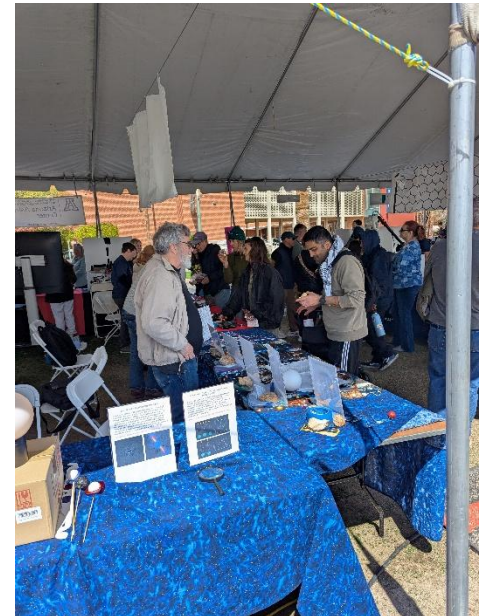


***Pictures:***

March continues to be very busy. Since the last Newsletter, we have had two Family Science Nights and the Tucson Festival of Books. At the science nights, Rob Lorenz and I did our “usual” hands-on meteorite presentation. At our last event, we were told that somewhere between 350 and 400 students and their families visited our two tables (nearly duplicate sets of meteorites and “meteorwrongs”). I will be doing a 6-hour workshop at the end of March focusing on stars and constellations. Here are a few pictures from the Festival. This year, our activity was “Exoplanets.” Many of you have seen the exoplanet activity, but for the Festival of Books, I also demonstrated the most common ways that exoplanets are discovered: transiting, radial velocity, imaging, gravitational microlensing, astrometry, and pulsar timing. It is sometime not easy to get good pictures of the Vatican Observatory staff in action where you can actually see what they are doing. I did not get everyone who worked over the two days of the event, but I did my best.



Upper left: Rev. David, Rev. Paul, S.J., and Rob (Outreach Officer) talking to participants about the various methods used to discover exoplanets. Upper right: Br. Guy, S.J., showing a group about the transit method for discovering exoplanets (an exoplanet with an atmosphere). Bottom left: Rev. Jean-Baptiste, S.J., at a lull, giving me time to explain the activities to him. Bottom center: Rev. Richard, S.J. and Michelle showing a father and son the discovery methods. Bottom right: Br. Guy, S.J. with a participant looking at the exoplanet scale models.

## *It's Spring:*

Welcome to Spring, the Vernal Equinox, It is a little earlier this year than “usual.” The Sun crosses the celestial equator, usually March 21 or 22. This year, it is a little earlier, occurring on March 20 at 5:01 EDT (2:01 PDT). I have attached a nice article that explains what the equinox is. For those of you in the southern hemisphere, this is the start of Fall.

<https://earthsky.org/astronomy-essentials/everything-you-need-to-know-vernal-or-spring-equinox/>

## Astronomy in the News

### *JWST*

- ***Exoplanet Atmospheres:***

Webb has been busy studying the atmospheres of exoplanets. Usually, atmospheres are studied when an exoplanet transits its host star, and astronomers see the light of the star that is transmitted through the atmosphere. However, if the exoplanet is young enough (a few tens of millions of years old) or large enough (almost big enough to be a brown dwarf), it may still be generating internal heat. This is when telescopes such as JWST can observe the warm atmosphere or the thermal light of the planet as it passes through the atmosphere.

In the first research article, astronomers using JWST have observed the “rogue planet”\* SIMP 0136.

SIMP 0136 is a planetary-mass object that is about 13 times the mass of Jupiter and is about 1.2 times Jupiter’s diameter. It is about 20 light-years from us, rotates once in 2.4 hours (we see it near equator-on) and has a temperature of about 1,100 K and is estimated to be about 200 million years old. Because of its mass and temperature, SIMP 0136 is classified as a super-Jupiter or a spectral class T 2.5 brown dwarf. JWST observed SIMP 0136 with NIRSpec from 0.6 to 5.3 microns and then with MIRI at lower spectral and time resolution from 5.0 to 14 microns. The observations confirmed prior HST observations of the wavelength-dependent and rotational-dependent variation which implies a highly complex atmosphere with clouds (see the image above on the right).

