LONGMONT ASTRONOMICAL SOCIETY October 2023

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Next LAS Meeting Thursday, October 19 at 7 pm

Astro-photography some Astro-physics Astro-art and Accidental Discoveries

David Elmore Longmont Astronomical Society

David Elmore is an Astronomer Emeritus for the National Solar Observatory. His professional career centered around conceptualization, design, and construction of solar research instruments attached to solar telescopes. His particular expertise is in measurement of magnetic fields on the sun utilizing the polarization properties of light. His instruments have been deployed at observatories around the world, the stratosphere, and on spacecraft. After decades at the High Altitude Observatory of the National Center for Atmosphere, Mr. Elmore served as Instrumentation Scientist for the newly completed and world's largest solar telescope, the National Science Foundation Daniel K. Inouye Solar Telescope.

Astrophotography has been a hobby for David from film to digital. Currently he remotely operates wide-field telescopes located in a rented observatory at a dark site in southern New Mexico. This talk features images from that observatory tracing the cycle of life in the Milky Way from clouds of galactic cirrus to new stars to planetary nebulae and super novae back to clouds in the galaxy. As a sidelight David will describe the accidental discovery of three never before identified planetary nebulae.

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About LAS

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The Longmont Astronomical Society is affiliated with the Astronomical League (https://www.astroleague.org). The Astronomical League is an umbrella organization of amateur astronomy societies in the United States.



Planets in October

Mercury

Mercury is visible low in the eastern morning sky the first week of October. It is magnitude -1.1 in brightness and the disc is 5.7 to 5.2 arc sec across.

Venus

Venus is visible around 6 am in constellation Leo. It is magnitude -4.4 in brightness and the disc decreases from 32 to 22 arc sec across during the month.

Mars

Mars is not visible this month.

Jupiter



Jupiter is in the constellation Aries. It is around magnitude -2.9 in brightness and disc is about 49 arc sec across. It will be at opposition on November 2nd. The following are good times to view the Great Red Spot (GRS) at mid transit:

- Oct 1 at 6:03 am altitude 46°
- Oct 2 at 1:54 am altitude 62°
- Oct 4 at 3:32 am altitude 65°
- Oct 4 at 11:23 pm altitude 39°
- Oct 6 at 5:10 am altitude 51°
- Oct 7 at 1:01 am altitude 57°
- Oct 9 at 2:40 am altitude 66°
- Oct 9 at 10:31 pm altitude 33°
- Oct 11 at 4:18 am altitude 56°
- Oct 12 at 12:09 am altitude 53°
- Oct 13 at 5:56 am altitude 38°
- Oct 14 at 1:47 am altitude 65°
- Oct 14 at 9:38 pm altitude 27°

- Oct 16 at 3:25 am altitude 60°
- Oct 16 at 11:16 pm altitude 47°
- \bullet Oct 18 at 5:03 am altitude 43°
- Oct 19 at 12:54 am altitude 63°
- Oct 19 at 8:45 pm altitude 21°
- Oct 20 at 6:41 am altitude 23°
- Oct 21 at 2:32 am altitude 63°
- Oct 21 at 10:23 pm altitude 41°
- Oct 23 at 4:10 am altitude 49°
- Oct 24 at 12:01 am altitude 59°
- Oct 25 at 5:48 am altitude 29°
- Oct 26 at 1:39 am altitude 65°
- Oct 26 at 9:31 pm altitude 36°
- Oct 28 at 3:17 am altitude 53°
- Oct 28 at 11:09 pm altitude 54°
- Oct 30 at 4:55 am altitude 34°
- Oct 31 at 12:47 am altitude 65°
- Oct 31 at 8:38 pm altitude 30°

Saturn

Saturn is visible in the evening sky in constellation Aquarius. It is magnitude +0.6 in brightness and the disc is 18 arc sec across.

Uranus

Uranus maybe best seen in the morning sky in constellation Aries. It is magnitude +5.6 in brightness and the disc is 3.7 arc sec across.

Neptune

Neptune is visible in the evening sky in constellation Pisces. It is magnitude +7.8 in brightness and the disc is 2.3 arc sec across.

Lunar Phases in October

- Third quarter: October 6 at 7:49 am
- New moon: October 14 at 11:56 am
- First quarter: October 21 at 9:31 pm
- Full moon: October 28 at 2:25 [m

Meteor Showers in October

• Orionids peak night of October 21/22; radiant is at RA=06h20m Dec=+16°00', expect 10-20 per hour. Best to view from dark location after the moon sets at 11:36 pm.

