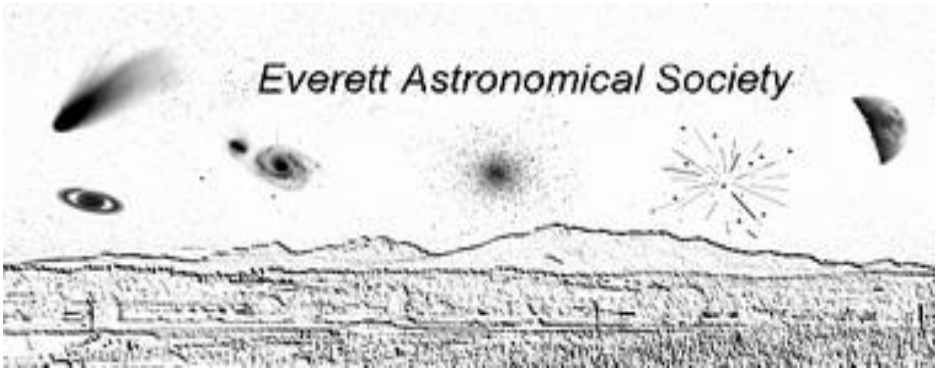
Volume MMXIII No. 4



The Stargazer

April 2013

President:	Mark Folkerts	(425) 486-9733	folkerts at seanet dot com	***The Stargazer***
VP and Programs:	Ron Mosher		ron.mosher69 at gmail dot net	**P.O. Box 13272**
Librarian:	Chris Dennis		chrisandlinda at frontier dot net	**Mill Creek, WA 98082**
Treasurer:	Cindy Perkins			
Web assistance:	Cody Gibson		cgibson41 at austin dot rr dot com	
Publicity	Bill Ferguson / Mike Kozak			
Intro Astro Classes	Jack Barnes		jackdanielb at comcast dot net	*See EAS website at:*
Public Outreach coord.	Mike Tucker		scalped_raven at yahoo dot com	http://everettastro.org

EAS BUSINESS…

APRIL EAS MEETING – SATURDAY APRIL 20, 3:00 PM, AT EVERGREEN BRANCH LIBRARY, MEETING ROOM

The next EAS monthly meeting will be 3:00 pm Saturday April 20th. Presentation will be 'Saturn: Lord of the Rings' (as it comes to opposition). EAS meetings have speakers or presentations, and updates on calendar events and upcoming activities, and are open to the public at no charge. Meeting is at the **Evergreen branch** of the **Everett Public Library** located at 9512 Evergreen Way. - Website · Directions

Upcoming EAS meetings are set for May 25th and Jun 22nd - Sat 3:00 pm at Evergreen Branch Library

PREVIOUS (MARCH) EAS MEETING RECAP

The March meeting covered doing a collimation to tune up your Newtonian telescope for spring and summer observing. Success at this comes down to doing three simple steps, in the correct order: 1 – Center the secondary mirror in its holder under the focuser, viewed from the eyepiece holder; 2 – Adjust the secondary adjustment screws to point the secondary at the center of the primary, centering the primary (and its retaining clips) in the view; 3 – Finally, adjust the bolts on the primary to center the reflections in the eyepiece holder view.

Also, the EAS unanimously adopted updated set of By-Laws to formally govern club activities, and for bank, state, and IRS requirements.

NEW MEMBER / BEGINNERS CLASS WITH JACK BARNES

Classes are as requested, please contact Jack Barnes to set up a date and time. Email - jackdanielb at comcast dot net

★ STAR PARTY INFO ★

★ Scheduled EAS Star Parties at Ron Tam's: ★

***** Friday April 5th, 7:30 pm at Ron's place. *****

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 star parties. 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 at frontier dot net**) but I don't check my email daily. They can email me for directions if they never have been out here."* Call Ron about unscheduled spur-of-the-moment observing.

Please also join the EAS e-mail list, and then send mail to the mail list at ***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. Also watch the EAS Facebook page !

Other Western US Star Parties in 2013

2013 Regional Star Parties

Apr 11-14 - Spring Camp Delany star party - http://Olympicastronomicalsociety.org

May 5-12 2013 - Texas Star Party - Ft Davis, TX http://texasstarparty.org/

May 22-27 2013 - RTMC Astronomy Expo http://www.rtmcastronomyexpo.org/

Jun 8-15 2013 - Grand Canyon Star Party, AZ - http://tucsonastronomy.org/gcsp/

Jun 5-9 2013 – Rocky Mountain Star Stare, Colorado - http://www.rmss.org/

Jul 6-10 2013 – Golden State Star Party, CA - http://www.goldenstatestarparty.org/

Aug 3-11 2013 - Mt. Kobau Star Party, Osoyoos BC - http://www.mksp.ca/

Aug 6-11 – Oregon SP - http://www.oregonstarparty.org/oregonstarparty/default.aspx

Aug 8-10 2013 - Table Mt Star Party, location TBD - http://www.tmspa.com/

Aug 30-Sep 2 2013 - RASCals Star Party - http://victoria.rasc.ca/events/StarParty/

Sep 4-8 2013 – Mt. Bachelor - Brothers Star Party - http://www.mbsp.org/

Sep 6-8 2013 - Alberta BC Star Party - http://calgary.rasc.ca/asp.htm

Oct 2-5 2013 - Enchanted Skies SP - Socorro, NM - http://enchantedskies.org/

Other Star Parties

http://www.amsky.com/calendar/events/

2013 ASTRO CALENDAR

April 2013 Astro Calendar

Apr 03 - Moon occults Pluto
Apr 06 - Venus passes 0.7 degrees from Mars
Apr 09 - Dwarf Planet 136108 Haumea at opposition (49.96 AU)
Apr 12 - Yuri's Night: World Space Party
Apr 14 - Asteroid 3 Juno occults TYC 5188-00638-1 (9.9 magnitude star)
Apr 15-21 - Astronomy Week
Apr 19 - Mercury passes 2.0 degrees from Uranus
Apr 19 - Comet P/2012 T2 (PANSTARRS) perihelion (4.82 AU)
Apr 20 - Astronomy Day
Apr 22 - Earth Day
Apr 22 - Lyrids meteor shower peak
Apr 25 - Partial lunar Eclipse
Apr 28 - Saturn at opposition
Apr 30 - Moon occults Pluto

May 2013 Astro Calendar

May 03 - Space Day
May 05 - Eta Aquarids meteor shower peak
May 07 - Mercury passes 0.5 degrees from Mars
May 10 - Annular solar eclipse (visible from Austrlia, Pacific Ocean)
May 25 - Penumbral lunar Eclipse
May 25 - Mercury passes 1.4 degrees from Venus
May 27 - Mercury passes 2.4 degrees from Jupiter
May 28 - Venus passes 1.0 degrees from Jupiter

June 2013 Astro Calendar

Jun 05-07 - Sedona Star Festival, Sedona, Arizona
Jun 06-09 - Cherry Springs Star Party 2013, Cherry Springs State Park, PA
Jun 12 - Mercury at its greatest eastern elongation (24 degrees) western sky
Jun 16 - Kuiper Belt Object 50000 Quaoar at opposition (42.05 AU)
Jun 20 - Mercury passes 2.0 degrees from Venus
Jun 20 - Asteroid 3325 TARDIS closest approach to Earth (2.26 AU)
Jun 21 - Summer Solstice, 05:04 UT
Jun 24 - Moon occults Pluto

July 2013 Astro Calendar

Jul 01 - Dwarf planet 134340 Pluto at opposition (31.45 AU)
Jul 05 - Earth at aphelion (1.017 AU from Sun)
Jul 08 - Asteroid 99942 Apophis closest approach to Earth (0.24 AU)
Jul 10-14 - Mason-Dixon Star Party, Welllsville, Pennsylvania
Jul 21 - Moon occults Pluto
Jul 22 - Mars passes 0.8 degrees from Jupiter
Jul 29 - South Delta-Aquarids meteor shower peak
Jul 30 - Mercury at its greatest western elongation (20 degrees) morning sky
Jul 31 - Mars Spring Equinox

August 2013 Astro Calendar

Aug ?? - New Horizons Crosses Neptune's Orbit
Aug 04 - Asteroid 3 Juno at opposition (8.6 magnitude)
Aug 04 - Asteroid 3 Juno occults 2UCAC 30282141 (12.2 magnitude star)
Aug 06 - Southern Iota Aquarids meteor shower peak
Aug 12 - Perseids meteor shower peak
Aug 16 - Asteroid 7 Iris at opposition (7.6 magnitude)
Aug 17 - Moon occults Pluto
Aug 25 - Northern Iota Aquarids meteor shower peak
Aug 27 - Neptune at opposition

September 2013 Astro Calendar

Sep 02 - Asteroid 3 Juno occults TYC 5741-02620-1 (11.4 magnitude star)
Sep 08 - Moon occults Venus
Sep 20 - Venus 3.7 Deg from Saturn closest approach to Earth (2.08 AU)
Sep 22 - Autumnal equinox, 20:44 UT

October 2013 Astro Calendar

Oct 01 - NASA's 55th birthday (1958)
Oct 03 - Uranus at opposition
Oct 04-10 - World Space Week
Oct 06 - Asteroid 2 Pallas occults TYC 5436-00385-1 (9.7 magnitude star)
Oct 09 - Juno, Earth flyby
Oct 09 - Mercury at its greatest eastern elongation (25 degrees) evening sky
Oct 09 - Draconids meteor shower peak
Oct 10 - Mercury passes 5.4 degrees from Saturn
Oct 13 - Moon occults Asteroid 3 Juno
Oct 15 - Dwarf planet 136199 Eris at opposition (95.48 AU)
Oct 18 - Penumbral lunar eclipse
Oct 21 - Orionids meteor shower peak
Oct 25 - Asteroid 1 Ceres occults TYC 0865-00911-1 (10.0 magnitude star)
Oct 28 - Mercury passes 4.1 degrees from Saturn
Oct 29 - Asteroid 8958 Stargazer closest approach to Earth (1.61 AU)
Oct 31 - Kuiper Belt Object 55637 (2002 UX25) at opposition (40.17 AU)

November 2013 Astro Calendar

Nov 01 - Venus at Its greatest eastern elongation (47 degrees)
Nov 02 - Asteroid 2 Pallas occults TYC 6028-00309-1 (9.6 magnitude star)
Nov 02 - Asteroid 3 Juno occults 2UCAC 27007662 (12.5 magnitude star)
Nov 03 - Hybrid solar eclipse
Nov 03 - Daylight Saving ends - Set clock Back 1 Hour (United States)
Nov 03 - Taurids meteor shower peak
Nov 15 - William Herschel's 275th birthday (1738)
Nov 17 - Leonids meteor shower peak
Nov 18 - Mercury at its greatest western elongation (19 degrees) morning sky
Nov 18 - Alan Shepard's 90th birthday (1923)
Nov 26 - Asteroid 2007 VW83 Near-Earth Flyby (0.066 AU)
Nov 28 - Comet C/2012 S1 (ISON) perihelion (0.013 AU)

December 2013 Astro Calendar

Dec 01 - Moon occults Saturn
Dec 07 - Kuiper Belt Object 174567 (2003 MW12) at opposition (48.2 AU)
Dec 08 - Kuiper Belt Object 2004 XR190 at opposition (56.67 AU)
Dec 09 - Kuiper Belt Object 19521 Chaos at opposition (40.54 AU)
Dec 13 - Geminids meteor shower peak
Dec 21 - Winter Solstice, 17:11 UT
Dec 21 - 45th anniversary (1968), Apollo 8 launch (Borman, Lovell and Anders)
Dec 22 - Ursids meteor shower peak
Dec 27 - Comet C/2012 S1 (ISON) closest approach to Earth (0.429 AU)
Dec 27 - Asteroid 6 Hebe occults HIP 95168 (3.9 magnitude star)
Dec 29 - Moon occults Saturn

January 2014 Astro Calendar

Jan 03 - Quadrantids meteor shower peak
Jan 04 - Earth at perihelion (0.983 AU from Sun)
Jan 05 - Jupiter at opposition
Jan 07 - Mercury passes 6.5 degrees from Venus
Jan 16 - Kuiper Belt Object 20000 Varuna at opposition (42.72 AU)
Jan 19 - Kuiper Belt Object 208996 (2003 AZ84) at opposition (44.03 AU)
Jan 31 - Chinese New Year

OBSERVER'S INFORMATION…

LUNAR PHASES FOR OBSERVING

Apr 10	New Moon
Apr 18	First Quarter Moon
Apr 25	Full Moon

May 02	Last Quarter Moon
May 09	New Moon
May 17	First Quarter Moon
May 24	Full Moon
May 31	Last Quarter Moon
Jun 08	New Moon
Jun 16	First Quarter Moon
Jun 23	Full Moon
Jun 19	Last Quarter Moon

UP IN THE SKY THIS MONTH - THE PLANETS (*AND PLUTO*)

Object	*Rises*	*Sets*	*Con*	*Diam.*	*Mag*
Sun	**06:12 am**	**20:05**	**Cap**	**30'**	**-27.5**
Mercury	**05:47 am**	**17:58**	**Cet**	**05"**	**-0.2**
Venus	**06:33 am**	**20:28**	**Ari**	**10"**	**-3.7**
Mars	**06:17 am**	**19:55**	**Ari**	**04"**	**+1.4**
Jupiter	**08:25 am**	**23:57**	**Tau**	**42"**	**-1.8**
Saturn	**20:37**	**06:52 am**	**Lib**	**17"**	**+0.7**
Uranus	**05:39 am**	**18:05**	**Psc**	**04"**	**+5.9**
Neptune	**04:31 am**	**14:56**	**Aqr**	**02"**	**+7.9**
Pluto	**01:39 am**	**10:32 am**	**Sag**	*	**+14.1**

(*times listed are in local time for Everett PDT*)

EAS MEMBER NEWS

IMPORTANT CHANGE - If you have NOT paid your dues yet this year (2013), you should pay $24 now, as everyone's dues are expected in January. Please send check to EAS P.O. Box 13272, Mill Creek WA, 98082, or bring to meeting.

MEMBER NOTE: See the great EAS member TMSP report and astro-photos, featured at the end of this month's newsletter !

$$ - FINANCIAL HEALTH - $$

The club currently maintains a $850+ balance. We try to keep approximately a $500 balance level to allow for contingencies.

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.

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

EAS MEMBERSHIP BENEFITS & INFORMATION

EAS Benefits - Membership in the Everett Astronomical Society (EAS) includes invitations to all of the club meetings and star parties, and entitles members to the monthly newsletter, *The Stargazer.* Only members may vote in EAS elections, or be eligible for EAS drawings.

Magazine Discounts – In addition you will be able subscribe to ***Sky and Telescope*** for $7 off the normal subscription rate, contact the treasurer (Jerry Galt) 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.** EAS treasurer 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 Library - Membership will give you access to all the material in the lending library. The library, 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 club librarian to borrow or donate any materials. See library items list here: http://everettastro.org/eas_library.htm

Joining or Renewing with the EAS -

EAS dues are $24 / year per family, payable in January. If you have not paid your dues yet for 2013, please send or bring a check to our Treasurer to re-subscribe, to keep the club financially solvent, and to continue to receive great membership benefits. http://everettastro.org/application.htm

>> Members – Your dues are payable each January if you have not paid for this year, please do so as soon as possible. If you become 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 distribution of newsletters and rolls for club elections. <<

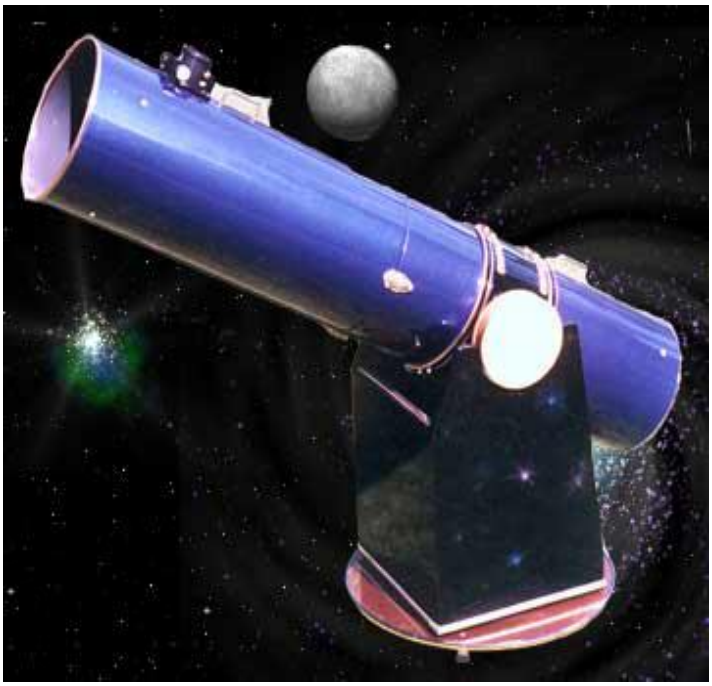
Send your annual dues renewals to
Everett Astronomical Society
P.O. Box 13272, Mill Creek, WA 98082.

