Nightfall

Monthly publication of the Huachuca Astronomy Club

APRIL 2014

President's Notes

April is here, and it is too busy "up there" to stay inside and sleep. The night sky is taking a break from the Milky Way and allowing us a view out to the realm of the galaxies just framed around the edges by our own galaxy. We have comets coming and going, Mars at opposition, Jupiter still up high but setting earlier, Saturn is coming up earlier, and asteroids (ok dwarf planet and proto-planet) Ceres and Vesta are getting close together (from our perspective) as they move through Virgo. They will really seem close towards the end of June and the beginning of July, but you know what happens around here in the season (insert ominous crack of thunder here).

Do not miss the total Lunar Eclipse during the late hours of April 14 into the early morning hours of April 15. Tommy Neyhart has a wonderful article on the importance of and the mechanical insights possible from the eclipse, and an experiment to do during the eclipse. It is very cool.

One last item that I think we need to think about this month. The old computer that runs your planetarium program or allows you to go on the Internet to get information about the latest comets may be running Microsoft Windows XP, and if so, it is time to retire it.

Microsoft is ending support for Windows XP and Office 2003, after 10 years of stable service. Microsoft will no longer provide security updates, or online content updates for Windows XP. It is important to understand that this means if you use an XP computer on the Internet it will be at risk to all kinds of malware. If you have an XP machine on a home network, it will become the weak link of your system and could lead to viruses getting through your firewall, so it is time to think about moving over to a newer operating system. The most XP-like operating system is Windows 7 and you can still get desktops and laptops with this operating system (some of the desktops still have serial and parallel ports). What a pain.

Next Meeting

The April Meeting of HAC will be April 11 at 7 P.M. in the community room of the Student Union Building at Cochise College. The night's talk is titled "Finding Life in the Galaxy". The meeting is free and open to the public. An astronomy themed door prize will be awarded, but you must be present to win. Cochise College is located at 901 N. Colombo Avenue in Sierra Vista.

Join University of Arizona Planetary Science PhD candidate Rob Zellem as he describes how he finds and characterize extrasolar planets, or planets outsides of our own Solar System, with the ultimate goal of finding extraterrestrial life.

Rob Zellem is a 4th year PhD candidate at the University of Arizona's Lunar and Planetary Laboratory. His love for astronomy and planetary science began at a very early age with multiple viewings of Star Wars and when he would look up to the night sky and wonder "are we alone?". In order to find extraterrestrial life, he received his Bachelor of Science in Astronomy & Astrophysics from Villanova University in 2008 and his Masters of Science in Space Science from University College London in 2009. Since 2010, he has been studying transiting exoplanets at the Lunar and Planetary Laboratory. Using observations from both ground and space-based platforms, he determines the thermal structure and molecular abundances of these extrasolar planets. After graduating with his PhD in May of 2015, he aims to work at a NASA center to help develop future space missions to better characterize these interesting objects.

Lunar Eclipses Tell Us So Much

Lunar eclipses are not nearly as spectacular as solar eclipses. They don't grab headlines, create Internet viruses, or draw hoards of the awe-struck curious to specific centralized locations. In fact, to the casual observer, they frequently go unnoticed.

Lunar Eclipse

(*The above photo has been intentionally placed on the far left side of the page to give you workspace room on the right, and above and below, to continue the curve of the shadow into a large circle as described below*)

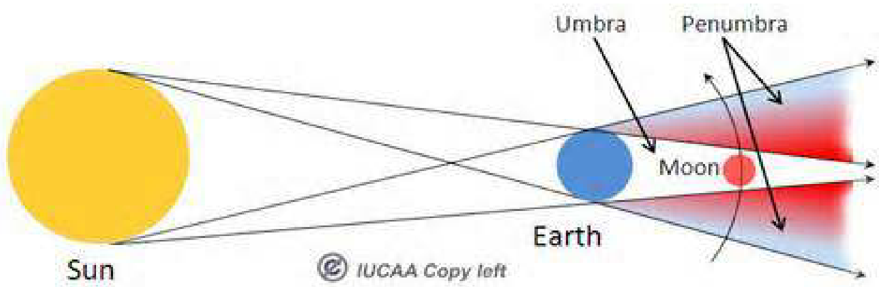


Diagram of a Lunar Eclipse

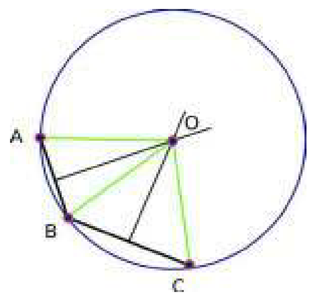
But the shadow of the Earth that slowly creeps across the Moon's surface actually tells us more, much more, about our home called Earth, and our two companions in space, the Moon and Sun, than does a solar eclipse.

You will soon see why.

But first, a few building blocks of knowledge must be established. You will undoubtedly wonder why they're being presented, but they will come in to play later. Please feel free to join in any or all of the activities presented.

Any three randomly placed dots can be shown to be on the edge of a circle. Here's how:

Making A Circle From Three Random Points



Making a circle from 3 points.

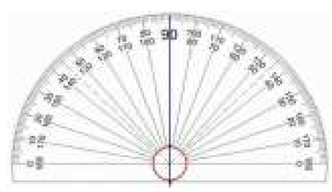
On a blank piece of standard-sized paper, near the center of the page, draw three dots about 2½ inches apart. Label them A, B, and C. Using a ruler, draw two straight lines, one between A and B, the other between B and C. Now find the halfway points of the two lines and draw two right-angle, or 90°, lines emanating from points. Where they intersect, point O, is the center of the circle, where points A, B, and C lie on the edge, or circumference. See the illustration above.

Comparing the Earth and Moon's Diameter
From the photograph at the start of this essay of a Lunar Eclipse, notice that when extended, the shadow of the Earth is part of a much larger circle than the Moon's outer edge.

But how large are these circles on a printout?

I first printed Page 1 of this essay for the purpose of measuring the Earth's diameter, and after some work with a compass and a ruler, the full circle of the Earth's shadow can be scribed, then measured. As you can see, the photograph was taken at the time when the Earth's shadow was about halfway across the Moon.