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Comet 2P/Encke							
Greated	cturus Coma DR mrs Spica suith Sky Tools 4	Berenices M53	Denebola 10/10 10/12 6n 10/10 60 10/10 60	Zosma lola en lolo en lolo en lo en	9 9 30 0 Algieba Moon Regulus Venus	Cance Alphard	
Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)	
Oct 1	5:38 am	10h31m55.5s	+17°01'37"	Leo	8.9	3.0	
Oct 7	5:48 am	11h18m17.2s	+10°01'32"	Leo	8.1	2.8	
Oct 13	5:57 am	12h02m37.4s	+02°41'01"	Virgo	7.3	2.5	
Oct 18	6:17 am	12h40m02.3s	-03°30'53"	Virgo	6.9	2.3	
Comet Vent	103P/Hart	tley Cancel	H Pollu 1017 1017 611 611	R 2890 Castor Ca	BO CONTRACTOR	Alnath Faurus Alde Betelgeuse Bellatrix	
Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)	
Oct 1	5:27 am	06h41m17.4s	+29°52'01"	Auriga	9.7	3.6	
Oct 7	5:32 am	07h12m22.4s	+24°34'16"	Gemini	9.6	3.5	
Oct 13	5:38 am	07h38m03.9s	+19°18'30"	Gemini	9.7	3.4	

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9.9

10.0

10.3

3.2

3.1

2.9

Cancer

Cancer

Hydra

Oct 19

Oct 25

Oct 31

5:43 am

5:49 am

5:55 am

07h59m14.7s

08h16m42.5s

08h31m04.4s

+14°18'58"

+09°42'50"

+05°32'25"

Comet C/2020 V2 (ZTF)



Created with SkyTools 4

Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)
Oct 1	1:49 am	01h32m32.0s	-32°18'16"	Sculptor	10.2	3.4
Oct 7	1:08 am	01h14m58.8s	-35°17'28"	Sculptor	10.3	3.3
Oct 13	12:27 am	00h57m25.9s	-37°43'41"	Sculptor	10.4	3.2
Oct 19	11:47 pm	00h40m31.5s	-39°36'58"	Phoenix	10.6	3.0
Oct 25	11:07 pm	00h24m48.6s	-41°00'01"	Phoenix	10.8	2.9
Oct 31	10:30 pm	00h10m40.0s	-41°57'07"	Phoenix	10.9	2.7

Comet 12P/Pons-Brooks



Alphekka

Created with SkyTools 4

Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)
Oct 1	8:09 pm	17h21m03.0s	+46°39'21"	Hercules	11.4	4.7
Oct 7	8:06 pm	17h23m32.1s	+45°35'51"	Hercules	11.2	4.8
Oct 13	7:57 pm	17h26m59.9s	+44°34'21"	Hercules	11.1	4.9
Oct 19	7:48 pm	17h31m24.3s	+43°35'34"	Hercules	11.0	4.9
Oct 25	7:38 pm	17h36m43.0s	+42°40'07"	Hercules	10.9	5.0
Oct 31	7:32 pm	17h42m54.6s	+41°48'27"	Hercules	10.7	5.1

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Binocular Highlights

A: On the western side of the Keystone glows the Great Hercules Cluster, a ball of 500,000 stars. B: 40% of the way between Altair and Vega, twinkles the "Coathanger," a group of stars outlining a coathanger. C: Sweep along the Milky Way for an astounding number of fuzzy star clusters and nebulae amid many faint glows and dark bays, including the Great Rift. D: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval. E: Between the "W" of Cassiopeia and Perseus lies the Double Cluster.



Astronomical League www.astroleague.org/outreach; duplication is allowed and encouraged for all free distribution.



ASTRONOMICAL LEAGUE Double Star Activity



Other Suns: Gamma Andromedae How to find Gamma Andromedae on an October evening Face northeast. Find the Great Square and the curve of stars extending to the lower left. This is Andromeda. Gamma is the third star on the string and is as bright as the major stars of the

Big Dipper. From the "W" of Cassiopeia, Gamma lies to the lower right.

Gamma Andromedae

A-B separation: 9.7 sec A magnitude: 2.3 B magnitude: 5.0 Position Angle: 63° A & B colors: orange, blue



1° field of view

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Newsletter Archive

30 years ago October 1993

From the President, Bob Spohn:

First of all, we have a big FRASC event this Saturday, the 23rd. This newsletter has all the info on what's going on that day: I specifically want to draw our attention to the FRASC meeting. These only happen twice a year, and are wonderful for keeping informed of what our neighbor clubs are up to. I'd like to encourage a big LAS turnout for several reasons: 1) they're fun!; 2) none of us made it last time!; 3) it keeps us all up to date on amateur astronomy in the Rocky Mountain region.

The LAS will be conducting a public observing session for the citizens of Lyons on the night of November 20th. The observing site is located at Meadow Park in the town of Lyons. Members are encouraged to bring their telescopes and make this an enjoyable and educational experience for the people of Lyons.