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.

HOW YOU CAN HELP THE EAS

Help the sidewalk astronomy committee with events this spring and summer: Plan and conduct urban/suburban sidewalk astronomy events to allow passers-by to experience astronomy. We are looking for multiple volunteers who could help with a series of Sidewalk Astronomy sessions this spring and summer, at a local park or public venue. Special events like eclipse or comets (ISON, for example?) especially draw the interest of the public. **Other volunteers?** Find a way to help and contribute. Come up with a new idea to promote the EAS and astronomy in your community.

CLUB SCOPES



EAS Club Telescope Borrowing – (Ken Ward 10" club telescope shown)

Being an EAS 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 Ron Tam, (360) 568-5152 to borrow a telescope.

Scope	Loan Status
NEW 8-inch SkyQuest Dob	**Available for Loan**
8-inch Dobsonian	**Currently On Loan**
10-inch Ken Ward Dobsonian	**Available for Loan**
10-inch Sonotube Dobsonian	Available
13-inch thin-mirror Dob	Finishing Rehab

A 25-inch mirror has been donated to the club, and investigation is under way to determine what would be required to turn it into a large club telescope. If you have interest or skills in mirror testing or telescope making, please let us know.

EAS members: contact Ron Tam, to borrow a scope for up to 60 days.

'It's Over Your Head' – Astronomy Podcasts

Web page with lots of archives and other info is available at http://www.celestialnorth.org/radio/index.php podcasts 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, Mon - Fri 6:30PM; Sat - Sun 6:00PM. 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.

Digital Lunar Orbiter Photographic Atlas of the Moon

The Lunar and Planetary Institute has created a digital version of Lunar Orbiter Photographic Atlas of the Moon, and Consolidated Lunar Atlas available at: http://www.lpi.usra.edu/research/cla/menu.html http://www.lpi.usra.edu/research/lunar_orbiter

Observing Jupiter's Moons – Java tool

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

Transit times for Jupiter's Great Red Spot in 2012

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

NOAA Sun Calculator

Need to know exactly what time the sun will set on Sep 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, available on the Web. http://www.srrb.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

Astronomical Notes -- On & Off the Web...

Hubble Sees a Horsehead of a Very Different Color!

Astronomers have used Hubble to photograph the iconic Horsehead Nebula in a new, infrared light to mark the 23rd anniversary of the famous observatory's launch aboard the space shuttle Discovery on Apr 24th , 1990. The new image is very striking and novel. Looking like an apparition rising from whitecaps of interstellar foam, the iconic 'Horsehead Nebula' has graced astronomy books ever since its discovery more than a century ago. The nebula is a favorite target for amateur and professional astronomers. It is shadowy in optical light. It appears transparent and ethereal when seen at infrared wavelengths. The rich tapestry of the Horsehead Nebula pops out against the backdrop of Milky Way stars and distant galaxies that easily are visible in infrared light. Hubble has been producing ground-breaking science for two decades. During that time, it has benefited from a slew of upgrades from space shuttle missions, including the 2009 addition of a new imaging workhorse, the high-resolution Wide Field Camera 3 (WFC-3) that took the new portrait of the Horsehead. The nebula is part of the 'Orion Molecular Cloud', located about 1,500 light-years away in the constellation Orion. The cloud also contains other well-known objects such as the 'Great Orion Nebula' (M42), the 'Flame Nebula', and 'Barnard's Loop'. It is one of the nearest and most easily photographed regions in which massive stars are being formed.

In the Hubble image, the backlit wisps along the Horsehead's upper ridge are being illuminated by Sigma Orionis, a young five-star system just out of view. Along the nebula's top ridge, two fledgling stars peek out from their now-exposed nurseries.

Scientists know a harsh ultraviolet glare from one of these bright stars is slowly evaporating the nebula. Gas clouds surrounding the Horsehead already have dissipated, but the tip of the jutting pillar contains a slightly higher density of hydrogen and helium, laced with dust. This casts a shadow that protects material behind it from being stripped away by intense stellar radiation evaporating the hydrogen cloud, and a pillar structure forms. http://hubblesite.org/news/2013/12 http://heritage.stsci.edu/2013/12 http://www.spacetelescope.org/news/heic1307

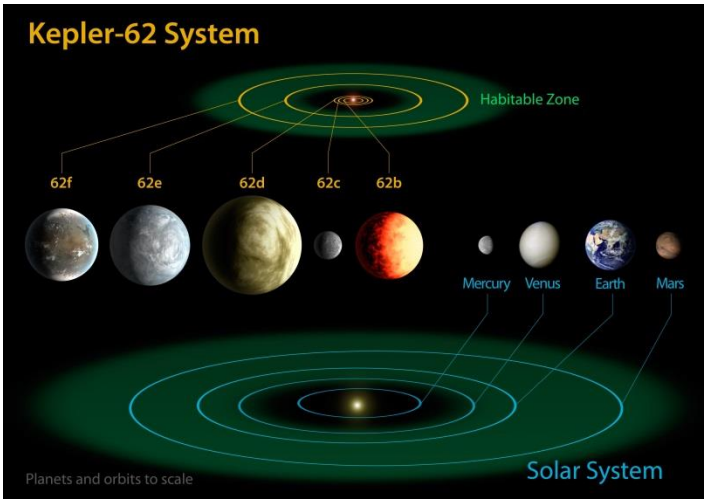
HST infra-red view of the Horsehead Nebula

Kepler Discovers Smallest Habitable Zone Planets

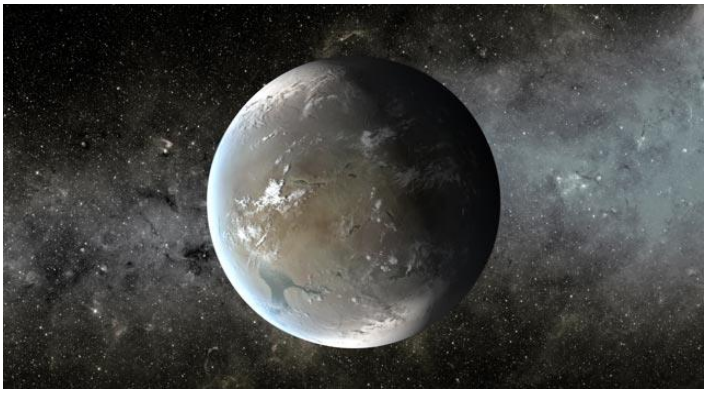
The Kepler mission has discovered two new planetary systems that include three super-Earth-size planets in the "habitable zone," the range of distance from a star where the surface temperature of an orbiting planet might be suitable for liquid water.

The 'Kepler-62' system has five planets: 62b, 62c, 62d, 62e and 62f. The 'Kepler-69' system has two planets: 69b and 69c. Kepler-62e, 62f and 69c are the super-Earth-sized planets.

The five planets of 'Kepler-62' orbit a star classified as a K2 dwarf, measuring just two thirds the size of the sun and only one fifth as bright. At seven billion years old, the star is somewhat older than the sun. Much like our solar system, Kepler-62 is home to two habitable zone worlds, 'Kepler-62f', and 'Kepler-62e', and orbit a star smaller and cooler than the sun. Orbiting its star every 122 days, 'Kepler-62e' was the first of these habitable zone planets identified.



'***Kepler-62' system vs. the Solar System - Diagram compares the planets of the inner solar system to Kepler-62, a five-planet system in Lyra.***



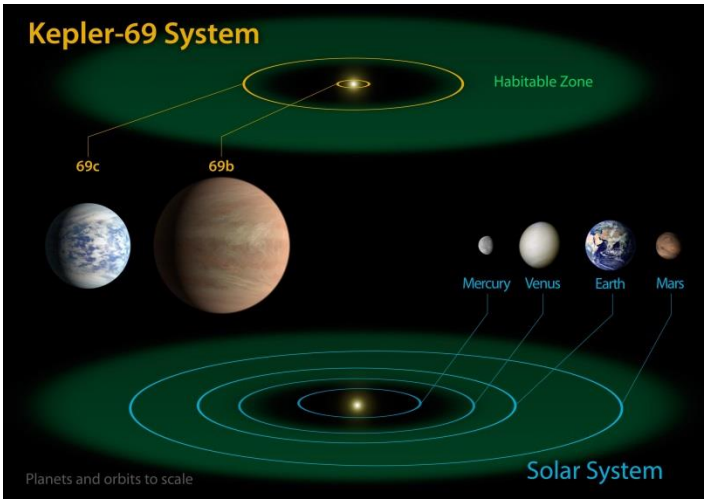
Artist's concept of Kepler-62f – found by Eric Agol from University of Washington! (a previous speaker to the EAS)

'**Kepler-62f', with an orbital period of 267 days, is only 40% larger than Earth, making it the smallest, and the exoplanet closest to the size of our planet, known in the habitable zone of another star, was later found by Eric Agol, associate professor of astronomy at the University of Washington, and co-author of a paper on the discoveries published in the journal Science.** The size of Kepler-62f is now measured, but its mass and composition are not. However, based on previous studies of rocky exoplanets similar in size, scientists are able to estimate its mass by association; Kepler-62f is likely to have a rocky composition.

The other habitable zone planet, Kepler-62e, orbits every 122 days and is roughly 60% larger than Earth. Kepler-62e orbits on the inner edge of the habitable zone. The two habitable zone worlds orbiting Kepler-62 have three interior companions, two larger than the size of Earth, and one about the size of Mars. Kepler-62b, Kepler-62c and Kepler-62d, orbit every 5, 12, and 18 days, respectively, making them very hot and inhospitable for life as we know it. The five planets of the Kepler-62 system orbit a star classified as a K2 dwarf, measuring just two-thirds the size of the sun and only one-fifth as bright. At seven billion years old, the star is somewhat older than the sun. It is about 1,200 light-years from Earth in the constellation Lyra.

The third planet announced, Kepler-69c; is 70% larger than the size of Earth, and orbits in the habitable zone of a star similar to our sun. Astronomers are uncertain about the composition of Kepler-69c, but its orbit of 242 days around a sun-like star resembles that of our neighboring planet Venus. The two planets of star 'Kepler-69' orbit a star that belongs to the same class as our sun, called G-type. Kepler-69c is the smallest yet found to orbit in the habitable zone of a sun-like star. Astronomers are uncertain about the composition of Kepler-69c, but its orbit of 242 days around a sun-like star resembles that of our neighboring planet Venus. The companion planet, Kepler-69b, is just over twice the size of Earth, and whizzes around its star once every 13 days. Kepler-69b is 93 percent the size of the sun, and 80 percent as luminous, and is located approximately 2,700 light-years from Earth in the constellation Cygnus.

The artistic concepts of the Kepler-69 planets are the result of scientists and artists collaborating to help imagine the appearance of these distant worlds. The Kepler space telescope, which simultaneously and continuously measures the brightness of more than 150,000 stars, is first mission capable of detecting Earth-size planets around stars like our sun.



Kepler-69 vs. the Solar System - Diagram compares the planets of the inner solar system to Kepler-69, a two-planet system about 2,700 light-years from Earth in the constellation Cygnus.

Scientists do not know whether life could exist on the newfound planets, but their discovery signals we are another step closer to finding a world similar to Earth around a star like our sun. "*The Kepler spacecraft has certainly turned out to be a rock star of science*," said John Grunsfeld, associate administrator of the Science Mission Directorate. "*The discovery of these rocky planets in the habitable zone brings us a bit closer to finding a place like home. It is only a matter of time before we know if the galaxy is home to a multitude of planets like Earth, or if we are a rarity*." (Kepler space telescope, which simultaneously and continuously measures the brightness of more than 150,000 stars, is the first mission capable of detecting Earth-size planets around stars like our sun.)

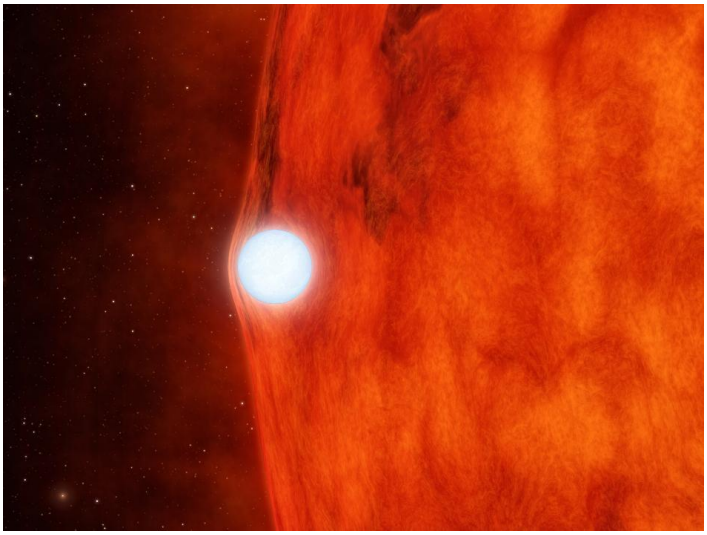
"*The detection and confirmation of planets is an enormously collaborative effort of talent and resources, and requires expertise from across the scientific community to produce these tremendous results*," said William Borucki, Kepler science principal investigator, and lead author of the Kepler-62 system paper. "*Kepler has brought a resurgence of astronomical discoveries and we are making excellent progress toward determining if planets like ours are the exception or the rule*." "*We only know of one star that hosts a planet with life, the sun. Finding a planet in the habitable zone around a star like our sun is a significant milestone toward finding truly Earth-like planets*," said Thomas Barclay, Kepler scientist, and lead author of the Kepler-69 system discovery paper.

When a planet candidate transits, or passes in front of the star from the spacecraft's vantage point, a percentage of light from the star is

blocked. The resulting dip in the brightness of the starlight reveals the transiting planet's size relative to its star. Using the transit method, Kepler has detected 2,740 candidates. Using various analysis techniques, ground telescopes, spectrometers, and other space assets, 122 planets have been confirmed. Early in the mission, the Kepler telescope primarily found large, gaseous giants in very close orbits of their stars. Known as "hot Jupiters," these are easier to detect due to their size and very short orbital periods, which must be seen at least 3 times for a discovery. Earth would take at least three Earth-years to accomplish seeing the three consecutive transits required to be accepted as a planet candidate. As Kepler continues to observe, transit signals of habitable zone planets the size of Earth that are orbiting stars like the sun will begin to emerge. http://www.jpl.nasa.gov/news/news.php?release=2013-142&cid=release_2013-142

GRAVITY-BENDING FIND LEADS TO KEPLER MEETING EINSTEIN

The Kepler space telescope has witnessed the effects of a dead star bending the light of its companion star. The findings are among the first detections of this phenomenon -- a result of Einstein's general theory of relativity -- in binary, or double, star systems. The dead star, called a 'white dwarf', is the burnt-out core of what used to be a star like our sun. It is locked in an orbiting dance with its partner, a small "red dwarf" star. While the tiny white dwarf is physically smaller than the red dwarf, it is more massive.

