ★ Saturn is composed mostly of hydrogen and helium (like Jupiter), but is the only planet to have a density lower than water (water = 1; Saturn = 0.7). If a large “piece” of Saturn could be brought to earth for a party, this “piece” of Saturn would float in the punch bowl if it were placed therein!!

★ ★ Fifty of the earth’s largest hurricanes could be placed side by side inside the Great Red Spot on Jupiter (see above), itself a massive anticyclonic “storm”!

★ ★ The Martian moon Deimos is so small, and its gravity so slight, that a human being could launch themselves into space by simply running at the relatively modest speed of seven miles per hour — the escape velocity of Deimos.

#### PLANETARY FOCUS - JUPITER

“Planetary Focus” is a periodic column that publishes occasionally in the EAS “Stargazer”, within which we list the astronomical facts about each planet. For the month of January 2009, our guest planet is Jupiter, and these are the facts:

**Rotation around the Sun:** every 11.86 years

**Orbit:** from 4.95 (closest or ‘perihelion’) to 5.46 (furthest or ‘aphelion’)

**Astronomical Units (AU)\*:** this is an orbit that varies between approximately 460 and 508 million miles from the sun. (\*Note: One AU equals approximately 93 million miles).

**Inclination of Orbit to Ecliptic:** 1.3 degrees.

**Mean Orbital Velocity:** 13.06 km/sec.

**Diameter at Equator:** 142,985 kilometers (or 88,865 miles).

**Mass:** 317.83 (approximately 318 times more massive than earth); (5.9742 x (10 e24 (10 to the 24th power)) kilograms = 1 Earth Mass).

**Density:** 1.3 times that of water (global density).

**Surface Gravity (Earth = 1):** 2.54

**Period of Rotation on its own axis:** approximately 9 hours, 55 minutes.

**Axis tilt:** 3.12 degrees.

**Satellites (moons):** 62, as well as planetary rings.

**Special Notes About Jupiter:** Jupiter is the largest planet in the solar system. Its rotation period is shorter than that of any other planet (less than 10 hours); this leads to a polar diameter (133,718 kilometers), much shorter than the equatorial diameter. Jupiter’s mass is more than twice that of all the other planets combined. A density of only 1.3 times that of water however, suggests that it is mostly composed of the lighter elements of hydrogen and helium. At opposition (approximately every 13 months), Jupiter shines at an apparent magnitude of –2.5, and has an apparent diameter of 47 arc seconds. Among the 16 moons of Jupiter are the four famous Galilean satellites (Io, Europa, Ganymede (the largest moon in the entire solar system), and Callisto), all discovered in 1610 by Galileo (and independently by Simon Marius). These Galilean moons (see below) are bright enough to be seen with binoculars. Although not as famous or readily visible as Saturn’s, Jupiter also has a ring system; they were discovered as the Voyager 1 probe moved inside of the orbit of one of the other 12 moons of Jupiter (Amalthea) in 1979. Jupiter has a series of wind-driven bands of light clouds (zones) and dark clouds (belts) that cross the disc of the planet parallel to the equator. Within these belts and zones, irregular streaks and spots are seen, including the Great Red Spot, which has been observed from earth since the 17th century; most of these spots and streaks are far more transitory or temporary, however.

Several probes have flown by and investigated Jupiter’s atmosphere and structure. These include Pioneer 10 and 11, the Voyager probes, and the Ulysses, and Galileo probes. Cloud zones and belts predominate below about +/- 45 degrees latitude. The lighter colored zones appear to be comprised of ammonia crystals, and are higher clouds lifted by convection of warmer gases; the darker belts are comprised of lower clouds of descending gas flows, and appear to be comprised of hydrogen, sulfur compounds, ammonium hydrosulphide, and possibly organic compounds formed in photochemical reactions. Jupiter is about 90% hydrogen and 10% helium with lower percentages of methane, water, ammonia, other trace compounds, and “rock” (core). This is similar to the composition of the primordial Solar System Nebula from which the entire solar system was formed. The rapid rotation of Jupiter produces the colorful cloud systems.

Our knowledge of the innermost aspects of Jupiter (and the other gas planets) is very indirect. Jupiter’s core is most likely silicate rock and iron, and above this is the vast bulk of the planet in the form of liquid metallic hydrogen. Outside of this is a layer of molecular hydrogen and helium, followed by the outermost hydrogen and helium atmosphere, with traces of other compounds as mentioned above. Liquid metallic hydrogen consists of ionized protons and electrons (like the interior of the Sun but at a far lower temperature). At the temperature and pressure of Jupiter’s interior, hydrogen is a liquid, not a gas; it is also an electrical conductor and the source of Jupiter’s immense magnetic field; this magnetic field is about 19,000 times stronger than the earth’s. Jupiter radiates about twice as much heat as it receives from the sun, indicating an internal reservoir of heat energy left over from its creation. This energy may play a part in Jupiter’s dynamic zonal and belted cloud (weather) systems (by contributing to convection and very high winds, for example). This energy flow, the planet’s rapid rotation, and a greenhouse effect, help to minimize temperature variations in various regions of the planet. Jupiter also emits radio waves (by several

mechanisms), but is not massive enough to undergo nuclear fusion reactions like the sun; Jupiter would have to be about 80 times more massive than it is for this to happen. Briefly, Jupiter's Galilean Moons are very interesting in their own right. Europa (the smallest) is smaller than the earth's moon; it is a smooth moon with an icy crust, which is crisscrossed by streaks and cracks. Callisto is the faintest and outermost of these famous moons, and is heavily rayed and cratered. Callisto is believed to have a thick crust of ice and rock, beneath which is thought to be water; this moon also has several systems of concentric ring mountain formations. Ganymede, the largest moon in the entire solar system, is also the brightest of these four Galilean moons. The main surface features on Ganymede are darker cratered areas, and lighter, geologically younger areas with long parallel grooves (sulci); these two features intermingle, and give Ganymede a very elaborate surface appearance; there are areas of exposed ice and long parallel mountain ridges. Finally, Io (the innermost) has intense volcanic action, and volcanoes have been seen to eject material over very extensive areas on this moon; Io is the most volcanically active body known in the solar system.

Io orbits within Jupiter's magnetosphere, and its volcanic activity is thought to result from the heating gained by interaction with Jovian tidal forces. Erupted material (such as sulfur and hydrogen) escapes into the Jovian magnetosphere and is ionized; it forms a ring or torus centered on Io. This ionized matter may affect several phenomena on Jupiter, including aurorae and radio bursts.

One very famous surface feature of Jupiter should be mentioned: The Great Red Spot. This oval spot is located about 22 degrees south of Jupiter's equator. It is an immense high pressure storm (anticyclone), much colder and higher than surrounding clouds. It has been noted that the Great Red Spot (GRS) rotates in a counterclockwise manner with a rotation period of about six days. The north winds on the spot are blowing to the west; the south winds to the east; these outer perimeter winds can reach velocities of over 250 mph. The GRS has been observed for over 300 years (first observed by Robert Hooke in 1664), with variations in size, brightness, and color. At its greatest observed dimensions, the GRS can be as large as 40,000 by 14,000 kilometers. Color varies from pale pinkish beige to bright red; these color changes have been attributed to chemical changes, such as the conversion of phosphene into red phosphorous. Try to enjoy this beautiful planet when visible anytime, but most especially, as for any superior (outside) planet, at opposition.

#### "MIRROR IMAGES" - PLANETARY NEBULAE

**"MIRROR" IMAGES:** Because we live in the Northern Hemisphere, we often tend to focus (in both observing and reading) on celestial objects in this hemisphere. The point of this new column is to inform club members about similar objects in the Southern Hemisphere (to the ones we are already familiar with in the Northern Hemisphere). The general class of object will first be defined, and then a representative object from each hemisphere will be described. Note: "MIRROR" IMAGES" is strictly the name of the new column, and is not intended to imply that there is optical mirror symmetry between the two objects.

**CLASS OF OBJECT: PLANETARY NEBULAE:** A cloud of expanding gas, usually symmetrical, that has been discharged from a dying star. Most of these clouds or shells are thought to be the ejected outer layers of red giant stars, released as a result of late-life instabilities. This gas cloud or evolving envelope is ionized by the remaining central star, and this shell becomes visible as a result of the light emission after ionization. Planetary nebulae are a type of emission nebulae. They are most often

less than 50,000 years old, and eventually fade into the interstellar medium. Usually ring-shaped or (less frequently) hourglass shaped, they were originally named "planetary nebulae" because, rather than point-like stars, they resembled planetary discs with low magnification. These nebulae occur alone, and generally lie close to the plane of the galaxy, nearer to the galactic center.

