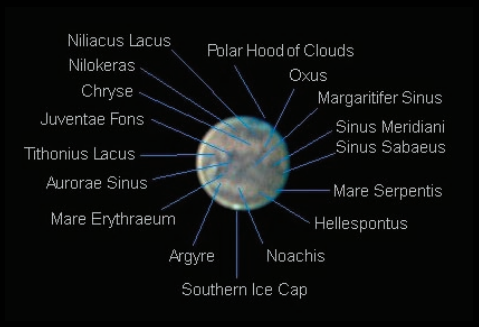
PRIMEFOCUS

Tri-Valley Stargazers



April 2016

TVS Tri-Valley Stargazers

Meeting Info

What:
Merging Galaxy Clusters, Dissections of the Cosmos

Who:
Dr. Will Dawson

When:
April 15, 2016
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

Inside

April Meeting

Merging Galaxy Clusters, Dissections of the Cosmos
Dr. Will Dawson

Galaxy clusters are the largest objects in the universe, containing hundreds to thousands of galaxies all gravitationally bound and orbiting one another. However, the majority of a galaxy cluster's mass is in the form of hot gas (13%) and dark matter (85%). Dark matter is a mysterious newly discovered form of matter that actually makes up the majority of the mass in our universe. When two galaxy clusters are close enough to one another they gravitationally accelerate towards each other and eventually collide. These collisions are the most energetic events since the Big Bang and provide unique dissections of the cosmos, as the galaxies, gas, and dark matter become dissociated during the merger. By comparing and contrasting the behavior of the mysterious dark matter with the well understood galaxies and gas we are beginning to shed new light on dark matter.

Will Dawson, a Research Scientist at Lawrence Livermore National Laboratory, received his Ph.D. in Physics from the University of California Davis, and his B.Sc. in Maritime Systems Engineering from Texas A&M University Galveston. He is playing a leading role in the Large Synoptic Survey Telescope Dark Energy Science Collaboration, with a focus using the correlated gravitational lensing signal contained in the images of faint distant galaxies to constrain the properties of dark energy. Before obtaining his Ph.D. from UC Davis, Will worked as a structural engineer for five years at Technip, an offshore oil engineering company based in Houston, TX.

Caption: This image of the galaxy cluster MACS J0025.4-1222 is a composite of images from the Hubble Space Telescope and the Chandra X-Ray observatory. Hot gas, seen in X-Rays, is pink, while the inferred distribution of Dark Matter is colored blue. Credit: www.digplanet.com/wiki/MACS_J0025.4-1222

News & Notes

2016 TVS Meeting Dates

The following lists the TVS meeting dates for 2016. 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**
Apr. 15	Apr. 18	
May 20	May 23	Apr. 29
Jun. 17	Jun. 20	May 27
Jul. 15	Jul. 18	Jun. 24
Aug. 19	Aug. 22	Jul. 29
Sep. 16	Sep. 19	Aug. 26
Oct. 21	Oct. 24	Sep. 30
Nov. 18	Nov. 21	Oct. 28
Dec. 16	Dec. 19	Nov. 25

Money Matters

As of the last Treasurer's Report on 3/21/16, our club's checking account balance is $13,430.28. Our new projector and projection screen arrived and debuted during last month's general meeting. The brighter image and larger screen make it easier for anyone throughout the room to follow and enjoy the presentations.

Club Star Parties

This year's club star parties will be held on:

Saturday 4/9/16: Tesla Winery Star Party

Saturday 5/28/16: H2O Open House

Saturday 6/25/16: Tesla Winery Star Party

Saturday 7/30/16: Tesla Winery Star Party

Saturday 8/27/16: H2O Open House

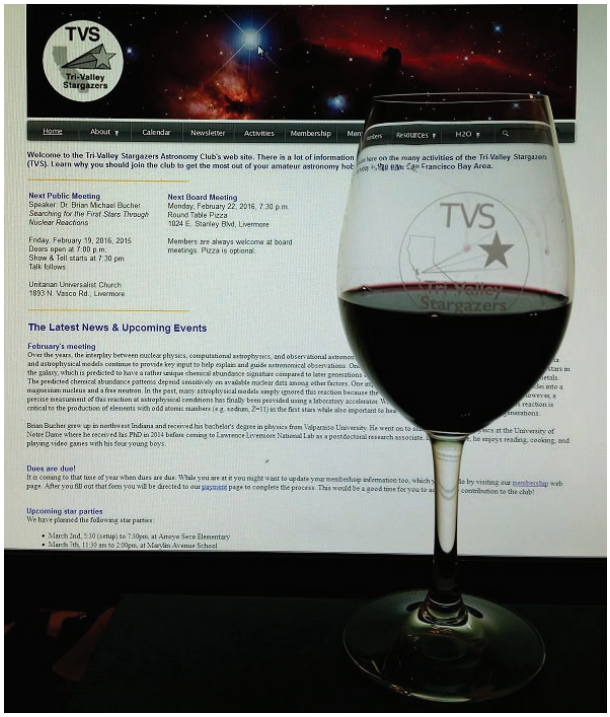
Saturday 9/24/16: Tesla Winery Star Party