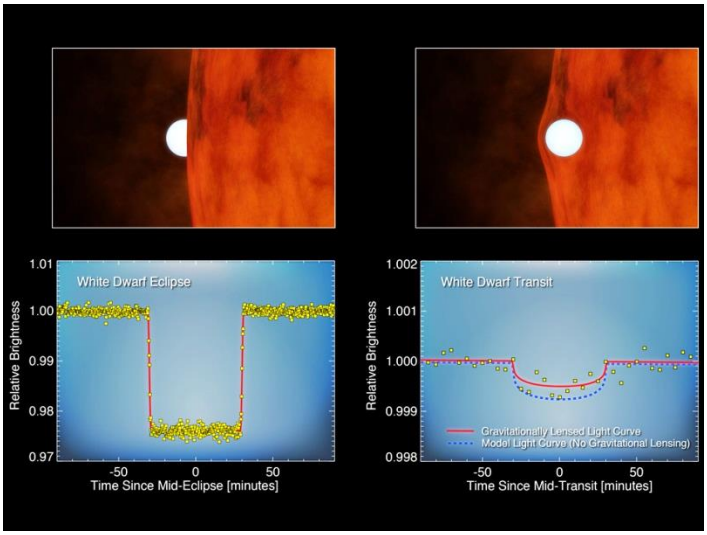


White dwarf dead star acts like magnifying glass - Artist's concept depicts a dense, dead star called a white dwarf crossing in front of a small, red star. The white dwarf's gravity is so great it bends & magnifies light from the red star. Kepler observed this effect in a double-star system called 'KOI-256' by monitoring changes in the red star's brightness. The red dwarf star is cooler & redder than our yellow sun. Its companion is a white dwarf, the burnt-out core of a star that used to be like our sun. Though the white dwarf is about the same diameter as Earth, 40x smaller than the red dwarf, it is slightly more massive. (The two objects circle around each other, but because the red dwarf is a bit less massive, it technically orbits the white dwarf.) Kepler is designed to look for planets by monitoring the brightness of stars. If planets cross in front of the stars, the starlight will periodically dip. In this case, the passing object turned out to be a white dwarf, not a planet. The finding was serendipitous for astronomers because it allowed them to measure the tiny "gravitational lensing" effect of the white dwarf, a rarely observed phenomenon and a test of Einstein's theory of relativity. These data also helped to precisely measure the white dwarf's mass. Image credit: NASA/JPL-Caltech

"*This white dwarf is about the size of Earth, but has the mass of the sun*," said Phil Muirhead, lead author of the findings. "*It's so hefty that the red dwarf, though larger in physical size, is circling around the white dwarf*."

Kepler's primary job is to scan stars in search of orbiting planets. As the planets pass by, they block the starlight by miniscule amounts, which Kepler's sensitive detectors can see. "*The technique is equivalent to spotting a flea on a light bulb 3,000 miles away, roughly the distance from Los Angeles to New York City*," said Avi Shporer, co-author of the study. Muirhead and his colleagues regularly use public Kepler data to search for and confirm planets around smaller stars, the red dwarfs, also known as M dwarfs. These stars are cooler and redder than our yellow sun. When the team first looked at the Kepler data for a target called 'KOI-256', they thought they were looking at a huge gas giant planet eclipsing the red dwarf. "*We saw what appeared to be huge dips in the light from the star, and suspected it was from a giant planet, roughly the size of Jupiter, passing in front*," said Muirhead.

To learn more about the star system, Muirhead and his colleagues turned to the Hale 5m Telescope, at Mt. Palomar Observatory. Using a technique called radial velocity, they discovered that the red dwarf was wobbling around like a spinning top. The wobble was far too big to be caused by the tug of a planet. That is when they knew they were looking at a massive white dwarf passing behind the red dwarf, rather than a gas giant passing in front. The team also incorporated ultraviolet measurements of 'KOI-256' taken by the 'Galaxy Evolution Explorer' (GALEX). The GALEX observations are part of an ongoing program to measure ultraviolet activity in all the stars in Kepler field of view, an indicator of potential habitability for planets in the systems. These data revealed the red dwarf is very active, consistent with being "spun-up" by the orbit of the more massive white dwarf.



White dwarfs - small and strong - Chart shows data from Kepler. As planets orbit in front of a star, they block the starlight, causing periodic dips. The plot on the left shows data collected by Kepler for a star called KOI-256, which is a small red dwarf. At first, astronomers thought the dip in starlight was due to a large planet passing in front of the star. But certain clues, such as the sharpness of the dip, indicated it was actually a white dwarf -- the dense, heavy remains of a star that was once like our sun. In fact, in the data shown at left, the white dwarf is passing behind the red dwarf, an event referred to as a secondary eclipse. The change in brightness is a result of the total light of the system dropping. The plot on the right shows what happens when the white dwarf passes in front of, or transits, the star. The dip in brightness is incredibly subtle because the white dwarf, while just over half as massive as our sun, is only the size of Earth, much smaller than the red dwarf star. The blue line shows what would be expected given the size of the white dwarf. The red line reveals what was actually observed: the mass of the white dwarf is so great, that its gravity bent and magnified the light of the red star. Because the star's light was magnified, the transiting white dwarf blocked an even smaller fraction of the total starlight than it would have without the

distortion. This effect, called 'gravitational lensing', allowed the researchers to precisely measure the mass of the white dwarf. Image credit: NASA/Ames/JPL-Caltech

The astronomers then went back to the Kepler data and were surprised by what they saw. When the white dwarf passed in front of its star, its gravity caused the starlight to bend and brighten by measurable effects. "*Only Kepler could detect this tiny, tiny effect*," said Doug Hudgins, the Kepler program scientist. "*But with this detection, we are witnessing Einstein's general theory of relativity at play in a far-flung star system*." One of the consequences of Einstein's general theory of relativity is that gravity bends light. Astronomers regularly observe this phenomenon, often called 'gravitational lensing', in our galaxy and beyond. For example, the light from a distant galaxy can be bent and magnified by matter in front of it. This reveals new information about dark matter and dark energy, two mysterious ingredients in our universe. 'Gravitational lensing' has also been used to discover new planets and hunt for free-floating planets.

In the new Kepler study, scientists used the gravitational lensing to determine the mass of the white dwarf. By combining this information with all the data they acquired, the scientists were also able to measure accurately the mass of the red dwarf and the physical sizes of both stars. Kepler's data and Einstein's theory of relativity have together led to a better understanding of how binary stars evolve.

POSSIBLE COMET ISON μ-METEOR SHOWER – JAN 12TH 2014

Anticipation is building as Comet ISON plunges into the inner solar system for a close encounter with the sun in Nov 2013. Blasted at point-blank range by solar radiation, the sun-grazer will likely become one of the finest comets in many years. When the Swift spacecraft observed the comet in Jan 2013, it was still near the orbit of Jupiter, but already very active. More than 112,000 pounds of dust were spewing from the comet's nucleus every minute. It turns out, some of that dust might end up on Earth, as micro-meteorites. In a new 'ScienceCast' video, experts discuss what might happen if Comet ISON does pepper Earth's atmosphere with small dust particles.

Veteran meteor researcher Paul Wiegert has been using a computer to model the trajectory of dust ejected by Comet ISON, and his findings suggest that an unusual meteor shower could be in the offing. "*For several days around Jan 12th, 2014, Earth will pass through a stream of fine-grained debris from Comet ISON*," says Wiegert. "*The resulting shower could have some interesting properties.*" According to Wiegert's computer models, the debris stream is populated with extremely tiny grains of dust, no more than a few microns wide, pushed toward Earth by the gentle radiation pressure of the sun. They will be hitting at an extreme speed of 56 km/s (125,000 mph). But because the particles are so small, Earth's upper atmosphere will rapidly slow them to a stop. "*Instead of burning up in a flash of light, they will drift gently down to the Earth below*," he says.

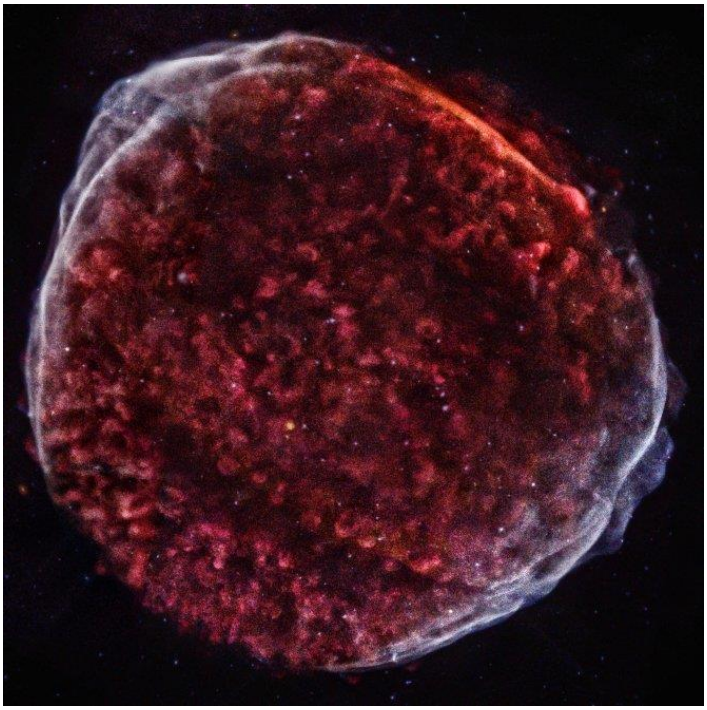
Don't expect to notice. The invisible rain of comet dust, if it occurs, would be very slow. It can take months or even years for fine dust to settle out of the high atmosphere. While the dust is "up there," it could produce noctilucent clouds (NLCs). NLCs are icy clouds that glow electric-blue as they float more than 80 km above Earth's poles. Recent data from the AIM spacecraft suggests that NLCs are seeded by space dust. Tiny meteoroids act as nucleating points where water molecules gather; the resulting ice crystals assemble into clouds at the edge of space itself. This is still speculative, but Comet ISON could provide the seeds for a noctilucent-cloud display. Electric-blue ripples over Earth's polar regions might be the only visible sign that a shower is underway.

Wiegert notes another curiosity: "*The shower is going to hit our planet from two directions at once*." When Earth passes through the debris stream, we will encounter two populations of comet dust. One swarm of dust will be following the Comet ISON into the sun. Another swarm will be moving in the opposite direction, pushed away from the sun by solar radiation pressure. The streams will pepper opposite sides of Earth simultaneously. "*In my experience, this kind of double whammy is unprecedented*," says Wiegert.

Bill Cooke, lead scientist at the NASA Meteoroid Environment Office, says there's little danger to Earth-orbiting spacecraft. "*These particles are just too small to penetrate the walls of our satellites, and they don't stand a chance against the heavy shielding of the ISS*." However, he adds, mission operators will be alert around Jan 12th for possible anomalies. Sky watchers should probably be alert, too. The odds of seeing anything are low, but Comet ISON could prove full of surprises. Credits: Author: Dr. Tony Phillips; Production editor: Dr. Tony Phillips; Credit: Science@NASA

NEW CHANDRA X-RAY IMAGE OF Ia SN 1006 REMNANT

This year, astronomers around the world have been celebrating the 50th anniversary of X-ray astronomy. Few objects better illustrate the progress of the field in the past half-century than the supernova remnant known as 'SN 1006'. When the object we now call SN 1006 first appeared on May 1, 1006 AD, it was far brighter than Venus and visible during the daytime for weeks. Astronomers in China, Japan, Europe, and the Arab world all documented this spectacular sight. With the advent of the Space Age in the 1960s, scientists were able to launch instruments and detectors above Earth's atmosphere to observe the universe in wavelengths that are blocked from the ground, including X-rays. SN 1006 was one of the faintest X-ray sources detected by the first generation of X-ray satellites.



In this new Chandra image of SN 1006 remnant, low, medium, and higher-energy X-rays are colored red, green, and blue respectively.

A new image of 'SN 1006' from Chandra X-ray Observatory reveals this supernova remnant in exquisite detail. By overlapping ten different pointings of Chandra's field-of-view, astronomers have stitched together a cosmic tapestry of the debris field that was created when a

white dwarf star exploded, sending its material hurtling into space. The new Chandra image provides new insight into the nature of SN 1006, which is the remnant of a so-called Type Ia supernova. This class of supernova is caused when a white dwarf pulls too much mass from a companion star and explodes, or when two white dwarfs merge and explode. Understanding Type Ia supernovas is especially important because astronomers use observations of these explosions in distant galaxies as mileposts to mark the expansion of the universe.

The new SN 1006 image represents the most spatially detailed map yet of the material ejected during a Type Ia supernova. By examining the different elements in the debris field -- such as silicon, oxygen, and magnesium -- the researchers may be able to piece together how the star looked before it exploded and the order that the layers of the star were ejected, and constrain theoretical models for the explosion. Scientists are also able to study just how fast specific knots of material are moving away from the original explosion. The fastest knots are moving outward at almost eleven million miles per hour, while those in other areas are moving at a more leisurely seven million miles per hour. SN 1006 is located about 7,000 light-years from Earth. The new Chandra image of SN 1006 contains over eight-days-worth of observing time by the telescope.

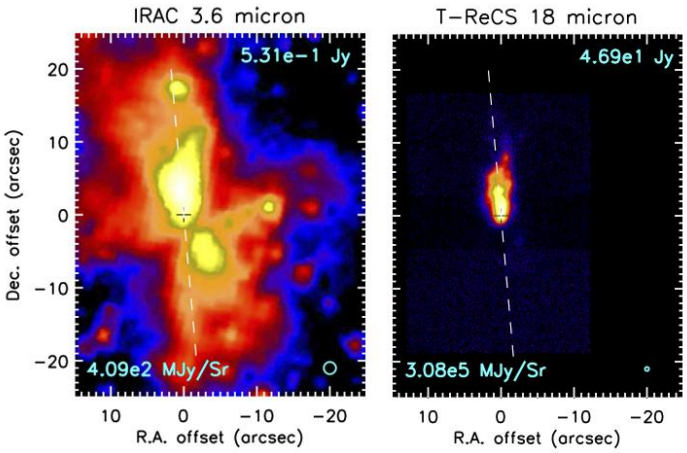
SOFIA REVEALS A SURPRISE IN MASSIVE STAR FORMATION

Researchers using 2.5 meter infra-red telescope aboard the airborne 'Stratospheric Observatory for Infrared Astronomy' (SOFIA) have captured the most detailed mid-infrared images yet of a massive star condensing within a dense cocoon of dust and gas. The star is 'G35.20-0.74', commonly known as 'G35'. It is one of the most massive known proto-stars and is located relatively close to Earth at a distance of 8,000 light-years. Until now, scientists expected the formation process of massive stars would be complicated by the turbulent, chaotic environments in the centers of new star clusters where they form. But observations of 'G35' suggest this giant star, more than 20 times the mass of our sun, is forming by the same orderly process as do stars with the same mass as the sun. Stars most like the sun are understood to form by simple, symmetric, collapse of interstellar clouds.

"*The focus of our study has been to determine how massive stars actually form*," said Yichen Zhang, lead author of a paper about the discovery. "*We thought the 'G35' proto-star's structure would be quite complicated, but instead we found it is simple, like the cocoons of proto-stars with the sun's mass*."

The observations of 'G35' were made in 2011 with a special camera aboard SOFIA, a modified Boeing 747-SP aircraft, that can carry a telescope with an effective diameter of 100" (2.5 m) to altitudes as high as 45,000 ft (13,700m). 'G35' was an ideal target for investigations because it is in an early stage of development. But infrared light coming from 'G35' is so strong it prevented infrared space telescopes from making detailed images. Also, the proto-star is embedded so deeply in its natal cloud that it cannot be detected by optical telescopes observing from the ground at visible wavelengths.

