Longmont Astronomical Society

June 2024

NGC 6888 by Stephen Garretson

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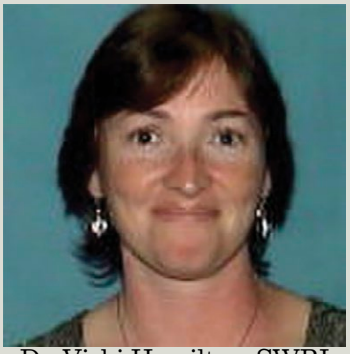
Next LAS Meeting June 20 at 7 pm

NASA's OSIRIS-REx Mission: Early Results from Asteroid Sample Analysis by Dr. Vicky Hamilton

Summary

The primary objective of NASA's Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) mission is to explore and return a pristine sample from the asteroid Bennu to help scientists understand the origin and evolution of our solar system and, ultimately, how life began. After arriving at Bennu in 2018, the spacecraft gathered data to understand the asteroid and select a sampling site. A sample was collected successfully in October 2020 and OSIRIS-REx began its return to Earth in May 2021. In September of 2023, the sample was successfully returned to Earth -- the mission science team has begun analysis of this incredible sample and this presentation will describe early results.

Biography


Dr. Vicki Hamilton, SWRI

Dr. Vicky Hamilton is an Institute Scientist at Southwest Research Institute (SwRI) in Boulder, Colorado. She received her Ph.D. from Arizona State University and her A.B. from Occidental College. She is a geologist specializing in laboratory spectroscopy of minerals, meteorites, and returned samples, and infrared remote sensing of planetary surfaces to determine composition and physical properties. She has been a science team Co-Investigator and Deputy Instrument Scientist/Principal Investigator on five NASA planetary science missions to Mars and asteroids. She is also the Chair of the Mars Exploration Program Analysis Group (MEPAG), a research community-based, interdisciplinary forum providing the science input needed to plan and prioritize NASA's Mars exploration activities.

The meeting will be at the First Evangelical Lutheran Church, 803 Third Avenue, Longmont, CO 80501. If you cannot attend the in-person meeting, it will be available on Zoom. Vicki will present in person.

About LAS

The Longmont Astronomical Society Newsletter ISSN 2641-8886 (web) and ISSN 2641-8908 (print) is published monthly by the Longmont Astronomical Society, P. O. Box 806, Longmont, Colorado. Newsletter Editor is Vern Raben. Our website URL is https://www.longmontastro.org and the webmaster is Sarah Davis. The Longmont Astronomical Society is a 501 c(3), non-profit corporation which was established in 1987.

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.

Contents

Planets in June

Mercury

Not visible this month.

Venus

Not visible this month.

Mars

Mars is visible in the eastern morning sky. It is magnitude +1.0 magnitude in brightness; the disk increases from 5.0 arc sec across to 5.4 this month. It won't be up high enough before sunrise to begin imaging until about the end of July.

Jupiter

After the 15th Jupiter becomes visible in the bright morning twilight in the ENE. It is -2 magnitude in brightness and disk is 33 arc sec across

Saturn

Saturn is visible in the morning sky in the SE. It is about magnitude +1.1 in brightness and the disk is 17 arc sec across.

Uranus

Uranus also returns to view in the morning sky the last week of the month. It is magnitude 5.8 in brightness and disk is 3.4 arc sec across.

Neptune

Neptune is visible in the ESE in constellation Pisces before sunrise. It is magnitude 7.9 magnitude in brightness and the disk is 2.2 arc sec across.

Lunar Phases in June

New Moon:
June 6 at 6:39 am

First quarter:
June 13 at 11:20 pm

Full Moon:
June 21 at 7:09 pm

Third quarter:
June 28 at 3:55 pm

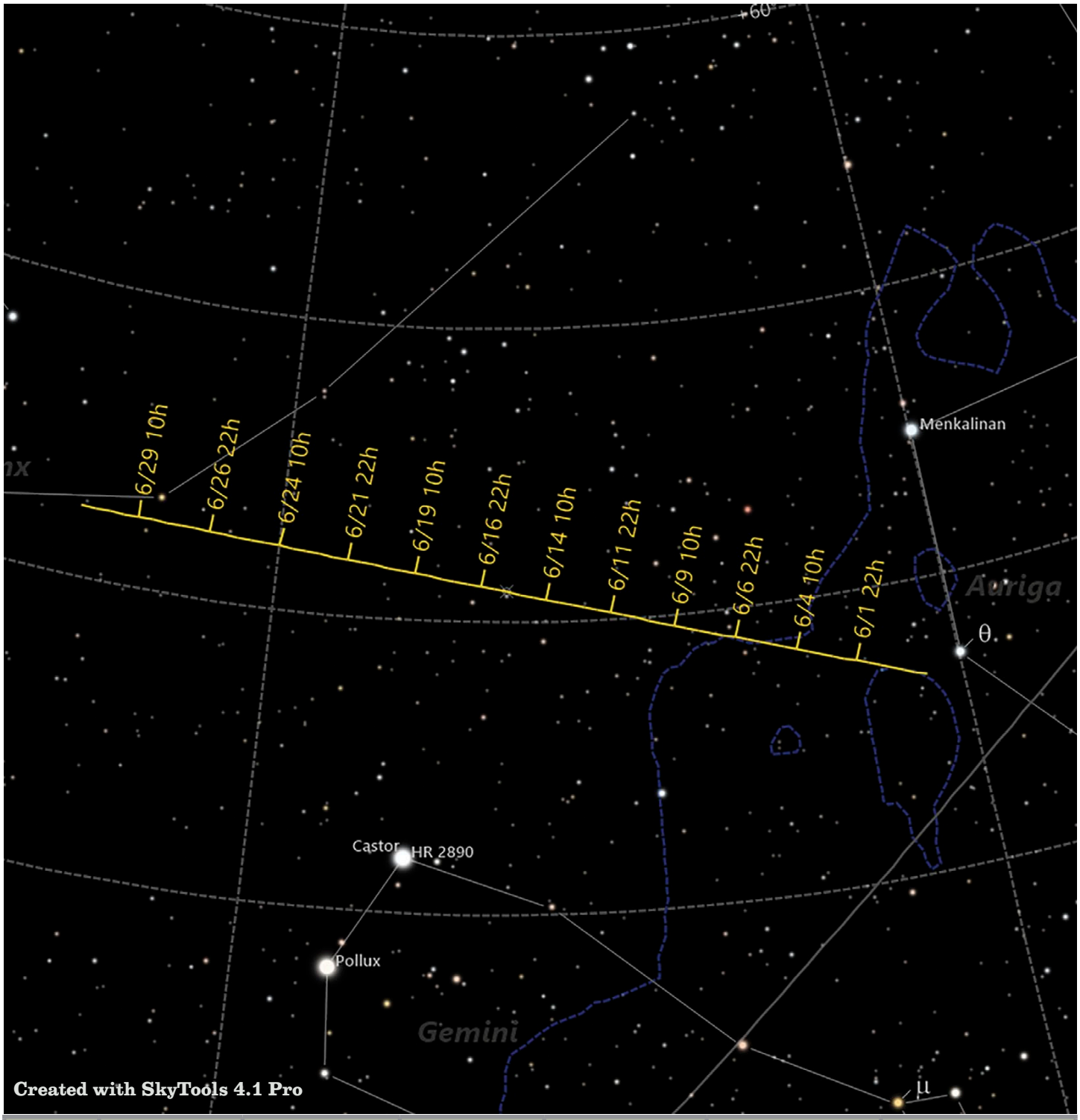
Images created with NASA Scientific Visual Studio's Moon Phase and Libration Tool.
See https://svs.gsfc.nasa.gov/5187/

Showpiece Objects in June

Some early evening objects for mid June:

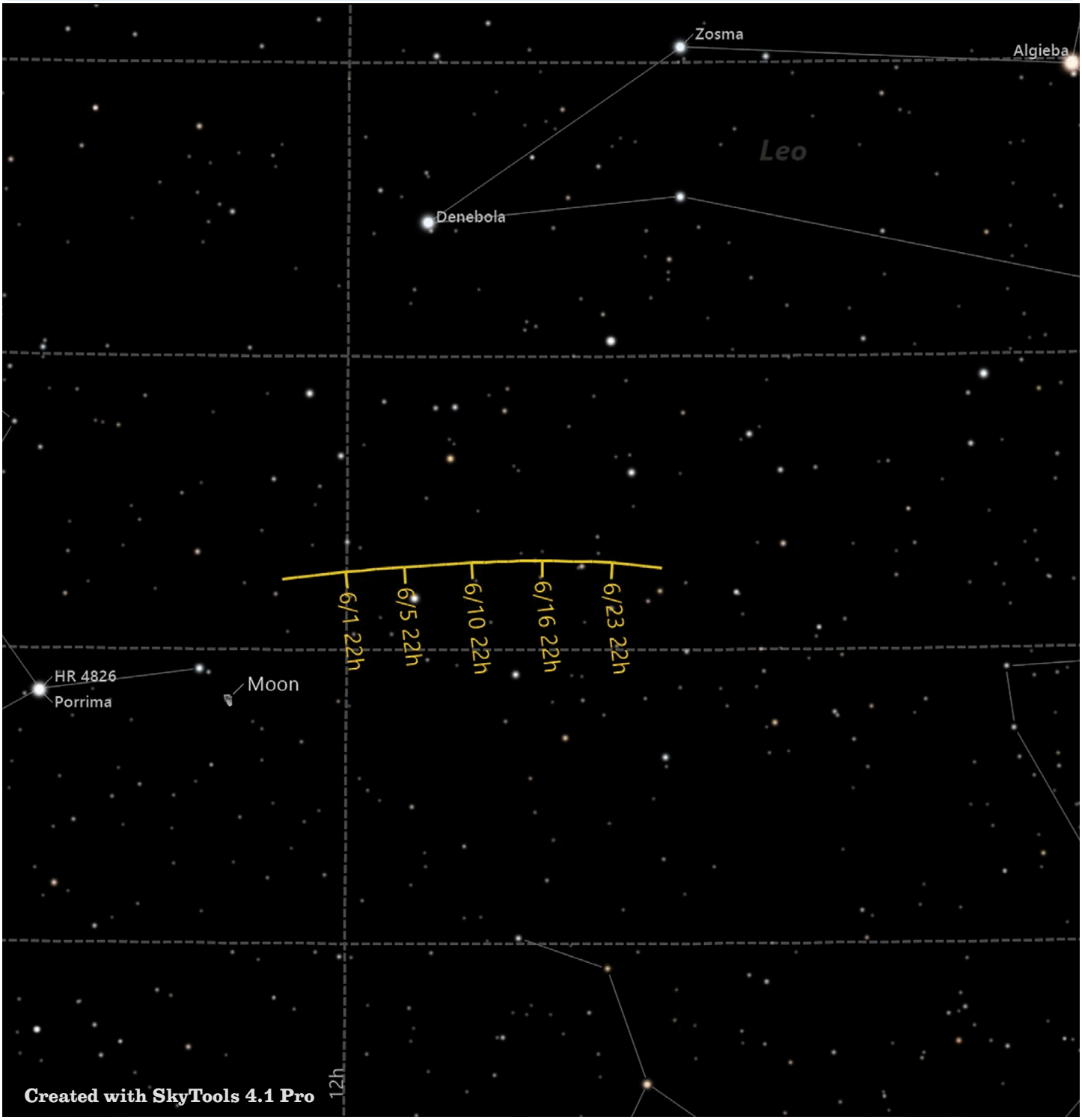
- M 5 globular cluster in Serpens, mag 5.7
- M 3 globular cluster in Canes Venatici, mag 7.7
- M 81 "Bodes" spiral galaxy in Ursa Major, mag. 7.8
- M 101 "Pinwheel" spiral galaxy in Ursa Major, mag 8.4
- M 51 "Whirlpool" spiral galaxy in Ursa Major, mag 8.7
- M 82 "Cigar" irregular galaxy in Ursa Major, mag 9.0
- NGC 5053 globular cluster in Coma Berenices, mag 9.0
- M 106 spiral galaxy in Canes Venatici, mag 9.1
- M 104 "Sombrero" galaxy in Virgo, mag 9.1
- NGC 5466 globular cluster in Bootes mag 9.2
- M 63 "Sunflower" galaxy in Canes Venatici, mag 9.2
- NGC 5634 globular cluster in Virgo mag 9.5
- M87elliptical galaxy in Virgo mag 9.6
- M 97 "Owl" nebula in Ursa Major, mag. 9.7
- NGC 4490, "Cocoon" galaxy in Canes Venatici, mag 9.8
- M 86 "Makarian's chain of galaxies" in Virgo, mag 9.8
- NGC 2683 spiral galaxy in Lynx, mag 10
- NGC 3115, "Spindle" galaxy in Sextans, mag 10.0
- NGC 4565, "Hockey stick" galaxy in Coma Berenices, mag 10.1
- M 96 spiral galaxy in Leo, mag 10.1
- M 88 spiral galaxy in Coma Berenices, mag 10.2
- NGC 4244 "Silver Needle" galaxy in Canes Venatici, mag 10.4

Comet 13P/Olbers in June



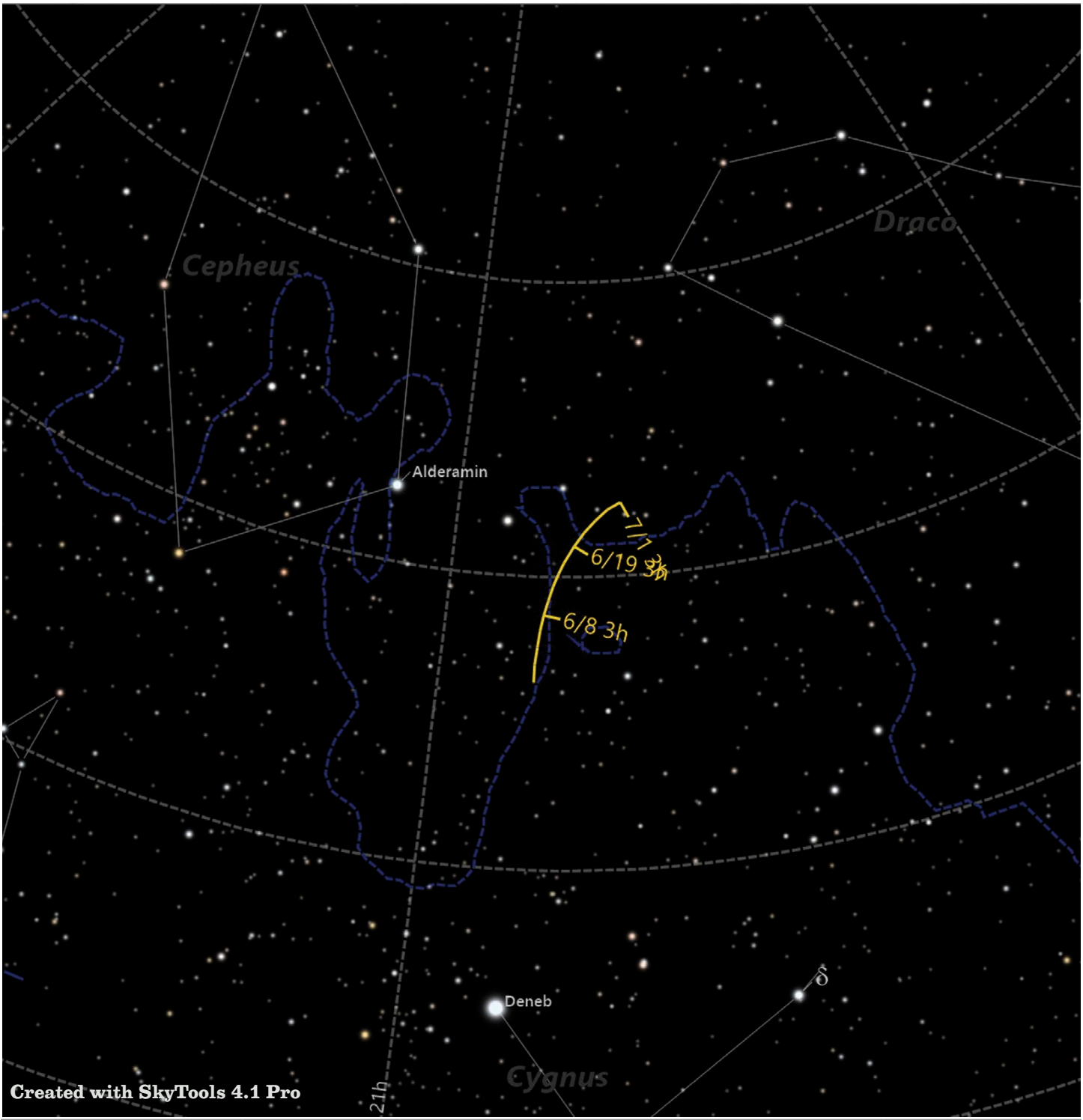
Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)
June 1	9:43 pm	06h19m09.6s	+37°36'55"	Auriga	7.6	2.5
June 8	9:49 pm	06h47m54.7s	+39°29'31"	Auriga	7.3	2.6
June 13	9:52 pm	07h10m15.3s	+40°36'11"	Auriga	7.1	2.6
June 19	9:54 pm	07h38m58.7s	+41°36'52"	Lynx	7.0	2.7
June 25	9:57 pm	08h09m34.2s	+42°12'04"	Lynx	6.9	2.7
June 30	9:58 pm	08h36m10.4s	+42°18'46"	Lynx	6.8	2.7

Comet C/2023 A3 (Tsuchinshan-ATLAS) in June



Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)
June 1	10:12 pm	12h01m25.3s	+02°30'57"	Virgo	9.7	1.5
June 8	10:14 pm	11h47m46.6s	+02°47'49"	Virgo	9.6	1.5
June 13	10:14 pm	11h39m15.9s	+02°53'24"	Virgo	9.5	1.5
June 19	10:12 pm	11h30m20.8s	+02°53'34"	Leo	9.3	1.4
June 25	10:11 pm	11h22m44.4s	+02°47'17"	Leo	9.1	1.4
June 30	10:07 pm	11h17m18.6s	+02°37'35"	Leo	9.0	1.4

Comet C/2021 S3 (PanSTARRS) in June

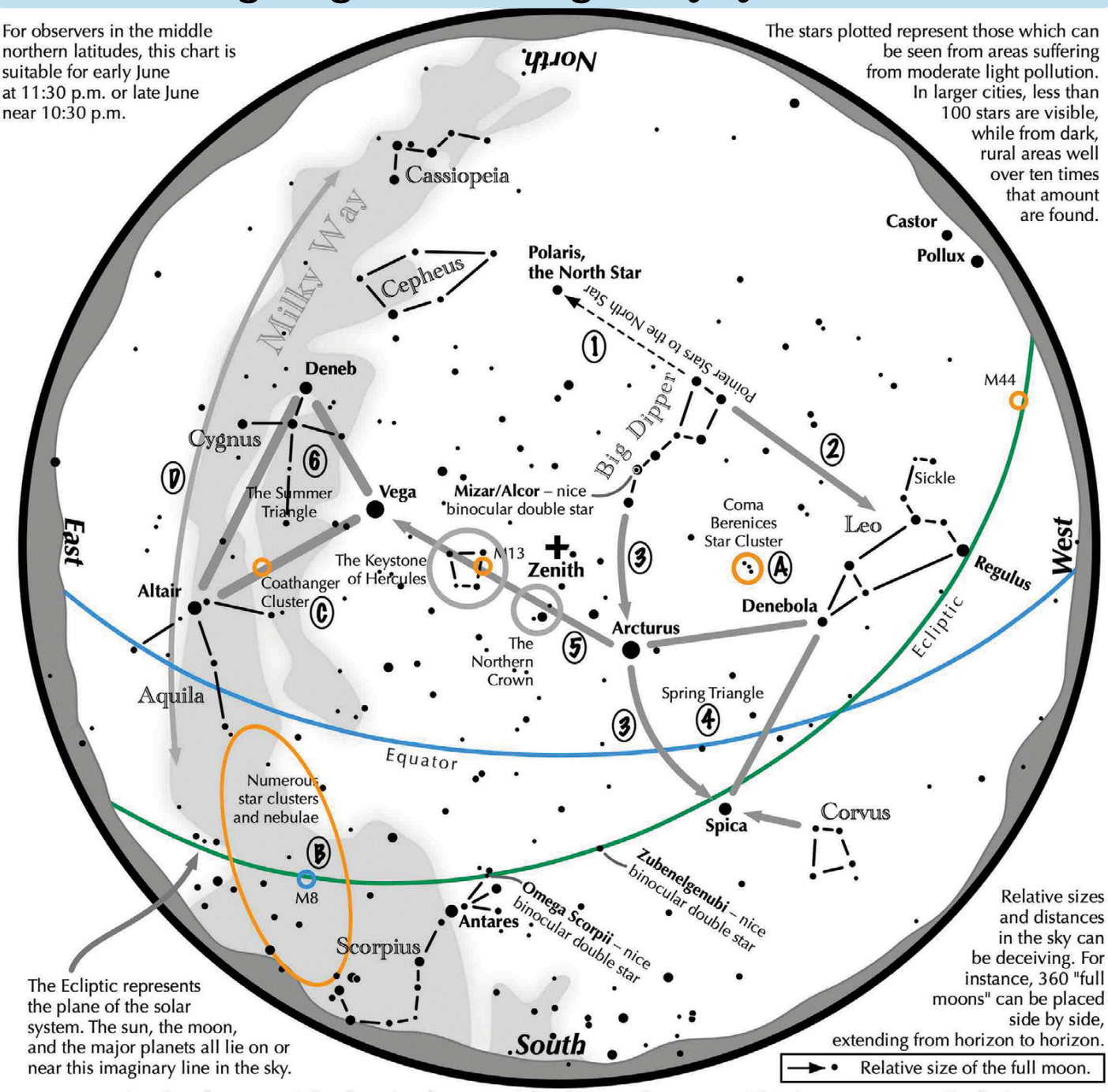


Date	Optimal time	RA	Dec	Constellation	Magnitude	Size (arc min)
June 1	3:24 am	20h36m54.3s	+57°04'41"	Cygnus	11.9	1.3
June 8	3:18 am	20h34m20.4s	+59°00'48"	Cygnus	12.1	1.2
June 13	3:12 am	20h31m07.8s	+60°09'38"	Cepheus	12.2	1.2
June 19	3:40 am	20h25m52.1s	+61°16'47"	Cepheus	12.4	1.2
June 25	11:49 pm	20h19m30.9s	+62°05'14"	Draco	12.5	1.1
June 30	2:13 am	20h13m09.6s	+62°34'03"	Draco	12.6	1.1

Navigating the June Night Sky by John Goss

For observers in the middle northern latitudes, this chart is suitable for early June at 11:30 p.m. or late June near 10:30 p.m.

