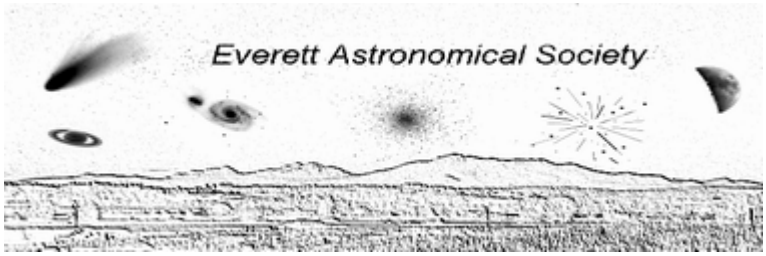
Volume MMV. No. 1



The Stargazer

December 2004 / January 2005

President: Mark Folkerts	(425) 486-9733	folkerts at seanet.com	***The Stargazer***
VP & Librarian: Mike Locke	(425) 259-5995	mlocke at lionmts.com	**P.O. Box 12746**
Treasurer: Carol Gore	(360) 856-5135	janeway7C at aol.com	**Everett, WA 98206**
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

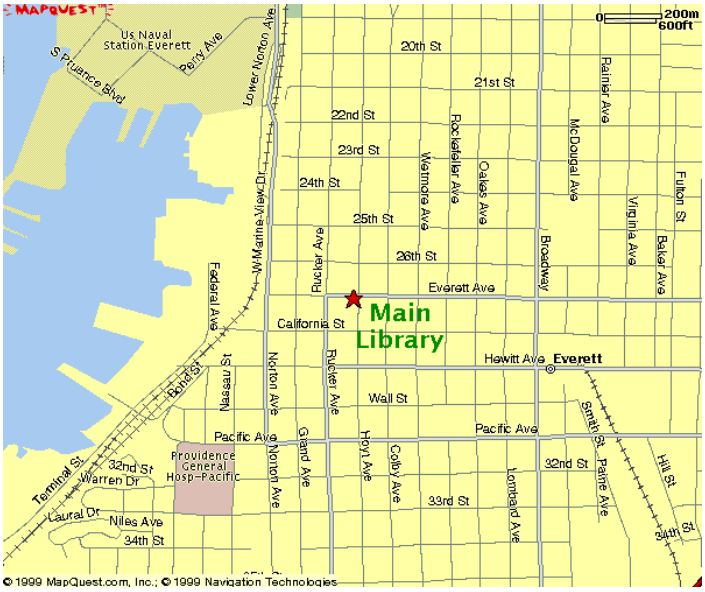
EAS BUSINESS…

NEXT EAS MEETING - SATURDAY JANUARY 29TH AT 4:00 PM (NEW TIME) AT THE EVERETT PUBLIC LIBRARY, (NEW PLACE) IN THE AUDITORIUM (DOWNSTAIRS) – *NOTE NEW TIME AND PLACE !!!*

★ January meeting topic - Film 'Unfolding Universe'.

Map and directions to the **EAS meeting at the Everett Public Main Library** are available at:

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



The Main Library is located at:
2702 Hoyt Avenue
Everett, WA 98201

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

Driving Directions to the Main Library

Directions from the North on I-5

- Take the Everett Avenue exit 194,
- Turn right onto Everett Avenue, drive west for 16 blocks,
- The library is at the intersection of Hoyt and Everett Avenues.

Directions from the South on I-5

- Take the Pacific Avenue exit 193,
- Turn left onto Pacific Avenue, drive west 15 blocks,
- Turn right onto Hoyt Avenue, drive north 4 blocks,
- The library is at the intersection of Hoyt and Everett Avenues.
- Parking is available in the library garage.
Enter from Everett or Rucker Avenues.

Scheduled Meeting Dates:

Jan 29 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Feb 19 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Mar 19 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Apr 15/16 - Astronomy Day Public Star Party
Apr 16 - Astronomy Day
Apr 30 - EAS MEETING - Saturday 4:00 PM at Everett Public Library

MEMBER NEWS

★ **NOTE NEW MEETING TIME AND PLACE – EVERETT LIBRARY !!!**

★ NEW OFFICERS FOR 2005 – MIKE LOCKE IS BOTH VP AND LIBRARIAN. MARK CONTINUES AS PRESIDENT, AND CAROL AS TREASURER

CLUB STAR PARTY INFO

Upcoming star party schedule:

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 $500+ balance. We try to keep approximately a $500 balance to allow for contingencies. Emailing a digital copy of the newsletter has been suggested to reduce printing and postage costs, and speed up delivery, please email Mark if electronic copy would be OK for you.

CLUB SCOPES' STATUS

SCOPE	LOAN STATUS	WAITING
10-INCH DOBSONIAN	ON LOAN	NO WAIT LIST

EAS members: contact Mike Locke at (425) 259-5995 or 'mlocke at lionmts.com' to borrow a scope.

ASTRO CALENDAR FOR 2005

January 2005
Jan 03 - Earth at Perihelion (0.983 AU From Sun)
Jan 03 - Quadrantids meteor shower peak
Jan 07 - Comet Machholz near Pleiades
Jan 10 - Moon closest to Earth for the year – nearest perigee
Jan 13 - Conjunction - Mercury 0.4 degrees S of Venus
Jan 13 - Saturn at Opposition
Jan 13 - Mercury Passes 0.3 degrees from Venus
Jan 14 - Huygens probe lands on Titan
Jan 15 - Comet Machholz near Algol
Jan 20 - 'Origins' talk, Dr. Neil deGrasse Tyson, 7:30 PM, at Town Hall
Jan 22 - SAS Amateur Telescope Makers – Peter Hirtlle's place
Jan 25 - Full Moon
Jan 26 - UW Saturn Madness event.
- Toby Smith speaking at 7:00 pm in Kane Hall
- SAS will have observing by the fountain afterwards

Jan 29 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Jan 31 - Moon Jupiter conjunction – 1.5 deg. north of Moon for western US

February 2005
Feb 07 - Mars 0.7 deg N of M8 (Lagoon) nebula
Feb 09 - Chinese New Year
Feb 10 - New Moon
Feb 12 - Potential Saturday star party night, location TBD
Feb 16 - Moon 1.5 deg S of Pleiades for western US
Feb 19 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Feb 26 - Look for Zodiacal light in evening western sky next 2 weeks
Feb 26 - SAS Amateur Telescope Makers – Peter Hirtlle's place
Feb 27 - Moon Jupiter conjunction – 1.9 deg. S of Moon for western US

March 2005
Mar 02 - Comet Machholz 2 Perihelion (0.753 AU)
Mar 03 - Moon occults Antares
Mar 08 - New Moon
Mar 09 - Potential Saturday star party night, location TBD
Mar 11-13 - South Pacific Star Party – Wiruna NSW Australia
Mar 11-13 - Rose City Messier Marathon Kah-Nee-Ta hot springs resort
Mar 12 - Mercury Greatest Eastern Elongation (18 Degrees)
Mar 19 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Mar 20 - Vernal Equinox, 12:33 UT – First day of Spring in N hemisphere
Mar 26 - Moon occults Jupiter
Mar 27 - Easter Sunday
Mar 30 - Mercury passes 4.2 degrees from Venus

April 2005
Apr 01 - Mars occults PPM 237883 (8.7 Magnitude Star)
Apr 03 - Daylight Saving - set clock ahead 1 Hour (North America)
Apr 03 - Jupiter at opposition
Apr 08 - New Moon
Apr 09 - Potential Saturday EAS star party night, location TBD
Apr 08 - Hybrid solar eclipse (Visible From Pacific, Central America)
Apr 09 - Moon occults Venus
Apr 11-17 - Astronomy Week
Apr 15, 16 - Astronomy Day Public Star Parties
Apr 16 - Astronomy Day
Apr 22 - Lyrids meteor shower peak
Apr 22 - Moon occults Jupiter
Apr 24 - Lunar eclipse
Apr 26 - Mercury at Greatest Western Elongation (27 degrees from Sun)
Apr 30 - EAS MEETING - Saturday 4:00 PM at Everett Public Library

