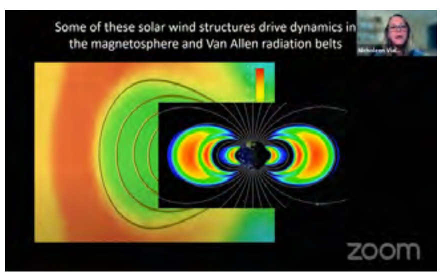
AOH Newsletter

Autumn 2021

News and Notes

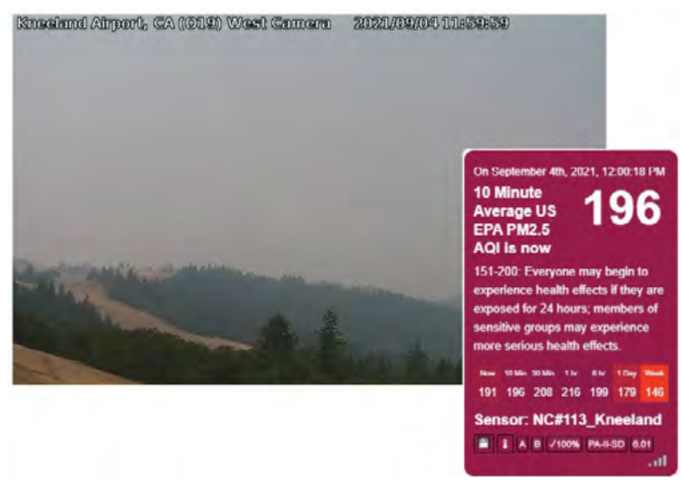
AOH has been continuing its monthly Zoom meetings, but has also begun scheduling in-person observing at Kneeland. Unfortunately, three out of our first four Kneeland meetings were canceled—the first, in June, because of clouds, and two others, in August and September, because of forest-fire smoke. We'll hope that fall will bring some clearer skies.

Outside of AOH meetings some of us have been observing, and photographing, on our own. See Grace's article beginning on page 3, and Rick's astrophotos on his website https://rickgustafson.com/. If you have anything to share, send it in to ken@astrohum.org.



Top row and bottom left: Our summertime Zoom meetings. Lower right: Night Sky Network webinar in July by Dr. Nicholeen Viall on "The Polarimeter to Unify the Corona and Heliosphere (PUNCH) Mission."

Above: setting up at Kneeland in July. —photo by Johnny Thomas



Right: our August and September meetings were canceled by smoke from the Monument fire burning just on the other side of Willow Creek. —screen captures by KY.

Meanwhile, keep checking the Upcoming Events page at www.astrohum.org/upcoming.html for happenings both in outer space (like meteor showers, conjunctions, occultations, etc.) and in cyberspace (NSN webinars, NASA live broadcasts, etc.). Here are a few upcoming special events to watch for:

Meteor Showers: The sky will be lit up by the Southern Taurids, October 9-10; the Orionids, October 20-21; the Northern Taurids, November 11-12; the Leonids, November 16-17; the Geminids, December 13-14; and the Ursids, December 21-22. See details at https://www.imo.net/files/meteor-shower/cal2021.pdf.

The Planets: Saturn and Jupiter both reached opposition in August; they are still high and bright throughout the night in the fall. But for a challenge hunt for Neptune, at opposition on September 14, and Uranus, at opposition on November 4. There are nice finder charts at https://in-the-sky.org/findercharts/10neptune 2021 1.pdf and https://in-the-sky.org/findercharts/09uranus 2021 1.pdf. You can see both of these in binoculars or a small scope. It helps to follow them for a few days to see them move among the background stars. Mercury is at its greatest western elongation (its farthest point from the sun, in the eastern sky, in the morning) on October 24. You generally have only a week or so on either side of the greatest elongation to catch Mercury before it speeds back toward the Sun. Venus reaches its greatest eastern elongation (its farthest point from the sun, in the western sky, in the evening) on October 29. But Venus will remain the "Evening Star" throughout the Fall.

The Sun and Moon: A deep partial lunar eclipse will occur on the night of November 18-19. The partial phase begins at 11:18 pm, Pacific Standard Time; the maximum eclipse occurs at 1:02 am; and the partial ends at 2:47 am. Two weeks later on December 3 there will be a total solar eclipse, but you'll have to go to Antarctica to see it live. Even the partial eclipse zone is limited to the southern tips of South America, Africa, and Australia. Check the internet between 11 pm and midnight for live broadcasts.

Sequential Conjunctions: On the evening of December 6, a thin crescent moon will be near a thin crescent Venus in the southwest. They are joined by Saturn and Jupiter, nearby, strung out along the ecliptic. Keep watching over the next three nights as the Moon glides along below the lineup of planets.

The Deep Sky: Tony Cecci's Twelve Months Tour of the Messier Catalog at https://www.messier.seds.org/xtra/12months/12months.html gives a nice month-by-month listing.

The Unexpected: Sunspots can appear at any time. Check https://sohowww.nascom.nasa.gov/sunspots/ for daily updates. You can read about newly discovered comets or near-Earth asteroids or novae or supernovae by scanning the headlines on our AOH News Page: https://www.astrohum.org/news.html. This page also contains links to Sky & Telescope's weekly Sky-at-a-Glance and monthly Sky-Tour-Podcast sites.

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International Observe the Moon Night: Once again AOH will host a virtual event for IOMN. Participants are invited to observe the moon with telescope, binoculars, or unaided eye; submit a picture, either photo or sketch; and write a description of their activity. Last year we received entries from four countries on three continents. You can participate in AOH's event up to a week before or after October 16th by going to https://www.astrohum.org/moon.html.

