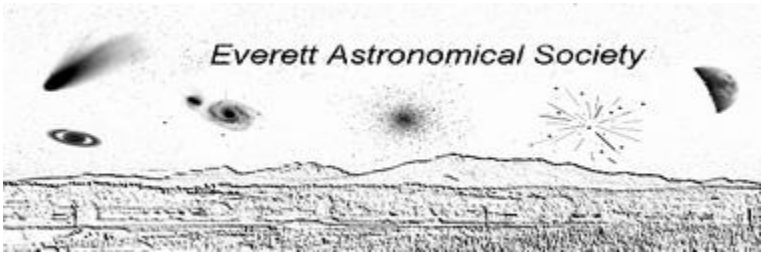
Volume MMVIV. No. 6




# The Stargazer

June 2009


| | | | |
|---|---|---|---|
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| | | (change 'at' to @ to send email) | http://everettastro.org |


## EAS BUSINESS…

### NEXT EAS MEETING – SAT. JUNE 13TH 6 PM AT AURORA ASTRO PRODUCTS STORE AT SILVER LAKE.

### ★★ Saturday June 13th 6:00 pm Meeting ★★

**The June 13th meeting speaker will be Sarah Knights from the Museum of Flight. Her talk will be about observing on Mauna Kea, why it is a good location for observations, her experiences with the Keck and Gemini telescopes, and some of the interesting things about the instruments she used for infrared astronomy and interferometry.** She will touch on some research she was working on, focused on star formation. She worked with the mid-infrared instrument on Gemini, and helped engineer some of the features now supported. Her research was on the rate of binary stars in Orion, collisions and formation of planetismals, and she discovered a Herbig Haro object (HH177) (by accident).

**Attending members will be eligible for a monthly door prize**.

**Map/Directions to Aurora Astro Products store location** -

**Silver Lake Plaza, 11419 19th AVE. SE, Everett, WA 98208**

***If you are traveling northbound on I-5:***

*Take exit #186/128th St. and go east - to the right on 128th St. continue until you come to Murphy's Corner/Intersection with Highway 527/19th Ave SE/Old Bothell-Everett Highway (all one in the same) and turn left/north. Follow until you see Silver Lake Plaza (red brick construction) on your right with the lake is on your left.*

***If you are traveling southbound on I-5:***

*Take exit 187/Everett Mall Way and at the top of the exit's hill turn right following signs for Highway 527. At the light turn right following the signs for Highway 527. Then stay on Highway 527/19th Ave SE/Old Bothell-Everett Highway until you have Silver Lake on your right and the Silver Lake Plaza on your left. You may also continue down I-5 until exit 186 and turn left onto 128th then follow previous directions. If you have a problem you* ***can*** *always call (425) 337-4384"*

### ★ STAR PARTY INFO ★

### ★ Scheduled EAS Star Parties at Ron Tam's: ★

**Saturday June 20**
Saturday July 18
Saturday August 22
Saturday September 19
Saturday October 17
Saturday November 14

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@verizon.net) but I don't check my email daily. They can email me for directions if they never have been out here."* Listed below are proposed dates for **planned EAS star parties** at my [Ron Tam's] place, depending upon the weather, of course. Call Ron about spur-of-the-moment observing.

**Please also join the EAS mail list**, **and then send mail to the mail list** at ***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 Jim Bielaga at (425) 337-4384 for info or check the EAS website.) Members contact Jim Bielaga for scope borrowing.

## *Other Western US Star Parties This Season*

***JUNE -***

**Jun 13 2009 - OMSI-RCA Summer Solstice Star Party**, Rooster Rock State Park & Stub Stewart State Park, OR http://www.rca-omsi.org/sp/sp_schedule.htm

**Jun 13-20 2009 Grand Canyon Star Party (GCSP)**, On South Rim - http://www.tucsonastronomy.org/gcsp.html

**Jun 17-21 2009 - The Rocky Mountain Star Stare (RMSS) 2009,** Pike Nat Forest, Colorado Springs, CO http://www.rmss.org/

**Jun 17-20 - Bryce Canyon Astronomy Festival**, Bryce Canyon Nat. Pk, UT http://www.nps.gov/brca/planyourvisit/astronomyprograms.htm

**Jun 19-21 2009 - RCA Maupin Dark Sky Star Party,** Maupin, OR - http://www.rca-omsi.org/sp/maupin.htm

**Jun 19-20, Jul 24-25, Aug 21-22 2009 - Stars Over Yellowstone Star Parties,** Madison Campground Amphitheater, http://smasweb.org/

**Jun 20-24 2009 - Golden State Star Party 2009,** Frosty Acres Ranch, Adin, CA http://goldenstatestarparty.blogspot.com/

**Jun 19-20 2009 Craters of the Moon Star Party 2009,** Craters of the Moon Nat. Monument, ID http://ifastro.org/web/index.php http://www.boiseastro.org/

***JULY -***

**Jul 15-19, 2009 - Mt Bachelor Star Party (MBSP) 2009,** Mt. Bachelor (Bend) OR http://www.mbsp.org/

**Jul 15-19, 2009 - RASCals Vancouver Island Star Party 2009,** Victoria Fish & Game Assoc - Holker Place, Malahat, (Near Victoria) BC, CA http://victoria.rasc.ca/events/StarParty/

**Jul 18 2009 - OMSI-RCA Summer Night Sky Star Party**, Rooster Rock State Park & Stub Stewart State Park, OR http://www.rca-omsi.org/sp/sp_schedule.htm

**Jul 20-25 2009 - Table Mt. Star Party (TMSP) 2009,** Ellensburg WA http://www.tmspa.com/

**Jul 24-25 2009 - Lava Hot Springs Star Party 2009**, Lava Hot Springs ID - http://ifastro.org/web/index.php

**Jul 24-26 2009 - RCA Trout Lake Star Party Weekend**, Trout Lake, WA - http://www.rca-omsi.org/sp/pix/troutlake.pdf

**Jul 25 2009 - OAS Hurricane Ridge Star Party**, Hurricane Ridge, WA http://www.olympicastronomicalsociety.com/Documents/2009_OAS_calendar.pdf

***AUGUST -***

**Aug 11 2009 - OMSI-RCA Perseid Meteor Shower Star Party**, Rooster Rock State Park & Stub Stewart State Park, OR http://www.rca-omsi.org/sp/sp_schedule.htm

**Aug 15-23 2009 - Mt. Kobau Star Party 2009 (MKSP),** Mt. Kobau, near Osoyoos BC http://www.mksp.ca/

**Aug 19-23 2009 - Oregon Star Party 2009 (OSP),** Ochocco NF http://www.oregonstarparty.org/

**Aug 20-22 2009 - SAS Brooks Memorial Park Star Party 2009,** SR 97 near Goldendale http://www.seattleastro.org/events.shtml

**Aug 20-22 2009 - 19th Annual 'Weekend Under the Stars' 2009,** Foxpark WY - http://home.bresnan.net/~curranm/wuts.html

**Aug 21-23 2009 - Idaho Star Party 2009,** Bruneau Dunes State Park - http://ifastro.org/web/index.php (Boise AS) http://www.boiseastro.org/

***SEPTEMBER -***

**Sep 12 2009 - OMSI-RCA Autumnal Equinox Star Party**, Rooster Rock State Park & Stub Stewart State Park, OR http://www.rca-omsi.org/sp/sp_schedule.htm

**Sep 17-18 2009 - OAS Camp Delany Fall Star Party**, Sun Lakes SP - http://www.olympicastronomicalsociety.com/Documents/FALLCAMPDELANYSign-UpForm.pdf

**Sep 18-19** - **Orion Nebula 2009 Star Party,** Table Mt. (Ellensburg) WA http://www.seattleastro.org/orionnebsp.shtml

**Sep 17-19 2009 - CalStar2009,** Lake San Antonio Park CA http://www.sjaa.net/calstar/ - http://www.sjaa.net/

**Sep 18-19 2009 - Craters of the Moon Star Party 2009,** Craters of the Moon Nat. Monument, ID http://ifastro.org/web/index.php http://www.boiseastro.org/

**Sep 19-20-28 2009 - Alberta Star Party 2009,** Starland Recreation Area Campground near Drumheller, Alberta, CA http://www.astronomycalgary.com/events/info/155 http://calgary.rasc.ca/asp2009.htm

***OCTOBER -***

**Oct 14-17 2009 - The Enchanted Skies Star Party 2009,** Socorro NM - http://enchantedskies.org/

***NOVEMBER -***

**Nov 12-15 2009 - Nightfall 2009,** Palm Canyon Resort, Borrego Springs, CA http://www.rtmcastronomyexpo.org/nightfall.htm

**Nov 14 2009 - Night Under the Stars 2009,** Alamo Lake, AZ - http://azstateparks.com/Parks/ALLA/events.html

***OTHER -***

(tbd Aug) - **Deception Pass Star Party 2009,** Bowman Bay, Deception Pass, WA - http://squakmountain.org/deception_pass_star_party.htm http://squakmountain.org/events.html#upcoming

(tbd Sep) - **White Sands Star Party**, Alamogordo/White Sands, NM http://www.zianet.com/wssp/

(tbd Oct) - **All Arizona Star Party** (near Arizona City, AZ) - http://www.eastvalleyastronomy.org/aasp.htm

(tbd) **- Blue Mountain Star Party,** Ukiah, OR http://www.stargazing.net/tcac/EventsCalendar.htm http://www.stargazing.net/tcac/gmBluMtn.htm

(tbd) - **Montana Starwatch**, Great Falls, MT http://smasweb.org/

**Other Star parties**: http://www.cloudynights.com/ubbthreads/showflat.php/Cat/0/Number/2858373/Main/2858366

## EAS MEMBER NEWS

**Outreach chairperson**: (currently **vacant**) - Coordinate requests from public for EAS member volunteers to conduct star parties or presentations at visits to schools, senior centers, scout meetings, etc. We often have requests for members of the EAS to come and help with an 'astronomy night' event from local schools, scout groups, senior homes, or similar groups. Usually this would be in the form of a star party at their gathering, or perhaps a short slide show or night sky talk. Providing education and support to the community about interest astronomy is one of the main missions of the EAS. Please let club president know if you are interested and available to be on list of volunteers to handle these requests, so that we can say YES when people ask. A star party night can be a rewarding event for all involved. **Please email Mark Folkerts with your interest (or suggestions).**

**Sidewalk astronomy committee**: (currently **vacant**). – Plan and conduct urban/suburban sidewalk astronomy events to allow passers-by to experience astronomy. Needs 2-3 people for each event, and to schedule events. We are looking for volunteers who could do a series of Sidewalk Astronomy sessions this spring and summer, at a local park or public venue. For safety, moral support, and effectiveness, this should be done in teams of at least two people with telescopes. Special events like eclipse or comets especially draw the interest of the public.

**Other volunteers?** Find a way to help and contribute. Come up with a new idea to promote the EAS and astronomy in your community. Come to Astronomy Day or a star party and share your interest in the sky…

## EAS MEMBERSHIP BENEFITS & INFORMATION

**EAS Benefits -**
**Membership in the Everett Astronomical Society (EAS) includes invitations to all of the club meetings and star parties, and entitles members to the monthly newsletter, *The Stargazer.*** Also, a 10% discount is also being offered to EAS members for purchases at Aurora Astro Products in Everett. Only members may vote in EAS elections, or be eligible for EAS drawings.

**Magazine Discounts –**
In addition you will be able subscribe to ***Sky and Telescope*** for $7 off the normal subscription rate, contact the treasurer (Carol Gore) for more information. http://everettastro.org/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 Carol Gore will renew your *Sky and Telescope* subscription for you. **Astronomy** magazine offers a similar opportunity to club members.)

**Membership in the Astronomical League -**
EAS is a member of the **Astronomical League** and you will receive the Astronomical League's quarterly newsletter magazine, ***The Reflector***.

**EAS Club Telescope Borrowing -**
Being a member also allows you the use of the club's telescopes, including an award winning 10 inch Dobsonian mount reflector, a second 10" dob, or and 8" Dobsonian. Contact Jim Bielaga (425) 337-4384 to borrow a telescope.

