PRIMEFOCUS
Tri-Valley Stargazers

November 2009

Meeting Info:

What
Back to the Future: Modern Astronomy 1909, 2009, 2109

Who
Richard Combs

When
November 20 2009
Doors open at 7:00 p.m.
Lecture at 7:30 p.m.

Where
Unitarian Universalist Church in Livermore
1893 N. Vasco Road

Inside

November Meeting

Back to the Future: Modern Astronomy 1909, 2009, 2109
Richard Combs

The idea for this talk began when I came across a summary book on "modern astronomy", published in 1909. Reading it was like hopping into a time machine and showed me a perspective quite different from our present view of the universe. I have since sought out other books and papers published 100 years ago, to try and immerse myself in the perspective of astronomers of that time. Comparing the changes that have occurred since then until now, in 2009, gives us a chance to forecast the changes in perspective that might have resulted a 100 years from now, in 2109.

I look forward to sharing this "Back to the Future" adventure with members and guests of the TVS.

Rich Combs has been employed at the Lawrence Livermore National Laboratory for many years. Most recently he has been working on high power lasers, part of the inertial fusion effort. For many years he's been an active amateur astronomer. He conducts summer star parties, having hosted events last year at Yosemite, Pinecrest, Lake Tahoe, Livermore Family Camp, among others.

Left: The 100" Hooker telescope on Mt. Wilson, built in 1917.

Below: The 10-meter telescopes Keck 1 (first light in 1992) and Keck 2 (first light in 1996).

Right: Proposed future Terrestrial Planet Finders (TPFs)

News & Notes

2009 TVS Meeting Dates

The following lists the TVS meeting dates for the rest of the year. The lecture meetings are on the third Friday of the month, with the Board meetings on the Monday following the lecture meeting. The *Prime Focus* deadline applies to that month's issue (e.g., the December 6th deadline is for the December issue).

Lecture Meeting	**Board Meeting**	***Prime Focus* Deadline**
Nov. 20	Nov. 23	Nov. 8
Dec. 18	Dec. 21	Dec. 6
Jan. 15	Jan. 18	Jan. 3

Money Matters

At the October Board Meeting, Treasurer David Feindel reported the TVS account balances as of October 18, 2009, were:

Checking	$3,599.66	
CD #1	$3,758.60	matures 11/17/09
CD #2	$2,653.02	matures 11/27/09

Our insurance was paid ($320), so we may continue to do public star parties.

TVS Elections This Month

November is election time for the Tri-Valley Stargazers. Our current slate of officers is as such:

President - Chuck Grant

Treasurer - David Feindel

Board of Directors - Jim Alves, Debbie Dyke, Gert Gottschalk.

We currently have no one in the positions of Vice-President and Secretary. We are sorely needing someone to fill in the Secretary position, as it is a legal requirement to maintain our non-profit status. The Secretary's responsible for taking the minutes of the board meetings and dealing with general correspondence (which is minimal).

The President and Treasurer wouldn't mind if someone wanted to take on either of those positions. The President leads the club lecture and board meetings. The Treasurer handles membership dues and pays a few bills.

We also need more members to be on the board of directors. Board members, and the officers, attend the monthly board meeting and make decisions involving the club. Meetings are in Livermore on the Monday following the lecture meeting, from 7:30 p.m. to around 8:30 or 9:00.

In order to conduct the meeting, one officer and at least two board members need to be present. With such a low number of officer and board members, it's getting more difficult to hold meetings. We really do need more members to become board members.

Should anyone wish to become more involved with the club, please come to the November meeting and nominate yourself for whichever position you wish. We can pretty much guarantee you'll get the job you want.

Editor Needed and Other Volunteer Positions Open

After seven years of doing Prime Focus, I'm finding it increasingly difficult to produce the newsletter. The time has come for me to step down and let someone else take over the reins. The new editor can totally redesign the newsletter, keep it the same, or make some changes but keep the rest as is. It's totally up to the editor. Content is pretty much open, as long as the speaker information is on the cover and the content of the newsletter deals with astronomy in general.