It was easy to measure the diameter of the Moon in the photograph, as the entire orb can be seen. The diameter of the circle was exactly 1 3/16", or 1.1875".


Using the "Making A Circle From 3 Points" skill just explained, I placed three dots along the Earth's curved shadow, roughly equidistant from one another. The shadow was fuzzier than the outer edge of the Moon, due its penumbra, the less distinct outer part of nearly every shadow. It made it a challenge to place the points, but I did, and using a ruler, connected them with straight lines. After finding both midway points, I used a protractor to measure right-angle points from them, drew two straight lines, and noted where they intersected. I placed the point of my compass on the intersection, spread the two arms until the pencil touched one of the dots, then scribed a circle. Not surprising, all three dots that I had previously made, were on the circle. I then measured its diameter. It was 4 3/8", or 4.375".

In comparing the diameters of the two circles, I deduced that the diameter of the Earth is 3.68 times the diameter of the Moon (4.375" / 1.1875" = 3.68). Once we find the actual diameter of the Moon, we can multiply it by 3.68 to find the Earth's diameter!

Finding The Diameter of the Moon
But how do we find the diameter of the Moon without using published data? It's really quite simple.

On a night when there's a full moon, find a nickel and a 12 foot length of string. Tape one end of the string to the nickel. Ask a friend to hold up the nickel while you take hold of the string near the nickel. When your eye is an inch or so from the nickel, the coin totally obscures the Moon and the surrounding topography. But as you back away from the nickel, with the string sliding through your fingers, you'll notice how the nickel covers less and less, until you reach a point where the outer edge of the nickel just touches and covers the outer edge of the Moon. When it does, pinch the point on the string.

Now using a tape measure, find the distance between the nickel and the point where you squeezed the string. For me, it was 89”. The distance from the point that was next to my eye to the nickel, was 89”, or 109.54 times the diameter of the nickel (0.8125”). We have just created a model that compares the distance to the Moon with the Moon's diameter.

If we can find the distance to the Moon, then use our model, we can easily find the diameter of the Moon.

Personnel working at Fort Huachuca have access to high-powered radar that focuses a powerful beam. They frequently test their equipment by bouncing radar off the surface of the Moon, timing how long it takes the beam, traveling at the speed of light (186,000 miles per second) to make the round trip. It takes almost exactly 2.5 seconds, or 1.25 seconds going one way. The Moon, therefore, is 1.25 light seconds away, or about 239,000 miles (1.25 x 186,000) from Earth.

Returning to our model where we found the distance to the Moon to be 109.54 times the diameter of the Moon, the distance across the Moon must be 2,182 miles (239,000 / 109.54 = 2,182). Taking a quick peek in a reference book to see how we're doing, the accepted diameter of the Moon . . . 2,160 miles.

Finding The Diameter of the Earth

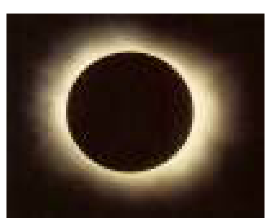
And earlier when we employed the lunar eclipse photograph, and using the arcs of the Earth's shadow and the Moon's outer edge, we found that the diameter of the Earth is 3.68 times that of the Moon, or 8,030 miles (3.68 x 2,182 = 8,030). The accepted diameter of the Earth . . . 7,926 miles.

But there's more, much more.

Finding The Distance Around the Earth

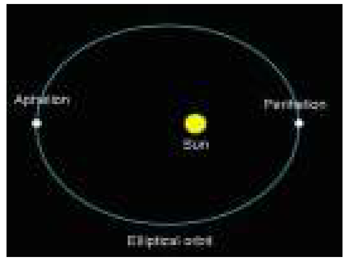
Because the Earth is nearly a perfect sphere, the distance around the Earth can be found by multiplying the diameter times the constant pi, π (3.14159). Using our previous calculation for the Earth's diameter, 8,030 miles, the distance around the Earth is 25,227 miles (3.14159 x 8,030 = 25,227). The accepted distance . . . 24,902 miles.

Finding The Diameter of the Sun



The Sun subtends virtually the same angle in the sky as the Moon, being about 400 times larger in diameter, but 400 times farther away. This can be seen, and experienced, during a total solar eclipse when the Moon barely covers the Sun. Using our model previously developed in reference to the Moon, because the two orbs are almost identical in visual size, we can use the distance to the Sun of 93,000,000 miles to determine the Sun's diameter. The distance across the Sun must be 849,005 miles (93,000,000 / 109.54 = 849,005). The accepted diameter . . . 864,000 miles.

Close, But . . .
As you've seen, our figures are slightly off. We have fallen victim to ellipses, the elongated circles that orbitals travel as they go around their larger and more massive centers.



An orb traveling in an ellipse.

Because the Moon orbits the Earth in an ellipse, the distance between the two orbs varies by as much as 26,600 miles. And the Earth, also traveling in an ellipse around the Sun can find itself 3,106,600 miles closer to the Sun (in our winter!) than at its most distant point. This all leads to the Moon and Sun's apparent size in the sky being slightly different at various times of the year.

We also have used approximate distances to both the Moon and the Sun.

Here is a summary table of our calculations vs. the accepted (in miles):

	Earth			
	Diameter	Circumference	Moon's Diameter	Sun's Diameter
Our Calculation	8,030	25,227	2,182	849,005
Accepted	7,926	24,902	2,160	864,000
Difference	104	325	22	-14,995
Percentage Error	1.3%	1.3%	1.0%	-1.7%

Yes, our calculations vary from the accepted, but using a photograph of the lunar eclipse, a few implements found in the kitchen drawer, and a nickel, our measurements are surprisingly accurate.

Summary
Using a photograph of the Lunar Eclipse of April 15, 2014, a hard copy was made and after extending the arcs of the Earth's shadow and the Moon's outer edge, it was found that the diameter of the Earth was 3.68 times that of the Moon. Using a nickel and a length of string to establish the relationship between the diameter of the nickel and its distance from the observer, the diameter of the Moon was calculated, then the Earth's diameter and circumference were derived using the 3.68 factor and the constant pi (π). Because the apparent size of the Sun and Moon are almost exactly the same, the diameter of the Sun was calculated after substituting its distance from Earth in to the formula.