Stars with masses up to eight (8) solar masses are thought to eventually result in the formation of planetary nebulae. Successive instabilities lead to successive releases (ejections) of shells of gas, until the central star is about 0.6 solar masses; this central star is now a white dwarf composed of degenerate matter (highly dense matter that can exert a pressure as a result of quantum mechanical effects). Some planetary nebulae have been discovered which have a binary star system at their centers; energy from the two orbiting stars is transferred to the encircling gas, which is then expelled as a planetary nebula. Planetary nebula spectra show emission lines of oxygen, nitrogen, hydrogen, and other compounds. About 1500 planetary nebulae have been found in our galaxy.

#### REPRESENTATIVE NORTHERN HEMISPHERE OBJECT:

**The Ring Nebula (M-57 or NGC-6720):** A planetary nebula, about one arc minute across and at magnitude 8.8, located in the constellation of Lyra. This is the famous Northern Hemisphere "smoke ring" visible in the summer, although higher power instruments show it to be more elliptical in shape. The central star is very faint at 15th magnitude, and difficult to see; this may be the result of not only its dim magnitude, but also intrinsic variability and regional nebulosity. Photographically, the inner regions of M-57 are green as a result of doubly ionized oxygen, and the outer edges red as a result of lower energy transformations involving nitrogen and hydrogen. M-57 is very easy to find in the sky; it is located about halfway between Beta and Gamma Lyrae, and is considered by many to be the most famous planetary nebula in the sky.

#### REPRESENTATIVE SOUTHERN HEMISPHERE OBJECT:

**Helix Nebula (NGC- 7293):** This planetary nebula in the southern constellation of Aquarius has the largest apparent diameter of any of the planetaries; its diameter of ¼ degree actually allows viewing with good binoculars under good dark skies. The Helix glows very brightly with an O-III filter, as it contains much oxygen and hydrogen. The Helix lies at a distance of about 140 parsecs; its central star is a 13th magnitude bluish star, which is visible in 8-inch or larger telescopes.

#### CONSTELLATION (S) OF THE MONTH: LYNX AND VELA

**LYNX:** This relatively dim constellation borders on the constellations of Auriga, Camelopardalis, Cancer, Gemini, Leo Minor, and Ursa Major, and ranks 66th in overall brightness, containing 31 visible stars brighter than magnitude 5.5. Its central point is located at RA=7h56m and Dec.= +46.5 degrees. It is completely visible from latitudes North of -28 degrees, and completely invisible from latitudes South of -57 degrees. This constellation ranks 28th in overall size, taking up 545.39 square degrees, or 1.322% of the sky. Lynx contains no very well known or very bright stars, and contains no Messier objects and no

known meteor showers. Its midnight culmination date is January 19th. Lynx is one of seven constellations invented by Johannes Hevelius and still in use. The star 41 Lyn, now in the constellation Ursa Major, was listed by Flamsteed in the early 18th century to be in the constellation Lynx. This is the star frequently singled out to show stellar motion and the overall transient nature of constellation boundaries. Lynx contains many other interesting

objects (including many interesting galaxies) best visible in the spring. These objects include NGC-2683 (Sb-spiral); NGC-2776 (Sc-spiral); NGC-2782 (Sb-spiral); NGC-2798 (barred spiral); IC-2233 (edge-on barred spiral); NGC-2549 (elliptical); Perek-Kohoutek 164-31.1 (large, amorphous planetary nebula (see "Mirror Images" column below); V-Lyncis (irregular variable star); R-Lyncis

(long-period variable); 38 Lyncis (bright triple star); 19 Lyncis (quadruple star); and NGC-2419. This last object is a small globular cluster, and relatively dim at magnitude 10.4. However, it lies 90 kiloparsecs away, and is very famous as one of the most distant globulars known. Harlow Shapley named NGC-2419 the "Intergalactic Tramp", and believed that it may have broken away from the gravitational constraints of the Milky Way and headed off into intergalactic space. However, while more recent observations show a highly eccentric galactic orbit, NGC-2419 will undoubtedly remain gravitationally bound to this local neighborhood of the universe. On a clear, moonless night this coming spring, try to enjoy the little-known but beautiful wonders of Lync.

**VELA:** Vela (Vel), or the "Sail of Argo Navis", is a well-known and interesting constellation which borders on some of the more familiar southern constellations, including Antlia, Carina, Centaurus, Puppis, and Pyxis. There are no asterisms associated with this constellation. The central point of Vela is at RA=9h43m, and Dec.= -47 degrees; its overall brightness is ranked among the constellations at 4th, with a size-related calculation of about 15 (15.211) visible stars for each 100 square degrees of constellation area. Vela also contains 76 visible stars brighter than magnitude 5.5. Its midnight culmination date is February 13th, which makes it well placed for winter observing (especially in the Southern Hemisphere, where it would be summer); the grouping has no associated meteor showers nor Messier objects. This constellation ranks 32nd in size among the constellations (taking up 499.65 square degrees (or about 1.211% of the sky), and is completely visible from latitudes S of +33 degrees and completely invisible from latitudes N of +53 degrees. The solar conjunction date of this constellation is August 18th.

Vela is one of the three constellations into which Lacaille divided the ancient constellation of Argo Navis: the other two component constellations are Carina and Puppis. The Vela Pulsar is located within this constellation. The second such object to be observed optically, radio telescopes had however discovered it years before. This pulsar was observed optically in 1977, a full ten years after the discovery of the pulsar within the famous Crab Nebula. The Vela Pulsar is among the faintest luminous objects yet observed: it has a visual magnitude of 26, and an absolute magnitude estimated at approximately (and only!) 34.5!! The constellation of Vela also contains the only complete break in the Milky Way band of light (which marks the plain of our Galaxy). This area, an immense dark nebulae composed of dust and cold gas, is known as the "Great Rift".

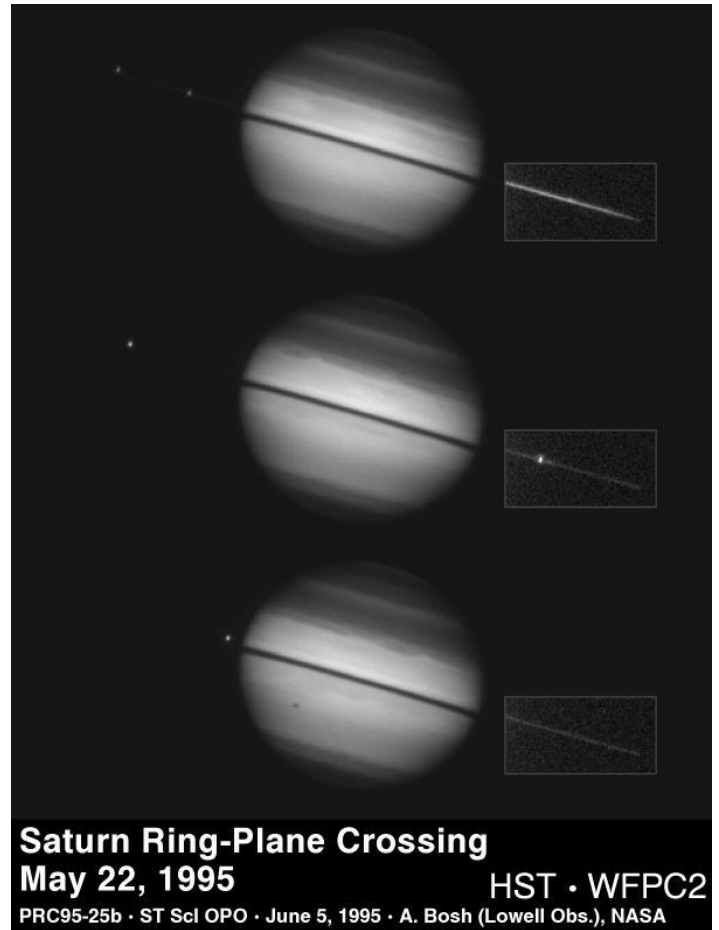
Vela contains many objects of interest to astronomers. NGC 3132 is a bright planetary nebula, shining at photographic magnitude 8.2, with a "central star" shining at magnitude 10.1; this planetary is one of the brightest in the entire sky. This nebula is similar in many ways in appearance to the Ring Nebula in Lyra. Indeed, this planetary in Vela has been nicknamed the "Eight-Burst Nebula" because it has a complex structure suggestive of a group of oval rings stacked one atop the other at differing angles of tilt. An interesting point about this object concerns the "central star". Studies conducted almost 30 years ago show that this star is indeed not the star illuminating the object (something that a true

central star does in a planetary); rather, a 16th magnitude dwarf star, about 1.7" away from the 10th magnitude "central" star, is the actual luminous object thought to excite the planetary shell gas to a state of fluorescence. Vela contains other objects of note as well: NGC 3201 (an 18.2' globular cluster glowing at magnitude 6.8); NGC 3228 (an open star cluster); IC 2488 (an open cluster with a combined photographic magnitude of 7.4); and the double star Delta Velorum, which is composed of a magnitude 2.1 yellow primary and a magnitude 5.1 (also yellowish) secondary star, separated by 2.6". Vela also contains IC 2391, the biggest and brightest (combined magnitude 2.5) open cluster in the constellation; IC 2395 (a smaller, rich open cluster containing 40 stars in an area only 8' across), with an integrated magnitude of 4.6 (naked eye); and NGC 2547, an open cluster with 80 stars located within an area about 20' across. NGC 2547 is also a naked eye object with a combined magnitude of 4.7, and contains a beautiful assortment of rings, chains, and arcs of stars as a visual treat. Try to enjoy the beautiful wonders – visual and telescopic – of this constellation, if you ever have the opportunity to visit more southern skies.

