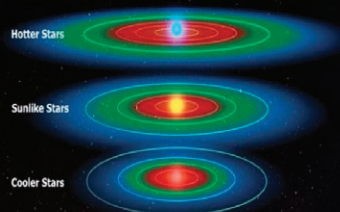


# PRIMEFOCUS

Tri-Valley Stargazers



May 2015



## Meeting Info

### What:

Beyond Kepler: Direct Imaging of Earth-like Exoplanets

### Who:

Dr. Ruslan Belikov, NASA Ames

### When:

May 15, 2015

Doors open at 7:00 p.m.

Meeting at 7:30 p.m.

Lecture at 8:00 p.m.

### Where:

Unitarian Universalist Church in Livermore  
1893 N. Vasco Road

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## May Meeting

### Beyond Kepler: Direct Imaging of Earth-like Exoplanets

#### Dr. Rus Belikov

Is there another Earth out there? Is there life on it? People have been asking these questions for over two thousand years, and we finally stand on the verge of answering them. The Kepler space telescope has already revealed that many stars have planets close to Earth size in regions close to their habitable zones. The next natural step after Kepler is spectroscopic characterization of exo-Earths, which would tell us whether they possess an atmosphere, oxygen, liquid water, as well as other biomarkers. In order to do this, directly imaging an exo-Earth may be necessary (at least for Sun-like stars and small planets).



Image Caption: Ames Center for Exoplanet Study (ACES): A Cross-disciplinary group advancing Exoplanet observations, theory, technology, and missions. Credit: NASA Ames

Directly imaging an exo-Earth is challenging and may require a 4m flagship-size optical space telescope with a high contrast imaging system (a coronagraph or starshade) capable of achieving contrasts of  $1e10$  very close to the diffraction limit. Such a telescope will probably not be launched until the 2030s. On the path towards that mission, NASA may launch smaller missions, ranging from Explorer class to coronagraphic instruments on a 2.4m telescope. In addition, if there were an "Earth" around Alpha Centauri (the closest star system to the Sun), it might be possible to detect and take its spectrum with a telescope as small as  $\sim 25$ cm. The Ames Coronagraph Experiment group at NASA Ames has been successfully maturing high contrast imaging technologies and mission concepts, which I will describe in my talk.

Ruslan Belikov has been active in the field of exoplanets since 2005, after graduating from Princeton and Stanford Universities. He is currently the lead of the Ames Coronagraph Experiment (ACE) research group at NASA Ames which has been pushing the state of the art and developing technologies for direct imaging of exoplanets, especially potentially habitable ones. Belikov is the principal investigator for the Alpha Centauri Exoplanet Satellite (ACESat) mission concept capable of directly imaging Earth-like planets around Alpha Centauri; a member of the WFIRST-AFTA mission as well as the EXCEDE and Exo-C mission concepts; and a member of the executive committee for NASA's Exoplanet Program Analysis Group (ExoPAG). He has over 100 publications, 2 patents, and his work was featured on Gizmodo, Future Talk TV, and other news outlets. He has also recently received the "Outstanding Early Career Space Scientist" award from NASA Ames.

## News & Notes

### 2015 TVS Meeting Dates

The following lists the TVS meeting dates for 2015. 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
May 15	May 18	
Jun. 19	Jun. 22	May 29
Jul. 17	Jul. 20	Jun. 26
Aug. 21	Aug. 24	Jul. 31
Sep. 18	Sep. 21	Aug. 28
Oct. 16	Oct. 19	Sep. 25
Nov. 20	Nov. 23	Oct. 30
Dec. 18	Dec. 21	Nov. 27

### Money Matters

As of April 20 the TVS checking account balance is \$14,591.00.

### H2O: New Picnic Table!

The TVS board authorized funds to purchase a new picnic table for H2O. Roland Albers gave of his time, and shopped around, obtaining a new 6ft. x 4ft. 9in. table for \$130 + tax from Costco (half the cost of the same table on Amazon.com). The table is made of high density polyethylene that is water-proof and stain resistant. I look forward to eating dinner on a flat table, rather than the warped, sun-beaten, splintered table that has been at H2O for 20+ years. Thanks, Roland!