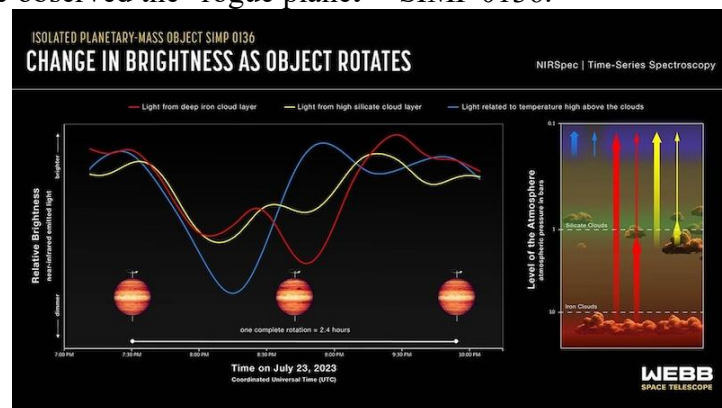
<https://www.livescience.com/space/exoplanets/james-webb-telescope-spots-a-strange-rogue-world-with-a-cake-like-atmosphere>

<https://earthsky.org/space/rogue-super-jupiter-simp-0136-atmosphere-exoplanets-webb/>

\*While astronomers will use terms such as rogue planet or free-floating (or isolated) planetary-mass object, the International Astronomical Union does not officially recognize the term “rogue planet.” An IAU working group came up with the term “sub-brown dwarf.” This is because the origin and formation of these objects is not known. They may have formed in free space in a manner similar to stars (the collapse of a dust cloud) or they may have formed in a star system and been expelled from the system by interaction with another exoplanet.

- ***Exoplanet Atmospheres, Continued:***

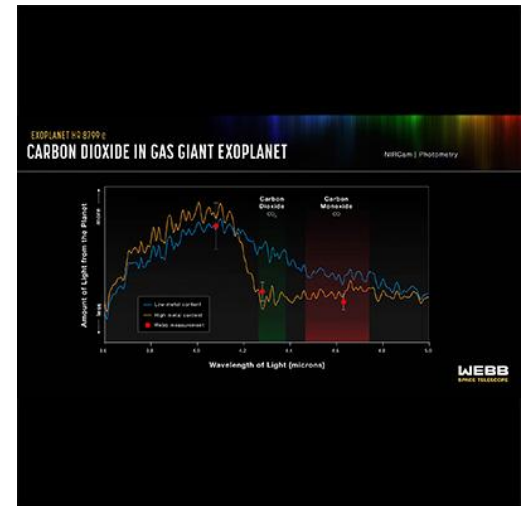
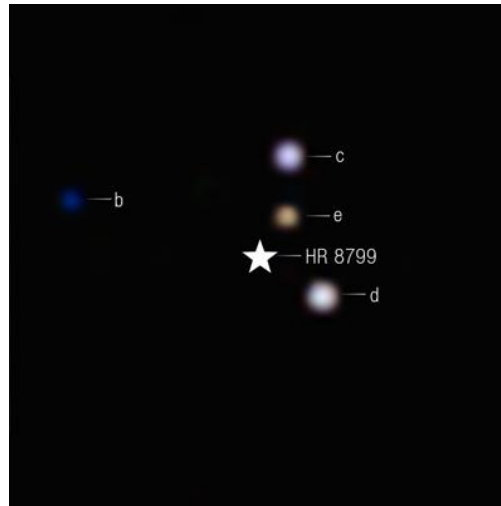
HR 8799 is an A-type (white) Main Sequence star that is hotter, larger, and more massive than the Sun. It is about 130 light-years from us and is estimated to be about 30 million years old. Between 2008 and 2010, 4 gas giants were imaged orbiting the star. They orbit from 16 to 72 AU from the star. Their masses range from 6 to 9 times the mass of Jupiter. Two dust disks were also detected, one at about 15 AU from the star and one 135 AU to 350 AU from the star (one of the most massive dust disks known). For comparison, Saturn is 9.5 AU from the Sun and Neptune is 30 AU from the Sun. It should be noted that, when looking at archived data, one of these exoplanets was seen in HST images dating back to 1998! Using a coronagraph to block out the light from the star, JWST was able to image the exoplanets