May 2005
May 05 - Eta Aquarids Meteor Shower Peak
May 6-8 - Olympic Astronomy club – Dry Falls Spring Star Party
May 07 - Potential Saturday EAS star party night, location TBD
May 08 - New Moon
May 19 - Moon Occults Jupiter
May 21 - EAS MEETING* - Saturday 4:00 PM at Everett Public Library
May 27-29 - Riverside Telescope Makers Conference Astronomy Expo
May 27-29 - Memorial Day Weekend
May 31 - Moon Occults Mars

June 2005
Jun 04 - Potential Saturday EAS star party night, location TBD
Jun 06 - New Moon
Jun 09 - Two moon shadows visible on Jupiter for USA – 10:30 pm
Jun 13 - Pluto at opposition
Jun 16 - Moon occults Jupiter
Jun 17 - Two moon shadows visible on Jupiter for USA – 12:57 am
Jun 21 - Summer Solstice, 06:46 UT – first day of N hemisphere summer
Jun 26 - Mercury passes 1.4 degrees from Saturn
Jun 27 - Mercury passes 0.1 degrees from Venus
Jun 25 - EAS MEETING - Saturday 4:00 PM at Everett Public Library

July 2005
Jul 02 - Potential Saturday EAS star party night, location TBD
Jul 03 - Venus 0.4 deg. North of M44 Beehive cluster
Jul 04 - Deep Impact, Comet Tempel 1 impact/flyby
Jul 04 - Earth at aphelion (1.017 AU From Sun)
Jul 6-10 - Mt Bachelor Star Party
Jul 6-10 - Shingleton Star Party – Redding California
Jul 09 - Mercury Greatest Eastern Elongation (26 Degrees)
Jul 09 - Potential Saturday EAS star party night, location TBD
Jul 12 - Asteroid 3259 Brownlee closest approach to Earth (2.19 AU)
Jul 13 - Moon occults Jupiter
Jul 18 - Moon occults Antares from southern US, near for north.
Jul 21 - Largest full moon for 2005
Jul 23 - 10th Anniversary (1995), Alan Hale's & Tom Bopp's Discovery of Comet Hale-Bopp
Jul 27-29 - South Delta-Aquarids meteor shower peak
Jul 30 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Jul 30-Aug 07 Mt. Kobau Star Party – Osoyoos BC

August 2005
Aug 01 - Alpha Capricornids Meteor Shower Peak
Aug 4-6 - Table Mountain Star Party
Aug 04 - Furthest lunar apogee of 2005
Aug 05 - Neil Armstrong's 75th birthday (1930)
Aug 06 - Southern Iota Aquarids meteor shower peak
Aug 08 - Moon 1.0 right of Venus
Aug 08 - Neptune at opposition – visible all night
Aug 11 - Perseid meteor watch - Rooster Rock St Park - Columbia Gorge
Aug 12 - Perseids meteor shower peak
Aug 24 - Mercury at Greatest Western Elongation (18 degrees from Sun)
Aug 25 - Northern Iota Aquarids meteor shower peak
Aug 27 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Aug 31 - Uranus at opposition – visible all night

September 2005
Sep 01 - Uranus at opposition
Sep 01 - Venus passes 1.2 degrees from Jupiter
Sep 03 - New Moon
Sep 03 - Potential Saturday EAS star party night, location TBD
Sep 1-4 - Oregon Star Party
Sep 2-5 – Olympic Astronomy – Dry Falls Star Party
Sep 05 - Labor Day holiday
Sep 07 - Moon occults Venus
Sep 22 - Autumnal Equinox (22:23 UT) – 1st day of autumn N hemisphere
Sep 24 - EAS MEETING - Saturday 4:00 PM at Everett Public Library

October 2005
Oct 01 - Potential Saturday EAS star party night, location TBD
Oct 03 - New Moon
Oct 03 - Annular Solar Eclipse, Visible From Africa
Oct 04 - Moon occults Mercury
Oct 05 - Mercury passes 1.3 degrees From Jupiter
Oct 09 - Draconids meteor shower Peak
Oct 16 - Venus occults PPM 265560 (7.7 Magnitude Star)
Oct 17 - Partial Lunar eclipse
Oct 21 - Orionid meteor shower peak

Oct 29 - EAS MEETING - Saturday 4:00 PM at Everett Public Library
Oct 30 - Daylight Saving - set clock back 1 Hour

November 2005
Nov 01 - New Moon
Nov 05 - Potential Saturday EAS star party night, location TBD
Nov 03 - Taurids meteor shower peak
Nov 03 - Mercury at its Greatest Eastern Elongation (23 Degrees)
Nov 03 - Venus at its Greatest Eastern Elongation (47 Degrees)
Nov 07 - Mars at opposition
Nov 19 - EAS MEETING - Saturday 4:00 PM at Everett Public Library

December 2005
Dec 02 - 10th anniversary (1995), SOHO Launch
Dec 12 - Moon occults Mars
Dec 12 - Mercury at its Greatest Western Elongation (21 Degrees)
Dec 13 - Geminids meteor shower peak
Dec 21 - Winter Solstice, 18:35 UT
Dec 22 - Ursids meteor shower peak
Dec 10th or 17th – EAS Dinner - Saturday 7:00 PM

UW 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).

Jan 20 - Neil Tyson - American Museum of Natural History
'Inside the 'Moon-to-Mars' Space Commission'

Jan 27 - Sangeeta Malhotra - Space Telescope Science Institute
'Energetics of the Starforming Interstellar Medium'

Feb 3 - Jean Brodie - University of California, Santa Cruz
'Extragalactic Globular Clusters and Galaxy Assembly'

Feb 10 - Lori Lubin - University of California, Davis
'High-Redshift Clusters of Galaxies: Understanding Structure Formation and Galaxy Evolution'

Feb 17 - Jason Kalarai - University of California, Santa Cruz
'The White Dwarf Initial-Final Mass Relation'

Feb 24 - Pat McCarthy - Carnegie Observatories
'Old Stars in the Young Universe'

Mar 3 - TBA

Mar 10 - Tim Beers - Michigan State University
'Mining the Milky Way Galaxy with the Sloan Digital Sky Survey'

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 8:58 A.M. and 5:58 P.M. Saturday and Sunday). The short 2 minute radio show deals with current topics of interest in astronomy. The University of Washington TV broadcasts programs from NASA at 12:00 AM Monday through Friday, 12:30 AM Saturday, and 1:30 AM Sunday on the Channel 27 cable station.

EAS LIBRARY – BOOK & VIDEO LIST

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

MEMBERSHIP BENEFITS & INFORMATION

Membership in the **Everett Astronomical Society** (EAS) will give you access to all the material in the lending library. The library, which is maintained by Scott Gibson, consists of several VCR tapes, many books, magazines, and software titles. Membership includes invitations to all of the club meetings and star parties, plus the monthly newsletter, ***The Stargazer.*** In addition you will be able subscribe to ***Sky and Telescope*** for $7 off the normal subscription rate, contact the treasurer for more information. **When renewing your subscription to *Sky & Telescope* you should send your S&T renewal form along with a check made out to Everett Astronomical Society to the EAS address.** The EAS treasurer will renew your *Sky and Telescope* subscription for you. **Astronomy** magazine offers a similar opportunity to club members.
EAS is a member of the **Astronomical League** and you will receive the Astronomical League's newsletter, ***The Reflector***. Being a member also allows you the use of the club's telescopes, an award winning 10 inch Dobsonian mount reflector, built as a club project or the 60mm refractor. Contact Bob Lyons (425) 337-1510 to borrow a telescope. EAS dues are $25. Send your annual dues to the **Everett Astronomical Society**, P.O. Box 12746, Everett, WA 98206. Funds obtained from membership dues allows the Society to publish the newsletter, pay Astronomical League dues and maintain our library.

OBSERVER'S INFORMATION…

LUNAR FACTS

Jan 03	Last Quarter Moon
Jan 10	New Moon
Jan 17	First Quarter Moon
Jan 25	Full Moon
Feb 02	Last Quarter Moon
Feb 08	New Moon
Feb 15	First Quarter Moon
Feb 23	Full 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

Mercury is very low in southeast in morning twilight in the early part of January, not easily seen later or in February.

Venus is sinking very low in southeast sky in morning twilight, not easily seen in February.

Mars is very low in southeast at dawn, somewhat higher in February.

Jupiter rises in east before midnight, south-southwest at dawn.

Saturn is at opposition on January 13th, rising ESE at sunset, sets WSW at dawn.