Keeping in mind the major points described in this essay, I sure hope you enjoy the Lunar Eclipse that starts on the night of Monday, April 14, 2014. Here are the eclipse stages, shown in local Sierra Vista times:

Lunar Eclipse Times

Partial Begins	9:58 p.m.	April 14, 2014
Totality Begins	11:07 p.m.	April 14, 2014
Mid-Eclipse	11:47 p.m.	April 14, 2014
Totality Ends	12:25 a.m.	April 15, 2014
Partial Ends	2:58 a.m.	April 15, 2014

For an event that gets so little attention by the general public, so much about our world and our neighbors in space can be learned from a Lunar Eclipse.

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Total Lunar Eclipse

By Bob Gent

On the night of April 14 and 15, we will be treated to a total lunar eclipse. Weather permitting, we will be able to see it from start to finish. The eclipse will begin on April 14 as the moon moves into the penumbral shadow at about 9:53 pm MST. At 10:50 pm MST, the partial begins. At about 12:06 am MDT on April 15, the total eclipse begins as the moon is inside the darkest part on the earth's shadow. Mid totality is at 12:46 am MST.

Below are a few photos from the last total lunar eclipse I was able to image from Sierra Vista, AZ in December 20-21, 2010. I used a Celestron 8-inch Newtonian with a Canon Digital Rebel to catch these images.

Clear skies, bright stars, and good observing,

Moon on December 20, 2010, 23:24 MST. 1/1,600 second exposure, C8-NGT with Canon Digital Rebel.

Nearing totality, 1/50 second, at 00:24 MST.

Mid-eclipse totality, 00:51 MST, 2 second exposure. During totality the moon becomes red

Three Comets

By Bob Kepple

Thursday, March 27, I did some imaging. There are three comets in the sky. PanStarrs and Jacques are both developing a small tail. PanStarrs will continue to bright and move up near the Big Dippers handle passing M51 the Whirlpool Galaxy on May 1st. The faintest is Comet 134P Kowal-Vaurova (It's just a faint fuzzy at 13.9 mag. in the center of the photo.)

Comet C/2012 K1 Pan-Starrs

Comet C/2014 E2 (Jacques) and Comet 134P Kowal-***Vavrova***

Old Tool, New Use: GPS and the Terrestrial Reference Frame

By Alex H. Kasprak

Flying over 1300 kilometers above Earth, the Jason 2 satellite knows its distance from the ocean down to a matter of centimeters, allowing for the creation of detailed maps of the ocean's surface. This information is invaluable to oceanographers and climate scientists. By understanding the ocean's complex topography—its barely perceptible hills and troughs—these scientists can monitor the pace of sea level rise, unravel the intricacies of ocean currents, and project the effects of future climate change.

But these measurements would be useless if there were not some frame of reference to put them in context. A terrestrial reference frame, ratified by an international group of scientists, serves that purpose. "It's a lot like air," says JPL scientist Jan Weiss. "It's all around us and is vitally important, but people don't really think about it." Creating such a frame of reference is more of a challenge than you might think, though. No point on the surface of Earth is truly fixed.

To create a terrestrial reference frame, you need to know the distance between as many points as possible. Two methods help achieve that goal. Very-long baseline interferometry uses multiple radio antennas to monitor the signal from something very far away in space, like a quasar. The distance between the antennas can be calculated based on tiny changes in the time it takes the signal to reach them. Satellite laser ranging, the second method, bounces lasers off of satellites and measures the two-way travel time to calculate distance between ground stations.

Weiss and his colleagues would like to add a third method into the mix—GPS. At the moment, GPS measurements are used only to tie together the points created by very long baseline interferometry and satellite laser ranging together, not to directly calculate a terrestrial reference frame.

"There hasn't been a whole lot of serious effort to include GPS directly," says Weiss. His goal is to show that GPS can be used to create a terrestrial reference frame on its own. "The thing about GPS that's different from very-long baseline interferometry and satellite laser ranging is that you don't need complex and expensive infrastructure and can deploy many stations all around the world."

Feeding GPS data directly into the calculation of a terrestrial reference frame could lead to an even more accurate and cost effective way to reference points geospatially. This could be good news for missions like Jason 2. Slight errors in the terrestrial reference frame can create significant errors where precise measurements are required. GPS stations could prove to be a vital and untapped resource in the quest to create the most accurate terrestrial reference frame possible. "The thing about GPS," says Weiss, "is that you are just so data rich when compared to these other techniques."

You can learn more about NASA's efforts to create an accurate terrestrial reference frame here: http://space-geodesy.nasa.gov/.

Kids can learn all about GPS by visiting http://spaceplace.nasa.gov/gps and watching a fun animation about finding pizza here: http://spaceplace.nasa.gov/gps-pizza.

Artist's interpretation of the Jason 2 satellite. To do its job properly, satellites like Jason 2 require as accurate a terrestrial reference frame as possible. Image courtesy: NASA/JPL-Caltech.

Editors: download photo at http://www.jpl.nasa.gov/missions/web/ostm.jpg

2013-2014 Observations

By Cindy Lund

March marked my second anniversary editing the HAC newsletter. Last March, I included a list of the observation I had made over the past year. This year's March edition was a bit long, so I decided to put my observations list in the April edition instead. Nevertheless, I have included only observations made between March 2013 and February 2014.

I went to nine Star Parties and Astronomy Nights, the same number as last year. Six were at Patterson Observatory, one was at Kartcher Caverns, one was at Desert Starlight Observatory, and one was at Blue Marvel Observatory.