⋆ ⋆ ⋆

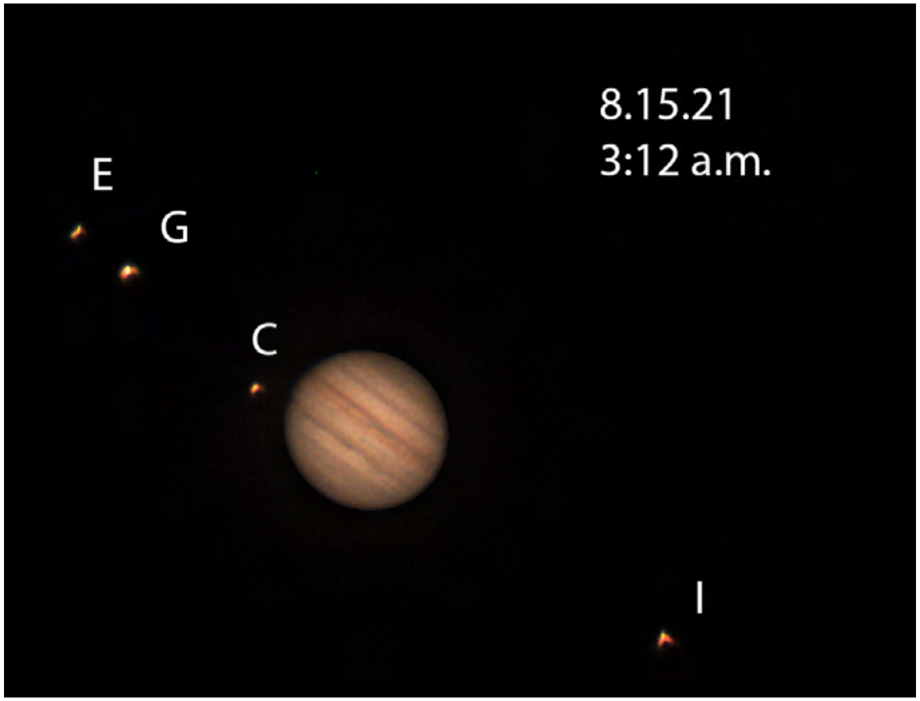
Thanks: To Grace and Susie for their contributions, and to Yoon and Susan for their consultations and support. Stay safe!

—Ken

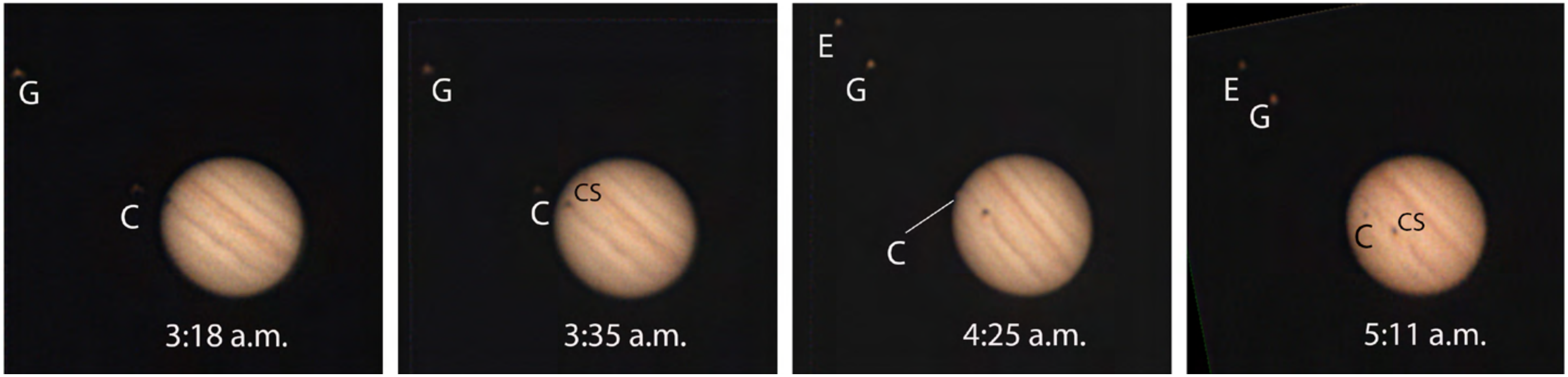
One-Third of a Triple Moon Transit of Jupiter

by Grace Wheeler

On August 15, a rare triple moon transit was observed in parts of Australia and Asia: for a brief time (about one and half minutes), Callisto, Ganymede, and Europa passed in front of the Jovian disc. An image of the triple moon transit can be seen on NASA APOD (https://apod.nasa.gov/apod/ap210821.html). In the western U.S., we could see the transit of Callisto which started around 3 a.m. but would miss the transits of Ganymede and Europa as these occurred well after Jupiter had set. Viewing a transit of Callisto is in itself an uncommon event. Callisto is the outermost Galilean moon and because it is relatively far from Jupiter, Callisto usually lies below or above the planet from Earth's perspective. So Callisto transits can be observed from Earth only during a three-year span centering on the Jovian equinox. The current period for observing transits of Callisto started in 2020 and ends in 2022.



I was able to observe the early morning transit of Callisto during a visit to Santa Rosa. Even though it was hazy from the wildfires, the sky was transparent enough to get good telescopic views. Shown in the figure is the progression of Callisto (C) and its shadow (CS). The shadow was seen on the eastern limb of Jupiter at about 3:18 a.m. and was trailing the Great Red Spot during the first half of the shadow transit (poorly seen in the image). The ingress of Callisto onto the Jovian disk is seen at 4:25 a.m. The last image at 5:11 a.m. shows both Callisto and its shadow on the disk. Also seen were the approach of the moons Ganymede (G) and Europa (E) toward the disk. Ganymede and Europa would not begin their transits for another three hours.

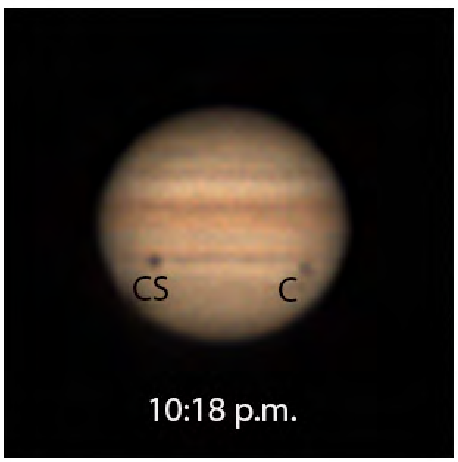


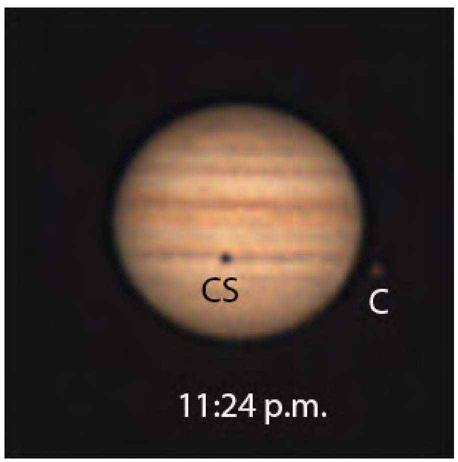
Addendum

Callisto has an orbital period of 16 days; and so, while transits are happening, it transits Jupiter about twice a month. Like clockwork, there was another transit of Callisto on August 31st. What is notable about this transit is that it occurred after the Jovian opposition (by 12 days), and the shadow of Callisto is seen trailing behind its moon. The opposite was seen during the August 15th transit: it occurred before opposition (by 4 days) and the shadow was seen racing ahead of the moon.

