

# ABOVE THE FOG

• BULLETIN OF THE SAN FRANCISCO AMATEUR ASTRONOMERS •

Vol. 63, No. 10 – October 2015

## GENERAL MEETING

**THE PRESIDIO . OBSERVATION POST . BUILDING 211**

**211 Lincoln Boulevard, San Francisco**

*7:00 pm Doors Open . 7:30 pm Announcements . 8:00 pm Speaker*

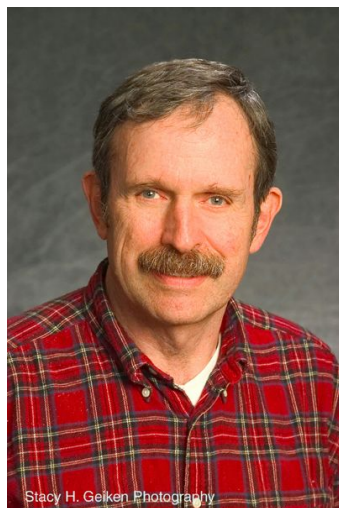
*SFAA's General Meetings occur on the 3<sup>rd</sup> **TUESDAY** of each month (except January)*

October 20, 2015

**NORMAN SLEEP, Ph.D.**

**Professor of Geophysics, Stanford University**

### **OUR MOON FROM FORMATION TO ASTEROID TARGET: MESSAGE FOR LIFE ON EARTH**



The present Earth-Moon system formed in the aftermath of the impact of a Mars-sized body on our planet. The Earth was then mostly melted and the Moon accreted from a ring of vapor and liquid orbiting the Earth. Part of the impactor's core ended up in the Moon-forming disk around the Earth. Iron metal within the disk was partly oxidized by ferric iron and water. Metallic iron remained and this formed our Moon's small core, and about 2% of the impactor's core ended up within Earth's mantle.

It is conceivable that early asteroid bombardment on the Earth was relatively benign and that planet sterilizing impact never occurred. A dense CO<sub>2</sub> atmosphere blanketed Earth within about 10 million years of the impact, and a solar-heated greenhouse maintained 200 degrees C temperatures at the surface. Earth did not become habitable until the CO<sub>2</sub> subducted into the mantle. Subducted oceanic crust carried carbonates into the mantle, which partially melted beneath island arcs to form alkaline CO<sub>2</sub>-rich lavas. Groundwaters within these lavas are an attractive prebiotic environment. By the time of Earth's earliest sedimentary record at about 3.8 billion years ago, the surface was clement, the ocean was near its current pH about 8, and the CO<sub>2</sub> pressure in the air was comparable to the modern value. By then, life had already begun to modify the composition of the Earth's surface, and even its mantle.

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*Norman Sleep graduated from Michigan State in 1967. He completed his PhD on island arcs at MIT in 1973. He was assistant professor of Geology at Northwestern from 1973 to 1979. He has since been on the Geophysics faculty at Stanford. His work applies heat and mass transfer to physical processes within the Earth and other planets. He is currently studying the aftermath of the moon-forming impact and its implications to early life. He also has interests in earthquake seismology including nonlinear rock failure during strong shaking. This work includes determining maximum past and future levels of shaking within Greater Los Angeles.*

### **UPCOMING LECTURES**

November 17

**AARON LEE, UC BERKELEY**

**ENDING THE DARK AGES: THE UNIVERSE'S FIRST STARS**



Our Universe is 14 billion years of age, and has generally been filled with stars and starlight. We here on Earth orbit one such star, which has been shining brightly for almost 5 billion years. But what about the “first” star. How did it form? What did it look like? What was the Universe like when this star starting bringing the Universe from a place of darkness to one filled with starlight? In this talk, we will explore how stars form and evolve, and how their environments play a significant role in their development. We will then look especially at the Universe half of a billion years after the Big Bang, when these first stars began to form. We now believe that these first stars were thousands to millions of times brighter than our own Sun, but live for less than a few million years. Nonetheless, these stars played a significant role in the development and evolution of the Universe, as well as the eventual development of intelligent life.

*Aaron Lee is a graduate student astronomer and dissertation fellow at the University of California Berkeley. His research focuses on the formation and evolution of both stars and planets across all of cosmic time, as well as the pedagogical methods used in teaching undergraduate and graduate level astronomy courses. Currently, Aaron is researching the formation of the first stars ever to form in our Universe.*

*Aaron researches the formation of planets and stars using some of the most powerful supercomputers in the world, often utilizing thousands of individual computers working simultaneously to simulate the flow of gas and radiation over millions of years. Using these computers, Aaron sifts through hundreds of terabytes of data in order to complete his research, which has been published in leading astronomical journals.*

**December 15                    GREGORY T. DELORY, SR. FELLOW, SPACE SCIENCES LAB, UC**

**BERKELEY**

**PRINCIPAL INVESTIGATOR, NASA MARS INSTRUMENT DEVELOPMENT  
WATER, WATER EVERYWHERE - FROM THE EARTH, THE MOON, MARS AND  
BEYOND**



Water, essential for life as we know it, is an important indicator of the conditions present on other planets and moons throughout recent history and in the distant past. The presence and state of water and other similar volatile compounds throughout our own solar system provides insight into its formation, and the origin of the life-sustaining environments that it supports.

