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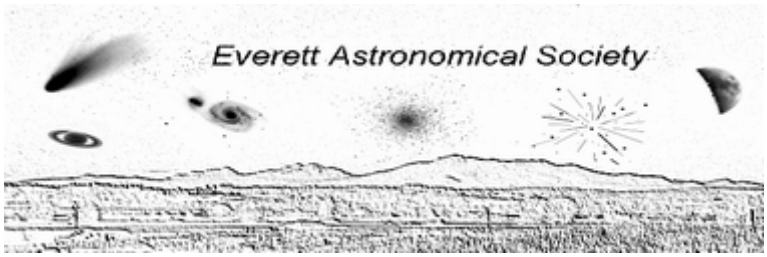


The Stargazer

January 2007

President: Mark Folkerts	(425) 486-9733	folkerts at seanet.com	***The Stargazer***
Vice President: James Bielaga	(425) 337-4384	jamesbielaga at aol.com	**P.O. Box 12746**
Librarian: Mike Locke	(425) 259-5995	mlocke at lionmts.com	**Everett, WA 98206**
Treasurer: Carol Gore	(360) 856-5135	janeway7C at aol.com	
Newsletter co-editor: Bill O'Neil	(774) 253-0747	wonastrn at seanet.com	
Web assistance: Cody Gibson	(425) 348-1608	sircody01 at comcast.net	*See EAS website at:*
		(change 'at' to @ to send email)	http://members.tripod.com/everett_astronomy

EAS BUSINESS…

NEXT EAS MEETING – SATURDAY JANUARY 27TH AT 3:00 PM AT THE EVERETT PUBLIC LIBRARY, IN THE AUDITORIUM (DOWNSTAIRS)

★★★ THIS MONTH'S MEETING PROGRAM: ★★★
Toby Smith, lecturer from the University of Washington Astronomy department, will give a talk featuring a visualization presentation he has prepared called "Solar System Cinema".

Map to library - http://www.epls.org/about/mlmap.htm

2702 Hoyt Avenue
Everett, WA 98201

Directions to library - http://www.epls.org/about/mldirect.htm

★ STAR PARTY INFO ★

Upcoming EAS star party schedule: (also see the regional star parties listed in the Astro Calendar)

EAS member Ron Tam has offered a flexible opportunity to EAS members to come to his home north of Snohomish for observing on clear weekend evenings and for EAS starparties. Anyone wishing to do so needs to contact him in advance and confirm available dates, and let him know if plans change**. "**Our place is open for star parties any Saturday except weekends of the Full Moon. People can call to get weather conditions or to confirm that there is a star party. Our phone number is (360) 568-5152. They can e-mail me too (tam1951@nwlink.com) but I don't check my email daily. They can email me for directions if they never have been out here."

PacSci Astronomy Weekend in North Cascades - July 13-15

This July, Pacific Science Center is excited to offer an incredible weekend of astronomy and natural discovery for its members. Educators from Pacific Science Center and the North Cascades Institute are teaming up to offer a variety of hands-on, family-friendly educational programs. During the day, there will be astronomy classes, guided nature hikes and canoe trips on nearby Diablo Lake. And then at night, discover the night sky like you've never seen it before. We hope you'll join us for a great weekend. July 13-15, North Cascades Environmental Learning Center North Cascades National Park. More information including pricing, detailed program, and reservation forms available shortly, so please check back at Pacific Science Center's website. **http://www.pacsci.org/travel/astronomy_weekend.html**

People should also join and send mail to the mail list *everett_astronomy@topica.com* to coordinate spur-of-the-moment observing get-togethers, on nights when the sky clears. We try to hold informal close-in star parties each month during the spring, summer, and fall months on a weekend near the New moon at a member's property or a local park. (call Mike Locke at (425) 259-5995 for info or check the EAS website.) Members contact Mike Locke for scope borrowing.

$$ - FINANCIAL HEALTH - $$

The club maintains a $650+ balance. We try to keep approximately a $500 balance to allow for contingencies. .

CLUB SCOPES

SCOPE	LOAN STATUS
10-INCH WARD DOBSONIAN	ON LOAN
10-INCH SONOTUBE DOBSONIAN	AVAILABLE
8-INCH DOBSONIAN	AVAILABLE

EAS members: contact VP James Bielaga at (425) 337-4384 or jamesbielaga at aol.com to borrow a scope.

ASTRO CALENDAR FOR 2007

January 2007

Jan 03 - Earth At Perihelion (0.983 AU From Sun)
Jan 03 - Quadrantids Meteor Shower Peak
Jan 08 - Stephen Hawking's 65th Birthday (1942)
Jan 12 - Comet C/2006 P1 (McNaught) at perihelion, mag -5.5
Jan 27 - EAS January Meeting – 3:00 PM – Everett Public Library

February 2007

Feb 01 – Rings & Moons of the Solar System Teleconference – 6:00 pm
Feb 07 - Mercury at Greatest Eastern Elongation
Feb 10 - Saturn at opposition
Feb 17 - EAS February Meeting – 3:00 PM – Everett Public Library

Feb 18 - Chinese New Year
Feb 23 - 20th Anniversary (1987), Supernova 1987A Explosion

March 2007

Mar 03 - Total Lunar Eclipse visible at moonrise
Mar 08 - 30th Anniversary (1977), Discovery of Uranus' Rings
Mar 11 - Daylight Saving - Set Clock Ahead 1 Hour (USA)
Mar 15 - Asteroid 99942 Aphophis Closest Approach To Earth (.865 AU)
Mar 18 - Best weekend for Messier Marathons
Mar 21 - Vernal Equinox, 00:07 UT
Mar 24 - EAS March Meeting – 3:00 PM – Everett Public Library

April 2007

Apr 08 - Easter Sunday
Apr 11-17 - Astronomy Week
Apr 20 - Astronomy Day – Friday Star party at Harborview Park
Apr 21 - Astronomy Day – Saturday Star party at Harborview Park
Apr 21 - Astronomy Day Saturday events at Everett Library
Apr 19-22 - OAS Camp Delaney Spring Star Party - http://www.olympicastronomicalsociety.com/Documents/CAMP%20DELANY%20V2.pdf
Apr 22 - Lyrids Meteor Shower Peak

May 2007

May 05 - Eta Aquarids Meteor Shower Peak
May 13-20 - Texas Star Party - http://www.texasstarparty.org/
May 17 - Comet 2P Encke Closest Approach to Earth (0.507 AU)
May 25-28 - Riverside Telescope Makers Conference - http://www.rtmc-inc.org/
May 26-28 - Fire In The Sky (WAC launch & star party) http://www.washingtonaerospace.org/launches.php
May 28 – Memorial Day Holiday

June 2007

Jun 01 - Asteroid 4 Vesta Closest Approach To Earth (1.144 AU)
Jun 06 - Jupiter at opposition
Jun 9-16 Grand Canyon Star Party - http://www.tucsonastronomy.org/gcsp.html
Jun 14-17 Rocky Mountain Star Stare - http://www.rmss.org/
Jun 18 - Dwarf Planet 134340 Pluto Closest Approach To Earth (30.2AU)
Jun 20 - Summer Solstice, 20:24 UT
Jun 22-24 - Klickitat County Star Party - http://www.klickitatstarparty.net/
June 30 - Blue Moon (2nd Full Moon of month)

July 2007

Jul 04 - 4th of July Holiday
Jul 07 - Earth At Aphelion (1.017 AU from Sun)
Jul 11-14 Golden State Star Party at Mt Lassen NP http://www.goldenstatestarparty.org/
Jul 13-15 - PacSci Astronomy Weekend in North Cascades http://www.pacsci.org/travel/astronomy_weekend.html
Jul 12-14 - Table Mountain Star Party - http://www.tmspa.com/
Jul 13-15 - Klickitat County Star Party - http://www.klickitatstarparty.net/
Jul 14 - OAS Hurricane Ridge Star Party - http://www.olympicastronomicalsociety.com/hurricane_ridge_star_parties.htm
Jul 29 - South Delta-Aquarids Meteor Shower Peak

August 2007

Aug 01 - Alpha Capricornids Meteor Shower Peak
Aug 3-4 - ALCON 2007 Portland Oregon - http://www.alconexpo.com/
Aug 06 - Southern Iota Aquarids Meteor Shower Peak
Aug 8-12 - Mt Bachelor Star Party - http://www.mbsp.org/
Aug 11 - Silver Falls (OR) Star Party - http://www.oregonstateparks.org/park_211.php
August 11 - ICAS Artist Point Lookout Star Party - http://groups.msn.com/WashingtonICAS/memberonlyevents.msnw
Aug 11-19 Mt. Kobau Star Party - http://www.mksp.ca/
Aug 12 - Perseids Meteor Shower Peak
Aug 11 - OAS Hurricane Ridge Star Party - http://www.olympicastronomicalsociety.com/hurricane_ridge_star_parties.htmAug 16-19 - Oregon Star Party - http://www.oregonstarparty.org/
Aug 24-26 - RASCal's Star Party - http://victoria.rasc.ca/events/StarParty/
Aug 25 - Northern Iota Aquarids Meteor Shower Peak
Aug 28 - Total Lunar Eclipse - entire eclipse visible

September 2007

Sep 03 - Labor Day Holiday
Sep 6-9 - OAS Camp Delaney Fall Star Party - http://www.olympicastronomicalsociety.com/Documents/CAMP%20DELANY%20V2.pdf
Sep 6-9 Alberta Star Party - http://calgary.rasc.ca/asp2007.htm
Sep 15 – ASTRONOMY DAY (For Fall too this year!) Star Party
Sep 14-16 - Klickitat County Star Party - http://www.klickitatstarparty.net/
Idaho Star Party, September 9-11, 2005 Boise Astronomical Society http://www.boiseastro.org/
Sep 23 - Autumnal Equinox (09:51 UT)
Merritt Star Quest - http://www.merrittastronomical.com/

October 2007

Oct 09 - Draconids Meteor Shower Peak
Oct 14 - Dwarf Planet 136199 Eris Closest Approach To Earth (95.8AU)
Oct 12-14 - Klickitat County Star Party - http://www.klickitatstarparty.net/
Orion Nebula Star Party - http://www.seattleastro.org/orionnebsp.html
Oct 21 - Orionids Meteor Shower Peak
Oct 31 - Halloween

November 2007

Nov 03 - Taurids Meteor Shower Peak
Nov 04 - End Daylight Saving time - Set Clock Back 1 Hour (US)
Nov 12 - Dwarf Planet Ceres Closest Approach To Earth (1.832 AU)
Nov 17 - Leonids Meteor Shower Peak
Nov 22 - Thanksgiving Holiday

December 2007

Dec 07 - 35th Anniv (1972), Apollo 17 Launch (Last Mission to Moon)
Dec 13 - Geminids Meteor Shower Peak
Dec 22 - Winter Solstice, 22:06 UT
Dec 22 - Ursids Meteor Shower Peak
Dec 24 - Mars at opposition
Dec 25 - Christmas Holiday

UW Astronomy Colloquium Schedule

The Astronomy Department weekly colloquium meets Thursdays at 4:00 pm in PAB A102 (the classroom part of the Physics/Astronomy Building complex).

OVER THE AIRWAVES

"Our group of radio script writers now consists of EAS and SAS members Jim Ehrmin, 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 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 about 6:05 pm. 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. See list here: http://members.tripod.com/everett_astronomy/eas_library.htm

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 Mike Locke, 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 subscribe to ***Sky and Telescope*** for $7 off the normal subscription rate, contact the treasurer for more information. Link to registration form: http://members.tripod.com/everett_astronomy/application.htm

(**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. Contact Mike Locke (425) 259-5995 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.

MEMBER NEWS

The Northwest Region of the Astronomical League (NWRAL) is putting together a new website and needs the following information from each club of the NWRAL. The EAS is looking for any information from members about the early history. Please contact Mark Folkerts if you have any info that could be of help. NRWAL would like a brief history of the club

- Club established date
- Who started the club
- When club joined the Astronomical League.