Comet Machholz 2004 Q2 - Article and maps:
http://skyandtelescope.com/observing/objects/comets/article_1396_1.asp

http://skyandtelescope.com/observing/objects/comets/article_1396_2.asp

Object	Rises	Transits	Sets	Constellation
Sun	**7:43 am**	**12:22**	**17:00**	**Capricornus**
Mercury	**7:14 am**	Daylight	15:43	**Sagittarius**
Venus	**6:58 am**	Daylight	Daylight	**Sagittarius**
Mars	**5:00 am**	Daylight	Daylight	**Ophiuchus**

Jupiter	**23:21**	**5:01 am**	Daylight	**Virgo**
★Saturn	**15:50**	**23:25**	**7:14 am**	**★ Gemini ★**
Uranus	Daylight	Daylight	**19:33**	**Aquarius**
Neptune	Daylight	**18:22**	**23:07**	**Capricornus**
Pluto	**4:28 am**	Daylight	Daylight	**Serpens**

(times local time for Everett PST)

Transit times for Jupiter's Great Red Spot in 2005

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

Constellations of the Month: Monoceros, Lynx, Gemini

MONOCEROS: Monoceros, or the Unicorn, is an interesting constellation which borders on many of our familiar winter star groupings, including Orion, Canis Major and Minor, Gemini, Hydra, Lepus, and Puppis. The constellation's central point is at RA=7h01m, and Dec.=+0.5 degrees; its overall brightness is listed at a magnitude of 7.476, and it contains 36 visible stars brighter than magnitude 5.5. Its midnight culmination date is January 5th, which makes it well placed for winter observing, and the grouping has one associated meteor shower (the Monocerotids), which peak on or about December 10th. This constellation ranks 35th in size, and is completely visible from latitudes +79 degrees to –78 degrees. Monoceros also contains one Messier object, M-50, which is a magnitude 6.3 galactic (open) cluster. Perhaps more famous than the Messier object however, are a trio of objects well known to many astronomers. The first is Plaskett's Star, which is in reality a pair of extremely massive stars, among the most massive pairs yet identified. This duo sits almost directly on the Galactic Equator, and the total mass of the system is more than 100 times that of the sun. Also in Monoceros is "Hubble's Variable Nebula", a fan-shaped reflection nebula which has been seen to undergo changes in brightness, size, and shape, (but no regular period of variability has been found for the nebula). It is illuminated by the star R Monocerotis, a very young infrared-emitting stellar object surrounded by a disk of dust which is ejecting a bi-polar flow; this flow causes the variability in the nebula. Lastly, and most famous of all, is the beautiful emission nebula known as the Rosette. It surrounds an open cluster of stars containing the star 12 Monocerotis, and is an H-II region heated and ionized by this centrally located group of hot young stars. Try to enjoy the beauties of this well-placed constellation during these winter months; your time will be well spent.

LYNX: This relatively dim constellation borders on the constellations of Auriga, Camelopardalis, Cancer, Gemini, Leo Minor, and Ursa Major, and ranks 66th in overall brightness, containing 31 visible stars brighter than magnitude 5.5. Its central point is located at RA=7h56m and Dec.= +46.5 degrees. It is completely visible from latitudes North of -28 degrees, and completely invisible from latitudes South of -57 degrees. This constellation ranks 28th in overall size, taking up 545.39 square degrees, or 1.322% of the sky. Lynx contains no very well known or very bright stars, and contains no Messier objects and no known meteor showers. Its midnight culmination date is January 19th. Lynx is one of seven constellations invented by Johannes Hevelius and still in use. The star 41 Lyn, now in the constellation Ursa Major, was listed by Flamsteed in the early 18th century to be in the constellation Lynx. This is the star frequently singled out to show stellar motion and the overall transient nature of constellation boundaries. Lynx contains many other interesting objects (including many interesting galaxies) best visible in the spring. These objects include NGC-2683 (Sb-spiral); NGC-2776 (Sc-spiral); NGC-2782 (Sb-spiral); NGC-2798 (barred spiral); IC-2233 (edge-on barred spiral); NGC-2549 (elliptical); Perek-Kohoutek 164-31.1 (large, amorphous planetary nebula (see "Mirror Images" column below); V-Lyncis (irregular variable star); R-Lyncis (long-period variable); 38 Lyncis (bright triple star); 19 Lyncis (quadruple star); and NGC-2419. This last object is a small globular cluster, and relatively dim at magnitude 10.4. However, it lies 90 kiloparsecs away, and is very famous as one of the most distant globulars known. Harlow Shapley named NGC-2419 the "Intergalactic Tramp", and believed that it may have broken away from the gravitational constraints of the Milky Way and headed off into intergalactic space. However, while more recent observations show a highly eccentric galactic orbit, NGC-2419 will undoubtedly remain gravitationally bound to this local neighborhood of the universe. On a clear, moonless night this spring, try to enjoy the little-known but beautiful wonders of Lynx.

GEMINI: The Twins, as this winter constellation is also known, borders on the constellations of Auriga, Cancer, Canis Minor, Lynx, Monoceros, Orion, and Taurus, and ranks 26th in overall brightness among the constellations, containing 47 stars brighter than magnitude 5.5. Its central point is located at RA=7h,1m and Dec.= +22.5 degrees. It is completely visible from latitudes North of –55 degrees, and completely invisible from latitudes South of –80 degrees; this constellation ranks 30th in overall size. Gemini's most famous bright stars are Castor (Alpha) and Pollux (Beta), better known as "The Twins". Gemini has two associated meteor showers: the Epsilon Geminids (19 Oct.), and the Geminids (14 Dec.), and one Messier object: the open cluster M35 (NGC 2168). Two of the planet "discoveries" took place within this constellation. In 1781 William Herschel found the planet Uranus near Eta Geminorum; in the first half of this century (1930), Clyde Tombaugh (working at Flagstaff's Lowell Observatory), discovered Pluto near Delta Geminorum. Castor, appearing as one star to the naked eye, is officially designated as a triple star, but is in reality six stars, each of the three having a companion. Studies indicate that star systems containing more than six stars will more rapidly become unstable and separate. Gemini's midnight culmination date is January 5th, so try to enjoy the beauty of this constellation, and its beautiful and interesting neighbors, on the next clear night.

Planetary Focus – Saturn – At its Best This Month !

"Planetary Focus" is published on a bi-monthly basis in the EAS "Stargazer". If you have a favorite planet that you would like information and/or statistics on, please contact newsletter co-editor Bill O'Neil. The planetary focus of this month's column is "Saturn", now at opposition and also much in the news lately because of recent fascinating and important Huygens and Cassini probe activity.

Rotation around the Sun: every 29.46 years

Orbit: from 9.01 (closest or 'perihelion') to 10.04 (furthest or 'aphelion') Astronomical Units (AU)*; this is an orbit that varies between approximately 838 and 934 million miles from the sun. (*Note: One AU equals approximately 93 million miles).

Inclination of Orbit to Ecliptic: 2.5 degrees.

Mean Orbital Velocity: 9.65 km/sec.

Diameter at Equator: 120,537 kilometers (or 75,335 miles).

Mass: 95.16 (approximately 95 times more massive than earth); (5.9742 x (10 e24 (10 to the 24th power)) kilograms = 1 Earth Mass)**.**

Density: 0.7 times that of water (global density); Saturn is the only planet with an overall density less than 1 (water = 1).

Surface Gravity (Earth = 1): 1.08

Period of Rotation on its own axis: approximately 10 hours, 39 minutes.

Axis tilt: 26.73 degrees.

Satellites (moons): 18, as well as the most famous of all planetary rings.

Special Notes About Saturn: Saturn is the second largest planet in the solar system. It has a polar diameter of 107,500 kilometers, and, as such, has the highest oblateness of any planet: 0.108. (Oblateness is the "elliptical" nature or "flattening" of a celestial body; i.e., the degree to which that body differs from a true sphere). The appearance of Saturn in a telescope is dominated by its ring system that lies in the plane of Saturn's equator; the axis of Saturn is tilted by approximately 27 degrees with respect to the plane of its orbit. This phenomenon leads to opposite ring faces being tilted toward the sun and Earth by up to 27 degrees. Approximately every 15 years, the rings of Saturn (which are at most only about 2 kilometers thick!) become "edge-on" to Earth observers and virtually disappear. The ring system, which is about 270,000 kilometers across, adds to the average apparent magnitude (approximately 0.7) of Saturn at opposition. We will talk more about the ring system below.