The next Callisto transit visible to us will start just after midnight on October 4, lasting until Jupiter sets at 3:14 a.m. Europa and its shadow will also put in an appearance. The shadow transit of Callisto will not begin until after Jupiter has set below our horizon.

October 20th will be the last chance to catch a transit of Callisto until winter. That transit will be visible from after sunset to 8 p.m. (the shadow transit of Io will also be seen). As on the 4th, Callisto's shadow hits Jupiter after Jupiter-set.





These photos and the ones on the preceding page were taken with a ZWO ASI290MC Planetary Web Camera mounted on an 8 inch Schmidt-Cassegrain Telescope. The frames were stacked in Autostakkert and processed in Registax.

—GW

Book Review: A History of the Hubble Space Telescope

by Ken Yanosko

The book is *Not Yet Imagined: A Study of Hubble Space Telescope Operations* by Christopher Gainor. This book "documents the history of HST from its launch through its first 30 years of operation in space. It focuses on the interactions among the general public, astronomers, engineers, government officials, and members of Congress during that time. The decision-making behind the changes in Hubble's instrument packages on servicing missions that made HST a model of supranational cooperation amongst scientists is chronicled, along with HST's contributions to our knowledge about our solar system, our galaxy, and our universe. This book also covers the impact of HST and the images it produces on the public's appreciation for the universe, and how HST has changed the ways astronomy is done." [quoted from the book jacket]

Gaynor documents the heartbreak of the discovery of the flaw in Hubble's mirror, the heroic mission to make the repairs, and the subsequent contributions to astronomy and cosmology made by this instrument. He lists his candidates for the three most important images made by Hubble. He writes about the fourth servicing mission, originally planned for 2004, canceled, and eventually reinstated and flown in 2009 partly because of public enthusiasm for the whole Hubble mission. Gaynor writes, "[I]t is likely that HST's mission would have ended before its 20th anniversary in 2010 without Servicing Mission 4. Instead, the success of SM4 allowed astronomers to continue HST operations into a third and even a fourth decade, and plan joint operations involving both HST and JWST."

This book was published by NASA. The author is a historian of space exploration. He holds a doctorate in the History of Space Technology, and is past president of the Royal Astronomical Society of Canada.

And here's the best part: the book is absolutely free. You can download it in mobi, epub, or pdf format from https://www.nasa.gov/connect/ebooks/not-yet-imagined.html.

The Great Square

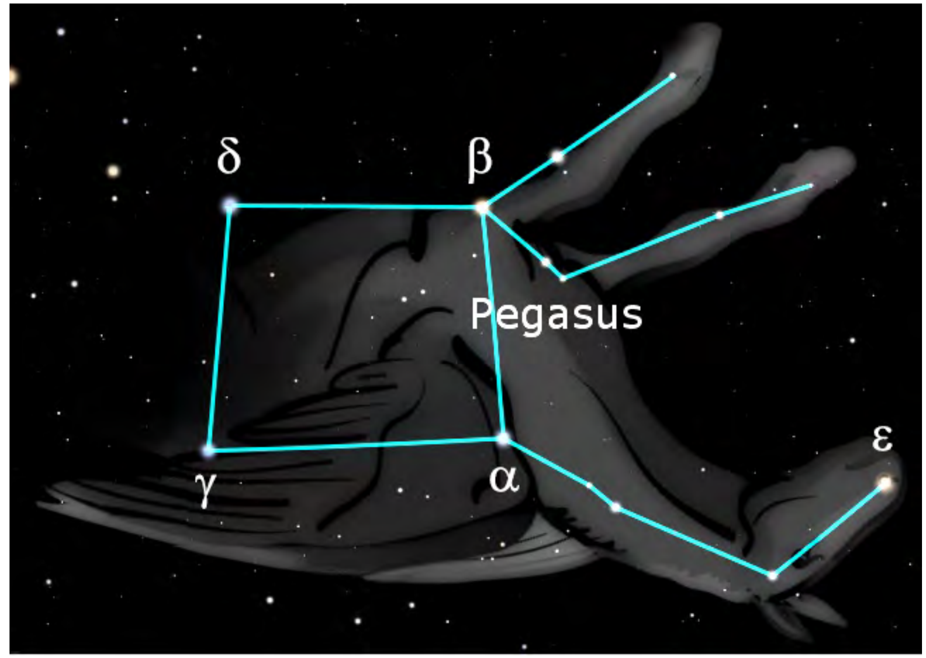
by Ken Yanosko

What comes after the Summer Triangle? Why, the Autumn Square, of course. Just east of the Triangle in the sky you'll find the Great Square of Pegasus, an asterism in the larger constellation of Pegasus, the winged horse of Greek mythology.

From our vantage point at forty degrees north, the horse gallops/flies upside down across the sky. Our modern proper names for the stars of Pegasus give the proper orientation: Alpha Pegasi is Markab, Arabic for "Saddle"; Beta Peg is Scheat, or "Upper Arm"; Gamma Peg is Algenib, or "Wing"; and Delta Peg is Alpheratz, a shortening of the Arabic "Al Surrat al Farras," or "The Navel of the Horse." Whereas Alpheratz has kept its proper name, it should be noted that the Bayer designation Delta Pegasi has become obsolete. This star happens to be located just across the boundary between Pegasus and Andromeda, and is part of both constellations. Modern astronomers have officially given it its other designation, Alpha Andromedae, but have inconsistently failed to adopt its Arabic descriptor "Rās al-Mar'a al-Musalsala," or "Head of the Woman in Chains." (If you want to learn about the mythological exploits of Pegasus, or, for that matter, about why Andromeda was enchained, see the go-to reference for these stories, *Bulfinch's Mythology*, which is in the public domain at https://en.wikisource.org/wiki/The_Age_of_Fable.) Getting back to star names, we also have Epsilon Pegasi, named Enif, "The Nose."

Curiously, there's no "Deneb" or "Tail" star in Pegasus. We get only the head, neck, forelegs, front half of the body, and the wings. Perhaps wings are enough to make up for the missing hindquarters.

Of course not all cultures have seen a horse in these stars. In the Far East the Chinese, Japanese, and Koreans saw the Great Square as a detached room or encampment with a defensive wall. In India the square was a bed; in Babylon it was a field. In the Americas the Lakota saw a turtle, the Ojibwa saw a moose, and the Inca pictured a square base for a grindstone. The Pacific Islanders saw a kite.