Night Sky Network – 'RINGS AND MOONS OF THE SOLAR SYSTEM' TELECONFERENCE: February 1st - 6:00 pm Pacific - Join us on February 1st for a fascinating evening with Dr. Mark Showalter, moon and ring specialist at the SETI Institute. He will be updating us on new discoveries from Cassini and telling us about some of the most interesting phenomena within our Solar System. It is often forgotten that Saturn is only one of four planetary ring systems. Rings also encircle Jupiter, Uranus, and Neptune. What all four have in common is that they show bizarre features that no theorist would ever have imagined if we hadn't seen them in our telescopes first. Learn about exciting discoveries Dr. Showalter and his team are making and get to ask him questions.

To log into the Telecon on February 1st, between 5:45 - 6:00pm (Pacific Time): Toll-free conference call line: 1-888-889-4951. An operator will answer and: You will be asked for the passcode: NIGHT SKY NETWORK You might be asked for the call leader: MICHAEL GREENE You will be asked to give your NAME and the CLUB you belong to, and number of people listening with you. If you have any questions, please contact the Night Sky Network Administrators at: nightskyinfo@astrosociety.org

OBSERVER'S INFORMATION…

LUNAR FACTS

Jan 25	First Quarter Moon
Feb 02	Full Moon
Feb 10	Last Quarter Moon
Feb 17	New Moon
Feb 24	First Quarter Moon
Mar 03	Full Moon
Mar 12	Last Quarter Moon
Mar 19	New Moon
Mar 25	First Quarter Moon
Apr 02	Full Moon
Apr 10	Last Quarter Moon
Apr 17	New 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	Con	Mag
Sun	**7:43 am**	**12:21**	**17:01**	**Cap**	**-27.5**
Mercury	Daylight	Daylight	**18:05**	**Lib**	**+1.0**
Venus	Daylight	Daylight	**18:54**	**Aqr**	**-3.9**
Mars	**6:10 am**	Daylight	Daylight	**Sag**	**+1.6**
Jupiter	**4:13 am**	Daylight	Daylight	**Oph**	**-1.9**
Saturn	**18:50**	**1:30 am**	Daylight	**Leo**	**+0.0**
Uranus	Daylight	**Daylight**	**20:12**	**Aqr**	**+5.8**
Neptune	Daylight	**Daylight**	**18:05**	**Cap**	**+7.9**
Pluto	**4:51 am**	Daylight	**19:06**	**Sag**	**+14.0**

(times local time for Everett PST)

Transit times for Jupiter's Great Red Spot in 2006

http://skyandtelescope.com/observing/objects/planets/article_107_2.asp

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

CONSTELLATION OF THE MONTH: CANIS MAJOR

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. Bessell 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.

http://www.dibonsmith.com/cma_con.htm
http://www.astro.uiuc.edu/~kaler/sow/cma-p.html
http://www.seds.org/Maps/Stars_en/Fig/canismajor.html
http://www.astro.wisc.edu/~dolan/constellations/constellations/Canis_Major.html

PLANETARY FOCUS - VENUS

Venus is in the southwest sky these winter nights. The focus of this month's column is 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.

YOUNG ASTRONOMER'S CORNER

TOPIC: THE HOLIDAY STARS: With the advent of the end of the year, and the Christmas, Hanukkah, and New Year holidays, this period gives many people pause to reflect and wonder at their

lives and the world around us. If the weather is clear, and you get the chance to look up at the night sky this holiday season, here's a few interesting facts to ponder:

** What was the "Christmas Star"?: The "Christmas Star", or the "Star of Bethlehem" is a well known phenomenon that, according to several traditions, guided the Wise Men to the birth site of Jesus Christ in Bethlehem. But was it truly a star? There have been many theories as to exactly what it was. According to one source, Jesus was very likely born somewhere between the years 7 and 4 B.C. During this time, we know that a beautiful, rare, and spectacular event occurred. On the western horizon, Jupiter, Saturn, and Mars were extremely close together (a phenomenon called a "conjunction"), and must have, together, burned very brightly in the Western sky. This event involving these three planets in this configuration is expected to happen only once every 800 years!! Additionally, these bright planets probably sat just south of the bright stars of the Great Square of Pegasus. This is the event that most current astronomers feel was actually the bright "Star of Bethlehem". It truly must have been an awe inspiring apparition (just as such an event would be today), but in those days, many more people were likely to assign a religious significance to it, as opposed to a purely scientific one. Another event that is a beautiful Christmas coincidence (that has also been assigned a religious significance, but much more so in the past), involves the constellation Cygnus. Cygnus, or the "Swan" actually looks like a cross, and the cross has spiritual significance in many cultures and religions. But did you know, that on Christmas Eve, the cross almost stands straight up and down, as the "Swan" dives down below the western horizon? At other times of the year as Cygnus makes its way across the heavens, the Cross or Swan is in various positions of flight with respect to the remaining stars in the sky. Although the "cross" configuration of the constellation is easy to see all year long, it is only at this time of year that the constellation Cygnus, or the Northern Cross, truly looks like a right-side-up, standing cross.

Finally, there are at least two important religious holidays this time of year: one for Christians (Christmas), and one for Judaism (Hanukkah). Why this time of year? One reason besides the more traditional ones may be that ancient cultures may have been trying to "replace the light" from the sun that is much weakened this time of year. This is the time of the winter solstice, when the sun is furthest south, and sunlight is at its weakest for people like us who live north of the equator. Since the "eight candles of Hanukkah", and all the Christmas lighting displays occur at this time of year, in addition to the religious significance, were these religions also trying to symbolically "replace the light" lost from the sun after it had traveled south? If you have the time during this busy season, and the nights are clear, take a minute to reflect on the astronomical events and traditions of the season as well.

ASTRONOMY AND TELESCOPE "LINGO"

ASTRONOMY "LINGO": "SMALL SOLAR SYSTEM OBJECTS": Solar system entities which are not defined as either planets, dwarf planets (such as Ceres, Pluto, and 2003-UB-313), or satellites, were placed in this category in 2006 by the International Astronomical Union (IAU). These objects include most asteroids, comets, Trans-Neptunian Objects, and other smaller solar system matter.

TELESCOPE "LINGO": "COMPTON GAMMA RAY OBSERVATORY": Launched April 7, 1991, to Earth orbit, the "GRO" was designed to make the first survey of gamma ray sources across the entire sky, including quasars, black holes, supernovae, neutron stars and pulsars. At the completion of its very successful mission, the "GRO" had its orbit disintegrated, and was sent crashing into the Pacific Ocean on June 4, 2000.

ASTRONOMY "FUN FACTS"

★★ Saturn's rings are probably far less than a mile thick; this value is still debated however. Assuming that they are about one kilometer thick, compare this thickness with a square section of the rings, with one side equivalent to the distance from the outermost edge of ring A to the tops of Saturn's clouds, or approximately 48,000 miles. This would be akin to imagining a single sheet of paper with the dimensions of 30 square feet, or as big as a living room!!

★★ The Voyager and Pioneer spacecrafts traversed the full 170,000 mile stretch of Saturn's rings in about 4 hours, traveling at approximately 43,000 mph as they passed under the planet's rings many years ago. Flying at the same velocity as these two groundbreaking spacecraft when they visited Saturn, a rocket leaving Earth would take just 6 hours to reach Earth's Moon, and only 35 minutes to make one orbit around the Earth!

★★ The "Great Comet of 1843" had a tail that stretched halfway across the sky; its tail was estimated to be about 500 million miles long, equivalent to just past the distance of Jupiter from the Sun. If one could wrap this comet's tail around the Earth, it would circle the Earth's equator about 20,000 times!!

★★ Alpha Centauri, at about 4.3 light years away, is the nearest star system to our own Sun; (actually, it is a triple star system and dimmer Proxima Centauri is somewhat nearer to our Sun than are the other two stars). Imagining it to be even remotely possible, an Apollo spacecraft would have taken about 850,000 years to reach this neighboring star system; a car traveling at 55 mph would take 52 ***million*** years to complete the same trip…assuming there is a 55 mph interstellar speed limit of course!!

"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 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.***

BETA CEPHEI STARS: Beta Cephei Stars are also known as Beta Canis Majoris Stars (see more information on Canis Major above). Beta Cephei and Beta Canis Majoris are the prototype stars for a small group of pulsating variable stars; these are very hot, very massive and luminous stars with spectral types O9 - B3. These stars have relatively short periods of rotation (approximately 3-7 hours), and small variations in visual brightness (around 0.01 to 0.25 magnitudes); this range in variation however is much larger at ultraviolet wavelengths. Some of these stars are known to have two or even more periods of radial-velocity variation. While the pulsation mechanism remains uncertain, both radial and nonradial pulsations could be involved. The position of Beta Cephei stars (pulsating variables) on the Hertzsprung-Russell diagram is just above the main sequence, beginning at spectral type B-3. A large number of Beta Cephei stars are among the brightest in the sky, and many are indeed the "alpha" and "beta" stars within their respective constellations.

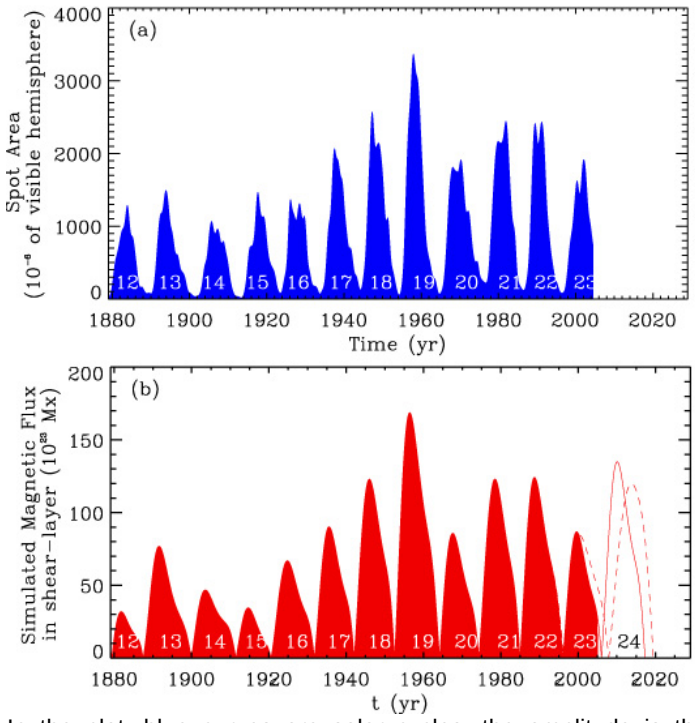
NORTHERN HEMISPHERE EXAMPLE (S): ***BETA CEPHEI; BW VULPECULAE.***

SOUTHERN HEMISPHERE EXAMPLE(S): ***BETA CENTAURUS; BETA CANIS MAJORIS; BETA CRUCIS.***

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

STORM WARNING - SCIENTISTS PREDICT BIG SOLAR CYCLE

Evidence is mounting: the next solar cycle is going to be a big one. Solar cycle 24, due to peak in 2010 or 2011 "*looks like its going to be one of the most intense cycles since record-keeping began almost 400 years ago*," says solar physicist David Hathaway. He and colleague Robert Wilson presented this conclusion at the American Geophysical Union meeting in San Francisco. Their forecast is based on historical records of geomagnetic storms. Hathaway explains: "*When a gust of solar wind hits Earth's magnetic field, the impact causes the magnetic field to shake. If it shakes hard enough, we call it a geomagnetic storm*." In the extreme, these storms cause power outages and make compass needles swing in the wrong direction. Auroras are a beautiful side-effect. Hathaway and Wilson looked at records of geomagnetic activity stretching back almost 150 years and noticed something useful:. "*The amount of geomagnetic activity now tells us what the solar cycle is going to be like 6 to 8 years in the future*," says Hathaway. A picture is worth a thousand words:



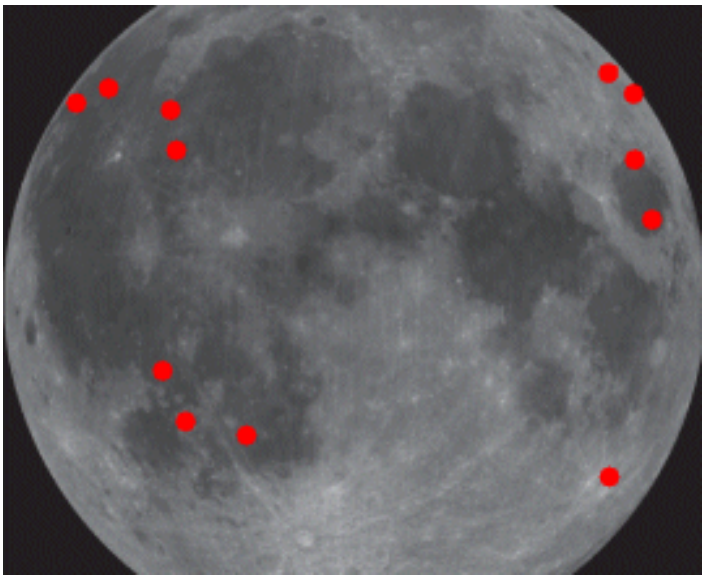
In the plot, blue curves are solar cycles; the amplitude is the sunspot number. Red curves are geomagnetic indices, specifically the Inter-hour Variability Index or IHV. "*These indices are derived from magnetometer data recorded at two points on opposite sides of Earth: one in England and another in Australia. IHV data have been taken every day since 1868*," says Hathaway.