### TVS Yosemite Star Party: July 17-18

Bob McKoon will be coordinating this year's TVS star party at Glacier Point, Yosemite National Park. We were lucky in drawing the nearly-new Moon weekend of July 17-18. TVS members who bring telescopes for public observing will receive free camping at the Bridalveil campgrounds. The Moon, with ~6% of the disk visible, will set by 10pm. On these dates sunset occurs at about 8:25pm with sunrise at about 6:00am. Contact Bob for more information (rmckoon"at"yahoo.com).

### TVS Tesla Winery Star Parties: June 20, September 19, and October 17

TVS will hold numerous star parties at Tesla Vintners in Livermore! Tesla Vintners is located on Tesla Road near Mines Road, and it has reasonably dark skies overhead and to the south, considering its urban location. The winery is private property, and we are the guests of Steve Powell, the owner. *This star parties are only open to current club members and their guests.*

The winery has two entrances. The main entrance is likely to be closed, so plan on using the unmarked delivery entrance, the one closer to Mines Road. The winery has a large parking area in the middle of the grounds plus a large open field in

the back. We are welcome to use both, but lights from the Wente winery to the east can be a problem in the back. The winery also has a bathroom which we will be able to use. The star party will run through midnight.

### TVS H2O Open House: August 8

TVS Open House at H2O on Saturday, August 8. Interested club members, especially those who have paid a key deposit but have not yet completed an orientation visit, are encouraged to attend. We will meet at the corner of Mines Rd. and Tesla Rd., and depart to H2O at 6:30pm in a caravan led by Chuck Grant. Admission is \$3/car; please bring the exact amount. The site is primitive, with 2 pit toilets, and no running water. Bring warm clothes, and food and water for the evening. Use a flashlight with a red filter so that people's dark adaptation is not ruined by white light. Check the TVS website for the latest information.

## Calendar of Events

### May 12, 12:00pm

What: Lakes, Fans, Deltas, and Streams: The History of Gale Crater, Mars  
Who: Marisa Palucis, UCB  
Where: SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
Cost: Free

It has been proposed that in Gale Crater, where the Curiosity rover landed in August 2012, lakes developed to various depths after the large central mound (informally referred to as Mt. Sharp) had evolved to a form close to its current topography. Using a combination of CTX and HiRISE imagery and CTX, HiRISE, and HRSC topography, we have documented a sequence of rising and falling lake levels, thereby providing a possible relative timeline of the hydrologic events within Gale Crater. Assuming that the entrance canyon deposits (the canyon which the Curiosity rover will ascend once it reaches Mt. Sharp) record a back-stepping sequence of fans and deltas, then a corresponding hydrologic sequence is suggested. After the formation of a gilbert-type delta exiting an 84-km long incised valley (Farah Vallis) that drains 270,000 km<sup>2</sup> to the south of Gale, and a corresponding lake with an average depth of 700 meters, the inflow of water from Farah Vallis fell or ceased. The lake level dropped considerably, to an elevation at least below the entrance canyon deposits. At a later time, local precipitation drove gully erosion of the Gale rim, and amplified by renewed Farah Vallis runoff, caused a rising

Header Image: The illustration shows the habitable zone for different types of stars. The distance to the habitable zone is dependent on how big and bright the star is. The green area is the habitable zone, where liquid water can exist on a planet's surface. The red area is too hot for liquid water on the planetary surface and the blue area is too cold for liquid water on the planetary surface. Credit: NASA, Kepler

## Calendar of Events (continued)

lake level that produced deltas on the western rim of Gale and the entrance canyon deposits on Mt. Sharp. This hydrologic system shut down sufficiently abruptly that the deltas did not cut down as the lake evaporated. The time gap between these two lake-forming events, perhaps driven by different hydrologic systems, is not yet established. Fan deposition around Gale Crater, including the Peace Vallis fan near the rover's landing site, likely occurred after these large lakes disappeared. This has implications for understanding regional paleo-climates on Mars after the Noachian, as well as providing context for the geology and sedimentology along the Curiosity rover traverse.

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

### May 16, 11:00am

**What:** Journey to the Center of Earth  
**Who:** Dr. Raymond Jeanloz, UCB  
**Where:** UC Berkeley, Genetics and Plant Biology Building, Room 100 (northwest corner of campus)  
**Cost:** Free, limited hourly pay parking on/nearby campus. The venue is within walking distance of BART and bus lines.