The H2O Open Houses will be open to all club members and the pubic. The Tesla Winery Star Parties will be open to club members and their guests. Start and end times for the parties will be announced later, but we usually plan to arrive at the observing site about 30 minutes before sunset and wrap up around midnight. Mark your calendars now!

Our Tesla Winery Star Parties will have a new twist this year. For those wishing to participate, each party will have a theme and observing list associated with it. The theme of the April 9 star party will be a Messier Half-Marathon. Other suggestions include lunar features observing, planetary night, star cluster observing, beginner's night, and constellation identification. If you have an idea for another theme, please mention it to a board member during any meeting.

TVS Crystal Wine Glasses For Sale

TVS is offering elegant crystal wine glasses for sale to club members. You don't have to drink wine to enjoy the beautiful TVS logo-etched stemware. Use them for your favorite beverage, or they can be used as a beautiful container for small plants. They are the perfect gifts for loved ones or friends. Look for them at club meetings, where they will be sold for $10/each. Don't drink alone, buy two! Support TVS.



Calendar of Events

April 9, 8:00pm

What: Dark Matter
Who: Dr. Holger Muller, UC Berkeley
Where: Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area
Cost: Free

Multiple lines of astronomical evidence demonstrate the existence of dark matter and dark energy — mysterious stuff whose gravity holds galaxies together and drives the accelerated expansion of the universe. Precision measurements in physics are suitable for searching for ultralight dark-sector candidates.

For more information see: http://www.friendsofmttam.org/

Header Image: Mars as imaged by Ken Sperber on October 23, 2005 using a Takahashi FS-102 , a 5x Powermate barlow, and a ToUCam. Mars once again reaches opposition on May 21, 2016.

Calendar of Events (continued)

astronomy/schedule

April 12, 12:00pm

What: Orbital Dynamics Suggests A Recent Formation of Saturn's Moons
Who: Matija Cuk, SETI Institute
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

The age of Saturn's rings and the source of Enceladus's hydrothermal energy have been hotly debated topics for years. Recently the age of Saturn's moons interior to Titan, previously thought to be as old as Saturn, also became actively debated. I will show how computer simulations of the past orbital dynamics of Saturn's moons Tethys, Dione and Rhea can tell us how long they have been around. It appears that the inner moons and rings of Saturn are only about 100 million years, equivalent to the Cretaceous period on Earth. I will also discuss how the present moons likely originated from debris resulting from a major orbital instability in which the previous generation of icy moons was destroyed.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

April 16, 10:00am-5:00pm

What: Celebrate History at Chabot
Who: Chabot Staff
Where: Chabot Space and Science Center, 10000 Skyline Blvd., Oakland, CA 94619
Cost: $18 Adults, $15 Students and Seniors, and $14 Youth (3-12)

Happy Anniversary, Rachel! Come learn about our historic telescope, Rachel, on this exciting day at Chabot Space & Science Center. Rachel opened to the public in the spring of 1916 and has been showcasing the wonders of the night's sky to audiences ever since. Participate in hands-on activities by crafting your own take-home telescope, watch science demonstrations showing how telescopes work, take a docent-led tour of Rachel with one of our historical experts, look at historic photographs from our collection and much more!

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

April 20, 12:00pm

What: The Twisted Universe: The Cosmic Quest to Reveal Which End is Up
Who: Brian Keating, UC San Diego
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

The cosmic microwave background (CMB) has spectacularly advanced our understanding of the origin, composition, and evolution of our universe. Yet there is still much to glean from this, the oldest light in the universe. Powerful telescopes are plying the skies in a quest to discover new physics. This talk concentrates on measurements by cutting-edge CMB telescopes which offer a glimpse into an exhilarating, and largely unexplored branch of astrophysics: the search for unique signatures in the polarization of the CMB. Professor Keating will explain how the CMB can constrain phenomena such as primordial magnetism, elementary particle masses, and even the origin of the universe itself. Further phenomena, such as tantalizing bounds on parity-violating effects such as cosmic birefringence — the rotation of the polarization plane of cosmic photons — will be discussed. He will describe early attempts to measure cosmic parity violation using distant galaxies as well as state-of the-art measurements made by the POLARBEAR telescope, which he co-leads. He will close by previewing the upcoming Simons Array, an advanced array of three millimeter-wave CMB telescopes in the Atacama Desert of Northern Chile.