Peaks in geomagnetic activity (red) foretell solar maxima (blue) more than six years in advance. Cross correlating sunspot number vs. IHV, they found that the IHV predicts the amplitude of the solar cycle 6-plus years in advance with a 94% correlation coefficient. "*We don't know why this works*," says Hathaway. The underlying physics is a mystery. "*But it does work*." According to their analysis, the next Solar Maximum should peak around 2010 with a sunspot number of 160 plus or minus 25. This would make it one of the strongest solar cycles of the past fifty years - which is to say, one of the strongest in recorded history.

Astronomers have been counting sunspots since the days of Galileo, watching solar activity rise and fall every 11 years. Curiously, four of the five biggest cycles on record have come in the past 50 years. "*Cycle 24 should fit right into that pattern*," says Hathaway. These results are just the latest signs pointing to a big Cycle 24. Most compelling of all, believes Hathaway, is the work of Mausumi Dikpati and colleagues. "*They have combined observations of the sun's 'Great Conveyor Belt' with a sophisticated computer model of the sun's inner dynamo to produce a physics-based prediction of the next solar cycle*." In short, it's going to be intense. Details may be found in the Science@NASA story Solar Storm Warning http://science.nasa.gov/headlines/y2006/10mar_stormwarning.htm .

LUNAR LEONID AND GEMINID STRIKES

Meteoroids are smashing into the Moon a lot more often than anyone expected. That's the tentative conclusion of Bill Cooke, head of NASA's Meteoroid Environment Office, after his team observed two Leonids hitting the Moon on Nov. 17, 2006. "*We've now seen 11 and possibly 12 lunar impacts since we started monitoring the Moon one year ago*," says Cooke. "*That's about four times more hits than our computer models predicted*." If correct, this conclusion could influence planning for future moon missions. But first, the Leonids:



In November, Earth passed through a "minefield" of debris from Comet 55P/Tempel-Tuttle. This happens every year in mid-November and results in the annual Leonid meteor shower. From Nov. 17th to Nov. 19th both Earth and the Moon were peppered with meteoroids. Meteoroids that hit Earth disintegrate harmlessly (and beautifully) in the atmosphere. But the Moon has no atmosphere to protect it, so meteoroids don't stop in the sky. They hit the ground. The vast majority of these meteoroids are dust-sized, and their impacts are hardly felt. But bigger debris can gouge a crater in the lunar surface and explode in a flash of heat and light. Some flashes can be seen from Earth.

During the passage through Tempel-Tuttle's debris field, Cooke's team trained their telescopes (two 14-inch reflectors located at the Marshall Space Flight Center) on the dark surface of the Moon. On Nov. 17th, after less than four hours of watching, they video-recorded two impacts: a 9th magnitude flash in Oceanus

Procellarum (the Ocean of Storms) and a brighter 8th magnitude flash in the lunar highlands near crater Gauss. "*The flashes we saw were caused by Leonid meteoroids 2 to 3 inches (5 to 8 cm) in diameter*," says Cooke. "*They hit with energies between 0.3 and 0.6 Giga-Joules*." In plain language, that's 150 to 300 pounds of TNT. How do you get so much energy out of a 3-inch meteoroid? "*Leonids travel fast - about 144,000 mph*," he explains. "*At that speed, even a 3-inch rock packs tremendous energy*." For comparison, the ESA's SMART-1 probe crashed into the Moon on Sept. 2nd, delivering 0.6 Giga-Joules of energy to the lunar surface - the same as the brighter of the two Leonids. "*Leonid impacts are as energetic as the crash of a 700-lb spacecraft*!" says Cooke.

With these latest detections, Cooke's group has tallied a dozen "lunar meteors" since Nov. 2005. Most were sporadic meteoroids--meaning they are part of no annual shower like the Leonids, but just random chips of asteroids and comets floating around in space. Cooke estimates that for every four hours they observe the Moon, they see one bright flash caused by the impact of a large meteoroid. And that's surprising. "*Our best models of the lunar meteoroid environment predict a much lower rate - only 25% of what we are actually seeing*." The problem may be with the computer models: "*They're based on observations of meteors in the skies of Earth*," and those data may not translate well to the Moon. The solution? "*We need to spend more time watching the Moon*," says Cooke. "*With more data, we can draw stronger conclusions about the impact rate*." NASA needs that kind of information to decide, e.g., if it's safe for astronauts to go moon-walking during a meteor shower; to calculate the necessary thickness of shielding for lunar spacecraft; and to answer the question, how often will a moonbase be punctured by a Leonid?

Of the Geminid meteor shower on December 13th-14th when once again Earth and Moon is peppered with meteoroids - this time from the asteroid 3200 Phaethon, Cooke says, "*we'll be watching*."

December Lunar Geminids - Another meteor shower, another bunch of lunar impacts... "*On December 14, 2006, we observed at least five Geminid meteors hitting the Moon*," reports Bill Cooke. Each impact caused an explosion ranging in power from 50 to 125 lbs of TNT and a flash of light as bright as a 7th-to-9th magnitude star. The explosions occurred while Earth and Moon were passing through a cloud of debris following near-Earth asteroid 3200 Phaethon. This happens every year in mid-December and gives rise to the annual Geminid meteor shower: Streaks of light fly across the sky as rocky chips of Phaethon hit Earth's atmosphere. It's a beautiful display. The same chips hit the Moon, of course, but on the Moon there is no atmosphere to intercept them. Instead, they hit the ground. "*We saw about one explosion per hour*," says Cooke. How does a meteoroid explode? "*This isn't the kind of explosion we experience on Earth*," explains Cooke. The Moon has no oxygen to support fire or combustion, but in this case no oxygen is required: Geminid meteoroids hit the ground traveling 35 km/s (78,000 mph). "*At that speed, even a pebble can blast a crater several feet wide*," says Cooke. "*The flash of light comes from rocks and soil made so hot by impact that they suddenly glow*."

Cooke's group has been monitoring the Moon's nightside (the best place to see flashes of light) since late 2005 and so far they've recorded 19 hits: five or six Geminids, three Leonids, one Taurid and a dozen random meteoroids (sporadics). "*The amazing thing is*," says Cooke, "*we've done it using a pair of ordinary backyard telescopes, 14-inch, and off-the-shelf CCD cameras. Amateur astronomers could be recording these explosions, too*." Indeed, he hopes they will. The NASA team can't observe 24-7. Daylight, bad weather, equipment malfunctions, vacations - "*lots of things get in the way of maximum observing*." Amateur astronomers could fill in the gaps. A worldwide network of amateurs, watching the Moon whenever possible, "*would increase the number of explosions we catch*," he says. To that end, Cooke plans to release data reduction software developed specifically for amateur and professional astronomers wishing to do this type of work. (The release will be announced on Science@NASA in the near future. Ready to assist? Stay tuned to Science@NASA for further instructions.) The software runs on an ordinary PC equipped with a digital video card. "*If you have caught a lunar meteor on tape, this program can find it. It eliminates the need to stare at hours of black and white video, looking for split-second flashes*." More data will help NASA assess the meteoroid threat as the agency prepares to send astronauts back to the Moon. http://science.nasa.gov/headlines/y2006/01dec_lunarleonid.htm

OREGON OMSI ASTRO-PHOTOGRAPHY CONFERENCE 2007

'Introduction to Astronomy Image Processing for Electronic and Film Cameras' - Saturday, March 10, 2007, 8:00 am to 10:00 pm. Oregon Museum of Science and Industry (OMSI) Auditorium, 1945 SE Water Avenue, Portland, OR 97214-3354.

Astrophotography using electronic cameras and film cameras provides many benefits such as observing fainter details, making scientific measurements and producing stunning images that are shared with others. A key part of astrophotography is using image processing software to remove camera defects, lens defects and telescope defects. Also, image processing seems to have a magical ability to reduce sky glow and to enhance hidden details in the image. The OMSI Astrophotography Conference covers the various aspects of image processing from the basics to advanced techniques. This conference is designed for attendees with no image processing experience to those who use image processing for their astro images.

The first session in the morning introduces the fundamentals of image processing as applied to astrophotography and provides a foundation for sessions that follow. The other sessions will show how to plan your image taking and how raw camera images are transformed into spectacular images of the universe. A special session on scientific measurements will provide you with a overview of astrometry and photometry and demonstrate how to use image processing software to make astrometry and photometry measurements on your images. Two image

processing labs, one using Photoshop and the other using free software, will take you step-by-step in improving astro images.

Attendees are encouraged to bring their laptops with Photoshop CS3 Beta, DeepSkyStacker, PixInsight LE and GIMP and follow along in these labs. Tables, soft seat chairs and AC power are provided for the attendees. At the end of the conference is an open session where attendees can present their image processing techniques or projects. A conference CD-ROM with presentations, reference materials and software is provided to each attendee. The conference is sponsored and hosed by Jim Todd, (OMSI). http://www.stargazing.net/david/OMSI/index.html http://www.stargazing.net/david/OMSI/OMSIAstrophotography2007014.pdf

Registration - Advanced registration is required because seating is limited. Registration ends on Thursday, March 1, 2007 8:00 AM PST. Registration is $60.00. OMSI electronic registration is at OMSI Education Programs: Online Catalog & Registration. Your email address is used for confirmation and to communicate lab downloads before the conference. Unfortunately OMSI registration is not flexible to register adults only, and it requires child information that is not required for this conference. To get around this computer registration form, enter NA for child fields, and 000-0000000 for phone number fields, that are for child registration.
http://www.cmiregistration.com/user/org/program.jxp?org=651&id=366391&refresh=1168633128938

BRIGHTEST COMET EVER OBSERVED BY SOHO

Comet C/2006 P1 (McNaught) has become the brightest comet that has been observed by the SOHO instruments since the start of routine operations in early 1996. In its own right, McNaught is the brightest comet observed in the last 40 years. The exact peak apparent magnitude of the comet is not yet determined, but it is currently estimated at -5.5. This makes it several magnitudes brighter than SOHO's previously observed brightest comet: C/2002 V1 (NEAT) at about -0.5 magnitude.