The fact that water is found in otherwise extreme environments on other planets and moons may indicate the presence of active, dynamic processes at work that serve to replenish this otherwise fragile, volatile resource. Water is also a potential resource that future human space missions can utilize in order to engage in the sustainable exploration of our solar system.

In this talk, Delory will discuss the significance of recent discoveries of water in the most unlikely of places - our own Moon - and what this means for our understanding of how both the Moon and our solar system have evolved over time. Mars represents the converse case - whereas it was no great surprise to find water there, it is likely that a significant amount of it was lost over time. The importance and value of observations from recent space missions in addressing these questions will be discussed, as we seek to understand more about our own origins as well as our future destinations beyond Earth.

# Monday October 19

## San Francisco Amateur Astronomers

### Dominican University Event

**Volunteers needed for star party at Dominican University on Monday October 19th.**



The San Francisco Amateur Astronomers continues its tradition of supporting the Big History Program at Dominican University in San Rafael with a star party. This year's star party will be held on Monday evening October 19th with a young Moon and Saturn as highlights. The Big History Program teaches students the 13.7 billion year history of the universe and the SFAA joins the program on the open fields at Dominican with a talk about the history of time and viewing of the night sky courtesy of telescopes with volunteers from SFAA.

We invite members of SFAA to join us for this special teaching event in San Rafael. If you have a telescope and wish to take part, send an email to organizer Paul Salazar ([urbanastronomersf@gmail.com](mailto:urbanastronomersf@gmail.com)) indicating the number of scopes and attendees in your party. Plan to arrive at 5:30 pm and be ready to show the sky shortly after sunset at 6:30 pm. Light snacks will be provided to all volunteers. The event should wrap up by 8:30 pm.

Additional information about the Big History program at Dominican can be found here:

<http://www.dominican.edu/academics/big-history>



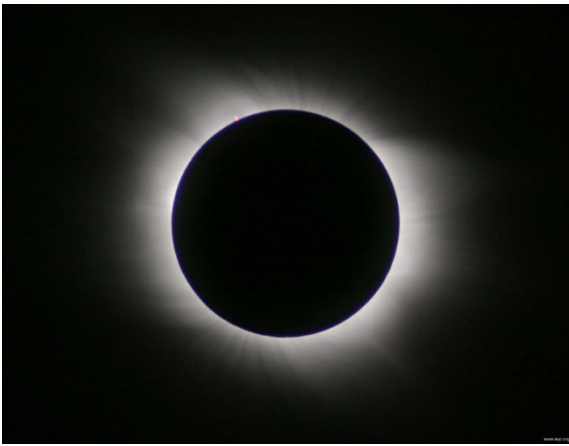
## SAN FRANCISCO AMATEUR ASTRONOMERS

### 2015 STAR PARTY DATES FOR BALANCE OF 2015

Scott Miller

Set forth below are the scheduled San Francisco City Star Parties staffed by volunteers of the SFAA for the balance of 2015. Note that the Presidio, our new host for SFAA meetings during the Randall Museum renovation, is a favored Star Party location. Lands End, a traditional City Star Party location, and the popular Exploratorium museum, are the other Star Party sites.

<b>Thursday</b>	<b>October 22</b>	<b>Presidio Parade Grounds, 6:00 PM</b>
<b>Saturday</b>	<b>November 21</b>	<b>Lands End, 5:30 PM</b>
<b>Saturday</b>	<b>December 19</b>	<b>Presidio Parade Grounds, 5:30 PM</b>



