Sky WAA tch

◀ An Ancient Streambed

Fresh evidence of an ancient stream has been found on Mars. The robotic rover Curiosity has run across unusual surface features that carry a strong resemblance to stream banks on Earth. Visible in the above image, for example, is a small overhanging rock ledge that was quite possibly created by water erosion beneath. Circled at the upper right is a larger rock possibly also made smooth by stream erosion.

Image Credit: NASA, JPL-Caltech, MSSS

The Waxing Moon ▶

David Parmet captured this lunar image with his 8’ SCT using a Nikon D80 camera.

Visible top-left near the terminator is the crater Plato. Notable (left to right) are the Seas of Serenity, Tranquility, and Fertility. The Mare Crisium is above the Sea of Fertility.

Events for November 2012

WAA Lectures

"Planets, Stars, Black Holes and the Quest for Our Cosmic Origins"
Friday November 2nd, 7:30pm
Miller Lecture Hall, Pace University
Pleasantville, NY

Our speaker will be Dr. Caleb Scharf, who will will elaborate on the subject of his latest book, *Gravity's Engines*. Dr. Scharf is the director of the Columbia Astrobiology Center. He writes the *Life, Unbounded* blog for *Scientific American*; has written for *New Scientist*, *Science*, and *Nature*, among other publications; and has served as a consultant for the Discovery Channel, the Science Channel, The New York Times, and more. Dr. Scharf has served as a keynote speaker for the American Museum of Natural History and the Rubin Museum of Art, and is the author of *Extrasolar Planets and Astrobiology*, winner of the 2011 Chambliss Astronomical Writing Award from the American Astronomical Society. Free and open to the public. Directions and Map.

More Upcoming Lectures

Miller Lecture Hall, Pace University
Pleasantville, NY

On December 7th, Jeffrey Jacobs will be showing his film " A Sidewalk Astronomer," followed by a Q&A session. Lectures are free and open to the public.

Annual Meeting

Friday December 7th, 7:30pm
Miller Lecture Hall, Pace University
Pleasantville, NY

The Annual Meeting of the Westchester Amateur Astronomers, Inc. will take place on Friday, December 7, 2012 at 7:30 pm at Miller Hall, Pace University, Pleasantville, NY, preceding the regular monthly lecture presentation. All members are invited.

Agenda:

- Call to order
- President's report to the membership
- Election of new officers
- Vote on proposed Bylaws amendments
- New business
- Adjournment

Instructions and a ballot are being sent to members via regular mail and the Bylaws changes will be posted on the web site.

Starway to Heaven

Saturday November 10th, Dusk
Meadow Picnic Area, Ward Pound Ridge Reservation, Cross River

This is our scheduled Starway to Heaven observing date for November, weather permitting. Free and open to the public. The scheduled rain/cloud date is November 17th. Participants and guests should read and abide by our General Observing Guidelines and Disclaimer. Directions.

New Members. . .

Paul Mayo - New Rochelle
Woody Umanof - Mount Kisco

Renewing Members. . .

James Frost - Rye Brook
Robie Burke - Brewster
Kevin Shaw - Yonkers
Olivier Prache - Pleasantville
Al Forman - Croton-on-Hudson
MaryPat Hughes - Briarcliff
Josh & Mary Ann Knight - Mohegan Lake
Michael Clark - Pound Ridge
Claudia & Kevin Parrington Family - Harrison
Sharon and Steve Gould - White Plains
Peter Knipp - Bedford

WAA APPAREL

Charlie Gibson will be bringing WAA apparel for sale to WAA meetings. Items include:

•**Caps, $10** (navy and khaki)

•**Short Sleeve Polos, $12** (navy).

Call: 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to periodically visit the WAA website.

Articles and Photos

The Lodestar
by Larry Faltz

One pleasant evening in late August, Elyse and I decided to have a look at the first quarter moon. I used my Stellarvue 105mm APO triplet and a Denkmeier binoviewer, mounted on the iOptron Minitower computerized alt-az mount. The f/7 scope (735 mm focal length) was an impulsive purchase at NEAF in 2011. It's a beauty. It's got perfect color-free optics in an elegant carbon-fiber tube, with a 3" Feathertouch focuser. It was primarily designed for imaging, but it's superb for lunar and planetary viewing. It's the only scope I have that entices me to observe double stars, showing them as colorful pinpoints inside tiny, perfect Airy disks. The lunar image is simply spectacular, the iridescent scalloped inner walls of Copernicus and Bullialdus being particular treats. Elyse used an 80mm f/5 iOptron "short tube" achromat that came with the lightweight Cube computerized mount. We picked up the mount and scope at NEAF 2012. We wanted a lightweight tracking mount to use with our Coronado 40mm H-alpha solar scope during the Transit of Venus in Hawaii. Although the inexpensive refractor has the expected fringing due to chromatic aberration, it gave quite decent lunar views at low power. We were joined by WAA member Sharon Gould, who came over from White Plains with her 90mm Celestron Maksutov on a non-mechanized alt-az mount. This is a compact and easily handled scope for lunar and planetary viewing, giving excellent images at all powers.

Stellarvue SVR-105. I didn't really need it, but I was smitten when I saw it.

We set up in the brightly-lit front parking lot of the Quaker Ridge School, right off Weaver Street near the Hutchinson River Parkway. I sometimes use this site for lunar and planetary viewing since the lights make set-up easy but don't significantly degrade viewing of bright, compact solar system objects. It's only 5 minutes from my house and provides good exposure to the entire ecliptic in every season. Few deep sky objects are viewable, although I did glimpse the Ring Nebula with the 4". As we were working our way around the naked-eye sky, sighting Saturn, Arcturus, the Summer Triangle, the Big Dipper and Polaris, Sharon recalled that Polaris was a double star, and so I turned the 4" to the pole (or rather, pushed a few buttons and let the Minitower do the work).

Indeed, 8th magnitude Polaris B was easily visible separated by only 18" from the much brighter Polaris A. Although I had used Polaris countless times as one of the alignment stars for my CPC800, I had never paid any attention to its nature as a double star. When I got home, I started reading about it, first in Burnham and then on line.

