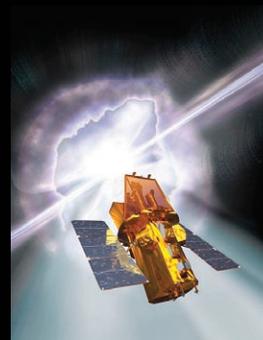


# PRIMEFOCUS

Tri-Valley Stargazers



August 2013



## Meeting Info

### What:

Ice Cream Social

### Who:

You

### When:

August 16, 2013

Doors open at 7:00 p.m.

Ice Cream and Show and Tell at  
7:30 p.m.

### Where:

Unitarian Universalist  
Church in Livermore  
1893 N. Vasco Road

## Inside

News & Notes	2
Journal Club	2
Calendar of Events	3
What's Up	6
NASA's Space Place	7
Membership/Renewal Application	8

## August Meeting

### Ice Cream Social and Show and Tell

Since the August meeting coincides with the TVS Yosemite Star Party, the board has decided to hold an ice cream social. People are invited to bring anything for show and tell, which can be more informal than getting up in front of the whole crowd.

### H2O Open House

Our next open house is tentatively scheduled for August 10th at the club's dark sky site, Hidden Hill Observatory, aka H2O. Anyone can come to our open houses, not just club members; but you cannot go there without an escort. We will meet at the corner of Mines and Tesla Roads at 6:30 PM, then caravan to the site on a drive that takes about 50 minutes. There is no gas on the way, so be sure to gas up before leaving. The site is essentially in the wilderness, so there is no electricity and water, and there are only a couple of pit toilets. Cell-phone reception is iffy at best. If you need a flashlight, bring a red LED flashlight, not a white-light flashlight. And use masking tape over your car door and interior lights, or pull the fuse. If you don't have a scope, you can always find someone who is willing to let you look through theirs. And don't forget to bring your binoculars. Expect to stay until about midnight and get back to Livermore at around 1:00 AM.

Check the club website: <http://www.trivalleystargazers.org/> for the latest news on the open house.

### Yosemite Star Party: Join the Fun!

This year's Yosemite Star Party will be held on Friday and Saturday, August 16 and August 17, at Glacier Point. TVS members who bring telescopes for public observing will receive free camping at the Bridalveil campgrounds. On these evenings, sunset occurs at about 8pm. On August 16, moonrise is at 4:18pm and moonset is at 2:35am. On August 17, moonrise is at 5:13pm and moonset is at 3:42am. If interested, contact Bob McKoon (rmckoon"at"yahoo.com)

### Group Observing at Lick Observatory

There is an opportunity for group observing at Lick Observatory on August 17, August 31, and September 21. The group rate is \$1000 for 30 people. Groups will observe a variety of astronomical objects through both the historic 36" Lick Refractor using its eyepiece and the 40" Nickel Reflector equipped with a CCD direct imaging camera; the camera has a 6.3x6.3-arcminute field of view and B, V, R, and I filters. Groups will be able to request the objects they would like to observe and will have access to that night's digital images from the Nickel Telescope. Participants may also bring their own telescopes to this prime viewing site. Communicate through the TVS yahoo users group to express your interest.

## News & Notes

### 2013 TVS Meeting Dates

The following lists the TVS meeting dates for 2013. The lecture meetings are on the third Friday of the month, with the Board meetings on the Monday following the lecture meeting.

Lecture Meeting	Board Meeting	Prime Focus Deadline
Aug. 16	Aug. 19	
Sep. 20	Sep. 23	Aug. 30
Oct. 18	Oct. 21	Sep. 27
Nov. 15	Nov. 18	Oct. 25
Dec. 20	Dec. 23	Nov. 29

### Money Matters

Treasurer David Feindel indicates that as of July 13, 2013 the TVS account balances are:

Checking    \$12,296.97

### TVS Needs YOU!!!

TVS needs your help. Please consider taking on the role of Vice-President or Program Director. Anyone interested in either (or both) of these positions is encouraged to contact any of the club officers via e-mail or at the monthly meeting.

