

PRIME FOCUS

Tri-Valley Stargazers

October 2006



Meeting Info:

What

Why Do Galaxies Look the Way They Do?

Who

Andrew West

When

October 20, 2006
Conversation at 7:00 p.m.
Lecture at 7:30 p.m.

Where

Unitarian Universalist
Church in Livermore
1893 N. Vasco Road

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October Meeting

Why Do Galaxies Look the Way They Do? A Multiwavelength Approach to Galaxy Evolution

Andrew West

Andrew will be talking about the importance of using many different wavelengths of light to answer the questions of how galaxies form and evolve. In particular, he will focus on using the optical (or visual) and radio wavelengths to examine how stars are currently forming in galaxies, the number of stars that have formed over the past several billion year histories of galaxies and clues to how stars will continue to form in the distant future. He will discuss how the star formation history (and future) of a galaxy can be tied to its shape, size and color and highlight some of the ongoing research to study the gaseous and stellar components of galaxies. Specifically, he will talk about two new radio telescope facilities affiliated with U.C. Berkeley, CARMA and the ATA, that will revolutionize our understanding of star formation and galaxy evolution in the nearby universe.



NGC2535



NGC3992

Andrew grew up in Mendocino county in the small town of Redwood Valley. He received his first telescope as a 10 year old and on clear nights (of which there were many) could be found looking at the satellites of Jupiter, the rings of Saturn or the Orion Nebula. After high school in Ukiah, he went to Haverford College just outside of Philadelphia where he studies physics and astronomy and wrote his senior thesis on the high energy jets coming out of supermassive black holes

in distant galaxies. He received his PhD from the University of Washington, where he studied the relationships between gas and stars in nearby galaxies as well as dabbling in the magnetic activity of red dwarfs in our own Galaxy. He is currently a postdoctoral fellow working at UC Berkeley in the Radio Astronomy Laboratory. He works on a variety of projects that span many wavelengths and scientific questions. When not being an astronomer, he enjoys playing ultimate frisbee, hiking, biking, skiing and listening to music.



A1045+66

News & Notes

2006 TVS Meeting Dates

Welcome two new members, **Tim Pierce** and **Daniel Vanderzanden**.

2006 TVS Meeting Dates

Below are the TVS meeting dates for the next few months. 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 November 5th deadline is for the November issue).

Lecture Meeting	Board Meeting	Prime Focus Deadline
Oct. 20	Oct. 23	Oct. 8
Nov. 17	Nov. 20	Nov. 5
Dec. 15	Dec. 18	Dec. 3

Money Matters

Treasurer **David Feindel** reports the TVS account balances (as of September 18, 2006):

Checking	\$3,232.41	
CD #1	\$3,556.37	matures 11/17/06
CD #2	\$2,513.57	matures 11/27/06

TVS November Elections

Come November 7, people throughout the nation will be casting ballots to elect a new crop (or renewing the current batch) of politicians. Come November 17, TVS members will be casting their ballots to elect the club officers and board of directors.

As always, the club is looking for volunteers to take on the various job positions to keep the club functioning. Any member can run for any office or to be on the board. All you need to do is to notify any existing officer or board member and they will add your name to the ballot. You don't have to have experience, just a desire to help the club.

We have room for more members on the Board of Directors. The Board meets in Livermore on the Monday after the general meeting to discuss club related business and to make decisions regarding the future of the club. Meetings usually last a couple of hours.

We are in need of a Secretary, whose primary duty is to attend the board meetings and take the minutes, type them up and distribute them at the next board meeting. Occasionally, the Secretary would need to respond to some club related correspondence.

Another big slot to fill, this one being a volunteer position, is that of Program Director. The Program Director is in charge of finding speakers for the monthly meetings. We need 10 speakers a year (the other two months

of the year are our potluck dinners). This position is very important and, unfortunately, the club has been without a Program Director for several years.

We also have a couple more volunteer positions to be filled. The Hospitality position requires bringing the refreshments to the meeting and making coffee and tea, and coordinating the summer and holiday potlucks. The amount of time spent taking care of the Hospitality job each month is about an hour.

Another volunteer position is that of Publicity. The job involves contacting local newspapers regarding club activities and meetings. The more "face time" the club can get, the more likely we can bring in new people to the meetings and increase membership.