continued on page 4

Calendar of Events (continued)

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

April 26, 12:00pm

What: The SOFIA Observatory: Revealing the Hidden Universe with Airborne Science
Who: Pamela Marcum, NASA Ames Research Center
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

No details available.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

May 3, 12:00pm

What: When Will We Find Life Beyond Earth?
Who: Nathalie Cabrol, Seth Shostak, SETI Institute
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

Is this the generation that will discover extraterrestrial life? Some scientists have opined that we'll find other living beings – whether they be microbes on other planets or intelligent beings in another star system – within two decades. An energetic panel of SETI Institute astrobiologists will discuss why both science and technology give support to the idea that we may soon prove that Earth is not the only world where life has arisen.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633

May 9, 7:30pm

What: Pluto Matters
Who: Prof. Renu Malhotra, University of Arizona
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.

Our understanding of the history of the solar system has undergone a revolution in recent years, owing to new theoretical insights into the origin of Pluto and the discovery of the Kuiper Belt and its rich dynamical structure. The emerging picture is one of dramatic orbital migration of the planets in the early history of the solar system, driven by interaction with the primordial Kuiper Belt, which produced the final solar system architecture that we live in today. The evidence is all over the solar system, as close as the Moon and as far away as Pluto and the remnant Kuiper Belt. Dr. Malhotra will review this new view of our solar system's history, describe the astronomical evidence, and critically assess current theoretical models.

See www.calacademy.org/events/benjamin-dean-astronomy-lectures for lecture and reservation information.

May 10, 12:00pm

What: Climate Simulations of Pluto in the Wake of the New Horizons Flyby
Who: Angela Zalucha, SETI Institute
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

No details available.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

May14, 8:30pm

What: Searching for life in Ocean Worlds of the Outer Solar System
Who: Dr. Chris McKay, NASA Ames Research Center
Where: Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area
Cost: Free

NASA's new program, "Ocean Worlds," focuses on the many oceans in the moons of the outer Solar System. Enceladus, Europa, and Titan are of particular interest. Where do we look, and how do we search for evidence of life?

For more information see: http://www.friendsofmttam.org/astronomy/schedule

May 17, 12:00pm

What: Charon: Pluto's Fascinating moon from New Horizons
Who: Ross Beyer, SETI Institute
Where: SETI Institute Colloquium, Microsoft Silicon Valley Campus (Galileo Room), 1065 La Avenida St., Mountain View, CA
Cost: Free