20 years ago October 2003

Fox Park Report- Gary Garzone

"We started at 7:30 pm, gets dark much earlier now, for very long night of viewing We had low temp of 24° but not much frost because it was so dry. The seeing totally sucked Friday, despite the very transparent skies. But Saturday night was much better with transparent skies and good seeing, awesome combo at 9000+ ft. The cold kept all bugs away, very nice after long summer of mosquitoes, and listen to elk bugle several times in the forest near us. Does it ever get any better than this??? Wow! The best Milky Way views all summer, working its way down to ground through the trees branches. You can only do that at true dark sky places which is why we drive so far to Fox park. I am still a little star struck with so many photons still racing around in my brain."



Jupiter by Vern Raben in Sept. 2013

10 years ago October 2013

From the President, Bill Tschumy:

We have a great meeting coming up this Thursday. Mike Roos is going to give a talk on Photographic Messier Marathons. Here is his blurb about the talk:

"I will cover some history of both visual and photographic Messier Marathons as well as variations such as the Messier Plus Marathon (110 objects, 73 Messier, 36 NGC and Coathanger Cluster designed to take place in the fall). Finally I will share images taken with the TEC-140 and Canon 6D from Pawnee Grasslands in March and Okie-Tex last week."

Friday we had a star party with the scouts scheduled. I called it off due to the iffy weather. However, Larry Bloom showed up anyway and was able to show them a few objects though the sucker holes. Thanks Larry.



Two Views of Veil Nebula (NGC 6892) by Gary Garzone in Sept. 2013



Observing the S. M. A. R. T. Way by Mike Hotka

You have a telescope and take it out under dark skies, those skies that are full of stars. You look up in awe and then start trying to find something to look at. You may start out by viewing the solar system objects. The Moon is cool to see. So are the brighter planets.

You may progress to things you've heard called Messier objects. These objects are pretty easy to find and cool to look at in your telescope. For the next few outings, you may revisit these same objects, or add newer Messier objects you did some research on.

There may become a point where you wonder if this hobby is really for you? You are not having any fun using your telescope. If you are not having fun, you are questioning, "Why am I doing this?"

For me, this question came shortly after I had started to consistently use my telescope under dark skies. I built a telescope with the help from my Dad, so I had invested quite a bit of time in the hobby already. But the satisfaction of seeing celestial objects was not there for me.

I was fortunate enough to find a mentor who helped guide me past this point and show me there was so much more to see than what I had been observing up to this point. He set me on the path I walk today.

Initially, I enjoyed the variety of objects in the Astronomical League's Messier Observing Program. After completing this program, I completed the Double Star Observing Program and some of the binocular Observing Programs.

Along the way, I met a good astro-friend, Brad Young, from Tulsa, Oklahoma at an Okie-Tex Star Party. In talking with him, I found out he had set himself a goal of observing 5,000 unique celestial objects. The unique aspect of this observing goal was the fact that no matter how many times you have seen M57, it only counts as one unique celestial object observation.

I was excited about this goal and adopted this same observing goal for myself. This one goal is the driving force that keeps me observing. Many years ago, I had to double this 5,000 object count goal because I had achieved 5,000 unique object observations. As I am writing this article, I have observed 7,534 unique celestial objects. What Brad had introduced me too was goal setting. This is the concept that if you have clearly defined goals, that are realistic to achieve, your mind takes over to find creative ways to achieve those goals.

There is a goal setting philosophy called S.M.A.R.T., which stands for Specific, Measurable, Achievable, Relevant and Time-Bound. S.M.A.R.T. goals are easily applied to our hobby. Whether you want to see 10,000 unique celestial objects, or image all the Abell Galaxy Groups, these kind of goals will drive you to getting your telescope out, month after month, and observing/imaging the wonders of the universe.

My Observing 10,000 Unique Celestial Objects goal fits the S.M.A.R.T. paradigm as follows:

- Specific 10,000 unique objects need to be observe
- Measurable It is a count. I use an astronomy database program to keep track of what I've observed and generate the statistics I need to support this goal.
- Achievable My initial goal was observing 5,000 unique objects which I surpassed many years ago.
- Realistic I had found a love for the sky by the time I heard Brad's goal and adopting this goal seemed very real to me.
- Time-Bound This is the one part of this goal setting process that is vague, with respect to our hobby. Looking at the idea behind Time-Bound another way, I get out as often as I can to view objects I have yet to see. I make time to observe.

Once this goal was defined, my mind took over to find objects to observe I have not seen before. There is a simple solution to my search for objects and that is the variety of Astronomical League Observing Programs, with each program having its own list of objects to view I had not seen.

