NIGHTFALL

A PUBLICATION OF THE HUACHUCA ASTRONOMY CLUB

APRIL 2016

PRESIDENT'S NOTES

I'M AN APRIL FOOL

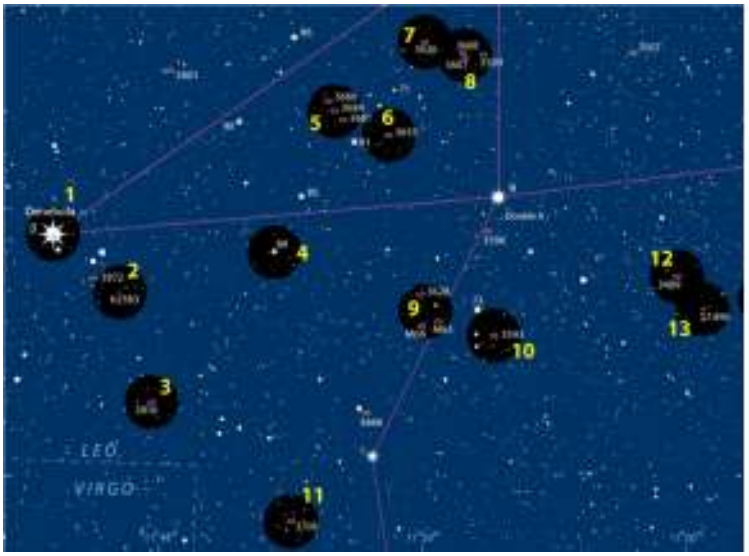
The year really starts for me in April. The nights get warm enough to stay out without losing feeling in my toes from the cold. The winter Milky Way gets out of the way and allows us to look beyond the veil of neighborhood stars and dust, out into deep dark of space. The rise of Leo heralds, time for peering into this deep looking for faint, fuzzy, smudges of light. Virgo and Coma Berenices showcase them. Small pinwheels, ovals, lines, and spheres of dim gray are lurking at the edge of our vision as we look into this realm. They barely have light, they barely have form, and yet each bit of fuzz is an echo from around 100 billion stars. Viewing in eyepieces in our normal amateur telescopes, we can see one or two of these. In the frame of my astro-camera I can routinely capture three or seven of these smudges, each as individual as a snowflake, and each as rich with stars as our own Milk Way. No, I cannot resolve those fuzzy patches into individual stars either, not by eye or camera, but for some of the larger ones I can give them a little more form by eye of monitor.

It's those larger galaxies that can get you hooked on faint fuzzies. This was not always the case however. Charles Messier (26 June 1730 – 12 April 1817), a French astronomer wanted to find comets (faint fuzzy objects that move), but kept stumbling upon fuzzy objects fixed in the night sky. Annoyed by these objects he developed a catalog of the brighter of these, so he could avoid them and go about his comet hunting in peace. Well, among those pesky "Messier Objects" are a number of the largest and brightest galaxies. The brightness and size are in relation to our point of view, so for us they are the cream of the crop.

As early as the 1700's there were theories that some of the nebulae visible in the night sky might be separate Milky Ways. In 1755, Immanuel Kant used the term "Island Universe" to describe them. However, it was not until the early 1900's that the true nature of these faint fuzzy were recognized as separate galaxies as large as or larger than our own.

There is a wonderful web article from Sky & Telescope magazine to help you tour the galaxies of Leo. Each patch of galaxies is given more context and deeper discussion to introduce you personally to this rich neighborhood. Give them a try, and let me know if I've set the hook.

The galaxy tour for spring evenings starts from 2nd-magnitude Denebola, the tail star of Leo.



The yellow-numbered circles highlight the 20 points of interest described in the text on *Sky & Telescopes* website http://www.skyandtelescope.com/observing/celestial-objects-to-watch/a-galaxy-hop-in-leo/

WELCOME OUR NEW MEMBERS

Miriam Allen of Sierra Vista was presented with a complimentary HAC family membership as part of her award for an astronomy themed science project in the YES Fair. Bruce Johnson of Sierra Vista joined the club in March. Bruce observes with an 8" Meade LX 200 SCT. Eric and Roberta Allen of Benson joined the club at the Astro Swap Meet. They observe with a 24" Dob and a 17.5" Dob. Welcome to the club, we are glad you joined!

AT THE APRIL MEETING

Guest speaker Sarah Morrison of the University of Arizona will deliver a talk entitled, Outer Planets: The New Frontier of Exoplanets

Within the last 10 years, we now have much more context for our Solar System with the discovery and characterization of thousands of exoplanet systems. To date, however, most of these systems provide insight mainly for the inner planets

since they sample planets that orbit close to their host stars. I will discuss cutting-edge efforts to start looking for outer exoplanets using direct imaging campaigns, as well as through indirect evidence in debris disks and current transit/radial velocity surveys and what these findings mean for our understanding of our own Solar System.

