

# PRIMEFOCUS

Tri-Valley Stargazers

May 2008



## Meeting Info:

### What

*Emission Line Imaging*

### Who

Richard Crisp

### When

May 16, 2008  
Doors open 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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## May Meeting

### Emission Line Imaging

*Richard Crisp*

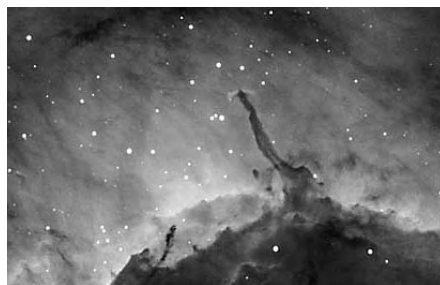
In the last five to ten years, technology has advanced to such an extent that amateur astronomers can compete with professional astronomers in imaging and collecting data of astronomical objects.

Richard was inspired by the Hubble image of the Pillars of Creation (M16 Eagle Nebula) to start imaging nebulae with narrowband emission line filters. The use of the filters allow specific wavelengths of light to be imaged. By combining the different wavelength images into one, more information can be gleaned regarding the particular nebula.

Emission line filters are also quite useful in light polluted areas, like Richard's backyard in Castro Valley, and moonlit nights. The narrowband picks up very little of the surrounding light, therefore allowing longer exposures to be taken with minimal negative effect.

Most of the narrowband images are taken in the Hydrogen Alpha (Ha), Oxygen doublet [OIII], Sulfur doublet [SII], and Nitrogen doublet [NII] emission lines. The different lines can then be combined in different wavelength order, creating multiple views of the same object depending on which order the individual images are stacked.

To see more of Richard's images, visit his web site at <http://www.narrowbandimaging.com>.



Herbig-Haro 555 in H $\alpha$ . Image, taken from Castro Valley, is a combination of six 30 minute exposures, using an 18" f/12.6 Classic Cassegrain.



Herbig-Haro 555 in [SII], Ha, and [OIII]. This image, also taken from Castro Valley with the 18" Cassegrain, is a combination of six 30 minute exposures in Ha, six 30 minutes exposures in [SII], and eight 30 minutes exposures in [OIII] for a total exposure time of ten hours.

## News & Notes



### Carter Roberts

After a long battle with cancer, Carter Roberts passed away on Thursday, April 24th at 12:20 a.m. True to his nature, he had stubbornly held on two months after the doctors told him that he'd only have two weeks to live.

Carter had been a member of TVS since 1992, and had been the President of the Eastbay Astronomical Society (EAS) for even longer. He also was on the RTMC, AANC, and Chabot Space and Science Center's Board of Directors. He participated in many public outreach events, as well as doing a lot of "behind the scenes" work.

Carter seemed to have an unending supply of energy to fight battle after battle, whether it was with the Port of Oakland for the light polluting fixtures they installed at the Port, or against the Oakland School Board in trying to keep the old Chabot Observatory open to the public and to school children.

He was methodical in his work involving the new Chabot location, going over site plans and architectural drawings, catching many errors. He conducted site surveys on his own, mapping out the locations of all the trees at the site, correcting the official survey.

Carter was one of the most avid solar eclipse chasers. He had made many trips to such far off places as Siberia and Zambia to catch a little Moon shadow. His photography of such events, and of the places he traveled to, are of the highest quality.

Besides his love of astronomy, Carter also enjoyed trains—traveling on them, as well as photographing them. He had a large train layout in his front room, and many large photos of old steam locomotives (taken by him) gracing the walls of his home. He also had an amazing collection of cameras, some quite old. It was unusual to see Carter without a camera.



Carter worked for the USGS in Menlo Park, measuring gravity (no wonder he like Newton so much!).

You can read an article about Carter, written by his friend Norm Sperling, at Sky & Telescope's web site: <http://www.skyandtelescope.com/news/18360994.html>. Astronomy Magazine also had a write up: <http://cs.astronomy.com/asycs/blogs/astronomy/2008/04/25/carter-w-roberts-1946-2008.aspx>.

There will be a memorial service for Carter on Monday, May 19, starting at 7:30 p.m. in Chabot's planetarium.

Nothing specific is yet planned—they'll probably show some slides of him and his works, and perhaps share a few tall tales from our collective experiences with him.