## ASTRONOMICAL NOTES -- ON & OFF THE WEB...

### SATURN'S CRAZY HOLIDAY TILT

You look through the telescope. Blink. Shake your head and look again. The planet you expected to see in the eyepiece is not the one that's actually there. Too much eggnog? No, it's just Saturn's crazy holiday tilt.



All year long, the rings of Saturn have been tilting toward Earth and now they are almost perfectly edge-on. The opening angle is

a paper-thin 0.8 degrees. Viewed from the side, the normally wide and bright rings have become a shadowy line bisecting Saturn's two hemispheres--a scene of rare beauty. Astronomers call the phenomenon a "ring plane crossing." As Saturn goes around the sun, it periodically (once every 14 to 15 years) turns its rings edge-on to Earth. Because the rings are so thin, they can actually disappear when viewed through a backyard telescope. At the precise moment of crossing, Saturn undergoes a startling metamorphosis. The ringed planet becomes a lonely ball of gas, almost unrecognizable: [Hubble photo http://hubblesite.org/newscenter/archive/releases/1995/25/image/b/format/web\\_print/](http://hubblesite.org/newscenter/archive/releases/1995/25/image/b/format/web_print/).

*(Historical note: Shortly after Galileo discovered Saturn's rings in 1610, they disappeared in precisely this fashion. Galileo didn't understand the nature of the rings and the vanishing act confused him mightily. Nevertheless, his physical intuition prevailed. "They'll be back," he predicted, and without ever knowing why, he was correct.)*

We're not quite there yet. The opening angle won't be precisely zero until Sept. 4, 2009. Don't bother marking your calendar, though. Saturn will be so close to the sun, no one will be able to see the rings wink out. The best time to look is now.

The 0.8 degree opening angle of Christmas 2008 is the minimum for some time to come. In January 2009 the rings begin to open up again, a temporary reversal caused by the orbital motions of Earth and Saturn. By the time narrowing resumes in summer 2009, Saturn will be approaching the sun; looking through a telescope then could actually be dangerous. The next ring plane crossing that's easy to watch won't come until 2038.

So wake up before sunrise in late December, point your telescope at the golden "star" in Leo, and behold Saturn's crazy holiday tilt. [http://science.nasa.gov/headlines/y2008/22dec\\_crazytilt.htm](http://science.nasa.gov/headlines/y2008/22dec_crazytilt.htm)

## SOLAR FLARE SURPRISE

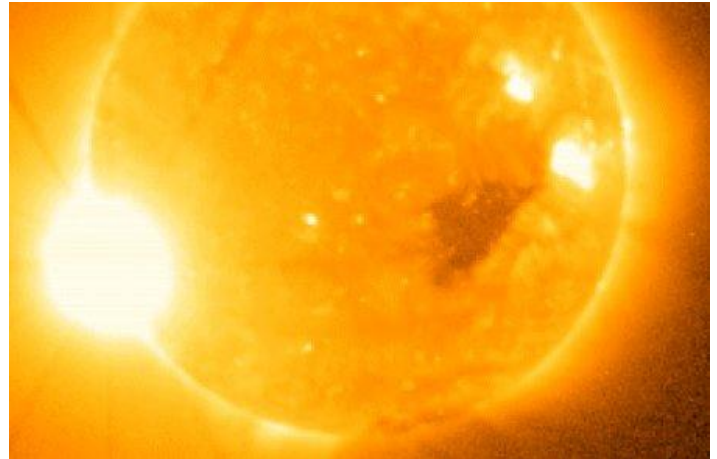
Solar flares are the most powerful explosions in the solar system. Packing a punch equal to a hundred million hydrogen bombs, they obliterate everything in their immediate vicinity. Not a single atom should remain intact. At least that's how it's supposed to work.

"We've detected a stream of perfectly intact hydrogen atoms shooting out of an X-class solar flare," says Richard Mewaldt of Caltech. "What a surprise! These atoms could be telling us something new about what happens inside flares." The event occurred on Dec. 5, 2006. A large sunspot rounded the sun's eastern limb and with little warning it exploded. On the "Richter scale" of flares, which ranks X1 as a big event, the blast registered X9, making it one of the strongest flares of the past 30 years. NASA managers braced themselves. Such a ferocious blast usually produces a blizzard of high-energy particles dangerous to both satellites and astronauts. Indeed, moments after the explosion, radio emissions from a shock wave in the sun's atmosphere signaled that a swarm of particles was on its way. An hour later they arrived. But they were not the particles researchers expected.

The twin STEREO spacecraft made the discovery: "It was a burst of hydrogen atoms," says Mewaldt. "No other elements were present, not even helium (the sun's second most abundant atomic species). Pure hydrogen streamed past the spacecraft for a full 90 minutes." Next came more than 30 minutes of quiet. The burst subsided and STEREO's particle counters returned to low levels. The event seemed to be over when a second wave of particles enveloped the spacecraft. These were the "broken atoms" that flares are supposed to produce protons and heavier

ions such as helium, oxygen and iron. "Better late than never," he says.

At first, this unprecedented sequence of events baffled scientists, but now Mewaldt and colleagues believe they're getting to the bottom of the mystery. First, how did the hydrogen atoms resist destruction? "They didn't," says Mewaldt. "We believe they began their journey to Earth in pieces, as protons and electrons. Before they escaped the sun's atmosphere, however, some of the protons recaptured an electron, forming intact hydrogen atoms. The atoms left the sun in a fast, straight shot before they could be broken apart again."



Second, what delayed the ions? "Simple," says Mewaldt. "Ions are electrically charged and they feel the sun's magnetic field. Solar magnetism deflects ions and slows their progress to Earth. Hydrogen atoms, on the other hand, are electrically neutral. They can shoot straight out of the sun without magnetic interference."

Imagine two runners dashing for the finish line. One (the ion) is forced to run in a zig-zag pattern with zigs and zags as wide as the orbit of Mars. The other (the hydrogen atom) runs in a straight line. Who's going to win? "The hydrogen atoms reached Earth two hours before the ions," says Mewaldt.

Mewaldt believes that all strong flares might emit hydrogen bursts, but they simply haven't been noticed before. He's looking forward to more X-flares now that the two STEREO spacecraft are widely separated on nearly opposite sides of the Sun. (In 2006 they were still together near Earth.) STEREO-A and B may be able to triangulate future bursts and pinpoint the source of the hydrogen. This would allow the team to test their ideas about the surprising phenomenon. "All we need now," he says, "is some solar activity." [http://science.nasa.gov/headlines/y2008/15dec\\_solarflaresurprise.htm](http://science.nasa.gov/headlines/y2008/15dec_solarflaresurprise.htm)

## PHOENIX SITE ON MARS MAY BE IN DRY CLIMATE CYCLE

The Martian arctic soil that Phoenix Mars Lander dug into this year is very cold and very dry. However, when long-term climate cycles make the site warmer, the soil may get moist enough to modify the chemistry, producing effects that persist through the colder times. Phoenix found clues increasing scientists' confidence in predictive models about water vapor moving through the soil between the atmosphere and subsurface water-ice. The models predict the vapor flow can wet the soil when the tilt of Mars' axis, the obliquity, is greater than it is now.

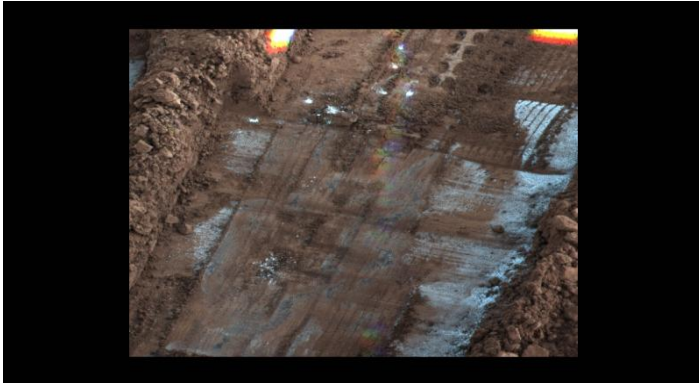
The robot worked on Mars for three months of prime mission, plus two months of overtime, after landing on May 25. The Phoenix science team will be analyzing data and running comparison experiments for months to come. With some key questions still

open, team members at a meeting of the American Geophysical Union today reported on their progress.

