



The Stargazer

January 2004

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EAS BUSINESS...

RECAP OF LAST MEETING

Meteorite Collector Adam Hupe and his brother brought a number of special meteorites, showed them, and discussed and described some of the stories that went with tracking them down. Included were lunar, and Mars meteorites, and a meteorite that struck a house in New Jersey.

Elections were held for 2004 officers, and the officers are:

President: Mark Folkerts
Vice President: Bob Lyons
Treasurer: Carol Gore
Librarian: Mike Locke

**NEXT EAS MEETING - SATURDAY JANUARY 31ST 7:00 PM -
 PROVIDENCE PACIFIC CLINIC (916 PACIFIC AVENUE)
 IN THE MONTE CRISTO ROOMS ON THE MAIN FLOOR.**

Map/directions to the meeting are available at:
http://members.tripod.com/everett_astronomy/directions_to_club_meeting_s.htm

Scheduled Meeting Dates:

Jan 31st - EAS Meeting - 7:00 PM
 Feb 28th - EAS Meeting - 7:00 PM
 Mar 27th - EAS Meeting - 7:00 PM
 Apr 17th - EAS Meeting - 7:00 PM
 Apr 24th - Astronomy Day
 May 22nd - EAS Meeting - 7:00 PM
 Jun 26th - EAS Meeting - 7:00 PM
 Jul 14-17th - Table Mt. Star Party
 Jul 31st - EAS Meeting - 7:00 PM
 Aug 11-14th - Oregon Star Party
 Aug 28th - EAS Meeting - 7:00 PM
 Sep 17-18th - Sun Lakes Star Party
 Sep 25th - EAS Meeting - 7:00 PM
 Oct 30th - EAS Meeting - 7:00 PM
 Nov 20th - EAS Meeting - 7:00 PM
 Dec 11th - EAS Holiday Dinner

MEMBER NEWS

Joanne Clark indicates there may be a talk on SETI given by Dr. Julie Lutz on Wednesday February 11 at EvCC. Check at the EAS meeting for confirmation, and room and time info.

FINANCIAL HEALTH

The club maintains a \$700+ balance. We try to keep approximately a \$500 balance to allow for contingencies.

CLUB STAR PARTY INFO

Upcoming star party schedule: None scheduled until spring.
 We try to hold informal close-in star parties each month during the spring and summer months on a weekend near the New moon at a member's property or a local park. (call Bob Lyon at (425) 337-1510 for info or check the EAS website.) Members contact Bob Lyons for scope borrowing.

CLUB SCOPES' STATUS

SCOPE	LOAN STATUS	WAITING
10-INCH DOBSONIAN	ON LOAN	NO WAIT LIST
60 MM REFRACTOR	AVAILABLE	NO WAIT LIST

EAS members: contact Bob Lyons (425) 337-1510 or bdlyons at verizon.net to borrow a scope.

ASTRO CALENDAR

January 2004

Jan 02 - STARDUST, Comet Wild 2 Encounter
 Jan 03 - Quadrantids Meteor Shower Peak
 Jan 04 - Earth at Perihelion (0.983 AU From Sun)
 Jan 10 - Asteroid 1 Ceres At Opposition (6.8 Magnitude)
 Jan 11 - Comet C/2003 L2 (LINEAR) Closest Approach To Earth (2.6 AU)
 Jan 11 - Asteroid 6 Hebe At Opposition (8.6 Magnitude)
 Jan 17 - Mercury at Greatest Western Elongation (24 Degrees)
 Jan 22 - Chinese New Year

Jan 31 - EAS Meeting - Providence Pac. Hospital - 7:00 PM

February 2004

Feb 26 - Moon Occults Mars

Feb 28 - EAS Meeting - Providence Pac. Hospital - 7:00 PM

March 2004

Mar 04 - Jupiter At Opposition

Mar 20 - Vernal Equinox, 06:49 UT

Mar 25 - Moon Occults Mars

Mar 28 - Daylight Saving - Set Clock Ahead 1 Hour (Europe)
 Mar 29 - Mercury Greatest Eastern Elongation (19 Degrees)
 Mar 29 - Venus Greatest Eastern Elongation (46 Degrees)
 Mar 31 - EAS Meeting - Providence Pac. Hospital – 7:00 PM

OVER THE AIRWAVES

“Our group of radio script writers now consists of EAS and SAS members Jim Ehrmin, Pat Lewis writer emeritus, Greg Donohue, and Ted Vosk, who are now regularly writing and helping to produce our astronomy radio show, "It's Over Your Head" on radio station KSER, FM 90.7. The six-minute segment is broadcast every Wednesday morning at approximately 7:20 A.M. and gives a weekly look at what's up in the sky over Snohomish County, with other information. If you have a good idea for an astronomy broadcast or would like to try your hand at writing a script, call Pat Lewis at (206) 524-2006 or email to joagreen@aol.com. If you are a listener to the program, show your support by giving the program director of KSER a call!" Web page with lots of archives and other info is available at <http://www.itsoveryourhead.org/>

KPLU 88.5 FM National Public Radio has daily broadcasts of "Star Date" by the McDonald Observatory of the University of Texas at Austin, Monday through Friday at 8:58 A.M. and 5:58 P.M. Saturday and Sunday). The short 2 minute radio show deals with current topics of interest in astronomy. The University of Washington TV broadcasts programs from NASA at 12:00 AM Monday through Friday, 12:30 AM Saturday, and 1:30 AM Sunday on the Channel 27 cable station.

EAS LIBRARY – BOOK & VIDEO LIST

The EAS has a library of books, videotapes, and software for members to borrow. We always value any items you would like to donate to this library. You can contact a club officer or **Librarian Mike Locke**, phone (425) 259-5995, email mlocke at lioninc.com, to borrow or donate any materials.

MEMBERSHIP BENEFITS & INFORMATION

Membership in the **Everett Astronomical Society (EAS)** will give you access to all the material in the lending library. The library, which is maintained by Scott Gibson, consists of several VCR tapes, many books, magazines, and software titles. Membership includes invitations to all of the club meetings and star parties, plus the monthly newsletter, *The Stargazer*. In addition you will be able to subscribe to *Sky and Telescope* for \$7 off the normal subscription rate, contact the treasurer for more information. **When renewing your subscription to *Sky & Telescope* you should send your S&T renewal form along with a check made out to Everett Astronomical Society to the EAS address.** The EAS treasurer will renew your *Sky and Telescope* subscription for you. **Astronomy** magazine offers a similar opportunity to club members.