Comet C/2006 P1 (McNaught) is a single-apparition comet on an hyperbolic orbit, inclined at ~78 deg to the ecliptic. It was discovered by Rob McNaught on 7 August 2006, when the comet was still at ~3 AU from the Sun, or nearly 450 million km. Over the past 5 months comet McNaught has been steadily closing in on the Sun, eventually passing it at 0.17 AU as it reached perihelion on 12 January 2007. Around perihelion, the comet's proximity to the Sun prevented it from being observable from the ground. SOHO, however, was able to observe the comet during this period. The sequence shows comet C/2006 P1 as it passes the field of view of the LASCO C3 instrument between 12 and 16 January 2007. LASCO (Large Angle and Spectrometric Coronagraph Experiment) is a coronograph dedicated to observing the Sun's corona and uses an occulting disk to block out direct sunlight, covering the central ~2 deg of the nearly 16 deg wide view. Also visible in the sequence is Mercury, which is moving slowly from right to left. As the LASCO detector is built to study the much fainter solar corona, the comet appears saturated, with the characteristic horizontal spokes extending from the comet's nucleus.

Having passed its perihelion, comet C/2006 P1 (McNaught) is moving away again from the Sun and will become increasingly better visible for ground observers, particularly in the southern hemisphere as its orbit now takes it to higher southern declinations. With the increasing distance to the Sun, however, the comets brightness will decline with time. http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=40532 .

RETHINKING CENTURY'S CLOSEST, BRIGHTEST SUPERNOVA

Twenty years ago next month, the closest and brightest supernova in four centuries lit up the southern sky, wowing astronomers and the public alike. Ongoing observations of the exploded star, called supernova 1987A, provided important tests for theories of how stars die, but it also raised some new questions. Principal among these was how a bizarre, triple-ring nebula surrounding the supernova -- ejected by the star a few thousand years before it exploded -- originated. Astronomers devised a complicated theory that, within a relatively short period of time, the original star, a red supergiant, merged with a companion and started spinning rapidly, then underwent a transition to a blue supergiant, and finally exploded.

Astronomer Nathan Smith has proposed a different theory for the origin of the nebula, arguing instead that SN1987A's progenitor star may have been in a class of unstable blue supergiant stars, called luminous blue variables, which eject material from their surfaces in recurring, volcano-like eruptions before they finally die in a supernova explosion. Smith recently discovered two such blue supergiant stars with nebulae closely resembling the peculiarly shaped cloud of dust and gas around SN1987A. A third such nebula was already known. "*Taken together, the three closest analogs of SN1987A in our galaxy are all around blue supergiants; two of them have not gone through a red supergiant phase at all, and one was ejected as a luminous blue variable*," said Smith. "*This makes a pretty solid case that we should rethink models for how the rings around SN1987A were formed. "If these other stars with rings are likely to explode, it may hint that LBVs and blue supergiants can explode even before becoming red supergiants, which would be a bit of a shock to our understanding of stellar evolution*."

The proximity of SN1987A, only 168,000 light years away in the Large Magellanic Cloud, and the availability of pre-existing data provided the first chance for astronomers to posthumously identify the star that exploded. Astronomers were surprised to find that it had been a hot blue supergiant -- not a cooler red supergiant, as most theories predicted at the time. Adding to the mystery, images taken in the early 1990s by instruments like the Hubble Space Telescope revealed a bizarre, triple-ring nebula. The origin of this nebula and its shaping mechanism are still difficult to understand. The merger theory with conversion from red supergiant to blue supergiant before exploding has become the prevailing view because it accounts for both the blue supergiant and the shape of the nebula. The surprise, Smith said, is that analysis of these new objects in our galaxy that resemble SN1987A provide good reasons to suspect that they ejected and shaped their nebulae while they were still blue supergiants, and not in the transition from red to blue as has been proposed for SN1987A. Furthermore, none of the three stars is spinning rapidly, as one might expect if it had recently merged with a close orbiting companion star. A merger and the subsequent red-to-blue transition are the key ingredients in the prevailing explanation for the nebula around SN1987A, but the three stars discussed by Smith apparently formed similar nebulae without either mechanism. "*We are seeing these nebulae before the stars blow up, and they look quite similar to the nebula around SN1987A,"* said Smith. "*The trouble is, they may contradict how we think the nebula around SN1987A was formed*." According to Smith, the unusual nebula around SN1987A, looking like a figure 8, was originally interpreted to mean that the star had recently been a red supergiant that had shed its outer envelope in an expanding shell, but then turned into a blue supergiant before exploding. The blue supergiant generated a faster wind that overtook the earlier wind and became distorted.

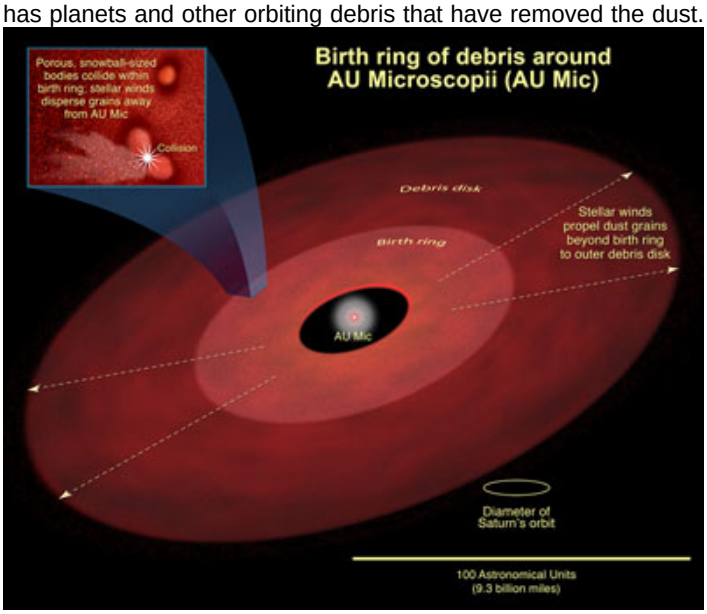
"*In that picture, the equatorial ring formed because the slow wind of the red supergiant had more material in the equator, so the waist of the blue supergiant wind was pinched*," Smith said. "*The fly in the ointment is that in order to get the enhanced density in the equator of the red supergiant, you need it to be spinning rapidly -- but red supergiant stars don't do that because they are so big. So the only solution would be if the progenitor of SN1987A swallowed a companion star and the two merged, while the added angular momentum made the red supergiant spin to make a disk*." "*This requires that the nearest and best observed supernova in modern history just happens to also be a freak, resulting from a coincidental merger event*," he added.

While looking through images taken by the Infrared Array Camera on the Spitzer Space Telescope, however, Smith noticed a similarly weird nebula around a nearby star designated HD168625. This star is a luminous blue variable (or LBV), an unstable massive star that burps from time to time and ejects a bipolar nebula as a blue supergiant, not a red supergiant. A well-known LBV is Eta Carinae, the brightest and most massive star in our Milky Way galaxy, weighing in at more than 100 solar masses. "*This new twin of the SN1987A nebula around an LBV gives us an alternative to the binary merger hypothesis for how these form*," Smith said. "*It hints that SN1987A may have ejected the nebula as a blue supergiant or an LBV, and not as a red supergiant*." Later, Smith identified a second ring nebula, identical in size to the equatorial ring around SN1987A but surrounding another blue supergiant in our galaxy. He found this in the Carina Nebula in the southern Milky Way in data taken by the 4-meter Blanco telescope at Chile's Cerro Tololo Inter-American Observatory, part of the National Optical Astronomy Observatory, and in images taken by one of two 6.5-meter Magellan telescopes in Chile. The second star, called SBW1, has almost the same spectral type as the progenitor of SN1987A, but the chemical abundances in the nebula imply that it has not yet been a red supergiant. This directly contradicts the old picture for how the rings around SN1987A were formed, he said. A third similar object in our galaxy, called Sher 25, was already known, and it has chemical abundances that also suggest it has not yet been a red supergiant..

DUST AROUND NEARBY STAR IS LIKE POWDER SNOW

Astronomers peering into the dust surrounding a nearby red dwarf star have found that the dust grains have a fluffiness comparable to that of powder snow, the ne plus ultra of skiers and snowboarders. This is the first definitive measurement of the porosity of dust outside our solar system, and is akin to looking back 4 billion years into the early days of our planetary system, say researchers. That was the era after the formation of planets, but before the remaining snowball- or softball-sized rubble was ground into dust by collisions and blown out of the inner solar system. "*We believe that this porosity is primordial, and reflects the agglomeration process whereby interstellar grains first assembled to form macroscopic objects*," said James Graham. The grains are probably microscopic dirty snowballs, a mixture of ice and rock. "*The difference between a snowflake and a hailstone -- both are ice but with very different porosities -- occurs because they form very differently*," he added. "*Hailstones grow in violent thunderstorms; snowflakes grow under much more sedate meteorological conditions. Similarly, we conclude that the dust grains in the AU Mic debris disk formed by gentle agglomeration*." Graham and Paul Kalas, discussed their findings on the AU Microscopii (AU Mic) system at the Seattle meeting of the American Astronomical Society.

Objects in our solar system also are porous -- comet grains that have lost their ice are like birds' nests, while some asteroids have been shown to be half-empty rubble piles -- but none are as full of nothingness as the dust in AU Mic, which is more than 90 percent vacuum. "*Most things we see have been compactified or compressed so that the vacuum has been squeezed out and filled in. Once you get to macroscopic objects a few inches across, those interstices are compressed and go away. So, 97 percent is a very high value*," Graham said. The astronomers were studying the closest known star with a dusty debris disk and possible planetary system, which were discovered around AU Mic by Kalas nearly three years ago. Red dwarfs like AU Mic, with a mass less than half that of the sun, are the most common stars in the Milky Way Galaxy. And at 33 light years distance, AU Mic is close enough for the Hubble Space Telescope to image with exquisite spatial resolution. Hubble observations have previously shown that the 12 million-year-old AU Mic system bears a strong resemblance to our much older solar system, with a ring of debris around it analogous to our Kuiper Belt of comets and Pluto-sized objects. This outer belt starts about 40 to 50 astronomical units (AU) from the central star, where an AU is 93 million miles, the average distance of the Earth from the sun. The inside of this region appears devoid of dust, hence the suspicion that the star has planets and other orbiting debris that have removed the dust.



The researchers, however, were curious about the dust grains far smaller than the rocks and planets. "*The big question in planet formation is how dust grains grow from interstellar sizes -- about 100 nanometers -- to macroscopic objects*," Graham said. A 100 nanometer grain is one-tenth of a micron; a thousand such grains would span the diameter of a human hair. "*We know that interstellar grains exist; we know that planets exist, but what we don't know is how they grow*." On August 1, 2004, the Hubble telescope slipped Polaroid glasses over its Advanced Camera for Surveys and snapped pictures of the nearly edge-on AU Mic disk as the polarizing filters rotated, sampling different linear polarizations. "*We use the polarizing filters to measure how the light reflects and scatters off the dust*," Graham said. "*The degree of polarization is useful for the same reason that polarizing sunglasses are useful to reduce the glare of reflected sunlight from the ocean*." By comparing the brightness of the scattered light at different polarizations, the researchers were able to calculate the porosity of the dust, which turned out to be greater than 90 percent, analogous to powder snow common in California's Sierra Nevada. The most porous dust is similar to the driest powder snow on Earth, termed "champagne powder," which

is 97 percent air and only 3 percent ice. These dust grains, which are on the order of a micron across, the size of soot or smoke particles, are quickly blown out of the inner disk by the stellar wind, which means that the dust is continually being replenished by colliding bodies in the inner system.