### Barcroft High Altitude Star Party

The Eastbay Astronomical Society and Tri-Valley Stargazers joint venture are planning this year's Barcroft High Altitude Star Party. The dates are Wednesday, September 4 through Sunday, September 8. The cost is \$65/night, with preference being given to those who sign up for all five nights. Reservations must be received no later than Tuesday, August 20, 2013.

The details of this star party are now posted on the Eastbay Astronomical Society website: <http://www.eastbayastro.org/index/Barcroft.htm>. Barcroft Observatory, located in the White Mountains east of Owens Valley, is located at ~12,450 feet so it is not for the faint of heart, but it is the ultimate dark sky experience. It is strongly recommended that participants acclimatize at altitude for at least one night in advance of their stay at Barcroft. Suggested acclimatization locations are Grandview Campgrounds (~8,600 feet), a hotel in Mammoth Lakes (~8,000 feet), or Bridalveil Creek Campground near Glacier Point.

## Journal Club By Ken Sperber

### Gamma-Ray Burst: Kilonova Flavor

Gamma-Ray Bursts (GRBs) come in two flavors, short-duration (less than 2 seconds in duration) and long-duration.

GRBs were first identified in 1967 by military satellites that were on the lookout for clandestine nuclear explosions during the cold war. Once it was realized that the gamma-ray sources were from space (thankfully all have occurred external to the Milky Way Galaxy), the astrophysicists got to work theorizing the possible types of objects that could give rise to these energetic explosions. Long-duration GRB's arise when massive stars explode as core-collapse supernovae. In these cases we are in the line of sight of the collimated relativistic jet of the explosion. Short-duration GRB's are believed to occur from the merger of two neutron stars or the merger of a neutron star and a black hole. In an effort to better understand GRB's, NASA launched the Swift satellite. It has 3 instruments: a burst alert telescope, an X-Ray telescope, and a UV/Optical telescope. These are used to locate the GRB, and take spectra of the X-Ray and UV/Optical glow. It discovers about 100 GRB's per year, with their locations made available in near-real time so that follow-up observations can be carried out with other instruments.

The afterglow of short-duration bursts are nearly impossible to observe since they fade so quickly. Thus, determination of the source of short-duration GRB's has been lacking. Fortunately, GRB130603B occurred in a galaxy that was relatively nearby ( $z=0.356$ ), so its afterglow could be monitored for at least 1 month. Tanvir et al. (2013) obtained two sets of follow-up observations of the burst region with the Hubble Space Telescope as well as additional ground-based observations. There was an excess of near-infrared (NIR) radiation in the first set of HST observations as compared to the second set of HST observations. This NIR radiation excess was consistent with theory, which suggests that mergers result in a kilonova. A kilonova is ~1000 times as energetic as a nova, but only 1/100 to 1/10 as bright as a supernova. With so many neutrons involved in the merger, there is the creation of r-process radioactive elements. The large amount of ejected material re-radiates the optical photons in the NIR. In the HST images the NIR emission is from "a compact transient source." This is the first time that follow-up observations have been adequate enough to verify the theory that short-duration GRB's are due to the merger two neutron stars (N-N), or a neutron star and a black hole (N-BH). The determination of whether the merger is N-N or N-BH can be made via the detection of gravity waves emitted during the merger process. However, existing gravity waves detectors (e.g., LIGO) are not sensitive enough to observe either of these events.

For more information see: <http://www.universetoday.com/103940/whats-a-kilonova-youre-looking-at-it/>, [http://en.wikipedia.org/wiki/Gamma-ray\\_burst#Long\\_gamma-ray\\_bursts](http://en.wikipedia.org/wiki/Gamma-ray_burst#Long_gamma-ray_bursts), [http://swift.gsfc.nasa.gov/about\\_swift/](http://swift.gsfc.nasa.gov/about_swift/) and <http://www.nature.com/nature/journal/vnfv/ncurrent/full/nature12505.html>

**Header Image:** Artist's illustration of the Swift observatory detecting a Gamma-Ray Burst. Credit: Spectrum and NASA E/PO, Sonoma State University, Aurore Simonnet

# Calendar of Events

## August 10, 8:30pm

**What:** The Lives of Stars  
**Who:** Dr. Ken Crowell, Astronomer and Author  
**Where:** Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area  
**Cost:** Free

The stars that speckle the sky have long fascinated humanity, but only in the past century have astronomers figured out how stars are born, live, and die and which stars might have planets with intelligent life.