I saw comet C/2011 L4 (PANSTARRS). I observed Jupiter and its four Galilean moons, Saturn and three of its moons, and Venus, Uranus and Neptune. I observed four galaxies: M82 (Cigar Galaxy), M81 (Bode's Galaxy), M104 (Sombrero Galaxy), and M31 (Andromeda Galaxy). I also viewed 13 open and globular clusters; M45 (Pleiades), M22, M35, M5, M4, M13 (Hercules Cluster), NCG 5139 (Omega Centauri), M70, M69, M29, M6 (Butterfly Cluster), NGC 457 (ET Cluster), NGC 2360 (Caroline's Cluster) and NGC 884 & 869 (Double Cluster). I saw seven nebulae: M42 (Orion Nebula), M57 (Ring Nebula), M27 (Dumbbell Nebula) M76 (Little Dumbbell Nebula), M8 (Lagoon nebula) NGC 7662 (Blue Snowball) and NGC 7009 (Saturn Nebula). I saw the double stars Albireo, Gamma Delphini, and Epsilon Lyrae (the double double). I also observed the asterism Stargate, and the star system Sigma Orionis, as well as the stars Betelgeuse and Rigel.

Among the observations I made were nine objects that I had never studied before. These were the open clusters M29 and M35, the Globular Clusters M22, M69, and M70, the planetary nebula NGC 7009 (Saturn Nebula) the double Star Gamma Delphni, the star Rigel, and the asterism Stargate. After all the years I've been studying the night sky, there are still new things to observe.

My observation notes follow.

March 14, 2013 Patterson Observatory		
M42 Orion Nebula	Diffuse Nebula	Nebulosity in a thick C wrapped around the Trapezium. Two arms off the C, the one above going up and to the right the one below forming a bigger C. Another small fuzzy patch to the lower left of the Trapezium
M82 Cigar Galaxy	Irregular Galaxy	Cigar shaped nebulosity, ellipse going from upper left to lower right, dust lane barely visible, no notable core
M45 Pleiades	Open Cluster	Saw an upside down thin isosceles triangle of bright stars, to left of lower point saw tiny triangle of stars, curved line of stars extending to the right of bottom point of the big triangle
M81 Bode's Galaxy	Spiral Galaxy	A bit like a fried egg, small bright core at top center of ellipse of faint gray nebulosity. Ellipse going from upper right to lower left so it looked like ·/
Earth's Moon	Moon	Mare right by terminator. Also many craters by terminator including at least 3 with central peaks, one above mare, one just below mare and the last farther below.
C/2011 L4 (PANSTARRS)	Comet	Very hard to see with naked eye. Saw in small telescope. Tiny bright white disk, with comet tail going straight up, so comet was pointing to the ground. Single narrow tail

Jupiter	Planet, Gas Giant	Two thin brown strips just above and below the equator. (Actually to left and right of equator)
4 Galilean Moons	moons of Jupiter	One above Jupiter, other three below. Lowest not in line with the others, but a bit left. It is also brighter that the others

May 6, 2013 Patterson Observatory		
M35	Open Cluster	Not at all dense, Some stars brighter than others, Saw V of stars to the left, C of stars on the right, pentagon of stars on center bottom, and short line of stars ending top right.
M5	Globular Cluster	Small bright core, very dense. Got less dense further from center. Seemed to have a gap just to the left of center. (Dust lane?) Gap shaped like thick vertical line.
Jupiter	Planet, Gas Giant	Yellow disk with two thin brown strips, one above the equator, one just below, so the strips are more toward the top.
4 Galilean Moons	moons of Jupiter	Three moons of the right side, two close to Jupiter, on further away. One left side, one moon far away.
Saturn	Planet, Gas Giant	Yellow disk with thin light brown strip across the equator. Rings yellow, tilted downward. Could not see the Cassini gap.
3 moons of Saturn	moons of Saturn	Titan in lower right corner of field. Two other moons, close to Saturn on right,

June 8, 2013 at DSO		
Stargate	Asterism	Triangle within a triangle. Outer triangle is equilateral, with three bright stars. Inner triangle is isosceles with short side on left.
M104 Sombrero Galaxy	Spiral Galaxy	Looks a bit like a upside-down fried egg. Small bright core with bright fuzziness on each side, extending out horizontally, forming a low hill, but upside down.
M5	Globular Cluster	Tiny bright core, with stars forming thick arms around it, making the cluster look a bit like a spider, or a flower, or a sea star.
NGC 5139 Omega Centauri	Globular Cluster? Galaxy?	Roughly elliptical like a large boulder, with a large core making up most of the object.
M4	Globular Cluster	Small core. Rest lopsided, with more stars above the core than below.
M13 Hercules Globular Cluster	Globular Cluster	Big, with a big bright core, larger than M4 or M5.
M57 Ring Nebula	Planetary Nebula	Elliptical disk. Dark gray outer ring, light gray inside.
C/2011 L4 (PANSTARRS)	Comet	Looks like a galaxy. Two tails, one on the top, going up and left, one on the bottom, going down and left.
Saturn	Planet, Gas Giant	Yellow disk with thin light brown strip across the equator. Rings yellow, tilted downward. Cassini division visible, near the outer edge of the rings.
3 moons of Saturn	moons of Saturn	All above Saturn. The brightest one to the left of Saturn, the two dimmer to the right

October 5, 2013 at Kartchner Carvens		
Epsilon Lyrae (Double double)	Double Star ea. Double Star	Two white stars of similar brightness, both a bit elongated
NGC 884 & 869 Double Cluster	2 Open Clusters	Both clusters similar in size and density. Gap between clusters. Both clusters have more stars close to the gap and fewer farther away. Noticed two bright stars close together in left cluster and a few other bight stars scattered in both clusters.
M31 Andromeda Galaxy	Spiral Galaxy	Bright dot core, less bright area around it, faint fuzziness around that making lens shape
M13 Hercules Globular Cluster	Globular Cluster	Very bright, lots of stars all similar in brightness. Half core by diameter
M70	Globular Cluster	Tiny faint fuzzy, like a star out of focus, similar in size to M69
M69	Globular Cluster	Tiny faint fuzzy, like a star out of focus, similar in size to M70
M57 Ring Nebula	Planetary Nebula	Small dark gray ring around light gray disk
M6 Butterfly cluster	Open Cluster	All stars similar in brightness. No notable core. Noticed square of stars near center
M8 Lagoon nebula	Emission nebula	Fuzzy patch divided by dark lane in center. (1/3 patch, 1/3 dark lane, 1/3 patch) Small open cluster the same size as the patch to its lower right. Cluster has no notable core and all its stars are similar in brightness. Another fainter fuzzy patch below the first.
Venus	Planet (inner)	Appeared small in telescope, shaped like a filled in "C". No visible detail