Flying high above the light-blocking water vapor in Earth's atmosphere, the airplane-mounted 'Faint Object Infrared Camera for the SOFIA Telescope' (FORCAST) enabled astronomers to see 'G35' where it hides -- inside a dark, dense, interstellar dust cloud -- by collecting infrared light escaping the cloud. Uniquely suited for this work, FORCAST detected faint details next to bright structures at wavelengths inaccessible to any other telescope on the ground or in space. "*Massive stars, although rare, are important because there is evidence they foster the formation of smaller stars like our sun, and because at the ends of their lives they create and distribute chemical elements that are the basic building blocks of Earth-like planets*," said co-author James De Buizer. http://www.nasa.gov/sofia

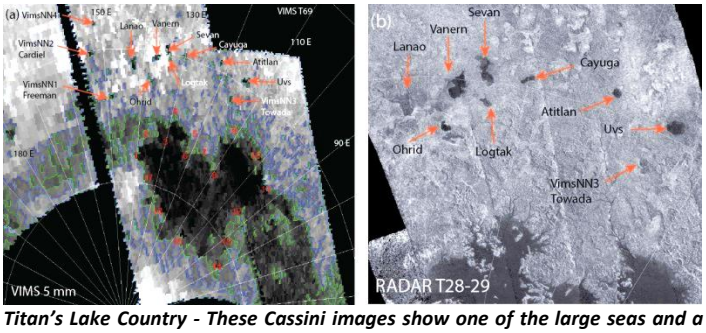


G35 images obtained by Spitzer Space Telescope (left), and the Gemini-North Earth-based telescope (right), used in this study.

The model images show greatly simplified versions of what is revealed especially in the SOFIA images: a luminous proto-star heating a dense interstellar cloud from the inside, while simultaneously expelling cone-shaped jets of gas toward the tops and bottoms of the frames. The top outflow cone appears brighter, because it is directed toward us, and there is less obscuring material along the line of sight. The high resolution of the images showcases the capability of modern infrared detector arrays when used on an airborne platform and gives scientists hope that data gathered in this way substantially will advance their understanding of the Milky Way galaxy.

TITAN'S METHANE: GOING, GOING, -- SOON TO BE GONE??

By tracking a part of the surface of Saturn's moon Titan over several years, the Cassini mission has found a remarkable longevity to the hydrocarbon lakes on the moon's surface. A team led by Christophe Sotin, fed these results into a model that suggests the supply of the hydrocarbon methane at Titan could be coming to an end soon (*on **geological** timescales, that is*). The study of the lakes also led scientists to spot a few new ones in images from Cassini's visual and infrared mapping spectrometer data in June 2010.

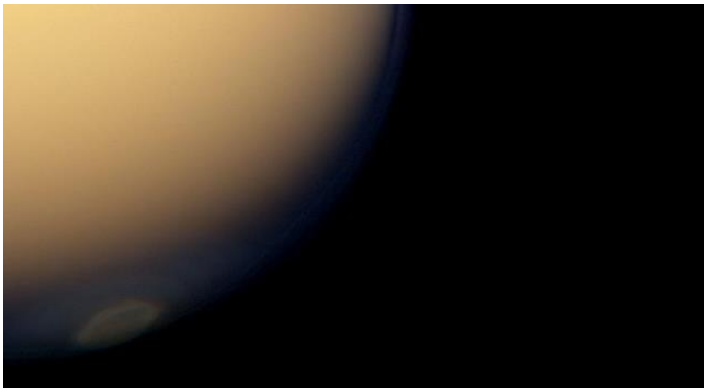


Titan's Lake Country - These Cassini images show one of the large seas and a bounty of smaller lakes on Saturn's largest moon Titan. Scientists saw these small lakes in data obtained by both Cassini's visual - infrared mapping spectrometer (left), and radar instrument (right). 'Ligeia Mare', about 50,000 square miles (125,000 square km) in area, is the large lake near the bottom of both images. Three new lakes of about 100 to 300 square miles (a few hundreds of square km) identified first in the visual and infrared mapping spectrometer images are labeled in the annotated version as Freeman ('VimsNN1'), 'Cardiel' ('VimsNN2') and 'VimsNN4'. The new lakes can be seen at the top left and middle right. The small lake 'Towada' first seen in radar images was also seen in this VIMS investigation ('VimsNN3') and can be seen in the middle right. Image Credit: NASA/JPL-Caltech/University of Arizona

Titan is the only other place in the solar system besides Earth that has stable liquid on its surface. Scientists think methane is at the heart of a cycle at Titan that is somewhat similar to the role of water in Earth's hydrological cycle - causing rain, carving channels and evaporating from lakes. However, the fact that the lakes seem remarkably consistent in size and shape over several years of data from Cassini's visual and infrared mapping spectrometer suggests that the lakes evaporate very slowly. Methane tends to evaporate quickly, so scientists think the lakes must be dominated by methane's sister hydrocarbon ethane, which evaporates more slowly. The lakes are also not getting filled quickly, and scientists haven't seen more than the occasional outburst of hydrocarbon rain at the moon over the mission's eight-plus years in the Saturn system. This indicates that on Titan, the methane that is constantly being lost by breaking down to form ethane and other heavier molecules is not being replaced by fresh methane from the interior. The team suggests that the current load of methane at Titan may have come from some kind of gigantic outburst from the interior eons ago possibly after a huge impact. They think Titan's methane could run out in tens of millions of years. http://saturn.jpl.nasa.gov/news/cassinisciencealeague/science20130412/ .

ICE CLOUD HERALDS AUTUMN AT TITAN'S SOUTH POLE

An ice cloud taking shape over Titan's south pole is the latest sign that the change of seasons is setting off a cascade of radical changes in the atmosphere of Saturn's largest moon. Made from an unknown ice, this type of cloud has long hung over Titan's north pole, where it is now fading, according to observations made by the composite infrared spectrometer (CIRS) on Cassini. "*We associate this particular kind of ice cloud with winter weather on Titan, and this is the first time we have detected it anywhere but the north pole*," said the study's lead author, Donald E. Jennings, a CIRS Co-Investigator.



Polar Vortex in Color - The recently formed south polar vortex stands out in the color-swaddled atmosphere of Saturn's largest moon, Titan, in this natural color view from Cassini.

The southern ice cloud, which shows up in the far infrared part of the light spectrum, is evidence that an important pattern of global air circulation on Titan has reversed direction. When Cassini first observed the circulation pattern, warm air from the southern hemisphere was rising high in the atmosphere and was transported to the cold north pole. There, the air cooled and sank down to lower layers of the atmosphere and formed ice clouds. A similar pattern, called a Hadley cell, carries warm, moist air from Earth's tropics to the cooler middle latitudes.

Based on modeling, scientists had long predicted a reversal of this circulation once Titan's north pole began to warm and its south pole began to cool. The official transition from winter to spring at Titan's north pole occurred in August 2009. But because each of the moon's seasons lasts about seven-and-a-half Earth years, researchers still did not know exactly when this reversal would happen or how long it would take. The first signs of the reversal came in data acquired in early 2012, which came shortly after the start of southern fall on Titan, when Cassini images and visual and infrared mapping spectrometer data revealed the presence of a high-altitude "haze hood" and a swirling polar vortex at the South pole. Both features have long been associated with the cold North pole. Later, Cassini scientists reported that infrared observations of Titan's winds and temperatures made by CIRS had provided definitive evidence of air sinking, rather than upwelling, at the south pole. By looking back through the data, the team narrowed down the change in circulation to within six months of the 2009 equinox. Despite the new activity at the south pole, the southern ice cloud had not appeared yet. CIRS didn't detect it until about July 2012, a few months after the haze and vortex were spotted in the south, according to the study published in Dec 2012. "*This lag makes sense because first the new circulation pattern has to bring loads and loads of gases to the south pole. Then, the air has to sink. The ices have to condense. And the pole has to be under enough shadow to protect the vapors that condense to form those ices*," said Carrie Anderson, a CIRS team member and Cassini participating scientist at Goddard.

At first blush, the southern ice cloud seems to be building rapidly. The northern ice cloud, on the other hand, was present when Cassini first arrived and has been slowly fading the entire time the spacecraft has been observing it. So far, the identity of the ice in these clouds has eluded scientists, though they have ruled out simple chemicals, such as methane, ethane and hydrogen cyanide, which are typically associated with Titan. One possibility is that "species X," as some team members call the ice, could be a mixture of organic compounds. "*What's happening at Titan's poles has some analogy to Earth and to our ozone holes*," said the CIRS Principal Investigator, F. Michael Flasar. "*And on Earth, the ices in the high polar clouds aren't just window dressing: They play a role in releasing the chlorine that destroys ozone. How this affects Titan chemistry is still unknown. So it's important to learn as much as we can about this phenomenon, wherever we find it*."

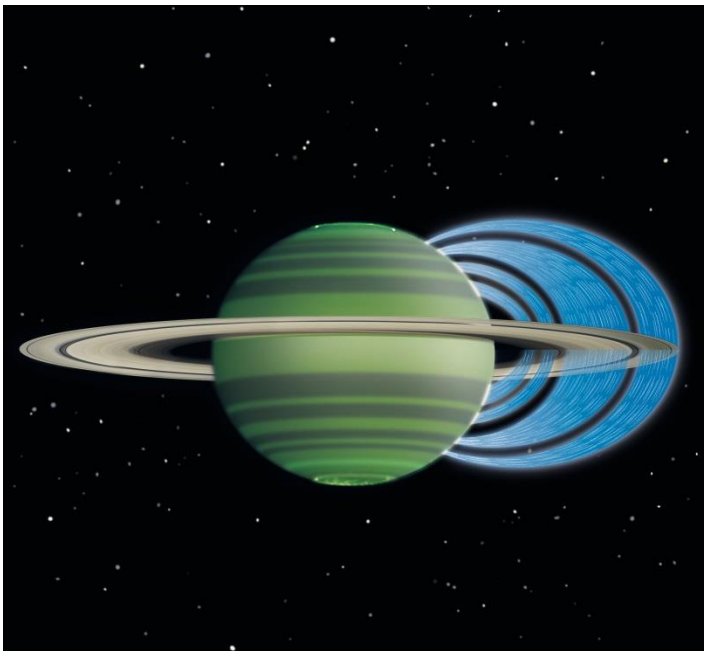
BLAME SATURN'S IR-DARK BANDS ON RAIN (FROM RINGS)

A new study tracks the "rain" of charged water particles into the atmosphere of Saturn and finds there is more of it and it falls across larger areas of the planet than previously thought. The study reveals that the rain influences the composition and temperature structure of parts of Saturn's upper atmosphere. "*Saturn is the first planet to show significant interaction between its atmosphere and ring system*," said James O'Donoghue, the paper's lead author. "*The main effect of ring rain is that it acts to **'quench'** the ionosphere of Saturn. In other words, this rain severely reduces the electron densities in regions in which it falls*." (which causes also IR radiation to appear dark) O'Donoghue explains that the ring's effect on electron densities is important because it explains why, for many decades, observations have shown those densities to be unusually low at certain latitudes on Saturn. The study also helps scientists better understand the origin and evolution of Saturn's ring system and changes in the planet's atmosphere. "*It turns out that a major driver of Saturn's ionospheric environment and climate across vast reaches of the planet are ring particles located some 36,000 miles [60,000 km] overhead*," said Kevin Baines, a co-author on the paper. "*The ring particles affect both what species of particles are in this part of the atmosphere, and where it is warm or cool*."

In the early 1980s, images from Voyager spacecraft showed two to three dark bands on Saturn, and scientists theorized that water could have been showering down into those bands from the rings. Those bands were not seen again until this team observed the planet in near-

infrared wavelengths with the Keck telescopes, in Apr 2011. The effect was difficult to discern because it involves looking for a subtle emission from bright parts of Saturn. It required an instrument like that on Keck, which can split up a large range of light.

The ring rain's effect occurs in Saturn's ionosphere, where charged particles are produced when the otherwise neutral atmosphere is exposed to a flow of energetic particles or solar radiation. When the scientists tracked the pattern of emissions of a particular hydrogen ion with three protons (triatomic hydrogen), they expected to see a uniform planet-wide infrared glow. What they observed instead was a series of light and dark bands - with areas of reduced emission corresponding to water-dense portions of Saturn's rings and areas of high emission corresponding to gaps in the rings.



This artist's concept illustrates how charged water particles flow into the Saturnian atmosphere from the planet's rings, causing a reduction in atmospheric brightness. Observations were made with Keck Observatory. Image credit: NASA/JPL-Caltech/Space Science Institute/University of Leicester

They surmised that charged water particles from the planet's rings were being drawn towards the planet along Saturn's magnetic field lines and were neutralizing the glowing triatomic hydrogen ions. This leaves large "shadows" in what would otherwise be a planet-wide infrared glow. These shadows cover some 30 to 43 percent of the planet's upper atmosphere surface from around 25 to 55 degrees latitude. This is a significantly larger area than suggested by images from the Voyager mission.

Both Earth and Jupiter have an equatorial region that glows very uniformly. Scientists expected this pattern at Saturn, too, but they instead saw dramatic differences at different latitudes. "*Where Jupiter is glowing evenly across its equatorial regions, Saturn has dark bands where the water is falling in, darkening the ionosphere*," said Tom Stallard, a paper co-author. "*We're now also trying to investigate these features with an instrument on Cassini spacecraft. If we're successful, Cassini may allow us to view in more detail the way that water is removing ionized particles, such as any changes in the altitude or effects that come with the time of day*."

Scientists Find that Moon & Asteroids Share History

Researchers have discovered that Earth's moon has more in common than previously thought with large asteroids roaming our solar system. Scientists discovered that the same population of high-speed projectiles that impacted our lunar neighbor four billion years ago, also hit the giant asteroid Vesta and perhaps other large asteroids. The research unveils an unexpected link between Vesta and the moon, and provides new means for studying the early bombardment history of terrestrial planets. "*It's always intriguing when interdisciplinary research changes the way we understand the history of our solar system*," said Yvonne Pendleton, NLSI director. "*Although the moon is located far from Vesta, which is in the main asteroid belt between the orbits of Mars and Jupiter, they seem to share some of the same bombardment history*."

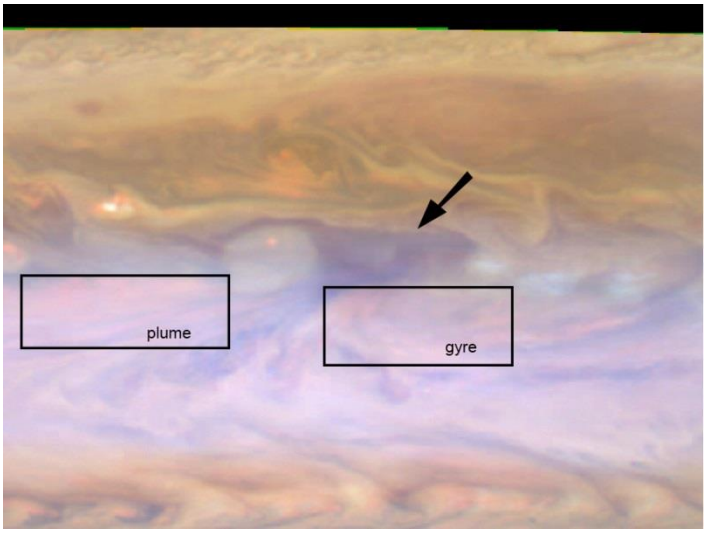
The findings support the theory that the repositioning of gas giant planets like Jupiter and Saturn from their original orbits to their current location destabilized portions of the asteroid belt and triggered a solar system-wide bombardment of asteroids billions of years ago, called the lunar cataclysm. The research provides new constraints on the start and duration of the lunar cataclysm, and demonstrates that the cataclysm was an event that affected not only the inner solar system planets, but the asteroid belt as well.