**10% Discount on Purchases at 'Aurora Astro Products' in Everett -**
EAS members are currently offered a 10% discount for all purchases of any telescopes, accessories, or other items at Aurora Astro Products, when they show their EAS membership card.

**EAS Library -**
Membership will give you access to all the material in the lending library. The library, consists of VCR tapes, DVDs, many books, magazines, and software titles. The EAS has a library of books, videotapes, and software for members to borrow, **located at Aurora Astro Products store**. 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 lockemi at comcast.net, to borrow or donate any materials, or **contact Jim Bielaga at Aurora Astro**. See library items list here: http://everettastro.org/eas_library.htm

**Joining or Renewing with the EAS -**

EAS dues are $25 / year per family. Funds obtained from membership dues allows the EAS to publish the Stargazer newsletter, pay Astronomical League dues, pay insurance, host a web site, and maintain our library. If it has been a year since you paid your dues, please re-subscribe to keep the club financially solvent, and to continue to receive membership benefits. http://everettastro.org/application.htm

**Send your annual dues renewals to the**
**Everett Astronomical Society**
**P.O. Box 12746, Everett, WA 98206**.

Those who have **subscriptions to Sky and Telescope** can now pay their own subscription as long as they are EAS members in good standing. Members will now be able to renew directly via mail or phone and still obtain the club discount. The subscribers may mail in the renewal notices with their payment, or renew via phone at (800) 253-0245. Payment at the time of renewal is required. Once a year, Sky and Telescope will check with the EAS club treasurer to see that the subscribers are still members in good standing to qualify for the discount. New members will continue to subscribe through the club treasurer.

**Attention EAS Members – 10% Discount for all Everett Astronomical Society Members at Aurora Astro Products**

*"Mention your EAS club membership at Jim Bielaga's astronomy store 'Aurora Astro Products' and receive a 10% discount on all purchases. This is an exclusive discount to current E.A.S. members only.*

*I am proud to be able to offer this discount to Everett club members, and thanks for the support you have shown me on opening my new store. Also I have made great friends and learned a lot being a club member since 1991.*

*- Clear Skies, Jim Bielaga"*

***>> Members – please look at your EAS membership card to see when your membership dues are payable. If you are more than three months past due, the club will officially assume that you no longer wish to be a member, and remove you from the membership rolls. <<***


**Aurora Astro Products**
"*Your Northern Light in the Astronomy Business*"
Over 37 product dealerships, and growing

**11419 19th Avenue SE #A102**
Everett, WA 98208 .
www.auroraastro.com .
425-337-4384 .
425-337-4758 fax .

*Hours*: .
Monday, Thursday, Friday – 9:00 am to 6:00 pm .
Tuesday/Wednesday – Noon to 6:00 pm .
Saturday – 10:00 am to 5:00 pm .

## $$ - Financial Health - $$

The club maintains a $750+ balance. We try to keep approximately a $500 balance to allow for contingencies. .

## Club Scopes

| Scope | Loan Status |
|---|---|
| 10-inch Ward Dobsonian | Available |
| 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 2009

### June 2009

**Jun 13 – EAS Meeting – Aurora Astro Products – 6:00 PM**
**Jun 20 – EAS Star Party at Ron Tam's place**
Jun 20-24 - Golden State Star Party 2009
Jun 21 - Summer Solstice, 05:45 UTC
Jun 23 - Pluto At Opposition

### July 2009

Jul 04 - Earth At Aphelion (1.017 AU From Sun)
Jul 07 - Penumbral Lunar Eclipse
Jul 15-19 - Mt Bachelor Star Party (MBSP) 2009
**Jul 18 – EAS Bar-B-Q Meeting and Star Party at Jim Bielaga's place on Camano Island**
Jul 20-25 - Table Mt. Star Party (TMSP) 2009
Jul 20 - 40th Anniversary (1969), 1st Man On The Moon (Apollo 11)
Jul 22 - Total Solar Eclipse (China/Pacific)
Jul 29 - South Delta-Aquarids Meteor Shower Peak

### August 2009

Aug 01 - Alpha Capricornids Meteor Shower Peak
Aug 06 - Penumbral Lunar Eclipse
Aug 06 - Southern Iota Aquarids Meteor Shower Peak
Aug 12 - Perseids Meteor Shower Peak

Aug 17 - Neptune At Opposition
Aug 19-23 Oregon Star Party 2009 (OSP)
**Aug 22 – EAS Star Party at Ron Tam's place**
Aug 24 - Mercury At Its Greatest Eastern Elongation (27 Degrees)
Aug 25 - Northern Iota Aquarids Meteor Shower Peak

## September 2009

Sep 04 - Saturn's Rings Edge-on From Earth
Sep 17 - Uranus At Opposition
**Sep 17-18 OAS Camp Delany Fall Star Party**
**Sep 18-19 Orion Nebula 2009 Star Party**
**Sep 19 – EAS Star Party at Ron Tam's place**
Sep 22 - Autumnal Equinox (21:18 UT)
Sep 26-27 - Pacific Astronomy & Telescope Show - Pasadena Conv. Ctr.

## October 2009

Oct 09 - Draconids Meteor Shower Peak
**Oct 17 – EAS Star Party at Ron Tam's place**
Oct 21 - Orionids Meteor Shower Peak

## November 2009

**Nov 14 – EAS Star Party at Ron Tam's place**

## December 2009

## UW Astronomy Speakers Colloquium Schedule

**Astronomy Department weekly colloquium meets Thursdays at 4:00 pm in PAB A102 - the classroom part of the Physics/Astronomy Building complex**.
http://www.astro.washington.edu/pages/colloquium.html

## On The Airwaves - KSER 90.7 - 'It's Over Your Head'

"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 five-minute segment is broadcast **every Wednesday morning at approximately 8:20 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.celestialnorth.org/radio/index.php and podcasts at http://www.celestialnorth.org/radio/index.php

**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.

# OBSERVER'S INFORMATION…

## Lunar Facts

| | |
|---|---|
| Jun 15 | Last Quarter Moon |
| Mar 22 | New Moon |
| Jun 29 | First Quarter Moon |
| Jul 07 | Full Moon |
| Jul 15 | Last Quarter Moon |
| Jul 22 | New Moon |
| Jul 28 | First Quarter Moon |
| Aug 06 | Full Moon |
| Aug 13 | Last Quarter Moon |
| Aug 20 | New Moon |
| Aug 28 | First Quarter Moon |
| Jul 06 | Full Moon |

## Up In The Sky -- The Planets (and Pluto)

| *Object* | *Rises* | *Sets* | *Con* | *Diam.* | *Mag* |
|---|---|---|---|---|---|
| ***Sun*** | ***05:11 am*** | ***21:08*** | ***Tau*** | ***30'*** | ***-27.5*** |
| **Mercury** | **04:14 am** | **18:54** | **Tau** | **08"** | **+0.5** |
| **Venus** | **03:10 am** | **16:59** | **Ari** | **22"** | **-4.2** |
| **Mars** | **03:05 am** | **17:17** | **Ari** | **05"** | **+1.1** |
| **Jupiter** | **00:37 am** | **10:42 am** | **Cap** | **43"** | **-2.5** |
| **Saturn** | **12:13** | **01:29 am** | **Leo** | **19"** | **+0.9** |
| **Uranus** | **01:36 am** | **13:23** | **Psc** | **03"** | **+5.9** |
| **Neptune** | **00:33 am** | **10:40 am** | **Cap** | **02"** | **+7.9** |
| **Pluto** | **21:06** | **06:33 am** | **Sag** | **--** | **+13.9** |

(*times listed are in local time for Everett PDT*)

**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

### Observing Jupiter's Moons – Java tool

http://skytonight.com/observing/objects/javascript/jupiter

### Transit times for Jupiter's Great Red Spot in 2008

http://skytonight.com/observing/objects/planets/3304091.html

### 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** – **Heavens Above**:

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 – CORONA AUSTRALIS

**CORONA AUSTRALIS:** (The Southern Crown). With a midnight culmination date of June 30th, Corona Australis (abbreviated CrA) is perfectly placed for winter viewing in the Southern Hemisphere (i.e., when it is summer in the North). It contains no asterisms or Messier objects, but it does contain the radiant of one meteor shower: the Corona Australids (March 16th). Bordering constellations include Ara, Sagittarius, Scorpius, and Telescopium. Corona Australis ranks 2nd in overall brightness among the constellations (overall brightness is calculated by dividing the number of visible stars in a constellation by the size of the constellation in square degrees, and then multiplying that number by 100). Only the constellation of Crux has a higher overall brightness. Corona Australis ranks 80th in size, taking up only 127.69 square degrees (0.310% of the sky; note: this square degree factor would be the denominator in the above equation: the smaller the denominator the larger the result – in this case, overall brightness). The number of visible stars in this small constellation is relatively large: there are 21 stars brighter than magnitude 5.5.

Corona Australis is completely visible from latitudes South of +44 degrees, and completely invisible from latitudes North of +53 degrees. Its central point is at RA=18h35m, Dec.= -41.5 degrees. The solar conjunction date of Corona Australis is December 31st. Some interesting facts about CrA:

If the brightest stars of nearby Sagittarius form a 'teapot', then the brighter stars (gamma, alpha, beta, delta, zeta, eta, theta) of CrA are well known to form the 'slice of lemon' nearby. Gamma CrA is a very interesting double star: both stars are main sequence stars of spectral type F-8, and they are almost exactly of the same magnitude (4.84 and 5.08). Sir John Herschel is quoted as calling this double star "superb". (However, the pair is separated by only 1.2 arc seconds, rendering it difficult to separate with telescopes smaller than 6 inches of aperture. The orbital period of the system is 122 years.) An easier – but still beautiful - double star to separate within the borders of CrA is Kappa CrA: its separation is 21.2 arc seconds, and its magnitudes are 6.0 and 6.5. Corona Australis contains an interesting NGC object of note: NGC 6541. This is a bright (magnitude 6.1) globular cluster with a moderately compressed core and a loosely structured outer halo. Even though the brightest members of the cluster are at magnitude 12.3, it is still possible to resolve the cluster with 6-inch or larger scopes. Corona Australis – if you ever have the opportunity to visit the Southern Hemisphere – provides a very interesting binocular sweep.

## YOUNG ASTRONOMER'S CORNER

**Now is the time of year when many amateur astronomers' thoughts turn to observing outdoors with their telescopes, binoculars, etc… This helpful column has been published before in the EAS Newsletter, but bears repeating this great time of year! Here are some helpful hints for observing at outdoor telescope "STAR" PARTIES this season: enjoy the night sky warmly and safely!**

★★ Dress warmly, or at least be prepared to do so. If the evening starts out warm, it may not end up that way!

★★ The warmest clothes include polypropylene worn directly against the skin; other warm clothes include those made of wool. Layered cotton clothing can also keep you warm, but you will tend to need more layering. Additionally, if cotton materials get wet, they do not transport moisture away from the body (like polypropylene and wool), but are rather more likely to chill you.

★★ Most body heat is radiated from the head, so make sure you have a good hat that also covers the ears. Good gloves are important as well. Polypropylene glove liners make excellent astronomy gloves because they are not bulky: it is thus easier to use equipment and read charts, etc.…

★★ An excellent all-purpose piece of clothing for use in observing is a hooded-sweatshirt. A hooded sweatshirt can cut down on chilling winds entering down your neck: it essentially serves two purposes: it cuts down on the aforementioned wind effects, and it serves to contain body heat radiating from the head.

★★ Always wear warm socks. Socks that wick moisture away from the skin (such as wool or polypropylene) are excellent. Extra pairs for layering can come in handy too.

★★ A good windbreaker jacket (with an integral hood) is an excellent way to conserve body heat and minimize chill, and can be the outermost clothing in any necessary layering.

★★ Eat well and drink plenty of fluids to avoid dehydration. Good nutrition (including carrots which can improve night vision as a source of Vitamin A) and hydration can help to maintain alertness, body warmth, and help to battle fatigue. Most areas allow camp stoves, but open fires are prohibited. Alcohol and nicotine can interfere with the conservation of body heat. Also – and importantly – tobacco use can be very annoying to your fellow astronomers, as the majority are non-smokers. Further, some people have medical conditions which can be aggravated by cigarette smoke. If you must smoke, please smoke far enough away from people and delicate optical instruments which can pick up smoke film residues. So always be courteous to your fellow astronomers - and good to your own body - by not smoking!