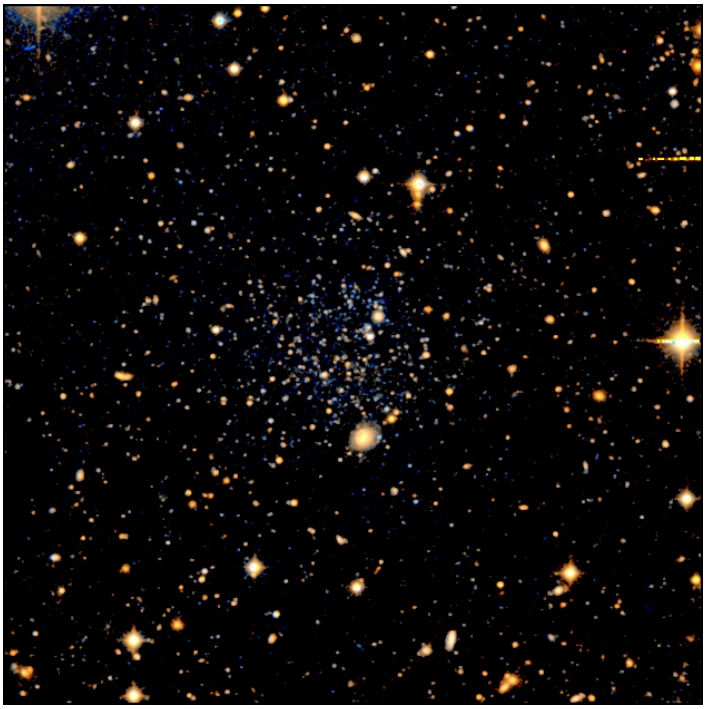
"*These colliding bodies must be fairly fluffy, too*," Graham said. "*These are the 10- to 20-centimeter snowballs, which are weakly bound together. Two of them have a glancing collision and release a puff of ice that we get to see in reflected light from the star*." The findings are consistent with a theory of planet formation whereby gas and dust coalesce into rocks and planets within the first 10 million or so years. While planet-size bodies continue to sweep up some of the remaining dust and debris, the debris also collides and creates small dust grains small enough for the stellar wind to blow it out of the inner system, leaving a hole dominated by larger objects, like the planets, dwarf planets and asteroids of our solar system. Theoretical astronomer Eugene Chiang coined the term "birth ring" to indicate the ring of objects around a star that divides a planetary system into an inner region devoid of small dust grains and an outer region into which these grains have been blown and still orbit the star in a belt like the Kuiper Belt. "*This gives quite a lot of credence to Chiang's theory*," Graham said. "*The thought is that these debris disks are in the cleanup phase, where all the small particles are colliding and being reduced to small dust grains and being blown away. So what is left in a few 100 million years is meter-sized objects and above. And, of course, the planetary mass objects*." http://hubblesite.org/newscenter/archive/releases/2007/02/image/

SLOAN AND THE SEVEN (MAKE THAT EIGHT) DWARFS - MANY MORE PREDICTED

With the prospect of finding dozens of new dwarf systems in our Local Group of galaxies, an international team of researchers from the Sloan Digital Sky Survey (SDSS-II) has moved the count ahead with the discovery of seven -- and perhaps eight -- new satellites of the Milky Way. "*Cold dark matter models predict that there should be tens to hundreds more dwarf galaxies in the Local Group than have been observed, if all dark matter halos are lit up with stars*," explains Dan Zucker, a member of the team. "*In less than a year, we have used SDSS-II data to find seven new Milky Way dwarf satellites. We've just discovered an eighth new dwarf, but we're not sure this one is a Milky Way satellite*." "*We've found almost as many new Milky Way satellites as were detected in the previous 70 years*," says Zucker's co-investigator Vasily Belokurov.

The discovery of "A New Population of Ultra-faint Local Group Galaxies" was announced at the American Astronomical Society's meeting in Seattle. Dwarf galaxies contain, at most, a few million stars and they often orbit around much larger galaxies such as the Milky Way. In its simplest form, the leading theory of galaxy formation predicts that the Milky Way should have a hundred or more surrounding dwarfs, but only a handful were known before SDSS-II. The new dwarfs have some unusual properties. "*They're more like hobbits than dwarfs*," comments Belokurov, since they are smaller and fainter than most previously known satellites. Several of the newly discovered systems appear to be on the verge of disruption -- probably by the tidal gravity of the Milky Way -- and the 'Ursa Major II' dwarf seems to already be in several pieces. "*They look as though they're being ground up*," notes Belokurov. Current theories of galaxy assembly suggest that many, perhaps all, of the stars in the halo and thick disk of the Milky Way originated in smaller dwarf galaxies, which were dissolved when they merged into the Milky Way itself. "*The new dwarfs are really just the crumbs from the galactic feast*," says Zucker. "*Most of the merging happened early on -- billions of years ago -- and what we're seeing here are the leftovers*."

The SDSS-II is a unique resource for finding Milky Way satellites because its deep, multi-color imaging allows detection of much fainter systems than were previously visible. The new objects are found using sophisticated computer algorithms that troll the digital data to find groupings of related stars. "*But the SDSS-II covers only a fifth of the sky*," notes co-investigator Wyn Evans, "*so there must be many more dwarfs out there*." The seven new Milky Way satellites all lie in the area of sky around the North Galactic Pole surveyed by the SDSS-II. There are two new dwarfs in the constellation of Canes Venatici (the Hunting Dogs), one in Bootes (the Herdsman), one in Leo (the Lion), one in Coma Berenices (Bernice's Hair), one in Ursa Major (the Great Bear) and one in Hercules.



The eighth and newest discovery may be the most intriguing. Named Leo T, it is about 1.4 million light years away, on the fringes of the Milky Way's gravitational influence. "*It may be a 'free-floating' Local Group dwarf, rather than a satellite of the Milky Way*," notes team member Sergey Koposov. In addition to its greater distance, Leo T is distinct from the previous seven discoveries in that it has both populations of fairly old stars (greater than five billion years old) and comparatively young populations (less that one billion years old). It also appears to have neutral hydrogen gas, so its star-forming days may not be over. Leo T could be the bellwether of a large population of faint galaxies that reside in the Local Group but are not closely associated with either the Milky Way or the Andromeda galaxy. Because it's too distant to be strongly influenced by the Milky Way's tides, Leo T's low luminosity (the equivalent of roughly 50,000 Suns) is likely intrinsic, not a consequence of tidal stripping of loosely bound stars. "*Leo T has probably always been very faint, retaining its gas and slowly forming stars in relative isolation*," comments Mike Irwin, a discovery team member. In combination with previously discovered systems from the SDSS-II and other sky surveys, the large number of new dwarfs changes the complexion of the cold dark matter theory's "missing satellite" problem. "*These discoveries bring the data and the theory closer together*," comments Zucker, though there may still be a gap between them. The new finds are part of SEGUE

(the Sloan Extension for Galactic Understanding and Exploration), one of three surveys comprising SDSS-II. "*The results from SDSS-I showed us that there was a great potential for finding new dwarf galaxies and the stars that have been ripped away from them by the Milky Way's gravity. They were one of the major reasons we undertook SEGUE*," explains SEGUE founder Heidi Jo Newberg. "*SDSS-II is likely to turn up more of these dwarf galaxies by the time it is done*."

The Sloan Digital Sky Survey-II (www.sdss.org) is the most ambitious survey of the sky ever undertaken. With more than 300 astronomers and engineers in 25 institutions around the world, the SDSS-II is continuing to map one quarter of the entire sky, determining the position and brightness of hundreds of millions of celestial objects, including the measurement of distances to more than a million galaxies and quasars from the Apache Point Observatory in New Mexico. In addition, the SEGUE (Sloan Extension for Galactic Understanding and Exploration) will undertake the mapping of the structure and stellar makeup of the Milky Way Galaxy. The new Supernova Survey will repeatedly scan a 300 square degree area to detect and measure supernovae and other variable objects. http://www.sdss.org/news/releases/20070109.leot_enlarge.html

SOME RARE ABNORMAL STARS MAY HAVE WHITE DWARF PARENTS TO BLAME

Astronomers have announced the discovery of huge quantities of an unusual variety of oxygen in two very rare types of stars. The finding suggests that the origin of these oddball stars may lie in the physics behind the mergers of white dwarf star pairs. The unusual stars are known as hydrogen-deficient (HdC) and R Coronae Borealis (RCB) stars. Both types have almost no hydrogen -- an element that makes up about 90% of most stars. Surprisingly, they contain up to a thousand times more of the isotope oxygen-18 than normal stars like our Sun. The discovery of abnormal quantities of oxygen-18 is based on near-infrared spectroscopic observations from the Gemini Near-Infrared Spectrograph (GNIRS) on the 8-meter Gemini-South telescope in Chile.

The findings were presented at the meeting of the American Astronomical Society in Seattle by a team consisting of: Dr. Geoffrey C. Clayton, Dr. Thomas R. Geballe, Dr. Falk Herwig, Dr. Christopher Fryer, and Dr. Martin Asplund. Prompted by the discovery, the team roughly simulated the nuclear reactions that would occur during a merger of two types of white dwarfs, an idea originally proposed for the origin of RCB stars in 1984 by Prof. Ronald F. Webbink. According to Clayton conditions had to be just right to yield the oxygen-18 observed in these stars. "*It's like the porridge in Goldilocks and the Three Bears. During the merger process, when nuclear reactions were taking place, the temperature was neither too hot, nor too cold, but just right for the production of large amounts of oxygen-18*." One of the challenges in understanding these stars is how oxygen-18 can be formed from nitrogen in the star while maintaining more normal amounts of the isotope oxygen-16 made from the star's preexisting carbon. "*It's really the ratio of oxygen-18 to oxygen-16 that is important and in these stars that ratio is very lopsided. Although we need to do more precise modeling, it appears that the white dwarf merger theory might just allow this to occur*," said Clayton. RCB stars are a small group of carbon-rich supergiants that undergo spectacular declines in brightness at irregular intervals, typically a few years in duration, before returning to their initial brightnesses. It is now thought that carbon grains intermittently condensing in the gas ejected by the star are responsible for dimming the star's light. On the other hand, the HdC stars, although resembling the RCB stars in their elemental abundances, do not eject gas and thus do not make dust or appear to vary in brightness.

An alternative theory to the merging of white dwarf pairs, originally proposed by Icko Iben, is that oxygen-18 rich stars could be formed when a single star on the verge of becoming a white dwarf undergoes a final flash of thermonuclear burning near its surface. This inflates the star to supergiant size and cools off its outer atmosphere. "*This final-flash model is a tempting explanation because two stars known as V605 Aquilae and Sakurai's Object have recently been discovered going through the final flash phase where they resembled RCB stars in abundances, temperature, and brightness*," said team member Geballe. "*However, both of these stars are now known to have spent only a few years in this phase and given this extremely short period as cool supergiants this makes it unlikely that they can account for even the small number of RCB stars currently known in the Milky Way Galaxy*." These stars are so rare that a total of only 55 HdC and RCB stars have been identified in our galaxy. "*The properties and antics of these weird stars have been the subject of intense observation and discussion for generations of astronomers*," said Geballe. "*This discovery should help us pinpoint how the combination of two degenerate stars is different than the sum of their parts*."

The atom that we think of as oxygen has eight protons and eight neutrons and is called "oxygen-16" or O-16. This form of oxygen is by far the dominant form of oxygen everywhere throughout our Milky Way, it's found in interstellar clouds and distant stars, as well as on Earth and in the Sun. Two other stable forms of oxygen exist (isotopes), with one and two extra neutrons, known as oxygen-17 and oxygen-18 (O-17 and O-18). However, both of these isotopes are extremely rare. Our Earth, Sun, and most other stars and clouds in interstellar space studied to date have about 2700 times as much O-16 as O-17 and about 500 times as much O-16 as O-18.

The unpredictable variability of RCB stars has made them popular targets for measurement by amateur astronomers and the source of much discussion by professionals seeking an explanation for their behavior. RCB star atmospheres are also extremely deficient in hydrogen, but very rich in carbon. Two different evolutionary models have been suggested for the origin of RCB stars. Both theories invoke objects known as white dwarfs, the ultra-dense cores of previously normal stars like the Sun. They typically have masses about half that of the Sun, and their sizes are close to that of the Earth. In one model an RCB star is formed when two white dwarf stars merge. In the other model the RCB star is formed when a single star on the verge of becoming a white dwarf undergoes a final flash of thermonuclear burning near its surface, blowing the star up to supergiant size and cooling off its outer atmosphere.