The stars plotted represent those which can be seen from areas suffering from moderate light pollution. In larger cities, less than 100 stars are visible, while from dark, rural areas well over ten times that amount are found.



The Ecliptic represents the plane of the solar system. The sun, the moon, and the major planets all lie on or near this imaginary line in the sky.

Relative sizes and distances in the sky can be deceiving. For instance, 360 "full moons" can be placed side by side, extending from horizon to horizon.

Relative size of the full moon.

Navigating the June night sky: Simply start with what you know or with what you can easily find.

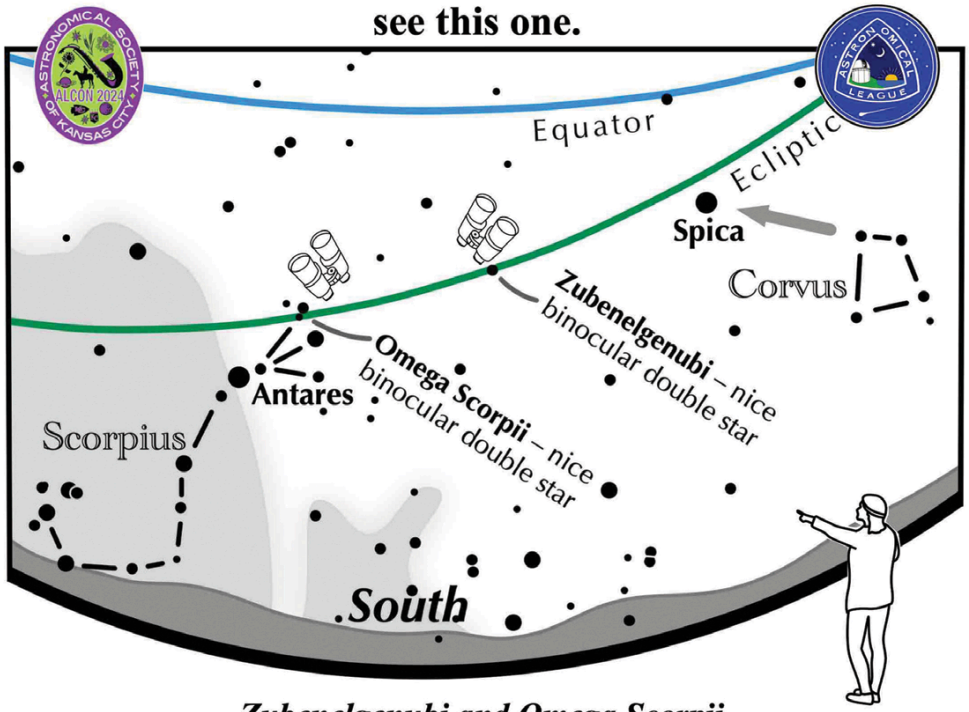
1. Extend a line north from the two stars at the tip of the Big Dipper's bowl. It passes by Polaris, the North Star.
2. Draw another line in the opposite direction. It strikes the constellation Leo high in the west.
3. Follow the arc of the Dipper's handle. It first intersects Arcturus, the brightest star in the June evening sky, then Spica.
4. Arcturus, Spica, and Denebola form the Spring Triangle, a large equilateral triangle.
5. To the northeast of Arcturus shines another star of the same brightness, Vega. Draw a line from Arcturus to Vega. It first meets "The Northern Crown," then the "Keystone of Hercules." A dark sky is needed to see these two dim stellar configurations.
6. High in the east are the three bright stars of the Summer Triangle: Vega, Altair, and Deneb.

Binocular Highlights

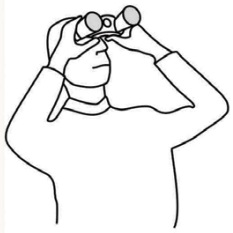
A: Between Denebola and the tip of the Big Dipper's handle, lie the stars of the Coma Berenices Star Cluster.
B: Between the bright stars of Antares and Altair, hides an area containing many star clusters and nebulae.
C: 40% of the way between Altair and Vega, twinkles the "Coathanger," a group of stars outlining a coathanger.
D. Sweep along the Milky Way for an astounding number of faint glows and dark bays.

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

If you can see only one celestial event this June, see this one.



Zubenelgenubi and Omega Scorpii, two easy binocular double stars.



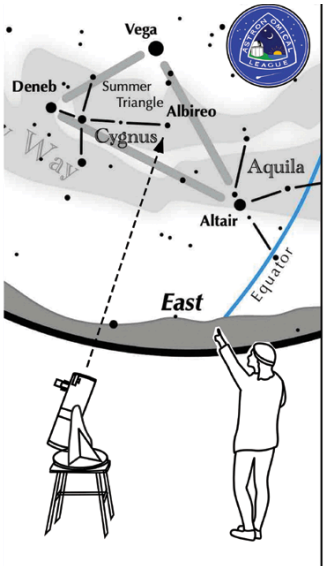
Enhance the scene – use binoculars!

Throughout June ninety minutes after sunset, look low in the south for the bright stars Spica and Antares.

- Almost mid–way between them shines the moderately bright star Alpha Librae, also called Zubenelgenubi.
- Aim binoculars at it and two stars will be seen.
- To Antares' right are the three "claw" stars of Scorpius. Directly below the uppermost claw, Graffias – or Beta Scorpii – is Omega Scorpii.
- Binoculars will easily show two 4th magnitude stars, Omega 1 and 2, separated by nearly a full moon width. The two Omega's are a chance line of sight pair. They are not gravitationally bound to each other.

The keen-eyed skywatcher will discern two stars when gazing at both Zuben and Omega.

www.astroleague.org



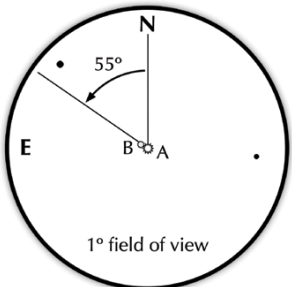
Other Suns: Beta Cygni (Albireo)

How to Beta Cygni on a June evening

Look in the east for the Milky Way and Cygnus. The Northern Cross shape of Cygnus lies in a horizontal position. The southernmost star of the Cross is Beta, also known as Albireo.

Beta Cygni
A-B separation: 35 sec
A magnitude: 3.4
B magnitude: 4.7
Position Angle: 55°
A & B colors: orange, blue

Suggested magnification: >30x
Suggested aperture: >2 inches



Try 10x50 binoculars to separate Albireo.

May 16 LAS Meeting Notes by Eileen Hall-McKim

I. Introduction

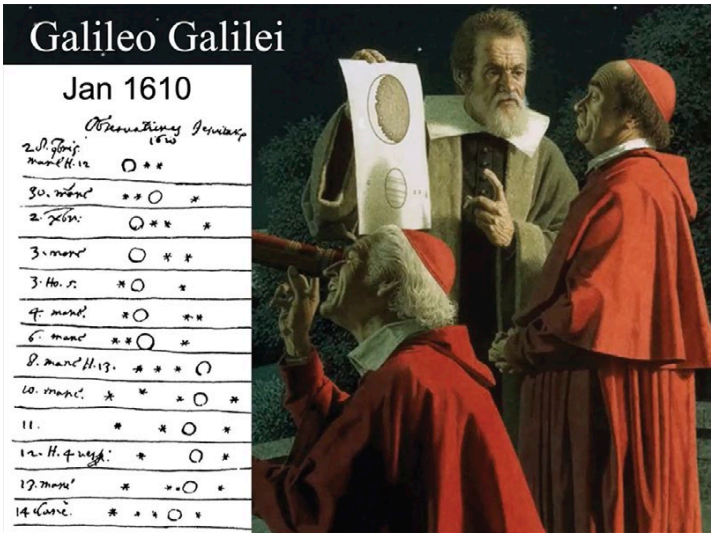
The May 2024 LAS monthly meeting was held in-person and by zoom on May 16th at the Longmont Lutheran Church, 803 Third Ave. President Vern Raben began the meeting with self-introductions of members attending in person and those on zoom. Twenty-two members attended in-person, 17 attended on-line by zoom.

II. Main Presentation

Our guest speaker for the May meeting was Dr. Fran Bagenal, a senior research scientist and professor at the University of Colorado, Boulder. Fran is co-investigator and team leader of the plasma investigations on NASA's New Horizons mission to Pluto and the Juno mission to Jupiter. Her main area of expertise is the study of charged particles trapped in planetary magnetic fields and the interaction of plasmas with the atmospheres of planetary objects, particularly in the outer solar system.

Born and raised in the UK, Dr. Bagenal received her bachelor degree in Physics and Geophysics from the University of Lancaster, England, and her doctorate degree in Earth and Planetary Sciences from MIT (Cambridge, Mass) in 1981. She spent five years as a postdoctoral researcher at Imperial College, London, before returning to the United States for research and faculty positions in Boulder, Colorado. She has participated in several of NASA's planetary exploration missions, including Voyager 1 and 2, Galileo, Deep Space 1, New Horizons and Juno. She edited the monograph Jupiter: Planet, Satellites and Magnetosphere (Cambridge University Press, 2004) https://lasp.colorado.edu/home/mop/home/people/fran_bagenal/

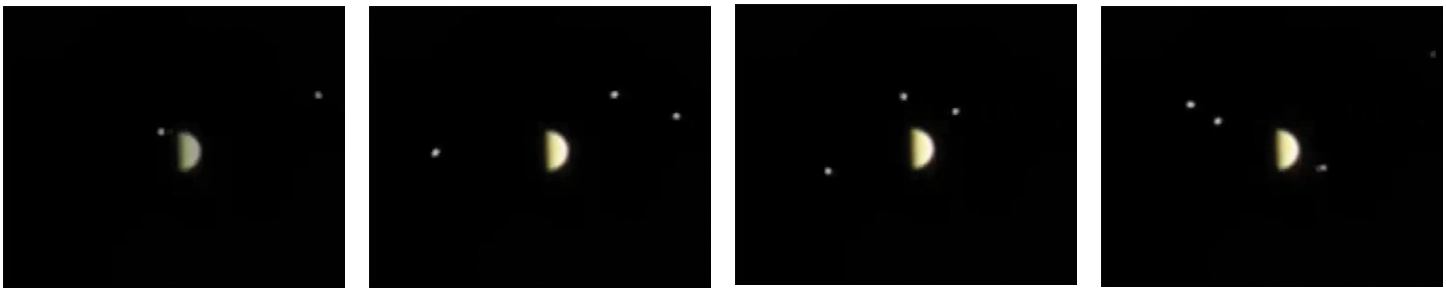
NASA's spacecraft Juno embarked on a 5-year journey in 2011 to study our solar systems largest planet, Jupiter, arriving in 2016. As Juno's orbit has evolved over 8 years, the spacecraft has also made fly-bys of the Galilean moons Ganymede, Europa and Callisto. This provides an opportunity to review the history of the Galilean moons, discuss previous observations made by Voyager, Galileo, Cassini and New Horizons missions to provide the context for recent Juno flybys. Looking to the future, ESA's JUICE and NASA's Europa Clipper missions will be probing deeper into these very different worlds.



Galileo Galilei Observations – January 1610

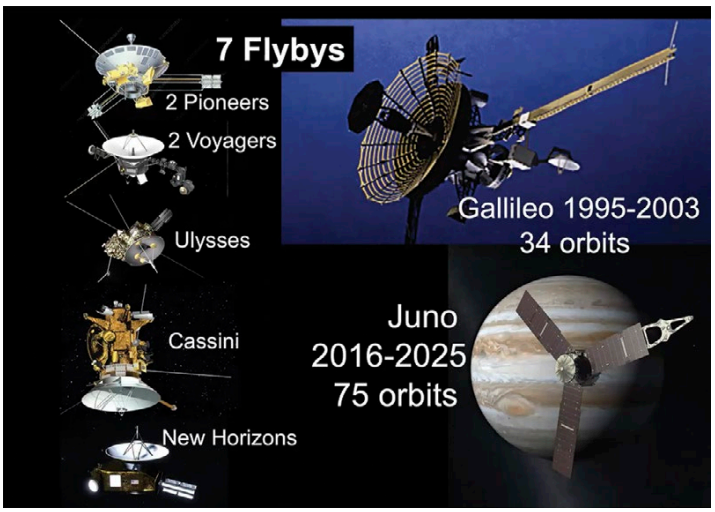
It's fun with all the observations we are making with Juno and some upcoming missions to go all the way back to the beginning to talk about the Galilean moons. In spike of opposition and battles with the Catholic Church over whether the Earth was the center of the Universe, Galileo Galilei (1564-1632) was one of the first to take up a telescope and point it up toward the sky.

- Observed craters on the moon, phases of Venus
- Very importantly, he also observed Jupiter and saw there were objects that seemed to be orbiting Jupiter, what were they? What was going on?
- Big discovery because if there are objects orbiting Jupiter – this means the Earth was not the center of everything, which had far reaching implications



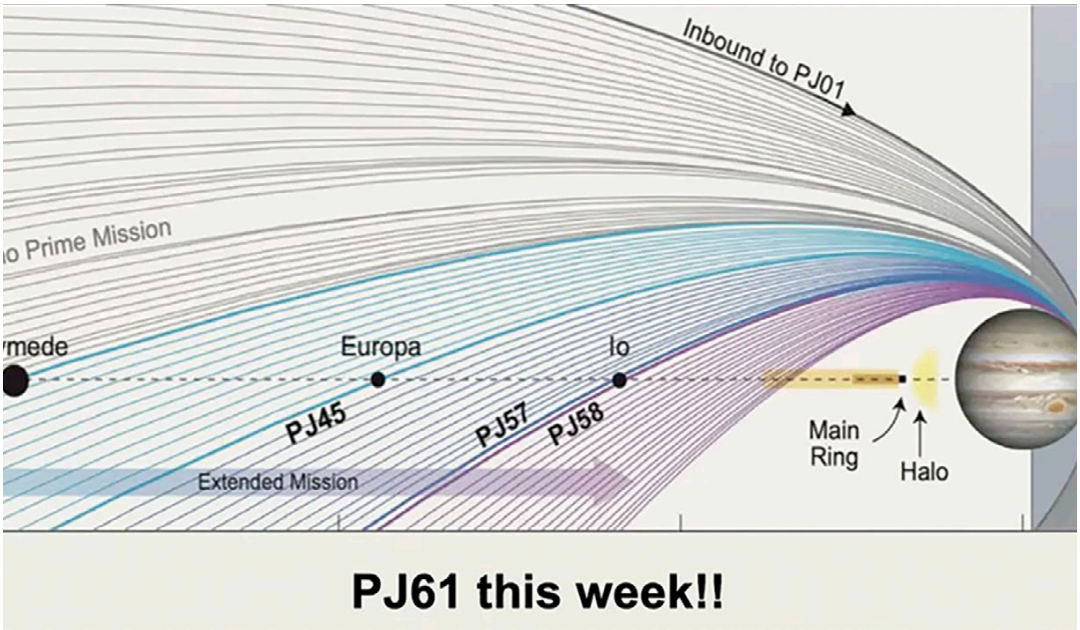
Orbits of Moons around Jupiter

Juno spacecraft approaching Jupiter – July 2016 made this amazing movie of Jupiter with orbiting moons. This is not an animation but are frames from an actual movie. You can see as they go around every couple weeks or so, and go behind Jupiter and get in the shadow they blink out and disappear. Galileo Galilei could not have seen this same sequence of orbiting moons. This cannot be seen from Earth because we have a day/night cycle and cannot observe this complete continuous sequence. Fortunate that we were able to see this as Juno approached Jupiter, and of course, for humanity this was our first glimpse of celestial harmonic motion.

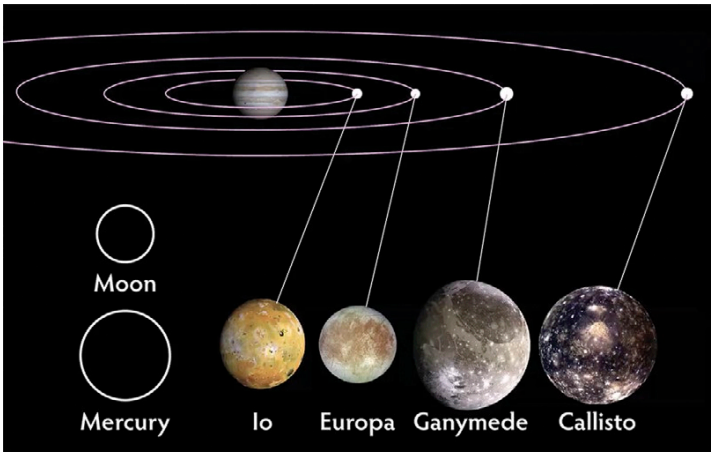


Exploration of the Jovial System
Seven Flybys
- 2 Pioneers
- 2 Voyagers
- Ulysses
- Cassini
- New Horizons

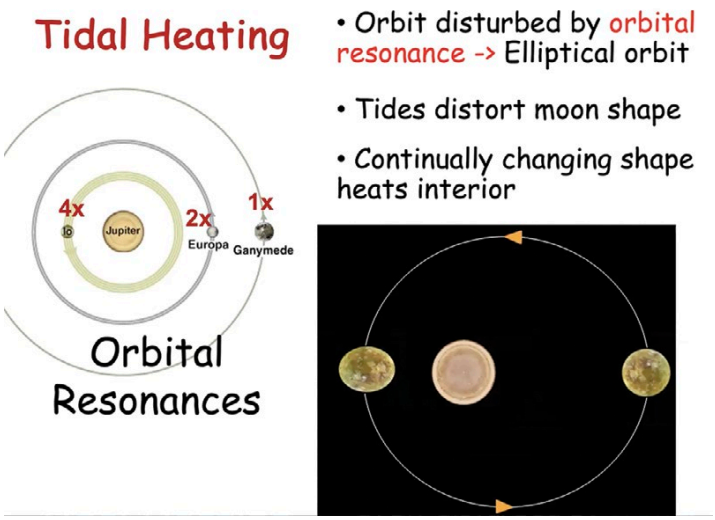
Two Orbital Missions
- Galileo 1995-2003 – 34 orbits
- Juno 2016-2015 – 75 orbits



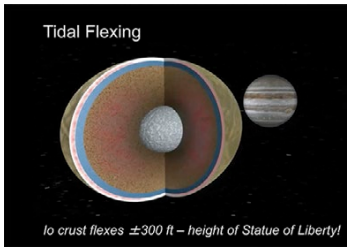
Juno Extended Mission – 76 orbits – Sept. 2025
- Started off long way out about 100x radius of Jupiter, orbits processes down
- Orbits come in, cross over equator from below, inside rings
- As orbits progressed downward began going past Europa and then Io
- Hope to keep going until orbits 76

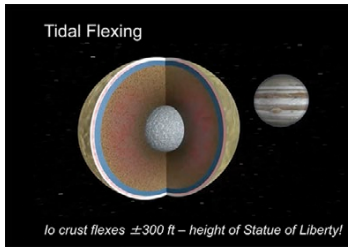


Interiors – Sizes compared to Moon and Mercury



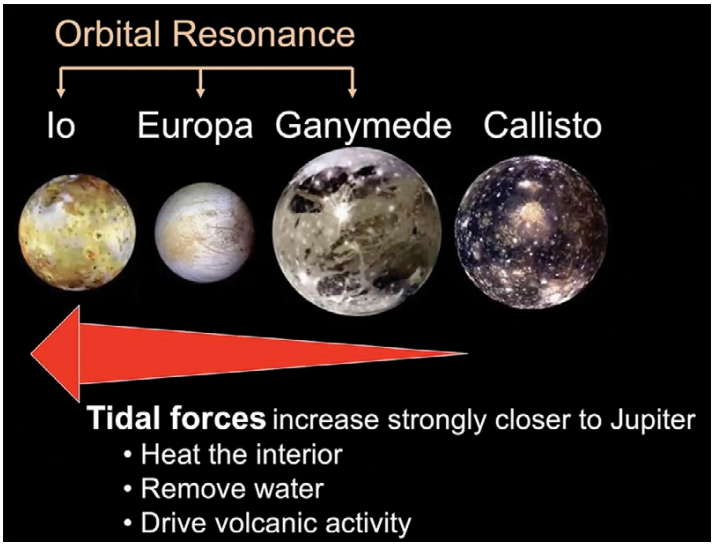
Tidal Heating
If you measure the orbital periods for every 1X Ganymede goes around Jupiter, Europa goes around 2X and Io goes around 4X, this is orbital resonance. Orbit disturbed by orbital resonance > elliptical orbit > tides distort moon shape > continually changing shape heats interior.