“This chart depicts the variations in brightness of SIMP 0136 as it rotates. Image via [NASA/ ESA/ CSA/ Joseph Olmsted \(STScI\)](#).”



at several wavelengths and was able to make observations that are consistent with the presence of carbon monoxide and carbon dioxide. These are not the first observations that detected these molecules but are the first to see them in all four satellites. Molecules such as these are consistent with high (relative to the



composition of the star) levels of heavier elements and is consistent with core accretion models where the heavier elements accrete first and then the lighter elements that make up the majority of their atmospheres.

<https://webbtelescope.org/contents/news-releases/2025/news-2025-114.html>

<https://www.space.com/space-exploration/james-webb-space-telescope/james-webb-space-telescope-sees-four-giant-alien-planets-circling-nearby-star-images>

- **Actively Forming Star System:**

Lynds 483 is a star-forming region that is 650 light-years from us. Hidden in the dense accretion disk of dust and gas at the center of the hourglass are two protostars that, as they intermittently accrete gas and dust, shoot out jets of material that interact with previously ejected material to form the hourglass that we see in the image on the right. The image is a composite of images made through 5 NIRCam filters from 1.1 to 4.5 microns.

<https://webbtelescope.org/contents/news-releases/2025/news-2025-111.html>

<https://www.sciencealert.com/incredible-image-reveals-a-cosmic-hourglass-shimmering-in-space>



## **HST:**

- ***Kuiper Belt Triplet:***

Over 140 Trans-Neptunian Objects (TNOs) are known to have satellites. Many of them are classified as binary systems as the two components are comparatively close in size. Hubble Space Telescope and ground-based Keck Telescope observations have discovered what appears to be a Kuiper belt object (KBO) with two satellites. The KBO, 148780 Altjira, was known to be a binary system with two components of almost equal size (250 kilometers and 220 kilometers in diameter). The observations show that the outer satellite has an orbital motion that is not consistent with the inner component being a single spherical body. The inner object is either an equal mass contact binary or, more likely, an equal mass close orbiting binary pair. This would be only the second known hierarchical triple system (one component orbiting the two inner components). The other system is 47171 Lempo (two similar-sized binary system orbited by a third object about half the diameter of the two inner components). “[Altjira] was named after the Arrernte creation deity, Altjira, who created the Earth during the Dreamtime and then retired to the sky.” It should be noted that there is one other triple system, the dwarf planet 136108 Haumea, but its satellites are much smaller than the primary.

<https://www.stsci.edu/contents/news-releases/2025/news-2025-007.html>

<https://earthsky.org/space/kuiper-belt-triplet-altjira-hubble-space-telescope-keck-observatory/>

- ***Andromeda Map:***

In the February Newsletter, we reported on the new 3D map of the Andromeda Galaxy that has been created by the Hubble Space Telescope. Andromeda is about 2.5 million light-years from us and its visible size is somewhat larger than our galaxy, the Milky Way Galaxy. The on-line article states that Andromeda is twice as massive as our galaxy. However, previous estimates put the mass at only about 25% to 50% more massive than the Milky Way and recent estimates give a mass that is about the same mass or even less massive than the Milky Way Galaxy. In an analysis of this map, astronomers have concluded that the Andromeda Galaxy has had a much more complex history than the Milky Way. The Andromeda Galaxy is asymmetric and there are many more satellite (dwarf) galaxies than orbit the Milky Way. Also, most of these smaller galaxies are still actively forming stars, unlike the one orbiting the Milky Way Galaxy. This may mean that, within the last few billion years, there was a collision between Andromeda and another galaxy.