October 10, 2013 at Patterson Observatory		
M13 Hercules Globular Cluster	Globular Cluster	About half core by diameter. Seemed to have arms spreading out from the core all around.
M57 Ring Nebula	Planetary Nebula	Elliptical gray ring, longer horizontally. Seemed to have some material pulled out at left and right edges. Inside of ring circular.
M27 Dumbbell Nebula	Planetary Nebula	Two vertically oriented elliptical lobes of nebulosity separated by a thin dark lane along their long sides. Lobes have somewhat irregular edges.
M76 Little Dumbbell Nebula (Peanut)	Planetary Nebula	Looks like a peanut. Two connected circular lobes of nebulosity. Upper lobe to right of lower.
M31 Andromeda Galaxy	Spiral Galaxy	Only core visible, Core brightest at center then more and more diffuse further out.
M29	Open Cluster	About 20 stars in field. Noticed two patterns made from brighter stars. On the left, three stars formed an equilateral triangle. On the right a shape like '--ı, and an upward facing arc below (like a shallow n).
Venus	Planet (inner)	White half-moon shape.
Neptune	Planet, Gas Giant	Tiny white disk, barely distinguishable form a star. Very faint blue tinge
Uranus	Planet, Gas Giant	Appeared larger than Neptune, but was viewed with different magnification. Definite disk. Disk round and white with a slight sea green tinge.

October 12, 2013 at Patterson Observatory		
M27 Dumbbell Nebula	Planetary Nebula	A thick short hourglass of bright nebulosity on its side, within a faint irregular ellipse of nebulosity
NGC 884 & 869 Double Cluster	2 Open Clusters	The clusters appeared one above the other with a gap between. Noted a triangle of brighter stars in the upper cluster and two bright stars close together in the lower. Also noted a bright orange star at the very bottom of the top cluster, partway into the gap.
M13 Hercules Globular Cluster	Globular Cluster	Core shaped as a thick ellipse, with a thin dark lane cutting across about 2/3 the way to the bottom. (like a θ, with a slightly lowered bar) The rest of the stars appear to be in arms, make the cluster resemble a spider.
Albireo	Double Star	Two bright stars, one orange, one blue, the orange star brighter than the blue. Both stars brighter than the others in the field.
Gamma Delphini	Double Star	Like Albireo, Two bright stars, one orange, one blue, the orange star brighter than the blue. Colors less intense than Albireo
M22	Globular Cluster	Faint fuzzy, tiny bright core, surrounded by round, slightly elliptical nebulosity.
M31 Andromeda Galaxy	Spiral Galaxy	Irregular lens shape of nebulosity, with a small round bright core
Earth's Moon	Moon	Viewed half the Mare Imbrium, which was cut off by the terminator. The Mare was near the top of the moon with mountains between it and the top. Several craters within the Mare, one right at the top and next to the terminator, another, just below the Mare and again, right by the terminator. Mountains outlined the Mare.
Uranus	Planet, Gas Giant	Light blue green disk. Color faint, but notable

November 2, 2013 at BMO		
NGC 7009 Saturn Nebula	Planetary Nebula	Looked like a white Saturn, if Saturn had no space between it and its rings. It looked like a flat head with ears, or a white lemon
NGC 457 ET Cluster	Open Cluster	ET was upside-down. Two bright stars near the bottom of the view were ET's eyes. Dimmer stars made up his body and long arms. Some of these stars were brighter than others.

December 12, 2013 at Patterson Observatory		
M45 Pleiades	Open Cluster	Bright stars made a shape like a smiling face wearing a top hat, or an upside-down fish with a face on its side. Dimmer stars surrounded and were within the smiley top hat guy. (The smiley guy's nose was a bit to the right)
Albireo	Double Star	Two stars, a brighter orange one on the left, a fainter blue one on the right. (Both much brighter than the others stars in the field.) The orange color was more intense than the blue.
NGC 7662 Blue Snowball	Planetary Nebula	Small gray disk, no blue color visible, seemed brighter at edge than at center of disk.
NGC 2360 Caroline's Cluster	Open Cluster	Bright stars made an x with a long middle, a shape like a person with arms raised in a V and legs spread.

M57 Ring Nebula	Planetary Nebula	Very faint due to moon, had to use averted vision to see. Saw a gray ellipse with a brighter outer ring and dimmer inner disk. A bit pulled at edges.
Venus	Planet (inner)	Medium crescent shape. Viewed when near horizon, so very blurry.
Earth's Moon	Moon	Waxing Gibbous phase. Saw mare, several craters, some with central peaks, and some without. Many mountains. Noted a backwards C at the top of the moon, made from mountains. Possibly a crater with part of the rim worn down.

January 9, 2014 at Patterson Observatory		
M42 Orion Nebula	Diffuse Nebula	Looked like a Chinese dragon. Nebulosity in an S shape, with wisps of nebulosity extending from the top curve of the S. Three stars along the outside of the middle of the S. Trapezium visible in nebulosity at inner top left "corner" of S. Dark lane to right of S, then star with small disk of nebulosity further right.
M31 Andromeda Galaxy	Spiral Galaxy	Only core and triangular wisps of nebulosity extending from either side of it visible. Shaped like >o<
Betelgeuse	Star (Red Supergiant)	Bright orange, like an orange. Round disk.
Rigel	Star (Blue-White Supergiant)	Blue-White disk. Had small white companion star at 8:00. Companion near Rigel A, so only visible when focused perfectly
Sigma Orionis	Star System	A "V" of stars in three "layers". One star at the bottom. The next layer had three stars real close together on the left (varying brightness) and a star on the right (medium brightness). The top layer hat two stars close together on the left, and one star on the right.
Jupiter	Planet, Gas Giant	Yellow white disk, flattened at the poles, (oblate spheroid). Two thin brown bands on either side of the equator.
4 Galilean Moons	moons of Jupiter	Two on the left, two on the right.
Earth's Moon	Moon	Moon at first quarter phase. Viewed near terminator. Saw C shape, made of mountains or an old crater. Similar sized Mare to the left. Several craters in and around the C