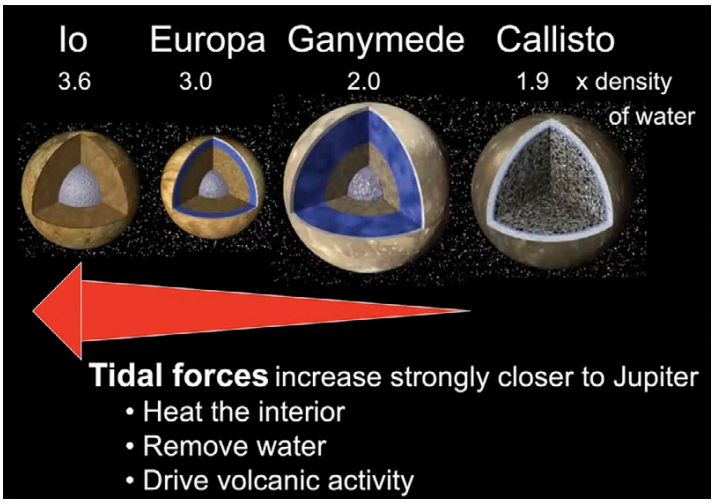
Tidal Flexing Io's crust flexes +/- 300 ft – about the height of the Statue of Liberty!

This is a big tidal range in rock - the mass of Jupiter 320X that of Earth which causes a lot of gravitational stress



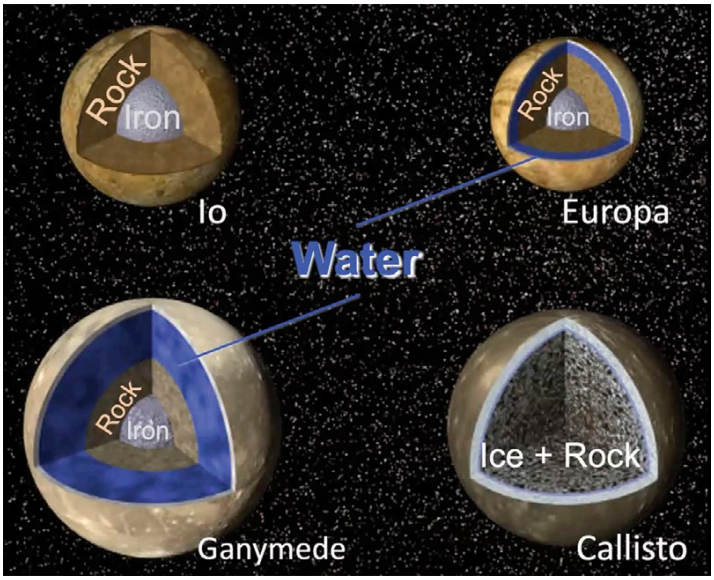
Orbital Resonance

- Tidal forces increase strongly closer to Jupiter
- Heat the Interior
- Remove water
- Drive volcanic activity
- Io has the strongest tidal forcing

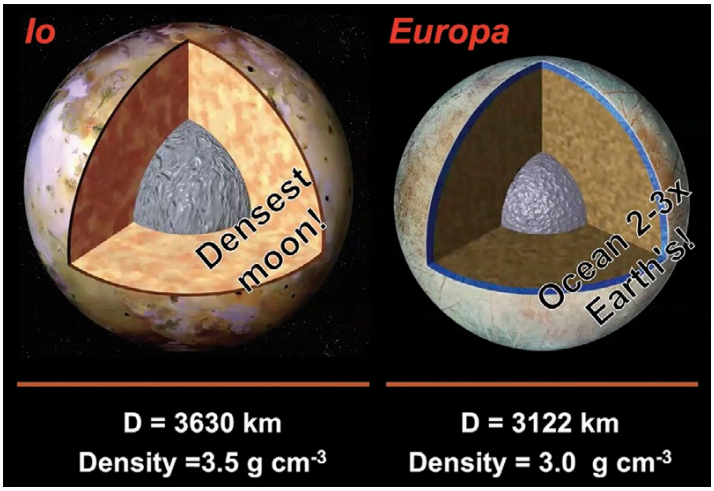


Looking at density and normalizing to water at 1

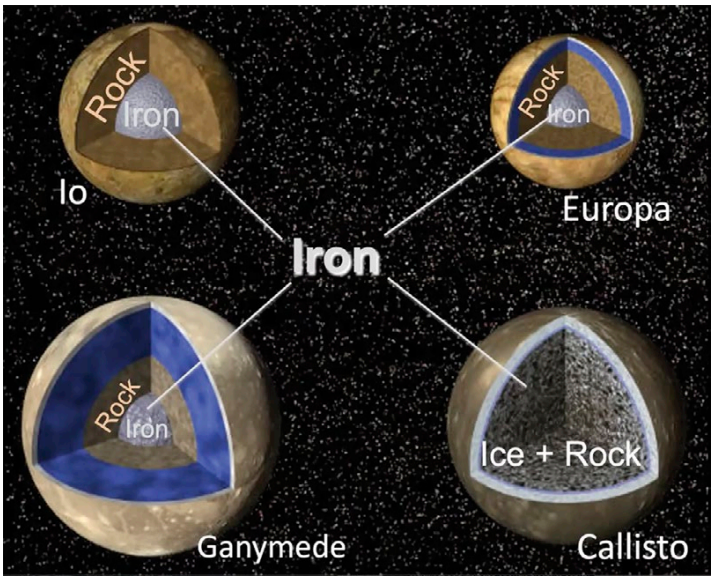
- Callisto and Ganymede both have roughly 2X the density of water, mixture of rock and water; interior of Callisto is undifferentiated rock and metal
- Europa has lost a lot of its water, has a big ocean, rock and metal inside
- Io has lost all of its water and is rock covered with volcanoes



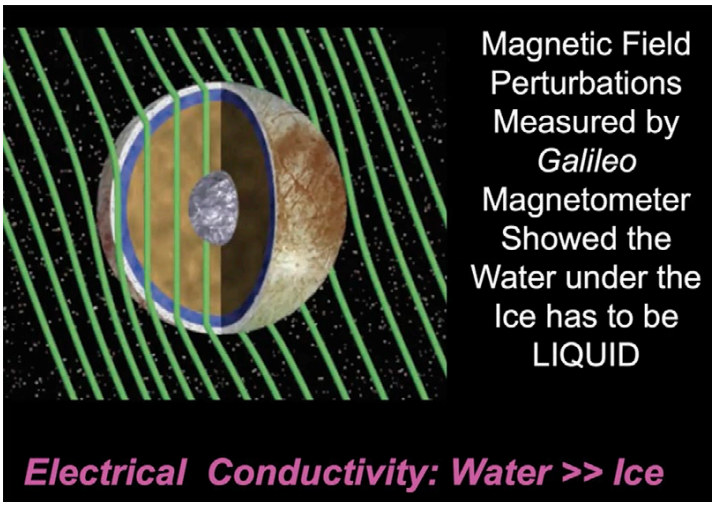
Water – Oceans on Europa and Ganymede



Density of Io and Europa – densest moon is Io



Iron – Is found in all of them, particularly in Ganymede

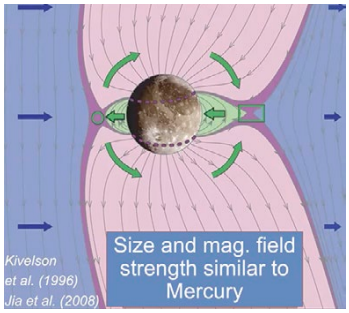


Electrical Conductivity: Water >> Ice

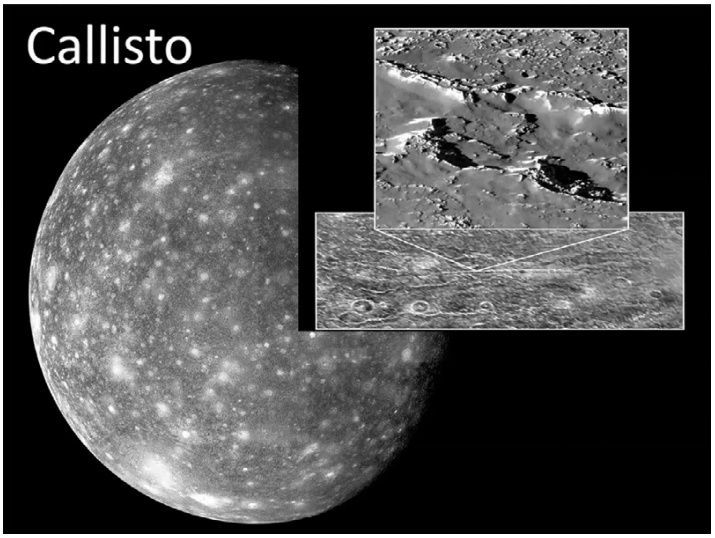
- We know Europa has a liquid ocean because magnetic field perturbations measured by Galileo Magnetometer showed the water under the ice has to be liquid
- Europa experiences a wobbling, time-varying magnetic field, and that induces electrical currents, cannot induce electrical currents through ice
- Liquid oceans with salt are electrically conductive, so we know this ocean has to be liquid; what we don't know is how deep the ocean is or how thick the ice is

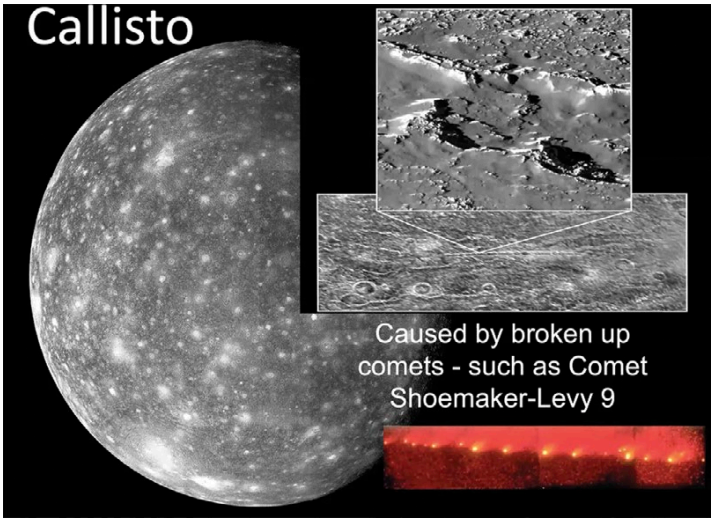
Ganymede

- Has dynamo essential ingredients: iron core, liquid, electrically conductive, flowing
- The only moon in our solar system with a magnetic field; size and magnetic field strength similar to Mercury; its own magnetosphere; dynamo is deep inside



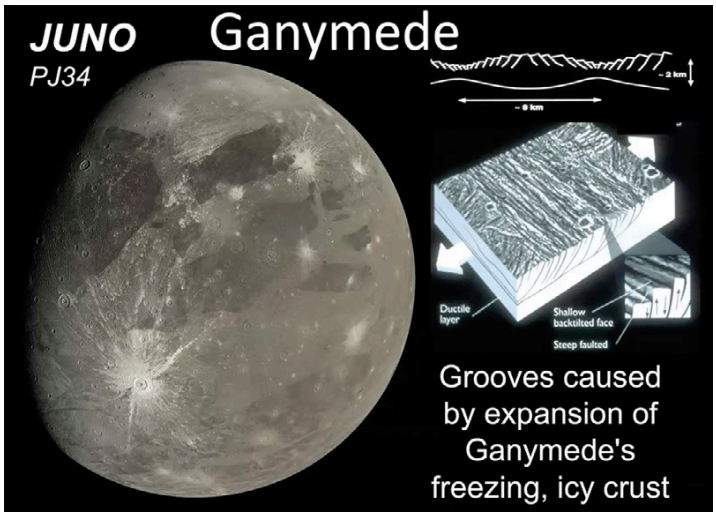
Surfaces of the Moons - Callisto

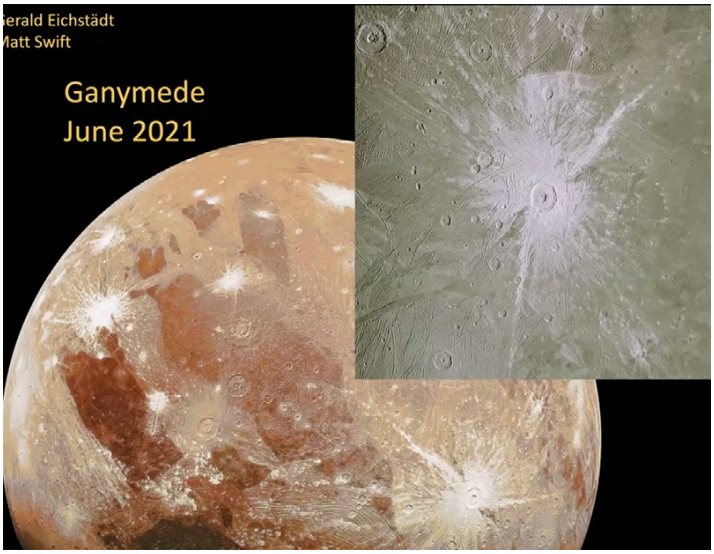




- At first look it is a rather boring landscape, similar to what we see on Moon. Looking closer see some interesting features; string of impact craters, possibly caused by broken up comets – such as Comet Shoemaker- Levy 9. Can imagine that if broken up comets came back around Jupiter and hit Callisto, this could leave this string of impact craters

Ganymede



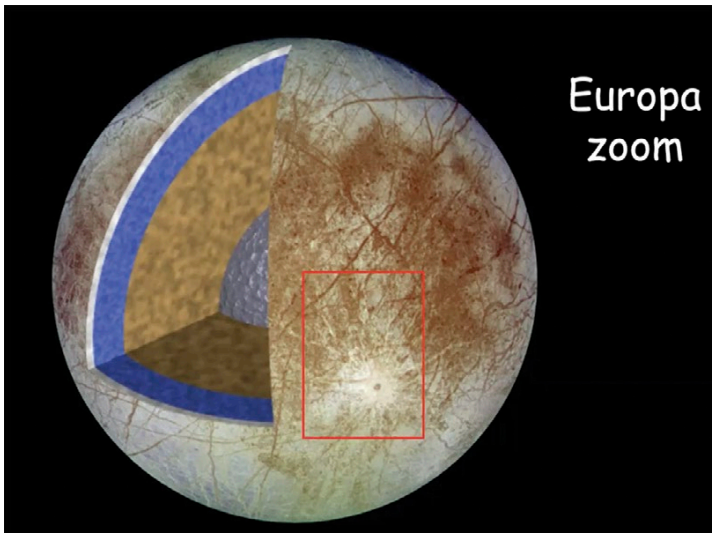


- Image taken from Juno PJ34; we were able to receive high resolution images. A few impact craters, new surfaces but also old, more geological activity than on Callisto. Surfaces have been cracked by the expansion of Ganymede's freezing, icy crust; creating ridges, grooves, steeply faulted regions. Lines shown as different color regions and stripes
- Exaggerated color scheme of image taken June 2021 shows horizontal cracks and ridges, near bottom, zoom image show fresher craters (in white) where ice has been spilled out

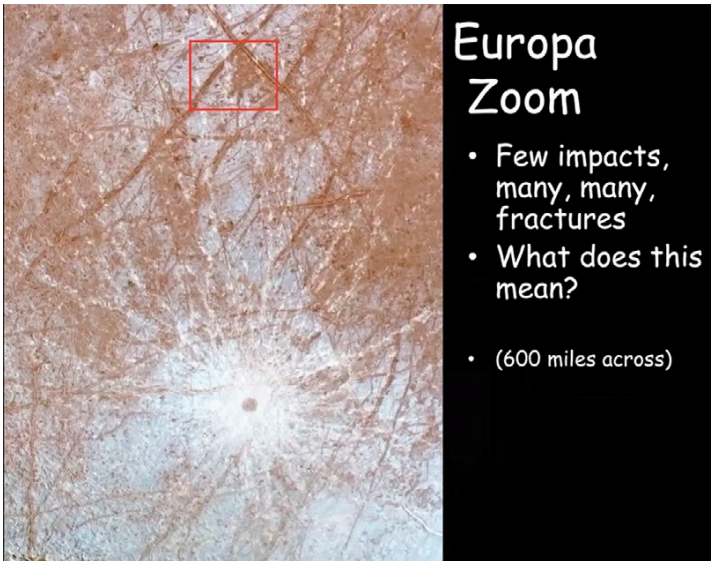
Galileo Image of Europa

Only a very few impact craters can be seen; this tells us the surface is young; lot of cracks, lot of ice. Looking at a few of the largest impact craters. Tyre is about 80 miles across; looks like impactor went right through the ice! So we can work out by thinking about impact craters on rock; can estimate that the depth of ice for impact to go through has to be something like 15-20 km.

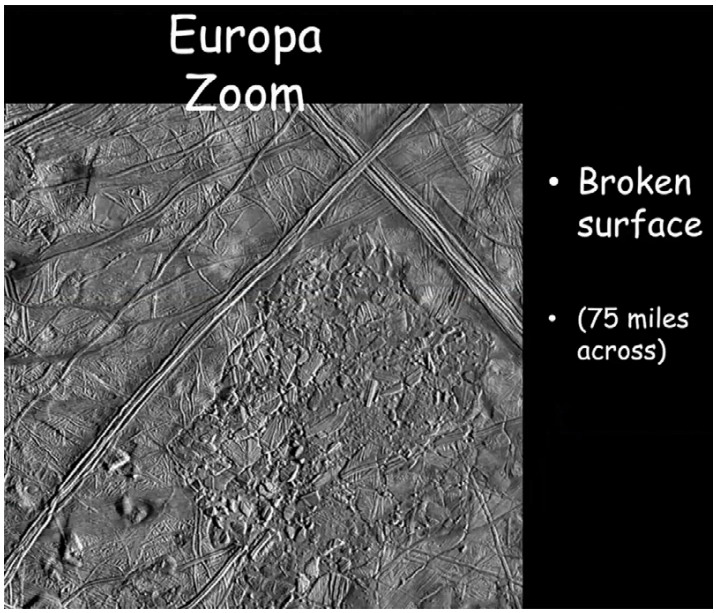
- The number of large impacts gives us an age; suggests 60 Myr that the surface turns over
- Tells us since the dinosaurs left the Earth, Europa has completely turned over its geology



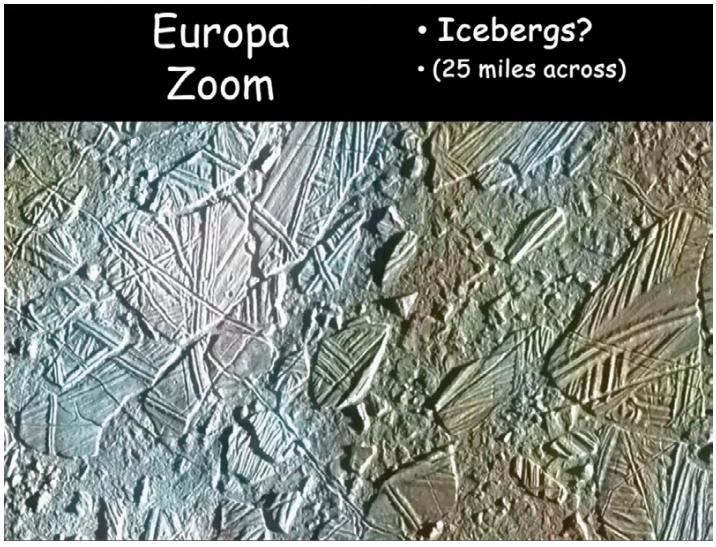
Europa Zoom Shows some of the territory; few impacts, many fractures



- First section look at large impact crater (600 miles across)