EAS is a member of the **Astronomical League** and you will receive the Astronomical League's newsletter, *The Reflector*. Being a member also allows you the use of the club's telescopes, an award winning 10 inch Dobsonian mount reflector, built as a club project or the 60mm refractor. Contact Bob Lyons (425) 337-1510 to borrow a telescope. EAS dues are \$25. Send your annual dues to the **Everett Astronomical Society**, P.O. Box 12746, Everett, WA 98206. Funds obtained from membership dues allows the Society to publish the newsletter, pay Astronomical League dues and maintain our library.

OBSERVER'S INFORMATION...

LUNAR FACTS

Jan 15	Last Quarter Moon
Jan 21	New Moon
Jan 29	First Quarter
Feb 06	Full Moon
Feb 13	Last Quarter Moon
Feb 20	New Moon
Feb 28	First Quarter Moon

Digital Lunar Orbiter Photographic Atlas of the Moon

The Lunar and Planetary Institute has created a digital version of the Lunar Orbiter Photographic Atlas of the Moon, and Consolidated Lunar Atlas available online at:

<http://www.lpi.usra.edu/research/cla/menu.html>

http://www.lpi.usra.edu/research/lunar_orbiter

UP IN THE SKY -- THE PLANETS

Object	Rises	Transits	Sets	Constellation
Sun	7:44 am	12:21	16:59	Capricornus
Mercury	6:30 am	Daylight	Daylight	Sagittarius
Venus	Daylight	Daylight	20:22	Aquarius
Mars	Daylight	19:32	1:02 am	Aquarius
Jupiter	20:38	3:11 am	Daylight	Leo
Saturn	Daylight	22:23	6:18 am	Gemini
Uranus	Daylight	Daylight	19:15	Aquarius
Neptune	Daylight	Daylight	Daylight	Capricornus
Pluto	4:19 am	Daylight	Daylight	Serpens

(times local time for Everett PST)

NOAA SUN CALCULATOR

Need to know exactly what time the sun will set on Sept. 26, 2065? Or when it rose in 565 BC? How about the length of daylight a week from Tuesday in Albuquerque, N.M.? Just go to NOAA's solar calculator, now available on the Web. <http://www.srrb.noaa.gov/highlights/sunrise/gen.html>

INTERNATIONAL SPACE STATION – VISIBLE SEATTLE PASSES

ISS Visibility –

<http://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/SightingData/Seattle.html> or also see link

<http://www.heavens-above.com/PassSummary.asp?lat=47.979&lng=-122.201&alt=0&loc=Everett&TZ=PST&satid=25544>

CONSTELLATIONS OF THE MONTH

CANIS MAJOR: Canis Major (CMa), or the "Greater Dog" as literally translated, is a well-known and interesting constellation which borders on many of our familiar winter star groupings, including Monoceros, Puppis, Lepus, and Columba. Asterisms associated with this constellation include the "Winter Octagon", the "Winter Oval" and the "Winter Triangle". The central point of Canis Major is at RA=6h47m, and Dec.= -22 degrees; its overall brightness is ranked among the constellations at 6th, with a size-related calculation of almost 15 (14.733) visible stars for each 100 square degrees of constellation area. Canis Major also contains 56 visible stars brighter than magnitude 5.5. Its midnight culmination date is January 2nd, which makes it well placed for winter observing; the grouping has no associated meteor showers and one Messier object (M-41). This constellation ranks 43rd in size among the constellations (taking up about 380 square degrees (or about 0.921% of the sky), and is completely visible from latitudes S of +57 degrees and completely invisible from latitudes N of +79 degrees. The solar conjunction date of this constellation is January 4th. Sirius (alpha CMa) has the brightest apparent magnitude of any star in the nighttime sky, appearing 4 times brighter than Vega and 25 times brighter than Polaris. Sirius has an absolute magnitude of +0.7, which makes it 36 times more luminous than the Sun. Sirius is also a double star: its companion (Sirius-B, also known as "the Pup") was the first white dwarf ever discovered (by Alvin Clark in 1862, while testing a new telescope objective lens; however, its existence was suspected by German astronomer F.W. Bessel as early as 1834). The first appearance of Sirius in the eastern morning sky each year (the heliacal rising) was the major astronomical event in ancient Egypt.

This occurrence marked the impending flooding of the Nile River each year (agriculturally important because of the deposition of rich silt layers over wide areas). The legends of CMA are as follows: Canis Major and Minor were the hunting dogs of Orion, with Canis Major being so swift that it could outrun and overtake any animal. The ancient Egyptians saw the star Sirius in CMA as the god Anubis, with a man's body and the head of a jackal. Sirius became known as the "Dog Star", and the hot days of summer between July and early September became known as the "Dog Days" of summer. Canis Major contains some interesting celestial objects. Sirius, while not one of the Galaxy's most luminous stars, appears as the brightest because it also happens to be the fifth closest at 2.7 parsecs. It is an A-1 type main sequence star, measuring 1.8 solar diameters across, and it contains almost 2.5 times the Sun's mass. With an apparent magnitude of -1.4 , only Venus, Jupiter, Saturn, and Mars can outshine Sirius in the night sky; it is also interesting to realize that Sirius is over 500,000 times farther away from us than our Sun. Sirius B, the white dwarf companion of Sirius, shines at magnitude 8.7, but lies only about 9" away from Sirius, which easily overpowers it from being visualized in average backyard scopes (although with proper technique and instrumentation, it has been done). Messier-41 is a beautiful open cluster located within the confines of Canis Major. It lies about 4 degrees south of Sirius, and shining with the light of a 5th magnitude star, it measures 32' across. M-41 contains about 100 stars of varying colors and temperatures, the brightest of which is about 7th magnitude. The brightest are G- and K-type giant stars, followed by several bright blue B-type giants with high intrinsic luminosities. This beautiful open cluster lies about 750 parsecs away, and it has a density of about 1.1 stars per cubic parsec. Other well-known open clusters in Canis Major are NGC-2354 and NGC-2362 (the latter surrounds the bright star Tau Canis Majoris, and is one of the youngest known galactic clusters, probably less than 1,000,000 years old). Still other open clusters in this region include NGC-2360, NGC-2374, and NGC-2383, NGC-2204, and NGC-2243. One of the most massive and also luminous stars known is the unusual variable star UW Canis Majoris, an eclipsing binary consisting of two stars that orbit each other in about 4.5 days. These two stars are flattened into elliptical shapes by the mutual tug of gravity, as the distance between them is a mere (in astronomical terms) 17 million miles. From Earth, the distance to this system is 1.0 kiloparsec, making its luminosity 16,000 times that of the Sun!! Other interesting objects in Canis Major include NGC-2359 (emission nebula), IC-468 (emission nebula), and IC-2165 (magnitude 12.5, 8" across planetary nebula). Canis Major also contains two galaxies of interest: NGC-2207 (spiral 12.3 magnitude galaxy, measuring 2.5' x 1.5' across) and NGC-2217 (SBa-barred spiral, 12th magnitude, measuring 4.0' x 3.0' across). The latter is shown in at least an 8-inch reflector on a good seeing night as a dim, fairly even halo of light surrounding a distinctly brighter, very condensed core. Try to get out this winter to do some observing in this very interesting and well-known constellation.