TVS continues with conducting star parties for any teacher, school, or group (like Scouts) that requests our presence. Our star party coordinator, Rich Campbell, can't always be at every star party, so it would be nice if we had one or two back-ups that would be able to do a little slide show, or do a Night Sky activity (or both!) for the group. We have an assortment of Night Sky Network activities for members to use for public outreach events.

Please consider helping out in whatever way you can, and don't be afraid of adding your name to the candidate list.

School Star Parties

We have a couple of star parties scheduled for the next couple of months.

The Vintage Hills Elementary school in Pleasanton would like some astronomers on hand for their Star Gazing Party hosted by their fifth graders. This will be in the first week of November.

On November 9th we'll be at the Livermore Valley Charter School from 6:00 to 9:00 p.m. Mike Rushford is the star party coordinator for this event.

December 7th we'll be helping out a Livermore Cub Scout group.

We'll have more information about these events when we get closer to their dates. Check our web site and the TVS eGroups list for the latest info.

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Newsletter header image: IC1396A & VDB 142

IC1396A, the Elephant Trunk Nebula, is a globule within IC1396, about 2,400 light years away in the constellation of Cepheus. VDB 142 is the small reflection nebula within it. This image of IC1396A and VDB 142 was taken with a ST-2000XM, Takahashi FS-102 @ f/6, L(47x5min), RGB(13x5min, 2x2 bin), and applying Lucy-Richardson deconvolution. For a larger view of this image, visit Ken's page at <http://www.trivalleystargazers.org/ken/index.html>.

Photo: Ken Sperber

Calendar of Events

October 21, 1:15 p.m. & 3:15 p.m.

What: *Alien Clones from Outer Space Workshop*

Who: H.B. Homzie

Where: Chabot Space & Science Center, Oakland

Cost: Free with General Admission

Join award winning children's book author H.B. Homzie for two of her out-of-this-world workshops.

1:15 p.m. - Create Your Own Secret Alien Language

Blast off to a fun time as you create your own alien words and then challenge others in a game of alien charades.

This workshop is for the kid or adult who's ever wanted to create his or her own secret language. Perfect for kids 4 through 104.

3:15 p.m. - Create and Make Your Own Alien Space Gadgets

In order to create her books, *Alien Clones From Outer Space*, H. B. Homzie came up with zillions of gadgets-everything from a snozelplat to a brain slurpie. What kind of a gadget would you create? Have fun making your own gadget that'll be out of this world. Perfect for kids ages 3 through 103.

Known for her zany and hysterical chapter books, this Wine Country-based author is a visiting professor in children's literature at Hollins University and has starred off-Broadway in sketch comedy shows, David Letterman and Saturday Night Live.

October 27, 8:00 - 11:00 p.m.

What: *Lunar Lounge Express Halloween Party*

Who: Flying Venus

Where: Chabot Space & Science Center, Oakland

Cost: \$15 adults, \$10 student

Come in costume, party under the stars and enjoy an evening of live music, a *SonicVision* or live planetarium show, telescope viewing, hands-on exhibits, giveaways and outta-this-world fun!

Enjoy food from the Celestial Café, along with refreshments from the cash bar.

Musical Guest - Flying Venus. An '80s retro sound with a fresh twist and fishnets. The B52s meet Aerosmith.

Tickets available at the Chabot Box Office, 510-336-7373.

October 28, 10:00 a.m. - 4:00 p.m.

What: *Spooky Science Laboratory Halloween Party*

Who: You

Where: Chabot Space & Science Center, Oakland

Cost: Free with General Admission

Bats, spiders and slime - oh my! Spooky punch for all and lots of ghoulish fun! Guest appearance by the Astro Wizard (the infamous Dave Rodrigues) and special costumed friends. Come dressed in costume!

November 8, 10:00 a.m. - 7:00 p.m.

What: *The Planet Pluto: Maligned but Not Forgotten*

Who: Dale Cruikshank (NASA Ames Research Center)

Where: Foothill College, Los Altos

Cost: Free (\$2 parking-need 8 quarters)

This non-technical, illustrated talk is part of the Silicon Valley Astronomy Lectures in the Smithwick Theater, Foothill College, at El Monte Road and Freeway 280 in

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Officers

President:

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

Vice-President:

Rich Campbell
r_photon@yahoo.com

Treasurer:

David Feindel
feindel1@comcast.net

Secretary:

Debbie Dyke
(acting secretary)

Board of Directors

Alane Alchorn, Jim Alves,
Debbie Dyke, Gert Gottschalk,
Stan Isakson, Mike Rushford,
John Swenson.