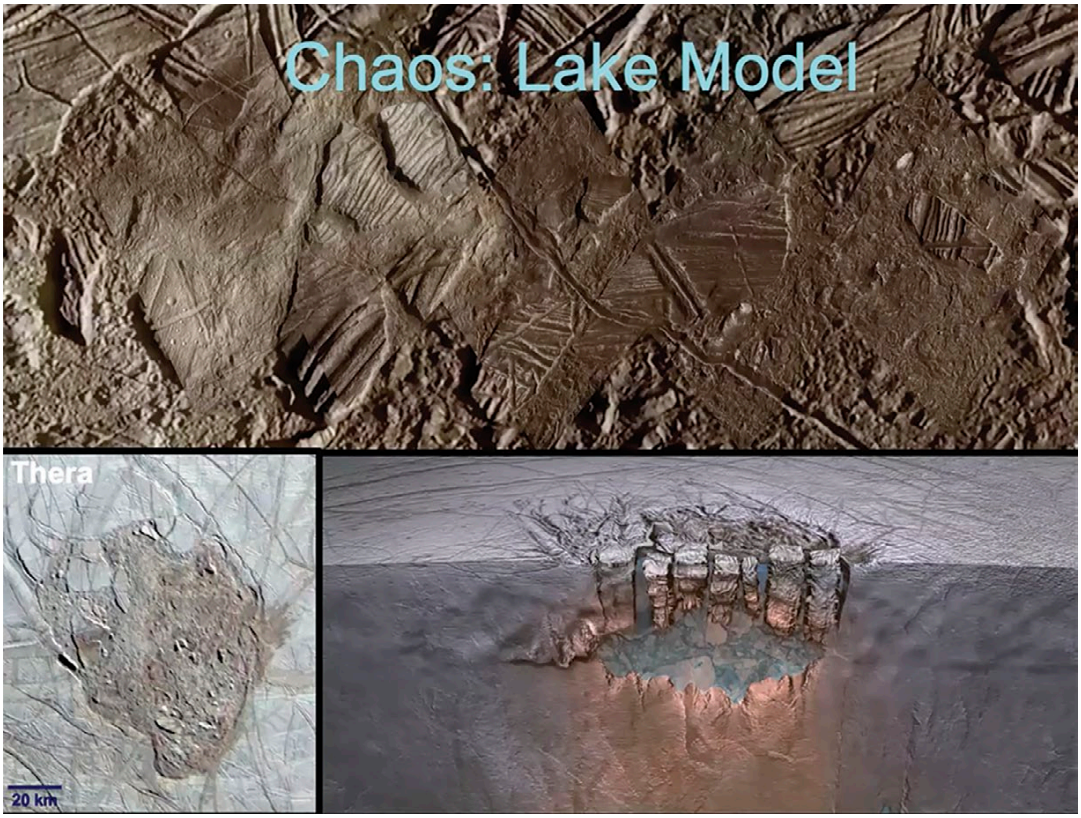


- Zoomed in upper section; we see broken up surface, (75 miles across) we see ridges going across, something has cracked the surface, how deep we do not know

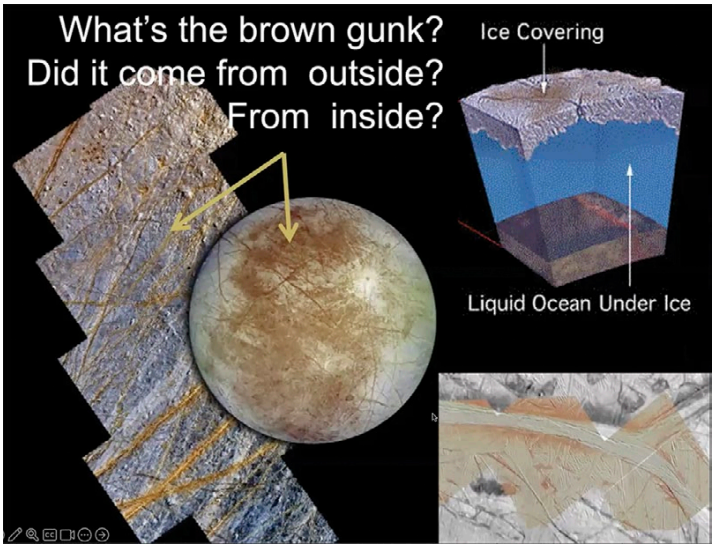


- Zooming in further, looks a bit like icebergs (25 miles across) that have been broken up and floating around in liquid; it's not liquid now, but looks like this could this be a place to go where the ice is particularly thin, and maybe where in the past, there has been some coupling here between the ocean below and the surface

Chaos Terrain: Lake Model

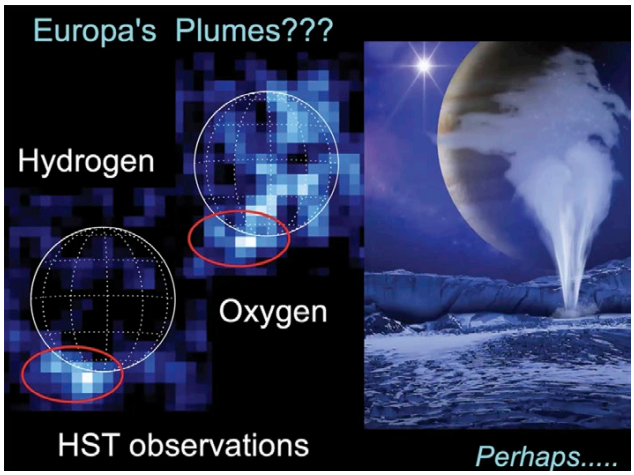


This brings us to the idea here, shown in sketch, that this chaos terrain may be a place of melting, even if it doesn't go all the way down to the ocean below, there may be an area of liquid water that was underneath and fractures going up towards the surface. (Sketch at bottom right)

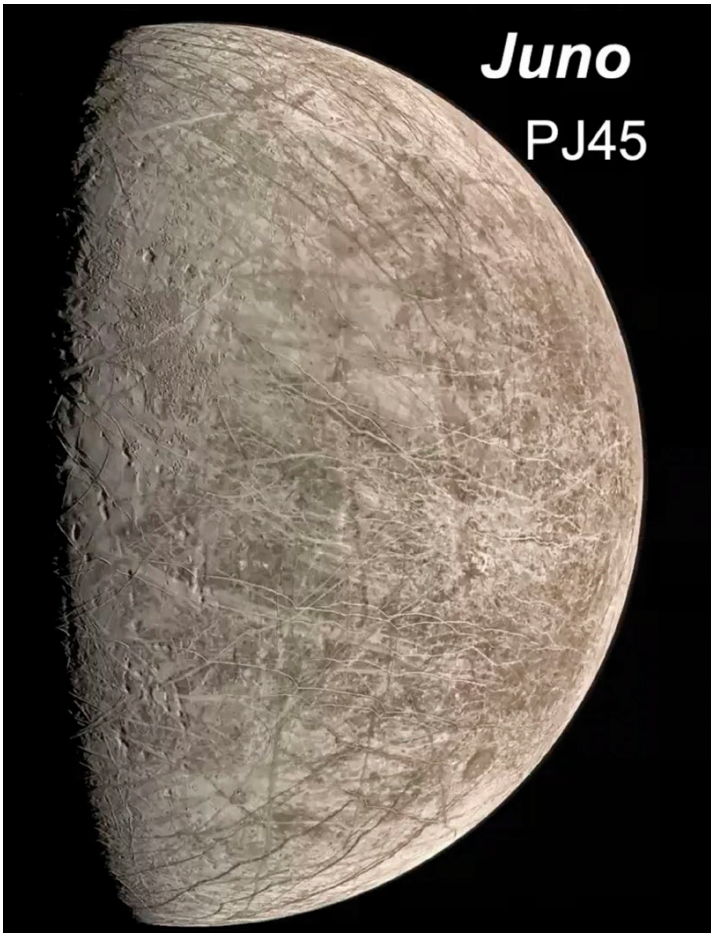


So the big question is; when looking at these images of the surface we see a lot of brown matter. What is this? Did it come from outside? From inside? It looks as if this brown gunky stuff comes out of these cracks, spills out and accumulates on the sides of the cracks. It looks like cracks go down deep possibly to the ocean inside. Could it be it come from the inside? (Bottom right image)

- Could be algae, bacteria, something like that, we don't know
- Idea of a large liquid ocean, heated from below with tidal heating much the same way as plate tectonics on the Earth has hot vents at bottom are heating the ocean and maybe the place of origin of life on Earth
- So this has a lot of people thinking that perhaps Europa may be the place to go

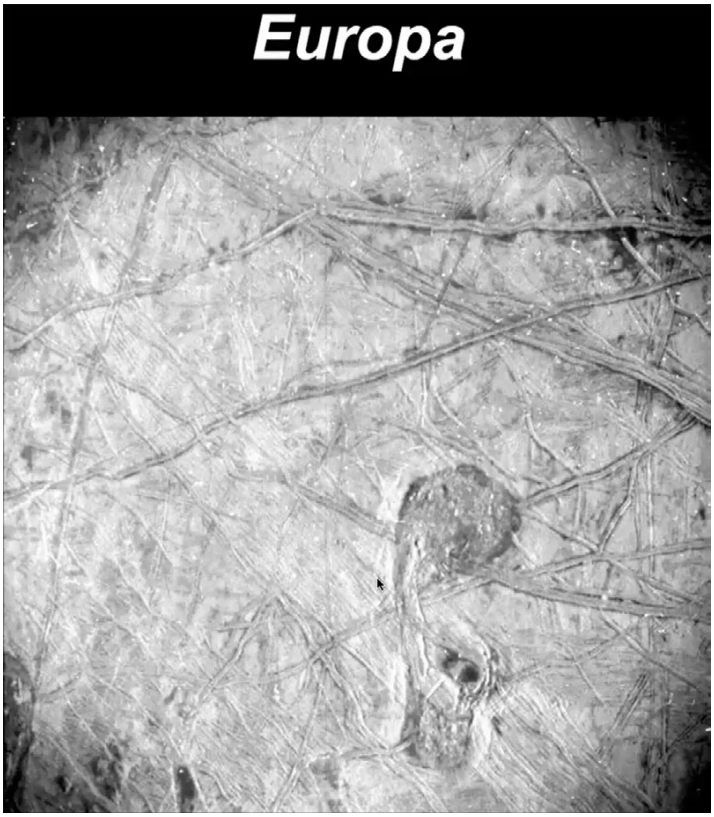


- A lot of speculation and debate from these Hubble Telescope observations
- Europa's "plumes" – steam vents? Active geysers? A real signal or noise?
- Could plumes be active geysers such as on Saturn's moon where geysers take water from below and spew it out into the atmosphere above?

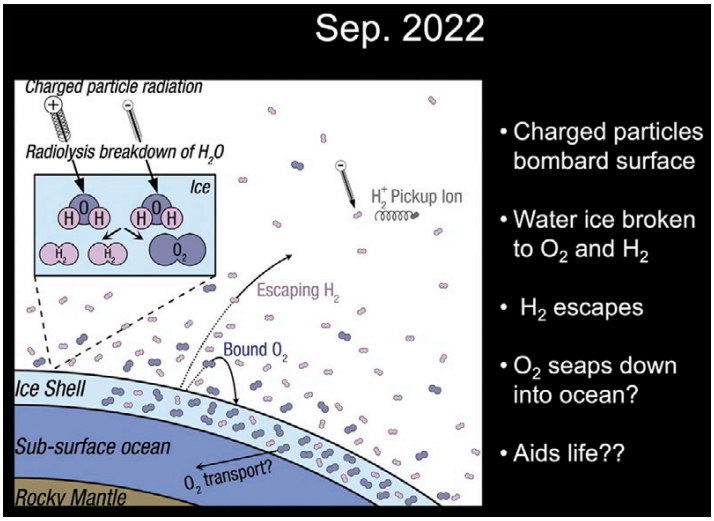


Two pictures taken of Europa during Juno Orbit 45 of September 2022 at 355 km.

- Interesting crack on the surface, geologists still analyzing to try to figure out what is happening. When zooming in closer beginning to see this looks like a place there is melting again with possible icebergs

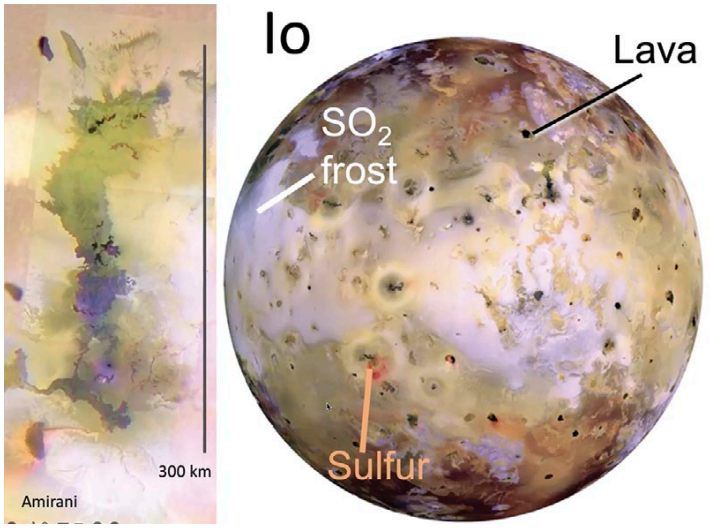


- Looks like another possible place of melting with iceberg. Craters look different at different times, one of craters scientists thought was there, when they look again had disappeared, still learning a lot about the geology of Europa



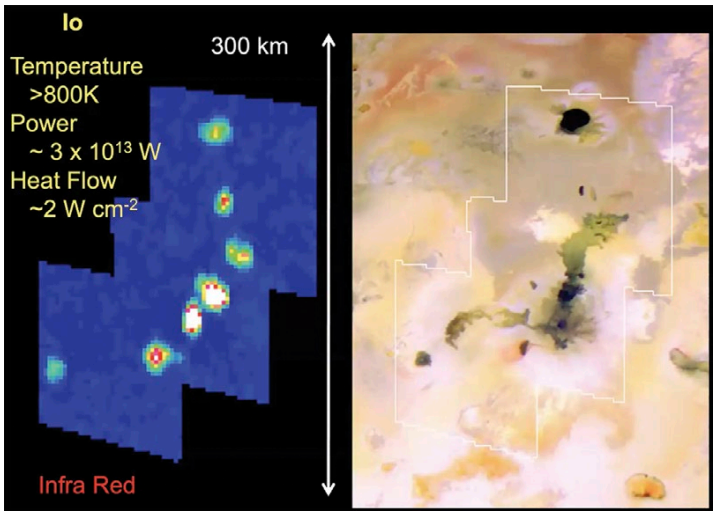
Juno was able to measure the charged particles

- Have energetic charged particles come in and bombard the ice on the surface
- Water H2O ice broken to 02 and H2
- H2 much lighter, escapes, becomes ionized and removed
- O2 comes back and hits the surface (radiolysis) could be producing oxygen
- Bombardment could allow 02 to seep through the ice; producing oxygen and some argue may help to oxygenize the ocean underneath, aiding life, these are big questions



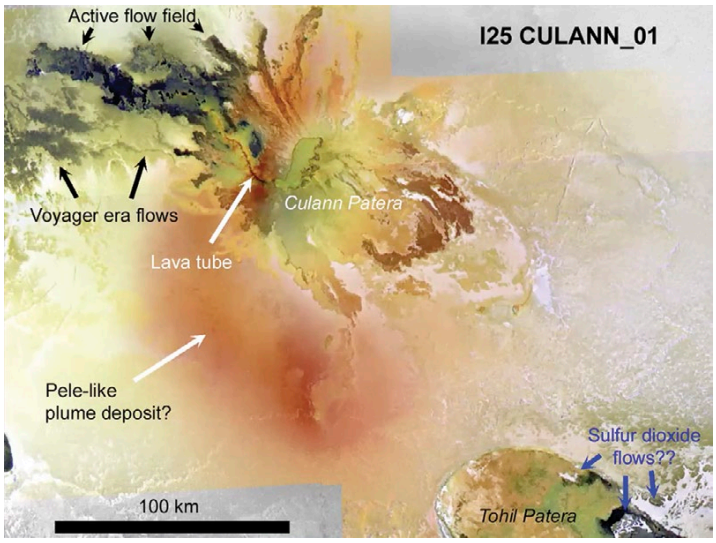
Io

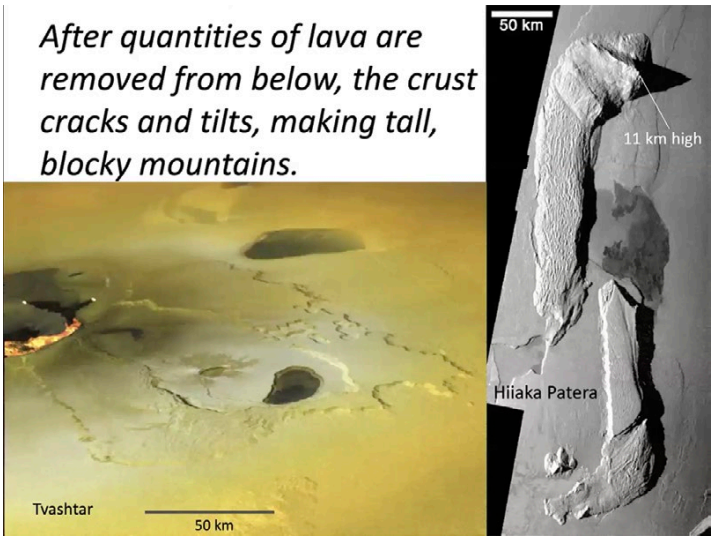
- Covered in volcanoes, 150 or so active at one time
- White is sulfur dioxide – comes out in vents, freezing on the surface as frost, evaporates to make SO2 atmosphere; orange reddish is sulfur; black is lava
- Inset blowup is Amirani volcano, 300 km in length, very big, very active.



Early pictures showing heat using infrared light

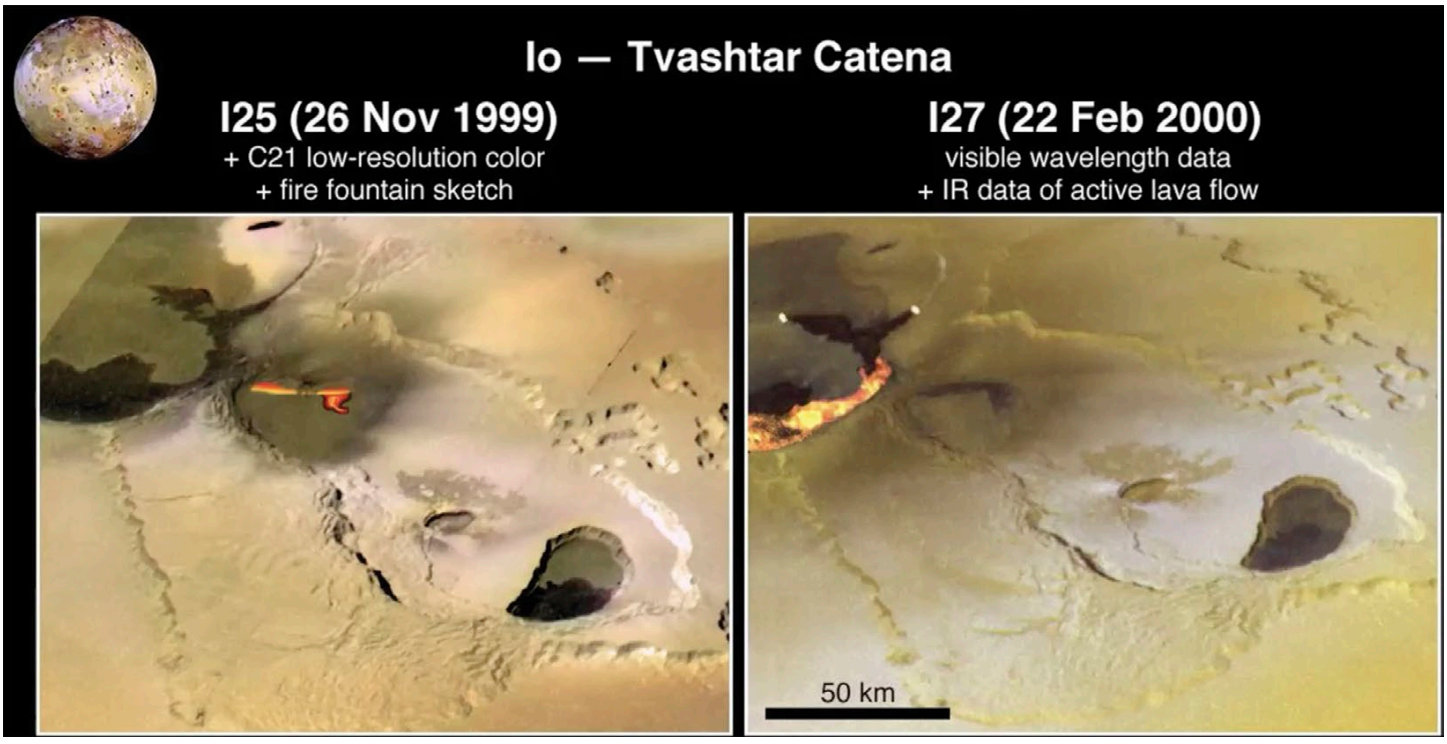
- Amirani lava flow covers 5km2/day
- What we can now conclude is there is a global re-surfacing – big turnover, 100x lava flow than on Earth, resurfacing all the time
- All craters removed in ~1million years
- Equivalent volume to turning inside out 40 times over age of solar system



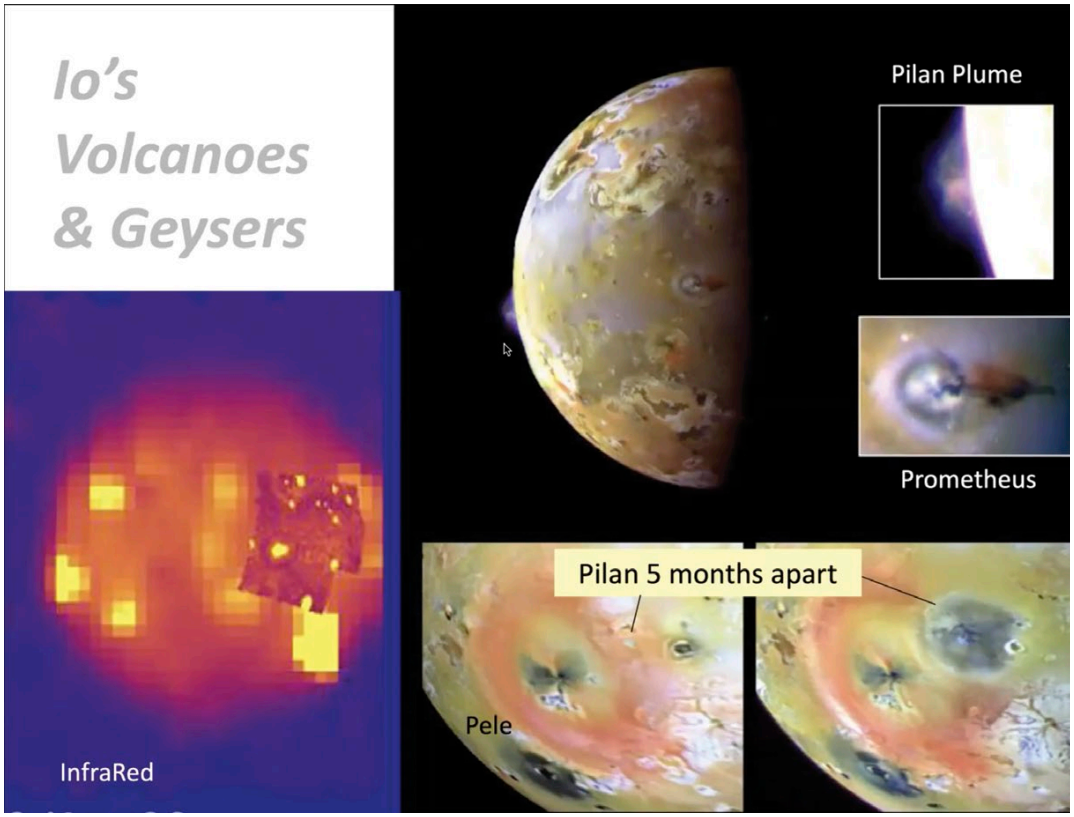


Pictures from the Galileo spacecraft

- See active lava flows, showing lava blowing out of vents; mountains are higher than Everest
- After quantities of lava are removed from below, leaves space below, the crust cracks and tilts, making tall, blocky mountains



Two pictures taken of the Io Tvashtar Catena Volcano – three months apart – can see quite a bit change in the volcano eruption.