## SAN FRANCISCO AMATEUR ASTRONOMERS EXPEDITION

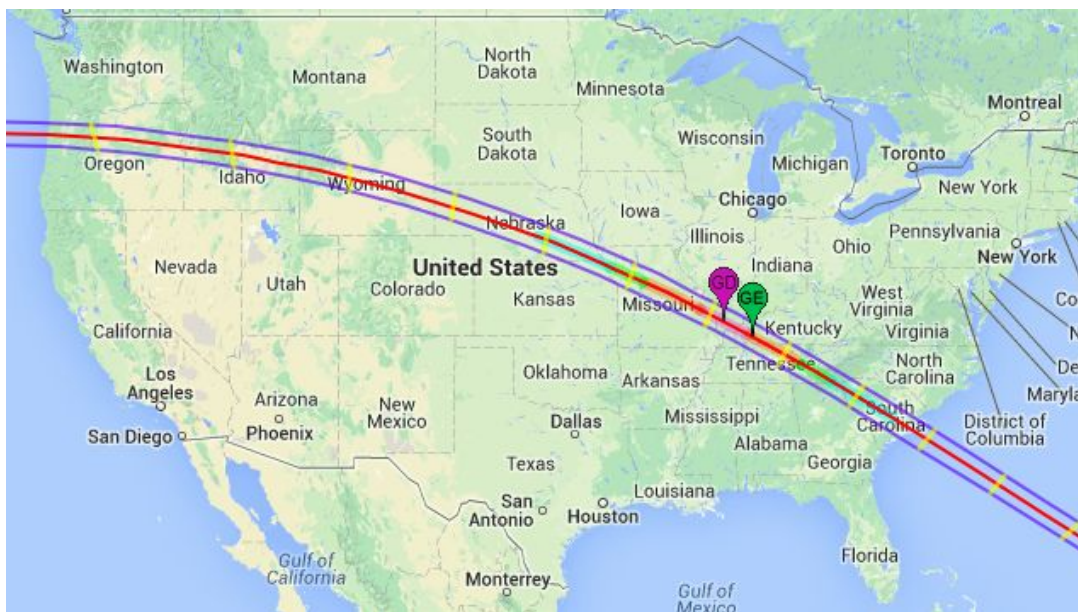
April 21, 2017

**TOTAL SOLAR ECLIPSE  
Jackson Hole, Wyoming  
(Teton Mountains)**

The San Francisco Amateur Astronomers is organizing an expedition to witness the August 21, 2017 Total Solar Eclipse. The eclipse will be visible across a broad swath of the USA, and club members will gather near Jackson Hole, Wyoming, to witness this spectacle high in the Teton Mountains. The trip is an opportunity for club members to gather in one place along the path of totality and journey together up the mountains for viewing of this spectacular astronomical phenomenon.

The club has arranged with a hotel in Teton Village, Wyoming, to enable advance bookings (2 years in advance!) with a special club rate of 10% discount. If you are a member of the SFAA and are interested in this, send an email to [2017eclipse@sfaa-astronomy.org](mailto:2017eclipse@sfaa-astronomy.org) and you'll be provided with additional details on the hotel and booking code. In the coming months the club will organize additional talks and events that will take place at the hotel on and before the date of totality. At this time, the most important thing is to book your hotel room so if you are at all considering this eclipse, get in touch and get your reservation in today. SFAA is not organizing air or ground transportation; that is left to each individual group or attendee.

If you have any other questions, send to [2017eclipse@sfaa-astronomy.org](mailto:2017eclipse@sfaa-astronomy.org).



**Commonwealth Club: Talk on Pluto in Palo Alto**  
**Monday, October 26**  
**Andrew Fraknoi**

The Commonwealth Club of California (in association with Wonderfest) presents:

**“THE REVENGE OF THE DWARF PLANET: WHAT REALLY HAPPENED TO PLUTO,  
AND WHAT WE ARE NOW LEARNING ABOUT THIS INTRIGUING WORLD”**

An Illustrated Public Talk by **Andrew Fraknoi**,  
Chair of the Astronomy Department, Foothill College

Bay Area astronomer Fraknoi takes us behind the scenes of how Pluto got “demoted” to a dwarf planet and why its story might still turn out OK. In July, the New Horizons spacecraft flew by the double planet Pluto-Charon and gave us superb close-up views of both worlds for the first time. Though New Horizons data will keep coming to us for a whole year, Fraknoi will give an update on what we now know about these icy worlds at the outskirts of our solar system.

**Location:** Cubberley Theatre, 4000 Middlefield Road, Palo Alto, CA 94303

**Date:** Monday evening, October 26

**Time:** 6:30 p.m. check-in, 7:00 p.m. program

**A discounted ticket can be purchased by using the code: PLUTO**

For more information or tickets, see:

<http://www.commonwealthclub.org/events/2015-10-26/andrew-fraknoi-revenge-dwarf-planet>

For a map and directions, see:

<http://www.paphil.org/pdf/cubberleycommunitycenter.pdf>

Andrew Fraknoi chairs the Astronomy Department at Foothill College in Los Altos, and is a senior educator for the Astronomical Society of the Pacific. He serves on the Board of Trustees of the SETI Institute and is vice-chair of the Lick Observatory Council. A frequent guest on Bay Area radio stations and NPR, Fraknoi is the lead author of *Voyages through the Universe*, a college-level introductory textbook and wrote *The Wonderful World of Space* for Disney. The International Astronomical Union has named asteroid 4859 *Asteroid Fraknoi* to recognize his contributions to the public understanding of astronomy.