In 1984 Prof. Ronald F. Webbink proposed that an RCB star is formed from the merger of a helium-rich white dwarf and a carbon/oxygen-rich white dwarf. He suggested that as the binary white dwarf coalesces into one object, the helium-white dwarf is disrupted, with part of it accreting onto the carbon/oxygen-white dwarf and undergoing thermonuclear "burning." The remainder forms an extended atmosphere around the object. Webbink proposed that this structure, a star with an He-burning outer shell in the center of a ~100 solar radii H-deficient envelope, is a RCB star. Additionally, in 2002, Dr. Simon Jeffery, and Dr. Hideyuki Saio, suggested that a white dwarf pair merger could also account for the abundances of elements such as hydrogen, helium, carbon, nitrogen and oxygen seen in RCB stars. However, little is known about how the isotopes of these elements were created in these stars.

SUPERNOVA SEARCH FINDS EXPLODING STARS FAST, FOLLOWS UP FASTER WITH GIANT TELESCOPE

SEATTLE - Robert Quimby is heading up the Texas Supernova Search - an effort to detect exploding stars of all types in the fastest way possible after their explosion, to better understand how they explode and the types of stars they were prior to the explosion. This information will aid scientists using supernovae in cosmology studies, including the study of dark energy. Quimby explained his search technique and results in a talk at the 207th meeting of the American Astronomical Society in Seattle.

The search program uses ROTSE IIIb, a robotic telescope located at The University of Texas at Austin McDonald Observatory in West Texas. The telescope is one unit of four placed around the world that make up the Robotic Optical Transient Search Experiment headquartered at The University of Michigan. Its primary purpose is to quickly track gamma-ray bursts. However, 30 per cent of the telescope's observing time is also available to The University of Texas for other studies like Quimby's Texas Supernova Search, which uses most of that allocation.

The project has some advantages over other supernova searches. The telescope has an extremely large field of view -- the width of 3.5 full Moons on a side (3.4 square degrees). Second, this project looks at the same patches of sky night after night, Quimby says, explaining that most other search projects don't work this way. His winter/spring targets include three grids, which cover the Virgo, Ursa Major, and Coma galaxy clusters. Together, these fields include hundreds of nearby bright galaxies, and thousands of nearby dwarf galaxies. Finally, ROTSE IIIb shares mountaintop space with one of the largest optical telescopes in the world, the 9.2-meter Hobby-Eberly Telescope (HET). When a supernova is found by ROTSE, it can immediately be followed up in great detail with HET. Since the fall of 2004, the Texas Supernova Search has found about 30 supernovae. Quimby explains that while "*hundreds of supernovae are found every year*" now by various search groups, the idea behind his project is to try to get the earliest look at new supernovae. In other words, he says, "*not to find the most supernovae, but to find the best supernovae*."

He explains that "*when a supernova explodes, the material expands and thins out. When it fans out, you see deeper into the explosion. Most people studying supernovae are looking fairly deep*" into the expanding debris cloud. In contrast, "*we look early*," he says. This enables him to study the exploded star's outer layers, before the debris cloud has had much time to expand. The benefit of catching supernovae as soon as possible after they explode, Quimby says, is to get information that is only available by studying the star's outer layers. This includes information about the progenitor star, and about the explosion itself. "*There are very few examples of supernovae that have been studied in the first few days*," Quimby says -- less than a dozen. His survey recently discovered one, known as supernova 2006bp. Quimby says the Texas Supernova Search found 2006bp about two days after it exploded. (It was independently reported earlier by amateur astronomer Koichi Itagaki of Yamagata, Japan.)

This early detection is important, because such studies might reveal differences in supernovae soon after they explode, which at later times look identical. The great value of supernovae (specifically, type Ia supernovae) to cosmology research is their uniformity -- astronomers can count on them to have a certain peak luminosity for a given light curve shape, which allows them to calculate distance to the supernova (and its host galaxy) with great confidence. These measurements were integral, for instance, in the calculations that revealed that the expansion of the universe is accelerating, and introduced what many call the greatest enigma in science today -- dark energy.

But what if all supernovae aren't the same? Quimby's search caught one exploded star that hints of this possibility: supernova 2005hj. Once the search found this supernova, they began following it as it changed day by day using the HET. Spectra taken over a period of time showed that the light output from this supernova changed over time in a way different from the norm. "*At first, the velocity of the ejecta decreased over time as is typical*," Quimby says. "*But this was followed by about a two-week period of nearly constant velocities, which is unusual*."

Quimby says there are two possible explanations for 2005hj's unusual behavior. It could be a merger of two white dwarf stars -- the so-called "double degenerate" model. The second possibility is that it could be a white dwarf star that tried to explode, but didn't release enough energy. So it puffed up a bit, then collapsed back onto the star's core, triggering a second (much larger) explosion. This case is known as a "pulsating delayed detonation." The Texas Supernova Search will continue. Quimby hopes to expand the program to include all four ROTSE telescopes. Besides unit IIIb at McDonald Observatory, there are ROTSE telescopes in Australia, Turkey, and Namibia..

ENORMOUS HALO OF RED GIANT STARS AROUND ANDROMEDA

Astronomers have found an enormous halo of stars bound to the Andromeda galaxy and extending far beyond the swirling disk seen in images of the famous galaxy, our nearest large galactic neighbor. The discovery, reported at the American Astronomical Society meeting in Seattle, suggests that Andromeda is as much as five times larger than astronomers had previously thought. "*I am absolutely astounded by how big this halo is. As we looked farther and farther out, we kept finding stars that look like halo stars*," said Puragra (Raja) Guhathakurta, who presented the findings. Guhathakurta and his collaborators are conducting an ongoing study of Andromeda's stellar halo, using observations at the Kitt Peak National Observatory in Arizona and the W. M. Keck Observatory in Hawaii. Their new findings are based on data gathered using the 4-meter Mayall Telescope at Kitt Peak and the DEIMOS spectrograph on the 10-meter Keck II Telescope in Hawaii.

The researchers detected a sparse population of red giant stars -- bright, bloated stars in a late stage of stellar evolution -- that appear to be smoothly distributed around the galaxy out to a distance of at least 500,000 light-years from the center. Even at that great distance, the stars are bound to the galaxy by gravity. These stars probably represent Andromeda's stellar halo, a distinct structural component of the galaxy that has eluded astronomers for over 20 years, Guhathakurta said. Following up on their discovery of Andromeda's halo, the researchers have found evidence that stars in the halo are chemically anemic compared with stars in the inner parts of the galaxy, said Jasonjot Kalirai. The halo stars are "metal-poor," meaning they contain smaller amounts of the heavier elements, a finding that is consistent with theoretical models of galaxy formation, Kalirai said.

Andromeda (also known as M31) is a large spiral galaxy very similar to our own Milky Way. While it is difficult for astronomers to study the overall structure of the Milky Way from Earth's vantage point within it, Andromeda offers a global view of a classic spiral galaxy that is close enough for astronomers to observe individual stars within it. Andromeda is about 2.5 million

light-years from Earth and is the largest galaxy in the "Local Group," which also includes the Milky Way and about 30 smaller galaxies. "*The physical size of this galaxy is really striking*," said coauthor R. Michael Rich. "*The suburbs of M31 and the Milky Way are so extended that they nearly overlap in space, despite the great distance between these two galaxies. If the whole of M31 were bright enough to be visible to the naked eye, it would appear to be huge, larger in apparent size than the Big Dipper*."

Spiral galaxies typically have three main components: a flattened disk, a bright central bulge with a dense concentration of stars, and an extended spherical halo of sparsely distributed stars. The concentration of stars in the central bulge decreases exponentially with increasing distance from the center, whereas the density of the halo stars falls off more gradually (as an inverse power of the radius). In Andromeda, the disk has a radius of about 100,000 light-years. Outside the plane of the disk, stars plausibly belonging to the central bulge can be found as far out as 100,000 light-years from the center of the galaxy, while the halo extends five times farther than that, according to Guhathakurta. "*We now believe that previous groups have been mistakenly identifying the outer parts of the Andromeda bulge as its halo*," he said. Guhathakurta's group was able to detect the halo by developing a sophisticated technique for clearly distinguishing halo stars in Andromeda from the more numerous foreground stars in the Milky Way. A foreground star with low luminosity and a luminous star that is much farther away can be hard to tell apart because they appear to be equally bright from our perspective, Guhathakurta said. "*A firefly 10 feet away and a powerful beacon in the distance can have the same apparent brightness. In this case, the fireflies are dwarf stars in our own galaxy and the beacons are red giant stars in Andromeda*," he said.

Karoline Gilbert developed the technique for separating the fireflies from the beacons. Her technique provided a clear separation between the two populations of stars by combining five diagnostic criteria based on photometry (brightness measurements) and spectroscopy (which separates starlight into a spectrum of different wavelengths). The diagnostic criteria include radial velocity and parameters based on differences in surface gravity between red giants and dwarf stars. "*We focused on detecting red giant stars in the halo because they are bright enough for us to obtain spectra*," Gilbert said. "*There are assuredly other kinds of stars in Andromeda's halo, but they are just too faint for us to get spectra of them*." The group's ongoing investigation of Andromeda's halo promises to shed new light on the question of how large galaxies formed, Guhathakurta said. "*Galaxy formation theories tell us that halos are pristine -- the oldest component of the galaxy -- but this is based almost entirely on studies of our own galaxy. A detailed study of this newly discovered Andromeda halo will allow us to test whether these theories apply more generally to galaxies other than the Milky Way*," he said..

RADIO TELESCOPES GIVE KEY CLUE ON BLACK HOLE GROWTH

Astronomers have discovered the strongest evidence yet found indicating that matter is being ejected by a medium-sized black hole, providing valuable insight on a process that may have been key to the development of larger black holes in the early Universe. The scientists combined the power of all the operational telescopes of the National Radio Astronomy Observatory (NRAO) to peer deep into the heart of the galaxy NGC 4395, 14 million light-years from Earth in the direction of the constellation Canes Venatici.

"*We are seeing in this relatively nearby galaxy a process that may have been responsible for building intermediate-mass black holes into supermassive ones in the early Universe*," said Joan Wrobel, an NRAO scientist in Socorro, NM. Wrobel and Luis Ho presented their findings to the American Astronomical Society's meeting in Seattle. Black holes are concentrations of matter so dense that not even light can escape their powerful gravitational pull. The black hole in NGC 4395 is about 400,000 times more massive than the Sun. This puts it in a rarely-seen intermediate range between the supermassive black holes at the cores of many galaxies, which have masses millions to billions of times that of the Sun, and stellar-mass black holes only a few times more massive than the Sun. Energetic outflows of matter are common to both the supermassive and the stellar-mass black holes, but the new radio observations of NGC 4395 provided the first direct image of such a suspected outflow from an intermediate-mass black hole. The outflows presumably are generated by little-understood processes involving a spinning disk of material being drawn toward the black hole at the disk's center. "*An outflow from a black hole can regulate its growth by pushing back on material being drawn toward it. This is an important aspect of black hole development. Our observations offer new and unique information on how this process works for intermediate-mass black holes*," Ho said. "*Intermediate-mass black holes may have been the starting points for the supermassive black holes that we now see throughout the Universe. By studying this contemporary analog to those earlier objects, we hope to learn how the less-massive ones grew into the more-massive ones*," Wrobel explained.

The black hole in NGC 4395 was added to a small number of known intermediate-mass black holes in 2005, when a research team led by Brad Peterson calculated its mass based on ultraviolet observations. Other ultraviolet and X-ray observations gave tantalizing hints that material might be flowing outward from the black hole. "*Fortunately, this object also is detectable by radio telescopes, so we could use very high precision radio observing techniques to make extremely detailed images*," Wrobel said. Wrobel and Ho used a technique called Very Long Baseline Interferometry (VLBI), in which multiple radio-telescope antennas are used together to simulate a much larger "virtual telescope," providing extremely great resolving power, or ability to see fine detail. The astronomers used all of NRAO's telescopes in their coordinated VLBI array, including the continent-wide Very Long Baseline Array (VLBA), the 27-antenna Very Large Array (VLA) in New Mexico, and the giant Robert C. Byrd Green Bank Telescope (GBT) in West Virginia. The combination of antennas spread far apart as well as the large amount of signal-collecting area in this system allowed the scientists to make a detailed image of the faint radio emission caused by fast-moving electrons in the suspected outflow from the black hole interacting with magnetic fields. The resulting image showed the suspected outflow stretching approximately one light-year from the black hole. "*This direct image bolsters the case for an outflow that was suggested by the earlier indirect evidence from the ultraviolet and X-ray observations*," Wrobel said. "*By measuring the length of this suspected outflow, we offer a unique constraint on theoretical models for how intermediate-mass black holes operate*," Ho said.