Satellites, nuclear explosions and the ability to reproduce in the laboratory the extreme conditions at our planet's center are revealing what is inside our planet, how it is changing and why. We'll open the hood to look at how Spaceship Earth works.

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

### May 19, 12:00pm

**What:** Geology before Pluto: Pre-encounter Considerations  
**Who:** Jeff Moore, NASA Ames  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA

**Cost:** Free

Jeff Moore will give a pre-encounter view of our expectations for the New Horizons flyby of Pluto.

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

### May 22, June 19, July 24, 8:30-10:30pm

**What:** Summer in Space Movie Series  
**Who:** You at the Outdoor Amphitheater  
**Where:** Chabot Space and Science Center, 10000 Skyline Blvd., Oakland, CA 94619

**Cost:** \$10 (does not include general admission)

Grab some popcorn and join us in our outdoor amphitheater as we celebrate classic science fiction films from the 1950's and 1960's. Inspired by comic books, these family-friendly films sparked the world's interest in interstellar travel, aliens and otherworldly terrains.

May 22: "The Phantom Planet"

June 19: "Radar Men From the Moon"

July 24: "Flash Gordon Conquers the Universe"

See <http://www.chabotspace.org/events.htm> for more information, or call (510) 336-7373.

### May 23, 8:30pm

**What:** What Wonderful Worlds: Exploring our Solar System  
**Who:** Dr. Imke de Pater, UCB, Chair Astronomy Dept.  
**Where:** Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area  
**Cost:** Free

Our knowledge about our own Solar System has increased by leaps and bounds over the past few decades due to a com-

continued on page 4

#### **Officers**

**President:**  
Chuck Grant  
[president@trivalleystargazers.org](mailto:president@trivalleystargazers.org)  
925-422-7278

**Vice-President:**  
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[vice\\_president@trivalleystargazers.org](mailto:vice_president@trivalleystargazers.org)

**Treasurer:**  
Roland Albers  
[treasurer@trivalleystargazers.org](mailto:treasurer@trivalleystargazers.org)

**Secretary:**  
Jill Evanko  
[secretary@trivalleystargazers.org](mailto:secretary@trivalleystargazers.org)

#### **Volunteer Positions**

**AANC Representative:**  
unfilled

**Astronomical League Representative:**  
Dennis Beckley  
[alrep@trivalleystargazers.org](mailto:alrep@trivalleystargazers.org)

**Historian:**  
Hilary Jones  
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**Loaner Scope Manager:**  
John Swenson  
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**Newsletter Editor:**  
Ken Sperber  
[newsletter@trivalleystargazers.org](mailto:newsletter@trivalleystargazers.org)  
925-361-7435

#### **Observatory Director/**

**Key Master:**  
Chuck Grant  
[h2o@trivalleystargazers.org](mailto:h2o@trivalleystargazers.org)

**Program Director:**  
Rich Combs  
[programs@trivalleystargazers.org](mailto:programs@trivalleystargazers.org)

**Publicity Coordinator:**  
Andy Coutant  
[publicity@trivalleystargazers.org](mailto:publicity@trivalleystargazers.org)

**Refreshment Coordinator:**  
Laurie Grefsheim

**Star Party Coordinator:**  
Eric Dueltgen  
[coordinator@trivalleystargazers.org](mailto:coordinator@trivalleystargazers.org)

**Webmaster:**  
Hilary Jones  
[webmaster@trivalleystargazers.org](mailto:webmaster@trivalleystargazers.org)

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

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

bination of spacecraft missions and technical advancements on ground-based telescopes. Why do we explore our Solar System? I'll review the numerous bodies now known to orbit the Sun, and familiar to us as individual worlds. Learn more about impacts on Jupiter, volcanic activity on Io, and planetary rings.

For more information see: <http://www.friendsofmetam.org/astronomy/schedule>

### May 26, 12:00pm

**What:** Giant Planet Interiors Studied with *ab initio* Computer Simulations  
**Who:** Burkhard Militzer, UCB  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Dr. Militzer will briefly review the interior structure of different types of planets and discuss how it is affected by the miscibility of various planetary materials. Results from recent *ab initio* computer simulations will be presented that focus on the miscibility properties of hydrogen-helium mixtures in gas giant planets, hydrogen-water mixtures in ice giants, silicate-iron mixtures in the interiors of terrestrial planets.