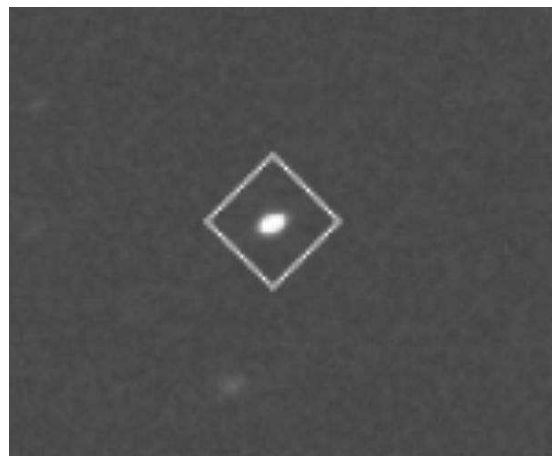
<https://earthsky.org/space/andromeda-galaxy-dwarf-galaxies-hubble-space-telescope/>

## ***Lucy, Age of 52246 Donaldjohanson:***

On April 20, Lucy will fly by the main belt asteroid 52246 Donaldjohanson at a distance of about 960 kilometers (600 miles). The asteroid is about 3.9 kilometers (2.4 miles) in diameter. Its reflectance is about 10% and is thought to be a C-type asteroid (carbonaceous). This is just a reminder of what I said in the last Newsletter and the picture on the right is the only image that was previously published. In the research paper referenced in the link below, astronomers from the Lucy team have made ground-based observations of the asteroid and discuss its unusual nature, in particular its apparent elongated shape (not unusual for many asteroids) and its apparent long (240-hour rotation period). It is proposed that the asteroid is part of the Erigone collisional family

that was formed about 150 million years ago. At one point, it was thought that the Near-Earth Asteroids Ryugu and Bennu were part of this family, but, more recently, other collisional families (more recent collisions) have been proposed for these asteroids associated with sample return missions. 52246 Donaldjohanson also appears to be very elongated. I am not sure that a contact binary can be ruled out.

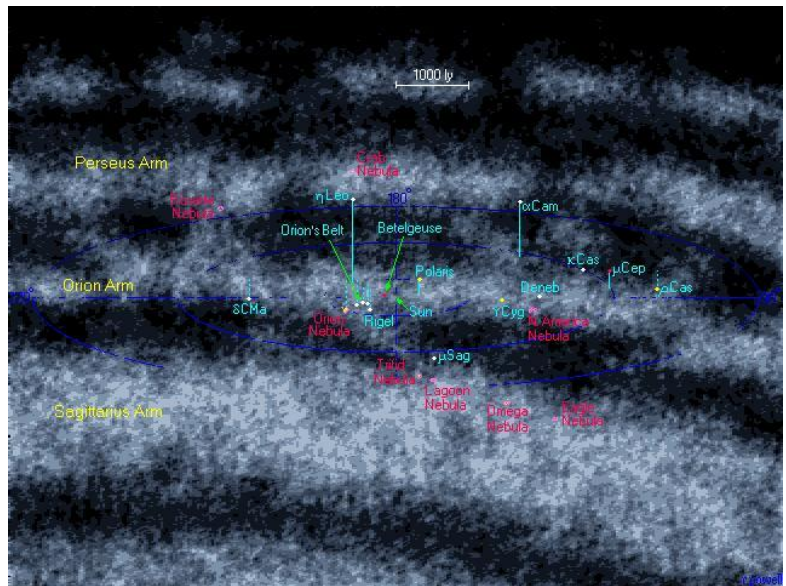
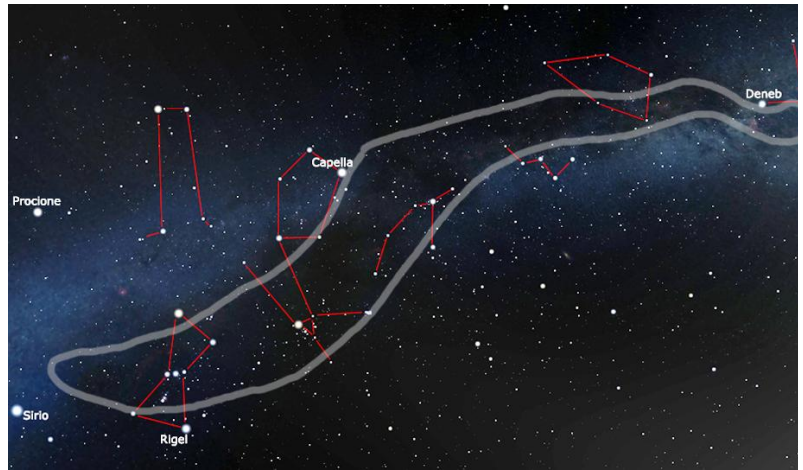
[https://www.spacedaily.com/reports/New\\_Modeling\\_Assesses\\_Age\\_of\\_Next\\_Target\\_Asteroid\\_for\\_NASAs\\_Lucy\\_999.html](https://www.spacedaily.com/reports/New_Modeling_Assesses_Age_of_Next_Target_Asteroid_for_NASAs_Lucy_999.html)