Satisfying the observing 10,000 unique celestial objects goal had a side benefit that was not initially obvious. It has allowed me to complete so many Astronomical League Observing Programs. When I complete one, I immediately start the next. I am always viewing new objects I have never seen before. Each new object I logged increments the unique object observed count, always inching closer to the end goal. Make sure your goals are Specific. For me, a goal of taking my telescope out every month was too vague. The goal I adopted infers that. A fine goal might be to observe all the Astronomical League's Observing Programs. Another might be to observe from all the National Parks in the continental United States. Be careful with a goal like this because a goal, as related to our hobby, should be designed to get your telescope out more often. Visiting National Parks to observe might only happen twice a year. But if that is all you have time to for observing, then that would be a good goal.

With my specific goal, the progress can measure one of the two ways. You could create an Excel spreadsheet of the objects you will observe. Then have a column that is the date and another, the time of the observation. Create a COUNTA equation to count the number of cells of the date column that have a value in it and voila, there is your observed object count. The rows list a unique objects, ergo, the count is the number of unique celestial objects observed.

I use an astronomy database program called SkyTools 4 (ST4) to keep track of what I've observed. I've purchased the Standard Edition, which aligns with my observing goal nicely. More on how I use ST4 for my astronomy hobby in next month's article.

To measure my 10,000 unique celestial object observation count, ST4 has the ability to count the different class of objects that I've observed and logged into the database. There is a user interface to search database for objects with an observing log created for them. The following picture is this ST4 interface. You can see the number of galaxies I've seen and logged into the ST4 database is 3576:

H SkyTools 4 Visua 14.2 Car Log Browser × **Objects with Matching Log Entries** Class Night Observer Location Instrument Constellation Search Misc Andromeda Galaxy Arp 141 Arp 233 Arp 248 Arp 248 Arp 273 Arp 291 Arp 291 Comets Stars Galaxies Galaxy groups Quasars Planetary nebulae Nebulae Arp 324 Barnard's Galaxy Bear Paw Black Eye Galaxy Dark nebulae Open clusters Globular clusters Blinking Galaxy Bode's Galaxy Bow and Arrow Centaurus A Cigar Galaxy Comment Cocoon Galaxy Coddington's Nebula 3576 objects View Export Share Print/Copy New Entry Close Help

You can separately search all the other classes of objects you've logged into the database. In an Excel spreadsheet, add a row per object class to a spreadsheet containing the count of these objects observed. Use the SUM function to create a total sum the individual counts. This allows me to measure my progress towards my 10,000 unique object observations goal after all the observed objects for that observing outing have been logged into the ST4 database.

If you find you have lost the fun of our hobby, try setting a near-term, achievable goal to rekindle your flame. I am proof that setting my S.M.A.R.T. goal made all the difference for me. I have fun observing and cannot wait for the next New Moon cycle, so I can get my telescope out under dark skies and find objects I've never seen before.

Secretary Notes Thursday, September 21, 2023 by Eileen Hall-McKim

I. Introduction

The September LAS in-person/hybrid meeting was held on September 21st at the Longmont Lutheran Church. President, Vern Raben began the meeting with a self-introduction by all members attending in person and those on zoom. Sixteen members attended in-person, 18 attended via zoom.

II. Meeting Presentations

This evening we have two presentations: our guest speaker is Dr. John Spencer, with his presentation "Europa Clipper: Voyage to an Ocean Moon." Following will be LAS member Bill Tschumy with a talk on Cloud Forecasts.

Dr. John Spencer is an institute Scientist at the Southwest Research Institute in Boulder, where he has worked since 2004. John is Europa Thermal Imaging System Deputy Principal Investigator for the Europa Clipper's temperature mapping instrument, and a science team member on its ultraviolet spectrometer. The Europa Clipper is currently being built to explore Jupiter's moon Europa. John specializes in observations of the outer solar system, and Jupiter's moons in particular, with telescopes on the Earth's surface, the Hubble Space Telescope, and Interplanetary spacecraft.

Europa Clipper: Voyage to an Ocean Moon

Jupiter has been known since ancient times, being one of brightest objects in the sky, but only in historical times we've started to learn that Jupiter is another world. We got



our first detailed views of Jupiter with Galileo's invention of the telescope over 400 years ago. Looking at Jupiter with any small telescope or binoculars it is possible to see the planet and the four moons. We don't always see all of the moons at the same time as they move around the planet. The moons have fascinated people since their first discovery. Through observations in historic times of the four moons, one of the first things learned about the moons revealed a remarkable fact; the movements are predictable and provide a clock.

A Clock in the Sky

• A means to determine longitude!

 Alexander Mackenzie, July 22nd 1793, Bella Coola, British Columbia, reaching the Pacific after the first crossing of Canada

- I observed an emersion of Jupiter's third satellite ... which is equal to 128. 2. West of Greenwich.
- I had now determined my situation, which is the most fortunate circumstance of my long, painful, and perilous journey, as a few cloudy days would have prevented me from ascertaining the final longitude of it.

Study of the moons' orbits for longitude predictions revealed a remarkable fact...