*"We have snowfall from the clouds and frost at the surface, with ice just a few inches below, and dry soil in between,"* said Phoenix Principal Investigator Peter Smith. *"During a warmer climate several million years ago, the ice would have been deeper, but frost on the surface could have melted and wet the soil."*

With no large moon like Earth's to stabilize it, Mars goes through known periodic cycles when its tilt becomes much greater than Earth's. During those high-tilt periods, the sun rises higher in the sky above the Martian poles than it does now, and the arctic plain where Phoenix worked experiences warmer summers.

*"The ice under the soil around Phoenix is not a sealed-off deposit left from some ancient ocean,"* said Ray Arvidson, lead scientist for the lander's robotic arm. *"It is in equilibrium with the environment, and the environment changes with the obliquity cycles on scales from hundreds of thousands of years to a few million years. There have probably been dozens of times in the past 10 million years when thin films of water were active in the soil, and probably there will be dozens more times in the next 10 million years."*



Cloddy texture of soil scooped up by Phoenix is one clue to effects of water. The mission's microscopic examination of the soil shows individual dust particles characteristic of windblown dust and sand, but clods of the soil hold together more cohesively than expected for unaltered dust and sand. Arvidson said, *"It's not strongly cemented. It would break up in your hand, but the cloddiness tells us that something is taking the windblown material and mildly cementing it."* That cementing effect could result from water molecules adhering to the surfaces of soil particles. Or it could be from water mobilizing and redepositing salts that Phoenix identified in the soil, such as magnesium perchlorate and calcium carbonate.

The Thermal and Electrical Conductivity Probe on Phoenix detected electrical-property changes consistent with accumulation of water molecules on surfaces of soil grains during daily cycles of water vapor moving through the soil, reported Aaron Zent, lead scientist for that probe. *"There's exchange between the atmosphere and the subsurface ice,"* Zent said. *"A film of water molecules accumulates on the surfaces of mineral particles. It's not enough right now to transform the chemistry, but the measurements are providing verification that these molecular films are occurring when you would expect them to, and this gives us more confidence in predicting the way they would behave in other parts of the obliquity cycles."*

<http://www.jpl.nasa.gov/news/news.cfm?release=2008-236>

## SATURN'S DYNAMIC MOON ENCELADUS SHOWS MORE SIGNS OF ACTIVITY

The closer scientists look at Saturn's small moon Enceladus, the more they find evidence of an active world. The most recent flybys of Enceladus made by the Cassini spacecraft have provided new signs of ongoing changes on and around the moon. The latest high-resolution images of Enceladus show signs that the south polar surface changes over time. Close views of the southern polar region, where jets of water vapor and icy particles spew from vents within the moon's distinctive "tiger stripe" fractures, provide surprising evidence of Earth-like tectonics. They yield new insight into what may be happening within the fractures. The latest data on the plume -- the huge cloud of vapor and particles fed by the jets that extend into space -- show it varies over time and has a far-reaching effect on Saturn's magnetosphere.



*"Of all the geologic provinces in the Saturn system that Cassini has explored, none has been more thrilling or carries greater implications than the region at the southernmost portion of Enceladus,"* said Carolyn Porco, Cassini imaging team leader.

*"Enceladus has Earth-like spreading of the icy crust, but with an exotic difference -- the spreading is almost all in one direction, like a conveyor belt,"* said panelist Paul Helfenstein, Cassini imaging associate. *"Asymmetric spreading like this is unusual on Earth and not well understood."* *"Enceladus has asymmetric spreading on steroids,"* Helfenstein added. *"We are not certain about the geological mechanisms that control the spreading, but we see patterns of divergence and mountain-building similar to what we see on Earth, which suggests that subsurface heat and convection are involved."*

The tiger stripes are analogous to the mid-ocean ridges on Earth's seafloor where volcanic material wells up and creates new

crust. Using Cassini-based digital maps of the south polar region of Enceladus, Helfenstein reconstructed a possible history of the tiger stripes by working backward in time and progressively snipping away older and older sections of the map. Each time he found that the remaining sections fit together like puzzle pieces.

Images from recent close Enceladus flybys also have bolstered an idea the Cassini imaging team has that condensation from the jets erupting from the surface may create ice plugs that close off old vents and force new vents to open. The opening and clogging of vents also corresponds with measurements indicating the plume varies from month to month and year to year.

*"We see no obvious distinguishing markings on the surface in the immediate vicinity of each jet source, which suggests that the vents may open and close and thus migrate up and down the fractures over time," Porco said. "Over time, the particles that rain down onto the surface from the jets may form a continuous blanket of snow along a fracture."*

Enceladus' output of ice and vapor dramatically impacts the entire Saturnian system by supplying the ring system with fresh material and loading ionized gas from water vapor into Saturn's magnetosphere. *"The ions added to the magnetosphere are spun up from Enceladus' orbital speed to the rotational speed of Saturn,"* said Cassini magnetometer science team member Christopher Russell. *"The more material is added by the plume, the harder this is for Saturn to do, and the longer it takes to accelerate the new material."*

With water vapor, organic compounds and excess heat emerging from Enceladus' south polar terrain, scientists are intrigued by the possibility of a liquid-water-rich habitable zone beneath the moon's south pole.

Cassini's flybys on Aug. 11 and Oct. 31 of this year targeted Enceladus' fractured southern region. An Oct. 9 flyby took the spacecraft deep into the plume of water vapor and ice shooting out of the moon's vents. Cassini's next flyby of Enceladus will be in November 2009. <http://saturn.jpl.nasa.gov/news/press-release-details.cfm?newsID=889>

## **JUPITER'S ROCKY CORE BIGGER & ICIER, MODEL PREDICTS**

Jupiter has a rocky core that is more than twice as large as previously thought, according to computer calculations by a geophysicist who simulated conditions inside the planet on the scale of individual hydrogen and helium atoms.

A new simulation of Jupiter's interior predicts a large rocky core surrounded by methane, water and ammonia ices, with hardly any ice in the hydrogen and helium atmosphere that makes up 95 percent of the planet's mass. Previous models predicted a core half the size and ices throughout the atmosphere.

The simulations predict the properties of hydrogen-helium mixtures at the extreme pressures and temperatures that occur in Jupiter's interior, which cannot yet be studied with laboratory experiments. Applying techniques originally developed to study semiconductors, Burkhard Militzer calculated the properties of hydrogen and helium for temperature, density and pressure at the surface all the way to the planet's center.

Coauthor William B. Hubbard, professor of planetary sciences used the theoretical data to build a new model for Jupiter's interior. A comparison of this model with the planet's known mass, radius, surface temperature, gravity and equatorial bulge implies that Jupiter's core is an Earth-like rock 14 to 18 times the mass of Earth, or about one-twentieth of Jupiter's total mass,

Militzer said. Previous models predicted a much smaller core of only 7 Earth masses, or no core at all.

The simulation suggests that the core is made of layers of metals, rocks and ices of methane, ammonia and water, while above it is an atmosphere of mostly hydrogen and helium. At the center of the rocky core is probably a metallic ball of iron and nickel, just like Earth's core. *"Our simulations show there is a big rocky object in the center surrounded by an ice layer and hardly any ice elsewhere in the planet,"* Militzer said. *"This is a very different result for the interior structure of Jupiter than other recent models, which predict a relatively small or hardly any core and a mixture of ices throughout the atmosphere."*

*"Basically, Jupiter's interior resembles that of Saturn, with a Neptune or Uranus at the center,"* he said. Neptune and Uranus have been called "ice giants" because they also appear to have a rocky core surrounded by icy hydrogen and helium, but without the gas envelope of Jupiter and Saturn.

*"This new calculation by Burkhard removes a lot of the old uncertainties of the 19-year-old model we have had until now,"* Hubbard said. *"The new thermodynamic model is a more precise physical description of what's going on inside Jupiter."*

The large, rocky core implies that as Jupiter and other giant gas planets formed 4.5 billion years ago, they grew through the collision of small rocks that formed cores that captured a huge atmosphere of hydrogen and helium. *"According to the core accretion model, as the original planetary Nebula cooled, planetesimals collided and stuck together in a runaway effect that formed planet cores,"* Militzer said. *"If true, this implies that the planets have large cores, which is what the simulation predicts. It is more difficult to make a planet with a small core."* In order to match the observed gravity of Jupiter, Militzer's simulation also predicts that different parts of Jupiter's interior rotate at different rates. Jupiter can be thought of as a series of concentric cylinders rotating around the planet's spin axis, with the outer cylinders - the equatorial regions - rotating faster than the inner cylinders. This is identical to the sun's rotation, Militzer said.