### ***Gaia, Earth's Journey Through Milky Way:***

Somewhere between 14.8 and 12.4 million years ago, the Earth and the Solar System passed through the Radcliff Wave, a dense region of gas and dust, an 8,800-light-year-long interconnected concentration of star-forming regions. Such a region could have had an effect on the Sun's protective magnetosphere and exposed the Solar System and the Earth to higher concentrations of interstellar dust. The authors note, but make no claims, that this period coincides with a period of cooling on the Earth and that this warrants further study. I have included two images from the Wikipedia article on the Radcliff Wave. The first one shows the Wave as we see it in the sky (from Roberto Mura - Own work), and an illustration of our neighborhood that is clickable on the Wikipedia page.

**“A clickable map [in the Wikipedia article] of the nearby circa one-sixth outer sector of the galaxy, thus clearly showing the Local Arm (Orion Arm) and neighboring arms - as well as the Great Orion Nebula (as a very luminous feature of the less bright Orion molecular cloud complex) and broad-clouds North America Nebula (and Pelican Nebula) which is an intrinsic part of the Radcliffe wave.”**



<https://scitechdaily.com/scientists-uncover-a-galactic-encounter-that-may-have-changed-earths-climate/>

[https://en.wikipedia.org/wiki/Radcliffe\\_wave](https://en.wikipedia.org/wiki/Radcliffe_wave)

### ***Athena on the Moon:***

It is now, unfortunately, 0 for 2 for Intuitive Machines' lunar landing attempts. About a year ago, they landed their Odysseus spacecraft, but it landed too hard and broke one of its legs, ending up on its side. This time, something again went wrong and Athena lander, ended up on its side. Its solar panels were generating power, and it was sending some data back to Earth, but no data has been made public as of yet.

<https://www.space.com/the-universe/moon/intuitive-machines-lands-private-athena-lander-near-moon-south-pole-historic-touchdown>

### ***Blue Ghost, Solar Eclipse and Sunrise and Sunset:***

However, the commercial lander, the Blue Ghost, successfully landed near the volcanic crater Mons Latreille in Mare Crisium in the northeast quadrant of the Moon. It took images of sunrise (left), sunset (right), and, at noon, the lunar eclipse (center), a solar eclipse from the perspective of the Moon. In the sunset picture, you can see the planet Venus. Of interest to scientists is the glow that one sees along the edge of the Moon at sunset. This haze was first seen by the Surveyor landers in the early 1960s and then by the Apollo astronauts. It is thought to be caused by the levitation of lunar dust that is charged by solar UV radiation.