Scientists have now discovered that studying meteorites from the giant asteroid Vesta helps them understand the event known as the "lunar cataclysm," when a repositioning of the gas giant planets destabilized a portion of the asteroid belt and triggered a solar-system-wide bombardment. Image credit: NASA/GSFC/ASU/JPL-Caltech/UCLA/MPS/DLR/IDA

The moon rocks brought back by Apollo astronauts have long been used to study the bombardment history of the moon. Now the ages derived from meteorite samples have been used to study the collisional history of main belt asteroids. In particular, 'howardite' and 'eucrite' meteorites, which are common species found on Earth, have been used to study asteroid Vesta, their parent body. With the aid of computer simulations, researchers determined that meteorites from Vesta recorded high-speed impacts which are now long gone. Researchers have linked these two datasets and found that the same population of projectiles responsible for making craters and basins on the moon were also hitting Vesta at very high velocities, enough to leave behind a number of telltale, impact-related ages. The team's interpretation of the 'howardites' and 'eucrites' was augmented by recent close-in observations of Vesta's surface by the Dawn spacecraft. In addition, the team used the latest dynamical models of early main belt evolution to discover the likely source of these high velocity impactors. The team determined that the population of projectiles that hit Vesta had orbits that also enabled some objects to strike the moon at high speeds. "*It appears that the asteroidal meteorites show signs of the asteroid belt losing a lot of mass four billion years ago, with the escaped mass beating up on both the surviving main belt asteroids and the moon at high speeds*" says lead author Simone Marchi. "*Our research not only supports the current theory, but it takes it to the next level of understanding*." http://lunarscience.nasa.gov www.nasa.gov/dawn

'HOT SPOTS' RIDE MERRY-GO-ROUND IN JUPITER'S CLOUDS

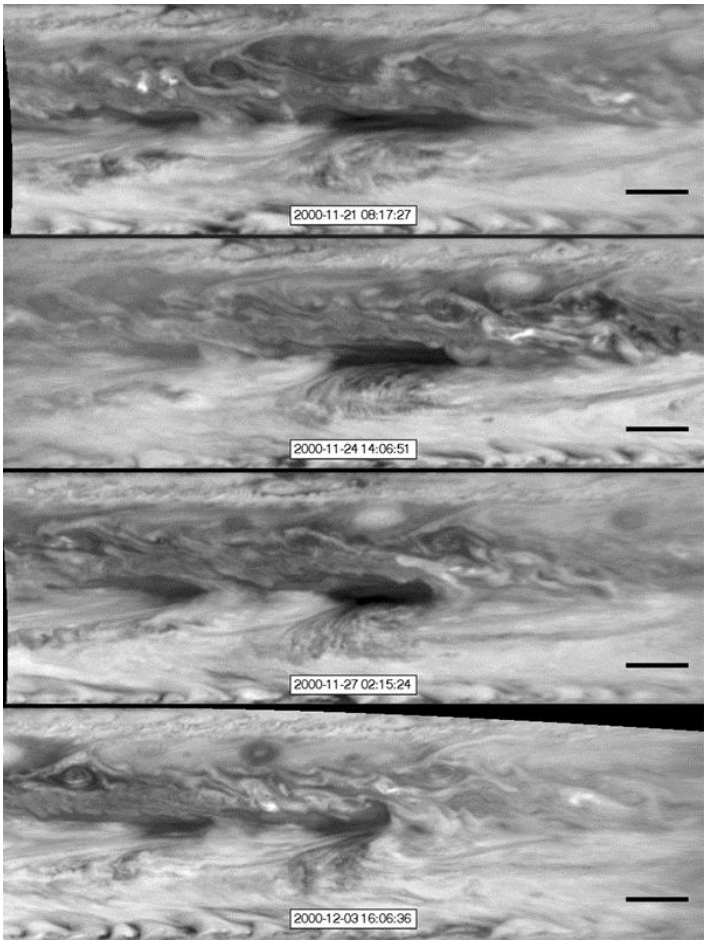
In the swirling canopy of Jupiter's atmosphere, cloudless patches are so exceptional that the big ones get the special name "hot spots." Exactly how these clearings form and why they're only found near the planet's equator have long been mysteries. Now, using images from Cassini, scientists have found new evidence that hot spots in Jupiter's atmosphere are created by a 'Rossby wave', a pattern also seen in Earth's atmosphere and oceans. The team found the wave responsible for the hot spots glides up and down through layers of the atmosphere like a carousel horse on a merry-go-round. "*This is the first time anybody has closely tracked the shape of multiple hot spots over a period of time, which is the best way to appreciate the dynamic nature of these features*," said the study's lead author, David Choi. Choi and his colleagues made time-lapse movies from hundreds of observations taken by Cassini during its flyby of Jupiter in late 2000, when the spacecraft made its closest approach to the planet. The movies zoom in on a line of hot spots between one of Jupiter's dark belts and bright white zones, roughly 7 degrees north of the equator. Covering about two months (in Earth time), the study examines the daily and weekly changes in the sizes and shapes of the hot spots, each of which covers more area than North America, on average. Much of what scientists know about hot spots came from the Galileo mission, which released an atmospheric probe that descended into a hot spot in 1995. This was the first, and so far only, 'in-situ' investigation of Jupiter's atmosphere.



The dark hot spot (arrowed) in this false-color image from Cassini is a window deep into Jupiter's atmosphere. All around it are layers of higher clouds, with colors indicating which layer of the atmosphere the clouds are in. The bluish clouds to the right are in the upper troposphere, or perhaps higher still, in the stratosphere. The reddish gyre under the hot spot to the right and the large reddish plume at its lower left are in the lower troposphere. In addition, a high, gauzy haze covers part of the frame. Image credit: NASA/JPL-Caltech/SSI/GSFC

"*Galileo's probe data and a handful of orbiter images hinted at the complex winds swirling around and through these hot spots, and raised questions about whether they fundamentally were waves, cyclones or something in between*," said Ashwin Vasavada, a paper co-author, and who was a member of the Cassini imaging team during the Jupiter flyby. "*Cassini's fantastic movies now show the entire life cycle and evolution of hot spots in great detail*." Because hot spots are breaks in the clouds, they provide windows into a normally unseen layer of Jupiter's atmosphere, possibly all the way down to the level where water clouds can form. In pictures, hot spots appear shadowy, but because the deeper layers are warmer, hot spots are very bright at the infrared wavelengths where heat is sensed; in fact, this is how they got their name. One hypothesis is that hot spots occur when big drafts of air sink in the atmosphere and get heated or dried out in the process. But the surprising regularity of hot spots has led some researchers to suspect there is an atmospheric wave involved. Typically, eight to 10 hot spots line up, roughly evenly spaced, with dense white plumes of cloud in between. This pattern could be explained by a wave that pushes cold air down, breaking up any clouds, and then carries warm air up, causing the heavy cloud cover seen in the plumes. Computer modeling has strengthened this line of reasoning.

From the Cassini movies, the researchers mapped the winds in and around each hot spot and plume, and examined interactions with vortices that pass by, in addition to wind gyres, or spiraling vortices, that merge with the hot spots. To separate these motions from the jet stream in which the hot spots reside, the scientists also tracked the movements of small "scooter" clouds, similar to cirrus clouds on Earth. This provided what may be the first direct measurement of the true wind speed of the jet stream, which was clocked at about 300 - 450 mph (500 - 720 km/hr) -- much faster than anyone previously thought. The hot spots amble at the more leisurely pace of about 225 mph (362 km/hr).



In this series of images from Cassini, a dark, rectangular hot spot (top) interacts with a line of vortices that approaches from on the upper-right side (second panel). The interaction distorts the shape of the hot spot (third panel), leaving it diminished (bottom). The black scale bar is about 6,200 miles (10,000 km) wide, or about twice as wide as the United States.

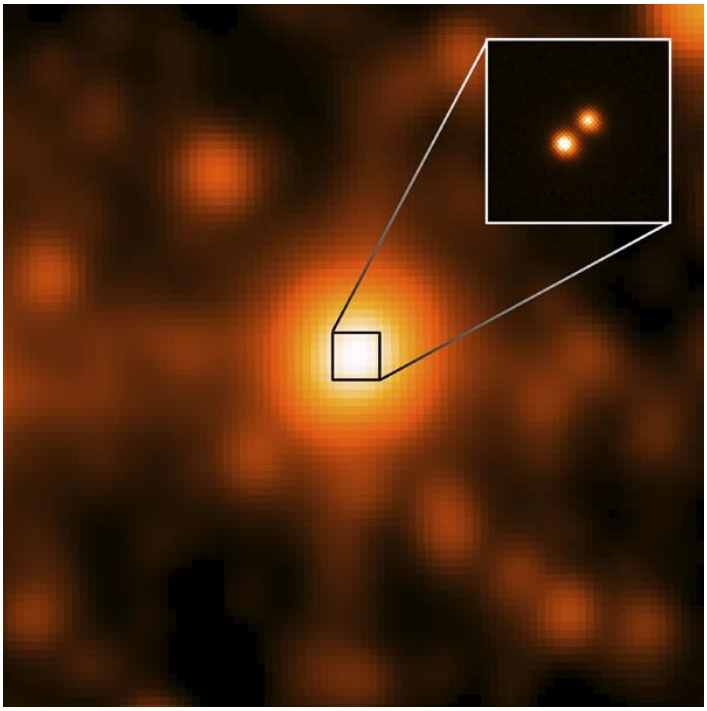
By teasing out these individual movements, the researchers saw that the motions of the hot spots fit the pattern of a Rossby wave in the atmosphere. On Earth, Rossby waves play a major role in weather.

For example, when a blast of frigid Arctic air suddenly dips down and freezes Florida's crops, a Rossby wave is interacting with the polar jet stream and sending it off its typical course. The wave travels around our planet but periodically wanders north and south as it goes. The wave responsible for the hot spots also circles the planet west to east, but instead of wandering north and south, it glides up and down in the atmosphere. The researchers estimate this wave may rise and fall 15 to 30 miles (24-50 km) in altitude. The new findings should help researchers understand how well the observations returned by the Galileo probe extend to the rest of Jupiter's atmosphere. "*And that is another step in answering more of the questions that still surround hot spots on Jupiter*," said Choi.

CLOSEST MULTI-STAR SYSTEM FOUND IN ALMOST A CENTURY

The 'Wide-field Infrared Survey Explorer' (WISE) has discovered a pair of stars that has taken over the title for the third-closest star system to the sun. The duo is the closest star system discovered since 1916. Both stars in the new binary system are "*brown dwarfs*," which are stars that are too small in mass to ever become hot enough to ignite hydrogen fusion. As a result, they are very cool and dim, resembling a giant planet like Jupiter, more than a bright star like the sun. "*The distance to this brown dwarf pair is 6.5 light-years -- so close that Earth's television transmissions from 2006 are now arriving there*," said Kevin Luhman, an associate professor of astronomy and astrophysics. "*It will be an excellent hunting ground for planets because the system is very close to Earth, which makes it a lot easier to see any planets orbiting either of the brown dwarfs*."

The star system is named 'WISE J104915.57-531906' because it was discovered in an infrared map of the entire sky obtained by WISE. It is only slightly farther away than the second-closest star, Barnard's star, which was discovered 6 light-years from the sun in 1916. The closest star system consists of: Alpha Centauri, found to be a neighbor of the sun in 1839 at 4.4 light-years away, and the fainter Proxima Centauri, discovered in 1917, at 4.2 light-years.



'***WISE J104915.57-531906' is at the center of the larger image, which was taken by the WISE. This is the closest star system discovered since 1916, and the third closest to our sun. It is 6.5 light-years away. At first, the light appeared to be from a single object, but a sharper image from Gemini Observatory in Chile revealed that it was from a pair of cool star-like bodies called brown dwarfs.***

Edward (Ned) Wright, the principal investigator for the WISE satellite, said, "*One major goal when proposing WISE was to find the closest stars to the sun. 'WISE J1049-5319' is by far the closest star found to date using the WISE data, and the close-up views of this binary system we can get with big telescopes like Gemini and the future 'James Webb Space Telescope' will tell us a lot about the low-mass stars known as brown dwarfs*." http://science.psu.edu/news-and-events/2013-news/Luhman3-2013

WISE completed its all-sky survey in 2011, after surveying the entire sky twice at infrared wavelengths. The maps have been released to the public, but an ongoing project called "AllWISE" will combine data from both sky scans. AllWISE will provide a systematic search across the sky for the nearby moving stars such as 'WISE J104915.57-531906', and also uncover fainter objects from the distant universe. Those data will be publicly available in late 2013.

'POST-MORTEM' YIELDS INSIGHT INTO KEPLER'S 1604 SN

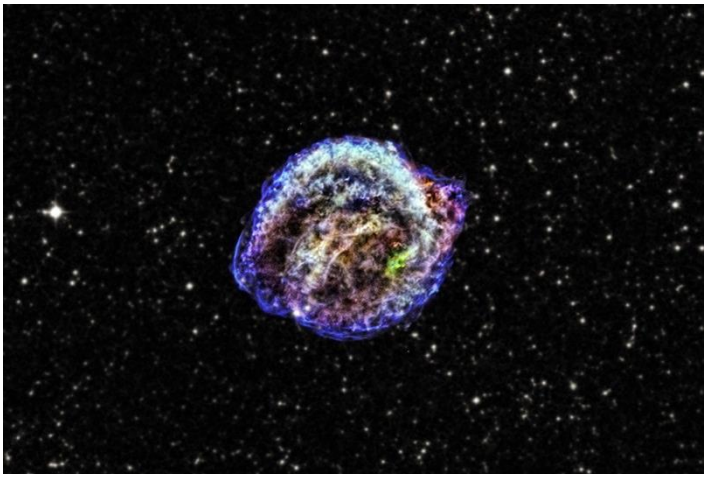
An exploding star observed in 1604 by the German astronomer Johannes Kepler held a greater fraction of heavy elements than the sun, according to an analysis of X-ray observations from the Japan-led Suzaku satellite. The findings will help astronomers better understand the diversity of type Ia supernovae, an important class of stellar explosion used in probing the distant universe. "*The composition of the star, its environment, and the mechanism of the explosion may vary considerably among type Ia supernovae*," said Sangwook Park, an assistant professor of physics. "*By better understanding them, we can fine-tune our knowledge of the universe beyond our galaxy and improve cosmological models that depend on those measurements.*"

The best way to explore the star's makeup is to perform a kind of 'post-mortem' examination on the shell of hot, rapidly expanding gas produced by the explosion. By identifying specific chemical signatures in the supernova remnant, astronomers can obtain a clearer picture of the composition of the star before it blew up. "*Kepler's supernova is one of the most recent type Ia explosions known in our galaxy, so it represents an essential link to improving our knowledge of these events*," said Carles Badenes, an assistant professor of physics and astronomy.

Using the Suzaku satellite's X-ray Imaging Spectrometer (XIS), the astronomers observed the remnant of Kepler's supernova in 2009 and 2011. With a total effective XIS exposure of more than two weeks, the X-ray spectrum reveals several faint emission features from highly ionized chromium, manganese and nickel in addition to a bright emission line from iron. The detection of all four elements was crucial for understanding the original star. "*Suzaku's XIS instrument is uniquely suited to this type of study thanks to its excellent energy resolution, high sensitivity and low background noise*," said team member Koji Mori, an associate professor of applied physics.

Cosmologists regard type Ia supernovae as "standard candles" because they release similar amounts of energy. By comparing this standard to the observed peak brightness of a type Ia supernova, astronomers can pin down its distance. Their similarity stems from the fact that the exploding star is always a compact stellar remnant known as a white dwarf. Although a white dwarf star is perfectly stable on its own, pair it with another white dwarf or a normal star and the situation eventually may turn volatile. The normal star may transfer gas onto the white dwarf, where it gradually accumulates. Or the orbits of binary white dwarfs may shrink until the two objects merge. Either way, once a white dwarf begins tipping the scales at around 1.4x the sun's mass, a supernova soon follows. Somewhere within the white

dwarf, carbon nuclei begin merging together, forming heavier elements and releasing a vast amount of energy. This wave of nuclear fusion rapidly propagates throughout the star, ultimately shattering it in a brilliant explosion, that can be detected billions of light-years away.