Militzer modeled Jupiter's interior as a collection of 110 hydrogen and nine helium atoms in a tiny cube that is replicated throughout the planet, a common approximation in "density functional theory." The ratio of hydrogen to helium atoms approximates the ratio measured on the surface of Jupiter. Each simulation took from one to seven days on parallel computing clusters. Based on this simulation, under the high pressure and temperature deep within the planet, hydrogen changes from a molecular to a metallic state, which provides good electrical conductivity and gives rise to Jupiter's magnetic field. This transition happens gradually, contrary to earlier models that predict a sharp transition.

The new model of Jupiter predicts that most of the ices are concentrated in the outer layer of the core, while only a small amount is mixed in the hydrogen-helium gas envelope that contains 95 percent of the planet's mass. The "planetary ices" in the envelope amount to about four Earth masses, or 1 percent of Jupiter's mass, Militzer said. *"Jupiter formed beyond the ice line and so accreted ice along with the rocky material,"* he said. *"As a result, the ice is part of the core and is not in the envelope."*

*"The simulation was in pretty good agreement with what the Galileo probe measured"* when the spacecraft descended through Jupiter's atmosphere in 1995, Hubbard said. [http://berkeley.edu/news/media/releases/2008/11/25\\_core.shtml](http://berkeley.edu/news/media/releases/2008/11/25_core.shtml)

## HUBBLE FINDS CO<sub>2</sub> ON AN EXTRASOLAR PLANET

The Hubble Space Telescope has discovered carbon dioxide in the atmosphere of a planet orbiting another star. This breakthrough is an important step toward finding chemical biotracers of extraterrestrial life. The Jupiter-sized planet, called HD 189733b, is too hot for life. But the Hubble observations are a proof-of-concept demonstration that the basic chemistry for life can be measured on planets orbiting other stars. Organic compounds also can be a by-product of life processes and their detection on an Earthlike planet someday may provide the first evidence of life beyond our planet.

Previous observations of HD 189733b by Hubble and the Spitzer Space Telescope found water vapor. Earlier this year, Hubble found methane in the planet's atmosphere. *"Hubble was conceived primarily for observations of the distant universe, yet it is opening a new era of astrophysics and comparative planetary science,"* said Eric Smith, Hubble Space Telescope program scientist. *"These atmospheric studies will begin to determine the compositions and chemical processes operating on distant worlds orbiting other stars. The future for this newly opened frontier of science is extremely promising as we expect to discover many more molecules in exoplanet atmospheres."*

Mark Swain, a research scientist, used Hubble's near infrared camera and multi-object spectrometer to study infrared light emitted from the planet, which lies 63 light-years away. Gases in the planet's atmosphere absorb certain wavelengths of light from the planet's hot glowing interior. Swain identified carbon dioxide and carbon monoxide. The molecules leave a unique spectral fingerprint on the radiation from the planet that reaches Earth. This is the first time a near-infrared emission spectrum has been obtained for an exoplanet.

*"The carbon dioxide is the main reason for the excitement because, under the right circumstances, it could have a connection to biological activity as it does on Earth,"* Swain said. *"The very fact we are able to detect it and estimate its abundance is significant for the long-term effort of characterizing planets to find out what they are made of and if they could be a possible host for life."*

This type of observation is best done on planets with orbits tilted edge-on to Earth. They routinely pass in front of and then behind their parent stars, phenomena known as eclipses. The planet HD 189733b passes behind its companion star once every 2.2 days. The eclipses allow an opportunity to subtract the light of the star alone, when the planet is blocked, from that of the star and planet together prior to eclipse. That isolates the emission of the planet and makes possible a chemical analysis of its atmosphere. *"In this way, we are using the eclipse of the planet behind the star to probe the planet's day side, which contains the hottest portions of its atmosphere,"* said team member Guatam Vasisht. *"We are starting to find the molecules and to figure out how many there are to see the changes between the day side and the night side."*

This successful demonstration of looking at near-infrared light emitted from a planet is very encouraging for astronomers planning to use James Webb Space Telescope after it is launched in 2013. These biomarkers are best seen at near-infrared wavelengths. Astronomers look forward to using the James Webb Space Telescope to look spectroscopically for biomarkers on a terrestrial planet the size of Earth or a "super-Earth" several times our planet's mass. *"The Webb telescope should be able to make much more sensitive measurements of these primary and secondary eclipse events,"* Swain said.

## NEW COMPOSITIONAL CLASS OF COMETS: FROM FIRE, ICE, OR BEYOND?

Comet 96P/Machholz1 shows extremely anomalous compositional characteristics helping pinpoint its origin to one of three intriguing scenarios. David Schleicher, a planetary astronomer, measured abundances of five molecular species in the coma of 150 comets and discovered that one comet, 96P/Machholz1, has an extremely unusual chemistry. The exact cause of this chemical anomaly remains unknown, but each of three possible explanations will yield important but differing new constraints on the formation or evolution of comets.

The discovery of comet Machholz1's extremely anomalous composition reveals the existence of a new class of comets. Astronomers identified two other classes in the 1990s. While Machholz1 also has strongly depleted C2 and C3 carbon species, what makes it anomalous is that the molecule cyanogen, CN, is extremely depleted. In Machholz1 CN is missing by about a factor of 72 from the average of other comets, i.e., only a little above one percent of normal. *"This depletion of CN is much more than ever seen for any previously studied comet, and only one other comet has even exhibited a CN depletion,"* said Schleicher.

One possible explanation is that Machholz1 did not originate in our Solar System, but instead escaped from another star. In this scenario, the other star's proto-planetary disk might have had a lower abundance of carbon, resulting in all carbon-bearing compounds having lower abundances. *"A large fraction of comets in our own Solar System have escaped into interstellar space, so we expect that many comets formed around other stars would also have escaped,"* said Schleicher. *"Some of these will have crossed paths with the sun, and Machholz1 could be an interstellar interloper."*

Another possible explanation for Machholz 1's anomalous composition is that it formed even further from the sun in a colder or more extreme environment than another other comet we have studied thus far. If this was the case, then the scarcity of such objects is likely associated with the significant difficulty of explaining how such comets moved into the inner solar system where they can then be discovered and observed.

A third possibility is that Machholz1 originated as a carbon-chain depleted comet but that its chemistry was subsequently altered by extreme heat. While no other comet has exhibited changes in chemistry due to subsequent heating by the sun, Machholz1 has the distinction of having an orbit that now takes it to well inside Mercury's orbit every five years. (Other comets get even closer to the sun, but not as often). *"Since its orbit is unusual, we must be suspicious that repeated high temperature cooking might be the cause for its unusual composition,"* said Schleicher. *"However, the only other comet to show depletion in the abundance of CN did not reach such high temperatures. This implies that CN depletion does not require the chemical reactions associated with extreme heat."*

Although comet 96P/Machholz1 was first sighted in 1986 and orbits the sun with a period of slightly over five years, compositional measurements only took place during the comet's recent 2007 apparition. Lowell Observatory's program of compositional studies, currently headed by Schleicher, includes measurements of over 150 comets obtained during the past 33 years. This research is unique because it compares and contrasts Machholz1 against this large database of 150 comets.

In the early 1990s, Lowell Observatory's long-term program first identified the existence of two compositional classes of comets. One class, containing the majority of observed comets, has a

composition called "typical." Most members of this typical class have long resided in the Oort Cloud at the very fringes of our Solar System but are believed to have originally formed amidst the giant planets, particularly between Saturn, Uranus, and Neptune. Other members of this compositional class arrived from the Kuiper Belt, located just beyond Neptune.

The second compositional class of comets has varying depletions in two of the five chemical species measured. Since both depleted molecules, C2 and C3, are wholly composed of carbon atoms, this class was named "carbon-chain depleted." Moreover, nearly all comets in this second class have orbits consistent with their having arrived from the Kuiper Belt. For this and other reasons, the cause of the depletion is believed to be associated with the conditions that existed when the comets formed, perhaps within an outer, colder region of the Kuiper Belt.

Comets are widely thought to be the most pristine objects available for detailed study remaining from the epoch of Solar System formation. As such, comets can be used as probes of the proto-planetary material that was incorporated into our Solar System. Differences in the current chemical composition among comets can indicate either differences in primordial conditions or evolutionary effects.

Although the location of origin cannot be definitively determined for any single comet, Machholz1's short orbital period means that astronomers can search for additional carbon-bearing molecular species during future apparitions. *"If additional carbon-bearing species are also strongly depleted, then the case for its origin outside of our Solar System would be strengthened,"* said Schleicher. The next opportunity for observations will be in 2012.