In addition, I will be giving up my other club duties: arranging for the refreshments, updating the web site, being on the board (and being the acting secretary), and helping to get speakers for the lecture meetings.

The refreshment bringer needs to bring snacks, make the coffee and tea, and set up and put away the refreshments at the meetings. Money spent on this endeavour would be reimbursed by the club.

The web master would need to update the site at least once a month, uploading that month's newsletter and updating the home page and newsletter page. The Coming Events page should also be maintained.

All TVS members can help with getting speakers for the lecture meetings. If you hear of anyone that might be available and who's interested in giving a talk that's astronomical in nature, please let the board members know so that the lead can be pursued.

Effective the end of this year, someone else (or more likely, several someone elses) will need to take on those tasks. Please consider helping the club out by taking on any of the job duties I am having to relinquish.

Newsletter header image: A Pale Blue Dot (aka Home)

This image of the Earth was acquired with the ESA's OSIRIS narrow-angle camera from a distance of 392,460 miles (633,000 km) on November 12, 2009 at 13:28 CET. The image is a part of a sequence of images taken every hour through one full rotation (24 hours). The movie will be published later.

Three images with an orange, green, and blue filter were combined to create this one image. The illuminated crescent is centered roughly around the South Pole (South at the bottom of the image). The outline of Antarctica is visible under the clouds that form the striking south-polar vortex. Pack ice in front of the coastline with its strong spectacular reflection is the cause for the very bright spots on the image. *Photo: ESA ©2009 MPS for OSIRIS Team MPS/UPD/LAM/IAA/RSSD/INTA/UPM/DASP/IDA*

Calendar of Events

November 18, 12:00 - 1:00 p.m.

What: *The Rings of Saturn as Seen by Cassini CIRS*
Who: Linda Spilker (Jet Propulsion Laboratory)
Where: SETI in Mountain View
Cost: Free

An extensive set of thermal measurements of Saturn's main rings has been returned by the Cassini Composite Infrared spectrometer (CIRS) over the past five years at a variety of ring geometries that are not observable from Earth. The largest temperature changes on the lit face of the rings are driven by variations in phase angle, including an unexpected thermal surge at low phase angles. Temperatures at equinox were retrieved for the first time, as the sun traversed from the south to north side of the rings in mid-August. Thermal phase curves, our preliminary equinox results and thermal modeling will be presented.

This lunchtime talk is part of the SETI Institute Colloquium Series. Location is 515 N. Whisman Road, Mountain View, CA 94043. For more info, visit their web site http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

November 21, 11:00 a.m. - 12:00 p.m.

What: *Cosmic Fireworks: The Explosive Deaths of Massive Stars*
Who: Maryam Modjaz
Where: UC Berkeley, Genetics and Plant Biology Building, Room 100
Cost: Free

Maryam Modjaz is a Miller Postdoctoral Fellow in Astronomy at UC Berkeley. She works on the explosive deaths of massive stars as supernovae and gamma-ray bursts. The recipient of Harvard University's Fireman Prize for an outstanding PhD dissertation, her work has been featured on National Public Radio, in the Christian Science Monitor, Astronomy Now, and in a feature article in UC Berkeley's *California* magazine.

Massive stars die violently. They produce the most powerful explosions in the Universe during their death-throes: supernovae and gamma-ray bursts. Supernovae are brilliant firework displays that become as bright as a billion suns combined, and gamma-ray bursts are monster explosions that launch jets moving nearly at the speed of light and outshining the whole gamma-ray Universe in a few seconds. Both explosions produce and expel heavy elements and an enormous amount of energy; they leave behind fascinating objects like black holes and pulsars, and like beacons they are visible over billions of light years across the vast Universe.

How are these types of explosions related? Are they dangerous to life on earth? How may they be vital for life on earth? These are some of the questions Dr. Modjaz will discuss during her breathtaking tour of the most powerful explosions of the Universe.