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2014—Astronomically Handy Sky Calendar from Doug Snyder & the H.A.C.—2014

ARIZONA Observers SKY EVENTS Calendar for 2014 —All Times listed are MOUNTAIN STANDARD

JANUARY 2014

HIGHLITES:

Quadrantid Meteors
Jupiter at Opposition

01 We ● **NEW MOON** 0414 hrs. (MST)
03 Fr **QUADRANTIDS** Meteor Shower very favorable; view after midnight; radiant near constellation Bootes; possible hourly rate of up to 120
04 Sa Earth at perihelion 0500hrs.; 0.983 A.U.
04 Sa **HAC** Member Star Party (S.P.)
05 Su JUPITER AT OPPOSITION 1400 hrs.; Mag. –2.7 distance=4.2 AU size=47”
07 Tu ☽ First Quarter Moon 2040 hrs.
09 Th **HAC** Public S.P.; P.O.;SS@ 1735 hrs.
10 Fr **HAC Meeting,** Cochise College 7pm
15 We ○ Full Moon 2153 hrs.; smallest of 2014
23 Th ☾ Last Quarter Moon 2220 hr
25 Sa Saturn 1.2° north of Moon, 0535 hrs.
30 Th ● **NEW MOON** 1439 hrs.; lunation 1127
31 Fr Mercury G_ Elong. East (18☒0300 h., view as ‘evening’ star in western sky 1/2 hour after sunset; mag. –0.7

Jupiter’s Galilean Moons—January 2014
There are no double-transit events this month, but satellite Callisto has four encounters with its mother planet (local dates and times):
1/11:1944 hrs. Occultation Disappearance
1/12: 0044 hrs. Eclipse Reappearance
1/20: 0438 hrs. Transit Ingress
1/28: 1854 hrs. Eclipse Reappearance
Note:**HAC=H**uachuca **A**stronomy **C**lub

FEBRUARY 2014

HIGHLITES:

Venus at its brightest,
Callisto’s Shadow on Jupiter

01 Sa **HAC** Member S.P.
06 Th ☽ First Quarter Moon 1221 hrs.
Double Shadow Transit, Jupiter; 0323 hrs. (Europa & Callisto); rare
HAC Public S.P.; P.O.;SS@ 1800 hrs.
07 Fr Alpha Centaurid Meteors, Pk. 2305 hrs. Radiant point in southern hemisphere
11 Tu Venus greatest magnitude: -4.6, 1600h.
14 Fr ○ Full Moon 1654 hrs.
HAC Meeting, Cochise College 7pm
15 Sa Venus at greatest illumination, mag.-4.9; morning ‘star’ in southeast sky
17 Mo Zodiacal Light in the west for next two weeks following evening twilight
19 We Spica (star) within 2.5° of Moon,0500 h.
22 Sa ☾ Last Quarter Moon 1016 hrs.
26 We Venus within 6° of Moon, 0500 hrs.

Long Period Variable Stars– Feb. 2014
Verify with www.aavso.org ;listed are stars brighter than mag. 8 at max.: period in days (d);date is predicted epoch max.

0228-13;U Cet;7.5>12.6;235d;Feb.10
1811+36;W Lyr;7.9>12.2;196d;Feb.17
1901+08;R Aql;6.1>11.5;267d; Feb.15
2044-05;T Aqr;7.7>13.1;202d; Feb. 04

MARCH 2014

HIGHLITES:

Kartchner Caverns S.P.(22)
Messier Marathon?(29)

01 Sa ● **NEW MOON** 0100 hrs.
01 Sa **HAC** Member S.P.
06 Th **HAC** Public S.P.; P.O.; SS@1823 hrs.
08 Sa ☽ First Quarter Moon 0628 hrs.
14 Fr Mercury G_Elong. W. (28°); morning ‘star’ in twilight to the east
14 Fr **HAC Meeting,** Cochise College 7pm
16 Su ○ Full Moon 1010 hrs.
18 Tu Zodiacal Light in the west for next two two weeks following evening twilight
20 Th **Vernal Equinox** 0957 hrs.
21 Fr Saturn close (north) to Moon
22 Sa **Kartchner Caverns S.P. ;**1830 hrs.
23 Su ☾ Last Quarter Moon 1847 hrs.
29 Sa **HAC Messier Marathon**-Proposed This date 110 objects should be visible
30 Su ● **NEW MOON** 1146 hrs.

Possible Favorable Periodic Comets—Reaching Perihelion March 2014
Obtain elements/ephemerides at www. minorplanetcenter.net; listed dates/times are in UT (to retain MPC accuracy)
P/2007 H3 (Garradd); Mar 01.23;1.8 AU
P/2008 A2 (LINEAR); Mar 03.40; 1.3 AU
52P (Harrington-Abell); Mar 07.54; 1.8 AU
290P/1998 U3(Jager); Mar 12.57; 2.15 AU
117P/Helin-Roman-Alu; Mar 27.16; 3.0 AU

APRIL 2014

HIGHLITE: **Total Lunar Eclipse (1 of 2 in 2014)**

03 Th **HAC** Public S.P.; P.O.; SS@1841 hrs.
07 Mo ☽ First Quarter Moon 0132 hrs.
08 Tu MARS at opposition, 1400 hrs.
09 We Comet 124P (Mrkos) at perihelion 0738 hrs.; perihelion distance 1.6 AU
11 Fr **HAC Meeting,** Cochise College 7pm
12 Sa Asteroid 4 Vesta at opposition 2200hrs.
14 Mo Mars closest approach, 0600 hrs.; 0.62 AU from Earth, mag. –1.5; Size:15.2 arc-seconds
14>15 (Mo>Tu): **Total Lunar Eclipse** 2157 hrs. (14th) to 0337 h.(15th) Total from 0010h. to 0124h. (15th)
15 Tu ○ Full Moon 0043 hrs.
17 Th Saturn close (north) to Moon, 0000h.
22 Tu ☾ Last Quarter Moon 0053 hrs.
23 We **Lyrid Meteor Shower,** Pk. 1045 h.; some 46% moon; view on 23rd am
26 Sa **HAC** Member S.P.
28 Tu ● **NEW MOON** 2315 hrs.