A Clock in the Sky

- If you want to know where you are on Earth you can determine from the elevation of the Sun what your latitude is but to determine your longitude you will need to compare where the Sun is in the sky to a standard clock
- Jupiter's moons are a means to determine longitude! Since the movements of the moons of Jupiter are predictable this makes a really good clock. A lot of work was done early on observing the movements of the moons to determine longitude
- Alexander Mackenzie, July 22nd 1793, Bella Coola, British Columbia, upon reaching the Pacific after the first crossing of Canada "I observed an emersion of Jupiter's third satellite, which is equal to 128.2 west of Greenwich, I have now determined my situation", the moons orbital pattern allowed him to determine his longitude and that of the far west side of America

Resonance between the inner three moons

- Study of the moons' orbits for longitude predictions revealed that the inner three moons are locked in a pattern of resonance between the three moons
- Green line when Ganymede and Europa reach same position in their orbits and meet, a red line when Io and Europa reach same positions
- Europa and Io always meet on the same side of Jupiter and Europa and Ganymede always meet on opposite side in Jupiter
- Io goes around twice for every orbit of Europa and Europa goes around twice for every orbit of Ganymede. 4th

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the other three are locked together in this pattern

• This has profound implications although this was not recognized for a long time



1970's Surface Composition



- We learned about the moons spectrum in the early 70s once we had infrared instruments. We could then tell from this the moons were very different from each other and different from any other objects in the inner solar system like the terrestrial moons we are familiar with.
- Callisto: Very Dirty Ice Surface
- Io: Sulfur Covered Surface
- Europa: Bright Clean Ice Surface
- Ganymede: Water Ice Surface; not as dirty as Callisto, brighter surface

View of Jupiter from Voyager 1, March 1979

- 1979 Voyager Flyby mission got first views
- Can begin to see the moons as disks and able to detect the moons surface features

moon Callisto does not participate in this resonance, but • Io appears a yellowish color; Ganymede being larger with mottled surface; Europa being very bright; Callisto is always off to the side.



Images from Voyager 1 were just stunning, though a lot of them were not fully appreciated at the time they were taken because we did not have computing power to produce the gorgeous mosaics and color composites, that allowed us to see the beauty of the data. Here is a more recent image showing beautiful detail, Jupiter's great red spot, shadow of a moon; Europa in front of Jupiter's clouds already showing some interesting surface detail.

Four New Worlds - This is more high resolution global views that Voyager 1 obtained of Jupiter's four moons, compared to Earth's moon, all very different from each other



The Big Surprise-Intense Tidal Heating of Io

One of the most remarkable things that was learned very soon after the flyby is that Io is geologically active and covered with active volcanoes. This was totally unexpected, Io is very small, not believed to have a lot of internal heat. In fact, there are many active volcano erupting on Io. It is because of resonance between the moons that is creating rhythmic perturbations on the moons and distorting their interior thus creating frictional heat.

The Big Surprise-Intense Tidal Heating of Io



Earth: Tides from our Moon

New England Bay drains and fills every day with tides



- Same thing happens on the Earth with our moon
- On Earth water moves a few meters vertically every day
- Land also moves up and down ~1 meter
- But imagine having Jupiter in our sky instead of our moon, they are about the same distance apart as our Earth/moon system, we have this enormous body producing enormous tides, now you have the solid surface of Io moving 100 meter every day

Io: Tides from Jupiter



- This would not happen if Io was in a circular orbit, but orbit is eccentric, disturbed by the other moons in a rhythmic way due to this resonance
- Tides distort Io when closer to Jupiter; solid surface of Io moves 100 meters every day, so sometimes circular, sometimes more egg-shaped
- The continually changing shape heats interior, generating frictional heat, volcanism
- Infrared image of Io from Juno (top right) each bright spot an active volcano!
- Same things happening on Europa, though has 10x less heat, but still fair amount of heat

Europa from Voyager



- Has a very strange surface, unlike anything we have ever seen before; completely criss-crossed with fractures. We knew the surface of Europa was covered with ice, but from its gravity we know it is solid underneath, so we have a rocky body with ice layer on the outside and internal heat
- Internal heat from the tides could melt the ice and we would have an ocean
- When we have an ocean, the question of the possibility of life comes up as water is a prerequisite for life as we know it
- Arthur C. Clark 2010 Odyssey Two; science fiction of exploration beneath ice of Europa
- Return to Jupiter: Galileo Orbiter, 1995-2003
- There was a lot of interest in going back to Jupiter to follow-up on the discoveries made by the Voyager. Next mission was Galileo Orbiter, rather than flyby it went into orbit around Jupiter, making many looping orbits around Jupiter, flying by the moons, getting much closer views than we were able to get from Voyager; now we were able to zoom in on Europa.

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Europa Zoom-(1) Global view of Europa, the bright surface with crisscrossing network of lines. Next image zooms in on red box.