Limited hourly pay parking is available on weekends on and nearby campus - please check the signs. For more info about the talks, please visit http://astro.berkeley.edu/~scroft/iya/ .

November 25, 12:00 - 1:00 p.m.

What: *Deep Space Flight and Communications: SETI, KLT and Astronautics in a 2009 Book*
Who: Claudio Maccone (Co-Vice Chair of the SETI Permanent Study Group, International Academy of Astronautics)
Where: SETI in Mountain View
Cost: Free

continued page 4

Officers

President:
Chuck Grant
cg@fx4m.com
925-422-7278

Vice-President:
unfilled

Treasurer:
David Feindel
feindel1@comcast.net

Secretary:
unfilled

Board of Directors

Jim Alves, Debbie Dyke, Gert Gottschalk

Volunteer Positions

Librarian:
Jim Alves
Ajaengr@yahoo.com
209-833-9623

Newsletter Editor:
Debbie Dyke
astrodeb@comcast.net
925-461-3003

Program Director: unfilled

Loaner Scope Manager:
John Swenson
johnswenson1@comcast.net

Webmaster:
Debbie Dyke

Observatory Director/ Key Master:
Chuck Grant

School Star Party Chair:
unfilled

Public Star Party Chair:
unfilled

Historian:
unfilled

Mentor:
Mike Rushford
rushford@eyes-on-the-skies.org

Addresses

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

Lecture Meeting:
Unitarian Universalist Church
1893 N. Vasco Road, Livermore

Board & Discussion Meetings:
Round Table Pizza
1024 E. Stanley Blvd., Livermore

Web & E-mail

www.trivalleystargazers.org

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). You may access it by visiting 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 asking to join the group. Make sure you specify the e-mail address you want to use to read and post to the group.

Dr. Maccone's new technical book about SETI, KLT and space missions to the Sun gravity focus will be presented in this talk. This 400-page book is entitled *Deep Space Flight and Communications,* costs (unfortunately) over $100, and is divided into two parts: (1) The first 200 pages describe the astrophysics of light-bending caused by the mass of the Sun. Since the minimal focal distance turns out to lie in between 550 and 1000 AU, any future space mission to exploit this effect must necessarily be a "deep space mission". These FOCAL space missions are studied in the book and a Phase A Proposal was submitted by Dr. Maccone to ESA back in 2000. He now argues that a similar Proposal should be submitted to NASA. (2) The second part of the book is devoted to the KLT as optimal telecommunication tool (better than the FFT). The KLT for SETI was presented by the author in various talks, but, in this book, the reader will find the relativistic KLT also. This is useful to keep the radio link between the Earth and any deep-space spacecraft, such as the FOCAL spacecrafts to 550 AU. Dr. Maccone discovered mathematically that the relativistic KLT eigenfunctions are Bessel functions of the first kind, and that the KLT eigenvalues are the zeros of such Bessel functions. All this paves the way to "Star-Trek-like" relativistic space flights of the future.

This lunchtime talk is part of the SETI Institute Colloquium Series. Location is 515 N. Whisman Road, Mountain View, CA 94043. For more info, visit their web site http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

December 2, 12:00 - 1:00 p.m.

What: *Titan's Ontario Lacus: Smoothness Constraints from Cassini RADAR*
Who: Lauren Wye (Stanford Univ., Dept of Electrical Engineering)
Where: SETI in Mountain View
Cost: Free

The Cassini spacecraft has been orbiting Saturn since 2004, with frequent flybys of the largest moon Titan. With its thick atmosphere rich in nitrogen and hydrocarbons, it was once thought that Titan was covered in a global ocean of methane. Cassini optical and microwave imaging instruments have since revealed a world with a solid surface, strikingly similar in physical appearance to Earth, complete with lakes of liquid methane/ethane in the polar regions. Cassini RADAR altimetry data collected on the 49th flyby of Titan (2008 December 21) over Ontario Lacus, the largest lake in the south polar region, show signatures of a specular reflection so strong that it saturated the radar receiver. From the specular echo strength, which declines exponentially with increasing surface height variance, we are able to constrain the rms surface height variation to be less than 3 mm over the 100m-wide Fresnel zone. Lauren Wye will review her analysis of this data and the implications for wind speeds and surface material properties.