Volunteer Positions

Librarian:

Jim Alves
jim_alves_engr@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:

Chuck Grant

Observatory Director/

Key Master:

Chuck Grant

School Star Party Chair:

Rich Campbell
r_photon@yahoo.com

Public Star Party Chair:

Rich Campbell

Historian:

Debbie Dyke

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

tvst@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 (tvst@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*

the Los Altos Hills. Call the series hot-line at 650-949-7888 for more information and driving directions.

Although Pluto is only one of many worlds beyond Neptune that are now recognized as dwarf planets, it is the one we know best.

And to generations of Americans who in their youth learned about Pluto's discovery by a Kansas farm boy in 1930, it is perhaps the one that is most loved. With a thin atmosphere, a layer of smog, three moons, and a patchy surface made of many kinds of ice, Pluto is the gateway to the vast outer fringe of the Solar System, where trillions of lumps of ice, rock, and organic chemicals orbit the Sun in a permanent deep freeze.

Recognizing Pluto's importance to our understanding of the outer regions of the Solar System, NASA launched the New Horizons spacecraft in January, 2006. Streaking outward at nearly 70,000 miles per hour, New Horizons will reach Pluto in July 2015. The knowledge gained from this first close-up inspection of Pluto and its moons will expand our understanding of all the dwarf planets beyond Neptune. This new understanding will be all the more important as the completion of new and powerful survey telescopes begins to accelerate the discovery of new objects out there.

Dr. Cruikshank is one of the world's foremost authorities on the outer solar system. He and his colleagues discovered the ices that make up Pluto's surface and evaporate to form its thin atmosphere. As a former amateur astronomer, he has a knack for explaining scientific ideas in simple, direct language.

The lecture is co-sponsored by: NASA Ames Research Center, The Foothill College Astronomy Program, The SETI Institute, The Astronomical Society of the Pacific.

News & Notes *continued*

A Nifty (Albeit Expensive) Accessory: Collins I-3 Eyepiece

Review by Hugh Bartlett

"Conrad, come here! You've got to see this!" Steve called to Chabot's astronomer last weekend. I had the Dumbbell nebula in my 12.5" Dob with the Collins I-3 image-intensified eyepiece. The hourglass' linear shape was unmistakable, and did not require averted vision to see. "Pretty nice!" was Conrad's understated response.

If you are like me, you have read the reviews, thought about getting one someday, but no

one ever shows up with one when you are observing, so you are not sure if it is worth the price of a large telescope just for one eyepiece! The reviews are full of nit-picky criticisms (cost, potential technological obsolescence, focus problems, scintillation, narrow field of view, etc.). But reading between the lines, one always senses the reviewer's pervasive exhilaration at the viewing experience.

So what is this contraption? The I-3 is about the same size and weight as a 2" widefield eyepiece. The 25mm focal length lens is generously wide, but has a relatively narrow 40° apparent field of view. It has a 1.25" barrel, and is powered by a common 3-volt camera battery in a side-mounted cylindrical compartment. Screwing or unscrewing the lid to the compartment turns it on and off. The technology involves taking an incoming photon, converting it to an electron, and multiplying that electron thousands of times so that the image that shows up when the electrons hit the phosphor screen is much brighter than can be seen in an ordinary eyepiece. However, because one is viewing the screen photons, the image is a monochromatic green. It also shows some background noise (scintillation) from stray electrons, which is more noticeable on magnified (Barlowed) images when the background sky is darker.

How well does it work? Quite well, as a matter of fact! It has totally rejuvenated my enthusiasm for a whole list of faint fuzzy objects that all of a sudden are neither faint nor fuzzy. With a broadband H-Alpha filter attached (highly recommended), nebulae are easily visible through hazy, light-polluted skies. Not only visible, but also showing more structure under these conditions than I have seen in any telescope up to 3 times my aperture from a dark sky site. The views were just as mind-blowing in my 10" f/4.5 Dob. The Helix, for goodness sake, clearly showed a solid ring around its perimeter. All I have ever seen before is a hazy oval slightly brighter than the background sky. With the I-3 in my 60mm finder scope, the whole North American nebula is clearly visible without averted vision from my backyard in Oakland. Globular clusters take on individual identity, and a 3-D effect of the brighter stars in front of the central mass. The whole extent of each is clearly seen, making it easy to compare one with another.