★★ Always follow established STAR PARTY etiquette (which is usually published): red flashlights only at night, and extra batteries can be helpful. If you must listen to music, bring headsets, as your taste in music may be different than your neighbors. Follow STAR PARTY rules about pets: most allow them, but they must be leashed. ALWAYS ask another astronomer if it is OK to look through their scope before you do: some may be taking pictures, or they may not want to be disturbed at that particular time. Many if not most astronomers are very friendly and helpful – and love to have people look through their scopes – but be sure to ask first!

★★ STAR PARTIES are frequently held in remote areas. Always let someone know where you are and what your expected time of return will be: this is especially true if you go off on your own. In that respect, it is ALWAYS better to go in two's with a friend or fellow astronomer. If you have any allergies or other medical conditions, be sure to take your allergy and/or other medicines (including bee sting antidote and heart and asthma medicines, for example) with you: you will generally be at least an hour away from medical attention.

★★ You can enjoy a STAR PARTY without a telescope. *IT IS NOT NECESSARY TO SPEND LOTS OF MONEY TO ENJOY THE NIGHT SKY*. A lawn chair and a blanket, perhaps with a pair of binoculars and a basic night sky book or map of your choice, can result in countless hours of enjoyment and learning about astronomy without spending a lot of money or time in preparation. Going to an official STAR PARTY is a great way to learn and meet new people with varying levels of astronomy knowledge. NEVER be intimidated because you think someone may know more about the subject than you do: everybody starts somewhere!!!... and most astronomers love to answer questions about the night sky and astronomy equipment!!

★★ Finally, respect for your fellow astronomers by following the simple rules above, and respect for the environment while you are there (never leave trash; stay away from fragile areas of grass and wilderness), will also make your star party experience much more enjoyable. See you at an upcoming STAR PARTY!!

## PLANETARY FOCUS -

This column is intended more as a bi-monthly column. It last printed in May 2009, and will return again in July or August.

## ASTRONOMY AND TELESCOPE "LINGO"

***ASTRONOMY LINGO: SUPERGALACTIC PLANE:*** The dominant plane of the greatest concentration of nearby galaxy clusters in the sky, which passes through the Virgo Cluster of galaxies.

***TELESCOPE / EQUIPMENT LINGO****: SPITZER SPACE TELESCOPE:* Formerly SIRTF (Space Infrared Telescope Facility), the SST was launched in August 2003, and is designed to take images and spectra – of infrared emissions in the wavelength range between 3 and 180 microns - by detecting

infrared energy in these wavelengths radiated by celestial objects blocked by Earth's atmosphere. (Most infrared energy is blocked by Earth's atmosphere and cannot be observed with ground-based telescopes.) SST-observable objects may include deep space gas and dust clouds, which can obscure areas of star formation, galaxy centers, and newly forming planetary systems. SST can also detect cooler objects such as very dim or non-visible smaller stars, giant molecular clouds, and extra-solar planets. The telescope must be cooled to near absolute zero so that it can detect infrared emissions from space without interference potentially caused by its own heat energy. The SST was the last mission in NASA's Great Observatories Program: four orbiting observatories which also included the Compton Gamma Ray Observatory; the Hubble Space Telescope; and the Chandra X-Ray Observatory.

***Astronomy "Lingo": OORT CLOUD:*** An immense spherical halo of icy objects around the solar system; it is the repository of long-period comets.

***Telescope / Equipment "Lingo": INTERFEROMETRY:*** The use of more than one telescope, with the goal of increasing resolution by combining light or radio waves emitted from the same celestial object.

## ASTRONOMY "FUN FACTS"

★★ Because of vast lava flows, the surface of the Jovian moon Io is less than 10 million years old, and Io is the only body in the Solar System that is turning itself inside out volcanically! On Earth, this "renewal" is accomplished not volcanically, but rather by earthworms!

★★ Sinope, one of the outermost moons of Jupiter, is only 9 miles in diameter and is 400 million miles from Earth – making it, among other things – a remarkable accomplishment that it was even discovered at all… and in no less than ***1914*** (by astronomer Seth Nicholson)!!

★★ Sinope is approximately 14.7 million miles from Jupiter, and it takes more than 2 years to orbit the giant planet. Sinope is thus about 61 times farther away from Jupiter than our Moon is to Earth, and it lies at about $1/6^{th}$ the Sun-Earth distance from Jupiter. Because of this distance, an Apollo spacecraft traveling at the average Earth to Moon velocity would take 6 months to travel from Jupiter to its tiny moon Sinope!

## "MIRROR IMAGES" – 'MIRA' STARS

**"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: MIRA STARS:** Variable stars whose luminosities vary over a long period of time. The prototype is Mira in the constellation of Cetus the Whale. Mira stars are long-period pulsating variables. These are either red giants or red supergiants that have periods ranging from around 80 to 1000 days, and a range of brightness from about 2.5 magnitudes to sometimes exceeding 10 magnitudes. The maximum brightness can vary considerably between periods; because of the large amplitude, they are easily recognizable and their high luminosity permits detection at great distances. Ninety percent of these stars have spectra that can be classified as either Me stars (hydrogen emission lines in addition to molecular bands of titanium oxide that are characteristic of M stars); Ce (carbon) stars; or Se (zirconium) stars: there are bright emission lines present in the spectra in addition to molecular bands. The pulsations of these huge variable stars are not very stable, and there is evidence of shock waves developing within the fragile atmospheres which travel outward, heating the gas and causing the production of these emission lines. Although the visual range of Mira stars is large, the infrared range is much smaller, and many of them are indeed infrared sources. Expanding envelopes of gas frequently contain condensed dust grains (which produce detectable infrared emissions), and simple molecules. In fact, Mira stars often show MASER (microwave amplification by stimulated emission of radiation) emission from hydroxyl, water, and silicon monoxide molecules in their outer atmospheres.

**REPRESENTATIVE NORTHERN HEMISPHERE OBJECT: T Cephei**.

**REPRESENTATIVE SOUTHERN HEMISPHERE OBJECT: Mira (omicron Ceti)** Also known as "the Wonderful", Mira is the prototype star for this class (see above).

## ASTRONOMICAL NOTES -- ON & OFF THE WEB…

### GREATER LONGEVITY PREDICTED FOR PLANETS WITH LIFE

Billion-year life extension for Earth also doubles the odds that advanced life will be found elsewhere in the universe. Roughly a billion years from now, the ever-increasing radiation from the sun will have heated Earth into inhabitability; the carbon dioxide in the atmosphere that serves as food for plant life will disappear, pulled out by the weathering of rocks; the oceans will evaporate; and all living things will disappear. Or maybe not quite so soon, say researchers who have come up with a mechanism that doubles the future lifespan of the biosphere—while also increasing the chance that advanced life will be found elsewhere in the universe.

A paper describing their hypothesis was published recently. Earth maintains its surface temperatures through the greenhouse effect. Although the planet's greenhouse gases—chiefly water vapor, carbon dioxide, and methane-have become the villain in global warming scenarios, they're crucial for a habitable world, because they act as an insulating blanket in the atmosphere that absorbs and radiates thermal radiation, keeping the surface comfortably warm.

As the sun has matured over the past 4.5 billion years, it has become both brighter and hotter, increasing the amount of solar radiation received by Earth, along with surface temperatures. Earth has coped by reducing the amount of carbon dioxide in the atmosphere, thus reducing the warming effect. (Despite current concerns about rising carbon dioxide levels triggering detrimental climate change, the pressure of carbon dioxide in the atmosphere has dropped some 2,000-fold over the past 3.5 billion years; modern, man-made increases in atmospheric carbon dioxide offset a fraction of this overall decrease.)

The problem, says Joseph L. Kirschvink, a coauthor of the paper, is that "*we're nearing the point where there's not enough carbon dioxide left to regulate temperatures following the same procedures*." Kirschvink and his collaborators Yuk L. Yung, professor of planetary science, and graduate students King-Fai Li and Kaveh Pahlevan, say that the solution is to reduce substantially the total pressure of the atmosphere itself, by removing massive amounts of molecular nitrogen, the largely

nonreactive gas that makes up about 78 percent of the atmosphere. This would regulate the surface temperatures and allow carbon dioxide to remain in the atmosphere, to support life, and could tack an additional 1.3 billion years onto Earth's expected lifespan.

In the "blanket" analogy for greenhouse gases, carbon dioxide would be represented by the cotton fibers making up the blanket. "*The cotton weave may have holes, which allow heat to leak out*," explains Li, the lead author of the paper. "*The size of the holes is controlled by pressure*," Yung says. "*Squeeze the blanket*," by increasing the atmospheric pressure, "*and the holes become smaller, so less heat can escape. With less pressure, the holes become larger, and more heat can escape*," he says, helping the planet to shed the extra heat generated by a more luminous sun.

Strikingly, no external influence would be necessary to take nitrogen out of the air, the scientists say. Instead, the biosphere itself would accomplish this, because nitrogen is incorporated into the cells of organisms as they grow, and is buried with them when they die. In fact, "*this reduction of nitrogen is something that may already be happening*," says Pahlevan, and that has occurred over the course of Earth's history. This suggests that Earth's atmospheric pressure may be lower now than it was earlier in the planet's history.

Proof of this hypothesis may come from other research groups that are examining the gas bubbles formed in ancient lavas to determine past atmospheric pressure: the maximum size of a forming bubble is constrained by the amount of atmospheric pressure, with higher pressures producing smaller bubbles, and vice versa. If true, the mechanism also would potentially occur on any extrasolar planet with an atmosphere and a biosphere.

"*Hopefully, in the future we will not only detect earth-like planets around other stars but learn something about their atmospheres and the ambient pressures*," Pahlevan says. "*And if it turns out that older planets tend to have thinner atmospheres, it would be an indication that this process has some universality*."

Adds Yung: "*We can't wait for the experiment to occur on Earth. It would take too long. But if we study exoplanets, maybe we will see it. Maybe the experiment has already been done*." Increasing the lifespan of our biosphere—from roughly 1 billion to 2.3 billion years—has intriguing implications for the search for life elsewhere in the universe. The length of the existence of advanced life is a variable in the Drake equation, astronomer Frank Drake's famous formula for estimating the number of intelligent extraterrestrial civilizations in the galaxy. Doubling the duration of Earth's biosphere effectively doubles the odds that intelligent life will be found elsewhere in the galaxy.

"*It didn't take very long to produce life on the planet, but it takes a very long time to develop advanced life*," says Yung. On Earth, this process took four billion years. "*Adding an additional billion years gives us more time to develop, and more time to encounter advanced civilizations, whose own existence might be prolonged by this mechanism. It gives us a chance to meet*." http://mr.caltech.edu/press_releases/13266

## "Missing Link" for Fast-Spinning Pulsar Mystery

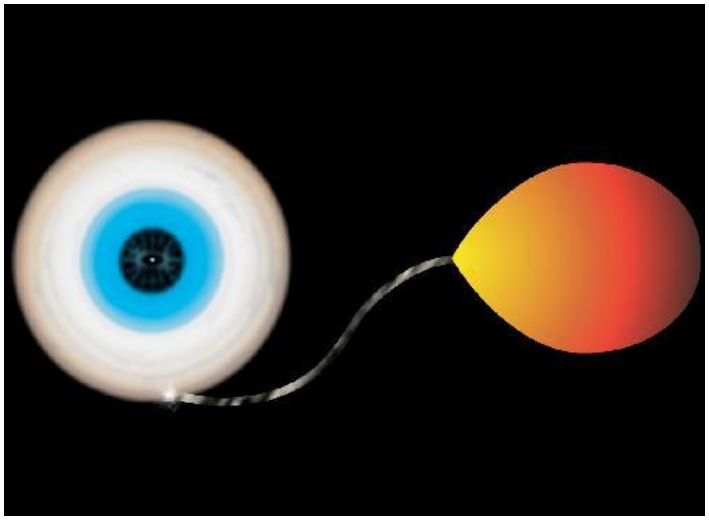
Astronomers have discovered a unique double-star system that represents a "missing link" stage in what they believe is the birth process of the most rapidly-spinning stars in the Universe -- millisecond pulsars. "*We've thought for some time that we knew how these pulsars get 'spun up' to rotate so swiftly, and this system looks like it's showing us the process in action*," said Anne Archibald. Pulsars are superdense neutron stars, the remnants left after massive stars have exploded as supernovae. Their powerful magnetic fields generate lighthouse-like beams of light and radio waves that sweep around as the star rotates. Most rotate a few to tens of times a second, slowing down over thousands of years.