For more information see: <http://www.mttam.net/astronomy/schedule.html>

## August 11, 7:30pm-10:30pm

**What:** Member Telescope Viewing  
**Who:** EAS and you  
**Where:** Chabot Space and Science Center, Space Cafe, 10000 Skyline Blvd., Oakland, CA 94619  
**Cost:** Free member admission. RSVP required. Space is limited and by reservation only, so call (510) 336-7392.

Each Sunday preceding the 1st quarter moon, the Eastbay Astronomical Society invites you to a special private telescope viewing. Unlike our regular viewing on Friday and Saturday evenings, EAS personalizes the experience by taking viewing requests, live interaction, and hosting tours and it's exclusively for our members!

See <http://www.chabot.space.org/events.htm> for more information.

## August 13, Noon-1:00pm

**What:** Spectroscopic Monitoring of Pluto's Volatile Ices  
**Who:** Will Grundy, Lowell Observatory  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Dr. Grundy will describe (in layman's terms) the implications of Pluto's near-infrared reflectance spectrum, which shows characteristic vibration absorptions of CH<sub>4</sub>, N<sub>2</sub>, and CO condensed ices on Pluto's surface. Long term monitoring of Pluto's spectrum from 1995 through present provides constraints on the evolution of these ices driven by seasonal volatile transport cycles. However, seasonal trends must be disentangled from spectral changes caused by continually changing viewing geometry coupled with the heterogeneous regional distributions of Pluto's ices.

Dr. Grundy is a team member on the RALPH instrument on-board New Horizons and he will give the latest news on observations of Pluto before the upcoming encounter in 2016.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

## August 16, Noon-1:00pm

**What:** Thermal History of Planetary Objects: From Asteroids to Super-Earths, From Plate Tectonics to Life  
**Who:** Tilman Spohn, Director of the Institute for Planetary Research at DLR, Berlin  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Convection in the interiors of planetesimals (asteroids), plan-

### **Officers**

#### **President:**

Chuck Grant  
[cg@fx4m.com](mailto:cg@fx4m.com)  
925-422-7278

#### **Vice-President:**

#### **Treasurer:**

David Feindel  
[feindel1@comcast.net](mailto:feindel1@comcast.net)

#### **Secretary:**

Jill Evanko

### **Volunteer Positions**

#### **Librarian:**

Jim Alves  
[ajaengr@yahoo.com](mailto:ajaengr@yahoo.com)  
209-833-9623

#### **Newsletter Editor:**

Ken Sperber  
[sperbs13@yahoo.com](mailto:sperbs13@yahoo.com)  
925-361-7435

#### **Program Director:**

#### **Loaner Scope Manager:**

John Swenson  
[johnswenson1@comcast.net](mailto:johnswenson1@comcast.net)

#### **Webmaster:**

Hilary Jones  
[hdjones@pacbell.net](mailto:hdjones@pacbell.net)

#### **Observatory Director/**

**Key Master:**  
Chuck Grant

### **Public Star Party Chair:**

Wayne Miller  
[starpartytvs@gmail.com](mailto:starpartytvs@gmail.com)

### **AANC Representative:**

Todd Billeci  
[todd129@yahoo.com](mailto:todd129@yahoo.com)  
650-593-2665

### **Historian:**

unfilled

### **Mentor:**

Mike Rushford  
[rushford@eyes-on-the-skies.org](mailto:rushford@eyes-on-the-skies.org)

### **Refreshment Coordinator:**

Laurie Grefsheim

### **Web & E-mail**

[www.trivalleystargazers.org](http://www.trivalleystargazers.org)  
[tvs@trivalleystargazers.org](mailto:tvs@trivalleystargazers.org)

### **Eyes on the Skies**

Eyes on the Skies is a robotic solar telescope run by Mike Rushford ([rushford@eyes-on-the-skies.org](mailto:rushford@eyes-on-the-skies.org)). You may access it by visiting [www.eyes-on-the-skies.org](http://www.eyes-on-the-skies.org).