No details available.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

Member Photos

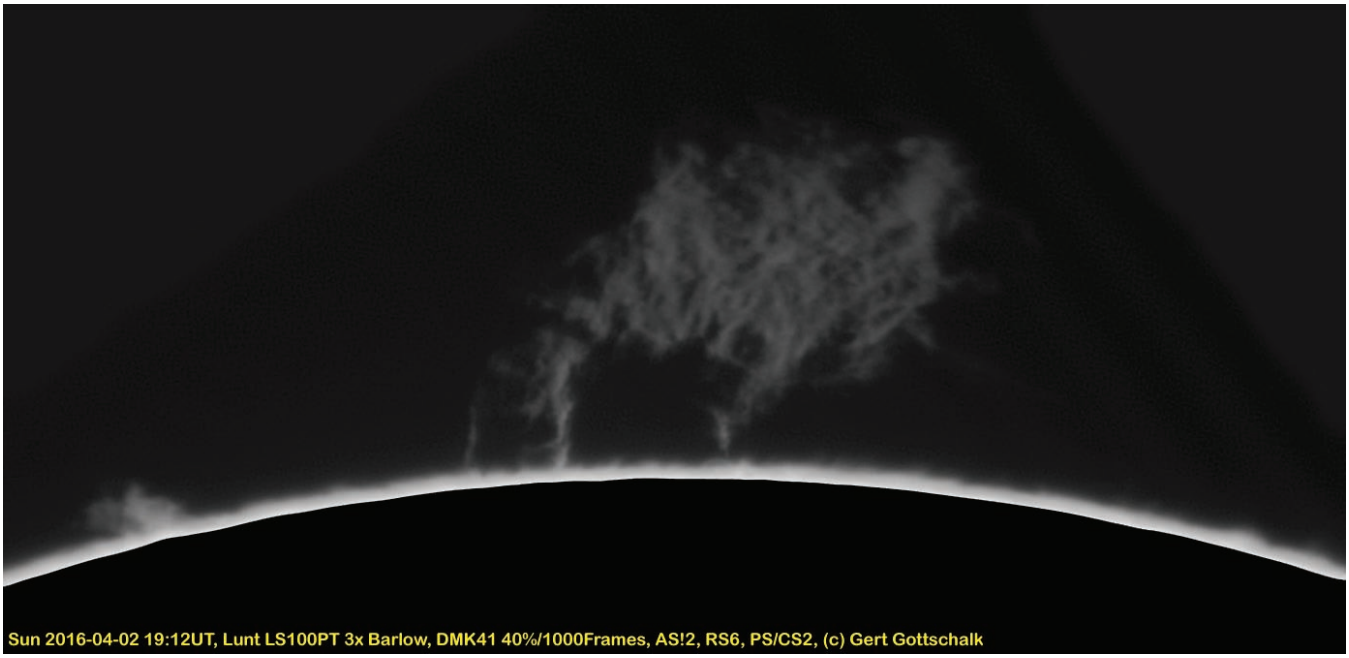


Image Caption: Gert Gottschalk used a Lunt LS100, a 3x barlow, and a DMK41 camera to capture the large prominence that adorned the Sun's edge on April 2, 2016. The exposures were adjusted for the prominences and the over exposed surface was blacked out.

Image Caption: Gert Gottschalk used a Lunt LS100, a 3x barlow, and a DMK41 camera to capture a pronounced sunspot on March 26, 2016.

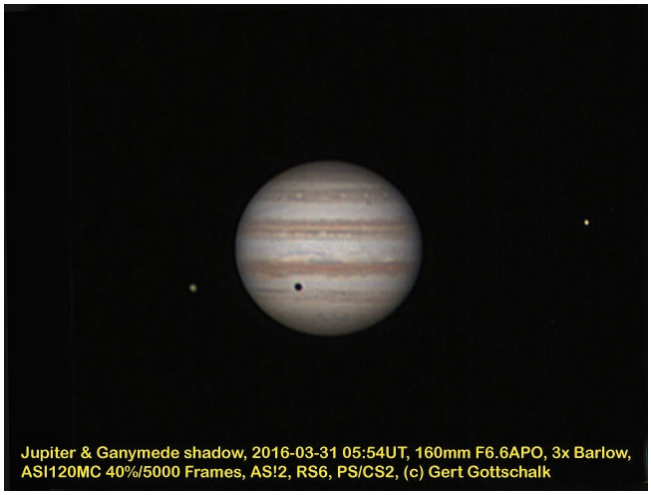


Image Caption: Gert Gottschalk imaged Ganymede (lower-left) casting its shadow on Jupiter on March 31, 2016. Europa is located to the right of Jupiter. Gert used a 160mm f/6.6 APO. a 3x barlow, and a ZWO120MC camera.

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

All times are Pacific Daylight Time.

April

7	Thu	New Moon (4:24am)
9-	Sat-	Mercury: best evening apparition of 2016 for the next 2 weeks (north-northwest after sunset)
10	Sun	Aldebaran occulted by the Moon, disappears behind dark limb at 2:21pm, reappears at 3:37pm
13	Wed	First-Quarter Moon (8:59pm)
16	Sat	The Moon is 3-4 degrees below Regulus (evening)
17	Sun	The Moon is about 3 degrees below Jupiter (evening)
20	Wed	The Moon is about 4-6 degrees above Spica
21	Thu	Full Moon (10:24pm)
21	Thu	Lyrid Meteor Shower peaks at about 11pm
24	Sun	The Moon forms an irregular quadrangle, about 10 degrees in size, with Saturn, Mars, and Antares
29	Fri	Last-Quarter Moon (8:29pm)

May

5	Thu	Eta Aquariid meteor shower (predawn; several mornings before and after the peak)
6	Fri	New Moon (12:29pm)
6	Fri	Double shadow transit on Jupiter (9:39-10:42pm)
7	Sat	Aldebaran 6 degrees to the upper-left of the crescent Moon (Evening)
9	Mon	Mercury transits the Sun (begins before sunrise; midpoint 7:58am, ends 11:42am; see p.48, May S&T)
13	Fri	First-Quarter Moon (10:02am)
13	Fri	The Moon is 3-4 degrees below Regulus (evening)
14	Sat	The Moon is about 4 degrees below Jupiter (evening)
21	Sat	Full Moon (2:14pm)
21	Sat	Mars reaches opposition, and is located about 7 degrees below the Moon
22	Sun	Saturn is about 4 degrees to the right of the Moon
29	Sun	Last-Quarter Moon (5:12am)
30	Mon	Mars is 0.5AU from Earth, the closest in 10.5 years, with a diameter of 18.6 arc seconds