Afterwards, there will be some light refreshments, and the telescopes will be open for a bit of viewing—a tribute to Carter's favorite pastime and passion.

Carter did so much for so many groups, his absence will be felt by many people. Ad astra Carter.

### Sycamore Grove Star Party

We have a tentative date for our first Sycamore Grove star party—June 7th. LARPD (Livermore Area Recreation and Park District) Ranger Glen Florey will be doing an astronomy program at the Wetmore entrance of the park, and would like TVS's assistance with the observing portion of the evening. If you can help, contact a Board Member and let them know.

### New Members

TVS would like to welcome our newest member, Paul Petricevich.

### 2008 TVS Meeting Dates

The following lists 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 May 16th deadline is for the May issue).

Lecture Meeting	Board Meeting	Prime Focus Deadline
May 16	May 19	May 4
June 20	June 23	June 8
July 18	July 21	July 6

### Money Matters

Treasurer **David Feindel** left word of the TVS account balances as of April 18, 2008.

Checking	\$3,583.03	
CD #1	\$3,712.17	matures 05/17/08
CD #2	\$2,619.26	matures 05/27/08

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**Newsletter header image:** Arp 148

Two galaxies are colliding with each other, causing material to be drawn towards the "opposing" galaxy. Arp 128 is located in the constellation of Ursa Major, about 450 million light-years away.

This image taken with the WFPC2 and ACS/WFC cameras on board Hubble. Exposure time was 10.3 hours.

*Photo: NASA, ESA, the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration, and A. Evans (Univ. of Virginia, Charlottesville/NRAO/Stony Brook University)*

# Calendar of Events

**May 16, 6:00 p.m.**

**What:** *The White House Astrologer, the Roswell UFO, the "Face" on Mars, and a Young Universe: A Skeptical Look at Fiction Science*

**Who:** Andrew Fraknoi

**Where:** World Affairs Council Auditorium  
312 Sutter St., 2nd Floor, San Francisco

**Cost:** \$10; Free to the "Friends of the Center for Inquiry"

Doors open at 6:00 pm; Presentation starts at 6:30 pm

Thanks to the popular media, an enormous amount of attention has been given to some pretty amazing claims on the fringes of astronomy. These include the idea that your life path and romantic destiny are determined by the position of objects in the sky at the moment of your birth; that extraterrestrial space-craft have regularly landed on our planet (and kidnapped innocent citizens without being noticed); that an ancient race left us a message on the planet Mars in the shape of a human face; and that the entire cosmos is less than 10,000 years old.

In this illustrated talk, astronomer and popular lecturer Andrew Fraknoi will discuss the most famous "fiction science" claims related to astronomy, and provide the background and analysis needed to appreciate them properly. He will unveil some recent detective work about these cases, and show how there is often a lot LESS to them than initially meets the eye. And he will demonstrate how a few skeptical questions and a bit of careful investigation can often help bring these extra-ordinary cosmic claims down to Earth.

Andrew Fraknoi is the Chair of the Astronomy Department at Foothill College and Senior Educator at the Astronomical Society of the Pacific. He served as the Society's Executive Director for 14 years, and has organized over 20 national workshops on teaching astronomy. Fraknoi is the lead author of *Voyages Through the Universe*, which has become one of the leading astronomy textbooks in the country and recently wrote a book for children, *Disney's Wonderful World of Space*. He appears regularly on local and national radio explaining scientific developments in everyday language. In 2007, he was selected as the California Professor of the Year by the Carnegie Endowment for Higher Education and won the Gemant Prize of the American Institute of Physics for a lifetime of contributions to combining physics and culture. The International Astronomical Union has named asteroid 4859 Asteroid Fraknoi in recognition of his contributions to the public understanding of astronomy.

For more information, contact: Michael D Adkisson, Coordinator, Center For Inquiry, at 415-335-4618, [www.centerforinquiry.net/sf](http://www.centerforinquiry.net/sf).

**May 17, 9:30 a.m. to 5:00 p.m.**

**What:** NCHALADA

**Who:** Punny People

**Where:** Chabot Space & Science Center, Oakland

**Cost:** Free

NCHALADA, the Northern California History of Astronomy, Luncheon, and Discussion Association will meet on Saturday, 17 May, from 9:30 a.m. through 5:00 p.m. (with a lunch break at noon) at Chabot's Soda Board Room. The morning session, *More Fun with Next to*

*continued page 4*

## **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:**

David Woolsey  
fatdawg@comcast.net

### **Board of Directors**

Alane Alcorn, Jim Alves,  
Debbie Dyke, Gert Gottschalk,  
Mike Rushford, John Swenson.