MAY 2014

HIGHLITE: **Astronomy Day & Saturn at opposition, May 10**

01 Th **HAC** Public S.P.; P.O.; SS@1900 hrs.
1 Th Mercury @ perihelion; evening star, mag. –1.6; view WNW at dusk
6 Tu **Eta Aquarid Meteor Shower**, Pk@ 0100 hrs.;40% Moon; rate 60+?
06 Tu ☽ First Quarter Moon 2016 hrs.
09 Fr **HAC Meeting,** Cochise College 7pm
10 Sa **NATIONAL ASTRONOMY DAY** (**HAC** event at Sierra Vista City Library)
10 Sa **Saturn** at opposition, 1100 hrs.; mag. +0.1, 8.9 AU from Earth, total size of 42.4” (planet itself 18.7”)
14 We ○ Full Moon 1217 hrs.
21 We ☾ Last Quarter Moon 0600 hrs.
24 Sa **NEW** Meteor Shower? Predicted strong peak from Midnight to 0100 on am of 24th; radiant in Camelopardalis; from Comet 209P/LINEAR; best of 2014?
28 We ● **NEW MOON** 1141 hrs.
31 Sa **HAC** Member S.P.

JUNE 2014

HIGHLITE:

Venus/Moon Conjunction (photo-op?)

05 Th **HAC** Public S.P.; P.O.;SS@1923 hrs.
☽ First Quarter Moon 1340 hrs.
12 Th ○ Full Moon 2112 hrs.
13 Fr **HAC Meeting,** Cochise College 7pm
19 Th ☾ Last Quarter Moon 1140 hrs.
21 Sa **Summer Solstice** 0351 hrs.
24 Tu Conjunction of crescent 7% Moon and Venus; 0518 to ENE
27 Fr June Bootids Meteor Shower; overhead to dawn on 27th; may show outburst
27 Fr ● **NEW MOON** 0109 hrs.
28 Sa **HAC** Member S.P.

Long Period Variable Stars–June 2014
Verify with www.aavso.org ;listed are stars brighter than mag. 8 at max.: period in days (d);date is predicted epoch max.

1946+32; x Cyg; 5.2>13.4; 407d; Jun 24
1432+27; R Boo; 7.2>12.3; 223d; Jun 21

*Times/Dates= ARIZONA Mountain STANDARD Time (MST; NO DST; UT-7hrs); **updates/ details,** see**:** www.hacastronomy.com or http://skycalendar.blackskies.org; **Abbr**: Tr=Transit; Pk=Peak; Merc=Mercury; E=East W=West; S=South; N=North; J, Jup.=Jupiter; V=Venus; v. = very; “=arc seconds; SS=SunSet; S.P.=Star Party; h., hrs.=hours (24 hour time system); MP=Minor Planet; MS=Moon Set; MR=Moon Rise; wks=weeks; Lt=Light; pm=evening; @=at; Pub.=Public ; NEA= **N**ear **E**arth **A**steroid; am=morning; mag.=magnitude; **meteor dates reflect predicted Peak Morning, but Moon may still be present; P.O.= Patterson Observatory; dbl= double; I=Io; Eu=Europa; G=Ganymede; C=Callisto; UT=Universal Time; **bold text=**possibly a promising/noteworthy event, activity or object; G_Elong=Greatest Elongation; AU=Astronomical Unit (93 million miles); °= degrees; *compiler*: **Doug Snyder**(C/2002 E2,MP15512, starhaven@me.com);V1.1.2014

2014—Astronomically Handy Sky Calendar from Doug Snyder & the H.A.C.—2014

ARIZONA Observers SKY EVENTS Calendar for 2014 —All Times shown are MOUNTAIN STANDARD TIME*

JULY 2014

HIGHLITE: Due to Monsoons, no scheduled observing events

03 Th Earth at aphelion,1700 hrs.; 1.016 AU
04 Fr Pluto at opposition, 0100 hrs.; mag. 14.1, distance 32.5 AU
05 Sa ☽ First Quarter Moon 0500 hrs.
07 Mo Saturn within 1.5° of 76% Moon; 2030 hrs.
11 Fr **HAC Meeting,** Cochise College, 7 pm
12 Sa ○ Full Moon 0426 hrs.
12 Sa Mercury G_Elong. W. (21°); morning 'star' in East, mag. +0.4; reaches mag. 0.0 on July 15
18 Fr ☾ Last Quarter Moon 1909 hrs.
26 Sa ● **NEW MOON** 1543 hrs.
29 Tu **Delta Aquarids** Meteor Shower Pk. at 0200 hrs.; rate may approach 20 per hour, some persistent trains.
30 We Alpha Capricornids Meteors– weak, slow moving, but yellowish fireballs can be photogenic; best rate of 5/hour?
July (first-half): C/2012 K1; evening hrs. in LEO; mag 7?

AUGUST 2014

HIGHLITE: Monsoon Season; Choose your own Highlite !

03 Su ☽ First Quarter Moon 1751 hrs.
08 Fr **HAC Meeting,** Cochise College, 7 pm
10 Su ○ Full Moon 1110 hrs; **largest** of 2014
12>13 Tu>We Perseid Meteor Shower Pk. at 1700 hrs. on the 12th; v. unfavorable due to strong moonlight; rates can be high as 90/hour under dark skies
17 Su **Conjunction:** Venus/Jupiter within 1.0° and close to Beehive cluster; 0500 hrs.; But very low in the ENE skies; closest planet-planet conjunction of 2014
17 Su ☾ Last Quarter Moon 0527 hrs.
24 Su Comet Siding Spring (C/2013 A1) at opposition, 1800 hrs.; may collide with MARS in mid-October !
25 Mo ● **NEW MOON** 0714 hrs.
29 Fr Neptune at opposition, 0800 hrs.; mag. +7.8; distance 29 AU; size 2.4"
31 Su Moon/Saturn/Mars within 5° circle; Moon will be at about 35%; 2000 hrs.