However, some, dubbed millisecond pulsars, rotate hundreds of times a second. Astronomers believe the fast rotation is caused by a companion star dumping material onto the neutron star and spinning it up. The material from the companion would form a flat, spinning disk around the neutron star, and during this period, the radio waves characteristic of a pulsar would not be seen coming from the system. As the amount of matter falling onto the neutron star decreased and stopped, the radio waves could emerge, and the object would be recognized as a pulsar.

This sequence of events is apparently what happened with a binary-star system some 4000 light-years from Earth. The millisecond pulsar in this system, called J1023, was discovered by the Robert C. Byrd Green Bank Telescope (GBT) in West Virginia in 2007 in a survey.

The astronomers then found that the object had been detected by Very Large Array (VLA) radio telescope during a large sky survey in 1998, and had been observed in visible light by the Sloan Digital Sky Survey in 1999, revealing a Sun-like star.

When observed again in 2000, the object had changed dramatically, showing evidence for a rotating disk of material, called an accretion disk, surrounding the neutron star. By May of 2002, the evidence for this disk had disappeared.



*Neutron star with accretion disk (left) drawing material from companion star (right). CREDIT: Bill Saxton, NRAO/AUI/NSF*

"*This strange behavior puzzled astronomers, and there were several different theories for what the object could be*," said Ingrid Stairs, who has been visiting the Australia Telescope National this year. The 2007 GBT observations showed that the object is a millisecond pulsar, spinning 592 times per second. "*No other millisecond pulsar has ever shown evidence for an accretion disk*," Archibald said. "*We know that another type of binary-star system, called a low-mass X-ray binary (LMXB), also contains a fast-spinning neutron star and an accretion disk, but these don't emit radio waves. We've thought that LMXBs probably are in the process of getting spun up, and will later emit radio waves as a pulsar. This object appears to be the 'missing link' connecting the two types of systems*," she explained. "*It appears this thing has flipped from looking like an LMXB to looking like a pulsar, as it experienced an episode during which material pulled from the companion star formed an accretion disk around the neutron star.*

*Later, that mass transfer stopped, the disk disappeared, and the pulsar emerged*," said Scott Ransom of the NRAO.

The scientists have studied J1023 in detail with the GBT, with the Westerbork radio telescope in the Netherlands, with the Arecibo radio telescope in Puerto Rico, and with the Parkes radio telescope in Australia. Their results indicate that the neutron star's companion has less than half the Sun's mass, and orbits the neutron star once every four hours and 45 minutes. "*This system gives us an unparalled 'cosmic laboratory' for studying how millisecond pulsars evolve*," Stairs said. Maura McLaughlin agrees: "*Future observations of this system at radio and other wavelengths are sure to hold many surprises*."

### AN EXPLODING STAR IN AN 'EXPLODING' GALAXY M82

An international team of radio astronomers have discovered the secret explosion of a massive star, a new supernova, SN 2008iz, in the nearby galaxy M82. Despite being the closest supernovae discovered in the last five years, the explosion is exclusively detectable at radio wavelengths since the dense gas and dust surrounding the exploding star leave it invisible in other wavebands. Without the obscuration, this explosion would have been visible even with amateur telescopes. The results are published in this week's release of Astronomy & Astrophysics Letters.

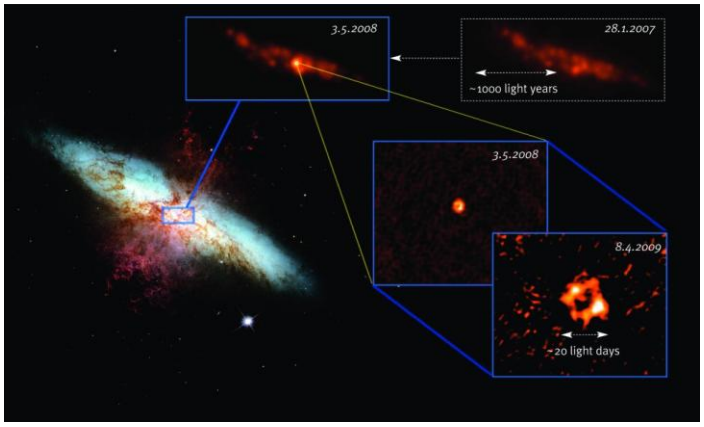



*Figure 1: Zooming into the center of the galaxy M82, one of the nearest starburst galaxies at a distance of only 12 Million light years. The left image, taken with the Hubble Space Telescope (HST), shows the body of the galaxy in blue and hydrogen gas breaking out from the central starburst in red. The VLA image (top left) clearly shows the supernova (SN 2008iz), taken in May 2008. The high-resolution VLBI images (lower right) shows an expanding shell at the scale of a few light days and proves the transient source as the result of a supernova explosion in M82.*

*Graphics: Milde Science Communication, HST Image: /NASA, ESA, and The Hubble Heritage Team (STScI/AURA); Radio Images: A. Brunthaler, MPIfR.*

M82 is an irregular galaxy in a nearby galaxy group located 12 million light-years from Earth. Despite being smaller than the Milky Way, it harbors a vigorous central starburst in the inner few hundred light-years. In this stellar factory more stars are presently born than in the entire Milky Way. M82 is often called an 'exploding galaxy', because it looks as if being torn apart in optical and infrared images as the result of numerous supernova explosions from massive stars (see Fig. 1, left). Many remnants from previous supernovae are seen on radio images of M82 and a new supernova explosion was long overdue. For a quarter of century astronomers have tried to catch this cosmic catastrophe in the act and have started to wonder why the galaxy has been so silent in recent years.

The new discovery was first made in April 2009 when Dr. Andreas Brunthaler examined data just taken (on April 8) with the Very Large Array (VLA) of the National Radio Astronomy Observatory, an interferometer of 27 identical 25 meter telescopes in New Mexico, USA. "*I then looked back into older data we had from March and May last year, and there it was as well, outshining the entire galaxy!",* he says. Observations taken before 2008 showed neither pronounced radio nor X-ray emission at the position of this supernova. On the other hand, observations of M82 taken last year with optical telescopes to search for new supernovae showed no signs of this explosion. Furthermore, the supernova is hidden on ultraviolet and X-ray images. The supernova exploded close to the center of the galaxy in a very dense interstellar environment. This could also reveal the mystery about the long silence of M82: many of these events may actually be something like "underground explosions", where the bright flash of light is covered under huge clouds of gas and dust and only radio waves can penetrate this dense material. "*This cosmic catastrophe shows that using our radio telescopes we have a front-row seat to observe the otherwise hidden universe*", Prof. Heino Falcke explains. If not obscured, the explosion could have been visible even in a medium-sized amateur telescope.

Radio emission can be detected only from core collapse supernovae, where the core of a massive star collapses and produces a black hole or a neutron star. It is produced when the shock wave of the explosion propagates into dense material surrounding the star, usually material that was shed from the massive progenitor star before it exploded.

By combining data from the ten telescopes of the Very Long Baseline Array (VLBA), the VLA, the Green Bank Telescope in Virginia, and the Effelsberg 100m telescope in Germany, using the technique of Very Long Baseline Interferometry (VLBI), the team was able to produce images that show a ring-like structure expanding at more than 40 million km/h or 4% of the speed of light, typical for supernovae. "*By extrapolating this expansion back in time, we can estimate the explosion date. Our current data indicate that the star exploded in late January or early February 2008*.", explains Dr. Andreas Brunthaler.

*Very Long Baseline Array Telescope Locations CREDIT: NRAO/AUI/NSF*

Only three months after the explosion, the ring was already 650 times larger than Earth's orbit around the Sun. It takes the extremely sharp view of VLBI observations to resolve this structure which is as large as a 1 Euro coin seen from a distance of 13.000 km.

The asymmetric appearance of the supernova on the VLBI images indicates also that either the explosion was highly asymmetric or the surrounding material unevenly distributed. "*Using the super sharp vision of VLBI we can follow the supernova expanding into the dense interstellar medium of M82 over the coming years and gain more insight on it and the explosion itself*." says Karl Menten, director at the MPIfR.

Discoveries like this supernova will be routine with the next generation of radio telescopes, such as the Low-Frequency Array (LOFAR) which is currently under construction in Europe, the Allen Telescope Array (ATA) in Hat Creek Valley, CA, or the planned Square-Kilometer Array (SKA). These will have the capability to observe large parts of the sky continuously.

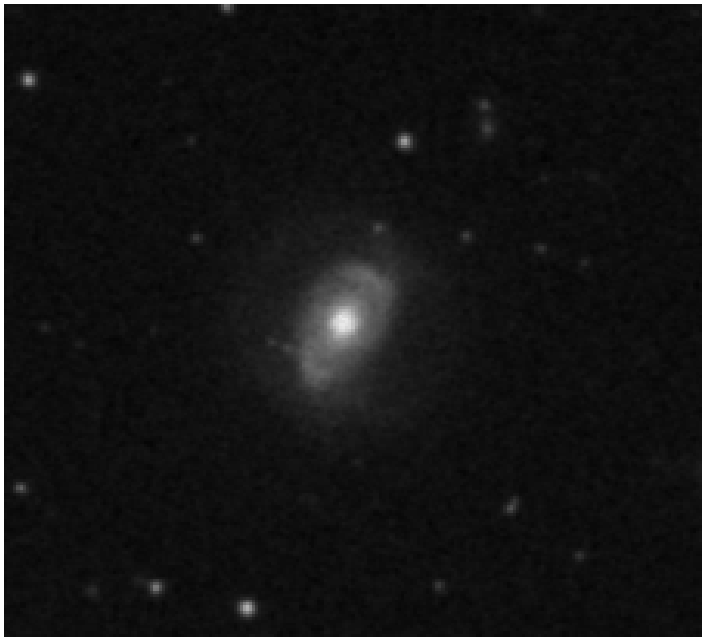
### RADIO TELESCOPES EXTEND ASTRONOMY'S BEST "YARDSTICK", PROVIDES VITAL TOOL FOR UNRAVELING DARK ENERGY MYSTERY

Radio astronomers have directly measured the distance to a faraway galaxy, providing a valuable "yardstick" for calibrating large astronomical distances and demonstrating a vital method that could help determine the elusive nature of the mysterious Dark Energy that pervades the Universe. "*We measured a direct, geometric distance to the galaxy, independent of the complications and assumptions inherent in other techniques. The measurement highlights a valuable method that can be used to determine the local expansion rate of the Universe, which is essential in our quest to find the nature of Dark Energy*," said James Braatz, of the National Radio Astronomy Observatory (NRAO).

*Robert C. Byrd Green Bank Telescope CREDIT: NRAO/AUI/NSF*

Braatz and his colleagues used the National Science Foundation's Very Long Baseline Array (VLBA) and Robert C. Byrd Green Bank Telescope (GBT), and the Effelsberg Radio Telescope of the Max Planck Institute for Radioastronomy (MPIfR) in Germany to determine that a galaxy dubbed UGC 3789 is 160 million light-years from Earth. To do this, they precisely measured both the linear and angular size of a disk of material orbiting the galaxy's central black hole. Water molecules in the disk act as masers to amplify, or strengthen, radio waves the way lasers amplify light waves.

The observation is a key element of a major effort to measure the expansion rate of the Universe, known as the Hubble Constant, with greatly improved precision. That effort, cosmologists say, is the best way to narrow down possible explanations for the nature of Dark Energy. "*The new measurement is important because it demonstrates a one-step, geometric technique for measuring distances to galaxies far enough to infer the expansion rate of the Universe*," said Braatz.