Saturn's disk appears similar to that of Jupiter, as it too is crossed by yellowish dark (belts) and light (zones) cloud bands which run parallel to the equator. These bands are not as striking as those of Jupiter, although they too contain anticyclonic (counterclockwise-rotating) "spots" or "weather systems", (although they are less common and generally less dramatic (e.g., compared to Jupiter's Great Red Spot). Like Jupiter however, these spots are probably caused by different rotation speeds of the planet between the equator and the poles. Saturn in the past has been studied by the Pioneer 11 and Voyager probes; the Cassini probe is on its way. (Note: The Cassini probe was launched in late 1997, and is scheduled to arrive at Saturn in July of 2004, at which time it will begin a four-year exploration of Saturn and its moons. However, along the way, the probe has been engaged in some imaging studies. For example, on February 11, 2000, the Jet Propulsion Laboratory in California released images of the asteroid named Masursky, which Cassini snapped on January 23, 2000, on its way through the asteroid belt between Mars and Jupiter. It will fly by Jupiter this coming December. Asteroid Masursky has not been extensively studied from Earth, and Cassini's information could shed light on several parameters, including the asteroid's size and rotation period.). The early probes helped to determine that Saturn, like Jupiter, most likely has an internal heat source that helps drive its convection-weather systems; Saturn also, like Jupiter, emits more radiation than it absorbs from the Sun. These convective weather systems give rise to the cloud banks that are observed and most likely composed of ammonia crystals; the weather systems are also, like Jupiter, somewhat dependent on the zones they are located in (i.e., equator winds are comparatively stronger). Further studies show that the bulk of Saturn's mass and atmosphere is more than likely hydrogen, with methane and ethane present in the upper atmosphere. Internal composition models for Saturn indicate an iron-rich rock core, surrounded by ammonia, methane and water, which is further surrounded by liquid metallic hydrogen and then liquid molecular hydrogen, and finally the atmosphere as described above. Saturn has a magnetic field that is approximately 20 times weaker than that of Jupiter. Pioneer also found radiation belts (composed of electrons and protons). These energetic particles interact in the magnetic field and contribute to the emission of radio waves from Saturn; they also interact with the ring system, contributing to the brightness and "spoking" pattern seen especially in one of the rings (ring B); lightning discharges have also been noted in this region of the ring system.

The most famous part of Saturn to most folks is indeed its ring system. They were first seen (but not clearly) by Galileo in 1610, and recognized as a true ring system later by Huygens in 1656. The rings are now known to be composed of literally thousands of smaller "ringlets" containing innumerable individual particles: all of these particles (maximum size is probably just a few meters in size; most are much smaller) are actually each an individual satellite of Saturn!! There are several distinct ring separations (divisions or gaps), creating distinctly appearing larger rings. These larger rings have been named (for example, the D-ring is closest to the planet itself, and may even interact with the upper atmosphere of Saturn). Other rings (heading outward from the planet) are the, C-ring (the "Crepe" ring, with a large number of distinct ringlets within its grooved confines), and the B-ring (see above), and then the A, F, G, and E-rings. There are significant gaps between several of these larger, more distinct rings. The most noticeable and well known of these gaps is also the largest (4,200 kilometers), and has been named the Cassini Division; with appropriate optical aid, it, and the larger rings, are easily visible from Earth by amateur astronomers. It is theorized that the Cassini Division, which separates the B and A rings, was probably formed from the disturbances from the orbit of one of Saturn's moons (Mimas), as well as the effect of the energetic particles in ring-B (see above).

Briefly, some of Saturn's moons are interesting in their own right. In addition to **Mimas** as mentioned above, at least two other moons bear mention: **Titan and Tethys**. **Titan** is the second largest moon in the entire solar system at 5,150 kilometers (Earth's moon = 3,476 kilometers), and it appears reddish-orange in color. Its atmosphere is mostly nitrogen, with traces of other molecules such as methane and hydrogen cyanide; it has enough of an atmosphere with the right gases to be warmed by a small greenhouse effect. Atomic and molecular hydrogen formed by photochemical reactions on this moon of Saturn probably lead to the formation of the doughnut-shaped ring around this moon as these types of hydrogen easily escape from its atmosphere. The interior is probably rock and water-ice, and the surface may have some very large methane "oceans". Titan will be visited by the Huygens "sub"-probe of the Cassini mission detailed above. **Tethys** is interesting not only as the largest of the inner moons of Saturn, but also because of an unusual and enormous canyon network that extends from its north to almost its south pole; this is known as the Ithaca Chasma, and it averages 100 kilometers wide and 4-5 kilometers deep. There is also a huge crater called Odysseus, which is 400 kilometers in diameter, a diameter that is fully 40% that of this moon's entire diameter! Substantial craters noted elsewhere on this moon of Saturn, indicates that Tethys

has suffered considerable bombardment by large debris in its history.

YOUNG ASTRONOMER'S CORNER

Here are some frequently asked questions by Young Astronomers. If you have an astronomy-related question that you would like answered, please contact EAS Newsletter co-editor Bill O'Neil

★★ **Question:** Does the same side of the Moon always face Earth?
Answer: Yes. This is why we always see the same craters and darker, smooth areas ("seas") when we look at the Moon at night. From a scientific standpoint, one side of the Moon has always been a little "heavier" than the other; because of the Earth's gravitational pull, the Earth 'tugged' on the heavier side, eventually slowing down the Moon's rotation and capturing it (so to speak), so that one side, the heavier side, always faces the Earth. Another reason for this is that the remaining very slowed (by Earth's gravity) period of rotation of the Moon (the time it takes to make one full rotation on its axis) is equal to the orbital period around the Earth (the time it takes to rotate around the Earth). Thus, for these reasons, the same side always faces the Earth.

★★ **Question:** Which planet has the largest moon? **Answer:** Jupiter. The name of the moon is Ganymede, and it also happens to be the largest moon in the entire solar system. It is 3,166 miles in diameter, and is thus larger than the planets Mercury (2,930 miles diameter) and Pluto (1,380 miles diameter). By comparison, Earth's Moon is 2,086 miles in diameter.

★★ **Question:** Why should we build a space station? **Answer:** The simple answer is that if humans are going to explore outer space, we need to know a lot more information about it. Space has no air to breathe and a micro-gravity atmosphere. The space shuttle and space station missions allow astronauts and cosmonauts to conduct many useful experiments in the weightlessness of space; but because shuttle missions are only about 2 weeks in duration, the longer orbiting time for the space station would allow longer time for some important experiments to be conducted. These include the long-term effects of weightlessness on humans, certain medical and laboratory experiments (including crystal, food and plant growth) and the effects of living in close, cramped quarters over long periods of time. By studying issues such as these in space, we can prepare perhaps for a future colony on the Moon and perhaps on another planet, as well as gain a fuller appreciation and knowledge of our life here on Earth.

****Question:** How long do stars live? **Answer:** When a star is born from a large cloud of gas and dust, its size determines how long it will live. In general, the smaller the star, the longer it will live. Smaller stars with very low mass make helium from hydrogen (also known as fusion) very slowly. These stars tend to be cooler and thus redder in appearance, and burn for trillions(!) of years before they use all of their hydrogen found in the core. Medium sized stars, like our Sun, burn faster however. Because they are larger, there is more pressure from gravity in their cores, which causes nuclear fusion reactions to happen more quickly: they use up their hydrogen fuel more quickly. Stars such as the size of our Sun live for a few billion years. The most massive stars are generally the hottest and most unstable; they 'die' from processes such as a collapse from their own weight to form supernovae, neutron stars, and/or pulsars for example; these largest stars die within 'only' a few million years. In general, when it comes to stars, the bigger you are, the shorter your life.

★★ **Question:** Is Saturn the only planet that has rings? **Answer:** No. All four of the gas giant planets (Jupiter, Saturn, Uranus, and Neptune) have rings. Saturn only happens to have, by far, the biggest and brightest.

ASTRONOMY & TELESCOPE LINGO

ASTRONOMY LINGO: ***EPIMETHEUS:*** A small, irregularly shaped satellite of Saturn, coorbital with Janus (another small satellite of Saturn). These two objects orbit between the F and G rings of the planet's ring system. Epimetheus has two named craters, Hilairea and Pollux.