Composite of images from Chandra shows the remnant of Kepler's supernova in low (red), intermediate (green) and high-energy (blue) X-rays. The background is an optical star field taken from the Digitized Sky Survey. The distance to the object is uncertain, with estimates ranging from 13,000 to 23,000 light-years, but recent studies favor the maximum range. This image spans 12 arc-minutes or about 80 light-years at the greatest distance. Credit: X-ray: NASA/CXC/NCSU/M.Burkey et al.; optical: DSS

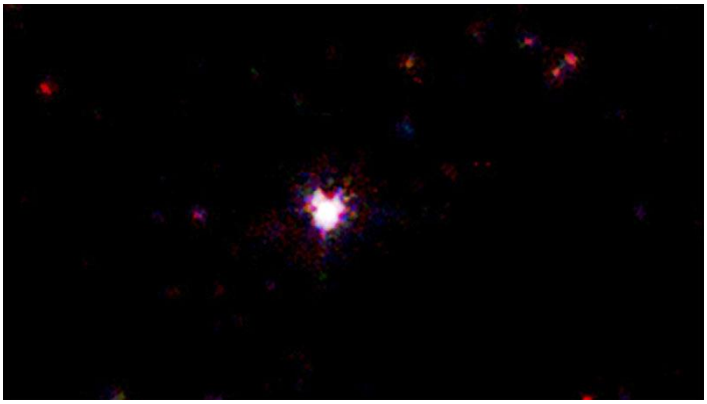
Astronomers can track some details of the white dwarf's composition by determining the abundance of certain trace elements, such as manganese, that formed during the explosion. Specifically, the ratio of manganese to chromium produced by the explosion turns out to be sensitive to the presence of a neutron-rich version of neon, called 'neon-22'. Establishing the star's neon-22 content gives scientists a guide to the abundance of all other elements heavier than helium, which astronomers call "metals." The findings provide strong evidence that the original white dwarf possessed roughly three times the amount of metals found in the sun, which is a lot. Progressive stellar generations seed interstellar gas with increasing proportions of metals. The remnant, which lies about 23,000 light-years away toward the constellation Ophiuchus, lies much closer to our galaxy's crowded central region than the sun does. There, star formation was probably more rapid and efficient. As a result, the star that blazed forth as Kepler's supernova likely formed out of material that already was enriched with a higher fraction of metals.

While the Suzaku results do not directly address which type of binary system triggered the supernova, they indicate that the white dwarf was probably no more than a billion years old when it exploded, or less than a quarter of the sun's current age. "*Theories indicate that the star's age and metal content affect the peak luminosity of type Ia supernovae*," Park explained. "*Younger stars likely produce brighter explosions than older ones, which is why understanding the spread of ages among type Ia supernovae is so important*." In 2011, astrophysicists won the Nobel Prize in physics for the discovery that the expansion of the universe is picking up speed, a conclusion based on measurements of type Ia supernovae. An enigmatic force called 'dark energy' appears to be responsible for this acceleration, and understanding its nature is now a top science goal. Recent high-precision findings by the Planck satellite reveal that dark energy makes up 68 percent of the universe.

Dying Supergiant Stars Implicated in Hours-Long Gamma-Ray Bursts

Three unusually long-lasting stellar explosions discovered by the Swift satellite represent a previously unrecognized class of gamma-ray bursts (GRBs). Two international teams of astronomers studying these events conclude that they likely arose from the catastrophic death of supergiant stars hundreds of times larger than the sun. GRBs are the most luminous and mysterious explosions in the universe. The blasts emit surges of gamma rays -- the most powerful form of light -- as well as X-rays, and they produce afterglows that can be observed at optical and radio energies. Swift, Fermi and other spacecraft detect an average of about one GRB each day. "*We have seen thousands of gamma-ray bursts over the past four decades, but only now are we seeing a clear picture of just how extreme these extraordinary events can be*," said Bruce Gendre, a researcher who led this study. (Prior to Swift's launch in 2004, satellite instruments were much less sensitive to gamma-ray bursts that unfolded over comparatively long time scales.)

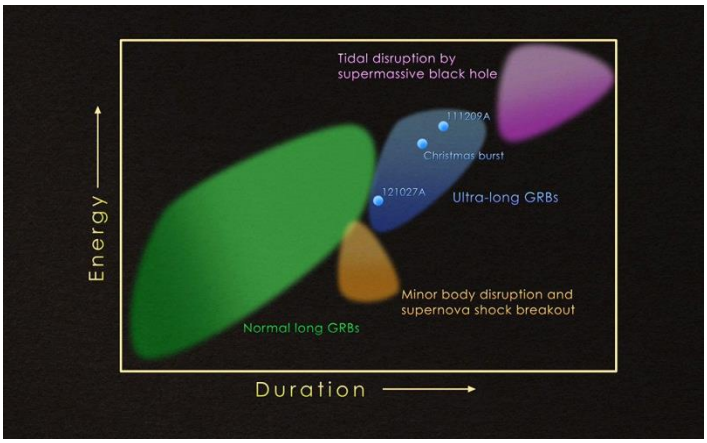
Traditionally, astronomers have recognized two GRB types, 'short' and 'long', based on the duration of the gamma-ray signal. 'Short' bursts last two seconds or less and are thought to represent a merger of compact objects in a binary system, with the most likely suspects being neutron stars and black holes. 'Long' GRBs may last anywhere from several seconds to several minutes, with typical durations falling between 20 and 50 seconds. These events are thought to be associated with the collapse of a star many times the sun's mass and the resulting birth of a new black hole. Both scenarios give rise to powerful jets that propel matter at nearly the speed of light in opposite directions. As they interact with matter in and around the star, the jets produce a spike of high-energy light.



GRB 111209A exploded on Dec 9, 2011. The blast produced high-energy emission for an astonishing seven hours, earning a record as the longest-duration GRB ever observed. This false-color image shows the event as captured by the X-ray Telescope aboard the Swift satellite. Credit: NASA/Swift/B. Gendre (ASDC/INAF-OAR/ARTEMIS)

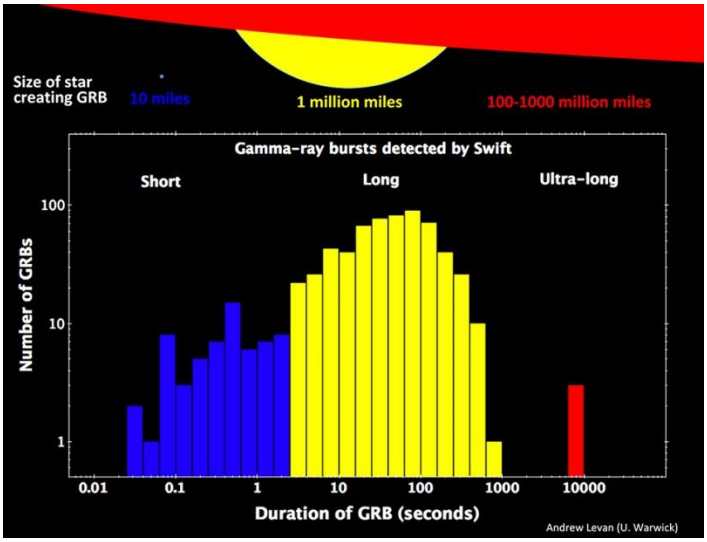
Gendre and his colleagues made a detailed study of 'GRB 111209A', which erupted Dec 9, 2011, using gamma-ray data from the Konus instrument on the Wind spacecraft, X-ray observations from Swift and the XMM-Newton satellite, and optical data from the TAROT robotic observatory in Chile. The burst continued to produce high-energy emission for an astonishing seven hours, making it by far the longest-duration GRB ever recorded. Another event, 'GRB 101225A', exploded on Christmas Day 2010 and produced high-energy emission for at least two hours. Subsequently nicknamed the "Christmas burst," the event's distance was unknown, which led two teams to arrive at radically different physical interpretations. One group concluded the blast was caused by an asteroid or comet falling onto a neutron star within our own galaxy. Another team determined that

the burst was the outcome of a merger event in an exotic binary system located some 3.5 billion light-years away.



Three recent GRBs (blue dots) emitted high-energy gamma-ray and X-ray light over time spans up to 100 times greater than typical long bursts and constitute a new ultra-long class. This plot compares the energy received and the event duration among different classes of transient high-energy events: long GRBs (green); the disruption of an asteroid or comet by a neutron star or stellar-mass black hole in our own galaxy, or the break-out of a supernova shock wave in another galaxy (orange); and the tidal disruption of a star by a supermassive black hole in another galaxy (purple). Credit: NASA's Goddard Space Flight Center, after B. Gendre (ASDC/INAF-OAR/ARTEMIS)

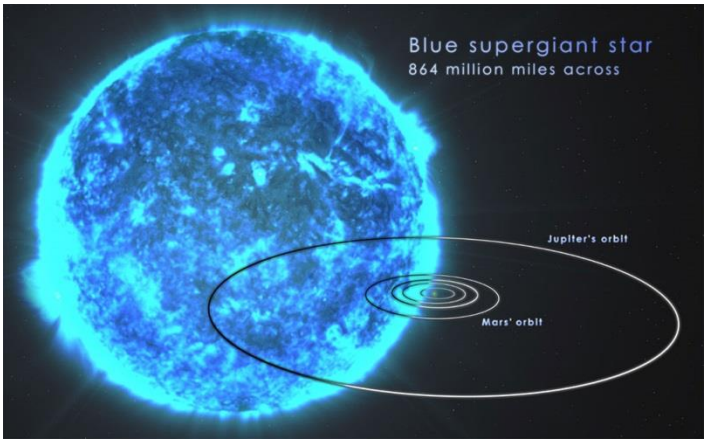
"*We now know that the Christmas burst occurred much farther off, more than halfway across the observable universe, and was consequently far more powerful than these researchers imagined*," said Andrew Levan. Using the 'Gemini North' telescope in Hawaii, Levan and his team obtained a spectrum of the faint galaxy that hosted the Christmas burst. This enabled the scientists to identify emission lines of oxygen and hydrogen and determine how much these lines were displaced to lower energies compared to their appearance in a laboratory. This difference, known to astronomers as a redshift, places the burst some 7 billion light-years away.



The number, duration and burst class for GRBs observed by Swift are shown in this plot. Colors link each GRB class to illustrations above the plot, which show the estimated sizes of the source stars. For comparison, the width of the yellow circle represents a star about 20 percent larger than the sun. Credit: Andrew Levan, Univ. of Warwick

As a part of this study, Levan's team also examined '111209A' and the more recent burst '121027A', which exploded on Oct 27th, 2012. All show similar X-ray, ultraviolet and optical emission and all arose from the central regions of compact galaxies that were actively forming stars.

The astronomers conclude that all three GRBs constitute a hitherto unrecognized group of 'ultra-long' bursts. To account for the normal class of long GRBs, astronomers envision a star similar to the sun's size but with many times its mass. The mass must be high enough for the star to undergo an energy crisis, with its core ultimately running out of fuel and collapsing under its own weight to form a black hole. Some of the matter falling onto the nascent black hole becomes redirected into powerful jets that drill through the star, creating the gamma-ray spike, but because this burst is short-lived, the star must be comparatively small. "*Wolf-Rayet stars fit these requirements*," explained Levan. "*They are born with more than 25 times the sun's mass, but they burn so hot that they drive away their deep, outermost layer of hydrogen as an outflow we call a stellar wind*." Stripping away the star's atmosphere leaves an object massive enough to form a black hole but small enough for the particle jets to drill all the way through in times typical of 'long' GRBs. Because 'ultra-long' GRBs persist for periods up to 100 times greater than 'long' GRBs, they require a stellar source of correspondingly greater physical size. Both groups suggest that the likely candidate is a supergiant, a star with about 20 times the sun's mass that still retains its deep hydrogen atmosphere, making it hundreds of times the sun's diameter.



Astronomers suggest that blue supergiant stars may be the most likely sources of 'ultra-long' GRBs. These stars hold about 20 times the sun's mass and may reach sizes 1,000 times larger than the sun, making them nearly wide enough to span Jupiter's orbit. Credit: NASA's Goddard Space Flight Center/S. Wiessinger

Gendre's team goes further, suggesting that 'GRB 111209A' marked the death of a blue supergiant containing relatively modest amounts of elements heavier than helium, which astronomers call metals. "*The metal content of a massive star controls the strength of its stellar wind, which determines how much of the hydrogen atmosphere it retains as it grows older*," Gendre notes. The star's deep hydrogen envelope would take hours to complete its fall into the black hole, which would provide a long-lived fuel source to power an ultra-long GRB jet. Metal content also plays a strong role in the development of long GRBs, according to a detailed study by John Graham and Andrew Fruchter.

Stars make heavy elements throughout their energy-producing lives and during supernova explosions, and each generation of stars enriches interstellar gas with a greater proportion of them. While astronomers have noted that 'long' GRBs occur much more frequently in metal-poor galaxies, a few of them have suggested that this pattern is not intrinsic to the stars and their environments. To examine this possibility, Graham and Fruchter developed a novel method that allowed them to compare galaxies by their underlying rates of star formation. They

then examined galaxies that served as hosts for 'long' GRBs and various types of supernovae as well as a control sample of 20,000 typical galaxies in the 'Sloan Digital Sky Survey' (SDSS). The astronomers found that 75 percent of 'long' GRBs occurred among the 10 percent of star formation with the lowest metal content. While the study found a few 'long' GRBs in environments with high-metal content, like our own galaxy, these occur at only about 4 percent the rate seen in low-metal environments per unit of underlying star formation. "*Most stars form in metal-rich environments, and this has a side effect of decreasing the prevalence of 'long' GRBs as the universe grows older*," Graham explained. "*And while a nearby 'long' GRB would be catastrophic to life on Earth, our study shows that galaxies like our own are much less likely to produce them*."

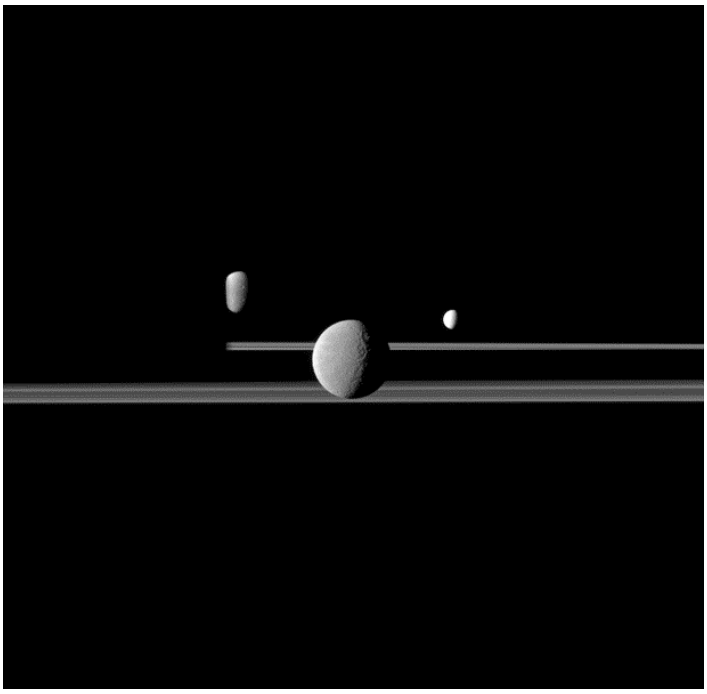
The astronomers suspect this pattern reflects a difference in how well a massive star manages to retain its rotation speed. Rising metal content means stronger stellar winds. As these winds push material off the star's surface, the star's rotation gradually decreases in much the same way as a spinning ice skater slows when she extends her arms. Stars with more rapid rotation may be more likely to produce a 'long' GRB. Graham and Fruchter hypothesize that the few 'long' GRBs found in high-metal environments received an assist from the presence of a nearby companion star. By feeding mass -- and with it, rotational energy / momentum -- onto the star that explodes, a companion serves as the physical equivalent of someone pushing a slowly spinning ice skater back up to a higher rotational speed.

Saturn's Antique Moons and Ring Particles

A new analysis of data from Cassini suggests that Saturn's moons and rings are gently-worn, vintage goods from around the time of our solar system's birth. Though they are tinted on the surface from recent "pollution," these bodies date back more than 4 billion years. They are from around the time that the planetary bodies in our neighborhood began to form out of the protoplanetary nebula, the cloud of material still orbiting the sun after its ignition as a star. The paper was led by Gianrico Filacchione, a Cassini participating scientist. "*Studying the Saturnian system helps us understand the chemical and physical evolution of our entire solar system*," said Filacchione. "*We know now that understanding this evolution requires not just studying a single moon or ring, but piecing together the relationships intertwining these bodies*."