*Visible-light image of UGC 3789 CREDIT: STScI*

Dark Energy was discovered in 1998 with the observation that the expansion of the Universe is accelerating. It constitutes 70 percent of the matter and energy in the Universe, but its nature remains unknown. Determining its nature is one of the most important problems in astrophysics.

"*Measuring precise distances is one of the oldest problems in astronomy, and applying a relatively new radio-astronomy technique to this old problem is vital to solving one of the greatest challenges of 21st Century astrophysics*," said team member Mark Reid. The work on UGC 3789 follows a landmark measurement done with the VLBA in 1999, in which the distance to the galaxy NGC 4258 -- 23 million light-years -- was directly measured by observing water masers in a disk of material orbiting its central black hole. That measurement allowed refinement of other, indirect distance-measuring techniques using variable stars as "standard candles." The measurement to UGC 3789 adds a new milepost seven times more distant than NGC 4258, which itself is too close to measure the Hubble Constant directly. The speed at which NGC 4258 is receding from the Milky Way can be influenced by local effects. "*UGC 3789 is far enough that the speed at which it is moving away from the Milky Way is more indicative of the expansion of the Universe*," said team member Elizabeth Humphreys.

Following the achievement with NGC 4258, astronomers used the highly-sensitive GBT to search for other galaxies with similar water-molecule masers in disks orbiting their central black holes. Once candidates were found, astronomers then used the VLBA and the GBT together with the Effelsberg telescope to make images of the disks and measure their detailed rotational structure, needed for the distance measurements. This effort requires multi-year observations of each galaxy. UGC 3789 is the first galaxy in the program to yield such a precise distance.

Team member Cheng-Yu Kuo presented an image of the maser disk in NGC 6323, a galaxy even more distant than UGC 3789. This is a step toward using this galaxy to provide another valuable cosmic milepost. "*The very high sensitivity of the telescopes allows making such images of galaxies even beyond 300 million light years,*" said Kuo.

### TO 300 MILLION LIGHT YEARS AND BEYOND - A NEW WAY TO MEASURE COSMIC DISTANCES

Researchers have found a way to measure distances to objects three times farther away in outer space than previously possible, by extending a common measurement technique. They discovered that a rare type of giant star, often overlooked by astronomers, could make an excellent signpost for distances up to 300 million light-years -- and beyond.

Along the way, they also learned something new about how these stars evolve. Cepheid variables -- giant stars that pulse in brightness -- have long been used as reference points for measuring distances in the nearby universe, said Jonathan Bird, doctoral student in astronomy. Classical Cepheids are bright, but beyond 100 million light-years from Earth, their signal gets lost among other bright stars.

In a press briefing Bird revealed that a rare and even brighter class of Cepheid -- one that pulses very slowly -- can potentially be used as a beacon to measure distances three times farther than their classical counterparts. This project is the latest in principal investigator Krzysztof Stanek's effort to gauge the size and age of the universe with greater precision.

There are several methods for calculating the distance to stars, and astronomers often have to combine methods to indirectly measure a distance. The usual analogy is a ladder, with each new method a higher rung above another. At each new rung of the cosmic distance ladder, the errors add up, reducing the precision of the overall measurement. So any single method that can skip the rungs of the ladder is a prized tool for probing the universe.

Stanek applied a direct measurement technique in 2006, when he used the light emerging from a binary star system in the galaxy M33 to measure the distance to that galaxy for the first time. M33 is 3 million light-years from Earth. This new technique using so-called "ultra long period Cepheids" (ULP Cepheids) is different. It's an indirect method, but this initial study suggests that the method would work for galaxies that are much farther away than M33.

"*We found ultra long period Cepheids to be a potentially powerful distance indicator. We believe they could provide the first direct stellar distance measurements to galaxies in the range of 50-100 megaparsecs (150 million - 326 million light-years) and well beyond that*," Stanek said.

Because researchers generally don't take note of ultra long period Cepheids, there are few of them in the astronomical record. For this study, Stanek, Bird, and doctoral student Jose Prieto uncovered 18 ULP Cepheids from the literature.

Each was located in a nearby galaxy, such as the Small Magellanic Cloud. The distances to these nearby galaxies are well known, so the astronomers used that knowledge to calibrate the distance to the ULP Cepheids. They found that they could use ULP Cepheids to determine distance with a 10-20 percent error -- a rate typical of other methods that make up the cosmic distance ladder. "*We hope to reduce that error as more people take note of ULP Cepheids in their stellar surveys*," Bird said. "*What we've shown so far is that the method works in principle, and the results are encouraging*."

Bird explained why astronomers have ignored ULP Cepheids in the past. Short period Cepheids, those that brighten and dim every few days, make good distance markers in space because their period is directly related to their brightness -- and astronomers can use that brightness information to calculate the distance.

Polaris, the North Star, is a well known and classical Cepheid. But astronomers have always thought that ULP Cepheids, which brighten and dim over the course of a few months or longer, don't obey this relation. They are larger and brighter than the typical Cepheid. In fact, they are larger and brighter than most stars; in this study, for example, the 18 ULP Cepheids ranged in size from 12-20 times the mass of our Sun. The brightness makes them good distance markers, Stanek said. Typical Cepheids are harder to spot in distant galaxies, as their light blends in with other stars. ULP Cepheids are bright enough to stand out.

Astronomers have also long suspected that ULP Cepheids don't evolve the same way as other Cepheids. In this study, however, the team found the first evidence of a ULP Cepheid evolving as a more classical Cepheid does. A classical Cepheid will grow hotter and cooler many times over its lifetime. In-between, the outer layers of the star become unstable, which causes the changes in brightness. ULP Cepheids are thought to go through this period of instability only once, and going in only one direction -- from hotter to cooler. But as the astronomers pieced together data from different parts of the literature for this study, they discovered that one of the ULP Cepheids -- a star in the Small Magellanic Cloud dubbed HV829 -- is clearly moving in the opposite direction. Forty years ago, HV829 pulsed every 87.6 days. Now it pulses every 84.4 days. Two other measurements found in the literature confirm that the period has been shrinking steadily in the decades in between, which indicates that the star itself is shrinking, and getting hotter. The astronomers concluded that ULP Cepheids may help astronomers not only measure the universe, but also learn more about how very massive stars evolve.

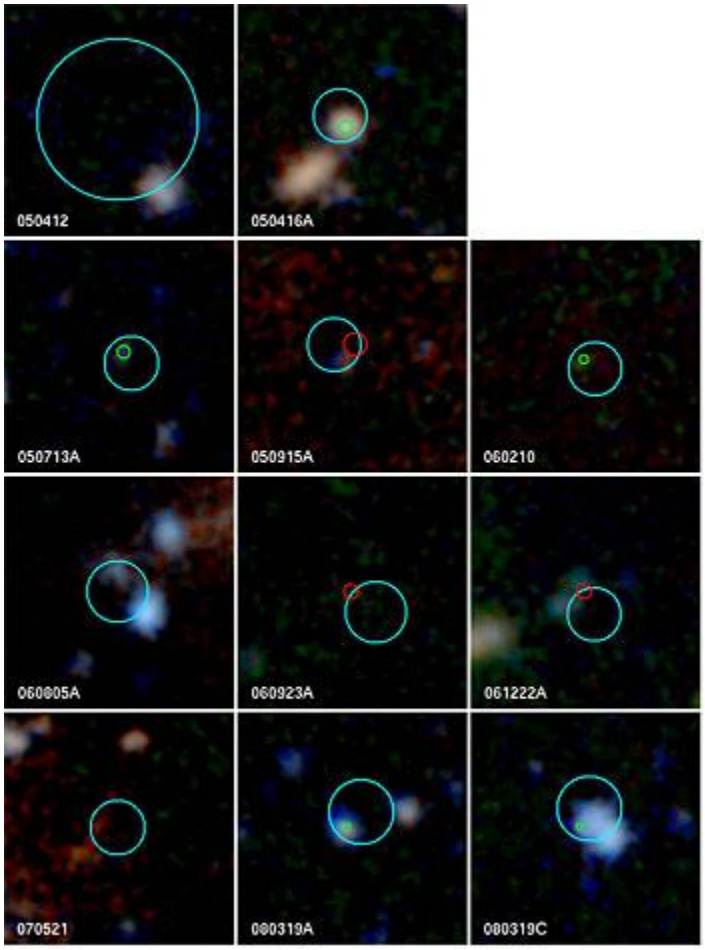
Some of these results were reported in April 2009. Since that time, the astronomers have started using the Large Binocular Telescope in Tucson, AZ, to look for more ULP Cepheids. Stanek says that they've found a few good candidates in the galaxy M81, but those results have yet to be confirmed.

### LIFTING THE FOG ON 'DARK' GAMMA-RAY BURSTS

Gamma-ray bursts, with their ability to pierce through gas and dust to shine brightly across the universe, are revealing areas of intense star formation and stellar death where astronomers have been unable to look - the dusty corners of otherwise dust-free galaxies.

The conclusion comes from a survey of "dark" gamma-ray bursts — bright in gamma- and X-ray emissions, but with little or no visible light. "*Our study provides compelling evidence that a large fraction of star formation in the universe is hidden by dust in galaxies that do not appear otherwise dusty*," said Joshua Bloom, associate professor of astronomy and senior author of the study.

Star formation occurs in dense clouds that quickly fill with dust as the most massive stars rapidly age and explode, spewing newly created elements into the interstellar medium to seed new star formation. Hence, astronomers presume that a large amount of star formation is occurring in dust-filled galaxies, although actually measuring how much dust this process has built up in the most distant galaxies has proved extremely challenging.




*Detected GRB burst locations*

*Artist's illustration of a gamma-ray burst occurring in a dusty region of intense star formation. If a dust cloud lies between the burst and Earth, the optical light will be almost entirely absorbed, but the gamma-rays and X-rays will easily penetrate the dust. New evidence suggests that most "dark" gamma-ray bursts — those without optical afterglows — form in similar dusty environments.*

Long-duration gamma-ray bursts, the most brilliant flashes of light in the universe, are thought to originate from the explosion of massive stars. These events create two pencil-like beams of light, akin to lighthouse beacons, bright enough to be seen from as far away as 13 billion light years, near the limits of the observable universe.

While most gamma-ray bursts continue to shine brightly in optical light for many hours after the gamma-ray emission subsides — a phenomenon known as an 'afterglow' — those with little or no detectable afterglow, dubbed "dark GRBs," have puzzled astronomers. Some have speculated that most were so far away, and thus at such high redshift, that their optical afterglow shifted out of the wavelength region that optical telescopes can detect.

Redshift refers to the Doppler-shifted reddening of light from distant stars because they are speeding away from us, a consequence of the expansion of the universe after the Big Bang.

"*Whatever the cause, it was like hearing the foghorn without seeing the lighthouse*," explained Bloom. "*Something interesting was happening towards those shores*."

Mosaic of 11 "dark" gamma-ray burst host galaxies imaged at the Keck Observatory. The circles indicate the position of the burst determined by Swift satellite or from ground-based optical or infrared imaging and, in all of the cases shown, contain a faint host galaxy. At distances of billions of light years from Earth, these galaxies appear only as faint smudges to ground-based telescopes. (Daniel Perley, Joshua Bloom)The new study, which focused on 14 bursts whose optical light was either much fainter than expected or completely absent, shows that almost every "dark" gamma-ray burst has a host galaxy detectable with Earth's largest optical telescopes - in this case, the Keck 10-meter telescopes in Hawaii. Because these galaxies would not be detectable if they were at high redshifts, this indicates that most "dark" bursts are similar to normal bursts with an afterglow, except that nearly all of the visible light is obscured by patchy dust within these host galaxies.

The findings suggest that gamma-ray bursts may be able to help track the rate at which stars form and die in distant galaxies, and confirm previous estimates that "*25 percent of the time, when massive stars form, they form in a dusty place*," said graduate student Daniel Perley, lead author of the study.

"*However, based on our survey of these dark gamma-ray bursts, the galaxies look normal and not dust filled*," he said. "*The dust is probably in clouds and knots around the forming stars*."