**BAY AREA ASTRONOMY EVENTS**

## Kenneth Lum

<http://tech.groups.yahoo.com/group/bayastro/?v=1&t=directory&ch=web&pub=groups&sec=dir&slk=94>

### BAY AREA REGULARLY SCHEDULED EVENTS

**EVERY FRIDAY NIGHT  
7:00 PM – 10:00 PM  
excluding major holidays**

**The Telescope Makers'  
Workshop**

**CHABOT SPACE AND  
SCIENCE CENTER  
10000 Skyline Boulevard  
Oakland, CA 94619-2450**

**THE TELESCOPE MAKERS' WORKSHOP** is held every Friday night from 7pm - 10pm, excluding major holidays (e.g. Christmas Day and New Year's Day) that fall on Fridays. The Workshop is always closed on Memorial Day Weekend. Attendance every Friday night is not mandatory, and members work at their own pace. The Workshop meets at Chabot Space & Science Center, 10000 Skyline Blvd., Oakland.

Chabot's TMW is one of only a handful of regularly scheduled telescope making workshops in the U.S., and probably the world; it meets every Friday evening throughout the year, except Memorial Day weekend. It has been in operation since December of 1930, founded by Franklin B. Wright, and is currently run by Eastbay Astronomical Society member Rich Ozer, with help from other EAS members, Dave Barosso, Barry Leska, and others. The price of admission is FREE. All you have to do is show up, buy a mirror blank and a "tool" (typically around \$100 - \$200 depending on the size of the mirror) and start "pushin' glass!" We supply you with instruction, the various grits you'll need to first grind, and then polish and figure your mirror, and all the testing equipment needed. With a small bit of luck, you could wind up with a telescope that costs 1/3 or 1/4 the cost of a store-bought telescope, that is yet optically superior! It does take time - depending on how much time you put in on it, and other factors, it could take a few months or several months. But, it's a fun project, great for kids, and at the end you get a great telescope!

For more information call or email Richard Ozer at [rozer@pacbell.net](mailto:rozer@pacbell.net) or phone (510) 406-1914.

**EVERY FRIDAY &  
SATURDAY EVENING,  
weather permitting  
7:30 PM – 10:30 PM**

**CHABOT SPACE AND  
SCIENCE CENTER  
10000 Skyline Boulevard  
Oakland CA 94619-2450  
(510) 336-7300**

#### **EXPLORE THE NIGHT SKIES AT THE CHABOT OBSERVATORIES**

For more information: <http://www.chabot.space.org/>

#### **Free Telescope Viewing**

Regular hours are every Friday & Saturday evening, weather permitting: 7:30pm - 10:30pm

Come for spectacular night sky viewing the best kept secret in the Bay Area and see the magnificence of our telescopes in action!

**Daytime Telescope Viewing** On Saturday and Sunday afternoons come view the sun, moon, or Venus through Chabot's telescopes. Free with General Admission. (weather permitting)

12pm - 5pm: Observatories Open

Sunset – 5:11 PM  
(TWICE MONTHLY)

**Inclement weather (clouds, excessive wind and showers) will cause the event to be canceled without notice.**

**SAN MATEO COUNTY  
ASTRONOMICAL SOCIETY  
STAR PARTY**

### **STAR PARTIES AT CRESTVIEW PARK, SAN CARLOS**

Come out and bring the kids for a mind expanding look at the universe

The City of San Carlos Parks and Recreation Department and the San Mateo County Astronomical Society have open Star Parties twice a month. These events are held in Crestview Park, San Carlos California. Note that inclement weather (clouds, excessive wind and showers) will cause the event to be canceled without notice.

For more information call Bob Black, (650)592-2166, or send an email to [SMCAS@live.com](mailto:SMCAS@live.com) or call Ed Pieret at (650)862-9602.

#### **Reasons to Attend**

If you have kids interested in space or planets bring them here for a real life view of planets, nebula, star clusters and galaxies.

If you are thinking of buying a telescope or want help using a telescope you own, come here to talk with experienced users. If you think you might have an interest in astronomy come and talk to experienced amateur astronomers.

#### **Cautions**

Dress warmly and wear a hat.

Visitors should park on the street and walk into the park so your headlights don't affect the observer's dark adaptation.

Only park in the parking lot if you are arriving before dark and plan to stay until the end of the event.

You shouldn't need lights but if you feel you do, only bring a small flashlight with the lens covered using red cellophane or red balloon.

Please respect the telescopes and ask permission from the owner if you wish to touch.

Parents, please watch your children.

The park is residential, and adjacent to homes and backyards, please keep noise to a minimum.

#### **Schedule Time**

Astronomers arrive to set up at around sunset. Observing starts at about one hour after sunset and continues for two to three hours.