TELESCOPE LINGO: ***EISCAT:*** Acronym for *European Incoherent Scatter Radars*. This radar system was used in the mid-1980's in Northern Scandinavia to study the Earth's ionosphere.

ASTRONOMY FUN FACTS

★★ How hot is the Sun's core? Hot enough that a cube of this core, one mile on each side, (and if placed on the Earth), has enough heat and energy to melt the Earth's polar ice-caps, and then boil all the water of the oceans, lakes, and rivers on the Earth!!!

★★ If the Sun had originally been composed of predominantly oxygen and carbon, (instead of hydrogen and helium to form the nuclear reactions which give us the heat and light for warmth, comfort, and plant growth), there would not be people on this planet, let alone an Astronomy newsletter for them to read on an April afternoon!!

★★ A part of the Sun's radiation continues to shine on the earth at night, even when the Sun is on the other side of the planet. Neutrinos, which are produced deep in the Sun's core from nuclear reactions, can travel through anything without being impeded, including the earth itself; that is, they can shine 'up' at us during the night!!

★★ The sunspot cycle reaches a maximum approximately every 11 years; during that time, the sun is considered to be in its most active phase. One of the largest sunspots ever recorded appeared during one such maximum in 1947, covering more than 1% (one percent) of the solar disk's area. This particular sunspot was estimated to be large enough to contain about 100 Earths (all of which of course would be totally incinerated!). Most sunspots last only a few days; a few however can last about a month, completing a full solar revolution. However, there was a very famous sunspot that was observed around 1840. This sunspot lasted 18 months(!!) – this is 220 times longer than the duration of the worst Earthly hurricane on record!

★★ The motion of the Sun across Mercury's sky, when the planet is closest to the Sun in its orbit, is strange to say the least. From a site on Caloris Basin (Mercury's largest geographical feature), viewers (who would need protection from broiling temperatures) would see the Sun (also 3x larger than it appears in Earth's sky) first rise in the east. Then it would move very slowly across the sky, slow down and come to a complete halt when almost due south, and then again move westward, finally setting in the west. An interesting detail however of Mercury's Sun cycle is that the entire process of sunrise, sunstop, and sunset would take about 88 Earth days!

"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.***

CLASS OF OBJECT: IRREGULAR GALAXY: Galaxies are giant collections of stars, gases, and dust into which most of the visible matter in our universe is located. One type of galaxy is known as an irregular galaxy. Unlike spiral or elliptical galaxies, which have some discernable symmetry, irregular galaxies have no symmetry in either shape or structure. They are highly variable in shape, but all of them are below average galaxy size. These systems contain large amounts of interstellar matter and much gas; the dust concentrations among them can be very variable however. When dwarf galaxies are included in the calculations, only about 10% of the brightest galaxies are irregular. Irregular galaxies contain about 100 million to 30 billion solar masses, and have diameters from 5,000 to 30,000 light years. They are as luminous as 10,000,000 to 2 billion suns, and have an absolute magnitude of anywhere between –13 to –18; they contain both old and young stars. Some galaxies (which used to be classified as irregular) are now more finely classified as starburst, active, and interacting galaxies.

REPRESENTATIVE NORTHERN HEMISPHERE OBJECT: *M-82 (NGC 3034)* This irregular galaxy is the only one of its kind (irregular) to be named as a Messier object. Its year 2000 coordinates are RA=9h 56.2 min, and its Dec.= +69 degrees and 42 seconds. It is about 9x4 minutes of arc in area, and is of magnitude 8.8 visually and 9.4 photographically. M-82 is at about the same distance from earth as it is from its famous neighbor, the spiral galaxy M-81. An eight-inch telescope at high power and with good seeing will show M-82 with a very condensed nucleus, as well as dusty patches crossing its well-defined surface. It has a small spectral red shift of about 325 kilometers per second.

REPRESENTATIVE SOUTHERN HEMISPHERE OBJECT: *Magellanic Clouds (Large (LMC) and Small (SMC)):* Two relatively small irregular galaxies (some texts call the LMC a barred spiral) that are nearby residents to our own Milky Way; both are Southern Hemisphere (only) naked-eye objects. The LMC has a diameter of about 10,000 parsecs, and is at a distance of 50,000 parsecs in the constellation of Dorado. The SMC is about 60,000 parsecs away in the constellation Toucan, and has a diameter of about 6,000 parsecs. Both these galaxies are rich in population I stars (metal-rich), and contain proportionately much more gas than the Milky Way. They share a cloud of cooler neutral hydrogen; this extends into the narrow Magellanic Stream which extends over 100 degrees of the southern sky. The Magellanic Clouds may be gravitationally bound to the Milky Way, but that has not yet been determined, although there appears to be at least some gravitational influence of the Milky Way. The LMC contains the beautiful Tarantula Nebula and the LMC Lagoon, and the SMC contains the magnificent globular Tucanae 47 at its western edge.

ASTRONOMICAL NOTES -- ON & OFF THE NET…

GREEN COMET MACHHOLZ ABOVE THE PLEIADES THIS MONTH

On Friday night, January 7th, Comet Machholz visited the Pleiades. A cloud of gas bigger than the planet Jupiter, glowing alien green, swept past the Seven Sisters in Taurus. This comet is visible in binoculars. Step outside on and face south. There's Orion the Hunter locked in combat with Taurus the Bull. The star patterns are unmistakable. Just above them hovers a delicate little dipper--the Seven Sisters, a.k.a. the Pleiades. http://www.spaceweather.com/images2004/31dec04/skymap_north.gif

This is how the sky looks almost any evening in January. Except this January, there's something extra: the green cloud. Look well above and to the right of the Pleiades. The cloud resembles a faint and fuzzy star, barely visible to the unaided eye, but easy to see through binoculars. If you've successfully followed these instructions, you've just found Comet Machholz. The cloud is the comet's wispy atmosphere or, as an astronomer would say, its "coma." With a diameter greater than 450,000 km, the coma is at least three times wider than Jupiter. Yet the comet itself is tiny. Comets are, basically, asteroids made of dusty dirty ice and this one is probably no more than a few kilometers wide, a miniscule nugget hidden deep inside its own atmosphere. Astronomers have been watching Comet Machholz approach Earth since amateur comet-hunter Don Machholz discovered it in August 2004. The week of January 5th, it makes its closest approach to our planet: 52 million km (0.35 AU) away. That's not very close, which is why Comet Machholz looks like a faint fuzz ball and not a jaw-dropping Great Comet. Still, it is pretty. Try looking through a small telescope. The comet not only has a beautiful green atmosphere, but also two faint tails. One tail is the ion tail. It's made of electrically charged atoms and molecules (ions) blown away from the coma by the solar wind. This tail points straight away from the sun. Gusts of solar wind can cause the ion tail to swing back and forth, to develop curlicues and temporary knots. Amateur astronomers have seen this happen in recent weeks. The other tail is the dust tail. Comet dust is weightier than gas. It resists solar wind pressure and lingers behind the comet, tracing its orbit. Solar wind gusts have little effect on the dust tail. Everything you see when you look at Comet Machholz--its giant coma and its long tails -- comes from the icy asteroid-sized "nugget" in the middle. Astronomers call this "the nucleus." When sunlight hits the nucleus, fragile ices vaporize, spewing jets of the dust and gas into space. These jets feed the coma and provide raw material for the tails. A frequently-asked question: Why do some comet atmospheres glow green? Answer: The coma contains cyanogen (CN), a poisonous gas, and diatomic carbon (C2). Both of these substances glow green when illuminated by sunlight. This is called "resonant fluorescence."