Europa Zoom -(2) (600 miles across) We see recent impact crater, not many craters are found, so surface is young,

further evident of internal heat, causing geological activity that is erasing those craters. We see many fractures. Next image will zoom in on the intersections of two fractures in red box at top of image.



Europa Zoom (3) (75 miles across) We see area of fractures crossing, actually parallel ridges, region below appears dark in the global view and is completely broken up and disrupted. Chaotic mass of broken chucks of surface. Next image will zoom in further on red box of this jumbled area.



Europa Zoom (4) (25 miles across) We see what looks a lot like "Icebergs" broken surface, pieces have been jostled, fractures displaced relative to each other, some pieces have been tilted on their side, there is believed to be an ice surface much softer underneath, not necessarily liquid immediately underneath, but material that can flow, when ridges break up allows those plates to move around. Next image will zoom in on small red box, low center



Europa Zoom (5) (2.5 miles across) Area of the highest resolution Galileo mission got. Erosion seen in extreme close-up. See end of ice plates, steep slopes and edges, this is a surface that has formed fairly recently



Galileo got color images as well. This is exaggerated color version, dark reddish brown material, concentrated along fractures in those broken, chaos regions, infrared instrument on board was able to measure the composition of these dark materials and there is a lot of salt. This is further evidence that there is an ocean underneath, wherever the surface is broken there is salt on the surface, further evidence for salty ocean, when the water gets to the surface it leaves the salt behind.



Europa really likes to make double ridges, they are everywhere; the most dominant land form on Europa (85 miles across) Whatever processes are occurring on Europa makes double ridges. Overlapping ridges indicate past chronology.



(10 miles across)

Cuspate Ridges – cracks spreading under the influence of the rhythmically changing stresses of Jupiter's tides. Double ridges not straight, sort of bounce across the landscape



A mobile surface – most geology lines up when adjusted in Photoshop, doesn't always match exactly but most geological surfaces line up: indicates very mobile surface



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Magnetic Sounding – What's going on in Europa's interior? Jupiter has a very strong magnetic field, because that field is tilted as Jupiter rotates, currents are generated that effect Europa's field, and it its constant changing in response to that. Can see in diagram interplay between Jupiter and Europa's magnetic fields. By analyzing this process can determine that there is a big ocean there. See Jupiter's fields (left) Europa field (right)













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Europa Habitable? Is it Inhabited?

- Big question could all this liquid water be hosting some kind life?
- Life (as we know it) needs three things; Liquid water, chemical raw materials, usable energy. We know there is liquid water, pretty sure about the chemical raw material building blocks, what not sure about is whether there is enough chemical energy or usable energy for life to thrive

Life without sunlight?



- Europa's ocean is below miles of ice- no sunlight
- Life occurs at vents in Earth's deep ocean but needs oxygen for photosynthesis, because of this, don't think this could be happening on Europa
- A few microorganisms exist deep in the Earth without sunlight or oxygen- this could certainly be happening on Europa

A Long Road Back to Europa

We learned from Galileo in the 1990's that Europa is a very exciting place and have wanted to get back there, has been

several ideas proposed but too many challenges for most.





Europa Clipper Mission (NASA Europa flyby mission) approved in 2015

Europa Clipper Mission Goals

Is Europa Habitable?

- Is the ocean really there?
- How thick is the ice? How deep is the ocean?
 Could we someday drill down into the ocean?
- What's the ocean composition?
 Is it a friendly environment for life?
- How much does the ocean interact with the surface?
- · Can surface chemicals reach the ocean to provide food for oceanic life?
- Do ocean materials erupt to the surface, maybe as plumes?

Mission Concept; will launch October 10, 2024 on a Falcon Heavy



- Mars gravity assist, 02/2025, Earth gravity assist, 12/2026
- Jupiter Orbit Insertions; 04/11/2030



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Engineering Challenges

Radiation

- Lethal dose for humans in ~1 day
- Lots of radiation shielding
 - Heavy!Not 100% effective
 - Not 100% effective
 Vault" contains mos
- "Vault" contains most of the sensitive electronics
- Power
 - Solar energy is 27x weaker than at Earth
 - Solar panels are huge, unwieldy
- Propulsion
- Getting a big, heavy, spacecraft into Jupiter orbit takes a lot of time and fuel
 6-year cruise, with flybys of Mars and Earth for gravity assist
- Have overcome all these challenges and spaceship is ready to go!