~~**EVERY CLEAR SATURDAY  
MORNING  
OBSERVATORY  
10:00 AM – 12:00 PM**~~

~~**FOOTHILL COMMUNITY  
COLLEGE  
12345 Moody Road  
Los Altos Hills**~~

~~**Cost: Free**~~

~~Solar observing with a Hydrogen alpha solar telescope every clear Saturday morning. This allows spectacular views of solar prominences and unusual surface features on the Sun not otherwise visible with regular white light telescopes. Admission is free.~~

~~Foothill Observatory is located on the campus of Foothill College in Los Altos Hills, CA. Take Highway 280 to the El Monte Rd. exit. The observatory is next to parking lot 4. Parking at the college requires visitor parking permits that are available from the machines in the parking lots for \$ 3.00.~~

**THE FOOTHILL COMMUNITY COLLEGE  
OBSERVATORY IS TEMPORARILY CLOSED FOR  
REPAIRS.**

<p><b>EVERY CLEAR FRIDAY EVENING</b>  <b>9:00 PM – 11:00 PM</b></p> <p><b>FOOTHILL COMMUNITY COLLEGE OBSERVATORY</b>  <b>12345 Moody Road</b>  <b>Los Altos Hills</b></p> <p><b>Cost: Free</b></p>	<p>Foothill Observatory is open for public viewing every clear Friday evening from 9:00 p.m. until 11:00 p.m. Visitors can view the wonders of the universe through the observatory's computer-controlled 16-inch Schmidt-Cassegrain telescope. Views of objects in our solar system may include craters and mountains on the moon, the moons and cloud bands of Jupiter, the rings of Saturn, etc. Deep space objects including star clusters, nebulae, and distant galaxies also provide dramatic demonstrations of the vastness of the cosmos. The choice of targets for Any evening's viewing depends on the season and what objects are currently in the sky.</p> <p>The public viewing programs at Foothill are free of charge and are open to guests of all ages. Please note that the observatory is closed when the weather is cloudy. Also note that visitor parking permits are available from the machines in the parking lots for \$3.00.</p> <p>Come to Foothill Observatory and join us in the exploration of our Universe!</p> <p>Foothill Observatory is located on the campus of Foothill College in Los Altos Hills, CA. Take Highway 280 to the El Monte Rd exit. The observatory is next to parking lot 4. Parking at the college requires visitor parking permits that are available from the machines in the parking lots for \$3.00.</p> <p style="text-align: center;"><b>THE FOOTHILL COMMUNITY COLLEGE  OBSERVATORY IS TEMPORARILY CLOSED FOR  REPAIRS.</b></p>
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**BAY AREA EVENTS – OCTOBER 2015**

<p><b>TUESDAY, 10/20</b>  <b>12:00 NOON</b></p> <p><b>GALILEO AUDITORIUM,  MICROSOFT SVC  BUILDING ONE</b>  <b>1065 La Avenida</b>  <b>Mountain View, CA 94043</b></p>	<p><b>ARE OLD GALAXIES REALLY RED AND DEAD?</b>  <b>LEO BLITZ, UC BERKELEY</b></p> <p>Galaxies are broadly divided into two classes: spiral and elliptical. Unlike the spirals, the ellipticals, often referred to as early-type galaxies, are largely composed of old stars that give them a reddish color, They typically have little interstellar material with which to form new stars; these galaxies are often referred to as “red and dead.” We will see, however, that a substantial fraction of these galaxies contain surprising amounts of neutral hydrogen and these do form stars, albeit at a reduced rate compared to their spiral cousins. Early-type galaxies outside of clusters can be seen to be accreting gas from their surroundings, which is the source of at least some of the gas fueling star-formation taking place within them. In addition, the galaxies are seen to contain super-massive black holes in their centers. The black holes appear to be responsible for ejecting much of the gas that falls into the nuclei of these galaxies, reenergizing the intergalactic medium.</p>
<p><b>WEDNESDAY, 10/21/15</b>  <b>06:30 PM - 07:45 PM</b></p> <p><b>BERKELEY CITY COLLEGE  AUDITORIUM</b>  <b>2050 Center Street</b></p>	<p><b>TO INFINITY AND BEYOND: THE MATH AND SCIENCE BEHIND PIXAR FILMS</b>  <b>DANIELLE FEINBERG, DIRECTOR OF PHOTOGRAPHY FOR LIGHTING AT PIXAR  ANIMATION STUDIO</b></p> <p>Discussion of a series of problems faced while making various Pixar films and how the Pixar Animation Scientists used math and science to save the day!</p>