Bloom and Perley were using some of the world's largest telescopes, the twin 10-meter telescopes of the W. M. Keck Observatory, to look for the host galaxies of "dark" gamma-ray bursts when Cenko, recently arrived from Palomar Observatory, suggested focusing on a specific sample of bursts observed by Palomar's 60-inch telescope. Through March 2008, Palomar conducted follow-up observations of 29 bursts discovered by Swift gamma-ray satellite, 14 of which were classified as dark. The Swift mission, equipped with a gamma-ray detector and X-ray, ultraviolet and optical telescopes.

For 11 of these 14 dark bursts, the team successfully detected a distant galaxy hosting the explosion, while the remaining three bursts without detectable hosts had faint optical counterparts. This indicates that none of these bursts had come from the most distant regions of the universe, since at distances greater than about 12.9 billion light years all the detectable light from both the afterglow and the host galaxy would be shifted into the infrared due to the expansion of the universe.

"*And while 12.9 billion light years is a large distance even by most astronomers' standards, gamma-ray bursts are so powerful that if these were frequent occurrences 13 billion years ago, we ought to be detecting large numbers of those same explosions today as high redshift events*," Cenko said. "*We don't, which indicates that the first stars formed at a less frenzied pace than some models suggested*."

The lack of any very high redshift events in the sample indicates that these distant explosions cannot comprise more than a few percent of all gamma-ray bursts, Cenko said. However, such distant bursts are known to exist. Just two months ago, a gamma-ray burst at a distance of 13.1 billion years was discovered.

"*Putting this recent event together with the others in our study, for the first time we can provide both an upper and lower limit to the fraction of gamma-ray bursts at very high redshift*," Perley said. Specifically, the authors conclude that the high redshift fraction is between 0.2 and 7 percent. Because none of the 14 bursts studied in the survey is at this distance, by far the most likely cause of the bursts' optical dimness is dust inside the host galaxy absorbing light from the afterglow before it escapes, the team concluded. However, the starlight shows no obvious signatures of dust, indicating that the dust may be hiding in patches or clouds where it is difficult to detect. Consequently, there could be much more dust than has been suspected as the result of measurements using other techniques, and "*dark gamma-ray bursts could provide a complementary way of answering the question of how much star formation was going on inside galaxies in the early universe*," Perley said.

The authors of the report propose more radio and sub-millimeter observations of the host galaxies of dark gamma-ray bursts to better understand the reasons behind the obscured optical emissions from GRBs.

### THE MOST DISTANT OBJECT YET DISCOVERED IN UNIVERSE

ESO's Very Large Telescope has shown that a faint gamma-ray burst detected last Thursday is the signature of the explosion of the earliest, most distant known object in the Universe (a redshift of 8.2). The explosion apparently took place more than 13 billion years ago, only about 600 million years after the Big Bang.

*ESO PR Photo 17a/09 Artist's impression of a gamma-ray burst*

Gamma-ray bursts (GRBs) are powerful flashes of energetic gamma-rays lasting from less than a second to several minutes. They release a tremendous amount of energy in this short time making them the most powerful events in the Universe. They are thought to be mostly associated with the explosion of stars that collapse into black holes.

The gamma-ray burst GRB 090423 was detected by the Swift satellite during the morning of Thursday 23 April 2009. The 10 second burst was located in the constellation of Leo (the Lion). It was soon being followed by a whole range of telescopes on the ground, including the 2.2-metre telescope at La Silla and ESO's Very Large Telescope (VLT) at Paranal, both in Chile.

VLT infrared observations, made 17 hours after the burst detection, allowed astronomers to establish the distance to the explosion. "*We find that the light coming from the explosion has been stretched, or redshifted, considerably by the expansion of the Universe*", says Nial Tanvir, the leader of the team who made the VLT observations. "*With a redshift of 8.2 this is the most remote gamma-ray burst ever detected, and also the most distant object ever discovered — by some way*." Because light moves at a finite speed, looking farther into the Universe means looking back in time. The explosion occurred when the Universe was about 600 million years old, less than 5 percent of its current age. It is believed that the very first stars only formed when the Universe was between 200 and 400 million years old.

"*This discovery proves the importance of gamma-ray bursts in probing the most distant parts of the Universe*", says Tanvir. "*We can now be confident that even more remote bursts will be found in the future, which will open a window to studying the very first stars and the ultimate end of the Dark Age of the Universe*."

The previous record holder for the most distant GRB — first detected by Swift last year and then also studied with the VLT — had a redshift of 6.7. The blast, designated GRB 080913, arose from a star exploding about 200 million years after GRB090423. The previous most distant object known in the Universe confirmed spectroscopically is a galaxy with a redshift of 6.96.

Gamma-ray bursts are discovered by telescopes in space. After releasing their intense burst of high-energy radiation, they become detectable for a short while in the optical and in the near-infrared. This 'afterglow' fades very rapidly, making detailed analysis possible for only a few hours after the gamma-ray detection. This analysis is important in particular in order to determine the GRB's distance and, hence, intrinsic brightness.

Gamma-ray bursts are the universe's most luminous explosions. Most occur when massive stars run out of nuclear fuel. As their cores collapse into a black hole or neutron star, gas jets — driven by processes not fully understood — punch through the star and blast into space. There, they strike gas previously shed by the star and heat it, which generates short-lived afterglows in many wavelengths.
http://www.nasa.gov/mission_pages/swift/bursts/farthest_grb.html
https://www.naoj.org/Pressrelease/2006/09/13/index.html

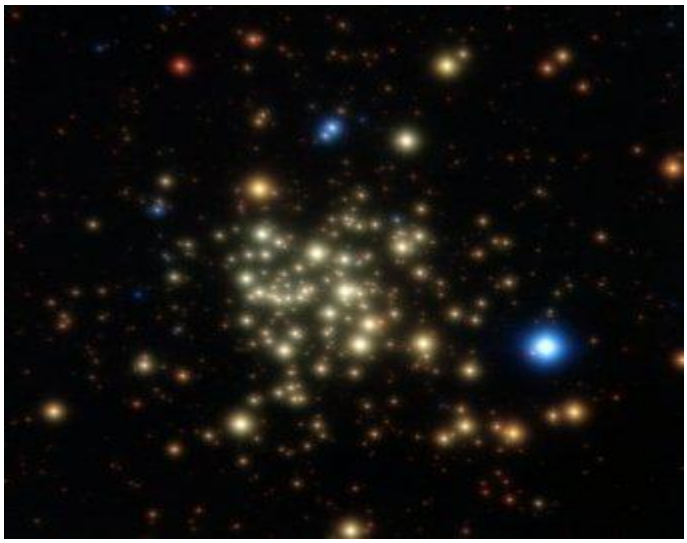
### STAR CLUSTER IN CROWDED, VIOLENT NEIGHBORHOOD PROVES TO BE SURPRISINGLY NORMAL

Using the NACO adaptive optics instrument on ESO's Very Large Telescope, located in Chile, astronomers have obtained one of the sharpest views ever of the Arches Cluster — an extraordinary dense cluster of young stars near the supermassive black hole at the heart of the Milky Way. Despite the extreme conditions astronomers were surprised to find the same proportions of low- and high-mass young stars in the cluster as are found in more tranquil locations in our Milky Way.

The massive Arches Cluster is a rather peculiar star cluster. It is located 25,000 light-years away towards the constellation of Sagittarius (the Archer), and contains about a thousand young, massive stars, less than 2.5 million years old. It is an ideal laboratory to study how massive stars are born in extreme conditions as it is close to the centre of our Milky Way, where it experiences huge opposing forces from the stars, gas and the supermassive black hole that reside there. The Arches Cluster is ten times heavier than typical young star clusters scattered throughout our Milky Way and is enriched with chemical elements heavier than helium.

Using the NACO instrument, astronomers scrutinized the cluster in detail. Thanks to adaptive optics, astronomers can remove most of the blurring effect of the atmosphere, and so the new images of the Arches Cluster are even crisper than those obtained with telescopes in space. Observing the Arches Cluster

is very challenging because of the huge quantities of absorbing dust between Earth and the Galactic Centre, which visible light cannot penetrate.



*ESO PR Photo 21a/09The Arches Cluster*

This is why NACO was used to observe the region in near-infrared light. The new study confirms the Arches Cluster to be the densest cluster of massive young stars known. It is about three light-years across with more than a thousand stars packed into each cubic light-year — an extreme density a million times greater than in the Sun's neighborhood. Astronomers studying clusters of stars have found that higher mass stars are rarer than their less massive brethren, and their relative numbers are the same everywhere, following a universal law. For many years, the Arches Cluster seemed to be a striking exception. "*With the extreme conditions in the Arches Cluster, one might indeed imagine that stars won't form in the same way as in our quiet solar neighborhood*," says Pablo Espinoza, the lead author of the paper reporting the new results. "*However, our new observations showed that the masses of stars in this cluster actually do follow the same universal law*". In this image the astronomers could also study the brightest stars in the cluster. "*The most massive star we found has a mass of about 120 times that of the Sun*," says co-author Fernando Selman. "*We conclude from this that if stars more massive than 130 solar masses exist, they must live for less than 2.5 million years and end their lives without exploding as supernovae, as massive stars usually do*." The total mass of the cluster seems to be about 30,000 times that of the Sun, much more than was previously thought. "*That we can see so much more is due to the exquisite NACO images*," says co-author Jorge Melnick.

(The name "Arches" does not come from the constellation the cluster is located in (Sagittarius, i.e., the Archer), but because it is located next to arched filaments detected in radio maps of the centre of the Milky Way).

### NEW TECHNIQUE IMPROVES ESTIMATES OF PULSAR AGES

Isolated pulsars gradually slow their spins, but the opposite happens if the pulsar is joined by a companion star as part of a binary system. Gas accreted from the star can force the pulsar to pin faster, resulting in rotation periods of just a few milliseconds.

Astronomers have developed a new technique to determine the ages of millisecond pulsars, the fastest-spinning stars in the universe. The standard method for estimating pulsar ages is known to yield unreliable results, especially for the fast-spinning millisecond pulsars, said Bülent Kiziltan, a graduate student in astronomy and astrophysics. "*An accurate determination of pulsar ages is of fundamental importance, because it has ramifications for understanding the formation and evolution of pulsars, the physics of neutron stars, and other areas*," he said.

Kiziltan has been working with Stephen Thorsett, professor of astronomy and astrophysics, to study the evolution of millisecond pulsars. A pulsar is a rapidly rotating neutron star, the collapsed core that remains after a massive star explodes as a supernova. The pulsar emits beams of radio waves (as well as x-rays and gamma-rays) from the magnetic poles of the neutron star. Because the magnetic poles are not aligned with the star's spin axis, the beams sweep around like a lighthouse beacon, sending pulses of radio waves toward observers on Earth. The period between each pulse of radio waves corresponds to the rotation rate of the neutron star.

"*In most cases, the only information we have is the radio pulse we receive from these compact stars. From these pulses we are trying to determine the ages, masses, and orbital parameters--a very challenging task indeed*," Kiziltan said. Ordinary pulsars tend to rotate a few times per second, and they gradually slow down with age, eventually becoming too faint to detect. Millisecond pulsars, however, rotate hundreds of time per second. They achieve these extraordinary spin rates by pulling in material from a binary companion star, a process that transfers angular momentum from the companion to the pulsar. "*This spin-up process is essentially like giving CPR to a dead or dying pulsar, giving it a second lease on life*," Kiziltan said.