### **TVS E-Group**

So how do you join the TVS e-group, you ask? Just send an e-mail message to the TVS e-mail address ([trivalleystargazers@gmail.com](mailto:trivalleystargazers@gmail.com)) asking to join the group. Make sure you specify the e-mail address you want to use to read and post to the group.

## Calendar of Events (continued)

ets, and satellites is driving the thermal and chemical evolution of these bodies including the generation of possible magnetic fields. The wide size range induces a wide range of time scales from hundreds of thousands of years for small planetesimals to a few tens of Gigayears for massive super-Earths.

Dr. Spohn will present a model that includes mantle convection, mantle water vapor degassing at mid-oceanic ridges and regassing through subduction zones, continental crust formation and erosion and water storage and transport in a porous oceanic crust that includes hydrous mineral phases.

Dr. Spohn will show how an abiotic world is predicted to have a much drier mantle than the present Earth but may have a similar surface coverage by continents. The reduced rate of continental crust production on the abiotic world would be balanced by a reduced rate of continent erosion. He will suggest that through the effect of water on the mantle rheology, the biotic world would tend to be tectonically more active and have a more rapid long-term carbon-silicate cycle.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

### August 17, 11:00am

**What:** How Many Planets are Out There?  
**Who:** Prof. Gibor Basri, UC Berkeley  
**Where:** UC Berkeley, Dwinelle Hall 145  
**Cost:** Free, limited hourly pay parking on/nearby campus. The venue is within walking distance of BART and bus lines.

Four years ago a dedicated space telescope (“Kepler”) was launched to search for terrestrial planets around other stars, and even possibly discover a planet that might be like the Earth. The main purpose of the mission is to find out how common planets are out to the distance we are from our Sun. I explain how the mission works, and highlight some of its most amazing discoveries. Nearly 3000 potential planets have been found, including many in multiple planet systems. The most common planet may be something that we don’t have in our own Solar System: “super-Earths” which are 1.5-3 times as big as our planet. Some of these may be rocky, some may be “water worlds”, and some may be more like warm Neptunes. The Kepler mission is rapidly leading us to the conclusion that most stars have planets going around them, and the number of earth-sized planets in our Galaxy is probably in the billions.

Gibor Basri has been a faculty member of the Astronomy department at UC Berkeley for 30 years. He is best known for his pioneering work on brown dwarfs. He produced a number of first discoveries on these “cosmic missing links” between stars and planets. He helped define their relation to stars and used them to inform the debate on “what is a planet?”. Another

major area of research has been star and planet formation, including the magnetic interface between newly forming stars and their surrounding protoplanetary disks. Prof. Basri has extensively studied the role of magnetism in the history of solar-type and low-mass stars. He is now a Co-Investigator on NASA’s Kepler exoplanet mission, which enables unprecedented detail on starspots and other magnetic activity for large numbers of stars. In addition to astrophysics, Prof. Basri has always worked to increase the participation of minorities in science, and is the founding Vice Chancellor for Equity and Inclusion at UC Berkeley.

For more information see: <http://scienceatcal.berkeley.edu/lectures>

### August 20, Noon-1:00pm

**What:** Ocean Surfaces on Snowball Earth  
**Who:** Steve Warren, University of Washington  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Dr. Warren will discuss the Snowball Earth events in Earth history, when the ocean apparently froze all the way to the Equator. These events were qualitatively different from the recent ice ages of the Pleistocene, in which ice sheets advanced over large parts of the northern continents. On Snowball Earth, by contrast, Warren will argue that most of the action was in the ocean.