<p><b>Berkeley, CA 94704</b></p> <p><b>Cost:</b> <b>Free &amp; reservations required</b></p>	<p>Danielle Feinberg began her career at Pixar Animation Studios in February 1997 on the feature film A Bug's Life. She quickly discovered her love for lighting and went on to light on many of Pixar's feature films including Toy Story 2, Monsters, Inc., the Academy Award®-winning Finding Nemo, The Incredibles, Ratatouille and WALL•E. Most recently, Feinberg completed work as the Director of Photography for Lighting on Disney•Pixar's Academy Award®-winning Brave, and is now working on a future Pixar film.</p> <p>Feinberg's love of combining computers and art began she was eight years old, and first programmed a Logo turtle to create images. This eventually led her to a Bachelor of Arts in Computer Science from Harvard University. Now, in addition to her Pixar work, she works with teenage girls, encouraging them to pursue code, math and science by demonstrating to them the same beautiful simplicity she found with the programmed art of the Logo turtle.</p> <p>Seating is limited, and we encourage you to reserve your seat in advance to ensure admission. Go to <a href="http://www.msri.org/general_events/21558">http://www.msri.org/general_events/21558</a></p> <p>Contact: Anne Pfister Email: <a href="mailto:annepf@msri.org">annepf@msri.org</a> Phone: 510.642.0143</p> <p>Website: <a href="http://www.msri.org/general_events/21555">http://www.msri.org/general_events/21555</a></p>
<p>SATURDAY, 10/24 10:30 AM - 04:00 PM</p> <p>HILLER AVIATION MUSEUM 601 Skyway ROAD San Carlos, CA 94070</p>	<p><b>BAY AREA SCIENCE FESTIVAL AERO DESIGN CHALLENGE</b></p> <p>The Aero Design Challenge introduces students to the engineering design process with a series of Museum-based, aerodynamics-themed inspiration experiences, then launches them into a mission to design, test, and present a prototype of an engineering vehicle designed to meet a specific design requirement.</p> <p>This year's program theme explores the aerodynamics of propellers. The exploration experience will include discovery stations throughout the Museum, including propeller evaluation, wind tunnel testing, flight simulation and more. Participants will then design, build and test a propeller of their own design able to provide sufficient thrust to propel a test vehicle across a designated distance.</p> <p>Registration Required</p> <p>There are no fees or cost for children and adults participating in the Aero Design Challenge on October 24, but space is limited and advance reservations are required. On-site registration ends at 1:30pm.</p> <p>Contact: Bay Area Science Festival Email: <a href="mailto:info@bayareascience.org">info@bayareascience.org</a></p> <p>Website: <a href="http://www.bayareascience.org/event/aero-design-challenge/">http://www.bayareascience.org/event/aero-design-challenge/</a></p>



# Total Eclipse of the Harvest Moon

**Video:** [https://www.youtube.com/watch?v=j7RMmitoex0&feature=player\\_embedded](https://www.youtube.com/watch?v=j7RMmitoex0&feature=player_embedded)

**Sept. 22, 2015:** In the days before light bulbs, farmers relied on moonlight to help them harvest their crops. Many crops ripen all at once in late summer and early autumn so farmers found themselves extremely busy at this time of year. They had to work after sundown. Moonlight became an essential part of farming, and thus, the Harvest Moon was born.

According to folklore, the Harvest Moon is the full Moon that falls closest to the autumnal equinox, the hectic beginning of northern autumn. In 2015, the Moon is full on Sept. 28<sup>th</sup>, less than a week after the equinox of Sept. 23<sup>rd</sup>. The coincidence sets the stage for a nice display of harvest moonlight.

But wait. This year's Harvest Moon is not like the others. It's going to be eclipsed.

On Sep. 27-28, 2015, the super Harvest Moon will pass through the shadow of Earth, producing a lovely amber total lunar eclipse.

On the night of Sept. 27 and into the early hours of Sept. 28, the full Moon will glide through the shadow of Earth, turning the Harvest Moon a golden-red color akin to autumn leaves.

The action begins at 9:07 PM Eastern Time on the evening of Sept 27<sup>th</sup> when the edge of the Moon first enters the amber core of Earth's shadow. For the next three hours and 18 minutes, Earth's shadow will move across the lunar disk.

Totality begins at 10:11 PM Eastern Time. That's when the Moon is completely enveloped by the shadow of our planet. Totality lasts for an hour and 12 minutes so there is plenty of time to soak up the suddenly-red moonlight.

The reason the Moon turns red may be found on the surface of the Moon itself. Using your imagination, fly to the Moon and stand inside a dusty lunar crater. Look up. Overhead hangs Earth, nightside facing you, completely hiding the sun behind it. The eclipse is underway.

You might suppose that the Earth overhead would be completely dark. After all, you're looking at the *nightside* of our planet. Instead, something amazing happens. When the sun is located directly behind Earth, the rim of the planet seems to catch fire! The darkened terrestrial disk is ringed by every sunrise and every sunset in the world, all at once. This light filters into the heart of Earth's shadow, suffusing it with a coppery glow.