The Pleiades, on the other hand, glow blue. Why? The Pleiades are a clutch of baby stars 400 light-years away. They formed 100 million years ago, during the age of dinosaurs on Earth, from a collapsing cloud of interstellar gas. The biggest and brightest Pleiades are blue-white and five times wider than the sun. Blue starlight reflecting from wisps of gas threading through the cluster give the ensemble a distinctly blue tint. A green comet, a blue star cluster, a close encounter: Check them out! http://science.nasa.gov/headlines/y2005/images/machholz/lawrence3.jpg

SEISMIC SHAKING ERASED SMALL IMPACT CRATERS ON ASTEROID EROS

Scientists have discovered why Eros, the largest near-Earth asteroid, has so few small craters. When the Near Earth Asteroid Rendezvous (NEAR) mission orbited Eros from February 2000 to February 2001, it revealed an asteroid covered with regolith -- a loose layer of rocks, gravel and dust -- and embedded with numerous large boulders. The spacecraft also found places where the regolith apparently had slumped, or flowed downhill, exposing fresh surface underneath. But what NEAR didn't find were the many small craters that scientists expected would pock Eros' landscape. "*Either the craters were being erased by*

something or there are fewer small asteroids than we thought," James E. Richardson Jr. of UA's planetary sciences department said. Richardson concludes from modeling studies that seismic shaking has obliterated about 90 percent of the asteroid's small impact craters, those less than 100 meters in diameter, or roughly the length of a football field. The seismic vibrations result when Eros collides with space debris. http://www.lpl.arizona.edu/~jrich/

"*Eros is only about the size of Lake Tahoe -- 20 miles (33 kilometers) long by 8 miles (13 kilometers) wide*," Richardson said. "*So it has a very small volume and a very low gravity. When a one-to-two-meter or larger object hits Eros, the impact will set off global seismic vibrations. Our analysis shows how these vibrations easily destabilize regolith overlaying the surface*." A rock-and-dust layer creeps, rather than crashes, down shaking slopes because of Eros' weak gravity. The regolith not only slides down horizontally, but also is launched ballistically from the surface and 'hops' downslope.

Very slowly, over time, impact craters fill up and disappear, Richardson said. If Eros were still in the main asteroid belt between Mars and Jupiter, a 200-meter crater would fill in about 30 million years. Because Eros is now outside the asteroid belt, that process takes a thousand times longer, he added. Richardson's research results match the NEAR spacecraft evidence. Instead of the expected 400 craters as small as 20 meters (about 70 feet) per square kilometer (three-fifths mile) on Eros' surface, there are on average only about 40 such craters.

The modeling analysis also validates what scientists suspect of Eros' internal structure. "*The NEAR mission showed Eros to most likely be a fractured monolith, a body that used to be one competent piece of material*," Richardson said. "*But Eros has been fractured throughout by large impacts and is held together primarily by gravity. The evidence is seen in a series of grooves and ridges that run across the asteroid's surface both globally and regionally*."

Large impacts fracture Eros to its core, but many smaller impacts fracture only the upper surface. This gradient of big fractures deep inside and numerous small fractures near the surface is analogous to fractures in the upper lunar crust, Richardson said. "*And we understand the lunar crust -- we've been there. We've put seismometers on the moon. We understand how seismic energy propagates through this kind of structure*." The scientists' analysis of how impact-induced seismic shaking has modified Eros' surface has a couple of other important implications. "*If we eventually do send spacecraft to mine resources among the near-Earth asteroids or to deflect an asteroid from a potential collision with the Earth, knowing internal asteroid structure will help address some of the strategies we'll need to use. In the nearer future, sample return missions will encounter successively less porous, more cohesive regolith as they dig farther down into asteroids like Eros, which has been compacted by seismic shaking*," Richardson noted. "*And it also tells us about the small asteroid environment that we'll encounter when we do send a spacecraft out into the main asteroid belt, where Eros spent most of its lifetime. We know the small asteroids -- those between the size of a beachball and a football stadium -- are out there. It's just that their 'signature' on asteroids such as Eros is being erased*," Richardson said. This finding is important because the cratering record on large asteroids provides direct evidence for the size and population of small main-belt asteroids. Earth-based telescopic surveys have catalogued few main-belt asteroids that small. So scientists have to base population estimates for these objects primarily on visible cratering records and asteroid collisional history modeling, Richardson said.

GIANT KUIPER BELT PLANETOID SEDNA MAY HAVE FORMED FAR BEYOND PLUTO

Recently, astronomers reported the surprising discovery of a very large diameter Kuiper Belt planetoid -- (90377) Sedna -- on a distant, 12,500-year-long, eccentric orbit centered approximately 500 astronomical units from the Sun. Sedna's estimated diameter is about 1,600 km, two-thirds that of Pluto. Initial studies of Sedna's origin have speculated that it might have been ejected from the giant planets region of our solar system far inside the orbit of Pluto, or perhaps was captured from a passing star's Kuiper Belt.

Planetary scientist Dr. Alan Stern shows Sedna could have formed far beyond the distance of Pluto. "*If this is actually what happened*," Stern points out, "*it would indicate that our solar system's planet factory operated across a much larger region than previously thought*." It would also indicate that the mysterious Kuiper Belt "edge" near 50 AU (one AU is the distance from the Earth to the Sun) is not an outer edge, but simply the inner edge of an annular trough, or gap, that is carved out of a much broader structure that has been called the "Kuiper disk."

The new Sedna formation study used a planetary accretion simulation software developed by Stern for studies of the formation of Kuiper Belt Objects. This software was used to explore the feasibility of building Sedna from boulder-sized and other small bodies at distances between 75 AU (Sedna's closest solar approach distance) and 500 AU (Sedna's average distance from the Sun). Stern's Sedna formation simulations assumed that Sedna's original orbit, while distant from the Sun, was circular.

Astronomers agree that Sedna could not have formed in its present, eccentric orbit because such an orbit allows only violent collisions that prevent the growth of small bodies. Stern's simulations further assumed that the solar nebula -- the disk of material out of which the planets formed -- was much more extended than most previous simulations had assumed. "*The Sedna formation simulations assumed that the primordial solar nebula was a disk about the size of those observed around many nearby middle-aged stars -- like the well-known example of the 1,500-AU-wide disk around the star Beta Pictoris*," Stern says. "*The model calculations found that objects as large, or even larger, than Sedna could easily form in circular orbits at distances of 75 to 500 AU, and that their formation time could have been fairly short -- just a few percent the age of the solar system*,"

Stern continues. "*If Sedna did form this far out, it is likely to be accompanied by a cohort of other large planetoids in this very distant region of the solar system. One telltale sign that these objects were formed where they are, rather than in another location, would be if a good fraction of them are on near circular orbits*." http://www.swri.org/press/sedna.htm

JUPITER'S MOON HAD A FAR-FLUNG PAST

The first ground based infrared spectrum of Jupiter's moon Amalthea reveals that it must have formed far from its current location. This new result, based on observations with the Subaru telescope and the Infrared Telescope Facility sheds new light on our Solar System's turbulent past.

Planets like Earth and Jupiter formed from the disk of gas and dust swirling around the Sun at the time of its birth. Rocky planets like Earth formed in the high temperature environment close to the Sun, while large gaseous planets like Jupiter formed in the cooler regions farther away. Similarly, Jupiter, the largest planet in the solar system, probably had its own disk of gas and dust. The four moons of Jupiter discovered by Galileo (Io, Europa,

Ganymede, and Callisto) are likely to have been born from this disk. In addition to the Galilean moons, Jupiter has two other types of satellites: four small inner moons orbiting Jupiter within the orbit of Io, the inner most Galilean satellite, and at least fifty five small outer moons outside the orbit of Callisto, the outer most Galilean satellite. All the outer satellites have tell-tale orbits that reveal that they must have been captured by Jupiter during or after the formation of the planet and its larger moons.

The origin of the four small inner moons remain a mystery, however. They have orbits compatible with the hypothesis that they formed in orbit around Jupiter like the Galilean moons. On the other hand, their small irregular shapes and their comparatively low reflectivity and low densities resemble asteroids and suggest that they were captured by Jupiter's gravitational pull just like the outer moons. The mystery persists because of the challenge inherent in observing Jupiter's small inner moons from Earth. The moons are small and therefore faint, and they are obscured by the bright glare from Jupiter. Although NASA's space probes Voyager and Galileo have captured detailed images of Jupiter's small inner moons, these data have been insufficient for resolving the question of their origin.

Naruhisa Takato and his collaborators have now had success in obtaining the first infrared spectrum of two of Jupiter's small inner moons, Amalthea and Thebe. To obtain a spectrum over a wide range of infrared wavelengths, the group combined the strengths of two instruments on two telescopes on the summit of Mauna Kea. For high resolution spectroscopy at wavelengths longer than 3 micrometers ,the group used the Infrared Camera and Spectrograph on the Subaru telescope. For shorter wavelengths, the group used SpeX on the IRTF, which has broad near-infra-red wavelength coverage.