YOUNG ASTRONOMER'S CORNER

The Young Astronomer's Corner has in the past been published in a question and answer format. The purpose of this periodic feature is to answer some common and familiar questions heard frequently in astronomy circles and classrooms. So, we hope to answer some of your astronomy-related questions in this manner. If not, let us know what your questions are (by calling or e-mailing an Officer or the Newsletter co-editor for example), and we will do our best to answer them for you!

QUESTION: *Why is it cold in winter and hot in summer?*

ANSWER: Because of the tilt of the Earth's axis. When the Earth's axis tilts away from the Sun during winter, the Northern Hemisphere doesn't get as much sunlight as during the summer months; it gets colder as a result (even though Earth is about 3 million miles closer to the Sun during the winter, which shows the overwhelming importance of the axis "tilt" vs. the relative seasonal closeness to the Sun). When the North Pole is pointed in the direction of the Sun during summer, the Northern Hemisphere of the Earth heats up!

QUESTION: *Do comets "blaze" across the sky?*

ANSWER: No. Over the time frame of a long night, you might be able to notice a comet (on the rare occasions when there is a visible one!) move very slowly across the background of stars, but you will never see one "blaze" across the sky in a matter of seconds or minutes! Comets are generally (and many would say "thankfully!!") very far away from Earth; the farther away an object is, the slower it appears to be moving. This phenomenon is somewhat similar to a jet flying 40,000 feet overhead. Even though it may be flying at around 600 miles per hour, from your vantage point on the ground it appears to be moving very slowly.

QUESTION: *Is the North Star the brightest star in the sky?*

ANSWER: No. The North Star is not anywhere near the brightest star in the sky. Because most people have heard about the North Star, many people think that it is the brightest of them all. But in reality, the North Star (also known as Polaris) is really just an average star. What makes Polaris special is that it is lined up with the north pole of the Earth, and if it were not located where it is, the North Star would simply be the brightest star in the constellation of the Little Bear (or Ursa Minor). The brightest star in all the sky is the Sun, but the brightest in the night sky is Sirius in the constellation of Canis Major.

QUESTION: *Will the North Star always point to the north?*

ANSWER: Again, the answer is no. For our lifetimes, and the lifetimes of many, many hundreds of more human generations, the North Star will show the way north. As mentioned above, the North Pole of the Earth points in the direction of Polaris. But the Earth's North Pole also wobbles somewhat as the Earth travels around the Sun, moving around in a huge circle that takes 26,000 years to complete. About 2,000 years ago, the North Pole pointed to another star (Thuban) in the constellation of Draco. In about 12,500 years from now, the North Pole will point to the bright summer star known as Vega (in the constellation of Lyra), and will point again back to the North Star (Polaris) as the circle is completed in 26,000 years.

QUESTION: *Is there a "South Star"?*

ANSWER: No. There are no bright stars that line up with the South Pole of the Earth, as Polaris does with the North Pole. Thus, although there is a South Pole, there is no "South Star". As mentioned above,

PLANETARY FOCUS

"Planetary Focus" is a periodic column that has been published occasionally in the EAS "Stargazer"; beginning this year, it will be published every other month. If you have a favorite planet that you would like information and/or statistics on, please contact newsletter co-editor Bill O'Neil.

Bright, beautiful Venus is becoming more spectacular each evening this winter in the southwest sky; the interval between sunset and Venus-set is also increasing (3 hours at month's end). Further, for mid-northern latitude skywatchers, the evening appearances of Venus will be at the highest above-horizon

altitudes in the entire 8-year cycle of repeating appearances. The focus of this month's column is thus very appropriately **Venus**, and these are the facts:

Rotation around the Sun: approximately every 225 days (earth = 365 days).

Orbit: from 0.72 to 0.73 Astronomical Units; this is an orbit that varies between approximately 67 and 68 million miles from the sun.

Inclination of Orbit: 3.4 degrees.

Diameter at Equator: 12,104 kilometers (or 7,565 miles).

Mass: 0.82 that of earth (about 8-tenths that of earth).

Density: 5.2 times that of water

Period of Rotation on its own axis: 243 days, zero hours, and 14.4 minutes (earth = 24 hours).

Satellites (moons): none

Gravity: about nine-tenths (0.91) that of earth.

Special Notes: Venus is never very far from the sun in the sky. It reaches its greatest elongation of 45 to 47 degrees approximately 72 days before and after inferior conjunction. At its greatest brightness, Venus is close to magnitude -4.4 , and is then brighter than everything in the sky except the sun and the moon. Venus has very hostile surface and atmospheric conditions; it has been determined that its atmosphere rotates almost 60 times faster than the solid planet itself. In a telescope, the disc of Venus appears a brilliant yellowish-white in color, and, like the moon, exhibits phases. The atmosphere of Venus consists primarily of carbon dioxide (98%), 1-3% nitrogen, and smaller percentages of helium, neon, krypton, and argon. The atmospheric pressure on the surface of Venus is about 90 times greater than that of earth, and the surface temperature is extremely high, much higher than that of earth's average surface temperature. In fact, the surface temperature of Venus is higher than that of any other planet. This is the result of the planet's "greenhouse effect" involving the layered clouds of Venus, and the large amount of carbon dioxide in its atmosphere. Venus has a nickel-iron core, which rotates slowly; as a result, Venus has little of its own magnetic field. The surface of Venus shows much evidence of past volcanic activity. Venus has had several man-made probes visit it: these include the Russian Venera probes, as well as the Mariner 2, 5, and 10 probes; the Pioneer Venus probes, and Magellan.

'ASTRONOMY & TELESCOPE LINGO' AND 'ASTRONOMY FUN FACTS'

Beginning this year and with this edition, [Astronomy and Telescope Lingo](#) and [Astronomy Fun Facts](#) will, like [Mirror Images](#) and [Planetary Focus](#), become bi-monthly columns. This month (January, 2004), [Mirror Images](#) and [Planetary Focus](#) will publish; starting in February, 2004, the set of [Astronomy and Telescope Lingo](#) and [Astronomy Fun Facts](#) feature columns will publish at a bi-monthly frequency. Each will have all new content. This change is being made to periodically preserve more room for timely and "hot off the press" astronomy-related internet content, and perhaps more membership contributions related to astronomy, in the future. See you next month!