This lunchtime talk is part of the SETI Institute Colloquium Series. Location is 515 N. Whisman Road, Mountain View, CA 94043. For more info, visit their web site http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

December 7, 7:30 p.m.

What: *At Saturn: Tripping the Light Fantastic*
Who: Dr. Carolyn Porco (Director of CICLOPS, Space Science Institute)
Where: California Academy of Sciences
Cost: Adults $12, Seniors $10, Academy members $6

For seven years, the Cassini spacecraft and its Huygens probe traveled invisible interplanetary roads to the place we call Saturn. Their successful entry into orbit, the mythic landing of Huygens on the cold, dark equatorial plains of Titan, and Cassini's subsequent explorations of the saturnian environment are already the stuff of legend. What they have shown us, and the images they have collected, have revolutionized our views of this very alien planetary system and the planetary processes responsible for its configuration.

Seating is limited. To purchase tickets in advance, go online or call 800-794-7576.

December 9, 12:00 - 1:00 p.m.

What: *Finding Planets Around Nearby Stars: The Lick-Carnegie Extrasolar Planet Search Program*
Who: Steven S. Vogt (UCO/Lick Observatory, UC Santa Cruz)
Where: SETI in Mountain View
Cost: Free

There are currently over 350 known extrasolar planets, the vast majority discovered through detection of periodic barycentric reflex motion of the planet's host star via high-precision Doppler radial velocity measurements. The Lick-Carnegie Extrasolar Planet Search Program is one such precision Doppler-based planet survey. It is currently monitoring over 1330 nearby F, G, K, and M stars for planets at 2-3 m/sec precision, and has contributed over 70% of the presently-known exoplanets. These extrasolar planetary systems display an unexpected diversity of orbital period, size, and eccentricity, and the emerging database is providing new insight into the origins and evolution of planetary systems. This talk will give a brief review of our program, reviewing details of the detection method, recent results, and future directions. The talk will also highlight the 2.4-meter Automated Planet Finder, nearing completion at Lick Observatory.

This lunchtime talk is part of the SETI Institute Colloquium Series. Location is 515 N. Whisman Road,

Mountain View, CA 94043. For more info, visit their web site http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

December 19, 11:00 a.m. - 12:00 p.m.
What: *Star Formation Through Radio Eyes*
Who: Dick Plambeck
Where: UC Berkeley, TBA
Cost: Free

Information about this talk will be posted online at UC Berkeley's *International Year of Astronomy 2009 Public Talks* web site closer to the lecture date http://astro.berkeley.edu/~scroft/iya/.

December 31, 10:45 a.m.
What: *10th Annual New Year's Eve Balloon Drop*
Who: Everyone
Where: Chabot Space & Science Center
Cost: Members $4 per child. Non-Members $4 per child plus General Admission

Start or continue a family tradition — celebrate New Year's Eve with your kids during the daytime. Kids will have a blast ringing in 2010 without staying up past their bedtime! Two locations available for kids of all ages to enjoy. Don't miss the celebration! SPACE IS LIMITED! Register: 510-336-7373

Drop Times:

10:45 a.m.: Ages 6 & Under (Rotunda)

12:45 p.m. & 3:45 p.m.: Ages 5 & Under (Discovery Lab) & Ages 6 & Up (Rotunda)

Astro Events

Jupiter Transits

The following are a few listings of transit times for various Jupiter related objects. The abbreviations are: G=Ganymede, C=Callisto, I=Io, E=Europa, GRS=Great Red Spot, and if you see a 's' next to one of the moons, it means its shadow (e.g., Is=Io's shadow); na means Jupiter is below the horizon or it is daylight at that time.