Dr. Warren will discuss recent fieldwork in Antarctica near the Allen Hills. On the equatorial ocean of Snowball Earth, climate models predict thick ice, or thin ice, or open water, depending largely on their albedo parameterizations; the measured albedos appear to be within the range that favors ice hundreds of meters thick.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

### August 27, Noon-1:00pm

**What:** Breaking the Seeing Barrier for Planetary Astronomy  
**Who:** Franck Marchis, SETI Institute  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

When Galileo Galilei pointed his telescope toward Jupiter in 1609 and discovered what we now call the Galilean moons, he did not realize that he had just established a new research field in astronomy. In the past four centuries, planetary astronomy, the study of our solar system bodies using telescopes, has increased our knowledge of the environment of Earth, the evolution of the planets, the origin of comets and asteroids and the formation of our solar system. Space ex-

## Calendar of Events (continued)

ploration accelerated planetary astronomy in the 1960s by allowing planetary scientists to access in-situ and detailed data. In this talk, I will discuss the contributions of telescopic observation over the past 50 years to planetary science, particularly the recent developments like adaptive optics which renewed interest in ground-based observations of planets. I will explore the contribution of all-sky surveys like Pan-STARRS and LSST, which provide several terabytes of data a week, changing radically the way we do astronomy. Looking to the future of space-based astronomy, I will consider whether the James Webb Space Telescope and ATLAST are potential successors to the successful Hubble Space Telescope. Finally I'll explore the way in which specialized low-cost telescopes designed to search and study exoplanets, planets around other stars, constitute a paradigm shift in our field.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

### September 3, Noon-1:00pm

**What:** Marine microbial mats and our early biosphere  
**Who:** David Des Marais, NASA Ames Research Center  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Photosynthetic microbial mats are complete microbial ecosystems that can construct laminated "miniature reefs" called stromatolites. Their fossilized equivalents are among the oldest most abundant evidence of early life. Dr. Des Marais will show how the mats' oxygenated zone reflects a dynamic balance between vigorous photosynthetic O<sub>2</sub> production and O<sub>2</sub> consumption by diverse sulfide-oxidizing and heterotrophic bacteria.

He will show how several previously unknown rRNA gene sequences of bacteria and eukarya were identified, indicating that these mats can extend our understanding of the diversity and early evolution of benthic microbial communities. He continues to catalog the diversity of lipid biosignatures, whose fossil equivalents can record the diversity of ancient microbial ecosystems.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

### September 7, 7:30pm

**What:** From Earth to Mars  
**Who:** Dr. Pascal Lee, Mars Institute  
**Where:** Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area  
**Cost:** Free

The first human mission to Mars will be humanity's great-

est undertaking in space exploration in the 21st century. As with all expeditions, its success will depend on planning and first steps towards the journey are already under way.

For more information see: <http://www.mttam.net/astronomy/schedule.html>

### September 9, 7:30pm

**What:** The Chelyabinsk Meteor: A Cosmic Wake-up Call?  
**Who:** David Morrison, Senior Scientist, NASA Lunar Science Institute  
**Where:** California Academy of Science, 55 Music Concourse Dr., Golden Gate Park, San Francisco, CA  
**Cost:** General \$12, Seniors \$10, Academy members \$8. Reserve a space online or call 1-877-227-1831.

What would happen if a large sized asteroid or space object collided with the Earth? On February 15 2013, a rocky projectile entered the Earth's atmosphere traveling at more than 11 miles per second. It was about 65 feet in diameter, or half the diameter of the famous Tunguska impact of 1908, which flattened a thousand square miles of Siberian forest. Its terminal explosion, at an altitude of 14 mi, released energy of about half a megaton, equivalent to a couple dozen Hiroshima-sized atom bombs. About two minutes later, the shock wave reached the ground in Chelyabinsk Russia, breaking windows and injuring about 1500 people from flying glass. The Chelyabinsk impactor was smaller than most asteroids that have been detected by the telescopes of the NASA Spaceguard Survey, which focuses on finding asteroids of about 100m or larger. Since it approached the Earth from very near the direction of the Sun, it could not have been seen by any ground-based optical telescope of any size. It therefore struck without warning. Has this event served as a kind of cosmic wake-up call for planetary defense? NASA scientist David Morrison will speak to us about how we survey space to try to determine when Earth will be impacted by a large space object, and what the potential implications could be for life on Earth.