Sarah Morrison is a PhD candidate in Planetary Sciences at the University of Arizona's Lunar and Planetary Laboratory studying the evolution of planetary systems using orbital dynamics. She received her B.A. in Astronomy from Cornell University calibrating cameras on the Mars Exploration Rovers and exploring the moons of Saturn with the Cassini mission. She currently enjoys observing the often clear Southwestern skies while pondering perplexing planetary puzzles.

First Annual HAC Astro-Gear Swap Meet

By most measures, HAC's first annual swap meet was a great success. Sellers from all over Arizona convened at the Patterson Observatory on Saturday, April 2 to display their wares. There was an array of scopes, mounts, cameras, books and accessories on display and for sale at bargain prices. A lot of buyers and sellers went away quite satisfied and it was a lucrative venture for the club; we took in over $500 in donations and a large Dob that will eventually be sold to bolster the treasury.

As good as it was, there is a lot of room for improvement. Sellers far outnumbered buyers and we need to find imaginative ways to attract more of the public next time. There were a number of lessons learned that will make future editions of the swap meet more effective including the need to advertise more widely and provide adequate signage to help people find us. Future swap meets might be held closer to the holidays, and some procedural improvements might improve sales. All in all, it was a fine effort that far exceeded expectations. Our thanks go out to all who helped organize and manage this event and especially to our president, David Roemer, who was the driving force behind the idea. .

Beginner Astros – Even Under Cloudy Skies!

By MaryFrances Clinton

The last two gatherings of our Beginner Astros were perfect Good News/Bad News balances. Both last month and this month, we were invited to enjoy the amazing rooftop view at Katherine Zellerback's beautiful home at the back end of Ramsey Canyon Road. But for both meetings we had cloudy skies! Instead of finding discouragement, but both meetings ended up being fun sky sharing in high-energy good company wrapped 'round with Katherine's warm hospitality.

Last month's March 9ths cloudy skies started a whole new backwards kind of sky watching. As wind swirled thin clouds across the sky one lone star after another would appear, then just as quickly disappear. The backward stargazing question became, which constellation was that star in?

The game was mostly wild guesses to begin with. Before long, though, we'd outsmarted those winds, clouds, and singleton stars. Jupiter in Leo got nailed first. It had to be Jupiter – over there, in that part of the sky. Didn't It? Sirius came next – in that other part of the sky. From there we proved up Aldebran and the Pleiades and finally even Gemini, one star twin at a time.

When the wind finally sealed all the stars behind that cloud cover, we took in the spectacular view toward Sierra Vista below. Our new sleuthing game was sorting out areas, landmarks and buildings until the promise of hot cocoa, coffee, and cookies couldn't be resisted. Warm again inside and well provisioned, we relaxed with the Winter Skies video – a second viewing by demand from the several of us who'd seen it the month before. The information in that video is so compacted and fast moving, even that second viewing was full of new understandings, this time for both first and second-time viewers.

We'd have talked longer except for a call to come see the moon. It was a perfect slice of new moon, slowly settling below the cloud cover into the western horizon. Feeling the earth turn counter-clockwise beneath us, we watched that beautiful moon slowly slide down the very last edge of earth until it dropped completely out of sight, lost in our eastward motion toward tomorrow morning's sun.

Tommy Neyhart transformed our April 6th Beginner Astros night from just another cloudy sky night into an inside view of our universe we'd never have guessed at.

Tommy started out with a fascinating look at how each ancient angular shape of the familiar numbers we take for granted carried within it the same number of angles as the counting value in that number. After teasing out that bit of trivia, Tommy shifted right to the balance of star spacing in the sky by spotting simple angles connecting them. We learned next how the partial shape of the earth seen eclipsing the moon could be used to figure out the size of the earth and even its distance from the moon.

From there, Tommy had us sharing his lifetime of traveling from an Arctic tundra solar eclipse to another perched on the high center point of a cruise ship lined up perfectly north

and south in the Caribbean at the exactly right solar eclipse time and place. He left us imagining the "black wall of darkness" screaming toward us from the west when he (and we) would gather as next year's North American Solar Eclipse approached. For most of us, that would be the first of our lifetime solar eclipse experiences.

And, Why Not! The Tommy Neyhart view of the universe and our place and enjoyment in it was even more amazing and fun than almost any night of actual Sky Looking could be. In sharing his special way of connecting with that universe we're part of, Tommy opened us up to an entirely new way of experiencing that Sky Looking we'll be doing again and again in each of the next Dark Moon times.