"MIRROR" IMAGES

"MIRROR" IMAGES: Because we live in the Northern Hemisphere, we often tend to focus (in both observing and reading) on celestial objects in this hemisphere. The point of this bi-monthly column is to inform club members about similar objects

in the Southern Hemisphere (to the ones we are already familiar with in the Northern Hemisphere). The general class of object will first be defined, and then a representative object from each hemisphere will be described. **Note: "MIRROR" IMAGES" is strictly the name of the new column, and is not intended to imply that there is optical mirror symmetry between the two objects.**

CLASS OF OBJECT: SYMBIOTIC STARS: A variable 'star' whose spectrum demonstrates spectral lines characteristic of gases at two very different temperatures; typically these lines are of an M-star (approx. 3,500 degrees K) and a B-star (approx. 20,000 degrees K) superimposed. A symbiotic 'star' is in fact a semi-detached close binary system. The red giant component produces the low-temperature spectral lines, whereas the higher-temperature spectral lines come from gas streams that are falling on to a companion star, which is usually a white dwarf or a main-sequence star, but it is suspected that this star may possibly also, with some systems, be a neutron star. Mass loss is due to the red giant's stellar wind, and is thus much slower than the gravitational transfer seen in otherwise similar recurrent novae systems. Symbiotic stars, a form of cataclysmic variable, have smaller and more irregular outbursts than other cataclysmics. An outburst in the R-Aquarii system has been noted to have produced a narrow jet, traveling at about 2,000 kilometers per second and approximately 1,500 AU in length, which is visible in both optical and radio telescopes.

ASTRONOMICAL NOTES -- ON & OFF THE NET...

MAJORITY OF PLANETARY NEBULAE ARISE FROM BINARIES

Near the end of its lifetime, a star like the Sun ejects its outer layers into space, producing a hazy cloud of material called a planetary nebula. The complex shapes and dazzling colors of planetary nebulae make them some of the most popular objects in the night sky, for both amateur observing and scientific study. New research suggests that many if not most of the stellar corpses at the centers of these wildly varied cosmic objects have companion stars, a surprising finding that will influence how astronomers explain their origins. Astronomers used the Wisconsin-Indiana-Yale-NOAO 3.5-meter telescope at the Kitt Peak National Observatory to take radial velocity measurements of 11 central stars of planetary nebulae (PNe), looking for the telltale, repeatable wobble that indicates the presence of a companion's gravitational influence. This technique is also used to search for extrasolar planets around nearby stars. Ten of the 11 central stars of the PNe in the recent study showed clear evidence for radial velocity oscillations. *"If our current results are confirmed with further observations, we could be at the start of a revolution in the study of the origin of planetary nebulae,"* says Howard Bond of the Space Telescope Science Institute. *"If these nebulae arise from binary stars, it implies a very different origin for these systems than what most astronomers had thought."* It might be expected that nebulae ejected from spherical stars would be spherical, but many years of telescope observations show this not to be the case. In fact, most PNe are either elliptical or have pronounced lobes, often accompanied by jet-like structures. There is general agreement that in order to eject gas with these observed morphologies, single stars would have to rotate rather rapidly or have reasonably strong magnetic fields, which themselves are the product of stellar rotation. However, the stars that most commonly eject PNe are large, bloated giants, indisposed to fast rotation. *"The most direct way to spin up these vast, fluffy stars is by the action of an orbiting companion. In extreme cases, as a red giant star gradually increases in size, it may actually swallow a companion star, which would then spiral*

down inside the giant and eventually eject its outer layers," explains Orsola De Marco, an astronomer at the American Museum of Natural History (AMNH) in New York. "Despite this, the mainstream astronomical view remains rooted in single star theories for the evolution of planetary nebulae, supported by the small percentage of planetary nebulae central stars that that were previously known to be binaries. However, our new research threatens to turn this viewpoint on its head." Astronomers currently believe that the majority of stars -- those that begin with no more than eight times the mass of our Sun -- end their lives by ejecting a planetary nebula and becoming a cosmic ember called a white dwarf. However, the new results from the WIYN telescope suggest that the story may be more complicated, in that an interaction with a companion star may be required to produce most planetary nebulae. "We need more data to determine the exact periods of the binary central stars, since this is the only way to be sure of their binarity and eliminate other possible physical sources that could simulate the stellar wobble," De Marco says. "We are reasonably sure that these variations are due to binarity, but determination of their precise periods is the only way to be sure. We must also increase the size of our sample." Among the objects observed in this initial study are Abell 78, NGC 6891, NGC 6210, and IC 4593. The new radial velocity measurements were taken by the WIYN Hydra spectrographic instrument. Previous Hubble image of NGC6210 <http://hubblesite.org/newscenter/newsdesk/archive/releases/1998/36/image/a>

STARDUST SURPRISE

When NASA's Stardust spacecraft flew by Comet Wild 2, the probe saw something that surprised astronomers. On Jan. 2nd, 2004, NASA's Stardust spacecraft approached Comet Wild 2 and flew into a storm. Flurries of comet dust pelted the craft. At least half a dozen grains moving faster than bullets penetrated Stardust's outermost defenses. The craft's 16 rocket engines struggled to maintain course while a collector, about the size of a tennis racquet, caught some of the dust for return to Earth two years hence. All that was expected. Then came the surprise. It happened when Stardust passed by the core of the comet, only 236 km distant, and photographed it using a navigation camera. The images were intended primarily to keep the spacecraft on course. They also revealed a worldlet of startling beauty. At the heart of every comet lies a "dirty snowball," a compact nucleus of dust and ice that the sun vaporizes, little by little, to form the comet's spectacular tail. These nuclei are hard to see. For one thing, most are blacker than charcoal; they reflect precious little sunlight for cameras. Plus they're hidden deep inside a cloud of vaporizing gas and dust, called "the coma." Stardust's plunge into Wild 2's coma allowed it to view the nucleus at close range. Previous flybys of Comet Halley by the European Giotto probe and Comet Borrelly by NASA's Deep Space 1 revealed lumpy cores without much interesting terrain--as expected. These comets have been sun-warmed for many thousands of years. Solar heating has melted away their sharpest features. Comet Wild 2, however, looks different. "We were amazed by the feature-rich surface of the comet," says **Donald Brownlee of the University of Washington**, the mission's principal investigator. "It is highly complex. There are barn-sized boulders, 100-meter high cliffs, and some weird terrain unlike anything we've ever seen before. There are also some circular features," he adds, "that look like impact craters as large as 1 km across." "The high cliffs tell us that the crust of the comet is reasonably strong," notes Brownlee. It's probably a mixture of fine-grained rocky material held together by frozen water, carbon monoxide and methanol. Certainly a lander could touch down there, or an astronaut could walk across the surface without worrying too much about the