Europa Clipper Spacecraft Image



- NASA's largest-ever interplanetary spacecraft
- 16 ft high; 100-foot "wingspan"
- 3.5 tons, without fuel
- Take a virtual tour at: <u>http://europa.nasa.gov/space-craft/meet-europa-clipper/</u>

Instruments on Board

- Ultraviolet Spectrometer (maps atmospheric emissions)
- Europa Imaging System (narrow and wide-angle cameras)
- Mapping Infrared Spectrometer for Europa (near-infrared; surface composition)
- Europa Thermal Emission Imaging System (thermal infrared camera: surface temperature)
- Europa Clipper Magnetometer (probes ocean)
- Plasma Instrument for Magnetic Sounding (probes ocean)
- Gravity science (measures Europa's tidal flexing)
- Radar (probes ice shell)
- Mass Spectrometer (chemical analysis of Europa's atmosphere and plumes)
- Surface Dust Mass Analyzer (chemical analysis of dust kicked up from the surface)

Europa Clipper Science Instruments - view of all 10 instruments



Mapping the Geology



E-THEMIS: Clipper's Thermal Mapper

Geological map of Europa showing the different types of surfaces we see. Red lines are all the ground tracks of the spacecraft during the 49-50 orbits it will make. Spacecraft will be coming low over the surface in all these places and as you can see there is quite good coverage of the ground surface from the entire mission.



This is the instrument John works on, he is Deputy Principle Investigator for this instrument. Measures thermal infrared wavelengths, mostly measuring temperature (John's dog on the left) By taking images with thermal radiation can measure surface temperatures and see how they vary across the surface.

Closeup of the thermal mapper:



Thermal mapper has small plate on side with the names of those who worked on it

The thermal mapper is an important instrument to find out where the heat is leaking out of Europa, where the ice is thinner, less insulation of surface, much like what be used on a house to see where heat leaking out



Telephoto Camera Delivered, **April 2023**, close-up below, looks sort of like a tabletop dobsonian, is an 8" telescope







Stacking of avionics onto propulsion module, June 13th 2023



A big moment when the "brain" of the spacecraft got mounted to avionics module including all the instruments. Really when the spacecraft first came together for the last time as a final unit. September 21. 2023 High-gain antenna installed, main antenna is attached, getting close to completion in a month or two will be sent to another building to do environment testing, vibrate, subject to magnetic radiation, see how it performs in thermal vacuum and under intense radiation, later in 2024 solar panels being built in Europe will be added to it, pretty much ready for launch in October 2024



The Science Team



Over 100 scientist working on this. Chief scientist, Bob Pappalardo, (bottom left) there are a lot of young scientists that we need because some will be retiring before end of mission, but also have Margy Kivelson, Leader of the magnetometer team: Age 94 (not a typo) Yes, she is 94!

This mission is of course, all about science, but also about a human endeavor. Poet Laureate, Ada Limon wrote a poem for the mission, which will be on a plaque on the spacecraft. Arching under the night sky inky with black expansiveness, we point to the planets we know, we

pin quick wishes on stars. From earth, we read the sky as if it is an unerring book of the universe, expert and evident.

Still, there are mysteries below our sky: the whale song, the songbird singing its call in the bough of a wind-shaken tree.

We are creatures of constant awe, curious at beauty, at leaf and blossom, at grief and pleasure, sun and shadow.

And it is not darkness that unites us, not the cold distance of space, but the offering of water, each drop of rain,

each rivulet, each pulse, each vein. 0 second moon, we, too, are made of water, of vast and beckoning seas.

We, too, are made of wonders, of great and ordinary loves, of small invisible worlds, of a need to call out through the dark.

Some of the questions raised by members during the talk: What forms dark reddish brown colors? What is significance of ridges crossing each other? Why some double ridges curved and others straight? Where does the spacecraft go after Europa? On the reddish brown compounds from earlier, are there believed to be carbon based compounds on Europa? Reaction Wheels- How big are they? Do they spin constantly? Do the surface ridges and cracks form quickly or gradually over time? Did Jupiter's moons all form together?

Full recording of meeting available on LAS members site

More information: <u>Europa.nasa.gov</u>

To have your name added to plaque: send your name to Europa: <u>https://go.nasa.gov/MessageInABottle</u>

Bill Tschumy – Cloud Forecasts

Amateur astronomers are very interested in knowing the expected cloud cover conditions and the timing of when the skies may be clearest to observe or image. We may look at local forecasts for weather, or something like weather underground, with hourly percentages of cloud cover, and must judge based on this. These are point forecasts, looking at a location right over you, but these are not very accurate for expected cloudiness over larger region. Many different weather models showing us their predictions, but many do not agree.

<u>Weather.US</u> Image – Bill uses and recommends paying for to avoid excessive ads.