Watch for our next Beginner Astros night in the days before or after the New Moon of May 6th. Katherine has invited us to come back then – up on her roof for the crystal clear night of Sky Looking we're certainly due for! See You Then!

Why (or How) The Dark Wall of Night Approaches From The West at a Solar Eclipse.

By Tommy Neyhart

Visualize a globe of the world sitting in front of you with the United States on the near side facing you. Arizona and the western states are to the left (west), while our nation's capital, New York, and Florida are to the right (east).

Keeping the globe still, raise up and peer down on the North Pole. Now imagine the Moon rotating around the Earth in a counterclockwise direction as seen from your vantage point above the North Pole. As you imagine a rotating Moon, lower yourself back down so you're roughly level with the Equator, the Moon traveling in its orbit from your left to right, or from west to east.

Because the Moon's shadow travels over a point of land faster than that point of land moves due to the Earth rotation on its axis, the Moon's shadow during a total solar eclipse moves from west to east. The black wall of the edge of the Moon's shadow approaches you from the west, and after the end of the eclipse, continues east to amaze fortunate enthusiasts who are positioned at points east.

As the edge of the Moon's shadow, the Black Wall, races toward you from the west just prior to totality, there is a race going on, one that has occurred for millions of years, and you're now part of it, standing where you are on wonderful Earth.

You are travelling at a tremendous speed now, thanks to the rotation of the Earth on its axis, and you will be when in Casper, Wyoming, latitude 43º N. To calculate your speed in Casper, we'll need to know the distance around the 43rd latitude before we divide it by 24 hours to obtain your speed while standing in Casper at the moment of the total eclipse.

If you were on the Equator, as the Earth spins on its axis, you cover 24,900 miles (the circumference of Earth at the Equator) in a scant 24 hours, or 1,038 miles per hour (24,900 miles / 24 hours = 1,038 mph). But you're in Casper, at latitude 43º N., where the circumference of the 43rd parallel is a much shorter distance around the Earth than at the Equator.

But, what is its length? At the Equator, the distance of the 0º latitude line is 24,900 miles. At the North Pole, latitude 90º N., the distance is zero miles, as you would only turn around and around as the Earth spins. One-third of the way to the Equator from the North Pole, at 60 N., the circumference of the latitude would be one-third of 24,900 miles, or 8,300 miles (24,900 / 3 = 8,300 miles). Half way between the North Pole and the Equator (Salem, Oregon), and the circumference would be half of 24,900 miles, or 12,450 miles.

For any latitude, here is the formula for determining the circumference of the latitude line:

[(90 – L) / 90] x 24,900 miles, where L = your current latitude.

Testing the formula for the two extremes, the Equator at 0º yields:

[(90 – 0) / 90] x 24,900 miles

[(90) / 90] x 24,900 miles

1 x 24,900 miles = 24,900 miles

At the North Pole, latitude 90º yields:

[(90 – 90) / 90] x 24,900 miles

[(0) / 90] x 24,900 miles

0 x 24,900 miles = 0 miles

Now, for Casper, Wyoming, latitude 43 N., the circumference of its latitude circle is:

[(90 – 43) / 90] x 24,900 miles

[(47) / 90] x 24,900 miles

0.522 x 24,900 miles = 12,998 miles

When standing in Casper, Wyoming, how fast are you travelling on the Earth's surface, keeping in mind that you're going at the rate of 12,998 miles in 24 hrs? You are moving at 541.6 miles per hour (12,998 miles / 24 hours = 541.6 miles per hour).

Who or what will win the race, you standing where you are in Casper, Wyoming, going 541.6 miles per hour as the Earth rotates or the Moon's shadow traveling over the land during the solar eclipse? We now need to calculate the speed of the Moon's shadow.

On the morning of August 21, 2017, the Moon's shadow first touches the western shore of North America in Oregon at 16h:04m:33s Universal Time ("UT"). 17 minutes and 42 seconds later, at 16h:22m:15s UT, the shadow reaches Casper, Wyoming, 880 miles ("as the crow flies") east of where it first struck the majestic Oregon coastline.

Going 880 miles in 17 minutes 22 seconds equates to 2,983 miles per hour [(880 miles x 60 minutes) / 17.7 minutes = 2,983 mph]. If nearly 3,000 miles per hour seems fantastic, it is. Test this speed calculation by approximating how quickly it travels the full length of the country (just over 3,000 miles). It takes just over an hour (1 hour 13 minutes) for the shadow to go from the west coast of Oregon (at 16h:05m UT) to where it last touches America on the east

coast of South Carolina (at 17h18m). That's just over 3,000 miles in just over an hour. The quick test works.