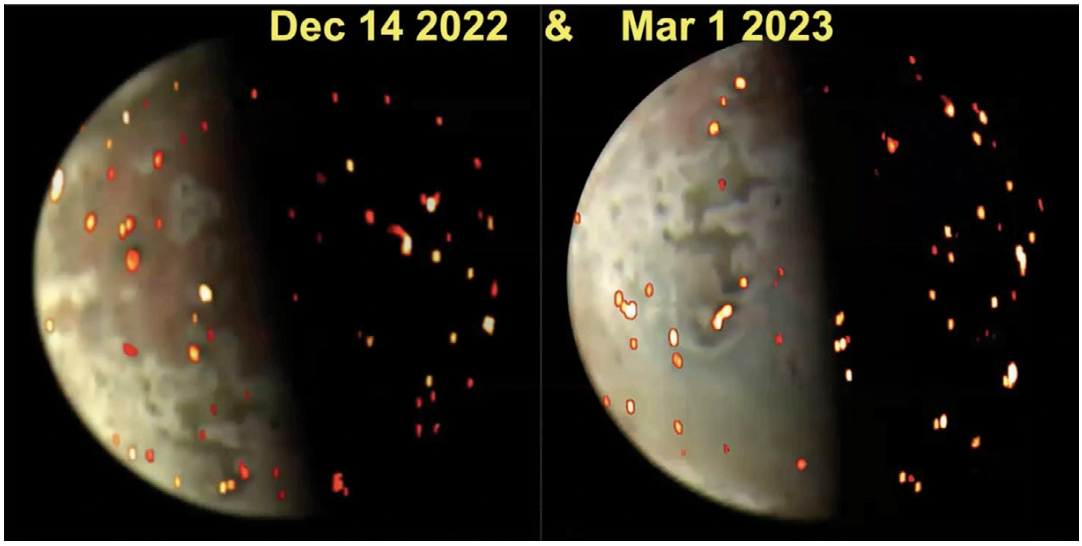


Images of Io's volcanoes and geysers – Very active landscape; much has changed in 5 months. Can see plumes pouring out hundreds of kilometers off the surface

Image of plume on Tvashtar taken by New Horizon on its way to Pluto (January 2007)

Mostly looking at dust being lifted up and carried out by gases

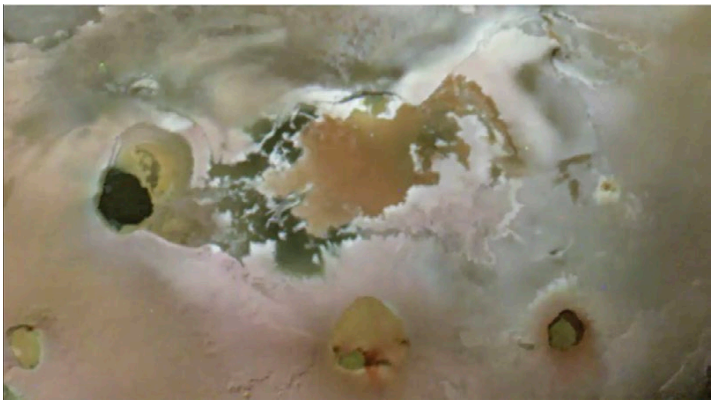
Juno JIRAM, Built in Italy. Juno's high resolution IR camera imaged Io's erupting volcanoes; all the bright spots are active volcanoes



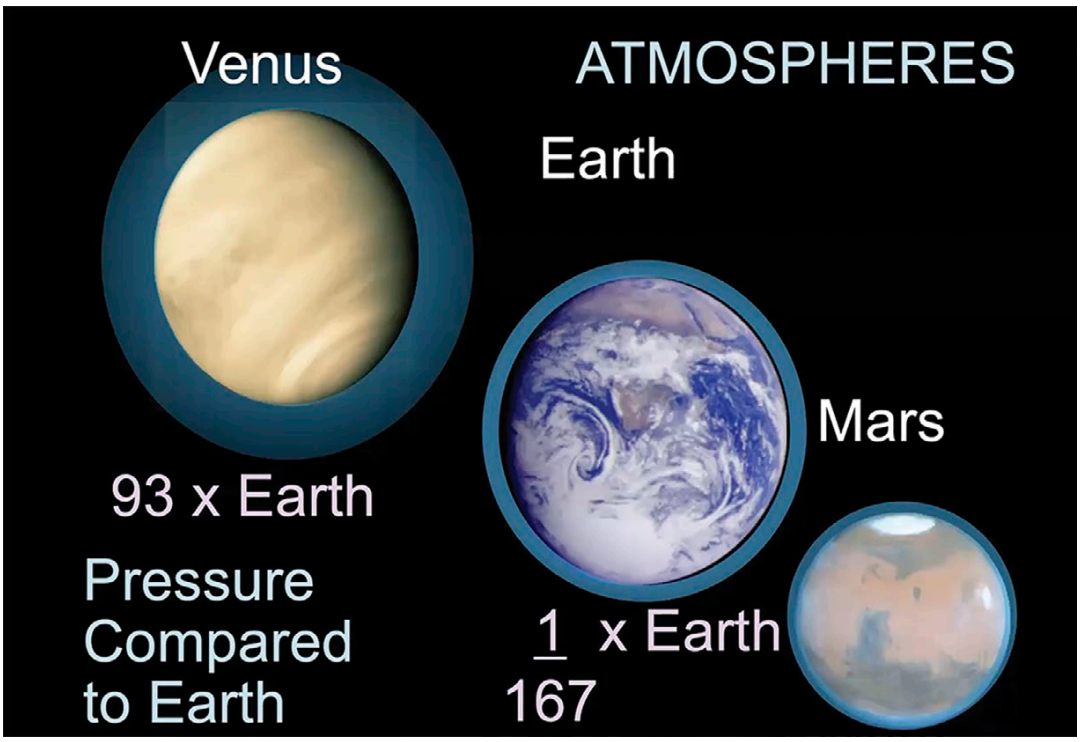
JIRAM Two images taken 3 months apart can show the activity changes

Juno image PJ57,58 of 30 Dec 2023 & 3 Feb 2024
Left: Jupiter shine, Right: Sun shine – like the terminator line on Earth's Moon. On certain days vertical structures, features, and mountains are well illuminated

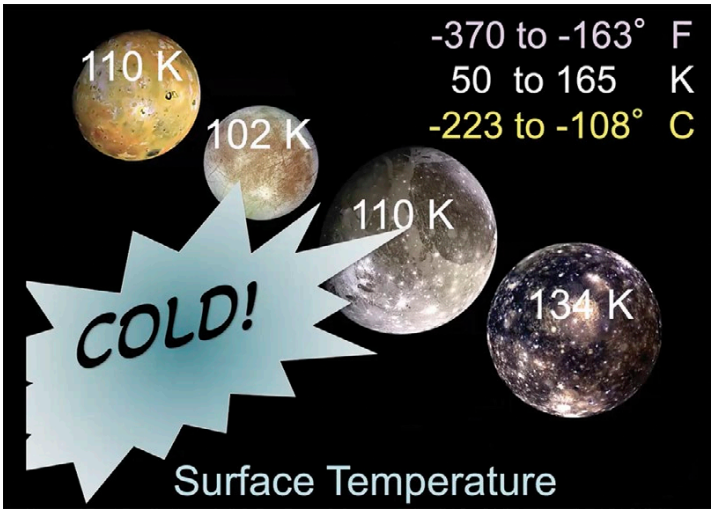
Io's Steeple Mountain (artists concept) not sure of the illustrated steepness



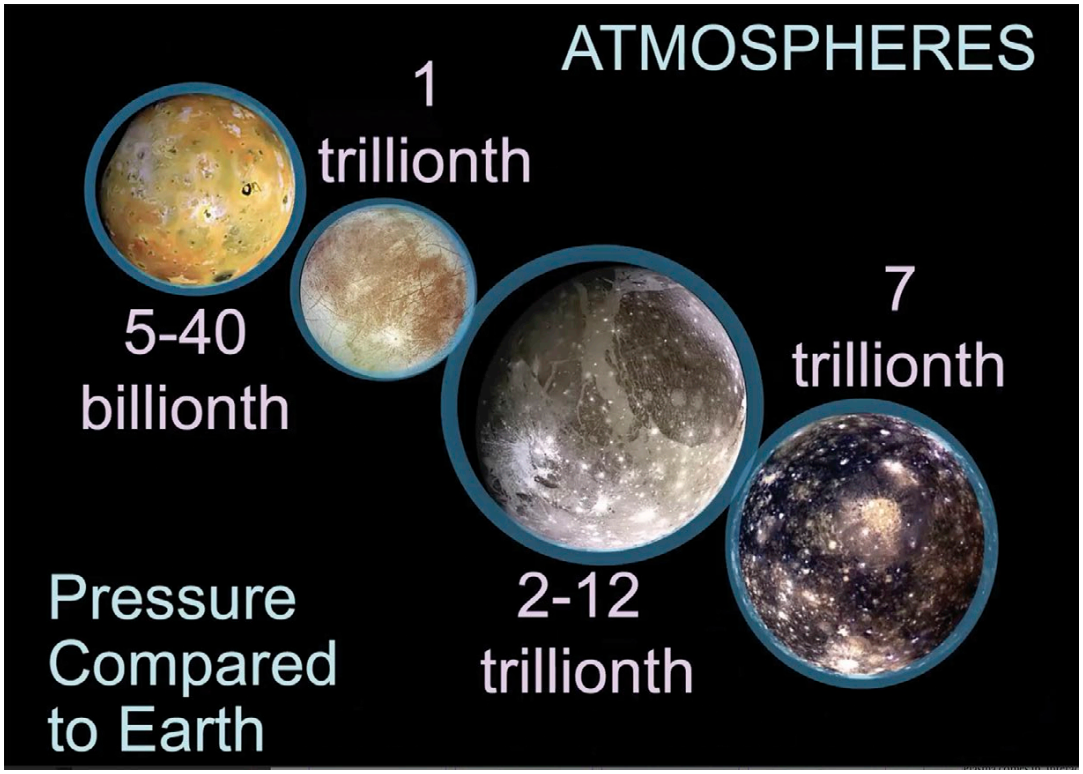
Lava lakes; Structure, Suggestion of Plume – not targeted observations just taken while flying by 3 Feb 2024 – Check out JunoCam online! https://www.missionjuno.swri.edu/junocam/



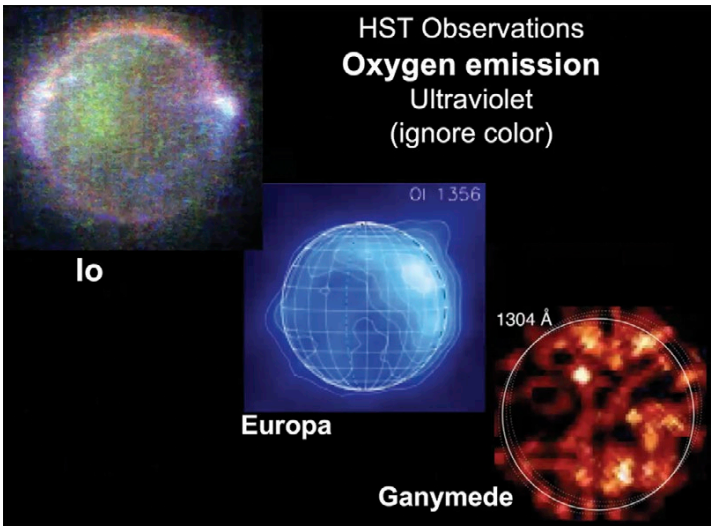
Atmospheres – Comparing Venus, Earth & Mars – all pretty close in distance but very different;
Venus pressure 93 X higher Earth's- much more; Mars atmosphere pressure is 1/167 that of Earth



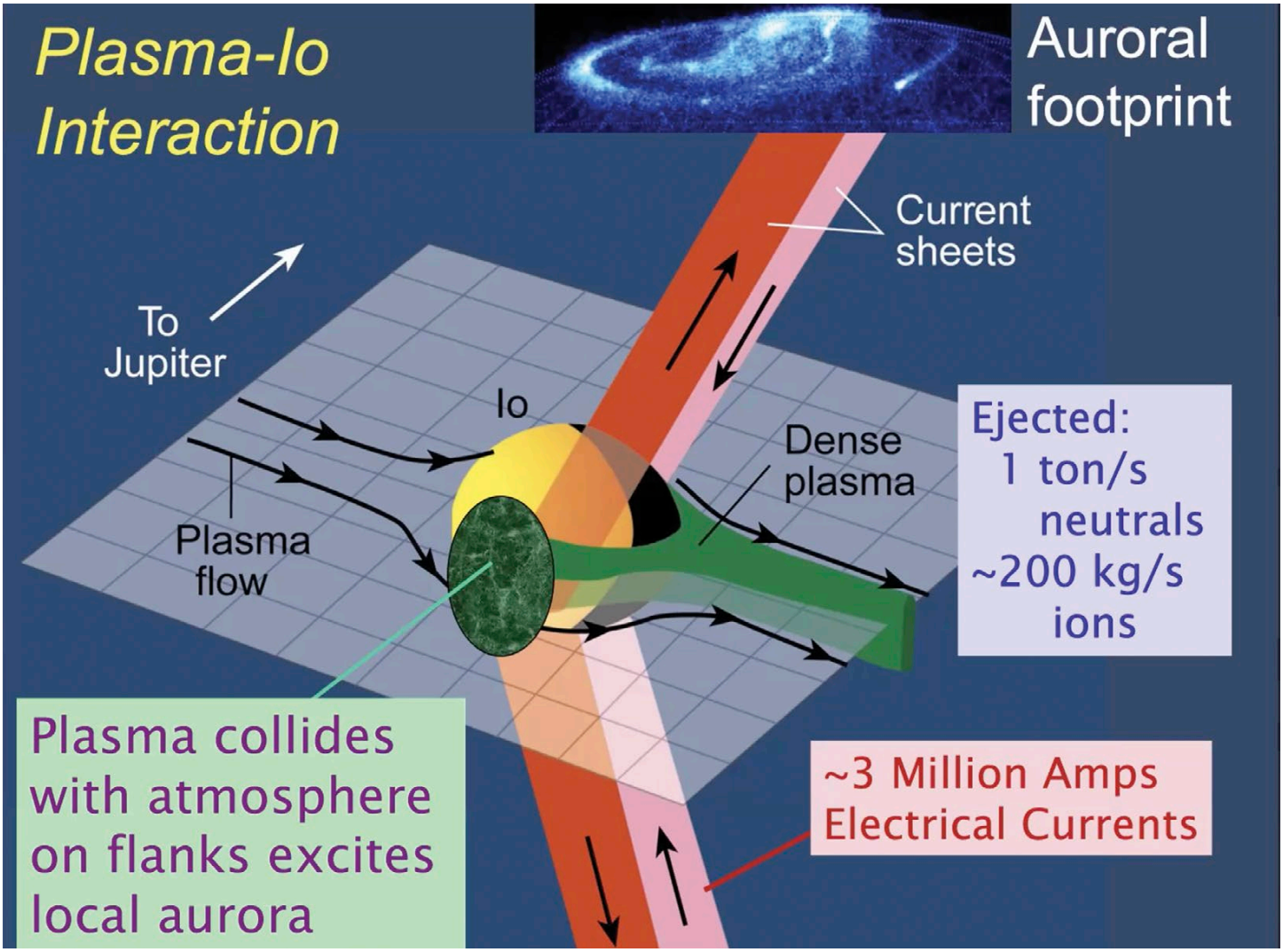
Surface Temperature - Going out to the Galilean moons, the temperatures are very cold, not much atmosphere



Pressure compared to Earth – much less atmosphere, much less pressure – numbers go into billionths and trillionths. Ganymede has a little bit of atmosphere, Europa next to nothing, Io seems to have a lot more than others due to volcanoes spewing out S02

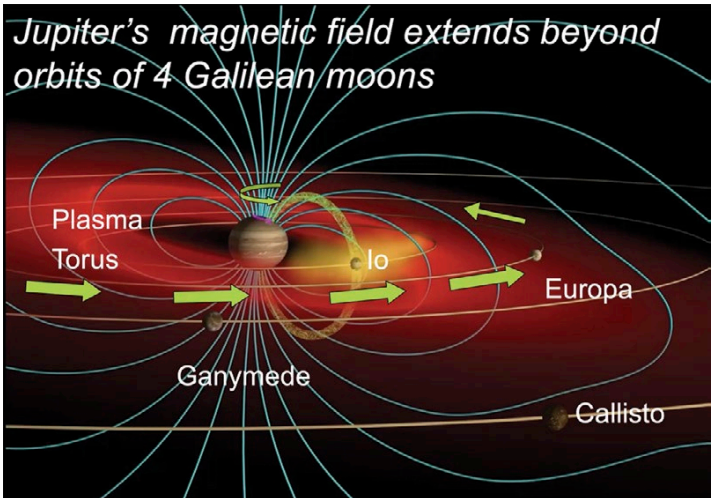


HST Observations Oxygen Emission Ultraviolet
This is important when looking for emissions from the atmospheres as we use mostly oxygen emissions that can be observed in ultraviolet light with HST. We get a sense of patchy atmospheres on these moons. In the case of Io we think these patches (aurora) on either side is caused by plasma reacting with the atmosphere, causing it to glow on either side.

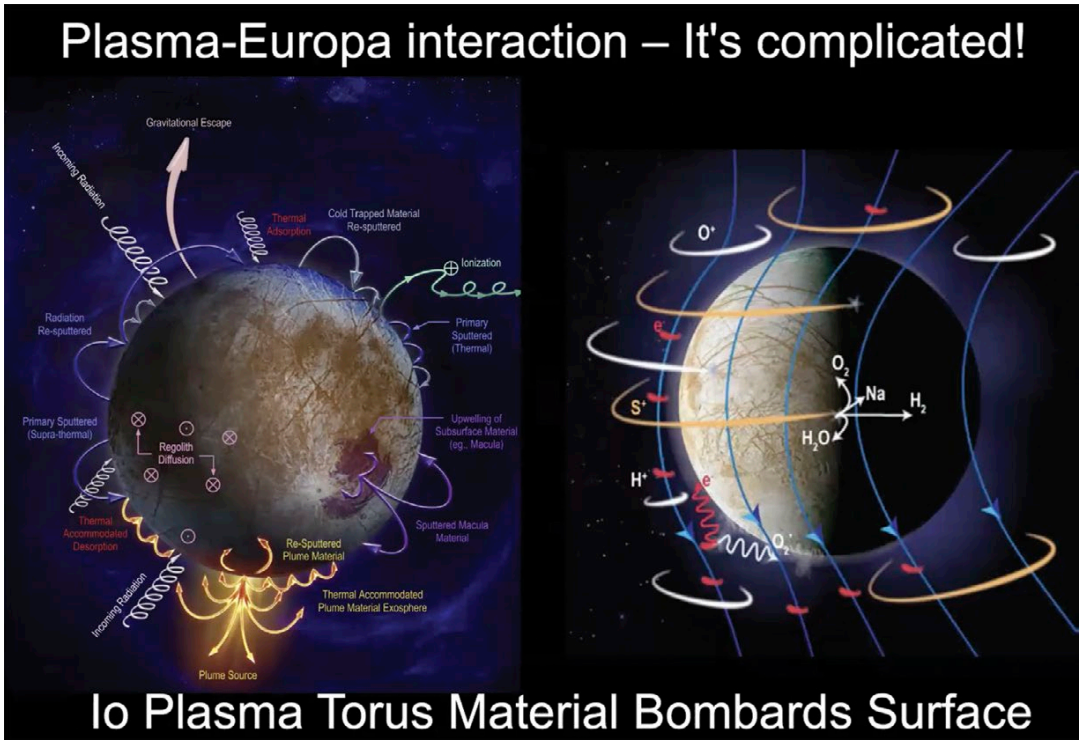


Plasma-Io Interaction (Fran's area of study)
Plasma comes in, interacts with Io, this is charged positive and negative particles, co-rotating with Jupiter because the magnetic field that comes out of Jupiter carries the plasma around with it and interacts on trailing side of Io as it orbits Jupiter.