Gravitational Wave Astronomy Will Be The Next Great Scientific Frontier

By Dr. Ethan Siegel

Imagine a world very different from our own: permanently shrouded in clouds, where the sky was never seen. Never had anyone see the Sun, the Moon, the stars or planets, until one night, a single bright object shone through. Imagine that you saw not only a bright point of light against a dark backdrop of sky, but that you could see a banded structure, a ringed system around it and perhaps even a bright satellite: a moon. That's the magnitude of what LIGO (the Laser Interferometer Gravitational-wave Observatory) saw, when it directly detected gravitational waves for the first time.

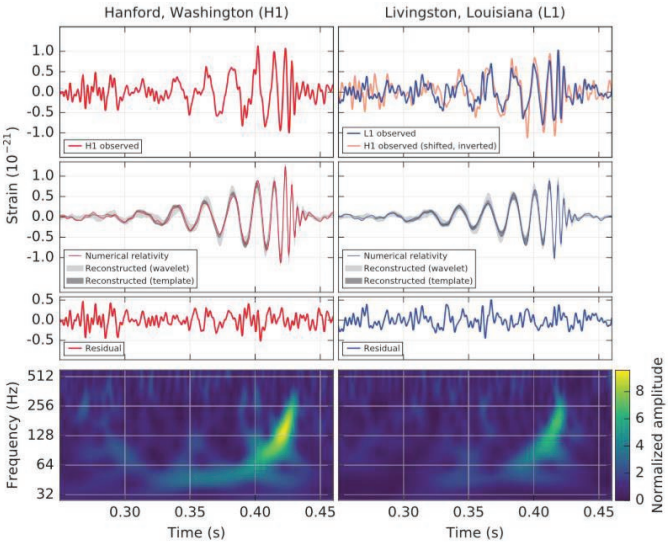


Image Credit: Observation of Gravitational Waves from a Binary Black Hole Merger B. P. Abbott et al., (LIGO Scientific Collaboration and Virgo Collaboration), Physical Review Letters 116, 061102 (2016). This figure shows the data (top panels) at the Washington and Louisiana LIGO stations, the predicted signal from Einstein's theory (middle panels), and the inferred signals (bottom panels). The signals matched perfectly in both detectors.

An unavoidable prediction of Einstein's General Relativity, gravitational waves emerge whenever a mass gets accelerated. For most systems -- like Earth orbiting the Sun -- the waves are so weak that it would take many times the age of the Universe to notice. But when very massive objects orbit at very short distances, the orbits decay noticeably and rapidly, producing potentially observable gravitational waves. Systems such as the binary pulsar PSR B1913+16 [the subtlety here is that binary pulsars may contain a single neutron star, so it's best to be specific], where two neutron stars orbit one another at very short distances, had previously shown this phenomenon of orbital decay, but gravitational waves had never been directly detected until now.

When a gravitational wave passes through an objects, it simultaneously stretches and compresses space along mutually perpendicular directions: first horizontally, then vertically, in an oscillating fashion. The LIGO detectors work by splitting a laser beam into perpendicular "arms," letting the beams reflect back and forth in each arm hundreds of times (for an effective path lengths of hundreds of km), and then recombining them at a photodetector. The interference pattern seen there will shift, predictably, if gravitational waves pass through and change the effective path lengths of the arms. Over a span of 20 milliseconds on September 14, 2015, both LIGO detectors (in Louisiana and Washington) saw identical stretching-and-compressing patterns. From that tiny amount of data, scientists were able to conclude that two black holes, of 36 and 29 solar masses apiece, merged together, emitting 5% of their total mass into gravitational wave energy, via Einstein's E = mc2.

During that event, more energy was emitted in gravitational waves than by all the stars in the observable Universe combined. The entire Earth was compressed by less than the width of a proton during this event, yet thanks to LIGO's incredible precision, we were able to detect it. At least a handful of these events are expected every year. In the future, different observatories, such as NANOGrav (which uses radiotelescopes to the delay caused by gravitational waves on pulsar radiation) and the space mission LISA will detect gravitational waves from supermassive black holes and many other sources. We've just seen our first event using a new type of astronomy, and can now test black holes and gravity like never before.

This article is provided by NASA Space Place. With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology. Visit spaceplace.nasa.gov to explore space and Earth science!

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

Tri-Valley Stargazers Membership Application

(or apply for membership online: *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 ($100). 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.