## **Volunteer Positions**

### **Librarian:**

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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:**

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](http://www.trivalleystargazers.org)

[tvst@trivalleystargazers.org](mailto: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](mailto:rushford@eyes-on-the-skies.org)). You may access it by visiting [www.eyes-on-the-skies.org](http://www.eyes-on-the-skies.org).

### **TVS E-Group**

So how do you join the TVS e-group you ask? Just send an e-mail message to the TVS e-mail address ([tvst@trivalleystargazers.org](mailto: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*

*Nothing*, about recent developments in infinitesimal calculus, will be chaired by Alan Fisher. The afternoon session, *Predicted but Disproved*, about astronomical predictions that have since been found not true, including the “element” Nebulium and the *other* planet Vulcan (not to be confused the planet of Spock’s birth), will be chaired by Nancy Cox.

### May 19, 7:30 p.m.

**What:** *Near-Earth Objects: Finding Them Before They Find Us*

**Who:** Dr. Don Yeomans (NASA Near Earth Object Program Office)

**Where:** Kanbar Hall, Jewish Community Center

**Cost:** \$5.00

Near-Earth comets and asteroids have both seeded the early Earth with the building blocks of life and altered the evolutionary process with major extinction events. Recent ground-based and space-based observations of these objects make it less likely that we will go the way of the dinosaurs.

Program begins at 7:30 p.m. in Kanbar Hall at the Jewish Community Center of San Francisco, 3200 California Street (at Presidio Avenue). Ticket prices: \$5 per lecture or \$20 for the complete series available in advance or at the door.

Parking is available across the street in the UCSF Laurel Heights campus parking lot for \$1.25 per night. Parking in the JCC garage is \$1.25 per half-hour. The #1 California, #3 Jackson, #4 Sutter, and #43 Masonic MUNI lines stop directly in front of the building. The #38 Geary and #24 Divisadero buses stop only a few blocks away.

You can purchase tickets online at <http://www.calacademy.org/lectures/tickets> or buy them at the door. For more information, call 415-321-8000.

## News & Notes *continued*

### TVS Loaner Scope Donation

TVS received a donation from Pan Ackel to its Loaner Scope Program. The newest acquisition is a 6" Orion Deep Space Explorer dobsonian, with one eyepiece (26mm Sirius Plossl), and a Telrad. It has a single stalk spider and a helical focuser. The scope will be available for rental soon.

TVS’ telescope loaner program is a great way to try out different telescopes. For just a \$15/month fee (\$5 for student members), and a \$50 refundable deposit, any member can check out one of our telescopes. Even better, if you bring the telescope to one of our public or school star parties, we will refund your entire rental fee.

### School Star Party

Our presence (and telescopes) have been requested for a school star party on Thursday, May 15th at the Joe Michell Elementary school. They are having their Open House and would love to have a few telescopes there to spark an interest in science and astronomy. The Open House is from 5 p.m. to 7 p.m. Our scopes wouldn’t be needed until the end of the event, from 7 p.m. to 9 p.m. If anyone can help out, please let Dave Woolsey know (fatdawg-at-comcast-dot-net). Joe Michell school is located at 1001 Elaine Ave, Livermore, 94550.

### H2O News

Our observing site, H2O, will be unavailable to TVS members from May 15th through the 18th due to our hosts being on vacation. The gate will be locked in such a way as to bypass our locks.

In other news, our Open House nights have been decided upon. The first chance to visit the site comes May 31st. The next opportunity will be on June 21st. Our Open Houses are meant to give members an idea of what our dark sky site is like, and to be able to get a guided tour (of sorts) of the site.

For those members who have yet to check out the site, it is about an hour’s drive south of Livermore, along a very windy road. It is a primitive site—no water or electricity, with a couple of outhouses. What it lacks in amenities, it makes up for in dark skies.

For the May 31st Open House, plan to meet at the corner of Mines and Tesla at 6:45 p.m. The caravan will depart at 7:00. There is a \$3 per car entrance fee (exact change is a good idea). Sunset is at 8:22 p.m.