Finally Dr. Militzer will discuss his recent model of Jupiter's interior that he and his team are putting together before NASA's Juno spacecraft inserts into orbit about this planet next year.

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

### June 2, 12:00pm

**What:** Atmospheric Tides and the Diurnal Cycle on Earth and other Terrestrial Planets  
**Who:** Curt Covey, LLNL  
**Where:** SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA  
**Cost:** Free

Abstract unavailable.

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

### June 6, July 3, 7:00pm

**What:** Lost in Space Adult Missions  
**Who:** Challenger Learning Center  
**Where:** Chabot Space and Science Center, 10000 Skyline Blvd., Oakland, CA 94619  
**Cost:** \$30, does not include general admission; RSVP recommended, space limited, register online or call (510) 336-7373

Just like our public missions for families, but this one is strictly

for adult flyers. Bring your friends and join an intrepid team to land on the red planet, construct a probe to send to one of the moons of Mars and save your crew from calamity. Grab your flight suit, strap on a helmet and experience the thrill and excitement of a NASA simulated space mission to Mars! Beer (provided by Federation Brewery), wine and light snacks will be provided.

See <http://www.chabot.space.org/events.htm> for more information, or call (510) 336-7373.

### June 8, 7:30pm

**What:** Exposing the Hidden Colors of the Infrared Universe  
**Who:** Robert Hurt, Visualization Scientist at NASA's Spitzer Space Science Center  
**Where:** California Academy of Science, 55 Music Concourse Dr., Golden Gate Park, San Francisco, CA  
**Cost:** Advanced ticketing required. Academy members \$8, Seniors \$10, General \$12. Reserve a space online or call 1-877-227-1831.

The Spitzer Space Telescope was launched into space in 2003 and has been studying everything from asteroids in our solar system to the most remote galaxies at the edge of the observable universe including taking pictures of the disk, or plane, of our Milky Way galaxy in infrared light. Our galaxy is a flat spiral disk; our solar system sits in the outer one-third of the Milky Way, in one of its spiral arms. When we look toward the center of our galaxy, we see a crowded, dusty region jam-packed with stars. Visible-light telescopes cannot look as far into this region because the amount of dust increases with distance, blocking visible starlight. Infrared light, however, travels through the dust and allows Spitzer to view past the galaxy's center.

In this talk, Robert Hurt will talk about the science legacy of NASA's Spitzer Space Telescope by explaining what hidden stories it has shed light upon over the past decade of operation. He spends much of his time rendering some of the most amazing astronomical datasets into images that everyone can view and to help understand what is going on in some of the most distant parts of the galaxy.

See [www.calacademy.org/events/benjamin-dean-astronomy-lectures](http://www.calacademy.org/events/benjamin-dean-astronomy-lectures) for lecture and reservation information.



Image Caption: Roland Albers took this image of NGC 2362, the Tau Canis Majoris Cluster. NGC 2362 is one of the youngest known open star clusters in the Milky Way, only 4 - 5 million years old. Most of the stars in the cluster are massive O and B stars, all of which are 1000-1500 times brighter than the Sun. He took this image with an AT6RC 6-inch f/9 astrograph and an unmodified Canon T3i DSLR. It is the result of combining 16 3-minute exposures at 800 ISO taken on March 26, 2015 from his backyard in Pleasanton.



Image Caption: Ron Kane took this photo of TVS club members setting up their telescopes at the inaugural Tesla Winery Star Party. As you can see, there is plenty of space to set up telescopes. This photo, taken toward the southeast, shows few structures in the distance, consistent with the sky being darkest in this general direction.

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

All times are Pacific Daylight Time.