ground collapsing. An astronaut standing on Comet Wild 2 would see a truly fantastic landscape, speculates Brownlee. "I imagine them inside one of the craters, surrounded by deep cliffs." Icy spires, as tall as a person, might rise out of the crater floor. "These would be the comet-equivalent of 'snow spikes' on Earth--those little jagged ridges that form when snow is exposed to sunlight and melts." Getting out of the crater would be easy. "Just jump," says Brownlee, "but not too hard." The comet's gravity is only 0.0001-g, so "you could easily leap into orbit." Some of the photos from Stardust reveal gaseous jets. "The jets come from active regions on the comet's surface, fissures or vents probably, where the ice is vaporizing and rushing into space," Brownlee says. This is how mass is transferred from the comet's nucleus to its tail. Viewed from the surface, the jets would be nearly transparent. But an astronaut could spot them by looking for "dust entrained with the gas. Dust grains glinting in the sunlight would look like tracer bullets shooting out of the ground." A careful explorer could survey the entire 5-km nucleus in only a few hours, leaping high above the surface, dodging the occasional jet. "What an experience that would be," he says. There are billions of comets in the solar system. "We've gotten a close-up look at only three," says Brownlee. And one of the three, Comet Halley, presented its night side to the cameras. So it's too soon to say whether Comet Wild 2, among comets, is truly unusual. Unlike comets Halley and Borrelly, notes Brownlee, "Wild 2 is a very recent arrival to the inner solar system." For billions of years it orbited in the cold deep space beyond Jupiter, until 1974 when it was nudged by Jupiter's gravity into a sun-approaching orbit. Since then the comet has passed by the Sun only five times; solar heating is only beginning to mold its surface. And, according to Brownlee, that might be the key to the comet's appearance. "Wild 2's surface is a mixture of young and old that we haven't see before," he explains. Young features include possible sinkholes collapsing as the terrain is warmed. Impact craters and their ejecta, on the other hand, are old scars from time spent in the outer solar system. The old parts of Wild 2 are what make the comet an attractive target for the Stardust probe, which captured a thousand or more grains of comet dust during the flyby. Such material, little altered since the formation of the solar system, could tell us a great deal about our origins. The craft's payload will return to Earth in 2006 for analysis by scientists. If a single picture from the navigation camera can surprise researchers, just imagine what's in store when they get their hands on a thousand pieces of the comet itself. http://science.nasa.gov/headlines/y2004/16jan_stardust.htm

ON-LINE VOLUNTEER FINDS CLOSE-APPROACHING ASTEROID

A volunteer who analyzes on-line images for the University of Arizona Spacewatch program has discovered a 60-to-120-foot diameter asteroid that missed Earth by about 1.2 million miles Jan. 22. While the asteroid is no cause for alarm, its discovery marks a milestone in a new project that relies on volunteers to spot fast-moving objects, or FMOs, in Spacewatch images. Even if asteroid 2004 BV18 hit Earth head-on, it would only create a bright flash of light in the upper atmosphere, and possibly streaks of light as asteroid fragments heat to incandescence while they rocket across the sky. "In other words, a bright meteoric display known as a bolide," said Robert S. McMillan, who directs Spacewatch. The asteroid appeared in images taken by Spacewatch astronomer Miwa Block with the 0.9-meter telescope at 1:49 UT on Jan. 19, which is 6:49 p.m. MST on Jan. 18. Volunteer Stu Megan reviewed the images on the Internet, and spotted the asteroid's light trail. Megan is part of a Web-based program that Spacewatch made public last October through a grant from the Paul Allen Charitable Foundation. "It's hard to explain the excitement when you find a fast-moving asteroid,"

Megan said in an E-mail message. Megan is semi-retired from a 35-year career in information technology and an amateur astronomer who is interested in finding potentially hazardous asteroids. A resident of Tucson, he has reviewed close to 6,500 Spacewatch images during the past three months. *"When I saw (this light trail), it just sat there screaming at me. It was very, very bright and a perfect length. I knew it could be nothing else."* Three observatories made follow-up observations of the asteroid, so scientists at the Minor Planet Center could compute its orbit. The Minor Planet Center gave Asteroid 2004 BV18 its provisional designation yesterday. (A provisional designation is one that's adopted until the asteroid's orbit is known well enough that astronomers won't lose it.) The center also published the discovery and follow-up studies in the Minor Planet Electronic Circular. The asteroid is classified as an "Apollo" asteroid because it is on average slightly farther from the sun than the Earth is, but its modest orbital eccentricity causes it to occasionally cross Earth's orbit. At the time Megan discovered the asteroid, it was six times farther from Earth than the Earth is from the moon. Seen from Earth, it appeared to move across the sky at about 6.5 degrees per day, or about the diameter of 13 full moons. At closest approach tomorrow, it will be five times the distance between Earth and the moon. Spacewatch operates 1.8-meter and 0.9-meter CCD-equipped telescopes on Kitt Peak, about 45 miles southwest of Tucson, Ariz. The project studies solar system dynamics through the movements of asteroids and comets. Spacewatch also finds potential targets for interplanetary spacecraft missions and hunts for objects that might pose a threat to Earth. The 0.9-meter telescope typically takes two-minute-long exposures, and objects closest to Earth move so quickly through the telescope's field of view that they trace a line on the sky image. Objects orbiting farther from Earth appear to move more slowly, just as an airplane flying at 40,000 feet appears to move slower than it does at takeoff. Computer software has a hard time detecting FMO light trails because they vary greatly in length and direction. Human observers are still much better than computers at finding FMOs in Spacewatch images. But the work is too time intensive for on-duty Spacewatch observers. So the astronomers have turned to 30 volunteers for help. FMO project volunteers are based in the United States, Germany, and Finland. They would gladly accept more. The only requirements are interest, sharp eyes, and access to a computer when astronomers are operating Spacewatch telescopes on Kitt Peak. *"Our reviewers are students, people with full-time jobs, retired - they run the gamut,"* McMillan said. *"While our most dedicated volunteers tend to be members of the amateur astronomy community or at least have a strong interest and knowledge of astronomy, we have members who have just begun to climb the learning curve. We hope that our Website helps fuel curiosity and participation in science in general, as well as provide a productive outlet for those eager to apply their computer skills,"* McMillan said. McMillan's Spacewatch team protects the privacy of its volunteers, releasing volunteers' names only to the Minor Planet Center when discoveries are to be published. Astronomers want to study small asteroids to know how many there are, their spin rates and surface properties, McMillan said. Spin rate tells observers if the asteroid is a single solid piece or a loose aggregate of rocks. The distribution of asteroid sizes tells scientists about the effects of asteroid collisions during the lifetime of the solar system. The smallest asteroids are free of regoliths, the blanket of loose dust or dirt that obscures the bare rock surfaces of larger asteroids. And the smallest asteroids are useful for studying non-gravitational forces that work on very long time scales, such as the Yarkovsky Effect, a phenomenon where heat propels objects through space. More details on how to volunteer

for the FMO Project are on the Web at http://fmo.lpl.arizona.edu/FMO_home/index.cfm