When compared to Canadian, European, American, German, Australian models- all are different. Some similarities, but differences in clearing and amount of cloud cover. There are many models out there: RPDS- Canadian model ECMWF- European model GFS- American model ICON- German model CONUS- Swiss weather model

ACCESS-G Australian model

- Take home message is that there are many models and all are different
- On scale of 20 miles or so, don't agree at all
- Can't assume going to be clear at your location
- Timing these models are generated about every 4 hours, more to consider
- An average of all models gives best chance of accuracy

Helps to look at a site that shows a map of the prediction Look at several models to see that many agree on 30 or so mile area

Use a map that can be animated so can look at forecast into several hours around your planned observing time When trying to plan for star-parties or observing, Bill look's at 5-6 weather models to try to get agreement of several models

NBM – National Blended Models- averages many models, often accurate but can also be wrong

Bottom line: Cannot depend on one particular model but need to look at several to try to get average or most agreed upon forecast of area you are going to try to observe sky from. Also look at larger scale maps of trajectory of weather movement to determine the timing of how An App Bill likes a lot is VentuSky. He also says Astrospheric is good, writer uses three different models, can click on full map, when planning, bring up big map, broader view, see where the big holes areas, need large clear areas predicted for planning to observe.

Here are some links to weather websites from Bill in a follow up email after the meeting:

<u>www.weather.us</u> - The weather.us site is geared towards weather nerds. Not the easiest site to use but it has lots of info. If you don't have a paid subscription I find the ads pretty much ruin the site.

<u>www.ventusky.com</u> - This site will show the cloud forecast from 5 different weather models. Since it is free they don't have quite a fine a time resolution as weather.us . They have apps for mobile devices as well.

<u>www.astrospheric.com</u> - This is a great site for quickly getting an idea of the cloud forecast over the next few days. Bill subscribes to the Pro level which adds some features he finds useful. This also has an app.

www.windy.com - It has really great visualizations of many weather parameters. It is primarily map based, but you can bring up a multi-day forecast for your location by using the "Search" field in the upper left. Windy has an app as well but on iOS the is at least one an imposter also called Windy. You want the red icon Windy.com app rather than the one with the blue icon.

III. Treasurer Report - Bruce Lamareaux



Longmont Astronomical Society

P.O. Box 806 Longmont, CO 80502-0806

LAS Treasurer's Report - Bruce Lamoreaux

9/21/2023

Main Checking Account (xxx-1587)

Begin Balance: Deposits: Expenses: Current Balance:	\$ \$ \$ \$	9,160.00 - - 9,160.00	8/3/2023 Bank Charges 9/5/2023		
<u>2-Year Savings Account</u> (xxx-1478)	(ma	atures 10/23/	(23)		
Past Balance:	\$	8,155.00	3/31/2023		
Interest:	\$	15.00			
Balance:	\$	8,170.00	6/30/2023		
<u>Telescope Fund</u> (xxx-0165)					
Past Balance:	\$	1,100.00	7/28/2023		
Deposits:	\$	-			
Expenses:	\$				
Balance	\$	1,100.00	8/30/2023		
Petty Cash					
Past Balance:	\$	50.00			
Deposits:	\$	-			
Expenses:	\$	_			
Balance	\$	50.00			
Total Assets	\$	18,480.00	\$18,480.00 \$	-	Same as Last Report
Active Membership:		99			
Student Membership:		2			
Total		101			

IV. Old/New Business

Upcoming Events:

- September 30 6:30pm-10 pm Talk by Hunter Morrison at Sandstone Ranch Visitor Center and Star Party in upper parking lot for City of Longmont Recreation Dept
- October 7 10am-12pm Solar Scopes with Longmont Astronomical Society at Louisville Public Library
- October 14 9am-11am Solar Eclipse Watch Party at Louisville Community Park
- October 19 7pm-9 pm LAS October Meeting

Other Topics

- LAS Membership Portal? Vern set up a membership portal several months ago @ <u>members.longmontastro.org</u> On here you will find you already have an account and will find links to all past meetings and presentations and more to come. This is separate from the LAS website <u>www.longmontastro.org</u> Squarespace does not keep track of memberships and some other things that this separate site can provide. The two sites are separate for now, but there will be link between the two on main website. Vern asks for email feedback on what members think about this setup.
- Will be getting dark earlier now, we can start doing some things early in the evenings around our usual meeting time. Is there interest in doing video workshops, tutorials as we did last year, such as M.J's Astrophotography Processing and Vern's Planetary Imaging? Also can do live astronomy events; planets, occultations like we did last year.
- Eileen Hall-McKim working on a research design project in Royal Astronomical Society of Canada (RASC) research/ discussion group P.A.R.S.E.C (Promoting Amateur Research and Scientific Exploration of the Cosmos) Looking for LAS images of globular clusters for research purposes. Compiling a Glob Gallery Portfolio to study such things as structure, density, concentration class, unique/similar characteristics and more. Please send to: eileen.mckim@colorado.edu include GC designation, approx. date of image, any other data or information about the cluster you have and want to ad. Suggestions, additional resources and information appreciated!



Comet C/2023 P1 (Nishimura on Sept 9 by Jim Pollock



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VDB 130 By DAVID ELMORE