- Strong electrical currents flow between Io and Jupiter (known about since late 50's)
- Io ejects about a ton of neutrals ~ 200kg/s ions, spreads out in a cloud and becomes ions
- Whole environment around Jupiter is populating material from Io
- Plasma collides with atmosphere on flanks excites local aurora

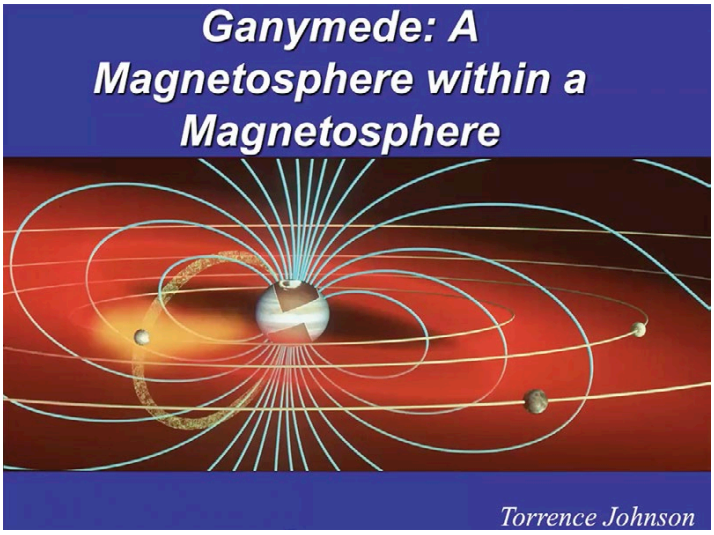


Jupiter's magnetic field is very strong, rotates every 10 hour with the planet, coupled with ionosphere and atmosphere of Jupiter. It extends beyond orbit of 4 Galilean moons, after it gets past moons, it spreads out filling up this vast region that's the influence of the magnetic field of Jupiter. As this flowing material goes past makes glowing Torus region; able to measure.



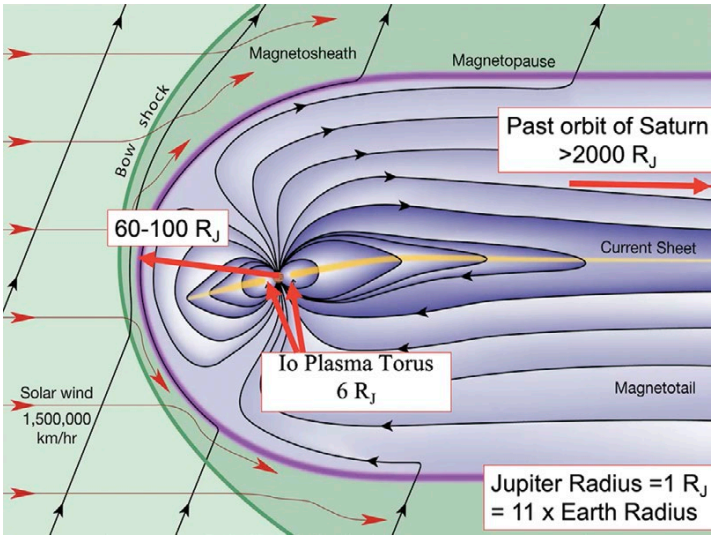
Plasma-Europa interaction

- When we move out to Europa it get complicated!
- Io Plasma Torus material bombards surface of Europa
- Breaks up ice on surface but also deposits sulfur and oxygen that may be going into the ice, influencing ocean chemistry; whole physics of effects of this bombardment is hot topic of research



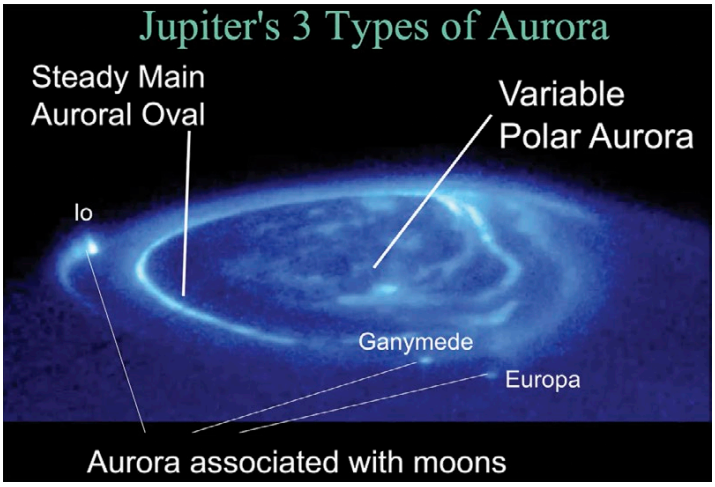
Plasma- Ganymede Interaction

- Has own magnetic field (a magnetosphere within a magnetosphere)
- Also has electric current that connect to Jupiter and generates an aurora

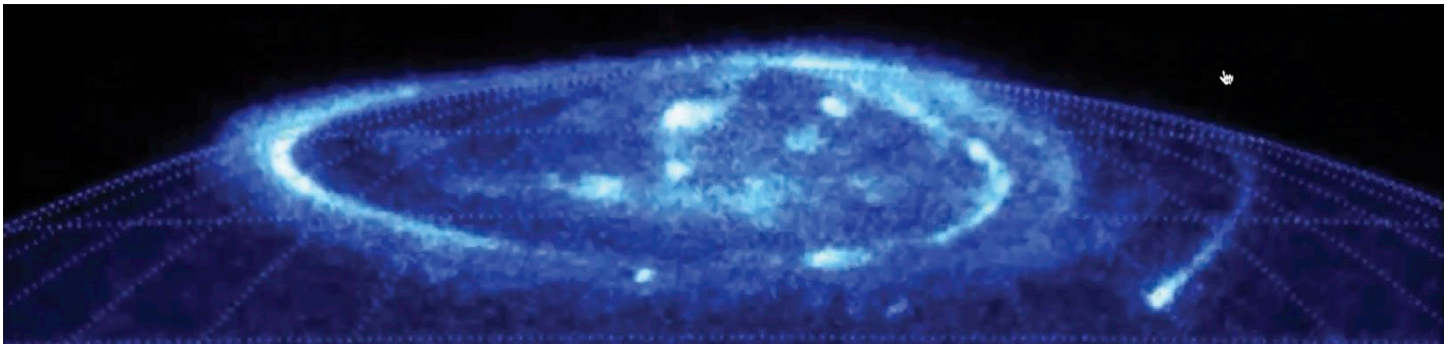


Scale of Magnetic Field of Jupiter

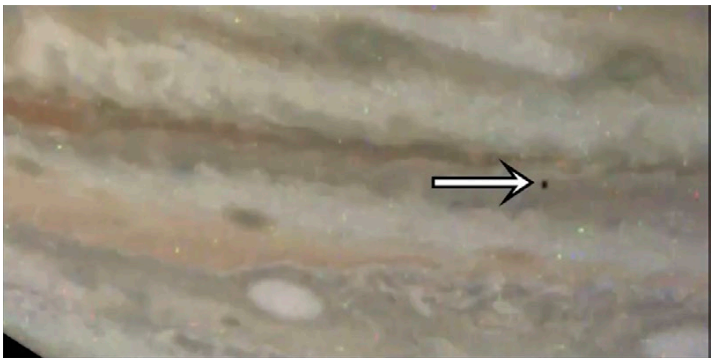
- Vast region stretches out 100x the radius of Jupiter
- Solar wind comes in, interacts with magnetic field and plasma inside
- Tail goes out past orbit of Saturn



Jupiter's 3 Types of Aurora
- Steady Main Auroral Oval
- Variable Polar Aurora – only around the polar region
- Aurora associated with moons

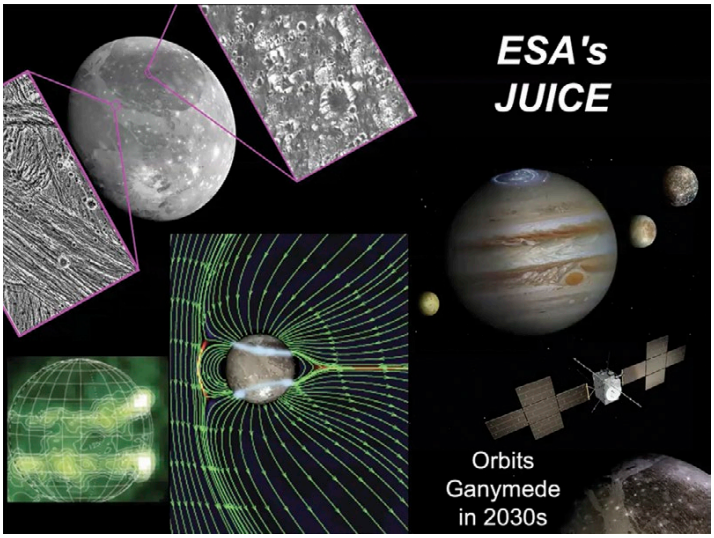


Hubble Space Telescope Movie UV Hs Emissions Excited by 10s keV electrons
Can see the main aurora around Jupiter is variable in polar regions but steady all the way around



Juno spotted Amalthea (smaller moon)

JWST image of Jupiter and aurora



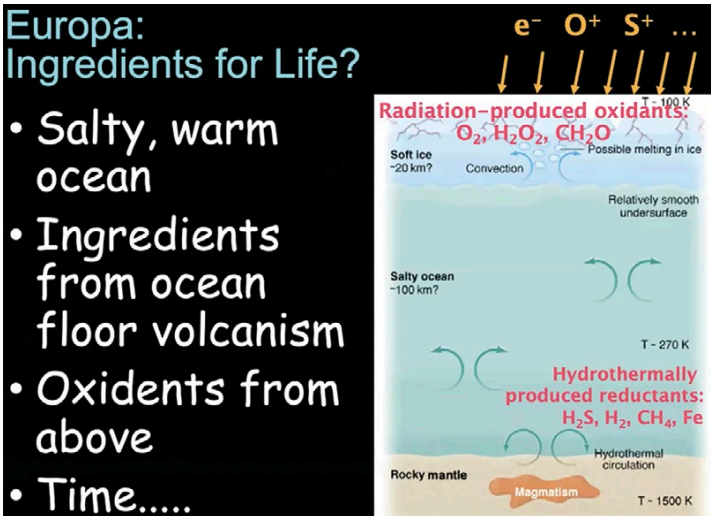
Future Missions

ESA's (European Space Agency) JUICE will go to Ganymede, has been launched, will arrive in 2031. JUICE will do orbits around Ganymede, measures of environment, the other moons are too small to orbit

Europa Clipper Mission

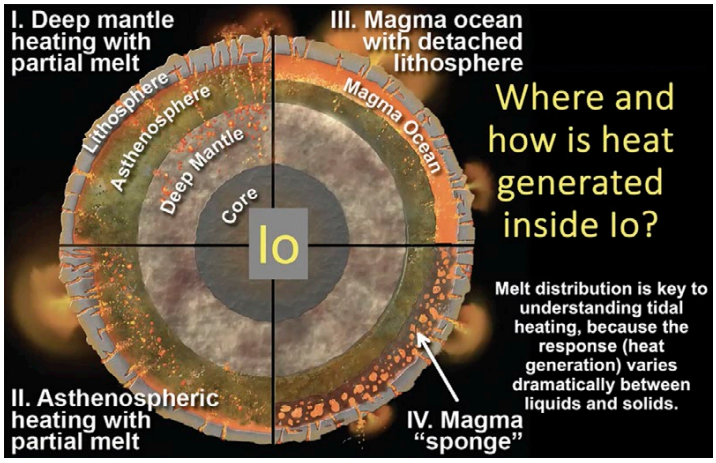
- Launch October 2024 - will make 45 flybys, measure heat coming out; where are hot places that may have connections to what is underneath, look at geology in detail; brown materials, measure thickness of ice, air

- CU-LASP's SUDA Instrument on board; is a dust detector wants to fly over Europa and measure material that is knocked off by impacts; also has mass spectrometer able to measure chemicals, map down to surface to know what these chemical are and where they came from



Big interest of what is going inside Europa?

- What is the brown gunk?
- How thick is the ice?
- Does water reach the surface?
- What's in the water?



What's going on with Io?

Io is a very tough place to go – very high radiation, high density of plasma is really difficult to make measurements....but there is hope of maybe a mission, maybe an orbiter, there are big questions we want to answer.

The presentation is followed by questions and comments. Are JUICE and the others orbiters? Some of these pictures you have shown tonight are from camera on Juno? Does all the tidal heating cause any degradation in the orbits of these moons? With the heating on Europa of the ocean given the lower gravity, what do we think the pressure is at the surface of the bottom of the ocean; how much heat is it getting from tidal heating there? Is it boiling there but we don't see it because it cools as it come up? Or more mineral ice? What size is Europa relative to our Moon? Is there as much interest in Ganymede's ocean? Is there an instrument there now or on the way that will allow us to determine the chemical composition on the surfaces?

III. Business Meeting - Treasurer Report by Bruce Lamoreaux

Longmont
Astronomical Society

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

LAS Treasurer's Report - Bruce Lamoreaux **5/16/2024**

Main Checking Account (xxx-1587)

Begin Balance:	$ 8,760.00	**4/3/2024**	
Deposits:	$ 70.00	Membership	
Expenses:	$ (10.00)	Bank Charges, State Fee	
Current Balance:	**$ 8,820.00**	**5/2/2024**	

2-Year Savings Account (xxx-1478) (matures 10/23/23)

Past Balance:	$ 8,200.00	**12/29/2023**
Interest:	$ 15.00	
Balance:	**$ 8,215.00**	**3/29/2024**

Telescope Fund (xxx-0165)

Past Balance:	$ 1,100.00	**3/28/2024**
Deposits:	$ -	
Expenses:	$ -	
Balance	**$ 1,100.00**	**4/29/2024**

Petty Cash

Past Balance:	$ 50.00
Deposits:	$ -
Expenses:	$ -
Balance	**$ 50.00**

Total Assets	**$ 18,185.00**	$ 60.00	Up from April

Active Membership:	**93**
Student Membership:	**1**
Total	**94**

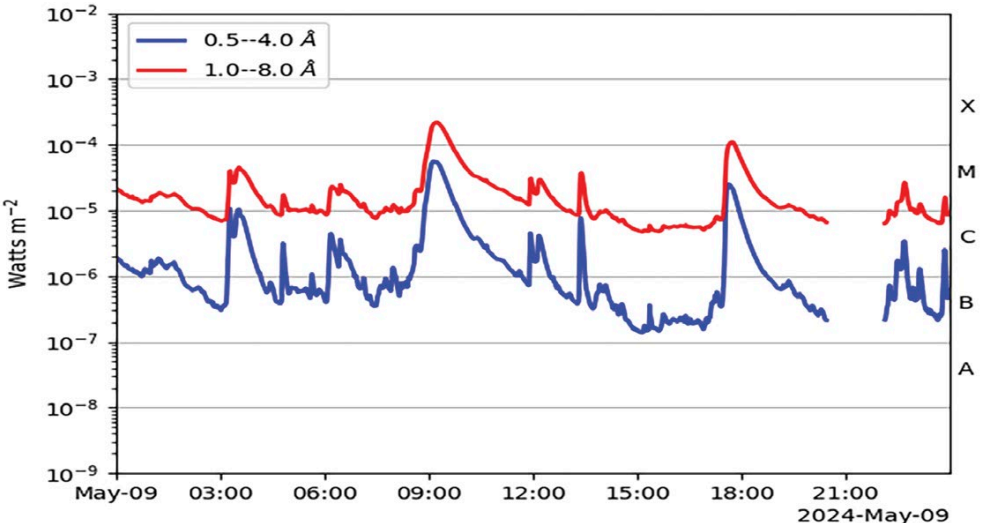
IV. Upcoming Events

Rabbit Mountain Star Party – June 7th Very thin crescent Moon (one day after New)

Videos of our meeting are available to members only at the LAS portal website https://members.longmontastro.org

Aurora night of May 10 - 11

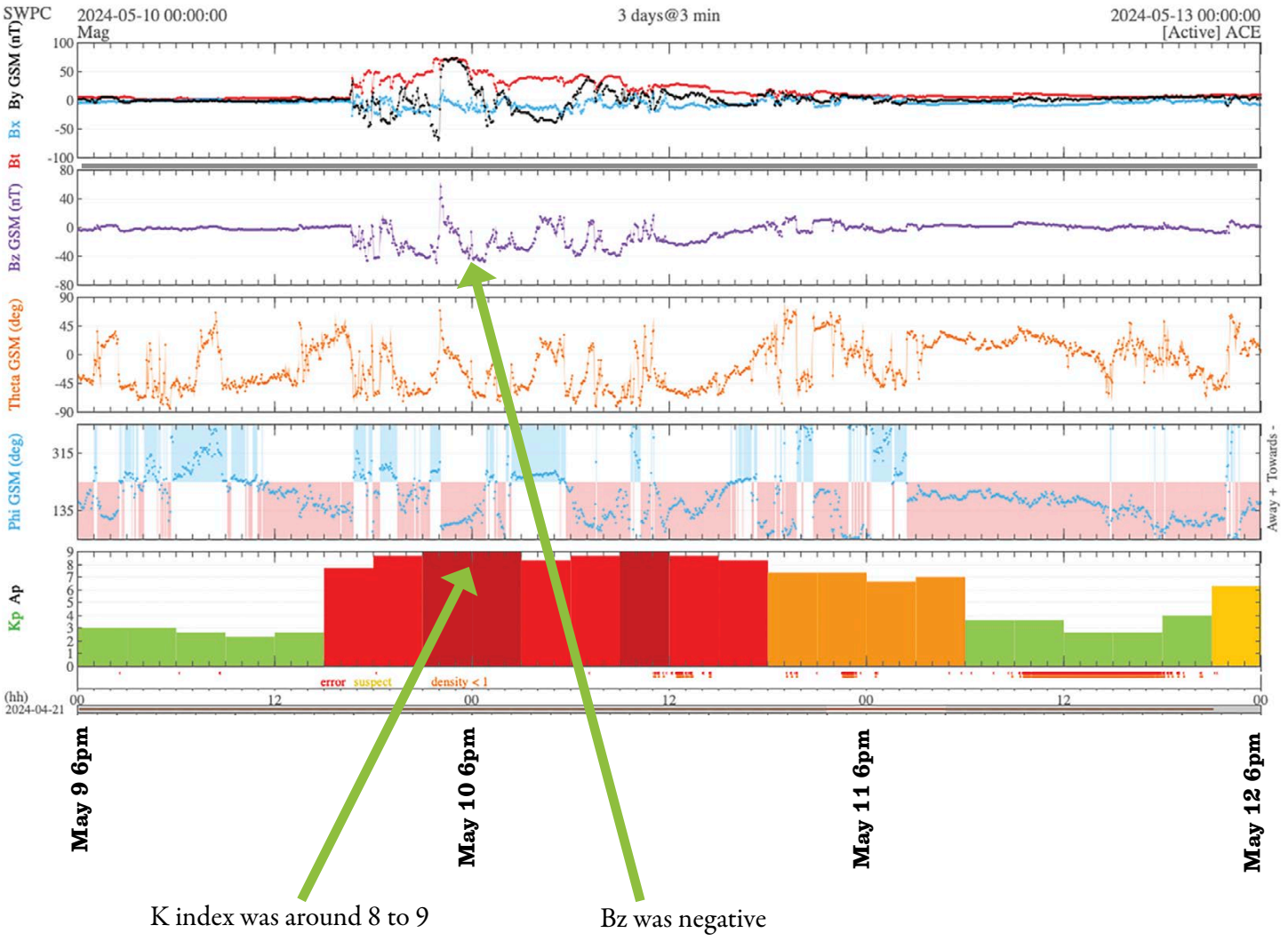
Early in May a couple regions on the sun, AR 3664 and 3668 produced a series of flare events that resulted in large expulsions of plasma and magnetic field or Coronal Mass Ejections (CMEs). X-ray detectors on NOAA's GOES 16 and 18 satellites detected multiple flares with magnitude 'X' range which is the highest level.