SATURN RINGS IN THE NEW YEAR

Lovely Saturn had a close encounter with Earth this year on New Year's Eve. At midnight, directly overhead you'll see a yellow star outshining the others around it. That star is a planet: Saturn, having its closest encounter with Earth for the next 29 years. *"Saturn's going to be really beautiful,"* says NASA astronomer Mitzi Adams. *"Not only will Saturn be about as close to Earth as it can get--748 million miles away-- but also its rings are tipped toward us. Sunlight reflected from Saturn's rings makes the planet extra bright."* If you have a telescope, advises Adams, be sure to point it at Saturn. Even a small 'scope will reveal the spectacular rings. *"They're breathtaking,"* she says. 2004 is going to be a big year for Saturn. The Cassini-Huygens spacecraft, en route since 1997, will arrive there in June. Other spacecraft have visited Saturn-- Pioneer 11 and the Voyagers--but they merely flew by, taking hurried pictures during encounters that lasted little more than days. When Cassini reaches Saturn it will stay, orbiting and studying the planet for at least four years. Saturn is a world of great mystery. Consider its rings: Researchers aren't sure what made them or when. Some evidence suggests that the rings are young--only a few hundred million years old. If so, they first encircled Saturn at about the same time dinosaurs took over the Earth. In the cosmic scheme of things, this is recent history. Saturn's rings might be collapsing just as fast as they formed--so say some theorists. Small moons orbiting through the outermost regions of the ring system are gaining angular momentum at the expense of the rings, a result of gravitational interactions between the moons and chunks of ring-matter. During the next few hundred million years, the outer half of the rings could sag toward the planet as the little moons (called shepherd satellites) are flung away. Saturn will look much less impressive after that. Could it really happen? Cassini will gather the data scientists need to answer that question and many others about Saturn's rings, moons, weather and magnetism. There's much to learn about this distant planet. At least as intriguing as Saturn is its giant moon Titan. *"You can see Titan through a telescope--an 8th magnitude 'star' a few ring-diameters from Saturn, moving from night to night as it orbits the planet,"* notes Adams. Titan is bigger than Mercury and Pluto, and it has an atmosphere 60% denser than Earth's. In other words, Titan is a full-fledged world. If it orbited the sun it would surely be considered a planet. The curious thing about Titan is how little we know about it. It could be teeming with life or peppered by ruins from ancient civilizations, and we wouldn't know because Titan is completely covered by thick orange clouds. A camera onboard the Hubble Space Telescope has been able to see through them, to a degree, by observing at infrared wavelengths. The images hint of continents and seas, but Titan is so far away even Hubble can't take a clear picture of it. In January 2005, Cassini will drop the European Space Agency's Huygens probe through the clouds to find out what lies underneath. This could be one of the most exciting moments in solar system exploration--ever. Huygens will take more than 1,100 pictures during its two and a half hour descent by parachute. Scientific instruments will sample Titan's atmosphere, gauge its winds, and--if the probe survives landing--measure the physical properties of the ground. Huygens probably won't find evidence of life, at least not life as we know it. Titan is too cold. Its surface temperature, researchers estimate, is 289°F below zero. This doesn't mean life is impossible, though. Titan's atmosphere is rich in organic compounds: ethane, methane, hydrogen cyanide and others. The low temperature of the moon encourages ethane and methane to liquefy, so there might be puddles, lakes or even oceans of liquid hydrocarbons sloshing

around on the surface. Perhaps these are places where organic molecules get together for the first stirrings of simple life. The truth is, no one knows what Huygens will find. Or Cassini. And that's what makes exploration fun--something worth pondering in this new year.
http://science.nasa.gov/headlines/y2003/12dec_saturn.htm

PLANETARY SURVIVOR STRATEGY: OUT-EAT, OUT-WEIGH, OUT-LAST!

Of the first 100 stars found to harbor planets, more than 30 stars host a Jupiter-sized world in an orbit smaller than Mercury's, whizzing around its star in a matter of days (as opposed to our solar system where Jupiter takes 12 years to orbit the Sun). Such close orbits result from a race between a nascent gas giant and a newborn star. Astronomers Myron Lecar and Dimitar Sasselov showed what influences this race. They found that planet formation is a contest, where a growing planet must fight for survival lest it be swallowed by the star that initially nurtured it. *"The endgame is a race between the star and its giant planet,"* says Sasselov. *"In some systems, the planet wins and survives, but in other systems, the planet loses the race and is eaten by the star."* Although Jupiter-sized worlds have been found orbiting incredibly close to their parent stars, such giant planets could not have formed in their current locations. The oven-like heat of the nearby star and dearth of raw materials would have prevented any large planet from coalescing. *"It's a lousy neighborhood to form gas giants,"* says Lecar. *"But we find a lot of Jupiter-sized planets in such neighborhoods. Explaining how they got there is a challenge."* Theorists calculate that so-called "hot Jupiters" must form farther out in the disk of gas and dust surrounding the new star and then migrate inward. A challenge is to halt the planet's migration before it spirals into the star. A Jupiter-like world's migration is powered by the disk material outside the planet's orbit. The outer protoplanetary disk inexorably pushes the planet inward, even as the planet grows by accreting that outer material. Lecar and Sasselov showed that a planet can win its race to avoid destruction by eating the outer disk before the star eats it. Our solar system differs from the "hot Jupiter" systems in that the race must have ended quite early. Jupiter migrated for only a short distance before consuming the material between it and the infant Saturn, bringing the King of Planets to a halt. If the protoplanetary disk that birthed our solar system had contained more matter, Jupiter might have lost the race. Then it and the inner planets, including Earth, would have spiraled into the Sun.