November

Mon 16	C	na	6:30p	8:52p
	GRS	9:18p	na	na
Tue 17	GRS	na	7:00p	8:55p
Wed 18	I	6:53p	8:00p	9:09p
	Is	8:10p	9:09p	10:25p
Thur 19	GRS	6:45p	8:40p	10:35p
Fri 29	Gs	7:03p	8:34p	10:30p
Sat 21	GRS	8:25p	10:28p	na
Sun 22	GRS	na	6:08p	8:00p
Tue 24	GRS	6:00p	7:48p	9:40p
Wed 25	I	8:52p	10:00p	na
	Is	10:08p	na	na
Thur 26	GRS	7:45p	9:35p	na
Fri 27	I	na	na	5:36p
	GRS	na	5:15p	7:25p
	Is	na	5:32p	6:48p
	G	5:57p	7:40p	9:28p
Sun 29	GRS	5:15p	7:00p	8:50p
Mon 30	E	na	na	5:48p
	Es	5:27p	6:37p	8:13p

continued page 7

The California Nebula (NGC1499) is an emission nebula about 1,500 light years away and about 100 light years long, in the constellation of Perseus. The bright star in the image is Xi Persei. This image is a nearly 7.5 hours long exposure, taken over two nights, using an Orion StarShoot Pro CCD camera attached to a Canon 400mm telephoto lens. *Photo: Conrad Jung*

What's Up *by Debbie Dyke*

All times Pacific Standard unless otherwise noted.

November

14 Sat 1969 Apollo 12 launched.

15 Sun 1738 Wilhelm Herschel born.

16 Mon **New Moon**. Lunation 1075. 11:14 a.m.
1974 Arecibo radio telescope sends a 3-minute message towards M13 — it should arrive in about 24,000 years.

17 Tue Mercury at aphelion.
Leonid meteor shower peaks. 8:00 a.m.
1970 Luna 17 lands on the Moon and sends Lunokhod 1 (a wheeled vehicle) to ramble along the surface.

18 Wed 1923 Alan Shepard born.

19 Thur 1969 Apollo 12 lands at Oceanus Procellarum on the Moon.

20 Fri **Tri-Valley Stargazers general meeting**. 7:30 p.m. at the Unitarian Universalist Church, 1893 N. Vasco Road, Livermore.
1889 Edwin Powell Hubble born.
1998 The first section of the International Space Station is launched from Baikonur.

22 Sun Moon at apogee (250,934 miles).
1682 Edmond Halley sees the comet that will later bear his name.

23 Mon **Tri-Valley Stargazers Board meeting**. 7:30 p.m. at the Round Table Pizza in Livermore on 1024 E. Stanley Blvd.
Jupiter 4°21' south of the Moon. 7:00 p.m.
1885 First photo of a meteor shower.

24 Tue **First Quarter Moon**. 1:39 p.m.

26 Thur **Thanksgiving Day**.

28 Sat 1964 Mariner 4 launched toward Mars.
1967 Jocelyn Bell discovers pulsars.

29 Sun 1803 Christian Doppler born.
1961 Mercury capsule launched into orbit with Enos, a chimpanzee, as passenger.

December

1 Tue The Full Moon is 1°38' south of the Pleiades (M45). 5:00 a.m.
Uranus stationary. 9:00 p.m.
Full Moon. 11:00 p.m.

2 Wed 1971 USSR's Mars 3 becomes the first spacecraft to make a soft landing on Mars.
1993 Hubble Space Telescope gets corrective optics.

3 Thur Moon 4°45' north of M35. 4:00 a.m.
1973 Pioneer 10 becomes the first spacecraft to fly by Jupiter.

4 Fri Moon at perigee (225,356 miles). 6:00 a.m.

6 Sun The Moon is 5°45' east of M44 and 8°10' west of Mars. 4:00 a.m.

7 Mon 1995 Galileo space craft arrives at Jupiter.

8 Tue **Last Quarter Moon**. 4:13 p.m.

11 Fri Hanukkah begins at sundown.
1863 Annie Jump Cannon born. She catalogued over 300,000 stars and completed the Henry Draper Catalogue.
1972 Apollo 17 lands at Taurus-Littrow on the Moon.