Back on Earth, the shadowed Moon becomes a great red orb.

One more thing: The full Moon of Sept. 28<sup>th</sup> occurs near the perigee of the Moon's orbit—that is, the point closest to Earth. This makes the Harvest Moon a "supermoon."

The super Harvest Moon eclipse will be visible from the Americas, Europe, and Africa. It brings an end to a remarkable series of four consecutive total lunar eclipses visible from North America—a so-called "tetrad." Perhaps the heavens have saved the best for last.

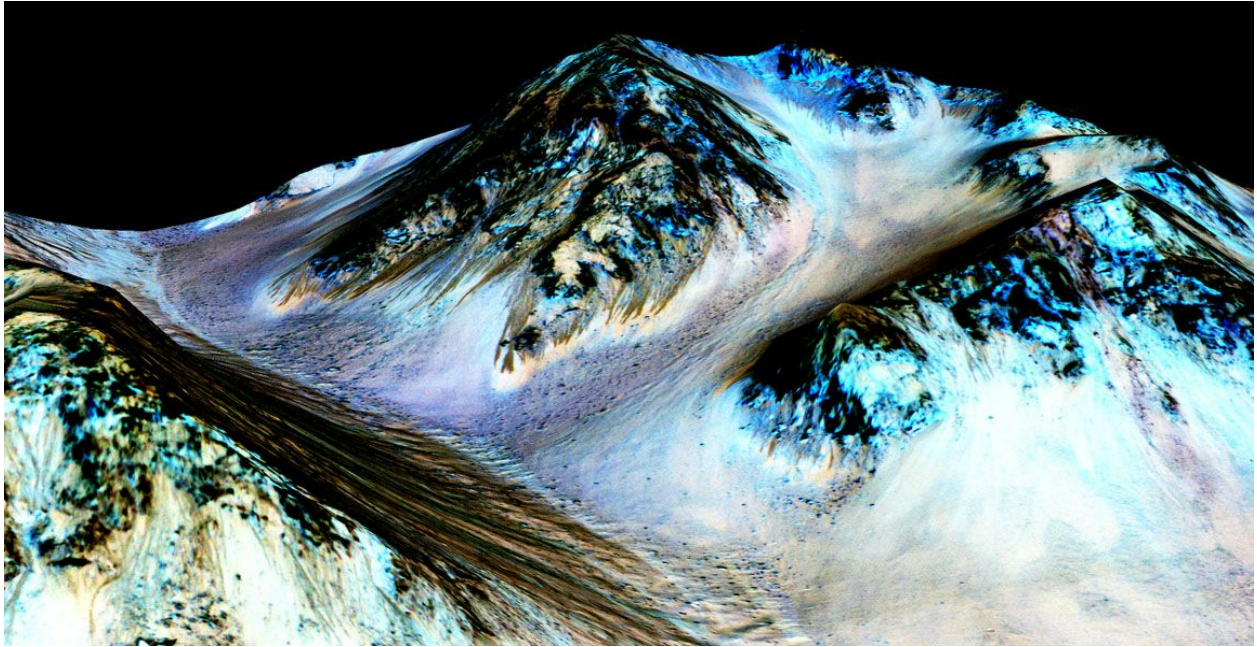
If you live in the eclipse zone, mark your calendar for Sept. 27-28, and enjoy the show.

For more beautiful sights in the night sky, stay tuned to [science.nasa.gov](http://science.nasa.gov)

**NASA – JET PROPULSION LABORATORY**

**September 28, 2015**

## **NASA CONFIRMS EVIDENCE THAT LIQUID WATER FLOWS ON TODAY'S MARS**



Dark, narrow streaks on Martian slopes such as these at Hale Crater are inferred to be formed by seasonal flow of water on contemporary Mars. The streaks are roughly the length of a football field. Image credit: NASA/JPL Caltech/Univ. of Arizona

New findings from NASA's Mars Reconnaissance Orbiter (MRO) provide the strongest evidence yet that liquid water flows intermittently on present-day Mars.

Using an imaging spectrometer on MRO, researchers detected signatures of hydrated minerals on slopes where mysterious streaks are seen on the Red Planet. These darkish streaks appear to ebb and flow over time. They darken and appear to flow down steep slopes during warm seasons, and then fade in cooler seasons. They appear in several locations on Mars when temperatures are above minus 10 degrees Fahrenheit (minus 23 Celsius), and disappear at colder times.

"Our quest on Mars has been to 'follow the water,' in our search for life in the universe, and now we have convincing science that validates what we've long suspected," said John Grunsfeld, astronaut and associate administrator of NASA's Science Mission Directorate in Washington. "This is a significant development, as it appears to confirm that water -- albeit briny -- is flowing today on the surface of Mars."