On any clear night, I try to find Polaris. Knowing how to find north is the primal demonstration of sky knowledge. It's probably the first thing we learn about the stars, and of course it's pretty darned useful even if you're not an astronomer.

We're lucky to have a reasonably bright (magnitude 1.97) star less than 1º from the pole. In the southern hemisphere, there are no stars brighter than 2nd magnitude within 20º of the pole. Mag 5.43 Sigma Octantis is within 1º (and is shown on some polar-finder reticles to aid mount alignment in the southern hemisphere), but this faint star is hardly useful for reliable naked-eye identification of the pole.

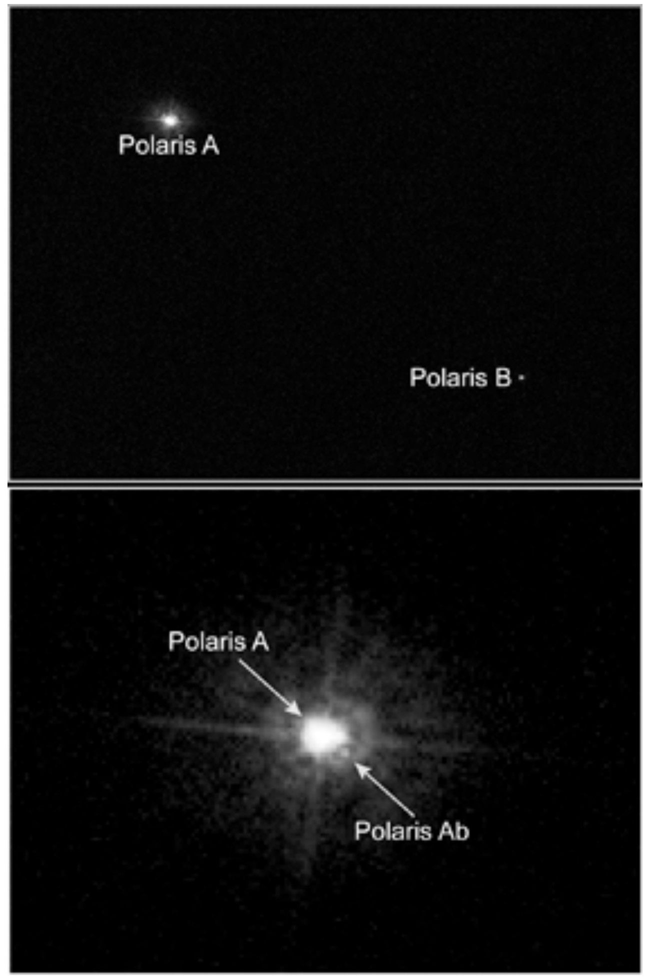
Polaris, the North Star, has a number of names—*Cynosura* (Latin), *Scip-Steorra* (Anglo-Saxon), *Phoenice* (Greek) and *Al Kaukab al Shamaliyy* (Arabic) among others—named by the many cultures that have used it as a guide star since ancient times. That's why it's often called the *Lodestar*, although this word, derived from Middle English, really refers to any guiding star. But the one fixed reference point in the northern heavens, the one sure guide regardless of time or season, is Polaris.

Burnham's indispensable *Celestial Handbook* has a marvelous recounting of Polaris' cultural impact on literature and religion. It is an important symbol in Hindu and Buddhist lore, even having a powerful influence on the architecture and decoration of giant temples that celebrate the large pantheon of their deities, including Angkor Wat, the largest Hindu temple in the world. Burnham provides literary examples from Marlowe, Bryant, Dante, Wordsworth, Keats, Shakespeare and Aeschylus. One reference that Burnham leaves out is John Masefield's poem *Sea Fever*, a staple of high school English classes everywhere, with its opening lines that surely refer to Polaris:

> I must go down to the seas again, to the lonely sea and the sky
> And all I ask is a tall ship and a star to steer her by.

Typical telescopic view of Polaris A and B

Polaris, α Ursa Minoris (αUMi for short), is actually a complex multiple star system. The easily seen components are the naked-eye 1.97-magnitude αUMi A and telescopic 8.2 magnitude αUMi B. A third close member, αUMi Ab was originally found as a spectroscopic binary of A and then later as an astrometric binary (identified by small periodic displacements of αUMi A in Hipparcos data) but it was not imaged until the Hubble Space Telescope captured it in 2006 just 0.2" from αUMi A (about 2 billion miles at the star's distance of 430 light years). It had been lost in A's glare in ground-based scopes until that time. More distant are faint αUMi C and D, which were discovered in the late 19th century. 13.1 magnitude αUMi C is 44.7" from A, while 12.1 magnitude D is 82.8" distant. There's a small chance that these are really background stars.



Hubble image of the main Polaris system

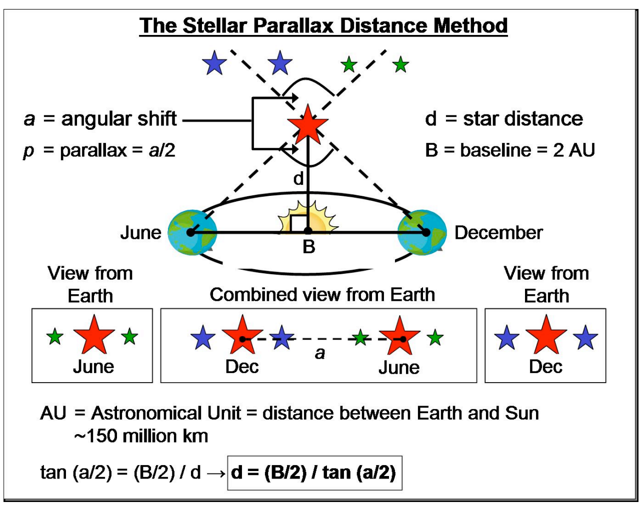
Polaris is remarkable not just for its position and for being a multiple star, but also because it's a variable star, the brightest member in the sky of the important group of variables called Cepheids.