### May

- 1-14 Fri- Mercury high above the west-northwest horizon, and to the lower right of Venus (about 1 hour after sunset)
- 11 Mon **Last-Quarter Moon (3:36am)**
- 17 Sun **New Moon (9:33pm)**
- 21 Thur Venus in Gemini, about 9 degrees to the upper right of the waxing crescent Moon (evening)
- 23 Sat Jupiter about 6 degrees north of the Moon, which sets at about midnight
- 25 Mon **First-Quarter Moon (10:19am)**
- 25 Mon Regulus about 5 degrees above the First-Quarter Moon
- 27 Wed Double shadow transit on Jupiter from 7:01pm-9:18pm
- 30 Sat The Moon draws closer to Spica all night long

### June

- 1 Mon Nearly Full Moon shines a few degrees away from Saturn in the southwest (dusk)
- 2 Tue **Full Moon (9:19am)**
- 3 Wed Double shadow transit on Jupiter (9:59-11:14pm)
- 9 Tue **Last-Quarter Moon (8:42am)**
- 13 Sat Jupiter and Venus 10 degrees apart, with M44 below Venus in the west (dusk)
- 16 Tue **New Moon (7:05am)**
- 19 Fri Venus and Jupiter below the crescent Moon (evening)
- 21 Sun Crescent Moon 5 degrees left of Regulus, with Jupiter and Venus to the lower right (evening)
- 24 Wed **First-Quarter Moon (4:02am)**
- 25 Thu Regulus about 5 degrees above the First-Quarter Moon
- 27- Sat- Venus and Jupiter less than 2 degrees apart, and closing, during the next week
- 28 Sun Saturn is about 2 degrees from the Moon
- 30 Tue Venus and Jupiter in conjunction, less than 1/3 degree apart



## Is the Most Massive Star Still Alive?

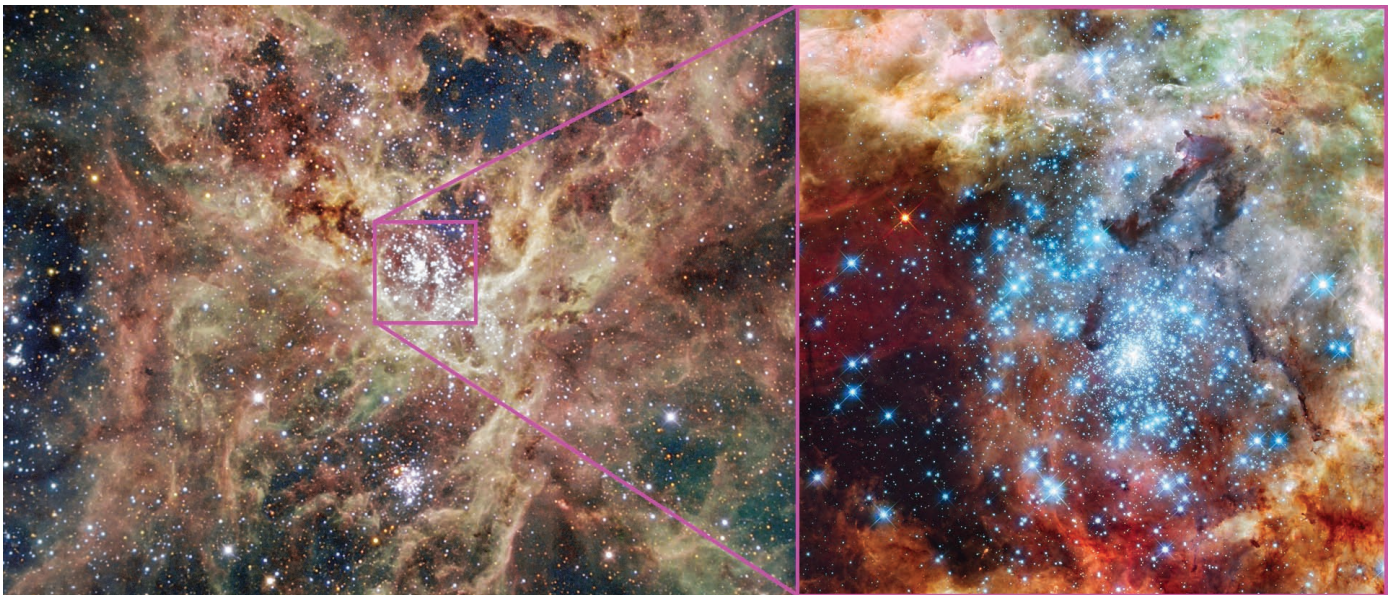
By Dr. Ethan Siegel

The brilliant specks of light twinkling in the night sky, with more and more visible under darker skies and with larger telescope apertures, each have their own story to tell. In general, a star's color correlates very well with its mass and its total lifetime, with the bluest stars representing the hottest, most massive and shortest-lived stars in the universe. Even though they contain the most fuel overall, their cores achieve incredibly high temperatures, meaning they burn through their fuel the fastest, in only a few million years instead of roughly ten billion, like our sun.