Data from Cassini's visual and infrared mapping spectrometer (VIMS) have revealed how water ice and also colors -- which are the signs of non-water and organic materials -- are distributed throughout the Saturnian system. The spectrometer's data in the visible part of the light spectrum show that coloring on the rings and moons generally is only skin-deep. Using its infrared range, VIMS also detected abundant water ice - too much to have been deposited by comets or other recent means. So the authors deduce that the water ices must have formed around the time of the birth of the solar system, because Saturn orbits the sun beyond the so-called "snow line." Out beyond the snow line, in the outer solar system where Saturn resides, the environment is conducive to preserving water ice, like a deep freezer. Inside the solar system's "snow line," the environment is much closer to the sun's warm glow, and ices and other volatiles dissipate more easily.

The colored patina on the ring particles and moons roughly corresponds to their location in the Saturn system. For Saturn's inner ring particles and moons, water-ice spray from the geyser moon Enceladus has a whitewashing effect. Farther out, the scientists found that the surfaces of Saturn's moons generally were redder the farther they orbited from Saturn. Phoebe, one of Saturn's outer moons and an object thought to originate in the far-off Kuiper Belt, seems to be shedding reddish dust that eventually rouges the surface of nearby moons, such as Hyperion and Iapetus.



Cassini observes three of Saturn's moons set against the darkened night side of the planet. Saturn is present on the left this image but is too dark to see. Rhea (1,528 km, or 949 miles across) is closest to Cassini here and appears largest at the center of the image. Enceladus (504 km, or 313 miles across) is to the right of Rhea. Dione (1,123 km, or 698 miles across) is to the left of Rhea, partly obscured by Saturn. This view looks toward the northern, sunlit side of the rings from just above the ring plane. Image credit: NASA/JPL/Space Science Institute

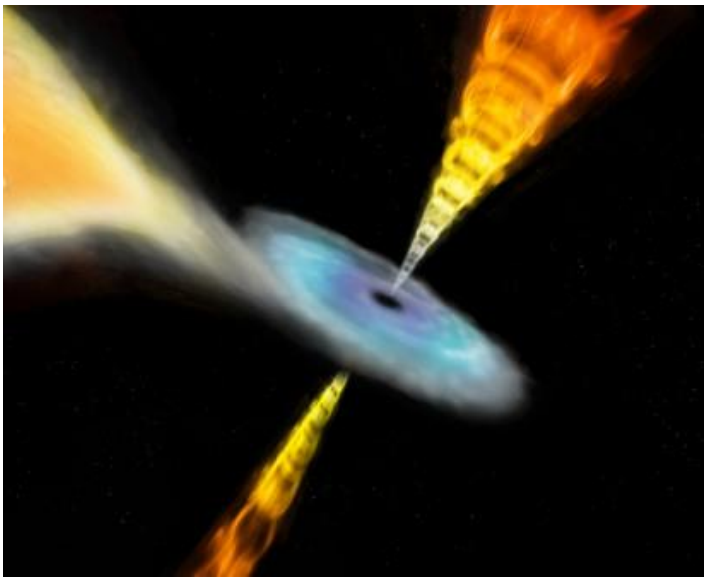
A rain of meteoroids from outside the system appears to have turned some parts of the main ring system - notably the part of the main rings known as the B ring -- a subtle reddish hue. Scientists think the reddish color could be oxidized iron -- rust -- or polycyclic aromatic hydrocarbons, which could be progenitors of more complex organic molecules. One of the big surprises from this research was the similar reddish coloring of the potato-shaped moon Prometheus and nearby ring particles. Other moons in the area were more whitish.

"*The similar reddish tint suggests that Prometheus is constructed from material in Saturn's rings*," said co-author Bonnie Buratti, a VIMS team member. "*Scientists had been wondering whether ring particles could have stuck together to form moons -- since the dominant theory was that the rings basically came from satellites being broken up. The coloring gives us some solid proof that it can work the other way around, too*." "*Observing the rings and moons with Cassini gives us an amazing bird's-eye view of the intricate processes at work in the Saturn system, and perhaps in the evolution of planetary systems as well*," said Linda Spilker, Cassini project scientist. "*What an object looks like and how it evolves depends a lot on location, location, location*."

Herschel Gets to the 'Bottom' of Black-Hole Jets

Astronomers using the Herschel spacecraft have detected emission from the base of black-hole jets for the first time. While studying the black-hole binary system 'GX 339-4' in a multi-wavelength observation campaign, they noticed changes in the source's X-ray and radio emissions signaling the onset of powerful jets being released from the black hole's vicinity. This prompted the astronomers to observe the

source at far-infrared wavelengths with Herschel. As the first observation of emission from jets in a black-hole binary system at these wavelengths, the data have allowed the astronomers to probe the jets down to their base, where the far-infrared emission originates. Herschel's contribution to the multi-wavelength observations has proved a crucial addition to the understanding of black-hole jets and of the physical processes that take place very close to a black hole.



Artist's impression of the 'GX 339-4' black-hole binary system. Credit: ESA/ATG medialab

When black holes – the densest objects in the Universe – accrete matter from their surroundings, they also trigger the release of powerful jets of highly-energetic particles that stem from the accretion disc into outer space. This phenomenon happens both at the stellar-mass black holes that derive from the death of massive stars and at the supermassive black holes lurking at the center of massive galaxies. The physical mechanisms underlying the outburst of jets and their connection with the accretion process, however, are still unclear although astronomers have been studying them for decades, first via observations at radio wavelengths and, more recently, across the entire electromagnetic spectrum.

Stellar-mass black holes that are accreting mass from a companion star in a binary system are of great help to astronomers interested in the dynamics of jets. Since they are much smaller than their supermassive counterparts, stellar-mass black holes give rise to jets whose properties change on relatively short time scales – of the order of a few hours or days – providing astronomers with a great opportunity to study their evolution and, possibly, the ignition mechanisms that trigger the appearance of jets. "*One of the best-studied stellar-mass black holes is the one hosted in the binary system 'GX 339-4': we can monitor its evolution quite closely because the source gives rise to bright outbursts every couple of years*," explains Stéphane Corbel, who led a new study of this system based on *far-infrared* (FIR) data from Herschel, as well as on observations performed at X-ray, optical, *near-infrared* (NIR) and *radio* wavelengths.

"*The multi-wavelength approach is essential for us to explore the vicinity of black holes, as different regions radiate at different wavelengths. Broadly speaking, the accretion disc shines most brightly in X-rays, whereas the jets emit mainly radio waves. But there is more: the base of the jets – closer to the black hole – emit light at shorter wavelengths than radio waves, up to the infrared: this is where Herschel's contribution proved crucial*," Corbel adds.

While 'GX 339-4' has been studied extensively at radio, NIR, optical and X-ray wavelengths, astronomers had rarely observed it in the vast portion of the spectrum between radio and NIR wavelengths. In fact, until now hardly any data from any stellar-mass black hole had been collected in this broad wavelength range. The astronomers requested to observe 'GX 339-4' with Herschel after they detected changes to its X-ray emission signaling that the outburst phase of this source, which had been going on for several months, was about to cease. Since timing was essential, the observations were performed under 'Director's Discretionary Time'. "*We believe that black-hole binaries give rise to outbursts when enough material has piled up in the accretion disc: then, just like a dam that bursts because it can no longer hold any more water, the material is accreted onto the black hole, giving rise to an enormous increase of the source's emission at soft X-ray wavelengths*," explains Corbel. The outburst phase, also known as 'soft' state, is accompanied by the release of 'ballistic jets' – jets that are very bright at radio wavelengths, consist of multiple ejections and extend up to 10,000 'Astronomical Units' (AU). When the outburst is over and the source evolves to the so-called 'hard' state, the appearance of the jets changes: with weaker radio emission and an extent up to only about 10 AU, these are known as 'compact jets'.

"*We had been monitoring 'GX 339-4's' outburst across the electromagnetic spectrum for several months. When we saw that it was transitioning to a more quiescent state, we were extremely curious to see what would happen to the jets*," says Corbel. "*It is the first time that we could witness the onset of compact jets and follow their evolution," he adds. "By combining radio observations with Herschel's FIR data, we could probe the jet emission down to the base, very close to the black hole*."

The Herschel data confirmed the current view, based on radio observations, which explains the emission from jets as synchrotron radiation released by highly-energetic electrons. In particular, the most energetic electrons, present at the base of the jets, radiate at FIR wavelengths, while the lower-energy ones, which are more abundant at larger distances from the black hole, give rise to radio emission. The new data, however, raise questions about what causes the emission detected at NIR and optical wavelengths; this emission is also associated with the jets but does not seem to have the same origin as the radio and FIR emission. Since the optical and NIR emission follows that at radio and FIR wavelengths, one of the possible explanations is that radio and FIR photons emitted in the jets are then reflected off the disc, gaining energy in the process and thus radiating at shorter wavelengths. "*With this result, Herschel has filled a long-standing gap in the monitoring of stellar-mass black-hole jets across the electromagnetic spectrum, bridging observations performed at radio and near-infrared wavelengths*," comments Göran Pilbratt, Herschel Project Scientist. "*This new view complements our current picture of these fascinating objects, while highlighting, at the same time, how their emission is even more complex than previously thought*," he concludes

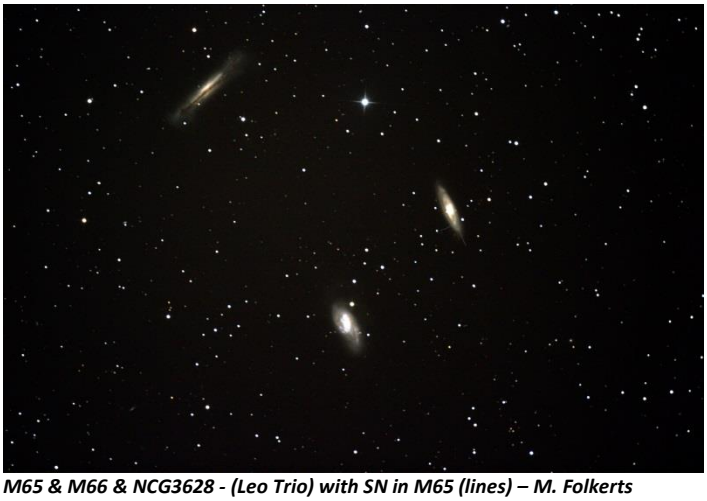
★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

[The EAS welcomes newsletter articles, photos, observing reports, and news contributions and submissions of all types from its members.]

Some Spring 2013 Astro-images - by Mark Folkerts

Comet PanStarrs (from Camp Delany star party, April 11) – M. Folkerts

Spring Galaxy NGC4565 (from Camp Delany star party) – M. Folkerts



M65 & M66 & NCG3628 - (Leo Trio) with SN in M65 (lines) – M. Folkerts

Comet PanStarrs from Harborview Park, March 22 – M. Folkerts

10" Scope and Mount For Sale

Meade LXD-55 SN-10 Schmidt-Newtonian Telescope & Mount- (10" mirror) Eyepieces - Orion 5.0mm Ultrascopic, Meade 26mm Super-Plossl, Meade 12.4mm Super-Plossl. Original mount with counterweights, Autostar controller, Telrad finder, with mounting plate already on the scope, do-it-yourself Hypertune kit, including: DVD video covering teardown, lubrication, parts, and reassembly. Set of tools - screwdrivers-long reach, Allen wrenches to fit scope, pliers - long nose and side cutters, cleaning brushes, micro-brushes, utility knife. Original manual, tune-up & enhancement guides, Autostar references, etc. This entire package is sold together. Asking $700; am open to negotiation. Please let me know if you have any questions.
-- John DeLisle, Everett, WA, (425) 353-6479

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

The Table Mountain Star Party 2012

-A report by Mark Simonson-

The TMSP Logo

Photo by Ron Mosher

Up until this last summer, I had always attended small area star parties with never more than a dozen people or so. It never failed, at every star party someone would say - "You gotta go to the Table Mountain Star Party." So I did a little research on the Table Mountain Star Party (I Googled it) and found out that the Table Mountain Star Party (TMSP) site is located about twenty miles north of Ellensburg, Washington. This is eastern Washington, and if you are from Washington you know that the climate west of the Cascade Mountains is comparable to a rain forest with maybe sixty or seventy good observing days per year. Western Washington also has a ton of light pollution.

Eastern Washington on the other hand, is comparable to a desert climate with only a couple of light pollution domes. The actual TMSP site is a very large meadow at an elevation of about 6300 feet with very dark skies. There are a couple of light domes from Ellensburg and Wenatchee, but they really aren't that bad. Another benefit of Table Mountain is that dew is normally not a problem.

The TMSP has been an annual event for over twenty years, and it is considered one of the most popular star parties in the US, and some believe the world. In years past, the TMSP would sometimes have as many as one thousand six hundred people attending, but that no longer happens because the land belongs to the U.S. Forest Service, who over the last couple years have maintained that that many people is too hard on the pristine mountain environment. So a limit of seven hundred people is the maximum allowed. Because of this, you must pre-register for the TMSP, and in the last couple of years they have reached their limit of seven hundred people about one month before the event. Registration opens normally about three months before the actual star party.

View of the star party area from the entrance road

I made the mistake of waiting right up to one month from the event, but I was lucky enough to get in before they were sold out. One of the benefits of the TMSP is that when you preregister you can also order and pay for your meals. This really cuts down on what you have to haul up the mountain. You also have to preorder any commemorative t-shirts, or hoodies, and pick them up with your meal tickets when check-in on site. The meals that are available are dinner Wednesday through Saturday, and breakfast Saturday morning. There is a portable grill on site in case you don't have a meal ticket. The grill also stays open very late to serve coffee and warm drinks for the stargazers.

Also on site were a number of vendors selling: T-shirts and apparel, pottery items, paintings and the gotta-have all important accessories for your telescope. So bring some cash!

Grill goodies

Fellow Everett Astronomical Society member, Ron Mosher, and I decided to convoy over to Table Mountain mid-morning on Wednesday. Ron was planning to set up his tent on site. I told Ron that he was welcome to stay in my trailer with me because there was more than enough room and having hunted in the Cascade Mountains over the last twelve years I know how unpredictable and downright dangerous that mountain weather can be.

Dinner preparation

Photos from the TMSP Website

The road to the star party site is paved almost all the way up. Maybe the last fifteen hundred yards are gravel. The road up the mountain is one lane for both directions with turnouts. About three quarters of the way up Ron's car overheated so we pulled over and took about a thirty minute break to let it cool and add more water to his radiator. The remainder of the trip up the mountain was uneventful. One thing we did notice on the trip up was that most of the wild mountain

flowers were in bloom revealing splashes of color almost everywhere you looked.

Artist Hulan Fleming ***Photos by William Ferguson***

EAS member Ron Mosher

Lupine and indian paintbrush

Photos by William Ferguson

Deer in the meadow

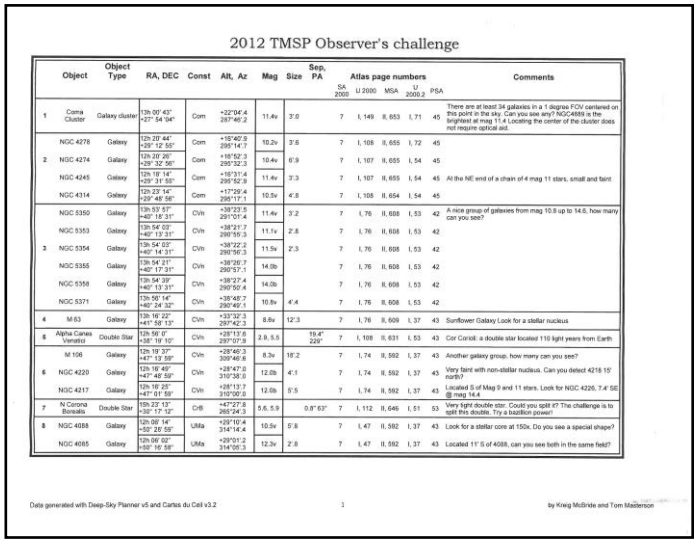
Once Ron and I arrived on site we were guided by volunteers to the area we could park and set up the camper. By the time we got the camper set up, Ron had decided he would stay in the camper. Next we set up all of our observing equipment in the designated telescope field.

Photo by William Ferguson

The trailer right next to us just happened to be another Everett Astronomical Society member by the name of William (Bill) Ferguson.