Relative to your position, and your rate of travel (541.6 miles per hour), the shadow will enter Casper, stay for 2 minutes and 26 seconds, then overtake you and move on at 2,441 miles per hour (2,983 mph – 542 mph = 2,441 mph).

Referring to the interactive NASA August 21st Eclipse Map on the Internet (http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html), it was easy to zoom in on the Casper area and measure the width of the Path of Totality. It is 68 miles wide. But, knowing that the shape of the shadow is elliptical when it meets Casper. And the speed of the shadow was just determined (2,983 miles per hour), the next logical step is to calculate how much distance would be covered by the shadow in the 2 minutes 26 seconds (2.43 minutes) of Casper totality, thereby determining the length of the ellipse.

During totality, the shadow covers 121 miles [(2,983 miles x 2.43 minutes) / 60 minutes = 121 miles]

As the shadow passes overhead in Casper, it is an oval, an ellipse, as the shadow is striking the ground at an angle. It measures 68 miles wide x 121 miles long. Progressing east, the two focus points of the ellipse slowly come together, and over Hopkinsville, Kentucky, they become one, as the shadow is now circular and astronomy enthusiasts stand in the Moon's shadow for a maximum amount of time (2 minutes and 40 seconds).

Leaving this location and heading east, the shadow again increasingly distends until it leaves Earth and returns to space, where it once again awaits another future meeting with landfall in a faraway remote location.

Space Place Article April 2016

Gravitational Wave Astronomy Will Be The Next Great Scientific Frontier

By Ethan Siegel

Imagine a world very different from our own: permanently shrouded in clouds, where the sky was never seen. Never had anyone see the Sun, the Moon, the stars or planets, until one night, a single bright object shone through. Imagine that you saw not only a bright point of light against a dark backdrop of sky, but that you could see a banded structure, a ringed system around it and perhaps even a bright satellite: a moon. That's the magnitude of what LIGO (the Laser Interferometer Gravitational-wave Observatory) saw, when it directly detected gravitational waves for the first time.

An unavoidable prediction of Einstein's General Relativity, gravitational waves emerge whenever a mass gets accelerated. For most systems -- like Earth orbiting the Sun -- the waves are so weak that it would take many times the age of the Universe to notice. But when very massive objects orbit at very short distances, the orbits decay noticeably and rapidly, producing potentially observable gravitational waves. Systems such as the binary pulsar PSR B1913+16 [the subtlety here is that binary pulsars may contain a single neutron star, so it's best to be specific], where two neutron stars orbit one another at very short distances, had previously shown this phenomenon of orbital decay, but gravitational waves had never been directly detected until now.

When a gravitational wave passes through an object, it simultaneously stretches and compresses space along mutually perpendicular directions: first horizontally, then vertically, in an oscillating fashion. The LIGO detectors work by splitting a laser beam into perpendicular "arms," letting the beams reflect back and forth in each arm hundreds of times (for an effective path lengths of hundreds of km), and then recombining them at a photodetector. The interference pattern seen there will shift, predictably, if gravitational waves pass through and change the effective path lengths of the arms. Over a span of 20 milliseconds on September 14, 2015, both LIGO detectors (in Louisiana and Washington) saw identical stretching-and-compressing patterns. From that tiny amount of data, scientists were able to conclude that two black holes, of 36 and 29 solar masses apiece, merged together, emitting 5% of their total mass into gravitational wave energy, via Einstein's E = mc2.

During that event, more energy was emitted in gravitational waves than by all the stars in the observable Universe combined. The entire Earth was compressed by less than the width of a proton during this event, yet thanks to LIGO's incredible precision, we were able to detect it. At least a handful of these events are expected every year. In the future, different observatories, such as NANOGrav (which uses radio telescopes to the delay caused by gravitational waves on pulsar radiation) and the space mission LISA will detect gravitational waves from supermassive black holes and many other sources. We've just seen our first event using a new type of astronomy, and can now test black holes and gravity like never before.