The new spectrum of Amalthea shows the characteristic signatures of water. The most likely location of this water is within water containing hydrous minerals. Such minerals typically form in low temperature environments, ruling out the possibility that Amalthea could have formed in the high temperature environment of Jupiter's immediate neighborhood while the planet was forming, and where Amalthea now is. If Amalthea did not form near its present location, where did it come from? The surface of Amalthea resembles regions of Callisto that are not covered by ice. This suggests that Amalthea may have been one of the many small "micro-satellites" orbiting Jupiter that was sucked into an inner orbit when the Galilean moons formed. However, the spectrum of Amalthea has similarities with asteroids orbiting the Sun, suggesting that is was a "micro-planet" that was pulled into Jupiter's orbit when Jupiter itself was forming. Takato says "*although we think Jupiter's moons formed as an assembly of many smaller bodies, the same way we think planets formed from 'planetesimals', until now we have not found any example of the original building blocks of a planet's moon. However, our results strengthen the argument that Amalthea is one of the few remaining pieces of the material that formed the Galilean moons. Amalthea may have ended up in orbit close to Jupiter rather than get incorporated into a larger moon or Jupiter itself. If this is the case, Amalthea would be the first known example of a 'satellitesimal.*'"

POSSIBLE 2029 EARTH IMPACT RULED OUT FOR ASTEROID 2004 MN4

December 27, 2004 - Over the past week, several independent efforts were made to search for pre-discovery observations of 2004 MN4. These efforts proved successful when Jeff Larsen and Anne Descour of the Spacewatch Observatory near Tucson, Arizona, were able to detect and measure very faint images of asteroid 2004 MN4 on archival images dating to 15 March 2004. These observations extended the observed time interval for this asteroid by three months allowing an improvement in its orbit so that an Earth impact on 13 April 2029 can now be ruled out.

As is often the case, the possibility of future Earth impacts for some near-Earth objects cannot be entirely ruled out until the uncertainties associated with their trajectories are reduced as a result of either future position observations, or in this case, heretofore unrecognized, pre-discovery observations. When these additional observations were used to update the orbit of 2004 MN4, the uncertainties associated with this object's future positions in space were reduced to such an extent that none of the object's possible trajectories can impact the Earth (or Moon) in 2029. Neither the nominal position of the asteroid, nor any of its possible alternative positions, touches the Earth, indicating that an Earth impact in 2029 is ruled out.

The passage of the asteroid by the Earth in 2029 alters its subsequent trajectory and expands the asteroid's position uncertainty region so the asteroid's subsequent motion after that time is less certain than it was prior to the 2029 close Earth approach. However, our current risk analysis for 2004 MN4 indicates that no subsequent Earth encounters in the 21st century are of any concern.

A NEW TWIST ON AN OLD NEBULA – THE HELIX

Looks can be deceiving, especially when it comes to celestial objects like galaxies and nebulas. These objects are so far away that astronomers cannot see their three-dimensional structure. The Helix Nebula, for example, resembles a doughnut in colorful images. Earlier images of this complex object -- the gaseous envelope ejected by a dying, sun-like star -- did not allow astronomers to precisely interpret its structure. One possible interpretation was that the Helix's form resembled a snake-like coil.

Now, a team of astronomers using observations from several observatories, including the Hubble Space Telescope, has established that the Helix's structure is even more perplexing. Their evidence suggests that the Helix consists of two gaseous disks nearly perpendicular to each other. A team of astronomers, led by C. Robert O'Dell made its finding using highly detailed images from the Hubble telescope's Advanced Camera for Surveys, pictures from Cerro Tololo Inter-American Observatory in Chile, and measurements from ground-based optical and radio telescopes, which show the speed and direction of the outflows of material from the dying star.

The Helix, the closest planetary nebula to Earth, is a favorite target of professional and amateur astronomers. Astronomers hope this finding will provide insights on how expelled shells of gas from dying stars like our Sun form the complex shapes called planetary nebulas. "*Our new observations show that the previous model of the Helix was much too simple*," O'Dell said. "*About a year ago, we believed the Helix was a bagel shape, filled in the middle. Now we see that this filled bagel is just the inside of the object. A much larger disk, resembling a wide, flat ring, surrounds the filled bagel. This disk is oriented almost perpendicular to the bagel. The larger disk is brighter on one side because it is slamming into interstellar material as the entire nebula moves through space, like a boat plowing through water. The encounter compresses gas, making that region glow brighter. But we still don't understand how you get such a shape. If we could explain how this shape was created, then we could explain the late stages of the most common form of collapsing stars*." "*To visualize the Helix's geometry*," added astronomer Peter

McCullough, a member of O'Dell's team, "*imagine a lens from a pair of glasses that was tipped at an angle to the frame's rim. Well, in the case of the Helix, finding a disk inclined at an angle to a ring would be a surprise. But that is, in fact, what we found*."

Another surprise is that the dying star has expelled material into two surrounding disks rather than the one thought previously to be present. Each disk has a north-south pole, and material is being ejected along those axes. "*We did not anticipate that the Helix has at least two axes of symmetry*," O'Dell said. "*We thought it had only one. This two-axis model allows us to understand the complex appearance of the nebula*." Using the Helix data, the astronomers created a three-dimensional model showing the two disks. These models are important to show the intricate structure within the nebula.

The team also produced a composite image of the Helix that combines observations from Hubble's Advanced Camera for Surveys and the 4-meter telescope's mosaic camera at Cerro Tololo. The Helix is so large that the team needed both telescopes to capture a complete view. Hubble observed the Helix's central region; the Cerro Tololo telescope, with its wider field of view, observed the outer region.

The team, however, is still not sure how the disks were created, and why they are almost perpendicular to each other. One possible scenario is that the dying star has a close companion star. Space-based X-ray observations provide evidence for the existence of a companion star. One disk may be perpendicular to the dying star's spin axis, while the other may lie in the orbital plane of the two stars. The astronomers also believe the disks formed during two separate epochs of mass loss by the dying star. The inner disk was formed about 6,600 years ago; the outer ring, about 12,000 years ago. The inner disk is expanding slightly faster than the outer disk. Why did the star expel matter at two different episodes, leaving a gap of 6,000 years? Right now, only the Helix Nebula knows the answer, the astronomers said.

The sun-like star that sculpted the Helix created a beautiful celestial object. Will the Sun weave such a grand structure when it dies 5 billion years from now? "*As a single star, it will create a similar glowing cloud of expelled material, but I wouldn't expect it to have such a complex structure as the Helix*," McCullough said. To study the intricate details of these celestial wonders, astronomers must use a range of observatories, including visible-light and radio telescopes. Astronomers also need the sharp eyes of Hubble's Advanced Camera for Surveys. "*The Hubble's crisp vision has revealed a whole new realm of planetary nebula structure, which has advanced the field and delighted our eyes*," said team member Margaret Meixner. http://hubblesite.org/news/2004/32 http://www.vanderbilt.edu/News

SURVIVING STAR FROM 1572 AD EXPLOSION SUPPORTS SUPERNOVA THEORY

An international team of astronomers announced that they have identified the probable surviving companion star to a titanic supernova explosion witnessed in the year 1572 by the great Danish astronomer Tycho Brahe and other astronomers of that era. This discovery provides the first direct evidence supporting the long-held belief that Type Ia supernovae come from binary star systems containing a normal star and a burned-out white dwarf star. The normal star spills material onto the dwarf, which eventually triggers an explosion. This research was led by Pilar Ruiz-Lapuente. "*There was no previous evidence pointing to any specific kind of companion star out of the many that had been proposed. Here we have identified a clear path: the feeding star is similar to our Sun, slightly more aged*," Ruiz-Lapuente says. "*The high speed of the star called our attention to it*," she added.

Type Ia supernovae are used to measure the history of the expansion rate of the universe and so are fundamental to helping astronomers understand the behavior of dark energy, an unknown force that is accelerating the expansion of the universe. Finding evidence to confirm the theory as to how Type Ia supernovae explode is critical to assuring astronomers that the objects can be better understood as reliable calibrators of the expansion of space.