See <http://www.calacademy.org/events/lectures/> for lecture and reservation information.

### September 10, Noon-1:00pm

**What:** To The Asteroids - and Beyond!  
**Who:** John Lewis, Professor Emeritus U. Arizona LPL  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Tsiolkovskii and Goddard dreamed of the day when we would have access to the resources of the asteroids. Today, with an enormous and rapidly growing body of data on meteorites, the Near-Earth Asteroids (NEAs) and their more distant counterparts, we can envision the propulsion

## What's Up by Ken Sperber (adapted from S&T and The Year in Space)

All times Pacific Daylight Time.

### August

- 3 Sat Jupiter to the lower left of the crescent Moon (Dawn)
- 6 Tue **New Moon (2:51pm)**
- 9 Fri Crescent Moon below Venus low in the west (half hour after sunset)
- 11-13 Sun- The Perseid meteor shower peaks the nights of 11-12, and 12-13; best after midnight. See p.50 August S&T
- 14 Wed **First-Quarter Moon (3:56am)**
- 16-17 Fri- TVS Yosemite Star Party. Interested parties should contact Bob McKoon (rmckoon"at"yahoo.com)
- 17-20 Sat- Pollux and Castor to the upper left of Mars (Dawn)
- 20 Tue **Full Moon (6:45pm)**
- 28 Wed **Last-Quarter Moon (2:35am)**
- 31 Sat Jupiter to left of crescent Moon (Dawn)

### September

- 3-17 Tue- Zodiacal Light visible in the east beginning ~2 hours before dawn
- 5 Thu **New Moon (4:36am)**
- 8 Sun Venus close to the crescent Moon, with Spica and Saturn nearby (Dusk)
- 8-9 Sun- Mars passes through M44, the Beehive Cluster (Predawn, see p.52 September S&T)
- 9 Mon Saturn and Venus to the right of the Moon (Dusk; see p.49 September S&T)
- 12 Thu **First-Quarter Moon (10:08am)**
- 16-19 Mon- Saturn less than 4 degrees from Venus
- 19 Thu **Full Moon (4:13am)**

## Calendar of Events (continued)

systems, transportation system architectures, ores, processing schemes and markets for products made from materials sourced in nearby space. Most of these products are of greatest value and significance in space; some, such as platinum-group metals and energy, would be worth returning to Earth. The resources of the NEAs also provide the propellants and structural materials for a broad expansion of human presence in space. This talk will survey the what, where, how and why of space resource utilization-- and raise the timely question of when.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.

### September 17, Noon-1:00pm

What: Mapping the Surface of a Rocky Extrasolar Planet: Kepler-10b  
Who: Jason Rowe, SETI Institute  
Where: SETI Headquarters, 189 N. Bernardo Ave.,

Mountain View, CA

Cost: Free

Kepler-10b is a terrestrial planet orbiting its host star every 20 hours. At semi-major axis of 0.017 AU the planetary surface receives a massive amount of flux that heats to approximately 2000 K. The Kepler photometer with its broadband filter can detect thermal emission from the planet and an occultation with a depth of 8 parts-per-million has been clearly detected. We also confirm the detection of a phase curve with a shape dominated by the day-night cycle of the planet. There is also significant asymmetry present. We present our interpretation of the asymmetry through thermal and reflection models of the planetary surface and present a surface brightness map of a rocky extrasolar planet.

For more information see: <http://www.seti.org/csc/lectures>, e-mail [info@seti.org](mailto:info@seti.org), or phone 650-961-6633.



## Inventing Astrophotography: Capturing Light Over Time

By Dr. Ethan Siegel

We know that it's a vast Universe out there, with our Milky Way representing just one drop in a cosmic ocean filled with hundreds of billions of galaxies. Yet if you've ever looked through a telescope with your own eyes, unless that telescope was many feet in diameter, you've probably never seen a galaxy's spiral structure for yourself. In fact, the very closest large galaxy to us--Andromeda, M31--wasn't discovered to be a spiral until 1888, despite being clearly visible to the naked eye! This crucial discovery wasn't made at one of the world's great observatories, with a world-class telescope, or even by a professional astronomer; it was made by a humble amateur to whom we all owe a great scientific debt.