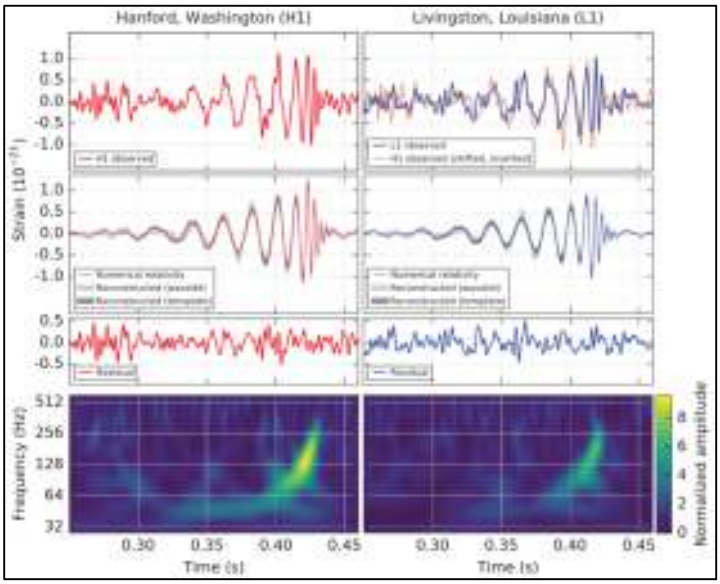


Image credit: Observation of Gravitational Waves from a Binary Black Hole Merger B. P. Abbott et al., (LIGO Scientific Collaboration and Virgo Collaboration), Physical Review Letters 116, 061102 (2016). This figure shows the data (top panels) at the Washington and Louisiana LIGO stations, the predicted signal from Einstein's theory (middle panels), and the inferred signals (bottom panels). The signals matched perfectly in both detectors.

Pictures from HAC Members

Star Party at Montezuma Pass – By Bob Gent

Moon at Montezuma Pass – By Bob Gent

Montezuma Star Pass: Woman with Telescope - By Adam Curtis

Jupiter - By Mike J. Shade

PGC 39432 – By David Roemer

Comet PANSTARRS by David Roemer

WantAds

FOR SALE: StellaCam

StellaCam II video camera with video to computer adapter to view on a computer monitor. $150.00.

Contact Bob Kepple at 520-366-0490, or Astrocards@aol.com.

FOR SALE: Meade Starfinder 8" Reflector Telescope

Will sell at a very reasonable price. Included are a Telrad Finder, Filters, and additional Lenses.

Contact Mr. Jim Moses at (520) 803-0913 or by email jjmoses2@gmail.com

FOR SALE: Celestron Celestar 8 inch S/C Deluxe - $1200.

Will also sell pieces individually

Contact Rhonda and Terry Taylor at (520) 366-2378 or by email at twrl2@yahoo.com. Or See Craigslist at http://sierravista.craigslist.org/bar/4523742100.html

FOR SALE: Older Optical Guidance Systems 12.5" f/9 Ritchey-Chretian telescope.

Very good Paul Jones ceramic optics, Robofocus secondary focuser, will include Takahashi collimating telescope. Some of the images through the scope are at Mshadephotography.com.

Contact Mike J. Shade at mshade@q.com

FOR SALE: 8" Celestron Nex Star

Good condition with all original accessories.

Contact Mae Childs at maechilds2014@aol.com

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For more information on products and contact information, their websites are:

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HAC March/April Calendar of Events

SU	MO	TU	WE	TH	FR	SA
10	**11**	**12**	**13** 11:59 PM	**14** Patterson Public Night 7:30PM	**15** HAC Meeting Library Commons S. Morrison	**16**
17	**18**	**19**	**20**	**21** Earth Day Vet Park SV 10 AM Lyrid Meteors	**22** 1:24 AM Lyrid Meteors	**23** Passover Begins Lyrid Meteors
24	**25**	**26** Juno Opposition	**27**	**28** Valley Union H.S. Elfrida 7PM	**29** 11:29 PM Math and Science Expo 8AM Patterson	**30** Passover ends
May 1 May Day	**2**	**3**	**4** Eta Aquariid Meteors	**5** Eta Aquariid Meteors	**6** 3:30PM Eta Aquariid Meteors	**7**
8 	**9** Patterson Obs. 7AM Transit of Mercury	**10**	**11** D.H.S.at Patterson 7:30PM	**12** Patterson Public Night 7:30PM	**13** 1:02PM	**14** Astronomy Day Sierra Vista Library 10AM-3PM
15	**16** 	**17**	**18**	**19**	**20** HAC Meeting Student Union John Kalas Bill Lofquist	**21** 5:14PM
22 Mars at Opposition	**23**	**24**	**25**	**26**	**27**	**28**
29 8:12AM	**30**  Mars closest approach	**31**	**Jun 1** MAC Lunch TMAC	**2**	**3**	

TRANSIT OF MERCURY MAY 9TH **ASTRONOMY DAY MAY 14**

All event times MST. Join Haclist to keep up to date with all of the Huachuca Astronomy Club events
Send an email to: haclist-subscribe@yahoogroups.com