Left: The Constellation Pegasus from Al-Sufi's Book of Fixed Stars, *published in Persia in 964.*

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Above, right: Pegasus as depicted in Stellarium, near midnight in the Autumn from 40 degrees north latitude. Note that the star labeled here as Delta is designated by the Intbernational Astromical Union as Alpha Andromedae.

Pegasus has one Messier object: M15 is a bright globular just off the horse's nose. And the galaxy NGC 7331 is also easy to find just below (above, from our point of view) the horse's leg. It's bright enough for Messier to have seen it, but he seems to have missed it. It's colloquially called the "Deer Lick Galaxy." Four distant galaxies called the "Fleas" are right next to it—see if you can find them. The Deer Lick is about 40 MLY away, and the Fleas are six to eight times farther.

And while you're at it, nudge your scope down toward Pegasus' leg and try to find Stephan's Quintet: NGC 7317-7320. Like the Deer Lick, Stephan's brightest member is in the foreground at 40 MLY, and the others are six to eight times distant.

Top: The globular cluster M15. Photo from Mpyat2, CC BY 4.0 <https://creativecommons.org/licenses/by/4.0>, via Wikimedia Commons

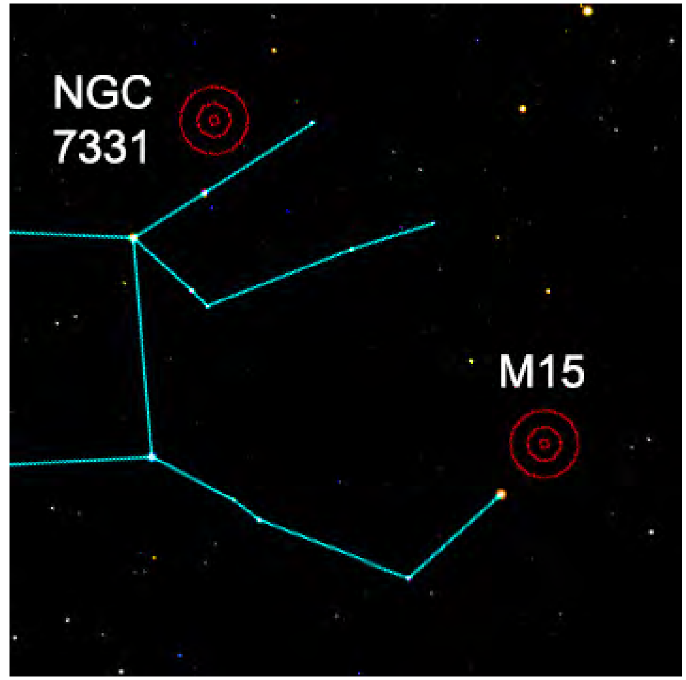
Middle: Deer Lick Galaxy and visual neighbors. Photo from Vicent Peris, CC BY-SA 2.0 <https://creativecommons.org/licenses/by-sa/2.0>, via Wikimedia Commons

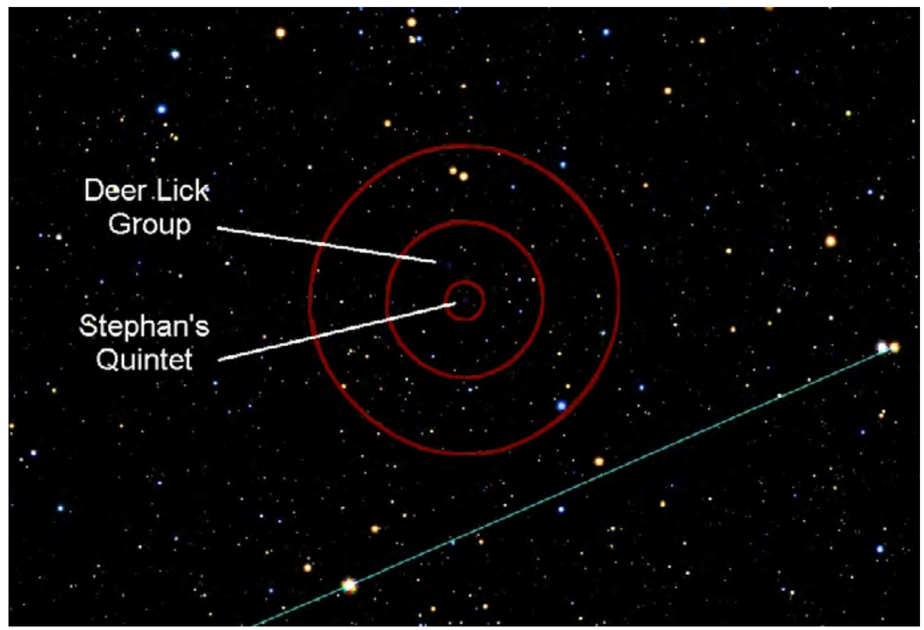
Bottom: Stephan's Quintet. Photo from W4sm astro, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

Stellarium charts with Telrad circles.

To starhop to M15 extend the line of the horse's face through Enif the Nose for a distance of about half the length of the face.

To get to NGC 7331 visualize a nearly-right triangle whose hypotenuse is the segment of the lower leg (upper in this view) from the knee to the hoof. The legs of the triangle are roughly aligned to the sides of the Great Square.





Finding Stephan's Quintet from the Deer Lick: the inner Telrad circle is one-half degree across.

This article is in the public domain in the United States because it was solely created by NASA. It can be found at https://solarsystem.nasa.gov/resources/754/what-is-a-lagrange-point/. It is based on the article (with equations) by Neil J. Cornish at https://map.gsfc.nasa.gov/ContentMedia/lagrange.pdf.

What is a Lagrange Point?

by NASA/WMAP Science Team

Lagrange Points are positions in space where the gravitational forces of a two body system like the Sun and the Earth produce enhanced regions of attraction and repulsion. These can be used by spacecraft to reduce fuel consumption needed to remain in position.