"If Jupiter goes, they all go," says Lecar. *"It's too early to say that our solar system is rare, because it's easier to find 'hot Jupiter' systems with current detection techniques,"* says Sasselov. *"But we certainly can say we're fortunate that Jupiter's migration stopped early. Otherwise, the Earth would have been destroyed, leaving a barren solar system devoid of life."*

A FAILED STAR IS BORN - THE ORIGINS OF BROWN DWARFS

In cosmic circles, brown dwarfs are something of a flop. Too big to be considered true planets, yet not massive enough to be stars, these free-floating celestial bodies are, in fact, sometimes referred to as failed stars. But do they really form as stars do -- from collapsing clouds of gas -- or are their origins completely different? A series of publications by astronomer Ray Jayawardhana and collaborators offers evidence that brown dwarfs and Sun-like stars are born in much the same way. *"They at least have very similar infancies, which may mean that they also have very similar origins,"* said Jayawardhana. Stars form in cold clouds of gas and dust in interstellar space. Dense clumps within these clouds contract under their own gravity, spinning up in the process and gathering material from the surroundings into

a disk. Eventually, if a growing proto-star accumulates enough mass, its core becomes hot and dense enough for nuclear fusion to occur, and the new star begins to shine. Some scientists have suggested that brown dwarfs form the same way but simply don't accumulate enough mass to ignite hydrogen fusion, and calculations show that it's at least theoretically possible for objects with masses as low as those of brown dwarfs to be born this way. But other scientists have proposed that brown dwarfs are runts kicked out of stellar litters. In this scenario, brown dwarfs are born in multiple star systems and compete with their siblings for matter from the natal cloud. In such systems, the slowest-growing object may be ejected before it gathers enough material to become a star, computer simulations suggest. One way to distinguish between the two possibilities is by studying disks of dust and gas around young brown dwarfs. If brown dwarfs form as stars do, they should have large, long-lived accretion disks like those found around young stars. But if they have been ejected from multiple star systems, their disks should be shaved down by the gravitational interactions that lead to ejection. Jayawardhana and colleagues searched for dusty disks around young brown dwarfs by observing their infrared emission with the 8-meter VLT in Chile and the 10-meter Keck I telescope in Hawaii. Because dust particles in a disk absorb light and re-radiate the energy at infrared wavelengths, a brown dwarf with a disk will emit more infrared light than one without a disk. *"We found that the majority of brown dwarfs are surrounded by dusty disks at an age of a million years or so,"* said Jayawardhana. *"That's similar to young stars at the same age."* Although it's not possible to directly determine the disks' sizes, their presence around some brown dwarfs as old as 10 million years suggests that they aren't pared away in early life. Other spectroscopic observations, using the twin 6.5-meter Magellan telescopes in Chile and the Keck I telescope, showed that brown dwarfs also accrete material from surrounding disks the same way as stars do -- although at a slower pace. *"We detect telltale signs of gas flowing from the inner edge of the disk onto the brown dwarf at velocities of over a hundred kilometers per second,"* said Jayawardhana. In one intriguing case, astronomers have also found evidence of material spewing out from the poles of a brown dwarf. Such jets have been seen in young stars of the same age, but not until now in brown dwarfs. *"If confirmed, the presence of jets would further strengthen the case for remarkably similar infancies for brown dwarfs and Sun-like stars,"* said Jayawardhana. *"I wouldn't say that the story is signed, sealed and delivered,"* Jayawardhana said, *"but the preponderance of evidence is very much leaning in the direction of these things forming the same way as stars."* And the evidence uncovered so far leads to even more tantalizing prospects. *"Now that we know many young brown dwarfs are surrounded by disks,"* he said, *"I can't help but wonder if comets and asteroids -- if not small planets -- could form in these disks."*

ASTRONOMERS MEASURE DISTANCE TO WELL-KNOWN STAR

The cluster of stars known as the Pleiades is one of the most recognizable objects in the night sky, and for millennia has been celebrated in literature and legend. Now, a group of astronomers has obtained a highly accurate distance to one of the stars of the Pleiades known since antiquity as Atlas. The new results will be useful in the longstanding effort to improve the cosmic distance scale, and to conduct research on the stellar life-cycle. The astronomers have reported the best-ever distance to the double-star Atlas. The star, along with "wife" Pleione and their daughters, the "seven sisters," are the principal stars of the Pleiades that are visible to the unaided eye, although there are actually thousands of stars in the cluster. Atlas, according to the team's decade of careful interferometric measurements, is somewhere between 434

and 446 light-years from Earth. The range of distance to the Pleiades cluster may seem somewhat imprecise, but in fact is accurate by astronomical standards. The traditional method of measuring distance is by noting the precise position of a star and then measuring its slight change in position when Earth itself has moved to the other side of the sun. This approach can also be used to find distance on Earth: If you carefully record the position of a tree an unknown distance away, move a specific distance to your side, and measure how far the tree has apparently "moved," then it's possible to calculate the actual distance to the tree by using trigonometry. However, this procedure gives only a rough distance estimate to even the nearest stars, due to the gigantic distances involved and the subtle changes in stellar position that must be measured. The team's new measurement settles a controversy that arose when the European satellite Hipparcos provided a much shorter distance measurement to the Pleiades than expected and contradicted theoretical models of the life cycles of stars. This contradiction was due to the physical laws of luminosity and its relationship to distance. A 100-watt light bulb one mile away looks exactly as bright as a 25-watt light bulb half a mile away. So to figure out the wattage of a distant light bulb, we have to know how far away it is. Similarly, to figure out the "wattage" (luminosity) of observed stars, we have to measure how far away they are. Theoretical models of the internal structure and nuclear reactions of stars of known mass also predict their luminosities. So the theory and measurements can be compared.

However, the Hipparcos data provided a distance lower than that assumed from the theoretical models, thereby suggesting either that the Hipparcos distance measurements themselves were off, or else that there was something wrong with the models of the life cycles of stars. The new results show that the Hipparcos data was in error, and that the models of stellar evolution are indeed sound. The new results come from careful observation of the orbit of Atlas and its companion -- a binary relationship that wasn't conclusively demonstrated until 1974 and certainly was unknown to ancient watchers of the sky. Using data from the Mount Wilson stellar interferometer, next to the historic Mount Wilson Observatory, and the Palomar Testbed Interferometer at Caltech's Palomar Observatory near San Diego, the team determined a precise orbit of the binary. Interferometry is an advanced technique that allows, among other things, for the "splitting" of two bodies so far away that they normally appear as a single blur, even in the biggest telescopes. Knowing the orbital period and combining it with orbital mechanics allowed the team to infer the distance between the two bodies, and with this information, to calculate the distance of the binary to Earth. *"For many months I had a hard time believing our distance estimate was 10 percent larger than that published by the Hipparcos team,"* said Xiao Pei Pan of JPL. *"Finally, after intensive rechecking, I became confident of our result."* Shrinivas Kulkarni said, *"Our distance estimate shows that all is well in the heavens. Stellar models used by astronomers are vindicated by our value."* *"Interferometry is a young technique in astronomy and our result paves the way for wonderful returns from the Keck interferometer and the anticipated Space Interferometry Mission that is expected to be launched in 2009,"* said Michael Shao of JPL, principal investigator for that planned mission, and for the Keck Interferometer, which links the two 10-meter telescopes at the Keck Observatory in Hawaii. The Palomar Testbed Interferometer served as an engineering testbed for the Keck Interferometer.