<https://www.livescience.com/space/space-exploration/sunrise-on-the-moon-captured-by-blue-ghost-spacecraft-after-nasa-and-firefly-aerospace-announce-successful-lunar-landing>

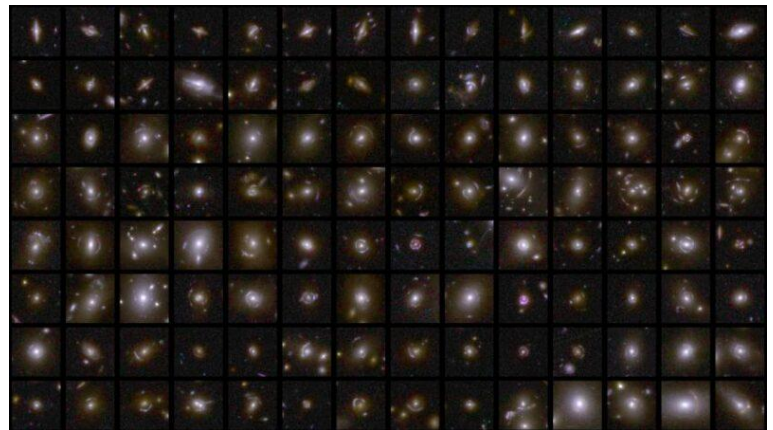
<https://www.sciencealert.com/stunning-sunset-images-on-the-moon-could-help-solve-enduring-mystery>

<https://www.sciencealert.com/incredible-photo-shows-blood-moon-eclipse-from-lunar-perspective>

### ***Euclid Mission:***

“***Euclid*** is a wide-angle space telescope with a 600-megapixel camera to record visible light, a near-infrared spectrometer, and photometer, to determine the redshift of detected galaxies.” The survey will cover about one-third of the sky, avoiding the Milky Way. It will also observe three deep fields (about 30 to 50 times). The first data release, the deep fields, observed 26 million galaxies, as far away as 10.5 billion light-years and observed/discovered 500 gravitational lenses. “The goal is to achieve insights into the mysterious nature of dark matter and dark energy.”

<https://earthsky.org/space/new-euclid-images-deep-field-galaxies-gravitational-lenses/>



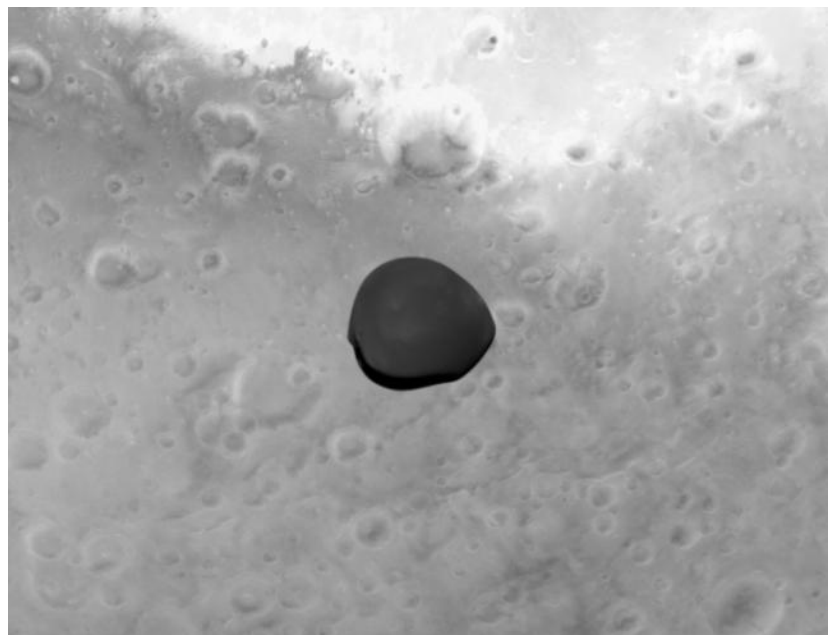
“Just look at all these gravitational lenses that ***Euclid*** captured in its first observations of the Deep Field areas! The small arcs around the galaxies in each image are peeks at more distant galaxies whose light is bent by the foreground galaxy and smeared into an arc shape. See more ***Euclid*** images below. Image via ESA/ ***Euclid***/ ***Euclid*** Consortium/ NASA/ Image processing by M. Walmsley/ M. Huertas-Company/ J.-C. Cuillandre (CC BY 4.0).”