GIANT PLANET EMBEDDED IN THE MAGNETOSPHERE OF STAR

Using the ESPaDOnS spectropolarimeter installed on the Canada-France-Hawaii telescope (Mauna Kea), an international team of researchers, led by two French astronomers (C. Catala, and J.F. Donati), has just discovered a magnetic field on tau Bootis, a star orbited by a giant planet on a close-in orbit: the first ever detection of this kind! Up to now, only indirect clues pointed to the presence of magnetic fields on stars hosting giant extra-

solar planets. This result opens major prospects, in particular the study of the interaction between the planet and the magnetosphere of its star. The catalogue of extrasolar planets is growing continuously, containing today more than 200 objects, and the detection of these exoplanets has almost become a routine. But what are the characteristics of the stellar hosts, how can we explain the formation of these planetary systems, or why are some of these giant exoplanets, which are called 'hotJupiters', migrating down to very close-in orbits? Astrophysicists suspect the magnetic field to play a crucial role in some of these questions. However, although indirect effects of magnetic fields have already been detected on stars hosting giant extrasolar planets, no direct measurement had ever been done until now.

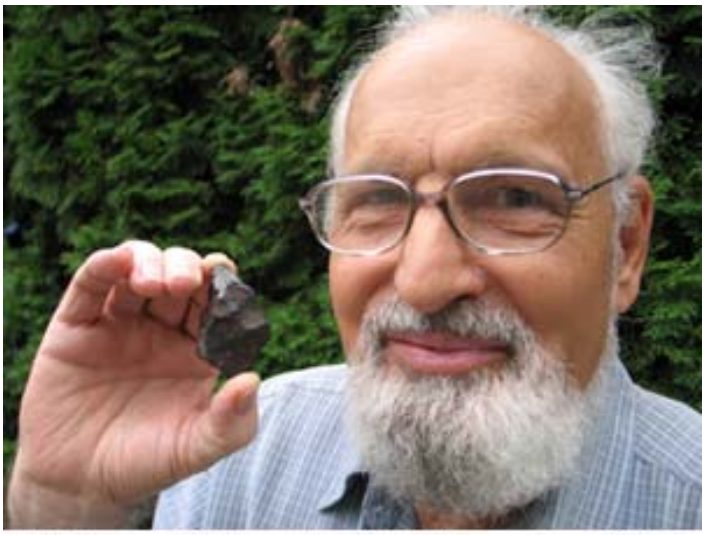
This first measurement of a magnetic field in a planet-hosting star has been obtained by an international team of astronomers with the ESPaDOnS spectropolarimeter installed on the Canada-France-Hawaii telescope. They detected the magnetic field of tau Bootis, a one billion year old star, having a mass of one and a half solar masses and located at nearly 50 light years from the Earth. This cool and weakly active star, orbited by a giant planet with 4.4 Jupiter masses on a very close-in orbit at 0.049 AU (i.e. 5% of the Sun-Earth distance), possesses a magnetic field of a few gauss, just a little more than the Sun's, but showing a more complex structure.

Moreover, astronomers have also measured the level of differential rotation of the star, a crucial parameter in the generation of magnetic fields. In the present case, the matter located at the equator rotates 18% faster than that located at the poles, leading by one full turn in approximately 15 days. By comparing the differential rotation of the star with the revolution of the giant extrasolar planet, astronomers have noticed that the planet is synchronized with stellar material located at about 45 degrees. This observation suggests very complex interactions between the magnetosphere of the star and its companion, perhaps similar to the interaction of the magnetosphere of Jupiter with its satellite Io, giving rise to the so-called "Io torus". The data collected for this study are not sufficient to describe precisely these interactions, but this first measurement is opening new prospects for detailed studies of star-planet systems. http://www.cfht.hawaii.edu/News/TauBoo/ .

ROUGH ROAD RESULTS IN B.C. METEORITE FIND

An impromptu detour on the back roads near Whistler, B.C. several decades ago led to the first new Canadian meteorite find of 2006 for a British Columbia man. The University of Calgary-based Prairie Meteorite Search has confirmed that a rock Vancouver resident Rolf Eipper picked up on the side of a gravel road in the 1980s is the 69th meteorite recovered in Canada. "*About 25 years ago I was trying to drive to Pemberton on Route 99, but the road was closed, so I tried a gravel road just north of Green Lake (near Whistler, B.C.) to see if I could detour around*," Eipper said. "*The gravel road was getting rough and I started dragging my muffler on a high spot, so I stopped and got out to see if I could manage to manoeuvre without ripping my muffler off. I noticed the meteorite as a dark, rusty rock amongst all the lighter-coloured pebbles in the gravel*." Eipper ground one corner of the unusual metal rock to examine the interior and then took it home, where it sat until this year.

In late July of this year, the Prairie Meteorite Search announced a meteorite find by a Kelowna woman but the identification of nickel in the rusted metal turned out to be an invalid analysis. Renee Johnson has since been informed of the error relating to the rock she found near Prince Rupert in 1968. "*I am acutely chagrined that we made and announced this misidentification, but am consoling myself that the resulting publicity led to Rolf Eipper bringing his meteorite forward for identification and study*," said Prairie Meteorite Search director and geology professor Dr. Alan Hildebrand.



Rolf Eipper with his meteorite. / Photo courtesy of Alan Hildebrand, University of Calgary

When Eipper saw media reports of the July announcement, he noticed that his unusual rock resembled Johnsons and contacted Hildebrand about his palm-sized, 100-gram specimen. "*Mr. Eippers rock looked very much like a weathered iron meteorite, so I visited him and cut off a small piece for study*," said Hildebrand, holder of a Canada Research Chair in Planetary Sciences. "*The meteorite definitely contains nickel as we did the analysis at the University of Calgary, instead of going to a commercial lab as we did for the first time with Renee Johnsons specimen. A polished mount also showed the expected textures*."

Dr. Stephen Kissin has also studied the polished mount further exploring the meteorites mineralogy and structure, and will continue with more detailed studies. Eippers meteorite is the fifth meteorite identified from British Columbia (and the first "find"; meteorites are classified as "falls" when the fireball is witnessed, or "finds" when it isn't seen). It is the 69th meteorite recovered in Canada, and also marks the modest milestone of 10 new meteorite discoveries for the Prairie Meteorite Search. The Prairie Search has now identified approximately 15% of all the meteorites ever found in Canada.

Adrian Karolko, the Prairie Meteorite Searcher for 2006, has returned to his studies at the University of Calgary this fall, after he spent the summer visiting communities around British

Columbia to inspect unusual rocks in hopes of finding those of extraterrestrial origin. "*I was amazed at the power of the media to reach people, so they would bring their unusual rocks out for identification. It was a great summer job and chance to learn about meteorites*," Karolko said. Both Karolko and Hildebrand encourage anyone with a rock that they think might be a meteorite to have it identified. Hildebrand says, "*We have looked at the rocks of more than 4,000 people since we started in 2000, and we will happily look at the rocks of thousands more*." http://www.ucalgary.ca/news/files/news/images/Eipper_meteorite.jpg

NEW EXPLANATION FOR PULSAR'S SPIN

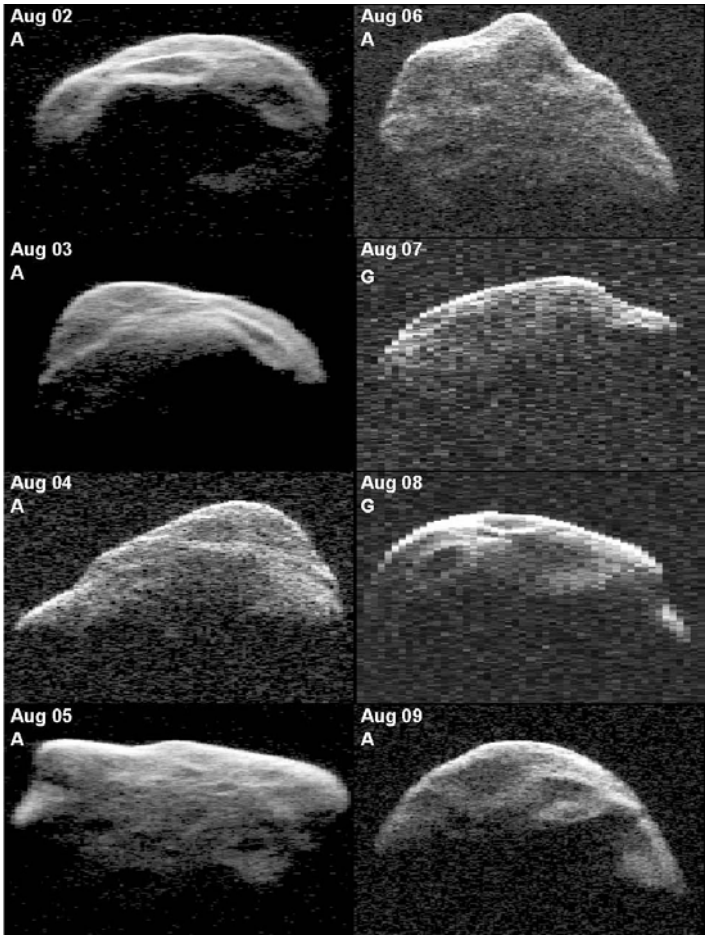
A researcher at has developed a three-dimensional computer model that shows how pulsars obtain their spin, which could lead to a greater understanding of the processes that occur when stars die. Dr. John Blondin, along with colleague Anthony Mezzacappa, used the CRAY X1E supercomputer to develop a three-dimensional model of a pulsar's creation, and in the process discovered that conventional wisdom concerning the formation of these celestial objects wasn't correct.

Pulsars are rapidly rotating neutron stars formed in supernova explosions, which occur when a massive star reaches the end of its life and explodes. The remaining matter is compressed into a dense, rapidly spinning mass -- a neutron star, or pulsar -- so-called because scientists first discovered them due to their regularly timed radio emissions. "*Picture something about the mass of the sun being pushed down to the size of a small American city, like Raleigh*," Blondin says. "*That's what happens when a neutron star is formed*." "*We've known about pulsars since the 1960s*," Blondin continues. "*We can determine how fast they're spinning by how rapidly they pulse. It's like a searchlight on a lighthouse -- each time the pulsar spins, and emits a radio pulse directed toward earth, we pick up on it. The period between the pulses tells us how fast it's spinning*." Pulsars spin very rapidly -- 20 or more times per second. Scientists have assumed that the spin was caused by the conservation of angular momentum from a star that was spinning before it exploded.