Variable stars have regular or irregular changes in their brightness. They can be divided into two major groups: intrinsic, with brightness variation due to changes in the star's physical properties, and extrinsic, with variation due to external properties such as rotation or eclipse. Among the intrinsic variables, the subgroup of pulsating variables consists of stars whose radii periodically change as energy fluxes interact with the star's physical layers. The most important of these are RR Lyrae stars and

Classical Cepheids. The rate and magnitude of the pulsations are very regular. Periodic variability in Eta Aquilae, subsequently determined to be a Cepheid, was found in 1784 by Edward Pigott, but the appellation *Cepheid* was given for Delta Cephei, discovered shortly thereafter by John Goodricke. Goodricke also found the variability of Algol (an eclipsing binary) and was elected to the Royal Society, but died of pneumonia at the age of 21.

The study of stars was a primary concern of astronomy in the 1800s, helped by technical advancements such as optically excellent long focal-length refractors, finely machined, massive, stable mounts, and eventually tools for spectroscopy, photography and photometry. These allowed astral brightness and spectra to be accurately measured. Coupled with distance measurements using stellar parallax for closer stars, these techniques led to the understanding of the relationship between temperature and luminosity, eventually codified in the Hertzsprung-Russell diagram.

Parallax measurements (observing the position of closer stars against the background of distant ones from different points in the Earth's orbit) are limited to relatively close stars. Even with high quality 19th-century instruments, parallax measurements of only about 60 stars were known by 1900.



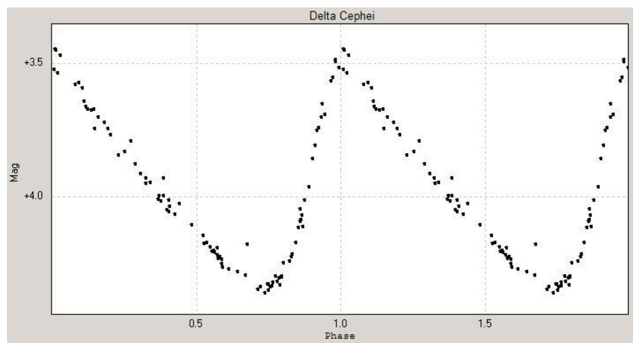
Measuring stellar parallax (York U, Canada)

Since we know a star's relative magnitude, once its distance is measured by parallax we can calculate its absolute magnitude, the star's intrinsic brightness, which is officially defined as being equal to the apparent magnitude if the star were 32.6 light years (10 parsecs) from earth. Once we know this relationship, we can calculate the distance of any star simply by knowing the magnitudes. The formula is

$$m_v - M_v = -5+5\log_{10}(d)$$

where m_v is the apparent magnitude, M_v is the absolute magnitude, and d is the distance in parsecs.

The problem is that we don't know the absolute magnitude for objects beyond our immediate neighborhood because the difference in angles is too small to measure. We had to wait for the European Space Agency's 1988-1993 Hipparcos Space Astrometry Mission, which improved astrometric resolution by virtue of being far above the earth's atmosphere in geosynchronous orbit. It was able to catalogue over 118,218 stars with parallax measurements down to 1 milliarc-second in addition to making a vast number of other observations. Hipparcos could make accurate parallax measurements out to about 1,600 LY. What was available before Hipparchos? Enter the Cepheids.



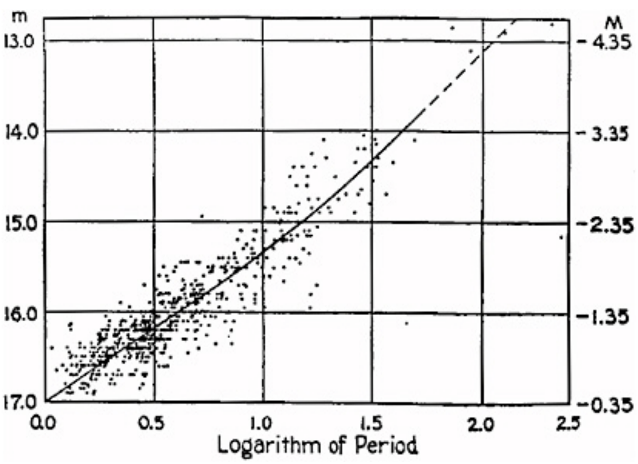
The light curve of Delta Cephei.

Cepheids are population I yellow supergiant stars, generally class F, larger (4-20 solar masses), younger and up to 10^5 times more luminous than the Sun (which is a G star: use the mnemonic "Oh Be A Fine Girl, Kiss Me" for the stellar classes from hottest to coolest). Their light curves show a rapid rise of a magnitude or two and then a slower fall, with a period of days to weeks (Delta Cephei's period is 5.366341 days). Another group of intrinsic variables are RR Lyrae stars, which differ by being older, metal-poor Population II stars, smaller and less luminous than the Sun. They have a shorter period than Cepheids (usually 0.2-2 days). They are commonly found in globular clusters and are used to determine their distance. NASA has posted a remarkable video animation of RR Lyrae stars in M3, which gives you an idea of their variability. A third type of intrinsic variable is the Type II Cepheid (W Virginis stars), which resemble RR Lyrae stars in being old, metal-poor population II stars but with even lower masses.

They have periods of 1-50 days and are divided into additional subgroups based on the timing of their brightness peaks.

For completeness' sake, I should mention that absolute magnitude is the measure of a star's output in visual wavelengths, while the term *luminosity* is the star's total radiative power output at all wavelengths. For most stable stars these are well correlated and the terms are sometimes used interchangeably.

The remarkable Harvard astronomer Henrietta Swan Leavitt determined the relationship between the brightness and periodicity of Cepheids by observing stars in the Magellanic Clouds. She painstakingly made brightness measurements of 1,777 stars from hundreds of photographic plates, and found 47 to be Cepheids. Since these stars were all at the same approximate distance, any difference in average apparent magnitude had to be correlated with average absolute magnitude. Leavitt found that brighter Cepheids had longer intervals between peaks. Her actual data plot looks like this:



The absolute magnitude is related to the period by the formula

$$M_v = -2.8 \log P - 1.43$$

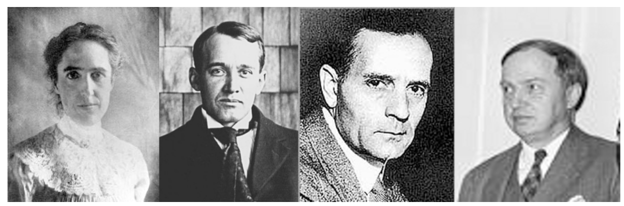
The constants are based on Hipparcos data.