These downhill flows, known as recurring slope lineae (RSL), often have been described as possibly related to liquid water. The new findings of hydrated salts on the slopes point to what that relationship may be to these dark features. The hydrated salts would lower the freezing point of a liquid brine, just as salt on roads here on Earth causes ice and snow to melt more rapidly. Scientists say it's likely a shallow subsurface flow, with enough water wicking to the surface to explain the darkening.

"We found the hydrated salts only when the seasonal features were widest, which suggests that either the dark streaks themselves or a process that forms them is the source of the hydration. In either case, the detection of hydrated salts on these slopes means that water plays a vital role in the formation of these streaks," said Lujendra Ojha of the Georgia Institute of Technology (Georgia Tech) in Atlanta, lead author of a report on these findings published Sept. 28 by Nature Geoscience.

Ojha first noticed these puzzling features as a University of Arizona undergraduate student in 2010, using images from the MRO's High Resolution Imaging Science Experiment (HiRISE). HiRISE observations now have documented RSL at dozens of sites on Mars. The new study pairs HiRISE observations with mineral mapping by MRO's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM).

The spectrometer observations show signatures of hydrated salts at multiple RSL locations, but only when the dark features were relatively wide. When the researchers looked at the same locations and RSL weren't as extensive, they detected no hydrated salt.

Ojha and his co-authors interpret the spectral signatures as caused by hydrated minerals called perchlorates. The hydrated salts most consistent with the chemical signatures are likely a mixture of magnesium perchlorate, magnesium chlorate and sodium perchlorate. Some perchlorates have been shown to keep liquids from freezing even when conditions are as cold as minus 94 degrees Fahrenheit (minus 70 Celsius). On Earth, naturally produced perchlorates are concentrated in deserts, and some types of perchlorates can be used as rocket propellant.

Perchlorates have previously been seen on Mars. NASA's Phoenix lander and Curiosity rover both found them in the planet's soil, and some scientists believe that the Viking missions in the 1970s measured signatures of these salts. However, this study of RSL detected perchlorates, now in hydrated form, in different areas than those explored by the landers. This also is the first time perchlorates have been identified from orbit.

MRO has been examining Mars since 2006 with its six science instruments.

"The ability of MRO to observe for multiple Mars years with a payload able to see the fine detail of these features has enabled findings such as these: first identifying the puzzling seasonal streaks and now making a big step towards explaining what they are," said Rich Zurek, MRO project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California.

For Ojha, the new findings are more proof that the mysterious lines he first saw darkening Martian slopes five years ago are, indeed, present-day water.

"When most people talk about water on Mars, they're usually talking about ancient water or frozen water," he said. "Now we know there's more to the story. This is the first spectral detection that unambiguously supports our liquid water-formation hypotheses for RSL."

The discovery is the latest of many breakthroughs by NASA's Mars missions.

"It took multiple spacecraft over several years to solve this mystery, and now we know there is liquid water on the surface of this cold, desert planet," said Michael Meyer, lead scientist for NASA's Mars Exploration Program at the agency's headquarters in Washington. "It seems that the more we study Mars, the more we learn how life could be supported and where there are resources to support life in the future."

There are eight co-authors of the Nature Geoscience paper, including Mary Beth Wilhelm at NASA's Ames Research Center in Moffett Field, California and Georgia Tech; CRISM Principal Investigator Scott Murchie of the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland; and HiRISE Principal Investigator Alfred McEwen of the University of Arizona Lunar and Planetary Laboratory in Tucson, Arizona. Others are at Georgia Tech, the Southwest Research Institute in Boulder, Colorado, and Laboratoire de Planétologie et Géodynamique in Nantes, France.

The agency's Jet Propulsion Laboratory in Pasadena, California, a division of the California Institute of Technology, manages the Mars Reconnaissance Orbiter Project for NASA's Science Mission Directorate, Washington. Lockheed Martin built the orbiter and collaborates with JPL to operate it.

More information about NASA's journey to Mars is available online at:

<https://www.nasa.gov/topics/journeymars>

For more information about the Mars Reconnaissance Orbiter, visit:

<http://www.nasa.gov/mro>

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2015-302



**San Francisco Amateur Astronomers**

PO Box 15097

**San Francisco Amateur Astronomers  
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3. Submitting appropriate dues in October, November, December, membership will run to 31 December of the next year; submitting appropriate dues in January, February or March, membership will run to 31 December of the same year.
4. Renewals are maintained at the original membership date unless the renewal is made later than the original cutoff date (e.g. September or March as described in 3). In such cases the membership date is shifted to the next renewal date 30 June or 31 December.
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New members will be entered onto the SFAA roster on the Night Sky Network (NSN) and will receive a verifying email from the NSN with username and password for the NSN. Renewing members will have their information updated but will not receive an email from the NSN. Both new and renewing members will receive a verifying email from the SFAA Treasurer upon completion of the membership process.