"*Think about figure skaters*," Blondin says. "*They start a spin with their arms and legs farther out from the body, and increase their rotation speed when they pull their limbs in more tightly. That's what the conservation of angular momentum is -- the idea that if you take a large object with a slight rotation and compress it down, the rotation speed will increase*." However, scientists had no idea if the stars that were producing the pulsars were even spinning to begin with. Blondin and his colleague decided to create a computer model of a supernova explosion using the new Cray X1E supercomputer at the National Center for Computational Sciences, the only computer with enough processing power to accomplish the task. The resultant model demonstrated that a pulsar's spin doesn't have anything to do with whether or not the star that created it was spinning; instead, the spin is created by the explosion itself. "*We modeled the shockwave, which starts deep inside the core of the star and then moves outward*," Blondin says. "*We discovered that as the shockwave gains both the momentum and the energy needed to blow outward and create the explosion, it starts spiraling all on its own, which starts the neutron star at the center of the star spinning in the opposite direction. None of the previous two-dimensional modeling of supernova explosions had picked up on this phenomena*." Blondin hopes that this new information about the creation of pulsars will lead to a greater understanding of supernova explosions. "*Supernova explosions produce many of the heavy elements found on the periodic chart, like gold*," he says. "*Understanding these explosions can help us to better understand our own planet and solar system*." http://news.ncsu.edu/releases/2007/jan/001_Pulsarformation.htm

RADAR LOVE: ASTEROID DETECTION AND SCIENCE

They are the celestial equivalent of sonograms. But their hazy outlines and ghostly features do not document the in-vivo development of a future taxpayer. Instead, they chronicle the exo-planetary comings-and-goings of some of Earth's least known, most nomadic, and at times most impactful neighbors. They are radar echoes that are bounced off of asteroids. Scientists around the world rely on their ethereal images to tell some out-of-this-world tales of near-Earth objects. "*The standard ground-based tools for asteroid science require a night's sky, and what you come away with in the end is an image of a dot*," said radar astronomer Dr. Steve Ostro. "*With radar astronomy, the sky at high noon is just as inviting as that at midnight, and without launching a full-blown space mission we can actually get valuable information about the physical makeup of these objects*." In some respects, radar astronomy utilizes the same technology as your microwave oven. But do not bother to haul your glorified croissant warmer outside -- it will just confuse the neighbors. Radar astronomy employs the world's most massive dish-shaped antennas, which beam directed microwave signals at their targets, which can be as close as our moon and as far away as the moons of Saturn. These pulses bounce off the target, and the resulting "echo" is collected and precisely collated. The results can be astounding. "*The closer the target, the better the echo*," said Ostro. "*From them we can generate detailed three-dimensional models of the object, define its rotation precisely and get a good idea of its internal density distribution. You can even make out surface features. A good echo can give us a spatial resolution finer than 10 meters*." Radar astronomy has detected echoes from over 190 near-Earth asteroids to date and has found that, like snowflakes, no two are the same. The returning echoes have revealed both stony and metallic objects, some flying through the cold, dark reaches of space alone, while others have their own satellites. The data indicate that some asteroids have a very smooth surface, while others have very coarse terrain. And finally, their shapes are virtually anything that can be imagined. One thing that does not have to be imagined is radar astronomy's ability to nail down the location of an object in time and space. This invaluable capability came in handy in the winter of 2004 when JPL's Near-Earth Object office was looking for a potentially hazardous asteroid called Apophis. Discovered by astronomers using optical telescopes, Apophis quickly drew the interest of the near-Earth object monitoring community when its initial orbital plots indicated there was a possibility the 1,300-foot-wide chunk of space rock could impact Earth in 2029. The Near-Earth Object office knew what was needed was more detailed information about Apophis' location, which they could then use to plot out a more accurate orbit.



Under the watchful eye of Ostro and three other radar astronomers, microwaves from the Arecibo Observatory in Puerto Rico reached out and touched asteroid Apophis on Jan. 27, 29, and 30, 2005. The Arecibo data significantly improved the asteroid's orbital estimate, ruling out a potential Earth collision in 2029. The 1,000-foot diameter Arecibo telescope is one of only two places in the world where radar astronomy is effectively performed. The other is at the 70-meter Goldstone antenna in California's Mojave Desert. The two instruments are complementary. The Arecibo radar is not fully steerable (while Goldstone is), but it is 30 times more sensitive. Together they make a formidable asteroid reconnaissance team. The future of radar astronomy may be just as amazing as some of the images and shape models of nearby space objects that its practitioners have already obtained. There is new technology in the pipeline that will allow imaging of surface features with up to four times more detail than what exists today. And then there are proposals on the table for a potential space mission to a near-Earth asteroid. Candidate asteroids for said mission will need to be pre-approved via detail scientific analysis. The kind of scientific analysis you can only get with radar astronomy.

HOW DO MULTIPLE-STAR SYSTEMS FORM? VLA STUDY REVEALS "SMOKING GUN"

Astronomers have used the Very Large Array (VLA) radio telescope to image a young, multiple-star system with unprecedented detail, yielding important clues about how such systems are formed. Most Sun-sized or larger stars in the Universe are not single, like our Sun, but are members of multiple-star systems. Astronomers have been divided on how such systems can form, producing competing theoretical models for this process. The new VLA study produced a "smoking gun" supporting one of the competing models, said Jeremy Lim in a study done with Shigehisa Takakuwa. Ironically, their discovery of a third, previously-unknown, young star in the system may support a second theoretical model. "There may be more than one way to make a multiple-star system," Lim explained. The astronomers observed an object called L1551 IRS5, young, still-forming protostars enshrouded in a cloud of gas and dust, some 450 light-years from Earth in the direction of the constellation Taurus. Invisible to optical telescopes because of the gas and dust, this object was discovered in 1976 by astronomers using infrared telescopes. A VLA study in 1998 showed two young stars orbiting each other, each surrounded by a disk of dust that may, in time, congeal into a system of planets.

Lim and Takakuwa re-examined the system, using improved technical capabilities that greatly boosted the quality of their images. "In the earlier VLA study, only half of the VLA's 27 antennas had receivers that could collect the radio waves, at a frequency of 43 GigaHertz (GHz), coming from the dusty disks. When we re-observed this system, all the antennas could provide data for us. In addition, we improved the level of detail by using the Pie Town, NM, antenna of the Very Long Baseline Array, as part of an expanded system," Lim said. Two popular theoretical models for the formation of multiple-star systems are, first, that the two protostars and their surrounding dusty disks fragment from a larger parent disk, and, second, that the protostars form independently and then one captures the other into a mutual orbit. "Our new study shows that the disks of the two main protostars are aligned with each other, and also are aligned with the larger, surrounding disk. In addition, their orbital motion resembles the rotation of the larger disk. This is a 'smoking gun' supporting the fragmentation model," Lim said. However, the new study also revealed a third young star with a dust disk. "The disk of this one is misaligned with those of the other two, so it may be the result of either fragmentation or capture," Takakuwa said. The misalignment of the third disk could have come through gravitational interactions with the other two, larger, protostars, the scientists said. They plan further observations to try to resolve the question. "We have a very firm indication that two of these protostars and their dust disks formed from the same, larger disk-like cloud, then broke out from it in a fragmentation process. That strongly supports one theoretical model for how multiple-star systems are formed. The misalignment of the third protostar and its disk leaves open the possibility that it could have formed elsewhere and been captured, and we'll continue to work on reconstructing the history of this fascinating system," Lim summarized

MAPPING A HYPERGIANT STAR'S MASSIVE OUTBURSTS

Using Hubble Space Telescope and the W.M. Keck Observatory, Kameula, Hawaii, astronomers have learned that the gaseous outflow from one of the brightest super-sized stars in the sky is more complex than originally thought.

The outbursts are from VY Canis Majoris, a red supergiant star that is also classified as a hypergiant because of its very high luminosity. The eruptions have formed loops, arcs, and knots of material moving at various speeds and in many different directions. The star has had many outbursts over the past 1,000 years as it nears the end of its life.

A team of astronomers led by Roberta Humphreys used the Hubble Space Telescope and the W.M. Keck Observatory to measure the motions of the ejected material and to map the distribution of the highly polarized dust, which reflects light at a specific orientation. The polarized light shows how the dust is

distributed. Astronomers combined the Hubble and Keck information to produce a three-dimensional image of the matter emitted from VY Canis Majoris.

"*We thought mass loss in red supergiants was a simple, spherical, and uniform outflow, but in this star it is very complex,"* Humphreys said. *"VY Canis Majoris is ejecting large amounts of gas at a prodigious rate and is consequently one of our most important stars for understanding the high-mass loss episodes near the end of massive star evolution. During the outbursts, the star loses about 10 times more mass than its normal rate. "With these observations, we have a complete picture of the motions and directions of the outflows, and their spatial distribution, which confirms their origin from eruptions at different times from separate regions on the star*."

Humphreys and her collaborators presented their findings at the American Astronomical Society meeting in Seattle, Wash.

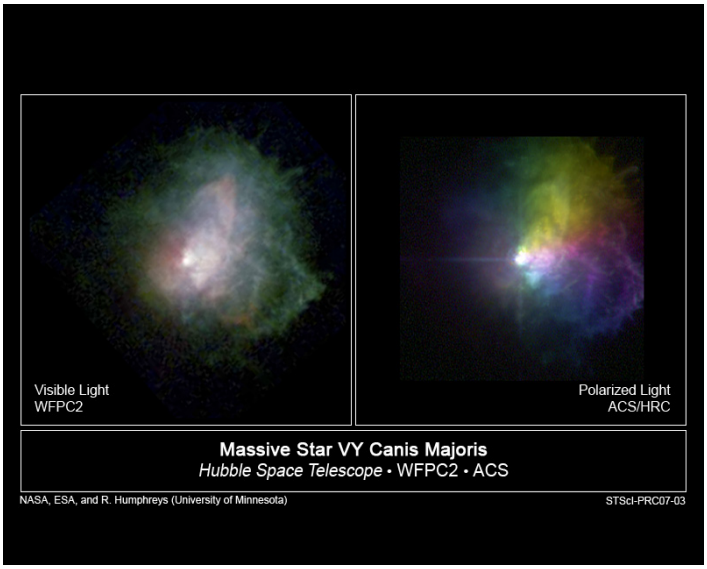
Astronomers have studied VY Canis Majoris for more than a century. The star is located 5,000 light-years away. It is 500,000 times brighter and about 30 to 40 times more massive than the Sun. If the Sun were replaced with the bloated VY Canis Majoris, its surface could extend to the orbit of Saturn. Images with Hubble's Wide Field and Planetary Camera 2 revealed for the first time the complexity of the star's ejecta. The first images provided evidence that the brightest arcs and knots were created during several outbursts. The random orientations of the arcs also suggested that they were produced by localized eruptions from active regions on the star's surface.

With spectroscopy obtained using the Keck Telescope, Humphreys and her team learned more about the shape, motion, and origin of the star's outflow. Line of sight velocities, measured from the spectra, showed that the arcs and knots were expanding relative to the star. With recently obtained Hubble images, the group measured the ejecta's motions across the line of sight. The team found that the numerous arcs, loops, and knots were moving at different speeds and in various directions, confirming they were produced from separate events and from different locations on the star. The astronomers also used the measurements to determine when the outbursts happened. The outermost material was ejected about 1,000 years ago, while a knot near the star may have been ejected as recently as 50 years ago.

The arcs and knots represent massive outflows of gas probably ejected from large star spots or convective cells on the star's surface, analogous to the Sun's activity with sunspots and prominences associated with magnetic fields, but on a vastly larger scale. Magnetic fields have been measured in VY Canis Majoris's ejecta that correspond to field strengths on its surface comparable to the magnetic fields on the Sun. These measurements show that the supergiant star's magnetic fields would supply sufficient energy for these massive outflows.

The astronomers used the measurements to map the velocity and direction of the outflows with respect to the embedded star. When combined with the dust distribution map, they also determined the location of the arcs and knots, yielding the three-dimensional shape of VY Canis Majoris and its ejecta. "*With these observations, we may have captured a short-lived phase in the life of a massive star*," Humphreys said. "*The most luminous red supergiants may all eventually experience high-mass loss episodes like VY Canis Majoris before ending their lives*."

The typical red supergiant phase lasts about 500,000 years. A massive star becomes a red supergiant near the end of its life, when it exhausts the hydrogen fuel at its core. As the core contracts under gravity, the outer layers expand, the star gets 100 times larger, and it begins to lose mass at a higher rate. VY Canis Majoris has probably already shed about half of its mass, and it will eventually explode as a supernova.



Images and additional information about this research are available on the Web at: http://hubblesite.org/newscenter/archive/releases/2007/03

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.

The Star Gazer
P.O. Box 12746
Everett, WA 98206

In January's StarGazer:

The next EAS Meeting is 3:00 P.M. Saturday January 27th at the Everett Public Library Auditorium.