So for any Cepheid, if we know the relative magnitude (by photometry) and the absolute magnitude (by periodicity), we can solve for distance by re-arranging the first equation:

$$d = 10^{\frac{m_v - M_v + 5}{5}}.$$

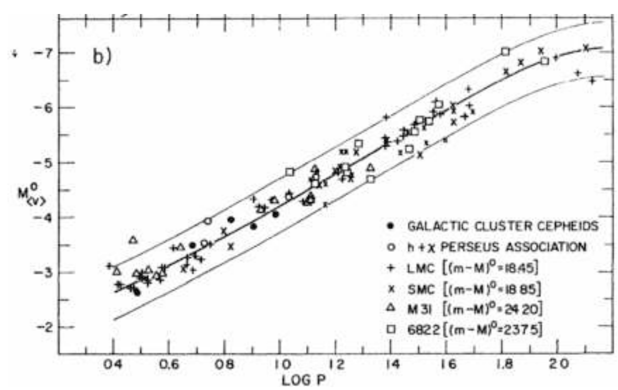
Of course, to be really accurate, corrections have to be made for intervening dust and the intensity of star's spectrum at different wavelengths.

Leavitt published her work in 1912. It was just the right time. Harlow Shapley suggested the mechanism for Cepheid variation in 1914 and was the first astronomer to make an absolute distance calculation with Cepheids, estimating the size and shape of the Milky Way in 1915. In 1924 Edwin Hubble, using the new 100-inch Hooker telescope on Mt. Wilson east of Los Angeles, observed Cepheids in the Andromeda Galaxy, proving it was a distinct galaxy far away from the Milky Way. Five years later he combined Cepheid distances in a number of nearby galaxies with Vesto Slipher's earlier red shift determinations to discover the expansion of the universe.



L to R: Leavitt, Slipher, Hubble, Shapley

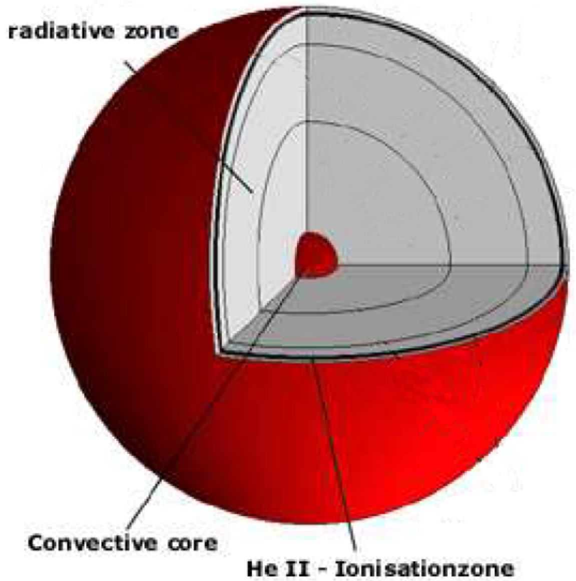
It helps that Cepheids are large and luminous stars, so they can be detected at distances far beyond the limit for parallax measurements. That the period/luminosity relationship holds at galactic distances can be seen from data published by Alan Sandage's group.



Period-luminosity relationship external to the Milky Way, from Sandage and Tammann (1968)

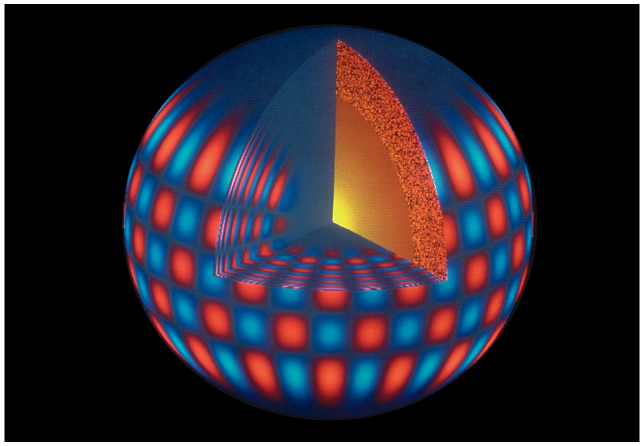
The most distant Cepheids found to date (by Hubble) are 36 examples in NGC 4603, a 12.3 magnitude spiral galaxy in Centaurus, distance ~110 million LY.

Cepheid and RR Lyrae variables are stars that have moved "off" of the main sequence in the Hertzsprung-Russell diagram as they have consumed their fuel. All stars have a central core, which is made up of hydrogen and helium in approximately a 3:1 ratio at stellar birth (reflecting the general chemical composition of the universe, and especially true of older population II stars). Fusion takes place in the central core; the outer layers are heated by convection and radiation, but fusion does not take place in those layers because it simply isn't hot enough. Even within the outer layers, there is a segregation of chemical species. As the temperature cools in an outward radial direction, there will be a zone above which hydrogen is neutral but below which it is ionized, called the partial ionization layer, with a mixture of ions and atoms. There is a deeper zone where helium undergoes the same process, and an even deeper zone where it gets doubly ionized. There are similar ionization zones for all of the elements in the sun, but they are less important since hydrogen and helium make up nearly all of the star's mass.