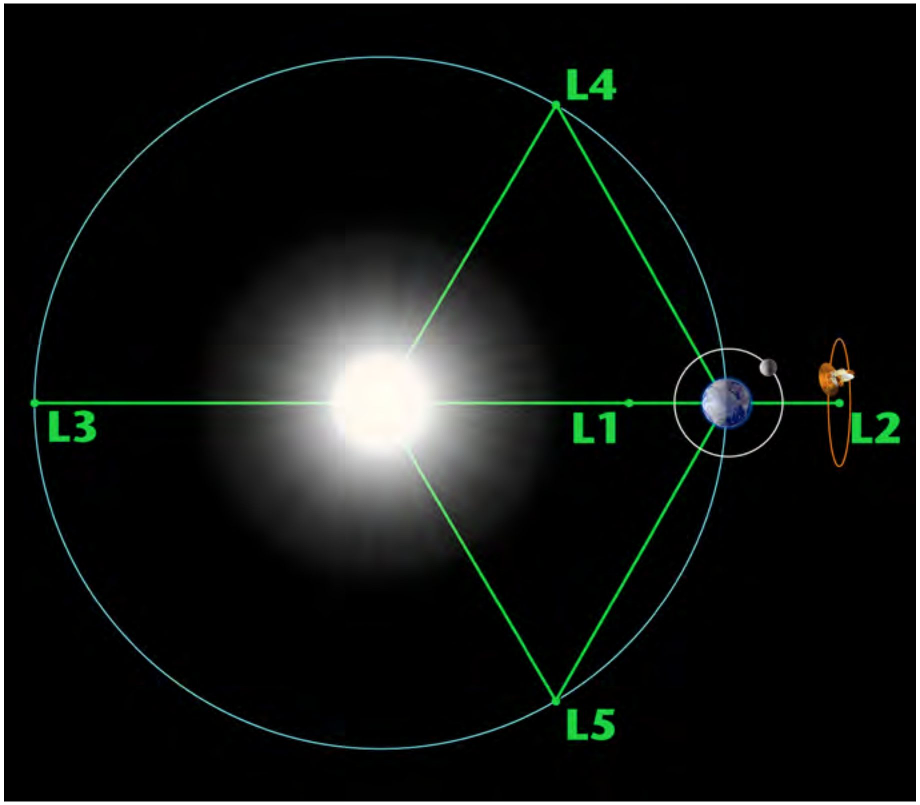
Lagrange points are named in honor of Italian-French mathematician Josephy-Louis Lagrange.

There are five special points where a small mass can orbit in a constant pattern with two larger masses. The Lagrange Points are positions where the gravitational pull of two large masses precisely equals the centripetal force required for a small object to move with them. This mathematical problem, known as the “General Three-Body Problem” was considered by Lagrange in his prize winning paper (Essai sur le Problème des Trois Corps, 1772).

Of the five Lagrange points, three are unstable and two are stable. The unstable Lagrange points—labeled L1, L2 and L3—lie along the line connecting the two large masses. The stable Lagrange points—labeled L4 and L5—form the apex of two equilateral triangles that have the large masses at their vertices. L4 leads the orbit of earth and L5 follows.

The L1 point of the Earth-Sun system affords an uninterrupted view of the sun and is currently home to the Solar and Heliospheric Observatory Satellite SOHO.

The L2 point of the Earth-Sun system was the home to the WMAP spacecraft, current home of Planck, and future home of the



James Webb Space Telescope. L2 is ideal for astronomy because a spacecraft is close enough to readily communicate with Earth, can keep Sun, Earth and Moon behind the spacecraft for solar power and (with appropriate shielding) provides a clear view of deep space for our telescopes. The L1 and L2 points are unstable on a time scale of approximately 23 days, which requires satellites orbiting these positions to undergo regular course and attitude corrections.

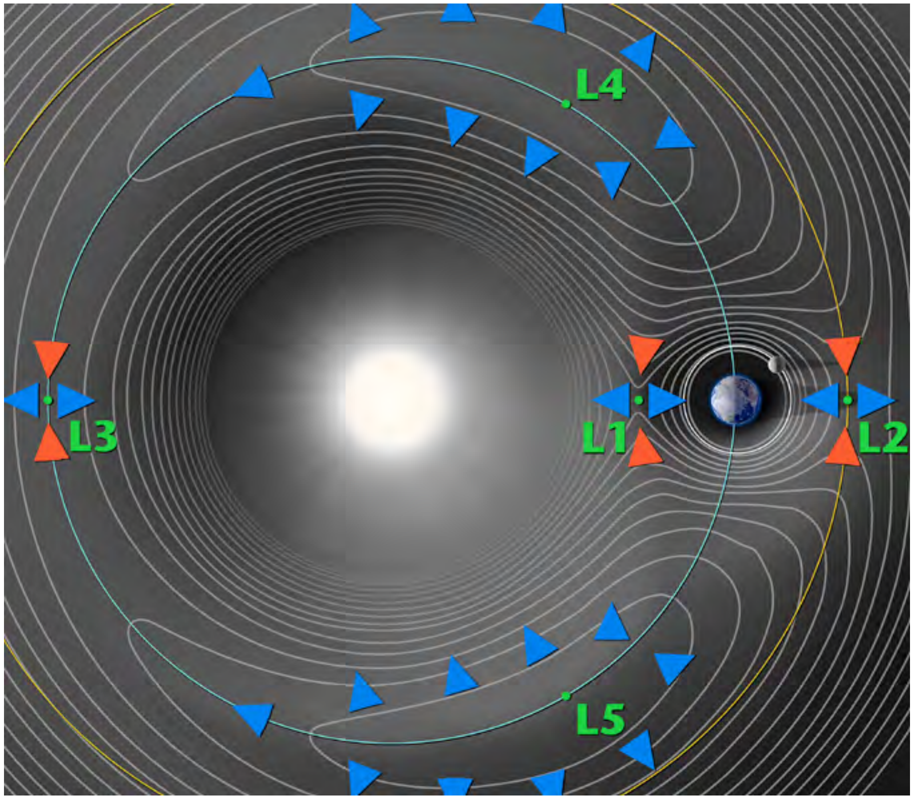
NASA is unlikely to find any use for the L3 point since it remains hidden behind the Sun at all times. The idea of a hidden planet has been a popular topic in science fiction writing.

The L4 and L5 points are home to stable orbits so long as the mass ratio between the two large masses exceeds 24.96. This condition is satisfied for both the Earth-Sun and Earth-Moon systems, and for many other pairs of bodies in the solar system. Objects found orbiting at the L4 and L5 points are often called Trojans after the three large asteroids

Agamemnon, Achilles and Hector that orbit in the L4 and L5 points of the Jupiter-Sun system. (According to Homer, Hector was the Trojan champion slain by Achilles during King Agamemnon's siege of Troy). There are hundreds of Trojan Asteroids in the solar system. Most orbit with Jupiter, but others orbit with Mars. In addition, several of Saturn's moons have Trojan companions.

In 1956 the Polish astronomer Kordylewski discovered large concentrations of dust at the Trojan points of the Earth-Moon system. The DIRBE instrument on the COBE satellite confirmed earlier IRAS observations of a dust ring following the Earth's orbit around the Sun. The existence of this ring is closely related to the Trojan points, but the story is complicated by the effects of radiation pressure on the dust grains.