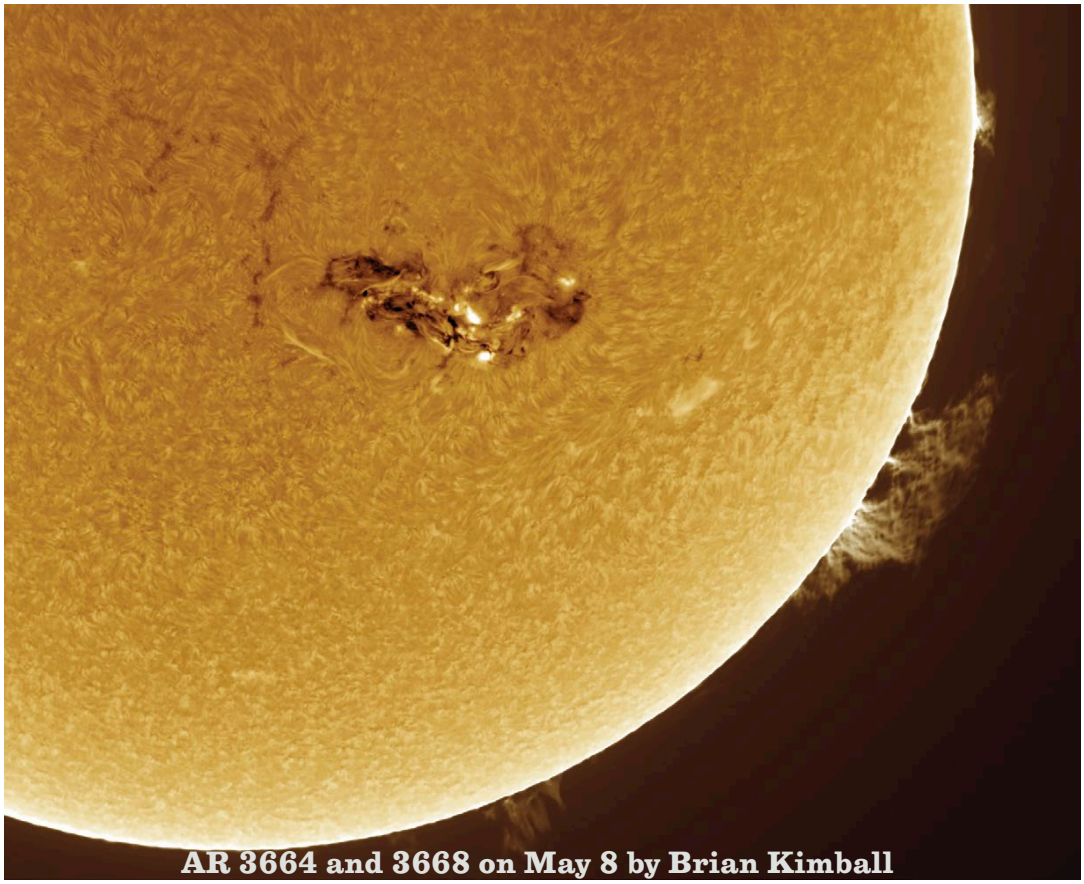
The NOAA ACE Satellite is located at the L1 libration point between the Sun and Earth. This enables advance warning of up to an hour. For aurora to be seen in Colorado the magnetic K index is usually 7 or greater. Also magnetic polarity of the solar wind (Bz) must be negative.

The conditions early on May 10-11 clearly indicated the possibility of aurora.

Below is the NOAA ACE Satellite Plot from Thurs May 10 at 6 pm MDT (0 UTC) to Sun May 12 at 6 pm



An instrument called a magnetometer is used to measure disturbances in the magnetic field of the Earth. The K index is used to characterize the magnitude of the horizontal component on scale of 1 to 9 with 9 indicating a major disturbance.



AR 3664 and 3668 on May 8 by Brian Kimball

Top center is active region 3664 and 3668 from which multiple CMEs orignated, causing the marvelous aurora we experienced on the night May 10-11.

For a CME to reach Earth it usually originates on the western hemisphere of the Sun between 20° West of center to 95° West of center (ie 5 degrees beyond the western limb).

A CME usually takes about 2 days to reach Earth. However they may take from 15 hours to several days depending on velocity.

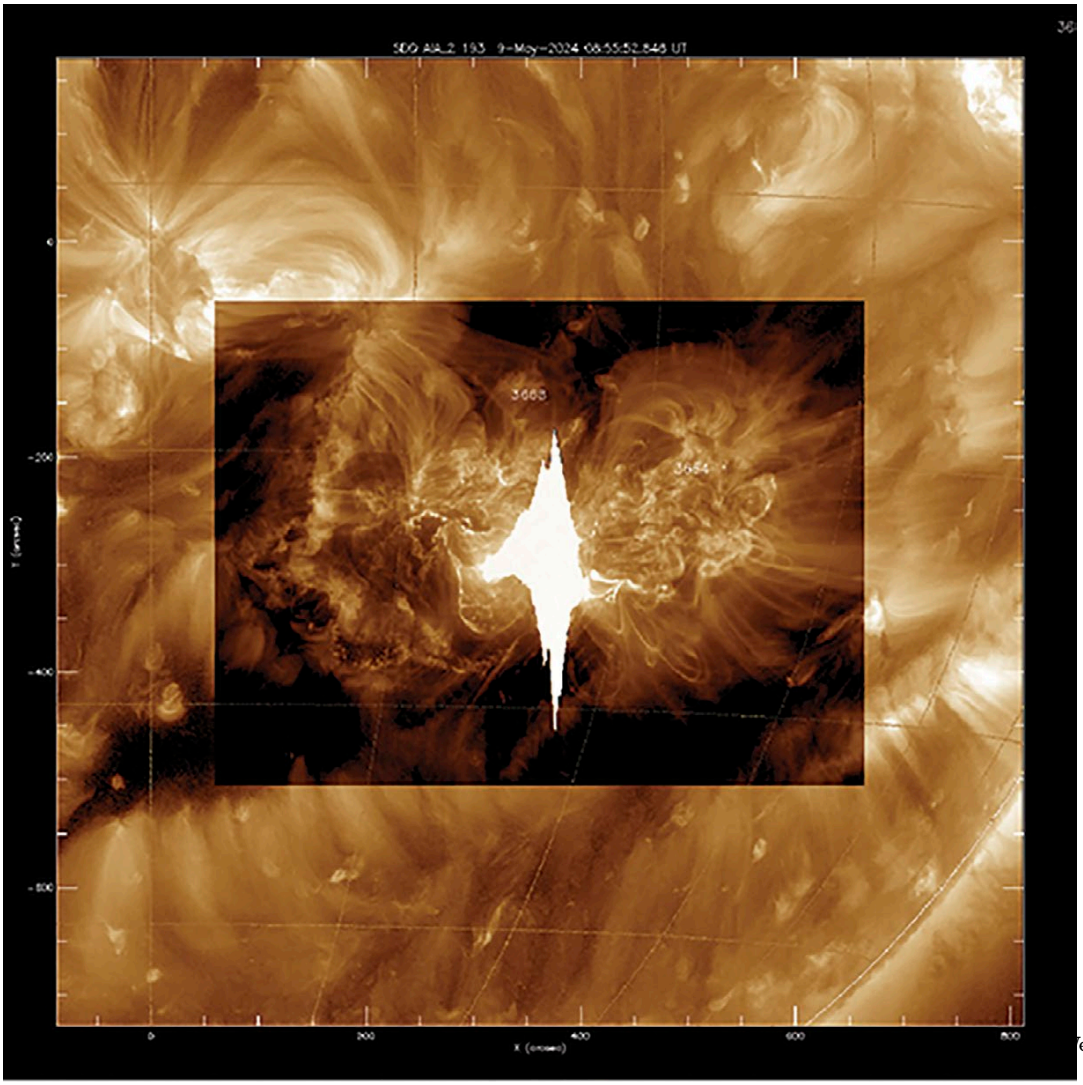


Image of one of the flares from the Solar Dynamic Observatory a couple days before the aurora.

To check the current values see the ACE real time solar wind page at https://www.swpc.noaa.gov/products/ace-real-time-solar-wind

To check K index see https://www.swpc.noaa.gov/products/planetary-k-index

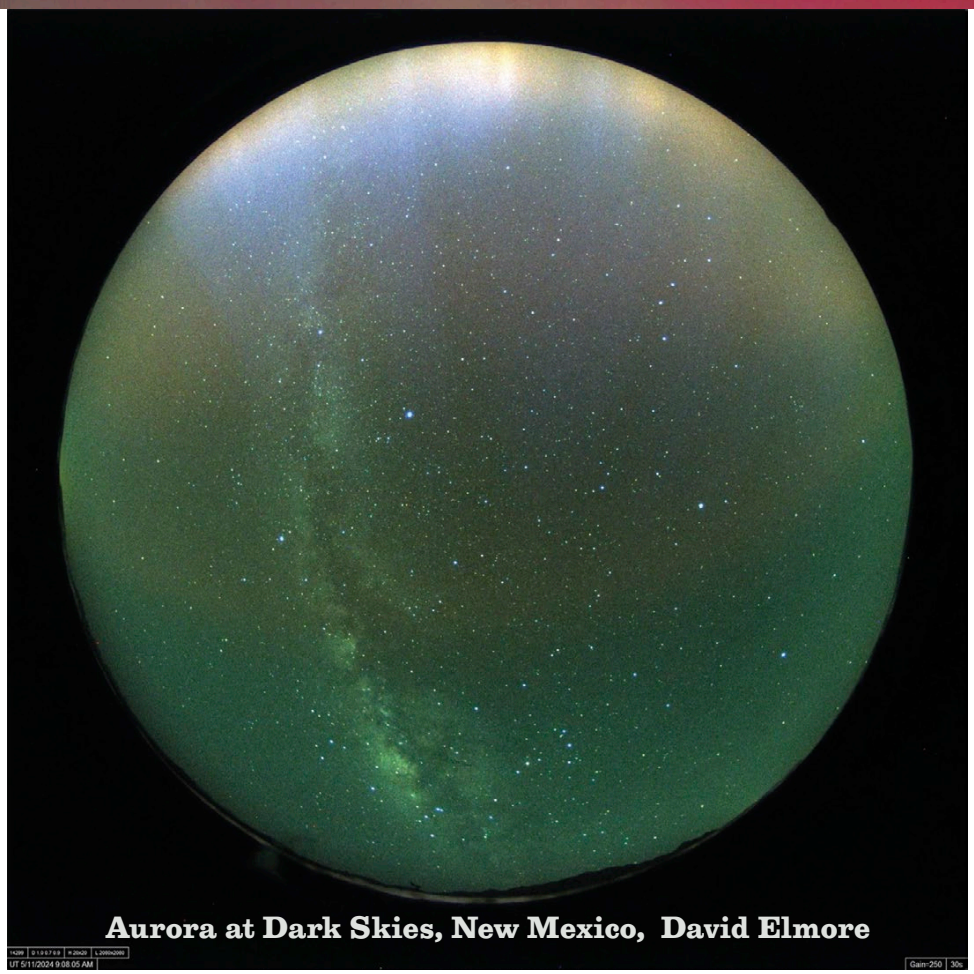
Aurora Allen Jeeter

Aurora by Arcus Evans

Aurora by Aref Namari

Aurora by Brian Raben

Aurora and Big Dipper by Gary Garzone



Aurora at Dark Skies, New Mexico, David Elmore

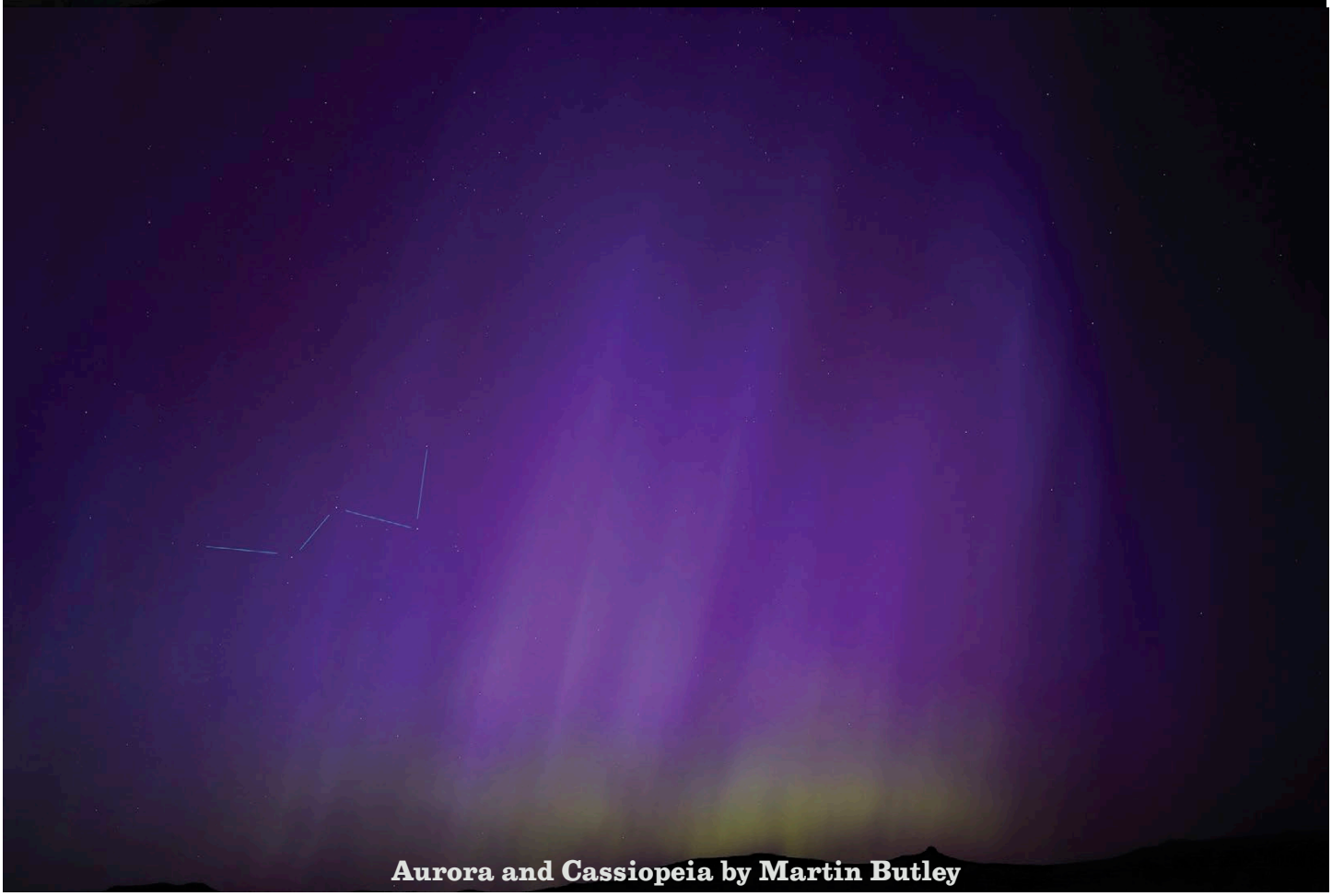
Aurora by Jim Pollock

Aurora by Mitch Glaze

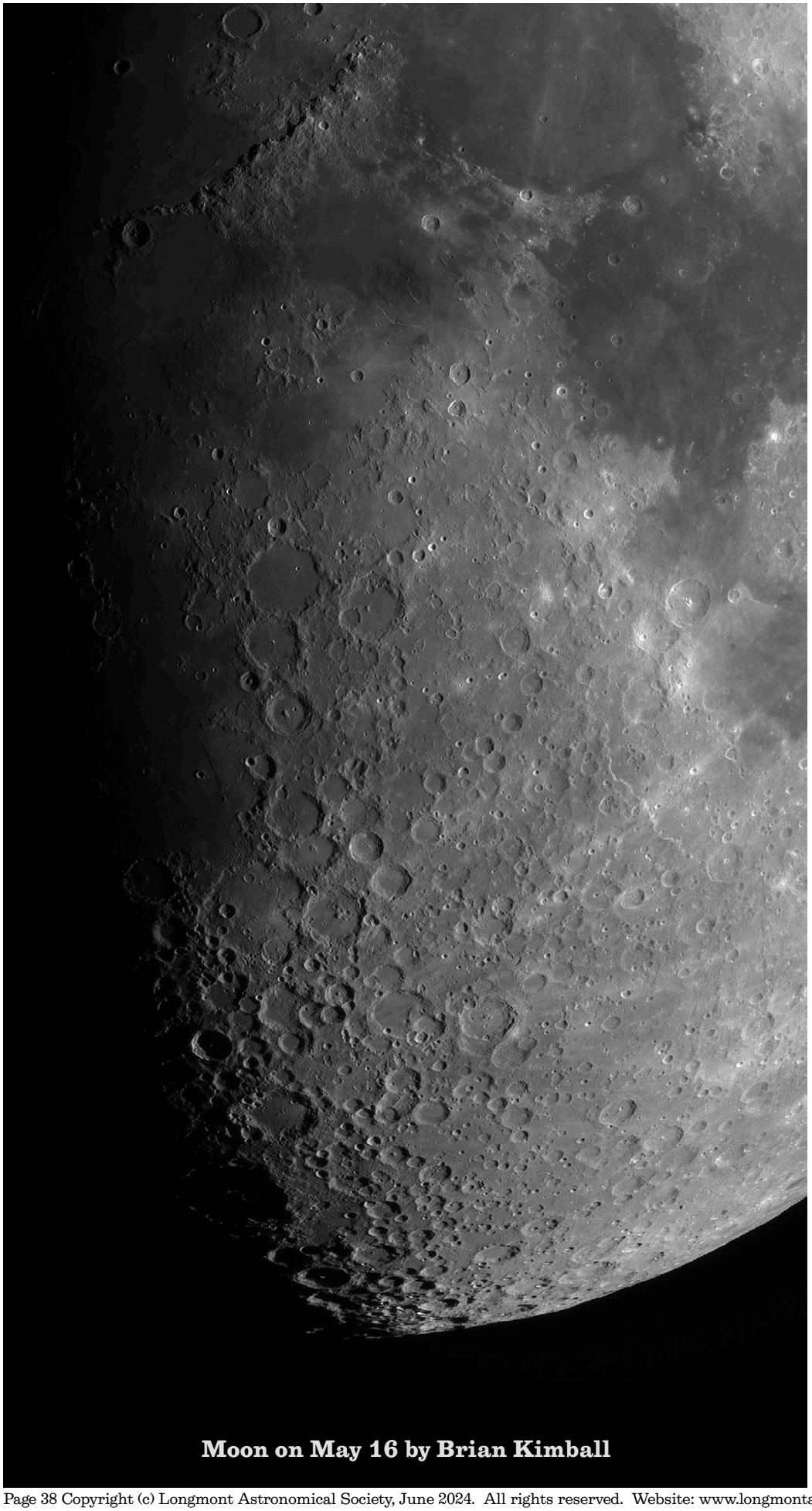
Aurora by Paul Robinson

Aurora by Paul Robinson

Aurora and Cassiopeia by Martin Butley



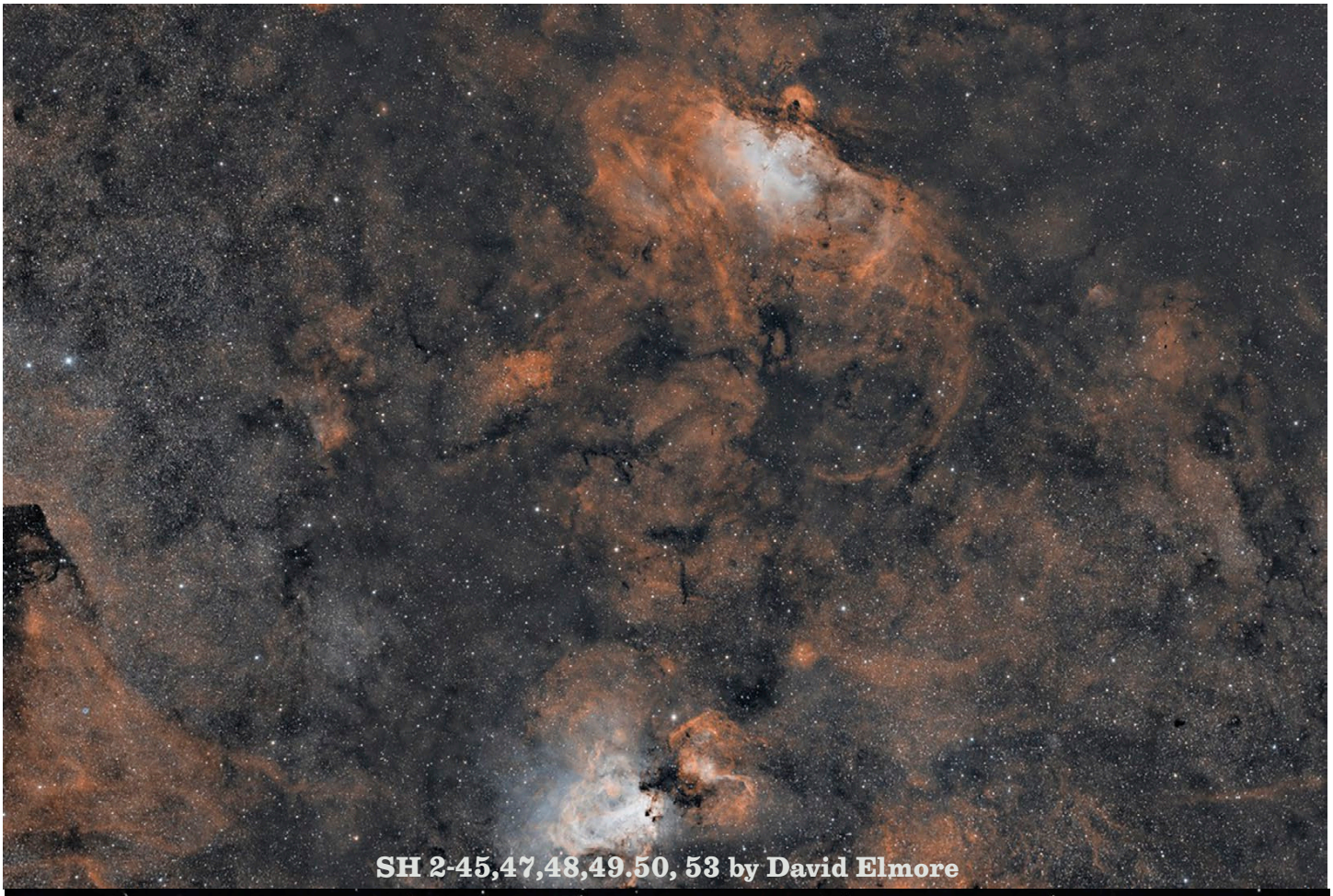
Aurora and Cassiopeia by Martin Butley



Moon on May 16 by Brian Kimball

Taken the evening of May 16 with moderate seeing.