The identification of the surviving member of the stellar duo reads like a crime scene investigation tale. Even though today's astronomers arrived at the scene of the disaster 432 years later, using astronomical forensics they have nabbed one of the perpetrators rushing away from the location of the explosion (which is now enveloped in a vast bubble of hot gas called Tycho's Supernova Remnant). For the past seven years the runaway star and its surroundings were studied with a variety of telescopes. The Hubble Telescope played a key role by precisely measuring the star's motion against the sky background.

The star is breaking the speed limit for that particular region of the Milky Way Galaxy by moving three times faster than the surrounding stars. Like a stone thrown by a sling, the star went hurtling off into space, retaining the velocity of its orbital motion when the system was disrupted by the white dwarf's explosion. This alone is only circumstantial evidence that the star is the perpetrator because there are alternative explanations to its suspicious behavior. It could be falling in at a high velocity from the galactic halo that surrounds the Milky Way's disk. But spectra obtained with the 4.2-meter William Herschel Telescope in La Palma and the 10-meter Keck telescopes in Hawaii show that the suspect has the high heavy-element content typical of stars that dwell in the Milky Way's disk, not the halo.

The star found by the Ruiz-Lapuente team is an aging version of our Sun. The star has begun to expand in diameter as it progresses toward a red-giant phase (the end stage of a Sun-like star's lifetime). The star turns out to fit the profile of the perpetrator in one of the proposed supernova conjectures. In Type Ia supernova binary systems, the more massive star in the pair will age faster and eventually becomes a white dwarf star. When the slower-evolving companion star subsequently ages to the point where it begins to balloon in size, it spills hydrogen onto the dwarf. The hydrogen accumulates until the white dwarf reaches a critical and precise mass threshold, called the Chandrasekhar limit, where it explodes as a titanic nuclear bomb. The energy output of this explosion is so well known that it can be used as a standard candle for measuring vast astronomical distances. (An astronomical "standard candle" is any type of luminous object whose intrinsic power is so accurately determined that it can be used to make distance measurements based on the rate the light dims over astronomical distances).

"*Among the various systems containing white dwarfs that receive material from a solar-mass companion, some are believed to be viable progenitors of Type Ia supernovae, on theoretical grounds. A system called U Scorpii has a white dwarf and a star similar to the one found here. These results would confirm that such binaries will end up in an explosion like the one observed by Tycho Brahe, but that would occur several hundreds of thousands of years from now*," says Ruiz-Lapuente.

An alternative theory of Type Ia supernovae is that two white dwarfs orbit each other, gradually losing energy through the emission of gravitational radiation (gravity waves). As they lose energy, they spiral in toward each other and eventually merge,

resulting in a white dwarf whose mass reaches the Chandrasekhar limit, and explodes. "*Tycho's supernova does not appear to have been produced by this mechanism, since a probable surviving companion has been found*," says Alex Filippenko, a co-author on this research. He says that, nevertheless, it is still possible there are two different evolutionary paths to Type Ia supernovae.

On November 11, 1572, Tycho Brahe noticed a star in the constellation Cassiopeia that was as bright as the planet Jupiter (which was in the night sky in Pisces). No such star had ever been observed at this location before. It soon equaled Venus in brightness (which was at -4.5 magnitude in the predawn sky). For about two weeks the star could be seen in daylight. At the end of November it began to fade and change color, from bright white to yellow and orange to faint reddish light, finally fading away from visibility in March 1574, having been visible to the naked eye for about 16 months. Tycho's meticulous record of the brightening and dimming of the supernova now allows astronomers to identify its "light signature" as that of a Type Ia supernova. Tycho Brahe's supernova was very important in that it helped 16th-century astronomers abandon the idea of the immutability of the heavens.

At the present time, Type Ia supernovae remain key players in the newest cosmological discoveries. To learn more about them and their explosion mechanism, and to make them even more useful as cosmological probes, a current Hubble Space Telescope project led by Filippenko is studying a sample of supernovae in other galaxies at the very time they explode.

AGING UNIVERSE MAY STILL BE SPAWNING MASSIVE GALAXIES

NASA's Galaxy Evolution Explorer has spotted what appear to be massive "baby" galaxies in our corner of the universe. Previously, astronomers thought the universe's birth rate had dramatically declined and only small galaxies were forming. "*We knew there were really massive young galaxies eons ago, but we thought they had all matured into older ones more like our Milky Way. If these galaxies are indeed newly formed, then this implies parts of the universe are still hotbeds of galaxy birth*," said Dr. Chris Martin.

Dr. Martin is principal investigator for the Galaxy Evolution Explorer and co-author of a study, led by Dr. Tim Heckman, that unearthed three-dozen bright, compact galaxies that greatly resemble the youthful galaxies of more than 10 billions years ago. These new galaxies are relatively close to us, ranging from two to four billion light-years away. They may be as young as 100 million to one billion years old. The Milky Way is approximately 10 billion years old.

The recent discovery suggests our aging universe is still alive with youth. It also offers astronomers their first, close-up glimpse at what our galaxy probably looked like when it was in its infancy. "*Now we can study the ancestors to galaxies much like our Milky Way in much more detail than ever before*," Heckman said. "*It's like finding a living fossil in your own backyard. We thought this type of galaxy had gone extinct, but in fact newborn galaxies are alive and well in the universe*," he added. The new discoveries are of a type called ultraviolet luminous galaxies. They were discovered after the Galaxy Evolution Explorer scanned a large portion of the sky with its highly sensitive ultraviolet light detectors. Since young stars pack most of their light into ultraviolet wavelengths, young galaxies appear to the spacecraft like diamonds in a field of stones.

Astronomers mined for these rare gems before, but missed them because they weren't able to examine a large enough slice of the sky. "*The Galaxy Evolution Explorer surveyed thousands of galaxies before finding these few dozen ultraviolet-bright ones*," said Dr. Michael Rich, a co-author of the study. The newfound galaxies are about 10 times as bright in ultraviolet wavelengths as the Milky Way. This indicates they are teeming with violent star-forming regions and exploding supernova, which are characteristics of youth. When our universe was young, massive galaxies were regularly bursting into existence. Over time, the universe bore fewer and fewer galactic progeny, and its newborn galaxies grew up into ones that look like our own. Until now, astronomers thought they had seen the last of these giant babies. http://www.nasa.gov/centers/jpl/missions/galex.html http://www.nasa.gov

SATURN'S MOON IAPETUS SHOWS A BULGING WAISTLINE

Images returned by NASA's Cassini spacecraft cameras during a New Year's Eve flyby of Saturn's moon Iapetus (eye-APP-eh-tuss) show startling surface features that are fueling heated scientific discussions about their origin. One of these features is a long narrow ridge that lies almost exactly on the equator of Iapetus, bisects its entire dark hemisphere and reaches 20 kilometers high (12 miles). It extends over 1,300 kilometers (808 miles) from side to side, along its midsection. No other moon in the solar system has such a striking geological feature. In places, the ridge is comprised of mountains. In height, they rival Olympus Mons on Mars, approximately three times the height of Mt. Everest, which is surprising for such a small body as Iapetus. Mars is nearly five times the size of Iapetus. http://saturn.jpl.nasa.gov http://www.nasa.gov/cassini and http://ciclops.org

Iapetus is a two-toned moon. The leading hemisphere is as dark as a freshly-tarred street, and the white, trailing hemisphere resembles freshly-fallen snow. The flyby images, which revealed a region of Iapetus never before seen, show feathery-looking black streaks at the boundary between dark and bright hemispheres that indicate dark material has fallen onto Iapetus. Opinions differ as to whether this dark material originated from within or outside Iapetus. The images also show craters near this boundary with bright walls facing towards the pole and dark walls facing towards the equator. Cassini's next close encounter with Iapetus will occur in September 2007. The resolution of images from that flyby should be 100 times better than the ones currently being analyzed. The hope is that the increased detail may shed light on Iapetus' amazing features and the question of whether it has been volcanically active in the past. With a diameter of about 1,400 kilometers (890 miles), Iapetus is Saturn's third largest moon. It was discovered by Jean-Dominique Cassini in 1672. It was Cassini, for whom the Cassini-Huygens mission is named, who correctly deduced that one side of Iapetus was dark, while the other was white.

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 4:00 P.M. Saturday, January 29th at the Everett Public Library Auditorium. (Note new time / location !!!)