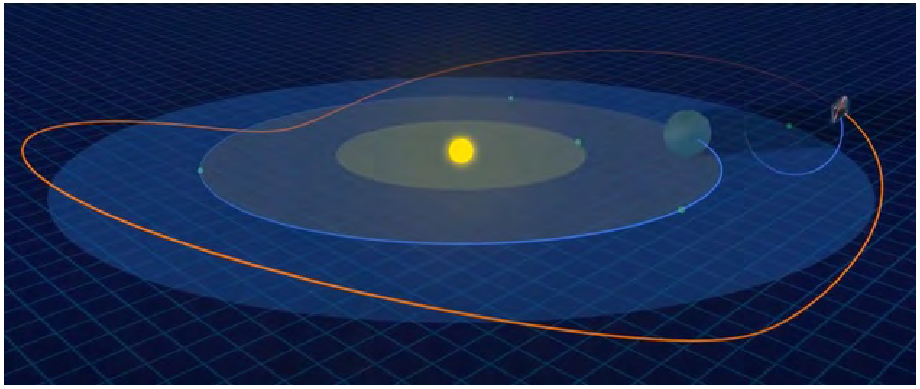
In 2010 NASA's WISE telescope finally confirmed the first Trojan asteroid (2010 TK7) around Earth's leading Lagrange point.



Finding the Lagrange Points

The easiest way to understand Lagrange points is to think of them in much the same way that wind speeds can be inferred from a weather map. The forces are strongest when the contours of the effective potential are closest together and weakest when the contours are far apart.

L4 and L5 correspond to hilltops and L1, L2 and L3 correspond to saddles (i.e. points where the potential is curving up in one direction and down in the other). This suggests that satellites placed at the Lagrange points will have a tendency to wander off (try setting a marble on top of a watermelon or on top of a real saddle and you get the idea). But when a satellite parked at L4 or L5 starts to roll off the hill it picks up speed. At this point the Coriolis force comes into play—the same force that causes hurricanes to spin up on the earth—and sends the satellite into a stable orbit around the Lagrange point.



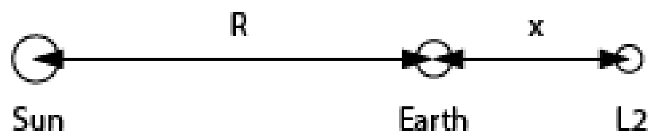
Addendum 1

Here's a three-dimensional view of the projected orbit of the James Webb Space Telescope about the Earth's L2 point. As JWST orbits L2, the L2 point orbits the Sun, keeping station with the Earth. The result is a potato-chip-edge-shaped orbit for JWST in space. Every six months or so JWST will fire its onboard thrusters to compensate for the instability described in this article. You can see a movie of this orbit at https://www.youtube.com/watch?v=IyyQqaF4tNY.

—KY

Addendum 2

The drawings on the preceding pages are clearly not to scale, which leaves open the question, "How far from Earth is this L2 point?" In other words , "How far away will JWST be stationed?"



For a small object at L2, the sun's gravity induces an acceleration equal to $GM/(R+x)^2$, where G is Newton's universal gravitational constant, M is the mass of the Sun, and R and x are the distances in the illustration. Likewise the acceleration of the same object induced by the Earth's gravity is Gm/x^2. where m is the mass of the Earth. The sum of these equals the centripetal acceleration $(R+x)\omega^2$, where ω is the angular velocity of the object around the Sun. Here is the equation:

$$GM/(R+x)^2 + Gm/x^2 = (R+x)\omega^2.$$

Now for the Earth's orbit around the Sun the corresponding equation is:

$$GM/R^2 = R\omega^2.$$

Since we expect our object to orbit the Sun at the same rate as the Earth does, the two ω's are the same. So if we solve the second equation for ω^2 and substitute into the first equation (and simplify) we get:

$$M/(R+x)^2 + m/x^2 = M(R+x)/R^3.$$

Note that as a bonus the G factors all cancel out.

From any astronomy book (or from the internet) we get $M = 2\times10^{30}$ kg, $m = 6\times10^{24}$ kg, and $R = 1.5\times10^{11}$ meters. This gives us an equation that can be solved for x. It's too hard to solve by hand, but my 1990's era TI-89 pocket calculator, in ten seconds or so of deep thought, gives $x = 1.5\times10^9$.

This means the distance of L2 from Earth is 1.5×10^9 meters, or 1,500,000 kilometers, or 930,000 miles, or 0.01 astronomical units, or just under 4 times the distance between the Moon and Earth.

—KY

Addendum 3

So now the next question is: "Will we be able to see JWST with our own telescopes?" I wrote to NASA to inquire:

> Has anyone calculated the magnitude (brightness) of the JWST solar shield as seen from Earth? Will amateur astronomers be able to see it with modest-sized telescopes?
>
> Ken Y.

Here's the response:

> There are a couple of ways to look at this question.
>
> One is that we can compare with some other telescopes that have been out at L2, Like Gaia, WMAP, and Planck. Gaia is at about a magnitude of 20-21. WMAP and Planck were about 18.0-18.5. Gaia has a large sunshield and was expected to be as bright as WMAP and Planck but ended up being fainter due to the angle its sunshield was inclined. Webb's sunshield is 2.5x Gaia's and is more sun-facing, so one might guess that Webb might be a magnitude brighter than WMAP or Planck at magnitude 17.
>
> Another engineer on our team did some math taking into account the amount of energy intercepted and reflected by Webb given its sunshield properties and dimensions, and came out with a magnitude of 17. (Note this calculation would be the maximum estimated brightness.)
>
> So magnitude 17 max would be a fairly solid estimate.
>
> Astronomer Nick Howes was able to catch Herschel with a 2 meter telescope with capability down to magnitude 20:
>
> https://asd.gsfc.nasa.gov/blueshift/index.php/2013/07/01/finding-herschel/
>
> I am not sure what size telescope you'd need to see magnitude 17.
>
> Maggie

So let's pick up where Maggie left off. At http://www.rocketmime.com/astronomy/Telescope/MagnitudeGain.html we can find this formula: $L = 2 + 5\times\log(D)$, where L is the limiting magnitude of a telescope and D is the diameter of its objective in millimeters. We can put in $L=17$ and simplify to get $3 = \log(D)$ so that $D = 10^3 = 1000$. So it would take at least a 1000 millimeter (or 1 meter) objective to see JWST at magnitude 17. I think we're out of luck.

—KY

This article is distributed by the [NASA Night Sky Network](), a coalition of hundreds of astronomy clubs across the US dedicated to astronomy outreach.