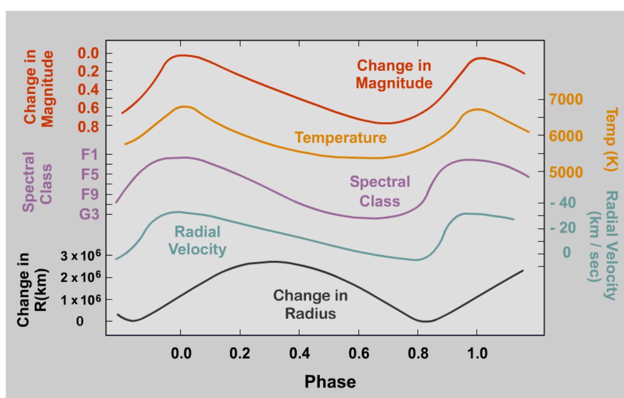
Zones within a Cepheid (from David Kilkenny, National Astrophysics and Space Science Programme, S. Africa)

The primary mechanism for variation in a Cepheid seems to reside in the partially ionized helium layer at about 40,000º K. Radiation flux causes some He^{+} in the atmosphere of the star to be ionized to He^{+2}, making the atmosphere more opaque to the radiation. This decreased transparency heats the gas inside the layer, which increases its pressure, which in turn expands the star's envelope, increasing its size and luminosity as well. As the star expands, it cools and He^{+2} gains an electron, converting back to He^{+}. Transparency to radiation increases, allowing more photons to escape, and the cooling atmosphere loses pressure and shrinks until it reaches a critical point where the radiation flux again begins to dominate the process. Larger Cepheids are more luminous with larger envelopes (outer layers of gas) of lower density. The variability period is proportional to the inverse square root of the density in the layer and is therefore longer.



Computer model of vibration modes in the outer solar layers (GONG, NSO, NOAO)

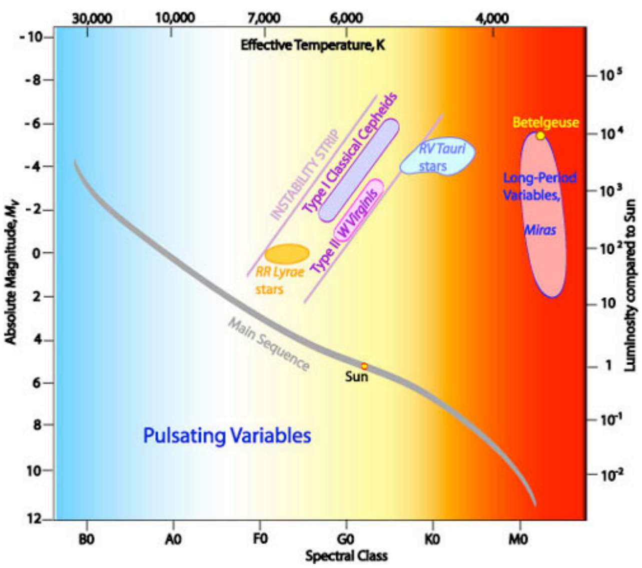
Why isn't every star a Cepheid? The answer is that all stars have a variety of oscillation modes: they essentially ring like a bell. This is the subject of helioseismology. The GONG Project (Global Oscillation Network Group) focuses on solar vibrations through observation and computer modeling. The sun, a typical star, has literally millions of vibration modes. These modes dampen each other out enough that there is no net expansion/contraction cycle to cause changes in radius. In Cepheids, there is not enough damping to prevent net changes in radial energy flux.



Change of a Cepheid Variable with Time

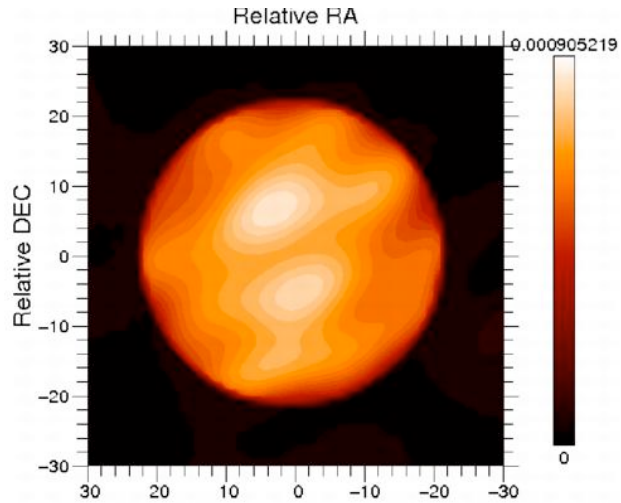
When spectroscopic data is included in the analysis, a number of parameters regarding stellar size, temperature, surface velocity and even spectral class can be correlated. There's a nice animation of how the size of the Cepheid changes relative to these parameters, displayed on-line by the University of Tennessee, Knoxville.

Pulsating stars are interesting because they offer astronomers the ability to understand something about stars' interiors, not just their surfaces. There are islands of instability in several areas of the HR diagram, meaning that pulsation can happen in stars of different temperatures, luminosities and evolutionary stages, but the largest populations of variables are Cepheids and RR Lyrae stars.

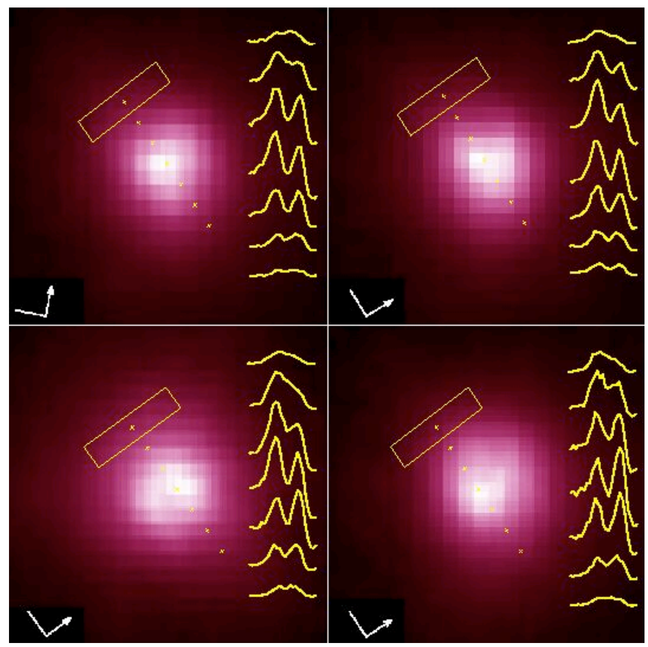


The Hertzsprung-Russell Diagram, annotated to show the most common intrinsic variables

Another group of variables are Long Period Variables, of which Mira (Omicron Ceti, mag 6.47) is the prototype but Betelgeuse (Alpha Orionis, mag 0.42) is the one we observe most frequently. These stars have periods of months to even years. They are red giants getting ready to throw off their outer layers to become planetary nebulae. Although they are not much larger in mass than the sun, they have expanded to enormous size as they move towards the end of their lives. Because Betelgeuse is so large (radius about 680 times that of the sun), bright (magnitude 0.42, the 8th brightest star in the sky) and close (643 LY by parallax), its surface has been observed and appears to be dominated by giant convection cells that are visible in interferometric images. Ultraviolet images from Hubble are interpreted as showing actual pulsations of the surface.