Beginning in 1845, with the unveiling of Lord Rosse's 6-foot (1.8 m) aperture telescope, several of the nebulae catalogued by Messier, Herschel and others were discovered to contain an internal spiral structure. The extreme light-gathering power afforded by this new telescope allowed us, for the first time, to see these hitherto undiscovered cosmic constructions. But there was another possible path to such a discovery: rather than collecting vast amounts of light through a giant aperture, you could collect it over time, through the newly developed technology of photography. During the latter half of the 19th Century, the application of photogra-

phy to astronomy allowed us to better understand the Sun's corona, the spectra of stars, and to discover stellar and nebulous features too faint to be seen with the human eye.

Working initially with a 7-inch refractor that was later upgraded to a 20-inch reflector, amateur astronomer Isaac Roberts pioneered a number of astrophotography techniques in the early 1880s, including "piggybacking," where his camera/lens system was attached to a larger, equatorially-mounted guide scope, allowing for longer exposure times than ever before. By mounting photographic plates directly at the reflector's prime focus, he was able to completely avoid the light-loss inherent with secondary mirrors. His first photographs were displayed in 1886, showing vast extensions to the known reaches of nebulosity in the Pleiades star cluster and the Orion Nebula.

But his greatest achievement was this 1888 photograph of the Great Nebula in Andromeda, which we now know to be the first-ever photograph of another galaxy, and the first spiral ever discovered that was oriented closer to edge-on (as opposed to face-on) with respect to us. Over a century later, Andromeda looks practically identical, a testament to the tremendous scales involved when considering galaxies. If you can photograph it, you'll see for yourself!

Astrophotography has come a long way, as apparent in the Space Place collection of NASA stars and galaxies posters at <http://spaceplace.nasa.gov/posters/#stars>



Caption: Great Nebula in Andromeda, the first-ever photograph of another galaxy. Image credit: Isaac Roberts, taken December 29, 1888, published in *A Selection of Photographs of Stars, Star-clusters and Nebulae*, Volume II, The Universal Press, London, 1899.

Tri-Valley Stargazers  
P.O. Box 2476  
Livermore, CA 94551



## PRIMEFOCUS

### Tri-Valley Stargazers Membership Application

Member agrees to hold Tri-Valley Stargazers, and any cooperating organizations or landowners, harmless from all claims of liability for any injury or loss sustained at a TVS function.

Name \_\_\_\_\_ Phone \_\_\_\_\_ e-mail \_\_\_\_\_

Address \_\_\_\_\_

Do not release my: \_\_\_\_\_ address, \_\_\_\_\_ phone, or \_\_\_\_\_ e-mail information to other TVS members.

- Membership category:
- \_\_\_\_\_ \$5 Student.
  - \_\_\_\_\_ \$30 Basic. You will receive e-mail notification when the PDF version of Prime Focus is available for download off the TVS web site.
  - \_\_\_\_\_ \$10 Hidden Hill Observatory (H2O) yearly access fee. You need to be a key holder to access the site.
  - \_\_\_\_\_ \$20 H2O key holder fee. (A refundable key deposit—key property of TVS).
  - \_\_\_\_\_ \$40 Patron Membership. Must be a member for at least a year and a key holder.
  - \_\_\_\_\_ \$34 One year subscription to Astronomy magazine.
  - \_\_\_\_\_ \$60 Two year subscription to Astronomy magazine.
  - \_\_\_\_\_ \$32.95 One year subscription to Sky & Telescope magazine. Note: Subscription to S&T is for new subscribers only. Existing subscribers please renew directly through S&T.
  - \$ \_\_\_\_\_ Tax deductible contribution to Tri-Valley Stargazers.
  - \$ \_\_\_\_\_ TOTAL – Return to: Tri-Valley Stargazers, P.O. Box 2476, Livermore, CA 94551

Membership information: Term is one calendar year, January through December. Student members must be less than 18 years old or still in high school.