Astrophotography With Your Smartphone

by David Prosper

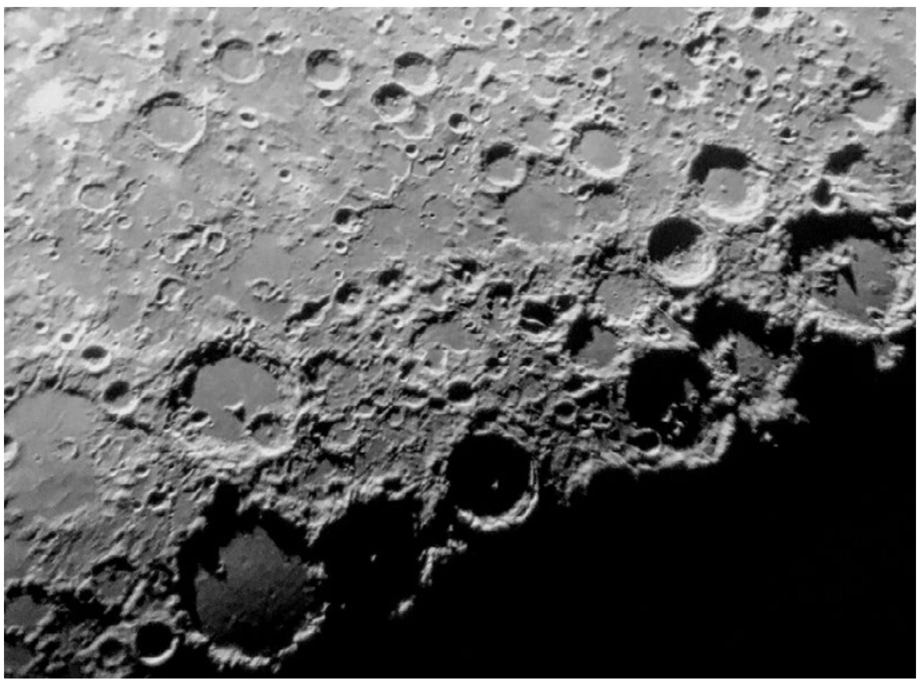
Have you ever wanted to take night time photos like you've seen online, with the Milky Way stretched across the sky, a blood-red Moon during a total eclipse, or a colorful nebula? Many astrophotos take hours of time, expensive equipment, and travel, which can intimidate beginners to astrophotography. However, anyone with a camera can take astrophotos; even if you have just a smartphone, you can do astrophotography. Seriously!

Don't expect Hubble-level images starting out! However, you can take surprisingly impressive shots by practicing several basic techniques: steadiness, locked focus, long exposure, and processing. First, steady your smartphone to keep your subjects sharp. This is especially important in low light conditions. A small tripod is ideal, but an improvised stand, like a rock or block of wood, works in a pinch. Most camera apps offer timer options to delay taking a photo by a few seconds, which reduces the vibration of your fingers when taking a shot. Next, lock your focus. Smartphones use autofocus, which is not ideal for low-light photos, especially if the camera readjusts focus mid-session. Tap the phone's screen to focus on a distant bright star or streetlight, then check for options to fine-tune and lock it. Adjusting your camera's exposure time is also essential. The longer your camera is open, the more light it gathers—essential for low-light astrophotography. Start by setting your exposure time to a few seconds. With those options set, take a test photo of your target! If your phone's camera app doesn't offer these options, you can download apps that do.

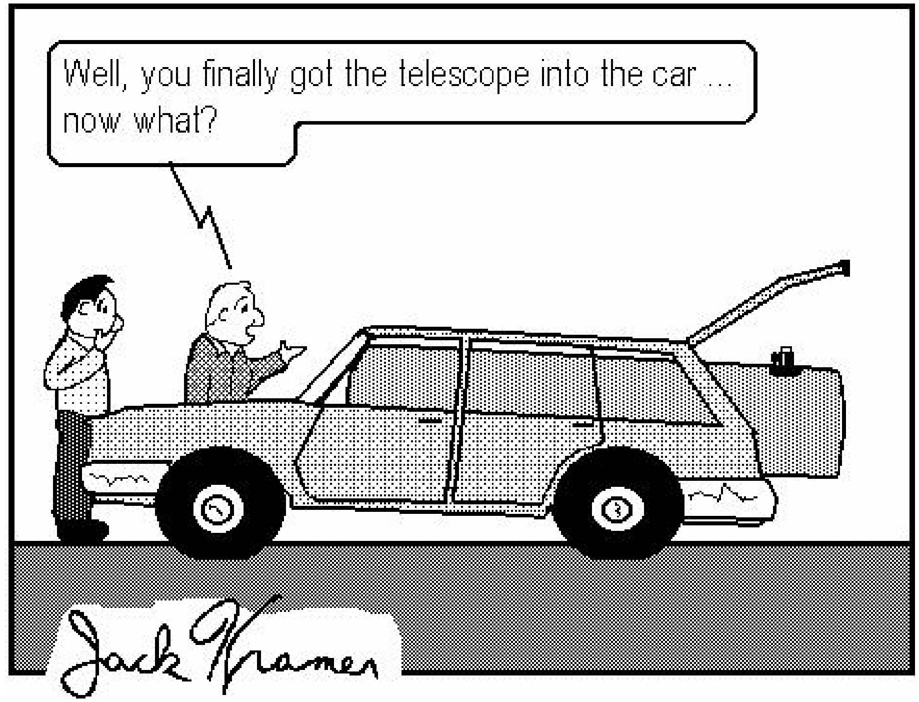
A small tripod for a smartphone. They are relatively inexpensive—the author found this at a local dollar store!

While some phones offer an "astrophotography" setting, this is still rare as of 2021. Finally, process your photos using an app on your phone or computer to bring out additional detail! Post-processing is the secret of all astrophotography.