Is there anything it does not do well? The input photocathode is more sensitive to the red end of the spectrum, even going into the near infrared range a bit allowing you to see things beyond human vision. As a result, the blue, star-forming regions in the spiral arms of galaxies do not show up as distinctly. Moreover, light pollution also has a



lot of blue light, so only the central galactic bulge with a large population of red stars is all that shows up from an urban location. Hence, galaxy observing remains limited to dark sky sites. However, from what I have read, the I-3 goes a couple magnitudes deeper on galaxies at a dark sky site. The only objects I have consistently heard that the I-3 does not enhance are reflection nebulae. That is no big deal; I can count on one hand the ones that might be worth observing.

Of all the drawbacks listed by the reviewers, I consider most to be negligible. The major stumbling block is the cost. I had hoped they would go down in price like most techno-gadgets. Instead, the new price has risen by 50% over the last 5 years! The good news is that the used price is coming down. A couple years ago, a used I-3 eyepiece cost two-thirds the price of a new one. Lately, I have seen a couple on Astromart (including the one I purchased) at less than half the cost new. Admittedly, the one I got was not the current “thin-film” version, which reduces the scintillation significantly. However, one quickly learns to ignore the scintillation and focus on the object, which is better than you have ever seen it in any eyepiece, anywhere!

Another issue concerns the I-3 needing about an inch of additional in-focus travel in a telescope. Most focusers have about 1.5" of travel, so if most of your eyepieces focus in the middle of that range, you might need about ¼" more in-focus travel. It was not a problem in my 10" Dob or 60mm finder, but I had to countersink my collimation screws slightly on my other Dob to move the primary about 1/8" closer to the focuser.

In summary, if I had to start all over, I'd skip buying my larger aperture scope and all those other \$\$\$ eyepieces, and get a 10" Dob with this eyepiece. With a broadband H-Alpha filter (about the price of a standard premium eyepiece) and a couple Barlow lenses, I would be set for a lifetime of unparalleled observing ecstasy.

Astronomical insights

by David Feindel

Tucson, Arizona, is home to Kitt Peak, one of the bastions of professional astronomy, with 23 optical telescopes and two radio telescopes on top of a 6,875 foot mountain. Kitt is famous for its favorable weather, steady seeing, and dark skies. I was in Tucson for work-related reasons, with a new moon weekend on tap. But I didn't really have any way to bring a telescope, and didn't want to risk shipping



Star Party at Kitt Peak. Photo: Dave Feindel

one. There is the program put on by the National Optical Astronomy Association [NOAA] (<http://www.noao.edu/outreach/nop>), but that involves being part of a group of up to 36, with only two scopes to look through. The solution was obvious. Tucson has a super-active amateur astronomy community, centered around the Tucson Amateur Astronomy Association (TAAA, www.tusconastronomy.org). Going to their web site and reading their newsletter revealed they were holding not one, but two star parties that weekend—one at Kitt Peak, and one at



25-meter Very Large Baseline Array radio telescope. Photo: Dave Feindel

their dark sky site 10 miles west of Tucson. A series of e-mails confirmed that I would be welcome at the Kitt Peak party, even without a scope.

First, the drive to Kitt Peak is awesome. The mountain is about 60 miles west of Tucson, which has perhaps the country's (the world's?) best dark sky lighting ordi-

nance. Other than that, it's high desert for 100+ miles in all directions. You slowly climb out of the desert with its trademark saguaro cactus and turn onto a 12-mile winding road that soon has you starting to climb fairly steeply up into a pinion forest. The views, both up the mountain and down into the valley, are spectacular. The telescopes are scattered along a 2-mile serpentine road along the top of the mountain. The star party was held at the picnic grounds, 300-400 feet below the summit. At the edge of the picnic grounds was the 25-meter Very Large Baseline Array radio telescope, part of a nationwide network of radio telescopes.

The weather turned out to be spectacular. Kitt Peak can be cold; but not tonight. No wind, and the temperature that started in the mid-70s only dropped to about 60 at 11:30, when the NOAA closes the mountain. Seeing was superb. Arcturus didn't start to flicker until about 10 degrees above the horizon. And did I mention how dark it was? The Milky Way was

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What's Up *by Debbie Dyke*

All times Pacific Daylight Saving Time unless otherwise noted.