#### NOVEMBER 2009 - RETURN OF THE LEONIDS

Astronomers from Caltech and NASA say a strong shower of Leonid meteors is coming in 2009. Their prediction follows an outburst on Nov. 17, 2008, that broke several years of "Leonid quiet" and heralds even more intense activity next November.

*"On Nov. 17, 2009, we expect the Leonids to produce upwards of 500 meteors per hour,"* says Bill Cooke. *"That's a very strong display."* Forecasters define a meteor storm as 1000 or more meteors per hour. That would make the 2009 Leonids *"a half-storm,"* says Jeremie Vaubaillon, who successfully predicted a related outburst just a few weeks ago.

On Nov. 17, 2008, Earth passed through a stream of debris from comet 55P/Tempel-Tuttle. The gritty, dusty debris stream was laid down by the Leonids' parent comet more than five hundred years ago in 1466. Almost no one expected the old stream to produce a very strong shower, but it did. Observers in Asia and Europe counted as many as 100 meteors per hour.

Vaubillon predicted the crossing with one-hour precision. *"I have a computer program that calculates the orbits of Leonid debris streams,"* he explains. *"It does a good job anticipating encounters even with very old streams like this one."* The Nov. 17, 2008 outburst proved that the 1466 stream is rich in meteor-producing debris, setting the stage for an even better display in 2009.

On Nov. 17, 2009, Earth will pass through the 1466 stream again, but this time closer to the center. Based on the number of meteors observed in 2008, Vaubaillon can estimate the strength of the coming display: five hundred or more Leonids per hour during a few-hour peak centered on 21:43 UT. *"Our own independent model of the debris stream agrees,"* says Cooke. *"We predict a sub-storm level outburst on Nov. 17, 2009, peaking sometime between 21:34 and 21:44 UT."*

The timing favors observers in Asia, although Cooke won't rule out a nice show over North America when darkness falls hours after the peak. *"I hope so,"* he says. *"It's a long way to Mongolia."*

Many readers will remember the great Leonid showers of 1998-2002. The best years (1999 and 2001) produced storms of up to 3000 Leonids per hour. The 2009 display won't be so intense. Instead, if predictions are correct, next year's shower could resemble the 1998 Leonids, a "half-storm"-level event caused by a stream dating from 1333. That old stream turned out to be rich in nugget-sized debris that produced an abundance of fireballs. Many observers consider the 1998 Leonids to be the best they've ever seen.

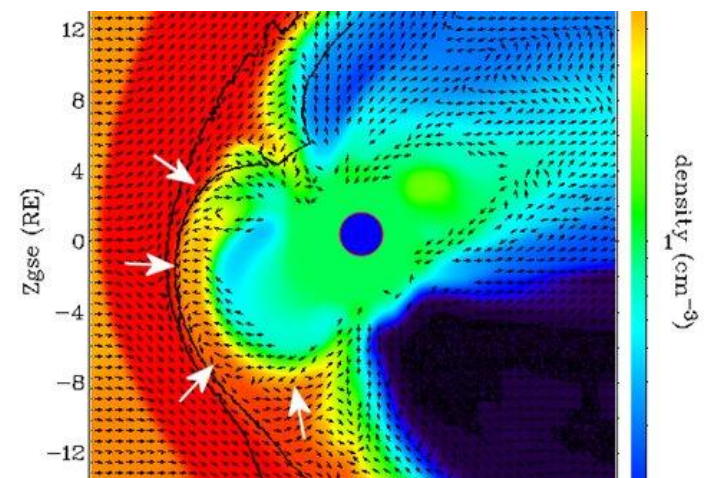
Could 2009 be the same? Vaubaillon expects a similar number of meteors but fewer fireballs. If the models are correct, the 1466 stream in Earth's path contains plenty of dust but not so many nuggets, thus reducing the fireball count. On the bright side, the Moon will be new next Nov. 17th so nothing will stand in the way of the shower reaching its full potential. Mark your calendar and stay tuned for updates from Science@NASA. [http://science.nasa.gov/headlines/y2008/04dec\\_leonids2009.htm](http://science.nasa.gov/headlines/y2008/04dec_leonids2009.htm)

#### A GIANT BREACH IN EARTH'S MAGNETIC FIELD

The five THEMIS spacecraft have discovered a breach in Earth's magnetic field ten times larger than anything previously thought to exist. Solar wind can flow in through the opening to "load up" the magnetosphere for powerful geomagnetic storms. But the breach itself is not the biggest surprise. Researchers are even more amazed at the strange and unexpected way it forms, overturning long-held ideas of space physics.

*"At first I didn't believe it,"* says THEMIS project scientist David Sibeck. *"This finding fundamentally alters our understanding of the solar wind-magnetosphere interaction."*

The magnetosphere is a bubble of magnetism that surrounds Earth and protects us from solar wind. Exploring the bubble is a key goal of the THEMIS mission, launched in February 2007. The big discovery came on June 3, 2007, when the five probes serendipitously flew through the breach just as it was opening. Onboard sensors recorded a torrent of solar wind particles streaming into the magnetosphere, signaling an event of unexpected size and importance.



*"The opening was huge, four times wider than Earth itself,"* says Wenhui Li, a space physicist who has been analyzing the data. Li's colleague Jimmy Raeder, says *"1027 particles per second were flowing into the magnetosphere - that's a 1 followed by 27 zeros. This kind of influx is an order of magnitude greater than what we thought was possible."*

The event began with little warning when a gentle gust of solar wind delivered a bundle of magnetic fields from the Sun to Earth. Like an octopus wrapping its tentacles around a big clam, solar magnetic fields draped themselves around the magnetosphere and cracked it open. The cracking was accomplished by means of a process called "magnetic reconnection." High above Earth's poles, solar and terrestrial magnetic fields linked up (reconnected) to form conduits for solar wind. Conduits over the Arctic and Antarctic quickly expanded; within minutes they overlapped over Earth's equator to create the biggest magnetic breach ever recorded by Earth-orbiting spacecraft.

The size of the breach took researchers by surprise. *"We've seen things like this before,"* says Raeder, *"but never on such a large scale. The entire day-side of the magnetosphere was open to the solar wind."* The circumstances were even more surprising. Space physicists have long believed that holes in Earth's magnetosphere open only in response to solar magnetic fields that point south. The great breach of June 2007, however, opened in response to a solar magnetic field that pointed north. *"To the lay person, this may sound like a quibble, but to a space physicist, it is almost seismic,"* says Sibeck. *"When I tell my colleagues, most react with skepticism, as if I'm trying to convince them that the sun rises in the west."*

Here is why they can't believe their ears: The solar wind presses against Earth's magnetosphere almost directly above the equator where our planet's magnetic field points north. Suppose a bundle of solar magnetism comes along, and it points north, too. The two fields should reinforce one another, strengthening Earth's magnetic defenses and slamming the door shut on the solar wind. In the language of space physics, a north-pointing solar magnetic field is called a "northern IMF" and it is synonymous with shields up! *"So, you can imagine our surprise when a northern IMF came along and shields went down instead,"* says Sibeck. *"This completely overturns our understanding of things."* Northern IMF events don't actually trigger geomagnetic storms, notes Raeder, but they do set the stage for storms by loading the magnetosphere with plasma. A loaded magnetosphere is primed for auroras, power outages, and other disturbances that can result when, say, a CME (coronal mass ejection) hits.

The years ahead could be especially lively. Raeder explains: *"We're entering Solar Cycle 24. For reasons not fully understood, CMEs in even-numbered solar cycles (like 24) tend to hit Earth with a leading edge that is magnetized north. Such a CME should open a breach and load the magnetosphere with plasma just before the storm gets underway. It's the perfect sequence for a really big event."* Sibeck agrees. *"This could result in stronger geomagnetic storms than we have seen in many years."* [http://www.nasa.gov/mpg/297403main\\_THEMIS\\_svsLG.mpg](http://www.nasa.gov/mpg/297403main_THEMIS_svsLG.mpg)  
[http://science.nasa.gov/headlines/y2008/16dec\\_qiantbreach.htm](http://science.nasa.gov/headlines/y2008/16dec_qiantbreach.htm)

#### FINDING 'MISSING' MINERAL & CLUES TO MARS MYSTERIES

Researchers using a powerful instrument aboard Mars Reconnaissance Orbiter have found a long sought-after mineral on the Martian surface and, with it, unexpected clues to the Red Planet's watery past. Surveying intact bedrock layers with the Compact Reconnaissance Imaging Spectrometer for Mars, or CRISM, scientists found carbonate minerals, indicating that Mars had neutral to alkaline water when the minerals formed at these locations more than 3.6 billion years ago. Carbonates, which on Earth include limestone and chalk, dissolve quickly in acid. Therefore, their survival until today on Mars challenges suggestions that an exclusively acidic environment later dominated the planet. Instead, it indicates that different types of watery environments existed. The greater the variety of wet

environments, the greater the chances one or more of them may have supported life.