NEW EVIDENCE FOR SOLAR-LIKE PLANETARY SYSTEM AROUND NEARBY STAR

Astronomers at the Royal Observatory, Edinburgh have produced compelling new evidence that Vega, one of the brightest stars in the sky, has a planetary system around it which is more like our own Solar System than any other so far discovered. All of the hundred or so planets that have been discovered around other stars have been very large gaseous (Jupiter-like) planets orbiting close to their star. This is very unlike our own Solar System. New computer modeling techniques have shown that observations of the structure of a faint dust disk around Vega can be best explained by a Neptune-like planet orbiting at a similar distance to Neptune in our own solar system and having similar mass. The wide orbit of the Neptune-like planet means that there is plenty of room inside it for small rocky planets similar to the Earth the Holy Grail for astronomers wanting to know whether we are alone in the Universe. The modeling is based on observations taken with the world's most sensitive sub-millimeter camera, SCUBA. The camera is operated on the James Clerk Maxwell Telescope in Hawaii. The SCUBA image shows a disk of very cold dust (-180 degrees centigrade) in orbit around the star. The irregular shape of the disk is the clue that it is likely to contain planets explains astronomer Mark Wyatt. Although we can't directly observe the planets, they have created clumps in the disk of dust around the star. The modeling suggests that the Neptune-like planet actually formed much closer to the star than its current position. As it moved out to its current wide orbit over about 56 million years, many comets were swept out with it, causing the dust disk to be clumpy. Exactly the same process is thought to have happened in our Solar System, said Wyatt, Neptune was pushed away from the Sun because of the presence of Jupiter orbiting inside it. So it appears that as well as having a Neptune-like planet, Vega may also have a more massive Jupiter-like planet in a smaller orbit. The model can be tested in two ways as Wayne Holland, who made the original observations, explains, *"The model predicts that the clumps in the disk will rotate around the star once every three hundred years. If we take more observations after a gap of a few years we should see the movement of the clumps. Also the model predicts the finer detail of the disks clumpiness which can be confirmed using the next generation of telescopes and cameras."* Paradoxically the star barely appears in the SCUBA image because it is far too hot to be seen with this kind of detector. Vega is, however, easily seen with the naked eye. It is the third brightest star visible from Northern latitudes and is bluish-white in color. You can see it in the west at around 7:00 PM

Facts about Vega

- * Vega is the fifth brightest star in the sky, and the third brightest visible in the Northern hemisphere.
- * It is 25 light years away from the Sun (1AU is the distance between the Earth and Sun).
- * It has a diameter three times bigger than the Sun.
- * It is 58 times brighter than the Sun.
- * Together with Deneb & Altair, Vega forms the summer triangle.
- * Vega is the brightest star in the constellation Lyra, the Harp. The lyre, or harp, is supposed to have been invented by the Greek God Hermes who gave it to his half-brother Apollo. Apollo then gave it to his son Orpheus, the musician of the Argonauts.
- * Vega was the first star ever to be photographed. During the night of July 16-17, 1850 the historic picture was taken at Harvard Observatory using a 15 inch refractor telescope during a 100 second exposure.

FINAL NEARBY STAR DEATH THROES WITNESSED FIRST-HAND

It takes only a few hundred to a thousand years for a dying Sun-like star, many billions of years old, to transform into a dazzling, glowing cloud called a planetary nebula. This relative blink in a

long lifetime means that a Sun-like star's final moments - the crucial phase when its planetary nebula takes shape - have, until now, gone undetected. Astronomers led by Dr. Raghvendra Sahai of JPL, have caught one such dying star in the act. This nearby star, called *V Hydrae*, has been captured by the Space Telescope Imaging Spectrograph onboard the Hubble in the last stages of its demise, just as material has begun to shoot away from it in a high-speed jet outflow. While previous studies have indicated the role of jet outflows in shaping planetary nebulae, the new findings represent the first time these jets have been directly detected. "*The discovery of a newly launched jet outflow is likely to have a significant impact on our understanding of this short-lived stage of stellar evolution and will open a window onto the ultimate fate of our Sun,*" said Sahai. Low-mass stars like the Sun typically survive around ten billion years before their hydrogen fuel begins to run out and they start to die. Over the next ten to hundred thousand years, the stars slowly eject nearly half of their mass in expanding, spherical winds. Then - in a poorly understood phase lasting just 100 to 1,000 years - the stars evolve into a stunning array of geometrically shaped glowing clouds called planetary nebulae. Just how these extraordinary "star-clouds" are shaped has remained unclear, though Sahai, in several previous papers, put forth a new hypothesis. Based on results from a recent Hubble Space Telescope imaging survey of young planetary nebulae, he proposed that two-sided, or bipolar, high-speed jet-like outflows are the primary means of shaping these objects. The latest study will allow Sahai and his colleagues to test this hypothesis with direct data for the first time. "*Now, in the case of V Hydrae, we can observe the evolution of the jet outflow in real-time,*" said Sahai, who together with his colleagues will study the star with the Hubble Space Telescope for three more years. The new findings also suggest what may be driving the jet outflows. Past models of dying stars predict that accretion discs - swirling rings of matter encircling stars - may trigger jet outflows. The *V Hydrae* data support the presence of an

accretion disc surrounding, not *V Hydrae* itself, but a companion object around the star. This companion is likely to be another star or even a giant planet too dim to be detected. The authors have also found evidence for an outlying large dense disc in *V Hydrae*, which could enable the formation of the accretion disc around the companion. Further support in favor of a companion-driven jet outflow comes from the scientists' observation that the jet fires in bursts: because the companion orbits the star in a periodic fashion, the accretion disc around it is expected to produce regular spurts of material rather than a steady stream.

FROM THE EDITOR'S TERMINAL

The Stargazer is your newsletter and therefore it should be a cooperative project. Ads, announcements, suggestions, and literary works should be received by the editor before the 1st of the month of publication, for example, material for May's newsletter should be received May 1st. If you wish to contribute an article or suggestions to *The Stargazer* please contact Mark Folkerts by email or by telephone (425) 486-9733 or co-editor Bill O'Neil, at (774) 253-0747.

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In January's Stargazer:

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- **** **CONSTELLATION OF THE MONTH**
- **** **YOUNG ASTRONOMER'S CORNER**
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The next EAS Meeting is 7:00 P.M. Saturday, January 31st at the Providence Pacific Clinic – 916 Pacific Avenue in Everett.