By the time Ron and I got everything set up it was mid-afternoon. In anticipation of nightfall Ron and I talked a little about the Observers Challenge and planned out how we would go about completing it. The TMSPA Observers Challenge list is an annual program designed for those interested in new challenges, goals and participation in an observing program. Included in the observers list are a wide variety of interesting objects, transient events which require planning, naked eye observing and both small and large aperture optical instruments. There are some volunteers with large aperture scopes assigned with the task of assisting those observers with objects beyond their reach. The large aperture volunteers had a sign designating their location, objects to be observed and times for public viewing. A special Observers Challenge pin is awarded to all observers who view twenty-five of the objects on the list. To be eligible to receive the award pin, the following criteria must be met:

- All observations must be made at the Table Mountain Star Party;
- You must log the date, time, telescope and magnification used;
- Write a brief description of the object or submit a sketch of the object.



2012 TMSP Observer's challenge

	Object	Object Type	RA, DEC	Const	Alt, Az	Mag	Size	Sep, PA	Atlas page numbers SA 2000	U 2000	MSA	U 2000.2	PSA	Comments
1	Coma Cluster	Galaxy cluster	13h 00' 43" +27° 54' 04"	Com	+22°04.4 287°46.2	11.4v	3'.0		7	I, 149	II, 653	I, 71	45	There are at least 34 galaxies in a 1 degree FOV centered on this point in the sky. Can you see any? NGC4889 is the brightest at mag 11.4 Locating the center of the cluster does not require optical aid.
2	NGC 4278	Galaxy	12h 20' 44" +29° 12' 55"	Com	+15°40.9 295°14.7	10.2v	3'.6		7	I, 108	II, 655	I, 72	45	
	NGC 4274	Galaxy	12h 20' 26" +29° 32' 56"	Com	+15°52.3 295°32.3	10.4v	6'.9		7	I, 107	II, 655	I, 54	45	
	NGC 4245	Galaxy	12h 18' 14" +29° 31' 55"	Com	+15°31.4 295°52.9	11.4v	3'.3		7	I, 107	II, 655	I, 54	45	At the NE end of a chain of 4 mag 11 stars, small and faint
	NGC 4314	Galaxy	12h 23' 14" +29° 45' 58"	Com	+17°29.4 295°17.1	10.5v	4'.8		7	I, 108	II, 654	I, 54	45	
3	NGC 5350	Galaxy	13h 53' 57" +40° 18' 31"	CVn	+38°23.5 291°01.4	11.4v	3'.2		7	I, 76	II, 608	I, 53	42	A nice group of galaxies from mag 10.8 up to 14.6, how many can you see?
	NGC 5353	Galaxy	13h 54' 03" +40° 13' 31"	CVn	+38°21.7 290°55.3	11.1v	2'.8		7	I, 76	II, 608	I, 53	42	
	NGC 5354	Galaxy	13h 54' 03" +40° 14' 31"	CVn	+38°22.2 290°56.3	11.5v	2'.3		7	I, 76	II, 608	I, 53	42	
	NGC 5355	Galaxy	13h 54' 21" +40° 17' 31"	CVn	+38°26.7 290°57.1	14.0b			7	I, 76	II, 608	I, 53	42	
	NGC 5356	Galaxy	13h 54' 39" +40° 13' 31"	CVn	+38°27.4 290°50.4	14.0b			7	I, 76	II, 608	I, 53	42	
	NGC 5371	Galaxy	13h 56' 14" +40° 24' 32"	CVn	+39°48.7 290°49.1	10.8v	4'.4		7	I, 76	II, 608	I, 53	42	
4	M 63	Galaxy	13h 16' 22" +41° 55' 13"	CVn	+33°32.3 297°42.3	8.6v	12'.3		7	I, 76	II, 609	I, 37	43	Sunflower Galaxy Look for a stellar nucleus
5	Alpha Canes Venatici	Double Star	12h 56' 0" +38° 19' 15"	CVn	+28°13'.6 297°07'.9	2.9, 5.5		19.4° 229°	7	I, 108	II, 631	I, 53	43	Cor Coroli: a double star located 110 light years from Earth
	M 106	Galaxy	12h 19' 37" +47° 13' 59"	CVn	+28°46'.3 309°46'.6	8.3v	18'.2		7	I, 74	II, 592	I, 37	43	Another galaxy group, how many can you see?
6	NGC 4220	Galaxy	12h 16' 49" +47° 46' 59"	CVn	+28°47'.0 310°38'.0	12.0b	4'.1		7	I, 74	II, 592	I, 37	43	Very faint with non-stellar nucleus. Can you detect 4216 15' north?
	NGC 4217	Galaxy	12h 16' 25" +47° 01' 59"	CVn	+28°13'.7 310°00'.6	12.0b	5'.5		7	I, 74	II, 592	I, 37	43	Located S of Mag 9 and 11 stars. Look for NGC 4226, 7.4' SE @ mag 14.4
7	N Corona Borealis	Double Star	15h 23' 13" +26° 17' 13"	CrB	+47°27'.8 260°24'.3	5.6, 5.9		0.6" 63°	7	I, 112	II, 646	I, 51	53	Very tight double star. Could you split it? The challenge is to split this double. Try a bazillion power!
8	NGC 4088	Galaxy	12h 06' 14" +50° 26' 55"	UMa	+29°10'.4 314°14'.4	10.5v	5'.8		7	I, 47	II, 592	I, 37	43	Look for a stellar core at 150x. Do you see a special shape?
	NGC 4085	Galaxy	12h 06' 02" +50° 35' 58"	UMa	+29°01'.2 314°05'.3	12.3v	2'.8		7	I, 47	II, 592	I, 37	43	Located 11' S of 4088, can you see both in the same field?

Data generated with Deep-Sky Planner v5 and Cartes du Ciel v3.2 — 1 — by Kreig McBride and Tom Masterson

The Observer's Challenge

There was a student telescope making program for children to build their own reflector telescopes.

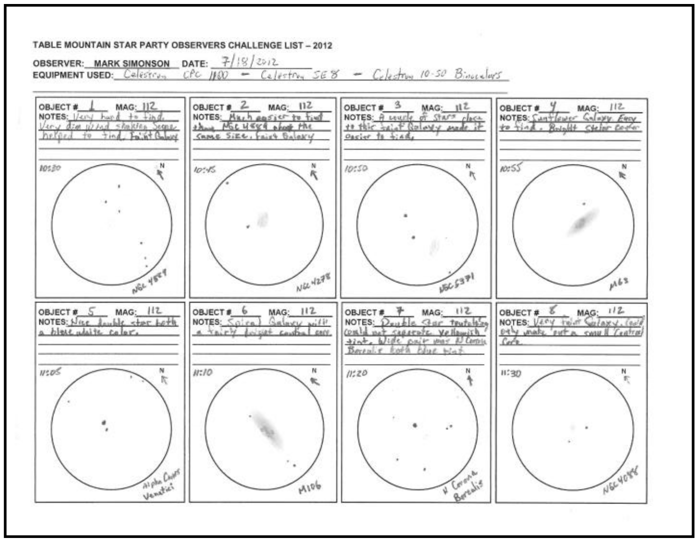


TABLE MOUNTAIN STAR PARTY OBSERVERS CHALLENGE LIST – 2012

OBSERVER: MARK SIMONSON DATE: 7/18/2012
EQUIPMENT USED: Celestron CPC 1100 – Celestron SE8 – Celestron 10-50 Binoculars

OBJECT # 1 MAG: 112 NOTES: Very hard to find. Very dim wind shaking scope helped to find. Faint Galaxy 10:30 NGC 4559	OBJECT # 2 MAG: 112 NOTES: Much easier to find than NGC 4559 about the same size. Faint Galaxy 10:45 NGC 4278	OBJECT # 3 MAG: 112 NOTES: A couple of stars close to this faint Galaxy made it easier to find. 10:50 NGC 5371	OBJECT # 4 MAG: 112 NOTES: Sunflower Galaxy. Easy to find. Bright stellar center 10:55 M63
OBJECT # 5 MAG: 112 NOTES: Nice double star both a blue white color. 11:05 Alpha Canes Venatici	OBJECT # 6 MAG: 112 NOTES: Spiral Galaxy with a fairly bright central core 11:10 M106	OBJECT # 7 MAG: 112 NOTES: Double star tantalizing could not separate. Yellowish tint. Wide pair near N Corona Borealis both blue tint. 11:20 ν Corona Borealis	OBJECT # 8 MAG: 112 NOTES: Very faint Galaxy. Could only make out a small Central Core. 11:30 NGC 4088

One of the pages I submitted

By the end of the star party Ron and I had completed the 2012 Observer's Challenge, and the 2011 Observer's Challenge. As you can see they do keep the challenges open for the prior years. Next year Ron and I plan on completing at least two of the prior challenges along with the 2013 challenge. Both Ron and I found that by participating in the challenges we got to see a lot more of the sky in a focused manner. This doesn't mean that we skipped some of our old favorites. We still got to check all of them out and even had ample time to show a few people what we were looking at along with some of their requests.

Some of the other activities that took place during the star party were a wide array of very interesting presentations. The presentations covered subjects like Spectroscopy, Lunar Phases, Astronomical League Observation Programs, Dark Skies Northwest, Citizen Science and the End of the World 12/21/2012.

There was music…

Photo by William Ferguson

Photo by William Ferguson

There was a telescope judging where individuals could enter to show off their handiwork...

Photo by William Ferguson

there were social gatherings and…

new friends…

Bill, Mark and Ron

Kevin and Judy Sullivan…

Photo by William Ferguson

The first evening of star gazing (Wednesday) was outstanding. The sky was very dark and steady. Ron and I got about three quarters of the 2012 Observer's Challenge completed at a nice comfortable pace and still had time to look at our old favorites. At times I caught myself just leaning back in my chair and staring up at the Milky Way. From my place on Camano Island I can see a hint of the Milky Way, but on Table Mountain it was so bright at times I thought there was a line of clouds were moving in. That first night Ron and I stayed up almost until dawn. One advantage of staying up that long was that we got to see Venus and Jupiter rise with the Pleiades and the Hyades. Ron took a picture of them rising while I washed a big Dobsonian telescope and ladder with my red flashlight. This picture is my favorite picture of the entire star party. I'm not sure if Ron and I were the last ones to call it a night, but it was really quite late when we turned in and I didn't see another soul.

Thursday late afternoon, we could see that there were some storm clouds on the horizon stretching from Yakima to the southeast all the way up to Wenatchee to the northeast. About a half hour before sunset the storm started to get very active with loud claps of thunder and quite a few lightning strikes. As the evening progressed the storm appeared to be moving in our direction. But we had luck on our side. Just as we were setting up to start observing the storm just broke apart and slowly dissipated. We did have a little bit of condensation/ dew that evening but nothing major. Ron and I were able to finish up the 2012 Observer's Challenge despite our pages being a little damp. The seeing was quite as good as it was the night before. Most likely caused by the storm's unstable air.

We woke Friday midmorning to a beautiful clear day in the low seventies. Ron and I decided to drive down to Ellensburg to get a couple of items. Once we got off the mountain the temperature really started to rise. In Ellensburg midday it was in the low eighties.

Heading back up the mountain it was sunny and warm however when we arrived at the TMSP site weather was moving in. The entire site was surrounded by heavy cloud cover and the temperature had dropped to the fifties.

Lightning strike

Hulan's scope, Hyades, Pleiades, and Jupiter

Back at the trailer Bill told us that Kevin and Judy Sullivan (also Everett Astronomical Society members) had arrived and were setting up their tent. No sooner did Bill tell us, when it started hailing. It was pea-size hail that stung like a thousand bee stings when it hit you. Once the hail stopped it seemed that the temperature had dropped another ten degrees. Maybe it was the layer of hail that was on the ground.

Forty-five minutes later Kevin and Judy stop by to say hi. They were both wrapped up like a couple of Eskimos. Apparently they were in the process of setting up the tent when the hail hit. It filled their tent with hail and they had to bail it all out. They looked really cold so we all piled into my trailer and I cranked the heat up. After a half hour everyone was warm again and the storm clouds were finally starting to break up.

That evening the stargazing was not the greatest experience for me. The temperature stayed low right into nightfall and everything seemed to have a thin layer of moisture on it. By midnight, my eleven inch

Schmidt-Cassegrain had lost its battle with the dew. Even with my dew suppression system cranked to full power it was a losing battle. Ron and I did get started on the 2011 Observer's Challenge and even got a few completed before turning in early because of the conditions. The final night of star gazing was by far the best night. The skies were absolutely perfect. It even started off great with me being able to catch and photograph a very thin moon as it was setting. It only got better from there. Ron and I easily finished off the 2011 Observer's Challenge. The Milky Way was so bright you almost didn't need a red flashlight at all. It was a perfect night of stargazing.

I had a great time at the TMSP. I plan on putting it on my calendar every year and attending as many years as possible. One final word, if you are even slightly interested in astronomy, **"You gotta go to the Table Mountain Star Party."**

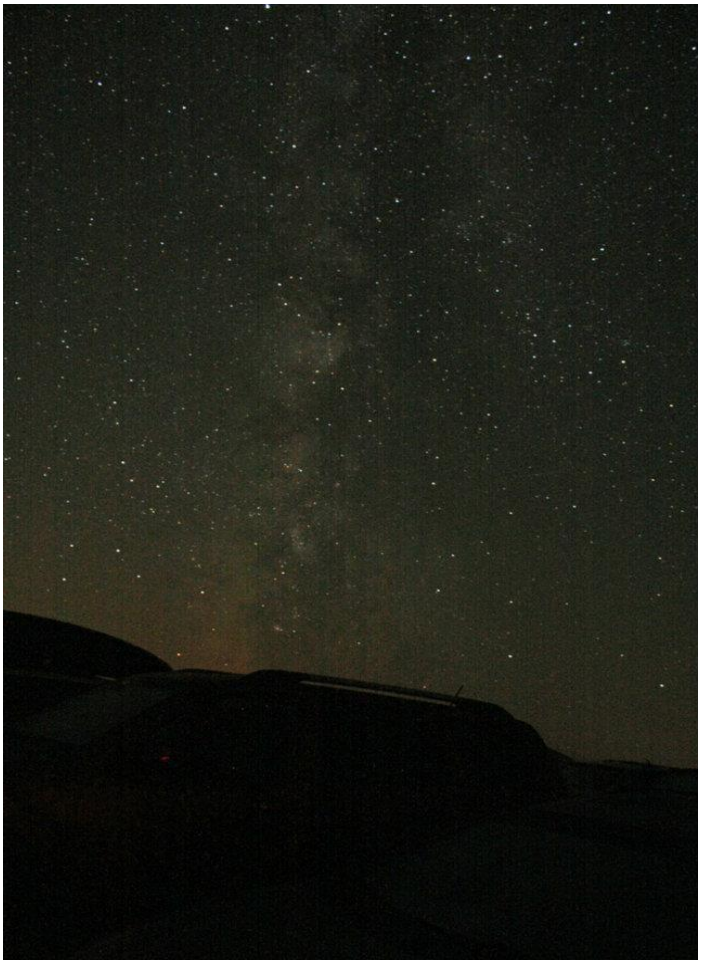


Photo by William Ferguson

Soon after attending the TMSP an extremely large forest fire swept through the area, including the area that the star party is normally held. So in 2013 the TMSP will still go on but will be held at another location (in the Okanagan valley, near the BC border). It may be years before the Star Party is on Table Mountain again. – Mark Simonson

The Seattle Times

Table Mountain fire triples in size

The Table Mountain Complex of wildfires in Chelan and Kittitas counties has tripled in size to more than 47 square miles.

FROM THE EDITOR'S TERMINAL

The Stargazer is <u>your</u> newsletter and therefore it is best when it is a cooperative project. Any content you have, such as ads, ASTRO-PHOTOs, observing reports, announcements, suggestions, or literary works, etc., should be e-mailed to the editor for inclusion into the Stargazer. If you wish to contribute an article or suggestions to ***The Stargazer*** please contact Mark Folkerts by e-mail (folkerts at seanet dot com) or by telephone (425) 486-9733.

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

In April's StarGazer:

The next EAS Meeting is *Saturday April 20th* at 3:00 pm at the Evergreen Branch Everett Public Library, in south Everett.