Surface of Betelgeuse at 1.6 microns (IR). Paris Observatory; data from IOTA, Mt. Hopkins (AZ)



Pulsations of Betelgeuse in UV light (Hubble)

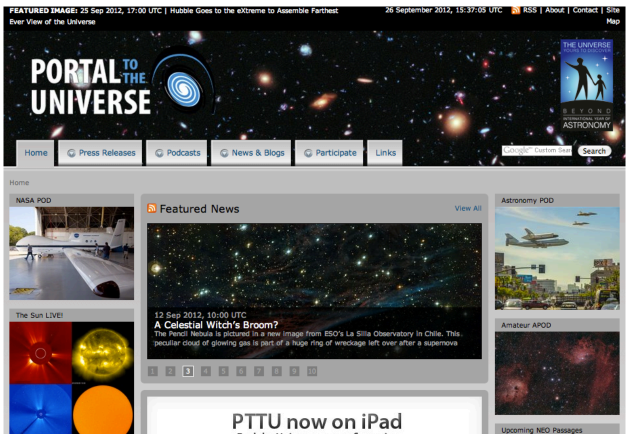
Less common are RV Tauri stars, of which about 100 are known. These supergiants of spectral class F and G have alternating primary and secondary minima, varying by as much as 4 magnitudes, with periodicities of 30-100 days. The brightest is R Scuti, which varies from magnitude 4.8 to as faint as 8.0 over 140 days or so. These stars are even closer to blowing off their surfaces on the path to becoming planetary nebulae.

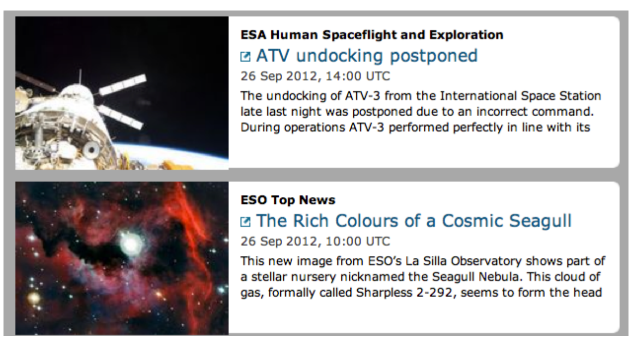
I found Polaris indeed to be a Lodestar: a guide to understanding and appreciating intrinsic variable stars, frankly something I had not thought much about before.

Internet Corner: Portal to the Universe
by Tom Boustead

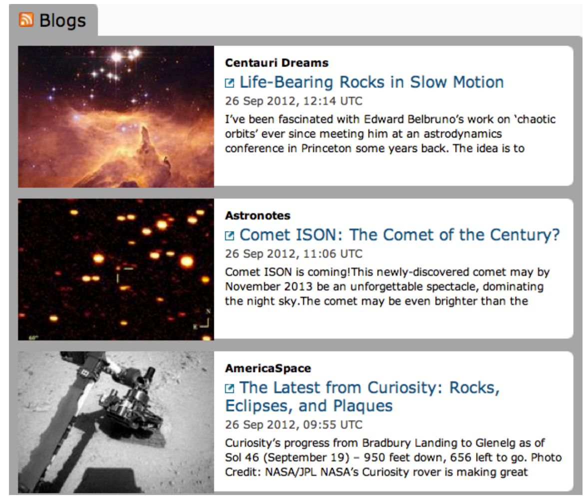
If you're looking for a one-stop website to keep you current with the latest in astronomy and space science, try Portal to the Universe (http://www.portaltotheuniverse.org/). Sponsored by the European Southern Observatory (ESO) and the European Space Agency (ESA), PTTU features news, blogs, video podcasts, audio podcasts, images, videos and more.

On opening PTTU, the visitor is greeted with a three column layout. News is featured at the top of the

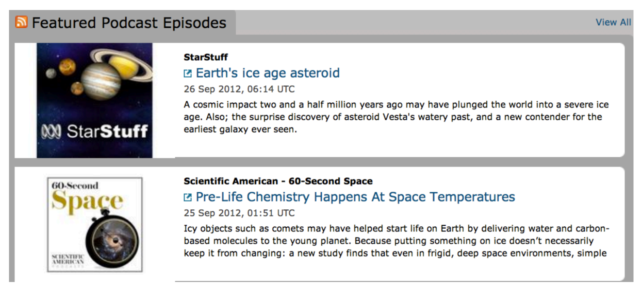




center column. Contributors normally include, but are not limited to, the ESA, ESO and NASA. Scroll down further and you can check out stories from a wide variety of astronomy blogs. Move further down and you'll find astronomy twitter. If you want more



information, navigate to the Press Release tab or News & Blog tab. For those who prefer their astronomy in video or audio form, PTTU has a tab with extensive links to Podcasts.



The Start Page left and right columns contain a number of interesting features--for example, the current lunar phase, the current count of exoplanets, the number of sunspots, etc.

Overall, PTTU performs as advertised and provides a comprehensive gateway to the universe of astronomy. An App is available for your tablet and mobile devices.

October Starway to Heaven

The October Star Party was originally scheduled for the 13th, and although students from the Fox Lane Middle School and Fordham University were in attendance, so were clouds, and so we rescheduled for the make-up date a week later. Fortunately, heavy rain the previous day resulted in crystal clear skies, and temperatures were in the low 60's, dropping to the 50's later on. The moon was 37% illuminated and low in the west. It made for a fine view in many of the scopes, but obscured some of the southern Milky Way objects.