*"We're excited to have finally found carbonate minerals because they provide more detail about conditions during specific periods of Mars' history,"* said Scott Murchie, principal investigator for the instrument. Carbonate rocks are created when water and carbon dioxide interact with calcium, iron or magnesium in volcanic rocks. Carbon dioxide from the atmosphere becomes trapped within the rocks. If all of the carbon dioxide locked in Earth's carbonates were released, our atmosphere would be thicker than that of Venus. Some researchers believe that a thick, carbon dioxide-rich atmosphere kept ancient Mars warm and kept water liquid on its surface long enough to have carved the valley systems observed today. *"The carbonates that CRISM has observed are regional rather than global in nature, and therefore, are too limited to account for enough carbon dioxide to form a thick atmosphere,"* said Bethany Ehlmann, lead author of the article and a spectrometer team member. *"Although we have not found the types of carbonate deposits which might have trapped an ancient atmosphere,"* Ehlmann said, *"we have found evidence that not all of Mars experienced an intense, acidic weathering environment 3.5 billion years ago, as has been proposed. We've found at least one region that was potentially more hospitable to life."*

The article reports clearly defined carbonate exposures in bedrock layers surrounding the 925-mile diameter Isidis impact basin, which formed more than 3.6 billion years ago. The best-exposed rocks occur along a trough system called Nili Fossae, which is 414 miles long, at the edge of the basin. The region has rocks enriched in olivine, a mineral that can react with water to form carbonate.

*"This discovery of carbonates in an intact rock layer, in contact with clays, is an example of how joint observations by CRISM and the telescopic cameras on the Mars Reconnaissance Orbiter are revealing details of distinct environments on Mars,"* said Sue Smrekar, deputy project scientist for the orbiter.

The Phoenix Mars Lander discovered carbonates in soil samples. Researchers had previously found them in Martian meteorites that fell to Earth and in windblown Mars dust observed from orbit. However, the dust and soil could be mixtures from many areas, so the carbonates' origins have been unclear. The latest observations indicate carbonates may have formed over extended periods on early Mars. They also point to specific locations where future rovers and landers could search for possible evidence of past life.

#### SWIFT LOOKS TO COMETS FOR A COOL VIEW

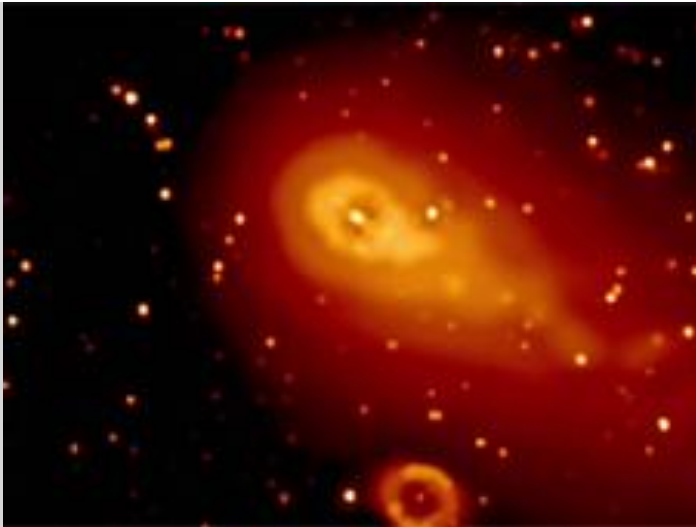
The Swift Gamma-ray Explorer satellite rocketed into space in 2004 on a mission to study some of the highest-energy events in the universe. The spacecraft has detected more than 380 gamma-ray bursts, fleeting flares that likely signal the birth of a black hole in the distant universe. In that time, Swift also has observed 80 exploding stars and studied six comets.

Comets? ... Comets are "dirty snowballs" made of frozen gases mixed with dust. X-rays come from superhot plasmas. What do cold comets have in common with exploding stars or the birth of black holes? *"It was a big surprise in 1996 when the ROSAT mission showed that comet Hyakutake was emitting X-rays,"* says Dennis Bodewits. *"After that discovery, astronomers searched through ROSAT archives. It turns out that most comets emit X-rays when they come within about three times Earth's distance from the sun."*

Bodewits is working with the Swift team to study comets using data from the spacecraft's Ultraviolet/Optical Telescope (UVOT)

and X-Ray Telescope (XRT). "Swift is an excellent platform for studying dynamic processes in comets," he says. Ultraviolet wavelengths let astronomers identify the chemical composition of the comet's atmosphere, observe the structure of dust emission, and identify the rotation of the comet's icy nucleus. X-rays reveal the structure of the comet's gas and the state of the solar wind, a stream of charged particles that flows from the sun at speeds upwards of 900,000 mph.

The piece, known as fragment C, is believed to be the comet's main body, which began splintering in 1995. In 2006, astronomers counted 66 fragments. Telescopes -- including Hubble and Spitzer -- revealed dust and condensations trailing several pieces. But fragment C showed no unusual changes -- except to Swift's ultraviolet eye. "It's subtle, but Swift caught clouds of dust and perhaps small pieces that no one else was able to," Immler says.



The UVOT also includes an ultraviolet 'grism', which combines a grating with a prism to separate incoming light by wavelength. "Swift's grism spans the wavelengths where carbon-bearing molecules and the hydroxyl molecule are most active. This gives us a unique view into the types and quantities of gas a comet produces, and that gives us clues about the origin of comets and the solar system," Bodewits explains. In fact, with the failure of the Hubble Space Telescope's ultraviolet spectrograph in 2004, Swift is currently the only space observatory covering this wavelength range.

As a comet's surface warms near the sun, the ices turn to gas and form a tenuous atmosphere, or coma, measuring hundreds of thousands of miles across. The solar wind pushes this gas back to form a comet's glowing gas tail. X-ray emission is a side effect of this interaction.

The X-rays arise through a process called charge exchange. Fast-moving ions in the solar wind snatch electrons from uncharged atoms in the comet's atmosphere. The solar-wind ions give off X-rays as the relocated electrons settle into their new home. Because the interaction occurs over such a broad region, the total power output of these emissions can reach one billion watts.

Charge exchange may play important roles in any objects where hot, expanding gas collides with cooler gas. One example: Young stars interacting with the gas and planets that might surround them. Comets provide excellent laboratories to explore these interactions.

When Comet 17P/Holmes underwent a surprising outburst in October 2007, Bodewits tasked both Swift and Chandra X-ray Observatory to observe it. "The comet was too bright to observe with the UVOT. We were afraid we'd damage the instrument," Bodewits says. "Despite this, we're still not sure whether we detected Holmes with the XRT or Chandra."

At the time of the outburst, Holmes was about 19 degrees above the ecliptic, the plane in which the planets orbit the sun. At that elevation, the comet was probably experiencing a cooler, steadier flow from the solar wind. "The source of this cooler flow wasn't hot enough to produce the ions Holmes needed to make X-rays," Bodewits notes.

Four years ago today, Swift captured its first x-rays. The radiation came from Cygnus X-1, one of sky's strongest sources at these energies. The system, located within our galaxy, contains a hot, blue-giant star orbited by a black hole.

"Swift has operated two years longer than we had hoped," says Neil Gehrels, the mission's lead scientist. "And while gamma-ray bursts and stellar explosions are the satellite's bread and butter, it's clear that Swift has a lot to contribute to other areas of astronomy."