SEPTEMBER 2014

HIGHLITE: Comet Possibilities

01 Mo Aurigid Meteor Shower; peak after midnight of Aug. 31 and into morning of Sept.01; fast and many are bright ; low hourly rate (5) but may outburst
02 Tu ☽ First Quarter Moon 0412 hrs.
08 Mo ○ Full Moon 1839 hrs; Harvest Moon
12 Fr **HAC Meeting,** Cochise College, 7 pm
15 Mo ☾ Last Quarter Moon 1906 hrs.
20 Sa **Kartchner Caverns/HAC S.P.,** dusk
21 Su Zodiacal Light in east before morning twilight for next two weeks
22 Mo **Autumnal Equinox** 1929 hrs.
23 Tu ● **NEW MOON** 2315 hrs.
25 Th **HAC** Public S.P.; P.O.; SS@1813 hrs.
27 Sa **Saturn** within 2° of 14% Moon, low in the WSW, 2000 hrs.

Comet Possibilities for September 2014
C/2013 A1:v.low in S., early evening;9/17>9/30 (Siding Spring); encounter MARS on 10/19
C/2012 K1: low in E., early morning; 9/1>9/30
C/2013 V5: low in E., morning; 9/1>9/13

OCTOBER 2014

HIGHLITES: MARS & COMET; 1 LUNAR ECLIPSE & 1 SOLAR ECLIPSE IN SAME MONTH !

01 We ☽ First Quarter Moon 1233 hrs.
04 Sa **NATIONAL ASTRONOMY DAY** **HAC** opens Patterson Observatory for Public Exhibits and Viewing
07 Tu Uranus at opposition, 1400 hrs.
08 We ○ Full Moon 0351 hrs.
08 We **TOTAL LUNAR ECLIPSE** Start: 0117hrs., End: shortly after moonset at 0630 hrs.; Totality: 0328 h. to 0423 hrs.
09 Th Draconids Meteor Shower; unfavorable due to bright Moonlight
10 Fr S. Taurids Meteor Shower; Pk. 0500h.
10 Fr **HAC Meeting,** Cochise College, 7 pm
15 We ☾ Last Quarter Moon 1213 hrs.
19 Su **Comet Siding Spring** (C/2013 A1) **Close** Encounter/Graze with **MARS!**
20 Mo Zodiacal Light in East before morning twilight for next two weeks
21 Tu **Orionid Meteor Shower**; v. favorable; Swift, some bright, rate about 20+/hr.
23 Th ● **NEW MOON** 1457 hrs.
23 Th Partial **Solar ECLIPSE,** Start:1430 hrs. End: 1648 hrs.; max: 1543 hrs.(29.3%) **HAC** viewing at S.V. City Library, 1 pm
25 Sa **HAC** Member S.P.
30 Th **HAC** Public S.P.; P.O.; SS@1733
30 Th ☽ First Quarter Moon 1949 hrs.

NOVEMBER 2014

HIGHLITE: METEORS & FIREBALLS

01 Sa Mercury at G_Elong. W.(19°), 0600 hrs.; **best** morning apparition of 2014, east
06 Th C/2012 K1 (PanSTARRS) at (2nd) opposition, 2000 hrs., in Pictor; possibly will or will have brightened to mag. 6
06 Th ○ Full Moon 1523 hrs.
11 Tu North Taurids Meteor Shower; rate of about 5/hr; waning 77% moon & bright
14 Fr **HAC Meeting,** Cochise College, 7 pm
14 Fr ☾ Last Quarter Moon 0816 hrs.
17>18 Mo>Tu **Leonid Meteor Shower** Peak at 1500 hrs on 17th; view pm hrs on 17th into am hours on 18th; about 20% moon; fast meteors & bright; a good number leave persistent 'trails' ; no 'storm' has been predicted, but do you remember 2001? Some of us do. WOW.
20 Th **HAC** Public S.P.; P.O.; SS@1720 hrs.
22 Sa ● **NEW MOON** 0532 hrs.
22 Sa **HAC** Member S.P.
29 Sa ☽ First Quarter Moon 0306 hrs.

Comet Of The Month—An Observing and Imaging Challenge for C/2012 K1 (PanSTARRS) Throughout November, this comet will remain VERY low near our southern horizon and reside in these constellations: Pictor, Dorado, Phoenix, Reticulum, Horologium, and Eridanus, but may reach mag. 6 this month. Close encounter with Globular Cluster NGC1261 on 11/13; good luck!

DECEMBER 2014

HIGHLITE: GEMINID METEOR SHOWER

06 Sa ○ Full Moon 0527 hrs.
12 Fr **HAC Meeting,** Cochise College, 7 pm
13 Sa **Geminid** Meteor Shower Pk. Favorable Year, but with 50% moon; Pk. 0500 hrs. Saturday am; hourly rate can be as high as 120/hr.; mostly bright, few leaving 'trains';12/14 (Sunday) morning activity is possible also; Parent body is asteroid 3200 Phaethon (1.5 year orbit); radiant is near Castor
14 Su ☾ Last Quarter Moon 0551 hrs.
15 Mo **Dbl. Shadow Transit**, J. ; 2312 hrs. (Europa & Io); Note: At 0025 hrs. on 12/16, **both** Europa & Io will be in the process of transiting Jupiter! See 'em?
18 Th **HAC** Public S.P.; P.O.; SS@1721 hrs.
20 Sa **HAC** Member S.P.
21 Su Winter Solstice, 1603 hrs.
21 Su ● **NEW MOON** 1836 hrs..
22 Mo Ursids Meteor Shower Pk. 1300 hrs.; good date, but poor peak timing; (favors northern Asia); radiant is near β Ursa Minor (Kokab); rate is about 10/hour; faint, with a few fireballs. Parent comet is 8P Tuttle
25 Th *MERRY CHRISTMAS TO ALL !*
28 Su ☽ First Quarter Moon 1132 hrs.
28 Su Conjunction of Moon and Uranus; 2245 hrs.; less than 1.0° apart; first quarter Moon and mag. 5.8 Uranus

HAPPY NEW YEAR !

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