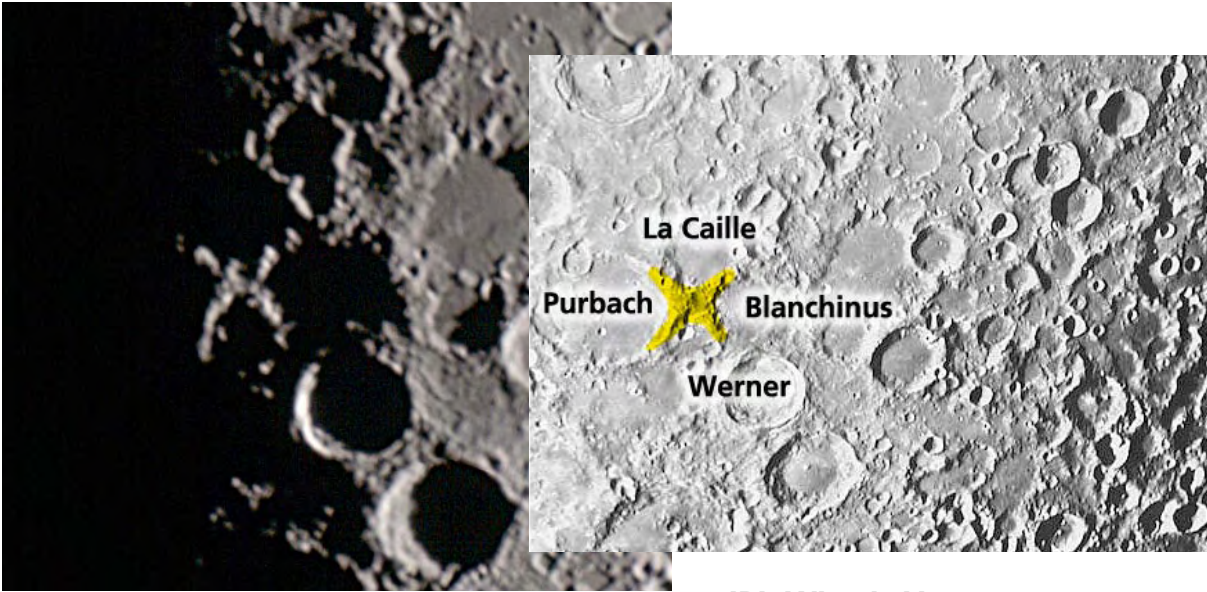
Our June 21st Open House will also meet at 6:45 p.m. for a 7:00 departure. Sunset is at 8:31 p.m.

### ISS Transits

We’ve all seen images of airplanes silhouetted against the Moon and figured capturing that image took a lot of luck. You’d think the same would be true for satellites, but there is a web site that will take the luck out of the equation.

The site <http://pictures.ed-morana.com/ISSTransits/predictions/> gives predictions of transits of the ISS in front of the Sun, Moon, and planets. The program can also give predictions for the Space Shuttle and some satellites.

You enter your location (latitude, longitude, elevation, etc.), and the program will download orbital information from the NASA web site. It will then generate a transit prediction file with details about each transit visible in that area. Being at the right place at the right time is made much easier.



"X" marks the spot. Photo: Conrad Jung

## Lunar X

Did you know that there's a big "X" marking a spot on the Moon? The "X" is known by various names: Lunar X, Werner X, and Purbach X.

Lunar X is an optical phenomenon that only occurs when conditions are just right during the first quarter Moon. It's found near the terminator line between craters Blanchinus, La Caille, Werner, and Purbach. The sunlight shines on the higher crater ridges, while the rest of the craters remain in darkness. This creates a light colored "X" standing out against the darker craters. This transitory event only lasts a few hours, so you'll need to know a fairly precise time and date in order to view the "X".

For 2008, you can view the X on the dates and times listed below (listed in UT and Pacific Time). The start times given are for when the X is in full bloom. If you want to see the progression of the X formation, you'll need to start viewing it about two hours before the listed start times.

Date	Start UT / PT	End UT / PT
May 12	15:00 / 7:00a	18:05 / 10:05a
June 11	02:10 / 6:10p (10th)	05:15 / 9:15p (10th)
July 10	12:35 / 4:35a	15:40 / 7:40a
Aug 8	22:55 / 2:55p	02:00 (9th) / 6:00p (8th)
Sep 7	9:45 / 1:45a	12:50 / 4:50a
Oct 6	21:35 / 1:35p	00:40 (Oct 7) / 4:40p (6th)
Nov 5	10:40 / 2:40a	13:40 / 5:40a
Dec 5	01:00 / 5:00p (4th)	04:00 / 8p (4th)

## JPL What's Up

The May edition of JPL's *What's Up* Podcast is online and it is available in both standard and high definition. <http://education.jpl.nasa.gov/amateurastronomy/archives.html>.