[http://www.nasa.gov/mission\\_pages/swift/bursts/cool\\_comet.html](http://www.nasa.gov/mission_pages/swift/bursts/cool_comet.html)

### RIVERS OF GAS FLOW AROUND STARS IN NEW IMAGE

A new image from Spitzer Space Telescope shows a turbulent star-forming region, where rivers of gas and stellar winds are eroding thickets of dusty material. The picture provides some of the best examples yet of the ripples of gas, or bow shocks, that can form around stars in choppy cosmic waters. "The stars are like rocks in a rushing river," said Matt Povich. "Powerful winds from the most massive stars at the center of the cloud produce a large flow of expanding gas. This gas then piles up with dust in front of winds from other massive stars that are pushing back against the flow." Povich is lead author of a paper describing the new findings. Spitzer's new infrared view of the stormy region, called M17, or the Swan nebula, is online at [http://www.nasa.gov/mission\\_pages/spitzer/multimedia/20081208.html](http://www.nasa.gov/mission_pages/spitzer/multimedia/20081208.html)

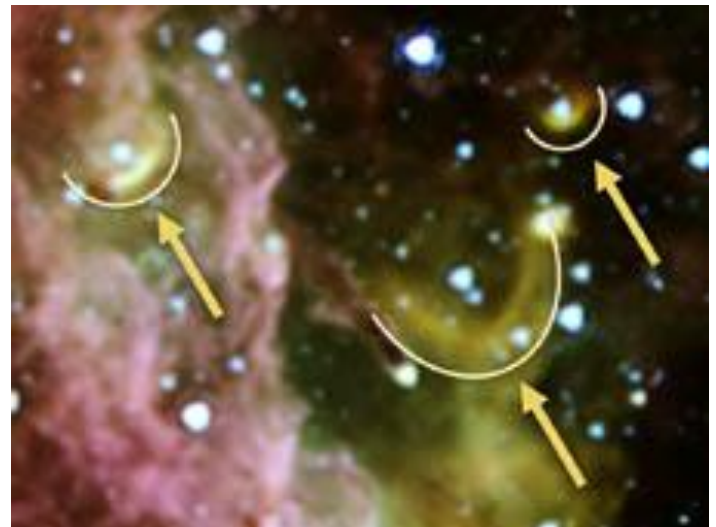


Image credit: NASA/JPL-Caltech/Univ. of Wisc.

The Swan is located about 6,000 light-years away in the constellation Sagittarius. Dominating the center of the Swan is a group of massive stars, some exceeding 40 times the mass of our sun. These central stars are 100,000 to one million times as bright as the sun, and roar with radiation and fierce winds made of charged particles that speed along at up to 7.2 million

kilometers per hour (4.5 million miles per hour). Both the wind and radiation carve out a deep cavity at the center of the picture -- an ongoing process thought to trigger the birth of new stars. The growth of this cavity pushes gas up against winds from other massive stars, causing "smiley-faced" bow shocks -- three of which can be seen in the new picture. The direction of the bow shocks tells researchers exactly which way the "wind is blowing." *"The bow shocks are like interstellar weather vanes, indicating the direction of the stellar winds in the nebula,"* said Povich.

Povich and his colleagues also used Spitzer to take an infrared picture of a star-forming region called RCW 49. Both photographs are described in the same *Astrophysical Journal* paper, and both provide the first examples of multiple bow shocks around the massive stars of star-forming regions.

Spitzer was able to spot the bow shocks because its infrared eyes can pierce intervening dust, and because it can photograph large swaths of sky quickly.

Ultimately, the new observations will help researchers understand how solar systems like our own are able to form and persist in the rough, celestial seas of space. *"The gas being lit up in these star-forming regions looks very wispy and fragile, but looks can be deceiving,"* said co-author Robert Benjamin. *"These bow shocks serve as a reminder that stars aren't born in quiet nurseries but in violent regions buffeted by winds more powerful than anything we see on Earth."*  
<http://www.jpl.nasa.gov/news/news.cfm?release=2008-228>

#### **DARK ENERGY FOUND STIFLING GROWTH IN UNIVERSE**

For the first time, astronomers have clearly seen the effects of "dark energy" on the most massive collapsed objects in the universe using Chandra X-ray Observatory. By tracking how dark energy has stifled the growth of galaxy clusters and combining this with previous studies, scientists have obtained the best clues yet about what dark energy is and what the destiny of the universe could be.

This work, which took years to complete, is separate from other methods of dark energy research, such as supernovas. These new X-ray results provide a crucial independent test of dark energy, long sought by scientists, which depends on how gravity competes with accelerated expansion in the growth of cosmic structures. Techniques based on distance measurements, such as supernova work, do not have this special sensitivity.

Scientists think dark energy is a form of repulsive gravity that now dominates the universe, although they have no clear picture of what it actually is. Understanding the nature of dark energy is one of the biggest problems in science. Possibilities include the cosmological constant, which is equivalent to the energy of empty space. Other possibilities include a modification in general relativity on the largest scales, or a more general physical field. To help decide between these options, a new way of looking at dark energy is required. It is accomplished by observing how cosmic acceleration affects the growth of galaxy clusters over time. *"This result could be described as 'arrested development of the universe,'"* said Alexey Vikhlinin, who led the research.

*"Whatever is forcing the expansion of the universe to speed up is also forcing its development to slow down."*

Vikhlinin and his colleagues used Chandra to observe the hot gas in dozens of galaxy clusters, which are the largest collapsed objects in the universe. Some of these clusters are relatively close and others are more than halfway across the universe. The results show the increase in mass of the galaxy clusters over time aligns with a universe dominated by dark energy. It is more difficult for objects like galaxy clusters to grow when space is stretched, as caused by dark energy. Vikhlinin and his team see this effect clearly in their data. The results are remarkably consistent with those from the distance measurements, revealing general relativity applies, as expected, on large scales.

*"For years, scientists have wanted to start testing how gravity works on large scales and now, we finally have,"* said William Forman, a co-author of the study from the Smithsonian Astrophysical Observatory. *"This is a test that general relativity could have failed."*

When combined with other clues -- supernovas, the study of the cosmic microwave background, and the distribution of galaxies -- this new X-ray result gives scientists the best insight to date on the properties of dark energy. The study strengthens the evidence that dark energy is the cosmological constant. Although it is the leading candidate to explain dark energy, theoretical work suggests it should be about 10 raised to the power of 120 times larger than observed. Therefore, alternatives to general relativity, such as theories involving hidden dimensions, are being explored.

*"Putting all of this data together gives us the strongest evidence yet that dark energy is the cosmological constant, or in other words, that 'nothing weighs something,'"* said Vikhlinin. *"A lot more testing is needed, but so far Einstein's theory is looking as good as ever."* These results have consequences for predicting the ultimate fate of the universe. If dark energy is explained by the cosmological constant, the expansion of the universe will continue to accelerate, and the Milky Way and its neighbor galaxy, Andromeda, never will merge with the Virgo cluster. In that case, about a hundred billion years from now, all other galaxies ultimately would disappear from the Milky Way's view and, eventually, the local superclusters of galaxies also would disintegrate.

#### **FROM THE EDITOR'S TERMINAL**

*The Stargazer* is your newsletter and therefore it should be a cooperative project. Ads, announcements, suggestions, and literary works should be received by the editor at least two weeks prior to the next upcoming scheduled EAS meeting.

If you wish to contribute an article or suggestions to *The Stargazer* please contact Mark Folkerts by email or by telephone (425) 486-9733 or co-editor Bill O'Neil, at (774) 253-0747.

**The Star Gazer**  
**P.O. Box 12746**  
**Everett, WA 98206**

### **In December/January's StarGazer:**

- \*\*\*\* **ASTRO CALENDAR - UPCOMING ASTRONOMY EVENTS**
- \*\*\*\* **OBSERVER'S INFORMATION - SUN, MOON, AND PLANET VISIBILITY**
- \*\*\*\* **CONSTELLATIONS OF THE MONTH**
- \*\*\*\* **"MIRROR IMAGES" – PLANETARY NEBULAE**
- \*\*\*\* **YOUNG ASTRONOMER'S CORNER**
- \*\*\*\* **PLANETARY FOCUS - JUPITER**
- \*\*\*\* **SATURN'S CRAZY HOLIDAY TILT**
- \*\*\*\* **SOLAR FLARE SURPRISE**
- \*\*\*\* **PHOENIX SITE ON MARS MAY BE IN DRY CLIMATE CYCLE PHASE**
- \*\*\*\* **SATURN'S DYNAMIC MOON ENCELADUS SHOWS MORE SIGNS OF ACTIVITY**
- \*\*\*\* **JUPITER'S ROCKY CORE BIGGER AND ICIER, MODEL PREDICTS**
- \*\*\*\* **HUBBLE FINDS CARBON DIOXIDE ON AN EXTRASOLAR PLANET**
- \*\*\*\* **NEW COMPOSITIONAL CLASS OF COMETS: FROM FIRE, ICE, OR BEYOND?**
- \*\*\*\* **NOVEMBER 2009 - RETURN OF THE LEONIDS**
- \*\*\*\* **A GIANT BREACH IN EARTH'S MAGNETIC FIELD**
- \*\*\*\* **FINDING 'MISSING' MINERAL & CLUES TO MARS MYSTERIES**
- \*\*\*\* **SWIFT LOOKS TO COMETS FOR A COOL VIEW**
- \*\*\*\* **RIVERS OF GAS FLOW AROUND STARS IN NEW IMAGE**
- \*\*\*\* **DARK ENERGY FOUND STIFLING GROWTH IN UNIVERSE**

**The next EAS Meeting is 7:00 P.M. Saturday January 31<sup>st</sup> at the 'Aurora Astro Products' store location at Silver Lake.**