Staring at Lightning

There's something mesmerizing about watching a thunderstorm. You stare at the dark, dramatic clouds waiting for split-second bursts of brilliant light — intricate bolts of lightning spidering across the sky. Look away at the wrong time and (FLASH!) you miss it.

Lightning is much more than just a beautiful spectacle, though. It's a window into the heart of the storm, and it could even provide clues about climate change.

Strong vertical motions within a storm cloud help generate the electricity that powers lightning. These updrafts are caused when warm, moist air rises. Because warmth and lightning are inextricably connected, tracking long-term changes in lightning frequency could reveal the progress of climate change.

It's one of many reasons why scientists want to keep an unwavering eye on lightning. The best way to do that? With a satellite 35,800 km overhead.

At that altitude, satellites orbit at just the right speed to remain over one spot on the Earth's surface while the planet rotates around its axis — a "geostationary" orbit. NASA and NOAA scientists are working on an advanced lightning sensor called the Geostationary Lightning Mapper (GLM) that will fly onboard the next generation geostationary operational environmental satellite, called GOES-R, slated to launch around 2015.

"GLM will give us a constant, eye-in-the-sky view of lightning over a wide portion of the Earth," says Steven Goodman, NOAA chief scientist for GOES-R at NASA's Goddard Space Flight Center. Once GLM sensors are flying on GOES-R and its sister GOES-S, that view will extend 18,000 km from New Zealand, east across the Pacific Ocean, across the Americas, and to Africa's western coast.

The Geostationary Lightning Mapper (GLM) on the next generation of GOES satellites will detect the very rapid and transient bursts of light produced by lightning at near-infrared wavelengths. This image was taken from the International Space Station and shows the Aurora Australis and lightning.

With this hemisphere-scale view, scientists will gather an unprecedented amount of data on how lightning varies from place to place, year to year, and even decade to decade. Existing lightning sensors are either on the ground — which limits their geographic range — or on satellites that orbit much closer to Earth. These satellites circle the Earth every 90 minutes or so, quickly passing over any one area, which can leave some awkward gaps in the data.

Goodman explains: "Low-Earth orbit satellites observe a location such as Florida for only a minute at a time. Many of these storms occur in the late afternoon, and if the satellite's not overhead at that time, you're going to miss it."

GLM, on the other hand, won't miss a thing. Indeed, in just two weeks of observations, GLM is expected gather more data than NASA's two low-Earth orbiting research sensors did in 10+ years.

The new data will have many uses beyond understanding climate change. For example, wherever lightning flashes are abundant, scientists can warn aircraft pilots of strong turbulence. The data may also offer new insights into the evolution of storms and prompt improvements in severe weather forecasting.

Staring at (FLASH!) Did you miss another one? The time has come for GLM.

Want to know how to build a weather satellite? Check the "how to" booklet at scijinks. gov/weather/technology/build_satellite.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Astro Events *continued*

December

Tue 1	GRS	6:45p	8:48p	na
Fri 4	GRS	na	6:06p	8:10p
	I	5:17p	6:23p	7:35p
	Is	6:31p	7:30p	8:43p
Sun 6	GRS	6:05p	7:55p	9:32p
Mon 7	E	5:39p	7:04p	8:30p
	Es	8:04p	9:20p	na
Tue 8	GRS	7:45p	9:36p	na
Fri 11	GRS	5:15p	7:00p	8:45p
	I	7:19p	8:26p	9:33p
	Is	8:26p	9:24p	na
Sun 13	GRS	6:55p	8:45p	na

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.
_____ $40 Regular. You will receive a paper version of *Prime Focus* in the mail.
_____ $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.