This month we step away from the Solar System and talk about 3 easy-to-see galaxies near the easy-to-find Big Dipper. These three galaxies, M81, M82 and M51 have also been imaged by the Spitzer Space Telescope. In the

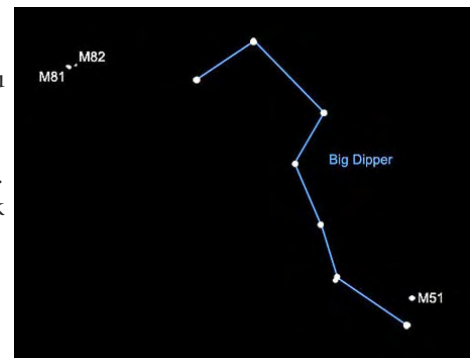
podcast, you can see the what Spitzer saw, and what you can see in a low power telescope or binocular view. Morris Jones took the astro photos this month—his first astrophotos!

It's not easy to find astrophotog-

rappers who will take piggyback wide field constellation photos, or low power images of the objects a novice might try to see, showing what they will see in their backyard telescope. Thanks, Mojo!

We have a second May *What's Up* in the works, and it'll be all about Mars. It will be available in time for the Phoenix Landing on May 25th.

This month Mars is still fairly high in the west at dusk and you won't want to miss it! It passes in front of an easy-to-see cluster of stars from the 22nd to the 26th. The cluster is called the Beehive Cluster, or Messier 44. It's a good binocular target too! On the day the Phoenix Lander



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## What's Up *by Debbie Dyke*

All times Pacific Daylight Saving Time.

### May

- 5 Mon **New Moon.** 5:18 a.m.  
Eta Aquarid meteors peak. 11:00 a.m.  
Moon at perigee (221,818 miles) 8:00 p.m.
- 10 Sat The Moon is less than  $2^\circ$  from the Beehive Cluster (M44). 11:00 p.m.
- 11 Sun Mother's Day.  
**First Quarter Moon.** 8:47 p.m.
- 12 Mon The Moon is  $5^\circ$  from Saturn and Regulus. 11:00 p.m.
- 13 Tue Mars at aphelion.  
Mercury at greatest elongation east ( $22^\circ$ ) 9:00 p.m.
- 15 Thur Try to spot Mercury very low in the northwest. 9:00 p.m.
- 16 Fri **Tri-Valley Stargazers general meeting.** 7:30 p.m. at the Unitarian Universalist Church,  
1893 N. Vasco Road, Livermore.
- 18 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.  
1910 Earth passes safely through tail of Comet Halley.
- 19 Mon Moon at apogee (251,969 miles) 7:00 a.m.  
**Full Moon.** Smallest in 2008. 7:11 p.m.  
**Tri-Valley Stargazers Board meeting.** 7:30 p.m. at the Round Table Pizza in Livermore.
- 20 Tues The Moon narrowly misses Pi Scorpii. 2:40 a.m.
- 22 Thur Mars occults the Beehive Cluster (M44). 11:00 p.m.
- 23 Fri 1980 The Tri-Valley Stargazers become incorporated as a non-profit organization.  
Start of RTMC-Riverside Telescope Makers Conference.
- 26 Mon Memorial Day.
- 27 Tue **Last Quarter Moon.** 7:57 p.m.
- 28 Wed 1959 First primates in Space—Able and Baker.
- 30 Fri 1966 Surveyor 1 makes the first soft landing on the Moon.
- 31 Sat 1935 Robert Goddard's rocket reaches 7,500'.

### June

- 1 Sun Texas Star Party starts today and runs through the 8th.  
1858 Lick Observatory dedicated
- 3 Tue **New Moon.** 12:23 a.m.  
Moon at perigee (221,495 miles) 6:00 a.m.  
1948 Dedication of the 200-inch Hale telescope at Palomar. Full time use of the scope doesn't take  
place until the following January.
- 4 Wed 1965 Ed White becomes first American to walk in space. His walk lasted 22 minutes.
- 7 Sat Mercury at aphelion.  
Mercury in inferior conjunction. 8:00 a.m.  
The Moon is just  $2.75^\circ$  from Mars. 11:00 p.m.
- 8 Sun 1625 Giovanni Cassini born.
- 10 Tue **First Quarter Moon.** 8:04 a.m.