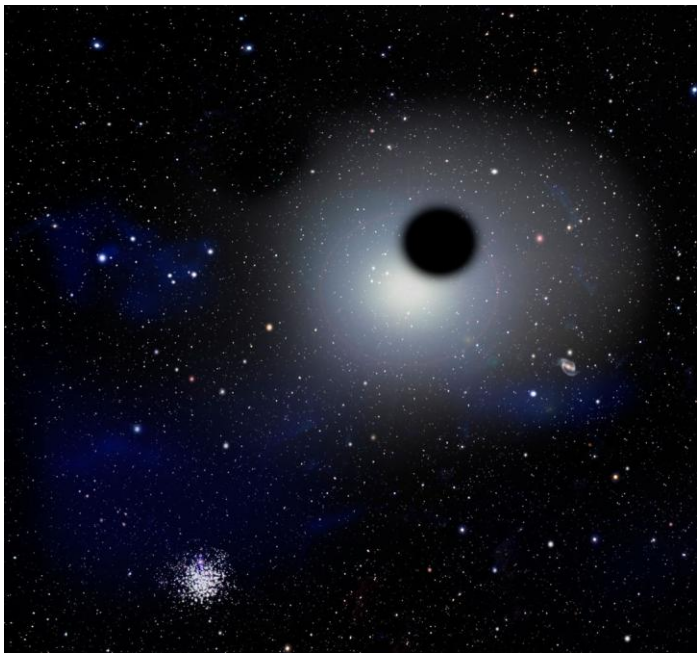
The standard approach to determine the "characteristic" or "spin-down" age of a pulsar is based on two parameters: the period between pulses and the rate at which they slow down. Kiziltan and Thorsett showed that this method may over- or under-estimate the age of a pulsar by a factor of 10 when applied to millisecond pulsars. To improve the accuracy of the standard technique, they incorporated additional constraints that arise from the spin-up process and physical limits on the maximum spin period. "*We modified the age calculations to be consistent with these constraints and showed that this approach can achieve estimates closer to the true age of the pulsar*," Kiziltan said. They show that, in some cases, millisecond pulsars that appear to be young can, in fact, be several billion years older. In other cases, young millisecond pulsars may mimic the characteristics of pulsars that are as old as the galaxy itself.

### ROGUE BLACK HOLES MAY ROAM THE MILKY WAY

It sounds like the plot of a sci-fi movie: rogue black holes roaming our galaxy, threatening to swallow anything that gets too close. In fact, new calculations by Ryan O'Leary and Avi Loeb suggest that hundreds of massive black holes, left over from the galaxy-building days of the early universe, may wander the Milky Way. Good news, however: Earth is safe. The closest rogue black hole should reside thousands of light-years away. Astronomers are eager to locate them, though, for the clues they will provide to the formation of the Milky Way. "*These black holes are relics of the Milky Way's past*," said Loeb. "*You could say that we are archaeologists studying those relics to learn about our galaxy's history and the formation history of black holes in the early universe*."

According to theory, rogue black holes originally lurked at the centers of tiny, low-mass galaxies. Over billions of years, those dwarf galaxies smashed together to form full-sized galaxies like the Milky Way. Each time two proto-galaxies with central black holes collided, their black holes merged to form a single, "relic" black hole. During the merger, directional emission of

gravitational radiation would cause the black hole to recoil. A typical kick would send the black hole speeding outward fast enough to escape its host dwarf galaxy, but not fast enough to leave the galactic neighborhood completely. As a result, such black holes would still be around today in the outer reaches of the Milky Way halo.



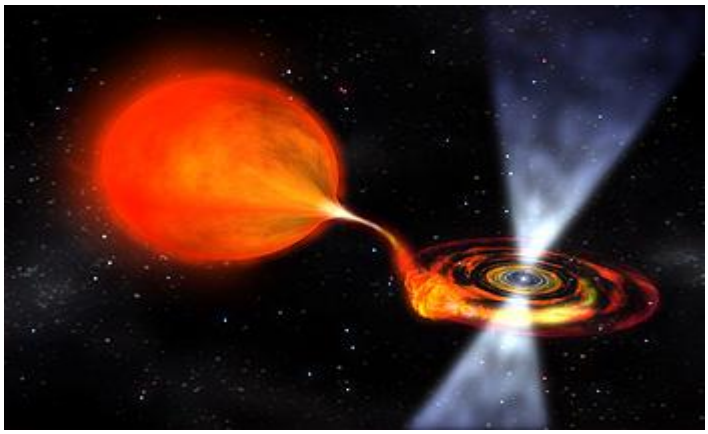
Hundreds of rogue black holes should be traveling the Milky Way's outskirts, each containing the mass of 1,000 to 100,000 suns. They would be difficult to spot on their own because a black hole is visible only when it is swallowing, or accreting, matter. One telltale sign could mark a rogue black hole: a surrounding cluster of stars yanked from the dwarf galaxy when the black hole escaped. Only the stars closest to the black hole would be tugged along, so the cluster would be very compact. Due to the cluster's small size on the sky, appearing to be a single star, astronomers would have to look for more subtle clues to its existence and origin. For example, its spectrum would show that multiple stars were present, together producing broad spectral lines. The stars in the cluster would be moving rapidly, their paths influenced by the gravity of the black hole. "*The surrounding star cluster acts much like a lighthouse that pinpoints a dangerous reef*," explained O'Leary. "*Without the shining stars to guide our way, the black holes would be all but impossible to find*."

The number of rogue black holes in our galaxy depends on how many of the proto-galactic building blocks contained black holes at their cores, and how those proto-galaxies merged to form the Milky Way. Finding and studying them will provide new clues about the history of our galaxy. Locating the star cluster signposts may turn out to be relatively straightforward. "*Until now, astronomers were not searching for such a population of highly compact star clusters in the Milky Way's halo*," said Loeb. "*Now that we know what to expect, we can examine existing sky surveys for this new class of objects*."

### PECULIAR, JUNIOR SUPERNOVA DISCOVERED BY NY TEEN

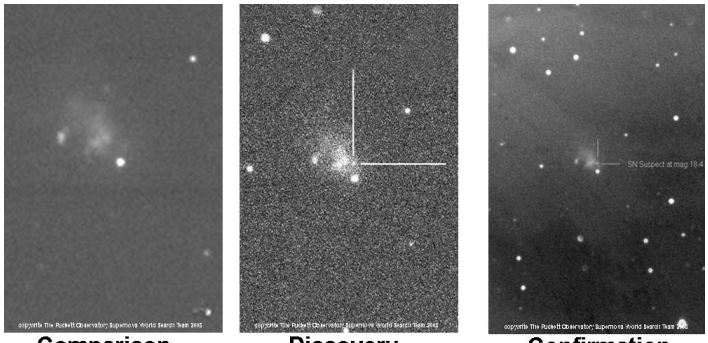
In November 2008, Caroline Moore, a 14-year-old student from upstate New York, discovered a supernova in a nearby galaxy, making her the youngest person ever to do so. Additional observations determined that the object, called SN 2008ha, is a new type of stellar explosion, 1000 times more powerful than a nova but 1000 times less powerful than a supernova. Astronomers say that it may be the weakest supernova ever seen. Even though this explosion was a weakling compared to most supernovae, for a short time SN 2008ha was 25 million times brighter than the sun.

However, since it is 70 million light years away, it appeared very faint viewed from Earth. The peculiar object effectively bridged the gap between a nova (a nuclear explosion on the surface of an old, compact star called a white dwarf) and a type Ia supernova (the destructive death of a white dwarf caused by a runaway nuclear reaction starting deep in the star).



SN 2008ha likely was a failed supernova where the explosion was unable to destroy the entire star. "*If a normal supernova is a nuclear bomb, then SN 2008ha is a bunker buster*," said team leader Ryan Foley, first author on the paper reporting the findings. "*From one perspective, this supernova was an underachiever, however you still wouldn't want be anywhere near the star when it exploded*."

Caroline was able to discover the object using a relatively small telescope, but some of the most advanced telescopes in the world were needed to determine the nature of the explosion. Data came from the Magellan telescopes in Chile, the MMT telescope in Arizona, the Gemini and Keck telescopes in Hawaii, and Swift satellite.




Suppernova discovery in UGC-12682 ( A2332-17 )
By Caroline K. Moore ( age 14 years old )

In typical supernova explosions, light from different chemical elements (such as calcium or iron) is smeared out across the electromagnetic spectrum by the Doppler effect (the same principle that makes a police siren change pitch as it passes). Because the ejected bits of the star were "only" moving at 4.5

million miles per hour (compared to 22 million miles per hour for a typical supernova), the light wasn't as smeared out, allowing the team to analyze the composition of the explosion to a new precision. "*You can imagine many ways for a star to explode that might resemble SN 2008ha*," said Robert Kirshner. "*It could have been a massive star suddenly collapsing to form a black hole, with very little energy leaking out. But it looks a lot like its brighter cousins, which we think are nuclear explosion of white dwarfs. Maybe this one was an explosion of that general type, just much, much weaker*."

One reason astronomers haven't seen this type of explosion before might be because they are so faint. "*SN 2008ha was a really wimpy explosion*," said Alex Filippenko, leader of the UC Berkeley supernova group, which monitors thousands of relatively nearby galaxies with a robotic telescope at Lick Observatory. But a new generation of telescopes and instruments is beginning to search greater distances than ever before, effectively monitoring millions of galaxies.

Foley's team concludes that hundreds of this type of event may be spotted in the next few years. "*Coincidentally, the youngest person to ever discover a supernova found one of the most peculiar and interesting supernovae ever*," remarked Filippenko. "*This shows that no matter what your age, anyone can make a significant contribution to our understanding of the Universe*."

**RED-GIANT STAR BETELGEUSE IS MYSTERIOUSLY SHRINKING**

The bright red supergiant star Betelgeuse, the bright reddish star in the constellation Orion, has steadily shrunk over the past 15 years, according to researchers. Long-term monitoring by the Infrared Spatial Interferometer (ISI) on the top of Mt. Wilson in Southern California shows that Betelgeuse (bet' el juz), which is so big that in our solar system it would reach to the orbit of Jupiter, has shrunk in diameter by more than 15 percent since 1993.

Since Betelgeuse's radius is about five astronomical units, or five times the radius of Earth's orbit, that means the star's radius has shrunk by a distance equal to the orbit of Venus.

"*To see this change is very striking*," said Charles Townes, a professor emeritus of physics who won the 1964 Nobel Prize in Physics for inventing the laser and the maser, a microwave laser. "*We will be watching it carefully over the next few years to see if it will keep contracting or will go back up in size*." Townes and his colleague, Edward Wishnow, a research physicist, recently presented their findings. Despite Betelgeuse's diminished size, Wishnow pointed out that its visible brightness, or magnitude, which is monitored regularly by members of the American Association of Variable Star Observers (AAVSO), has shown no significant dimming over the past 15 years.

The ISI has been focusing on Betelgeuse for more than 15 years in an attempt to learn more about these giant massive stars and to discern features on the star's surface, Wishnow said. He speculated that the measurements may be affected by giant convection cells on the star's surface that are like convection granules on the sun, but so large that they bulge out of the surface. Townes and former graduate student Ken Tatebe observed a bright spot on the surface of Betelgeuse in recent years, although at the moment, the star appears spherically symmetrical.

"*But we do not know why the star is shrinking*," Wishnow said. "*Considering all that we know about galaxies and the distant universe, there are still lots of things we don't know about stars, including what happens as red giants near the ends of their lives*."

*Physicist Charles Townes, who won the 1964 Nobel Prize in Physics for invention of the laser, cleans one of the large mirrors of the Infrared Spatial Interferometer.*

Betelgeuse was the first star ever to have its size measured, and even today is one of only a handful of stars that appears through the Hubble Space Telescope as a disk rather than a point of light. In1921, Francis G. Pease and Albert Michelson used optical interferometry to estimate its diameter was equivalent to the orbit of Mars. Last year, new measurements of the distance to Betelgeuse raised it from 430 light years to 640, which increased the star's diameter from about 3.7 to about 5.5 AU. "*Since the 1921 measurement, its size has been re-measured by many different interferometer systems over a range of wavelengths where the diameter measured varies by about 30 percent*," Wishnow said. "*At a given wavelength, however, the star has not varied in size much beyond the measurement uncertainties." The measurements cannot be compared anyway, because the star's size depends on the wavelength of light used to measure it"*, Townes said. This is because the tenuous gas in the outer regions of the star emits light as well as absorbs it, which makes it difficult to determine the edge of the star.

The ISI that Townes and his colleagues first built in the early 1990s sidesteps these confounding emission and absorption lines by observing in the mid-infrared with a narrow bandwidth that can be tuned between spectral lines. The ISI consists of three 5.4-foot (1.65-meter) diameter mirrors separated by distances that vary from 12 to 230 feet (4-70 meters), said Townes. Using a laser as a common frequency standard, the ISI interferometer combines signals from telescope pairs in order to determine path length differences between light that originates at the star's center and light that originates at the star's edge.