October

- 9 Mon The Moon passes in front of M45, the Pleiades. 9:00 p.m.
- 13 Fri **Last Quarter Moon.** 5:26 p.m.
- 15 Sun Moon 2° from M44, the Beehive cluster. 3:00 a.m.
- 16 Mon Moon 2° from Saturn. 5:30 a.m.
Mercury at greatest elongation east (25°). 9:00 p.m.
- 19 Thurs Moon at apogee (251,765 miles). 3:00 a.m.
- 20 Fri **Tri-Valley Stargazers general meeting.** 7:30 p.m. at the Unitarian Universalist Church, 1893 N. Vasco Road, Livermore.
For the next two weeks, look for the Zodiacal Light in the east before morning twilight.
- 21 Sat Mercury at greatest heliocentric latitude south.
Orionid meteor shower peaks. 8:00 a.m.
New Moon. 10:14 p.m.
- 22 Sun **Tri-Valley Stargazers discussion meeting.** 2:00 p.m. at the Round Table Pizza on 1024 E. Stanley Blvd., Livermore. Discuss astro stuff with your fellow members.
Mars in conjunction with the Sun. 12:00 a.m.
4000 BC The world was created, according to James Ussher, archbishop of Ireland.
1975 Venera 9 becomes first spacecraft to return images of the surface of Venus.
- 23 Mon **Tri-Valley Stargazers Board meeting.** 7:00 p.m. at the Round Table Pizza in Livermore.
Mercury 4° south of, and Jupiter 6° above, the Moon right after sunset.
Ramadan ends (Eid Al-Fitr).
- 24 Tues 3936 BC According to Johannes Hevelius, the world was created on this date at 6:00 p.m.
Ramadan ends (Eid Al-Fitr).
- 27 Fri Venus in superior conjunction. 11:00 a.m.
- 29 Sun **Daylight Saving Time ends.** 2:00 a.m. Set your clocks back one hour.
First Quarter Moon. 1:25 p.m. PST
- 31 Tues **Halloween.** Take your scope out to treat the passing ghosts and goblins.
Mercury and Jupiter low in the southwestern sky right after sunset.
The Moon and Uranus less than 2° apart during the night.
1992 The Vatican absolves Galileo of all heresy charges.

November

- 2 Thurs 1917 First light for Mt. Wilson's 100-inch Hooker telescope.
- 3 Fri 1957 First dog in space (Laika). She's put to sleep 10 days later while still in orbit aboard Sputnik 2.
- 5 Sun **Full Moon.** 4:58 a.m. PST
S. Taurid meteors peak. 8:00 a.m. PST
- 7 Tues Election Day.
1991 The 10-meter Keck Telescope dedicated on Mauna Kea, Hawai'i.
- 8 Wed Mercury in inferior conjunction. 2:00 p.m. PST
Transit of Mercury. 1st Contact 11:12 a.m. PST – 2nd Contact 11:13 a.m. –
Greatest transit 1:41 p.m. – 3rd Contact 4:08 p.m. – 4th Contact 4:10 p.m.
1656 Edmond Halley born.
- 9 Thurs 1934 Carl Sagan born.
- 11 Sat Veterans Day.

Staggering Distance

by Dr. Tony Phillips

Tonight, when the sun sets and the twilight fades to black, go outside and look southwest. There's mighty Jupiter, gleaming brightly. It looks so nearby, yet Jupiter is 830 million km away. Light from the sun takes 43 minutes to reach the giant planet, and for Earth's fastest spaceship, New Horizons, it's a trip of 13 months.

That's nothing.