## Stellar Compass for Space Explorers

by Patrick L. Barry

In space, there's no up or down, north or south, east or west. So how can robotic spacecraft know which way they're facing when they fire their thrusters, or when they try to beam scientific data back to Earth?

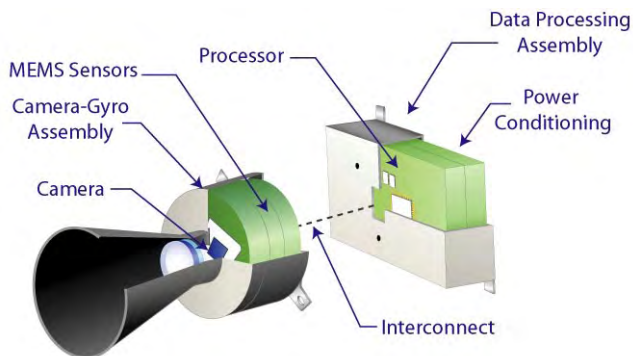
Without the familiar compass points of Earth's magnetic poles, spacecraft use stars and gyros to know their orientation. Thanks to a recently completed test flight, future spacecraft will be able to do so using only an ultra-low-power camera and three silicon wafers as small as your pinky fingernail.

"The wafers are actually very tiny gyros," explains Artur Chmielewski, project manager at JPL for Space Technology 6 (ST6), a part of NASA's New Millennium Program.

Traditional gyros use spinning wheels to detect changes in pitch, yaw, and roll—the three axes of rotation. For ST6's Inertial Stellar Compass, the three gyros instead consist of silicon wafers that resemble microchips. Rotating the wafers distorts microscopic structures on the surfaces of these wafers in a way that generates electric signals. The compass uses these signals—along with images of star positions taken by the camera—to measure rotation.

Because the Inertial Stellar Compass (ISC) is based on this new, radically different technology, NASA needed to flight-test it before using it in important missions. That test flight reached completion in December 2007 after about a year in orbit aboard the Air Force's TacSat-2 satellite.

"It just performed beautifully," Chmielewski says. "The data checked out really well." The engineers had hoped that ISC would measure the spacecraft's rotation with an accuracy of 0.1 degrees. In the flight tests, ISC sur-



Compass is built as two separate assemblies, the camera-gyro assembly and the data processor assembly, connected by a wiring harness. The technology uses an active pixel sensor in a wide-field-of-view miniature star camera and micro-electromechanical system (MEMS) gyros. Together, they provide extremely accurate information for navigation and control.

passed this goal, measuring rotation to within about 0.05 degrees.

That success paves the way for using ISC to reduce the cost of future science missions. When launching probes into space, weight equals money. "If you're paying a million dollars per kilogram to send your spacecraft to Mars, you care a lot about weight," Chmielewski says. At less than 3 kilograms, ISC weighs about one-fifth as much as traditional stellar compasses. It also uses about one-tenth as much power, so a spacecraft would be able to use smaller, lighter solar panels.

Engineers at Draper Laboratory, the Cambridge, Massachusetts, company that built the ISC, are already at work on a next-generation design that will improve the compass's accuracy ten-fold, Chmielewski says. So ISC and its successors could soon help costs—and spacecraft—stay on target.

Find out more about the ISC at [nmp.nasa.gov/st6](http://nmp.nasa.gov/st6). Kids can do a fun project and get an introduction to navigating by the stars at [spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.shtml](http://spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.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*



touches down, May 25th, you'll see Mars just to the west of the cluster. This open cluster of stars is almost 600 light years distant and has thrilled astronomers since pre-historic times. Through binoculars,

Mars will be the brightest object among two dozen or more stars in the cluster. There'll be some images and charts for these views in the next *What's Up*. But a pair of binoculars aimed at Mars will offer this same view.

Jane Houston Jones  
Senior Outreach Specialist, Cassini Program  
Cassini SOC <http://soc.jpl.nasa.gov/index.cfm>  
What's Up? <http://education.jpl.nasa.gov/amateurastronomy/index.html>

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.