I counted at least 15 scopes; one or two more might have been set up in the dark after I took the census. Scopes of all types were represented. In the SCT category, Carl Lydon (Stamford, CT) was impressively set up for an evening of astrophotography with his 11" Celestron HD Edge SCT with an 80mm guidescope on a CGEM mount, a Canon Rebel DSLR, computer, dew heaters and lots of batteries. Al Ferrari (Yonkers) had his new Mallincam Extreme video camera on an 8" Meade SCT, with dramatic on-scope and laptop image displays. Dave Butler (Mohegan Lake) had his trusty 8" Meade, a veteran of countless Ward Pound star parties. Claudia and Kevin Parrington (Harrison) brought their auto-everything Meade 8" SCT Lightswitch, complete with dramatic audios that make it sound like you're on the bridge of the starship Enterprise (the male voice resembles Patrick Stewart; I'm sure not by accident). Kevin used an 8-24 mm Meade Series 4000 variable eyepiece to very good effect on objects such as M13. Sharon Gould (White Plains) brought a Nexstar 6 and Harry Butcher (Mahopac) had a Nexstar 5. Sharon found an interesting open cluster and wondered if I knew what it was. I didn't, but I knew about the "Identify" function in the Nexstar hand control, and just a few clicks later the told us that it was M25. If you've got a go-to scope, familiarize yourself with this extremely useful function. Christina and Rob Stenz (Long Beach) came to Westchester with a new Nexstar 8" that we put through its paces, the beginning of their learning curve.

There were a number of impressive Newtonians. Gary Miller (Pleasantville) and WAA President Doug Baum (Pound Ridge) both had 12.5" Obsessions on tracking bases. 10" Orion Intelliscopes were brought by Art Linker (Scarsdale) and Tom Crayns (Brooklyn). Bob Kelly (Ardsley) was using a regular 8" Orion Dob, proudly announcing he was "not using any electrons." Former WAA President and avid telescope maker Francis O'Reilly (Putnam Valley) brought a beautifully made 8" f/6 Newtonian that was an entry in the 2008 Stellafane ATM competition. It didn't win, but his 2011 entry, a 12½" f/7 Newtonian on a GEM took 1st place in the optical 12" and over class.

There were just two refractors: Eva Anderson (Croton-on-Hudson) brought a Televue 101 on an alt-azimuth mount. She showed me a lovely view of the Dumbbell. Ben Baum (Doug's son) had an 80mm Stellarvue and was set up for some experiments in lunar imaging.

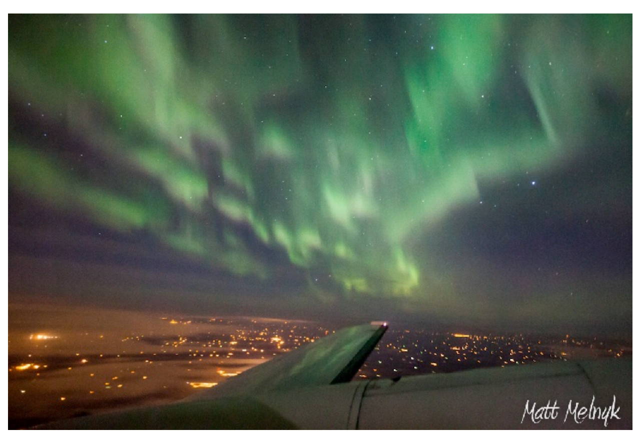
There were a number of non-scoping members in attendance, including Satya Nitta and his daughter Maya and later on Charlie Gibson, who came from a business engagement wearing a tie. I suspect this may have been the first time a tie was worn at a Ward Pound viewing event! Several members of the public also came, as did some folks who were camping in the park that evening, among them WAA member Richard Strongwater and his family (including dog).

I would have stayed longer, but Elyse and I had just returned from London that afternoon and our bodies were still on GMT. We missed what I am sure were many fine views of Jupiter, which was just rising as we left around 9:15 (2:15 am GMT).

There's one more Star Party scheduled for 2012, on November 10th (raid/cloud date Nov. 17th). We'll pick up again in March 2013.

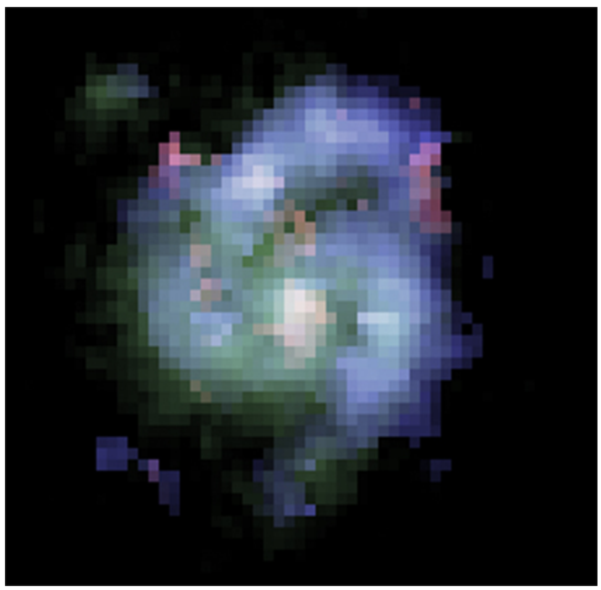
An Eventful Flight by Karen Seiter

I flew to London on October 9, 2012. There were geomagnetic storms resulting from a coronal mass ejection (CME) that hit during the early hours of October 8th. I had a window seat on the left side of the aircraft so I was in for a great show. At first there was a green haze off in the distance. Then the haze became discreet rectangles similar to piano keys being played. Next were ribbons of green whipping back and forth. I was happy up until this point. However the storms then came closer to the plane and turned pink and white. There were discreet curtains of light streaming to the ground. The plane started to shake and the flight



attendants had to be seated. I don't know if the two were connected but I stopped being happy at this point. I tried to take some photos but they didn't come out clearly. However pilot Matt Melnyk took photos the same night from his cockpit over Canada. They were posted on www.spaceweather.com (which kindly provided permission for their use here). The appearance is very similar to what I saw. On the way back I was able to capture a less dramatic but still satisfying astronomical event--a view of the Earth's shadow from the airplane. As they say if you see a sunset, don't forget to look backwards.