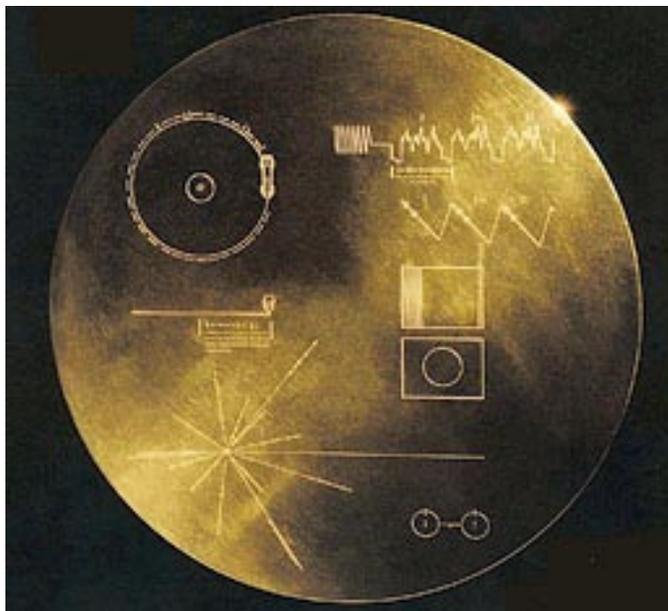
Not far to the left of Jupiter is Pluto. Oh, you won't be able to see it. Tiny Pluto is almost 5 billion km away. Sunlight takes more than 4 hours to get there, and New Horizons 9 years. From Pluto, the sun is merely the brightest star in a cold, jet-black sky.

That's nothing.

A smidgen to the right of Pluto, among the stars of the constellation Ophiuchus, is Voyager 1. Launched from Florida 29 years ago, the spacecraft is a staggering 15 billion km away. It has traveled beyond all the known planets, beyond the warmth of the sun, almost beyond the edge of the solar system itself.

Now that's something.

"On August 15, 2006, Voyager 1 reached the 100 AU mark—in other words, it is 100 times farther from the Sun than Earth," says Ed Stone, Voyager project scientist and the former director of NASA's Jet Propulsion Laboratory. "This is an important milestone in our exploration of the Solar System. No other spacecraft has gone so far."



In case it is ever found by intelligent beings elsewhere in the galaxy, Voyager carries a recording of images and sounds of Earth and its inhabitants. The diagrams on the cover of the recording symbolize Earth's location in the galaxy and how to play the record.

At 100 AU (astronomical units), Voyager 1 is in a strange realm called "the heliosheath."

As Stone explains, our entire solar system—planets and all—sits inside a giant bubble of gas called the heliosphere. The sun is responsible; it blows the bubble by means of the solar wind. Voyager 1 has traveled all the way from the bubble's heart to its outer edge, a gassy membrane dividing the solar system from interstellar space. This "membrane" is the heliosheath.

Before Voyager 1 reached its present location, researchers had calculated what the heliosheath might be like. "Many of our predictions were wrong," says Stone. In situ, Voyager 1 has encountered unexpected magnetic anomalies and a surprising increase in low-energy cosmic rays, among other things. It's all very strange—"and we're not even out of the Solar System yet."

To report new developments, Voyager radios Earth almost every day. At the speed of light, the messages take 14 hours to arrive. Says Stone, "it's worth the wait."

Keep up with the Voyager mission at voyager.jpl.nasa.gov. To learn the language of Voyager's messages, kids (of all ages) can check out spaceplace.nasa.gov/en/kids/vgr_fact1.shtml.

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

News & Notes *continued*

visible 5 degrees BELOW Cassiopeia. It was a night for faint fuzzies, globulars, doubles, planetaries, whatever you wanted to look at.

Most impressive of all, though, was the warm welcome my wife and I were given by the members of TAAA. Everyone was gracious offering views through their telescopes. The highlights were numerous. Georgie's 14" SCT displaying the spiral structure in M33, and (at my request) picking out M51 shortly after dusk and seeing the "bridge" to NGC5195. Quite a sight. John's AP refractor included a binoviewer, my first view through a telescope using both eyes. A look at the Veil (NGC 6960 and 6992) was spectacular through an OIII filter and the binoviewer. The Wild Duck Cluster was another wow object through the binoviewer. M13 is usually an overworked object, but looking at it through a good 16" dob revealed structure I've never seen before, except in the Lick 36" refractor. The Dumbbell and Little Dumbbell looked great through multiple scopes using an OIII. Someone else's 8" SCT provided excellent views of M92, M15, and M55 in a Goto comparison of globulars. Unfortunately, the night ended all too soon. But an excellent night, perhaps the best I've ever experienced in my four years in astronomy.

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.
_____ \$32.95 One year subscription to *Sky & Telescope* magazine.
_____ \$34 One year subscription to *Astronomy* magazine.
_____ \$60 Two year subscription to *Astronomy* magazine.
_____ \$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.
\$ _____ 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.