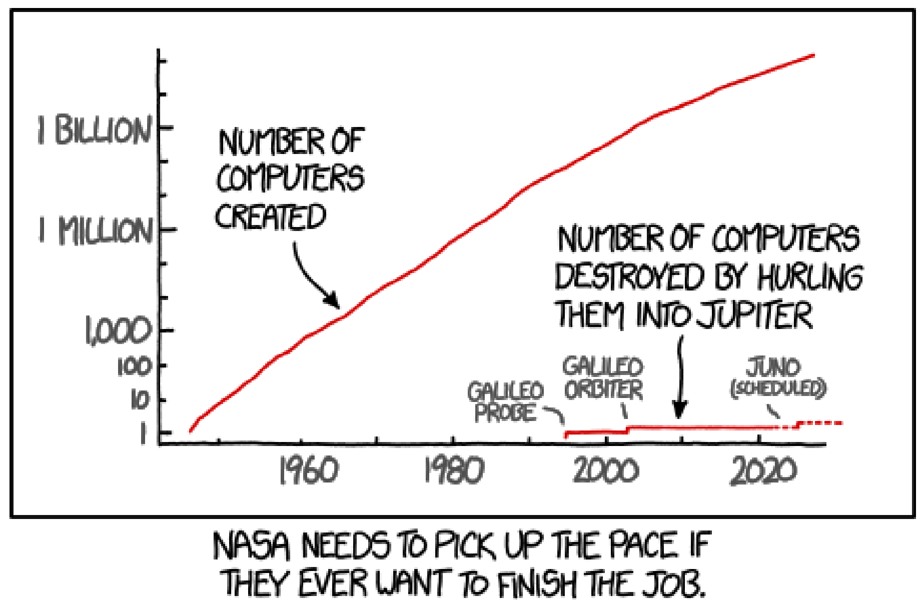
You now have your own first astrophotos! Wondering what you can do next? Practice: take lots of photos using different settings, especially before deciding on any equipment upgrades. Luckily, there are many amazing resources for budding astrophotographers. NASA has a free eBook with extensive tips for smartphone astrophotography at bit.ly/smartastrophoto, and you can also join the Smartphone Astrophotography project at bit.ly/smartphoneastroproject. Members of astronomy clubs often offer tips or even lessons on astrophotography; you can find a club near you by searching the "Clubs and Events" map the Night Sky Network's website at nightsky.jpl.nasa.gov. May you have clear skies!



The Moon is large and bright, making it a great target for beginners. The author took both of these photos using an iPhone 6s. The crescent moon at sunset (previous page) was taken with a phone propped on the roof rack of a car; the closeup shot of lunar craters (above) was taken through the eyepiece of a friend's Celestron C8 telescope.



Jack Kramer, Lake County (Illinois) Astronomical Society, used with permission.



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After Words

"Astronomy is useful because it raises us above ourselves; it is useful because it is grand.... It shows us how small is man's body, how great his mind, since his intelligence can embrace the whole of this dazzling immensity.... Thus we attain the consciousness of our power, and ... this consciousness makes us mightier."

— Henri Poincare
The Popular Science Monthly,
January 1907

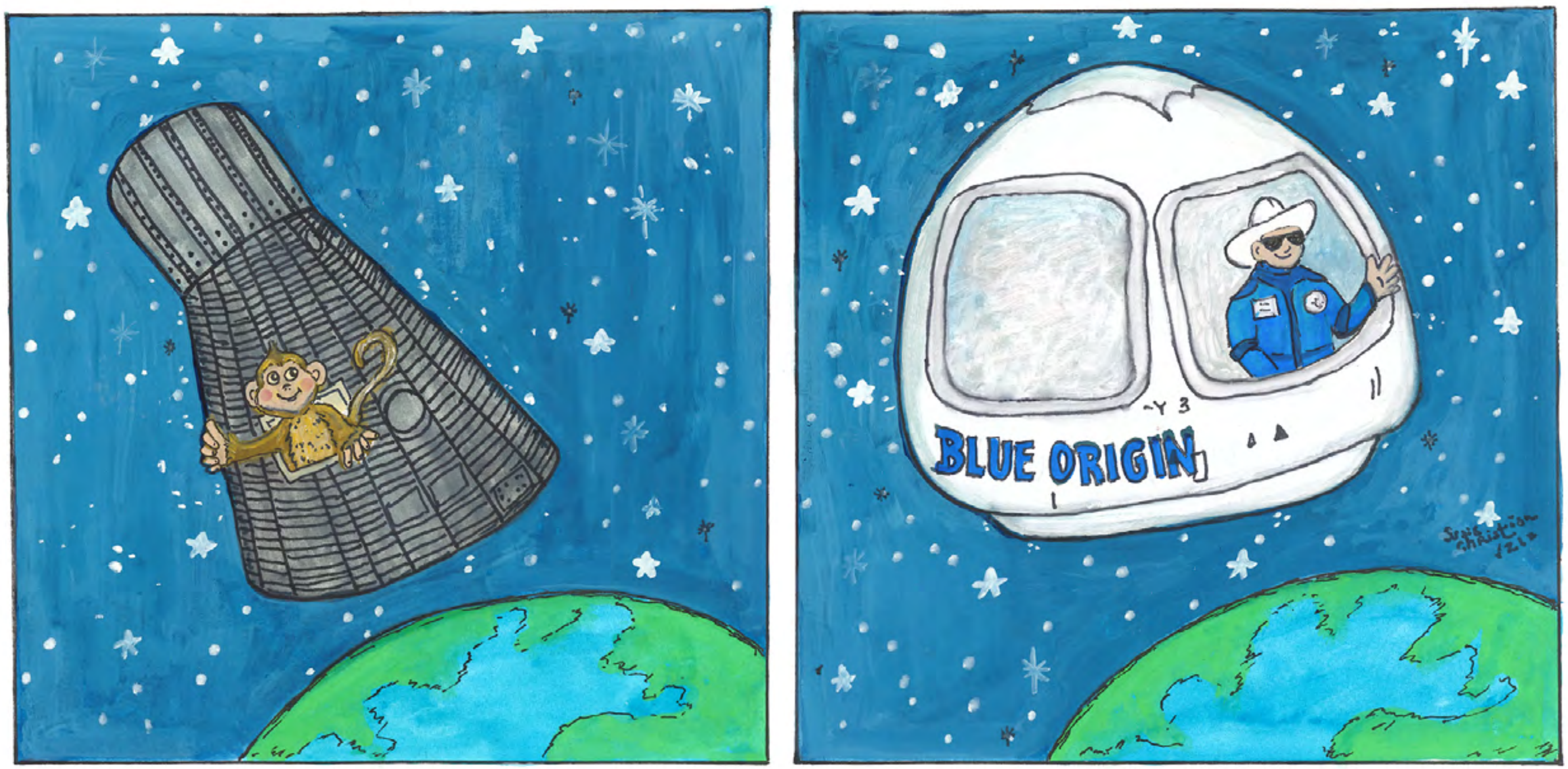
⋆ ⋆ ⋆

Here's my new high tech red dot finder mount. It's that purple thing holding the finder to the barrel. It cost me $2.49 at Safeway and came with a free bunch of celery.

⋆ ⋆ ⋆

Hmm. Isn't it strange that flat-earthers don't believe that we live in a flat galaxy?

Heavenly Bodies by Susie Christian



In 1961 we were sending Chimps into outer space. Sixty years later, we're sending CEOs.