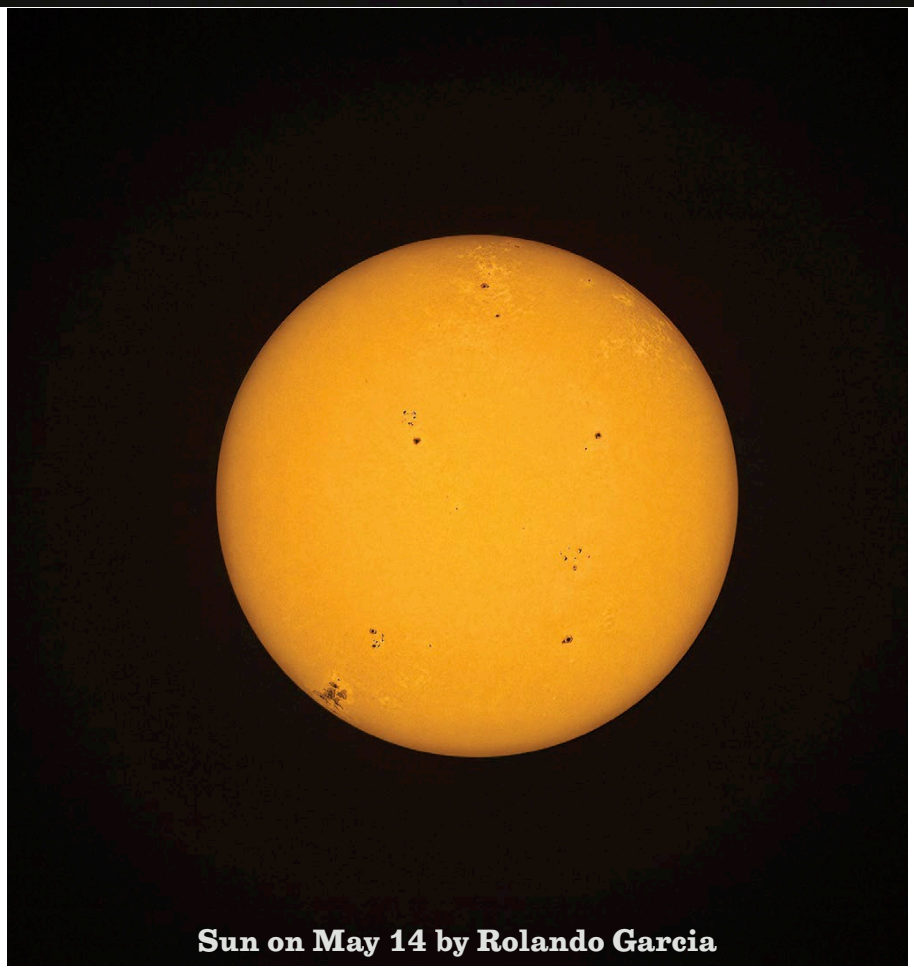
This is a four pane mosaic taken with a 6" f8 IStar refractor and a Zwo 174mm camera.



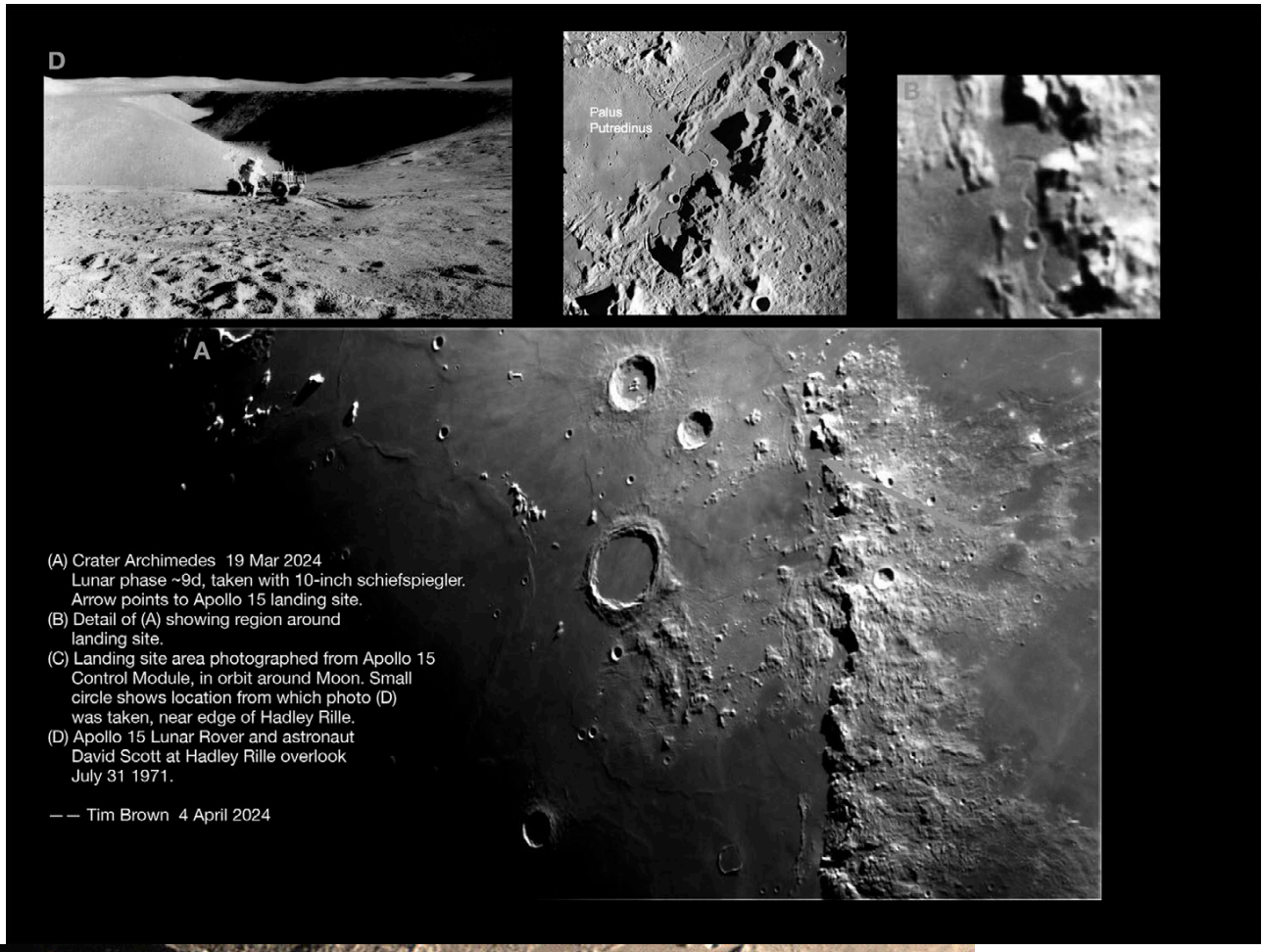
SH 2-45,47,48,49.50, 53 by David Elmore

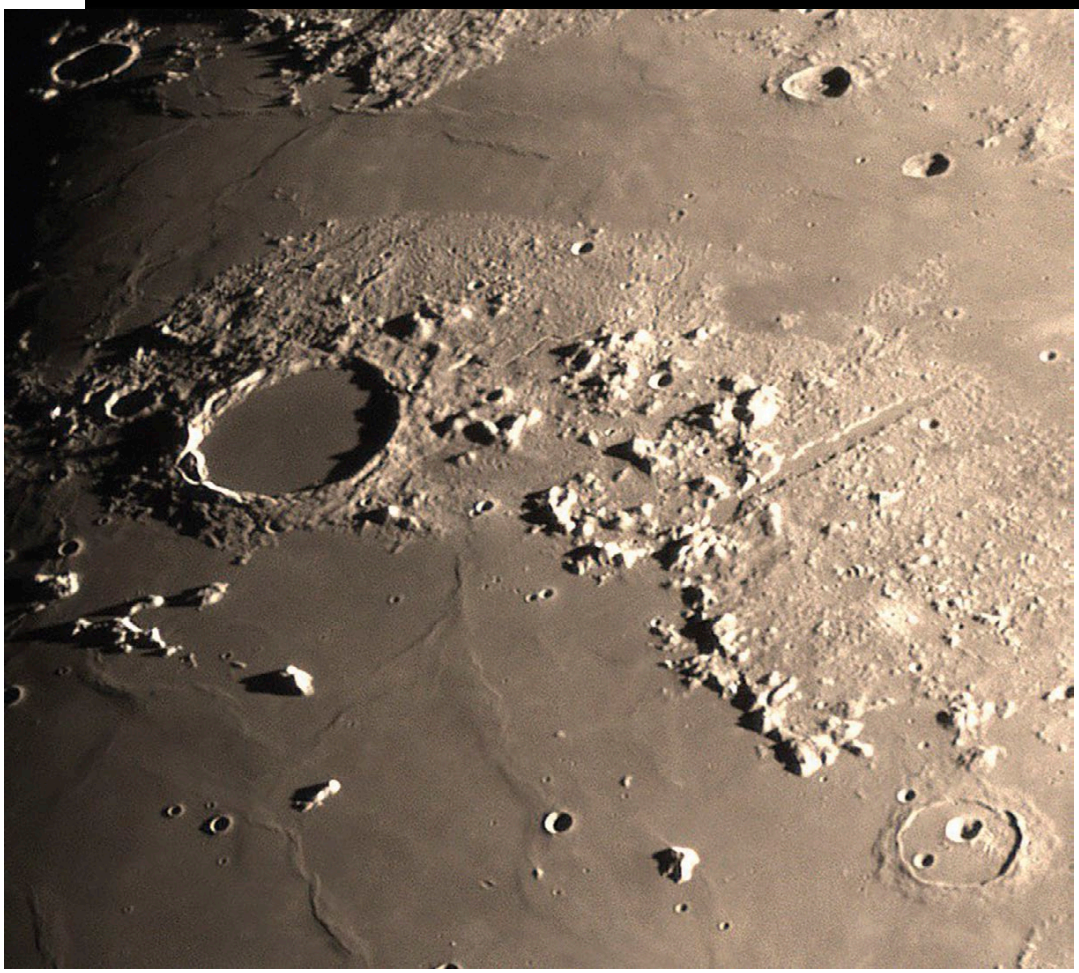
NGC 4216 with SN2024gy by Jim Pollock

Comet C/2023 A3 (Tsuchinshan/ATLAS) by Jim Pollock on May on18



Sun on May 14 by Rolando Garcia





Center left is the crater Plato, with the low sun angle giving long shadows cast by the crater's eastern rim on the flat, lava-flooded crater floor. In the upper left corner is the crater Fontenelle, with its entire rim lit up. To the right of Plato are the Lunar Alps, From lower left to upper right of Alps is the Alpine Valley, a graben formed between two parallel fault lines generated by the same impact. The mountains Pico (below Plato) and Piton (to the lower right) are prominent, The crater Cassini lies at lower right, a big crater flooded with lava almost up to its rim, with two newer craters inside it.

Newsletter Archives by Eileen Hall-McKim

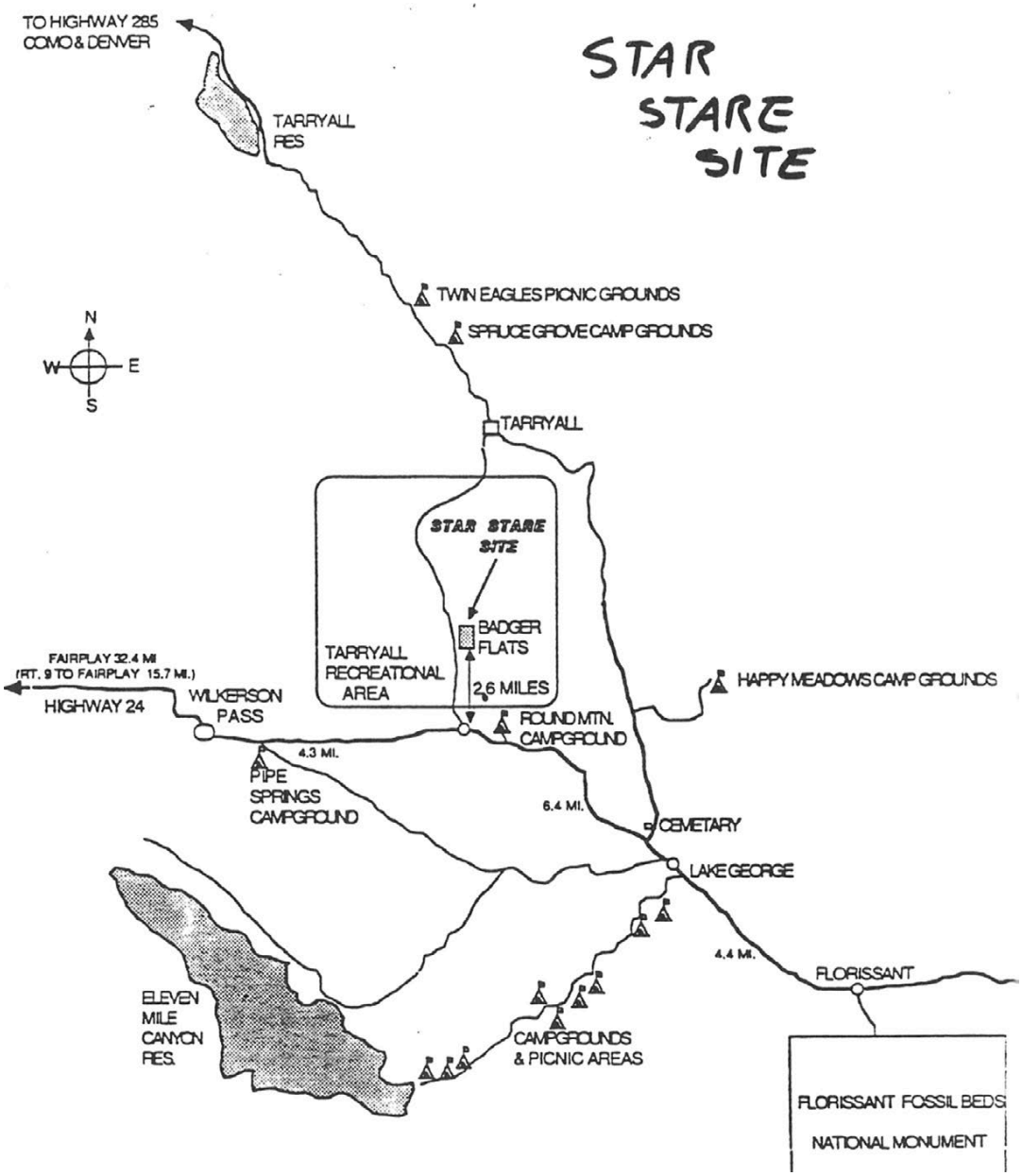
30 Years Ago June 1994

The meeting was started by Jim Sharpe, President, at 7:40

- ALCOR, Dan Cochran gave his report regarding dues and the new A.L. deep sky binocular observing program.
- Dave Street had a trip report and a video of the eclipse as seen from Roswell, NM.
- Bob Ross showed eclipse photos from Deming, NM.
- Brian Kimball showed his slides of the eclipse that were taken from Anthony TX.
- Jerry Wilkinson gave an informative presentation regarding telescope collimation – the why and how.

Rocky Mountain Star Stare ' 94

The Colorado Springs Astronomical Society's 8th annual Rock Mountain star Stare will be held this year on July 1-4. Our observing site for this event is very near the geographical center of the state of Colorado, about an hour's drive west of Colorado Springs and 3.65 miles ENE of Wilkerson Pass (off U.S. Hwy 24). We call the site Badger Flats for its proximity to 11,294 ft. Badger Mountain. It's in the Tarryall Mountains and Pike National Forest at an elevation of 8750 ft, long 105°28'05" West, lat. 39° 3' 58.9' North.



Badger Flats is a large meadow surrounded by open ponderosa pine and aspen forests. The night sky, which is only minimally obstructed by mountains, is very dark and transparent. Many say they've never seen the summer Milky Way appear to be so close and to stand out in such splendor. In the past few years we have averaged around 160 attendees from all over the U.S. and 50+ scopes (of all shapes and sizes).

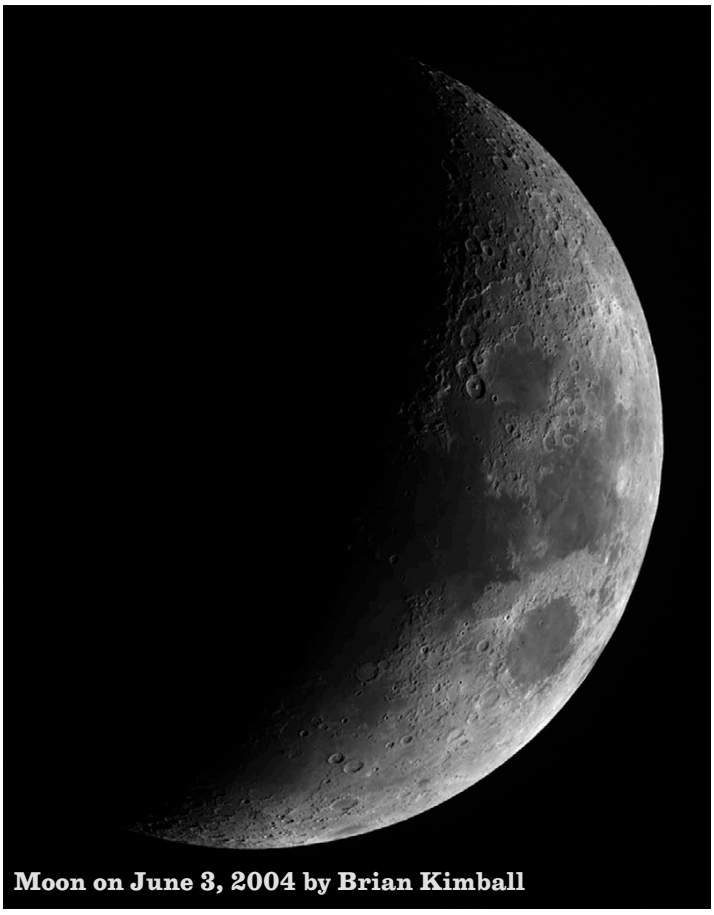
10 Years Ago June 2004

The May 15th meeting at Fiske Planetarium was attended by 34 people. Dr. Doug Duncan gave a presentation on trips to Yellow Knife, NWT, Canada to observe aurora. Also, he will be leading a trip to view the 2017 total solar eclipse at the Jackson Lake Lodge in Yellowstone National Park. Following that was the show in the planetarium. The opening sequence of the International Station with the moon in the background was absolutely amazing.

For our next meeting Dr. Fran Bagenal, professor in the Department of Astrophysical and Planetary Sciences at the University of Colorado, Boulder, will talk about auroras of different planets and discuss the various processes that cause planetary auroras.

M5 by Gary Garzone 2004

June is a great time for hunting globular clusters. The majority of these wonderful objects are visible in constellations Ophiuchus, Sagittarius, and Scorpius which are now visible in the evening sky. Globular clusters are spherical collections of stars orbiting a common core and are tightly bound gravitationally. They contain from tens of thousands to perhaps a million stars. They are fascinating objects to view and photograph with a telescope. Some have intense, bright, highly concentrated centers; others are sparsely populated; some gradually decrease in brightness and density Messier 5 is a type 5 globular cluster which is 26.3 arc min in diameter and magnitude 5.6 in brightness. It is located in Serpens Caput. To find it manually, first locate 3.9 mag star Beta Virginis at the foot of Virgo. Next find Alpha Serpens and then hop to Epsilon Ser and then Omega Ser. M5 is located roughly midway between the line from Omega Ser and Beta Virginis



Moon on June 3, 2004 by Brian Kimball

M57 by Jim Pollock 2004

Around 10:30 pm or so, take a look at one of the show pieces of the summer sky, Messier 57- "the Ring Nebula" in constellation Lyra. First locate the bright bluish +0 magnitude star Vega. Then look for a diamond shaped group of stars forming constellation Lyra. The Ring Nebula is located approximately midway between the stars Beta and Gamma Lyrae. Messier 57 is one of our best examples of a planetary nebula. The star in the center has expelled envelopes of gas and dust and has collapsed to a white dwarf. Intense radiation causes gases surrounding the star to ionize and glow. The ionized oxygen glows a greenish color and the ionized hydrogen a reddish color. Messier 57 is estimated to be 2,300 light years (705 parsec) from our solar system.

Longmont Astronomical Society
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Longmont, CO 80506

NGC 3344 by M. J. Post