Earliest Spiral Galaxy Found by Keck 10-Meter



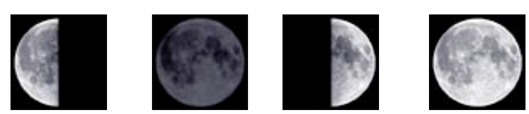
Following up on a survey by the Hubble Space Telescope, astronomers at Keck have imaged the most ancient spiral galaxy found to date. Known as BX442, the galaxy is 10.7 billion light years distant. The earliest galaxies were mostly irregular because gas in the early universe was too hot and clumpy to permit the arms to form.

The image was acquired with the Keck II telescope on Mauna Kea using adaptive optics (giving resolution equal to or better than HST). Over 13 hours of observing time on 3 nights was required to get the image as well as spectroscopic data that showed that the galaxy was rotating as a unit, and therefore was not merely two objects in the same line of sight. The authors speculate that the structure may be the result of a merger between two even older irregular galaxies.

The research was published in *Nature* in July by Charles Steidel, the Lee A. DuBridge Professor of Astronomy at the California Institute of Technology; Naveen Reddy, assistant professor of Physics and Astronomy at UC Riverside; Charlotte Christensen, postdoctoral scholar at the University of Arizona, and Dawn Erb, assistant professor of Physics at the University of Wisconsin, Milwaukee.

Almanac

For November 2012 by Bob Kelly



Nov 6 Nov 13 Nov 21 Nov 28

"Bend and stretch, reach for the stars
Here comes Jupiter, there goes Mars."

Are you up to combining exercise with viewing bright objects in our evening skies? In any case, this Romper Room rhyme describes this month's situation as Mars fades into the twilight and Jupiter gives us something bright to sight as we walk home from work. With the change back to standard time on the 4th, sunset jumps back to 5pm, leaving many office workers to go home in darkness. But that gives us an earlier rising time -- just before 8pm during Daylight Time days, then around 6:35pm on the 4th to rising at sunset by the end of the November. But Mars, low in the southwest and slowly dimming as it gets farther away from us, is the only other 'bright' planet in the evening sky this month.

Jupiter is a planet with a surprise for scopes of every size. Jupiter lost a dark cloud belt last year. As if embarrassed by the telescopic views that make him look fat, he's been trying on different belts this year, with the changes visible in most scopes. And as we approach opposition in December, Jupiter's every-changing alignment of moons can be seen in the smallest of optical equipment.

The lesser observed morning sky is where most of the bright objects are hanging out. Venus is lower each week, but that only makes its brilliant light easier to see from your east-facing window or elevated train platform. Also pre-dawn, Jupiter is setting in the opposite side of the sky with the bright winter-time stars. Saturn skulks into sunrise sky, returning from its hiatus behind the Sun, and gracefully glides by Venus, closest on the 26th and 27th, allowing us to use Venus to point out where Saturn is in the sky.

Viewing Saturn low in the sky, through our thick atmosphere, will make the ringed planet seem fuzzy, but with the rings opening wider, it's still worth a look. Compare it to Venus in the same telescope field on the 26th and 27th. The two planets are nearly the same apparent size, but Saturn's rings give its identity away. How long can you use Venus to find Saturn as the Sun rises?

With Mars and Venus heading to the opposite side of the solar system from us, Mercury, as so often the case, ends up as the closest planet to Earth all month. Mercury's little light is drowned out in the solar glare while passing between us and the Sun. Then Mercury surprises us with its jump into the dawn the last week of November. It will be well below and to the left of Saturn and Venus. But that makes four bright planets you could see in the pre-sunrise sky at once.

In a children's book, Alistair was such a brilliant student that the school set its clocks by his watch. He also had some humorous adventures with an extra-terrestrial species that were not good at directions. Well, Alistair made a list each day of the things he had to do and the things he did not have to do. Here's our list of what we can't do this month from our area! A total solar eclipse sails the southern Pacific Ocean, only touching land at sunrise in northeastern Australia on the 14th, then crossing the International Date Line to end on the 13th in the Pacific well off the coast of Chile. On the 28th, an observer on the Moon would see the Sun partially eclipsed by the Earth. But all we might see is a faint graying of the full moon on the 28th, but only if we were in southeastern Asia or Australia.

An event that we also can't see is the second closest the Moon will be to the Earth this year. That occurs on the 13th, coincidentally with the new moon, increasing the tidal extremes around that date. Let's hope for no major storms to build on those already higher tides.

Disappointed by the Orionids in October? We have another reasonably good meteor shower like that, the Leonids, peaking around Saturday the 17th but only in the post-midnight skies after moonset. Leonids are dust from Comet Tempel-Tuttle and are occasional bright meteors with some leaving a trail. The Geminids in December typically have many more bright meteors, but peak on a school night. Remember what you learned about viewing the Orionids – use a lounge chair, cover yourself with a blanket to keep the dew off your coat, etc.

The Moon gets cozy with Jupiter on the 1st/2nd and the 28th/ 29th and a thin crescent points the way to Mars and the 15th and 16th. Venus gets a visit on the 11th, followed by a lunar pose with Saturn on the 12th.

The International Space Station glides over us some evenings through the 3rd, and some mornings from the 9th through December 3rd. The best times to see bright satellites pass overhead are as soon as the sky gets dark until about 7:45pm in early November, but only by about 7:00 pm later in the month. Sometimes, as we saw at the October Starway to Heaven, sunlight bouncing off an extremely reflective surface, fortuitously aimed at our location, can increase the brightness impressively.

Heard about a bright comet coming our way? That would be (might be) Comet ISON. Its closest approach to us and the Sun, and peak brightness, is *next* November and December. A good blog entry that puts the prospects in perspective is at http://cumbriansky.wordpress.com/2012/09/26/comet-fever/

Bob's blog is at bkellysky.wordpress.com