"*We observe around 11 microns, the mid-infrared, where this long wavelength penetrates the dust and the narrow bandwidth avoids any spectral lines, and so we see the star relatively undistorted*," said Townes. "*We have also had the good fortune to have an*

*instrument that has operated in a very similar manner for some 15 years, providing a long and consistent series of measurements that no one else has. The first measurements showed a size quite close to Michelson's result, but over 15 years, it has decreased in size about 15 percent, changing smoothly, but faster as the years progressed*."

Townes, who turns 94 in July, plans to continue monitoring Betelgeuse in hopes of finding a pattern in the changing diameter, and to improve the ISI's capabilities by adding a spectrometer to the interferometer. "*Whenever you look at things with more precision, you are going to find some surprises and uncover very fundamental and important new things*," he said.

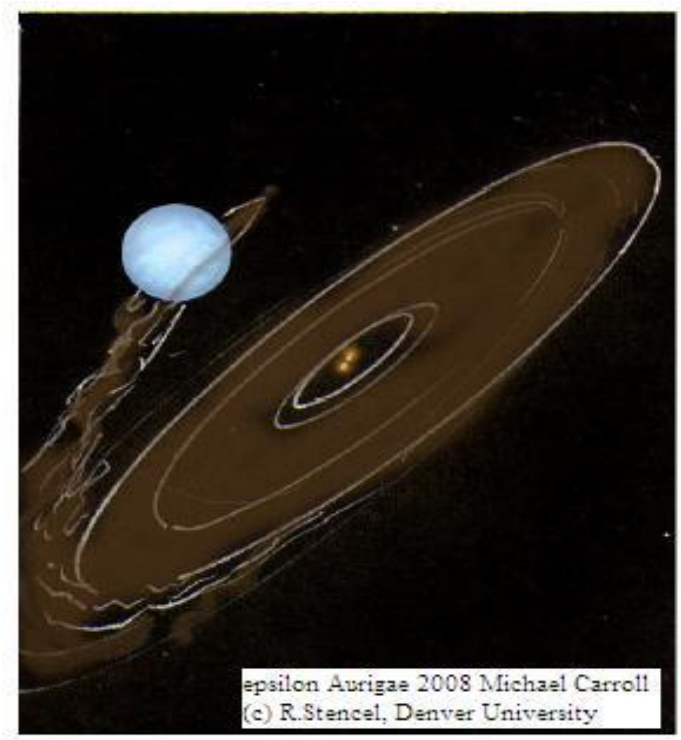
**PREDICTED NEARBY STELLAR FIREWORKS BY MID-CENTURY**

Astronomers are announcing the prediction that the bright northern star called Epsilon Aurigae is headed for a "doomsday event" within a few decades. The prediction is from Dr. Robert Stencel, based on observed changes in the stars behavior. Observations over the coming three years, when the mysterious star undergoes a once-per-generation eclipse event, may hold the secret to the extreme changes detected during the past few decades.

There is a theory, called the Vogt-Russell theorem, that says the mass, composition and age uniquely determine the stellar structure, when normal laws of physics are applied. This theorem appears largely true, except for epsilon Aurigae - a real "demon star". Its behavior has "bedeviled" astronomers for centuries. The spectrum of epsilon Aurigae looks like a normal F supergiant star, estimated at about 12 to 15 times the mass of the Sun. The orbit data implies that the mass ratio in the binary is close to one, implying that the companion is about 12 to 14 solar masses as well. Epsilon Aurigae exhibits Algol-like eclipses every 27 years, which last for nearly 2 years. The next one starts in August 2009, and should run through May 2011.

The problem? The 12-14 solar-mass second "star" is largely invisible! The best model for this system, (Huang, 1965) says the secondary is a huge dark disk, not a sphere. Such a shape needs a massive central object(s) to stabilize it.

Normal eclipsing binary star analysis suggests that the secondary is about 10 A.U. across (10 times the distance from the Earth to the Sun, or 930 million miles). It does not emit anywhere near the amount of light expected from a star of its size. Scientists are confident that it is not a black hole, because it hasn't been detected with X-ray observations (Einstein, Swift). Epsilon Aurigae shows low amplitude quasi-periodic light variations, similar to Cepheid variable stars. Cepheid variable stars are close relatives of epsilon Aurigae, being high mass yellow stars prone to pulsation - a useful property in terms of their Period-Luminosity relationship. Currently the light variations in epsilon Aurigae are on a 67 day cycle, but these were nearer to 100 days during the last two decades. Something is accelerating in this system! At this rate, variations will become very rapid within six decades, perhaps cataclysmically so. Much of photometric data showing this has been obtained by Jeff Hopkins, Il-Seong Nha observers. http://www.hposoft.com/EAur09/EAur0307Plots.html




But wait—there's more. Observations made during the last eclipse suggest that the F supergiant star may be shrinking by about 1/2 percent per year, noted in a 1986 study by Saito and Kitamura. The duration of total eclipse (during which the F star is partially covered by the disk shaped companion) has increased by about 25 percent between the 1956 and 1983 eclipses. Despite this, the overall length of the total plus partial phases of eclipse - especially the time where the F star moves out from the cover of its partner - has gotten shorter! If these trends continue, the F star will come out of eclipse (from totality) in only 1 or 2 weeks during 2011. BUT, it will still take 140 days or so to move from the beginning of the eclipse to totality next year, autumn.

What is changing, and what do the variations mean? Is this binary system preparing for an energetic event? Is the light variation due to changes in the F supergiant star's radius or temperature? Using a well-known correlation among stellar luminosity, radius and temperature, a ten percent change in Luminosity can result from a 5 percent change in Radius, or a 2.5 percent change in Temperature. At an estimated distance of 625 pc, and assuming the F supergiant star is close to the nominal 100 solar diameters appropriate for its type, then the implied angular diameter is 3 milli-arcseconds. Modern interferometers, like the Palomar Testbed Interferometer, are capable of measuring down to fractions of one milli-arcsecond, close to that 5 percent change anticipated, and these measurements are underway. These measurements would help confirm that the F star could be causing the accelerating light changes.

(What's a milli-arcsecond? Astronomers use angular measures much finer than degrees on a protractor. The arc-second is 1/3600 part of one degree, and a milli-arcsecond is 1,000 times

finer. A 25 cent US coin seen at a distance of 6,500 miles (10,000 km) subtends about one milli-arcsecond.)

The best model for the eclipsing object makes a clear, testable prediction that is suitable for interferometry: the F supergiant star should be bifurcated (cut in half) by the eclipse-causing disk, if indeed it is a disk. Next generation imaging interferometers like CHARA at Mt. Wilson and MROI at Socorro, should be easily able to monitor this set of changes. If the disk is causing the changes in the system, that should be seen with these measurements.

**Possible public observing participation!**

The epsilon Aurigae eclipse event is being promoted as one facet of the International Year of Astronomy, IYA2009: http://astronomy2009.us/citizen_science/epsilon-aurigae/. It is a bright star that can be seen despite light pollution, monitored both visually and with the simplest of digital camera equipment. One goal is to better define the eclipse duration and catch the mysterious central eclipse brightening. The observing activity is intended to promote citizen science in honor of the 400th anniversary of the telescope and Galileo's applications of it.

In summary, the bright northern star, epsilon Aurigae, is exhibiting rapid changes suggestive of dramatic events within one or two eclipse cycles, later this century. "*These changes offer a chance to examine the dynamics of rapidly changing stellar disks on a human timescale, and an opportunity for the public to see for themselves that stars change*."

**Calendar of Predicted Eclipse Events:**

2009 Aug 6th - start of eclipse (partial phase)
2009 Dec 21st - start of totality
2010 Aug 1st - mid-eclipse
2011 March 12th - end of totality
2011 May 15th - end of eclipse
2036 autumn - next eclipse starts

http://www.du.edu/~rstencel/epsaur.htm
http://www.du.edu/~rstencel/epsaurnews.htm

## NEARBY BLACK HOLES LARGER THAN PREVIOUSLY BELIEVED

A re-examination of the vast black hole at the core of the nearby M87 galaxy indicates it could have 6.4 billion times the mass of the Sun, two to three times larger than previous studies had suggested. The reassessment has led scientists to speculate that many other black holes are also under-recorded, said Dr. Karl Gebhardt. Most galaxies are believed to have enormous central black holes, with a very close correlation between the galaxy's size and the core that devours all the matter that comes too close to it. However, if a hole gets too large, too quick, it begins to push back, emitting high-velocity streams of matter out into space.

"*There are processes that happen around the black hole that affect how much material you can dump on it*," said Dr. Gebhardt. "*Eventually, it gets so massive that the jets that are common in these galaxies blow out and they can actually halt the material that falls in*." If the black holes truly are larger than astronomers previously believed, the assumptions that describe the hole's relationship to their galaxies might need to be re-evaluated, he added.

Astronomers weigh supermassive holes by examining the size of their host galaxies and the velocity with which stars move around within those galaxies. The new study used innovative computer modeling methods to differentiate the relative contributions to the total mass of M87 from its black hole, its visible stars and its "dark halo" -- a spherical area that surrounds the galaxy and extends beyond its visible structure. The "dark halo" contains "dark matter", a material not yet identified that telescopes cannot directly detect. Nevertheless, astronomers know it is there from its gravitational interaction with all the other matter that can be seen. "*In order to get the small-scale analysis correct, you have to include what the stars are doing at the outer envelope of the galaxy, i.e., you have to understand the effect of the dark halo because that is where the dark halo lives - at the edge of the galaxy*."

Dr. Gebhardt and colleague Dr. Jens Thomas are the first team to include the dark halo into the mass calculations. The work was so complex that a supercomputer was required. "*This model took a few days to run whereas in the past it would have taken 10 years*," Dr. Gebhardt told BBC News. The research indicates that the masses of black holes for the largest galaxies may have been underestimated. The reassessment was supported by data from the latest observations of the world's most sophisticated telescopes, Dr. Gebhardt said. The realization that nearby super-massive black holes are larger than previously thought may also help solve a paradox that has long puzzled astronomers about the masses of giant black holes in the distant Universe.

The black holes that power quasars - small but very luminous galaxies seen in the early history of the Universe - are substantially larger than anything seen in the local Universe. "*By increasing masses [of local black holes] by two to three, it almost makes that problem go away*," Dr. Gebhardt said. "That is, we're beginning to resolve the differences between the masses of the black holes in quasars and the masses of black holes from nearby galaxies. That's quite exciting when things start to come together."

## 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 at least two weeks prior to the next upcoming scheduled EAS meeting.

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**
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## In June's StarGazer:

**** ASTRO CALENDAR - UPCOMING ASTRONOMY EVENTS
**** OBSERVER'S INFORMATION - SUN, MOON, AND PLANET VISIBILITY
**** UP IN THE SKY -- THE PLANETS (AND PLUTO)
**** WESTERN US STAR PARTIES THIS SEASON
**** CONSTELLATION OF THE MONTH – CORONA AUSTRALIS
**** "MIRROR IMAGES" – 'MIRA' STARS
**** YOUNG ASTRONOMER'S CORNER
**** ASTRONOMY AND TELESCOPE "LINGO"
**** ASTRONOMY "FUN FACTS"
**** GREATER LONGEVITY PREDICTED FOR PLANETS WITH LIFE
**** NEARBY BLACK HOLES LARGER THAN PREVIOUSLY BELIEVED
**** PREDICTED NEARBY STELLAR FIREWORKS BY MID-CENTURY FROM EPSILON AURIGAE
**** AN EXPLODING STAR IN AN 'EXPLODING' GALAXY M82
**** ROGUE BLACK HOLES MAY ROAM THE MILKY WAY
**** NEW TECHNIQUE IMPROVES ESTIMATES OF PULSAR AGES
**** PECULIAR, JUNIOR SUPERNOVA DISCOVERED BY NY TEEN
**** *AND MANY MORE NEWS ITEMS FROM THE JUNE 2009 AAS MEETINGS…*

**The next EAS Meeting is 6:00 PM Saturday June 13th at the 'Aurora Astro Products' store location at Silver Lake.**