Because of this, it's only the youngest of all star clusters that contain the hottest, bluest stars, and so if we want to find the most massive stars in the universe, we have to look to the largest regions of space that are actively forming them right now. In our local group of galaxies, that region doesn't belong to the giants, the Milky Way or Andromeda, but to the Large Magellanic Cloud (LMC), a small, satellite galaxy (and fourth-largest in the local group) located 170,000 light years distant.

Despite containing only one percent of the mass of our galaxy, the LMC contains the Tarantula Nebula (30 Doradus), a star-forming nebula approximately 1,000 light years in size, or roughly seven percent of the galaxy itself. You'll have to be south of the Tropic of Cancer to observe it, but if you can locate it, its center contains the super star cluster NGC 2070, holding more than 500,000 unique stars, including many hundreds of spectacular, bright blue ones. With a maximum age of two million years, the stars in this cluster are some of the youngest and most massive ever found.

At the center of NGC 2070 is a very compact concentration of stars known as R136, which is responsible for most of the light illuminating the entire Tarantula Nebula. Consisting of no less than 72 O-class and Wolf-Rayet stars within just 20 arc seconds of one another, the most massive is R136a1, with 260 times the sun's mass and a luminosity that outshines us by a factor of seven million. Since the light has to travel 170,000 light years to reach us, it's quite possible that this star has already died in a spectacular supernova, and might not even exist any longer! The next time you get a good glimpse of the southern skies, look for the most massive star in the universe, and ponder that it might not even still be alive.



Images credit: ESO/IDA/Danish 1.5 m/R. Gendler, C. C. Thöne, C. Féron, and J.-E. Ovaldsen (L), of the giant star-forming Tarantula Nebula in the Large Magellanic Cloud; NASA, ESA, and E. Sabbi (ESA/STScI), with acknowledgment to R. O'Connell (University of Virginia) and the Wide Field Camera 3 Science Oversight Committee (R), of the central merging star cluster NGC 2070, containing the enormous R136a1 at the center.



Tri-Valley Stargazers  
P. O. Box 2476  
Livermore, CA 94551  
[www.trivalleystargazers.org](http://www.trivalleystargazers.org)

## Tri-Valley Stargazers Membership Application

(or apply for membership online: [www.trivalleystargazers.org/membership.shtml](http://www.trivalleystargazers.org/membership.shtml))

### Contact information:

Name: \_\_\_\_\_ Phone: \_\_\_\_\_

Street Address: \_\_\_\_\_

City, State, Zip: \_\_\_\_\_

Email Address: \_\_\_\_\_

Status (select one): \_\_\_\_\_ New member \_\_\_\_\_ Renewing or returning member

**Membership category** (select one): Membership term is for one calendar year, January through December.

\_\_\_\_\_ Student member (\$5). Must be a full-time high-school or college student.

\_\_\_\_\_ Regular member (\$30).

\_\_\_\_\_ Patron member (\$70). Patron membership grants use of the club's 17.5" reflector at H2O. You must be a member in good standing for at least one year, hold a key to H2O, and receive board approval.

**Hidden Hill Observatory Access** (optional):

\_\_\_\_\_ One-time key deposit (\$20). This is a refundable deposit for a key to H2O. New key holders must first hear an orientation lecture and sign a usage agreement form before using the observing site.

\_\_\_\_\_ Annual access fee (\$10). You must also be a key holder to access the site.

**Magazine Subscriptions** (optional): Discounted subscriptions are available only to new subscribers. All subsequent renewals are handled directly with the magazine publishers.

\_\_\_\_\_ One-year subscription to Sky & Telescope magazine (\$32.95).

\_\_\_\_\_ One-year subscription to Astronomy magazine (\$34).

**Donation** (optional):

\_\_\_\_\_ Tax-deductible contribution to Tri-Valley Stargazers

**Total enclosed:** \$ \_\_\_\_\_

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. TVS will not share information with anyone other than other club members and the Astronomical League without your express permission.

Mail this completed form along with a check to: Tri-Valley Stargazers, P.O. Box 2476, Livermore, CA 94551.