### ***Hera Mission, Mars Flyby:***

The Hera mission is an ESA mission to study the 65803 Didymos binary asteroid system after NASA’s Double Asteroid Redirection (DART) spacecraft impacted Didymos’ satellite, Dimorphos. Hera will go into orbit around Didymos in December 2026. On March 12, the spacecraft used Mars as a gravitational assist and flew within 5,000 km (3,100 miles) of Mars and was able to take images of its smaller moon Deimos. The articles below have other images, as well as a video of the flyby.

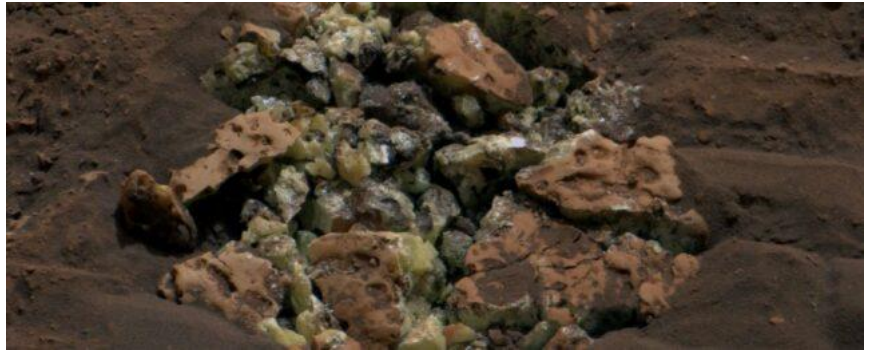
<https://www.space.com/the-universe/mars/tiny-mars-moon-deimos-gets-a-rare-close-up-thanks-to-europes-hera-asteroid-probe-photos>

<https://www.sciencealert.com/en-route-to-asteroid-collision-hera-snaps-rare-images-of-martian-moon>



### ***Mars Rover Curiosity, Rock Surprise:***

This is an update from articles that were published last year. Last May, on Mars, the Curiosity Rover accidentally rolled over a rock and broke it open. To the surprise of the scientists, this rock contained yellow crystals of elemental sulfur (image on the right). Sulfates are relatively common on Mars (and Earth) when sulfur-bearing minerals interact with liquid water. However, it is unusual to find elemental sulfur. Since the discovery of this rock, other similar rocks have been seen and are now being studied.



<https://www.sciencealert.com/curiosity-cracked-open-a-rock-on-mars-and-discovered-a-big-surprise>

### ***TESS, Contrasting Exoplanets:***

Not all this information is from the linked article. TESS (transiting telescope) has discovered two contrasting exoplanets that orbit a star 260 light-years from us and that is a little smaller and cooler than the Sun. TOI-1453 A is a K star (orange) that is about 0.7 times the mass of the Sun. It is a binary system with an M-dwarf star that orbits at a distance of about 170 AU. It is estimated to be about 12 billion years old. TOI-1453 A is orbited by two exoplanets that orbit close to their host star but are very different. TOI-1453 Aa is a “super-Earth.” It is 1.17 times the diameter of the Earth (transit measurement) and has a mass that is 1.3 times that of the Earth (radial velocity measurement). This means that it has a density of about 4.2 gm/cc (Earth is 5.5 gm/cc and Mars is 3.9 gm/cc), so it is likely to be a rocky exoplanet. TOI-1453 Ac is a sub-Neptune with a diameter of 0.56 times that of Neptune (2.2 times that of Earth) and a mass of about 3 times that of Earth which gives it a density of 1.5 gm/cc (Neptune is 1.6 gm/cc). This is considered low as most sub-Neptunes have densities that are greater than Neptune’s density (less atmosphere and more rock/ice). TOI-1453 Ab orbits in 4.3 days at a stellar distance of about 0.06 AU (my estimate) and TOI-1453 Ac orbits in 6.6 days at a stellar distance of about 0.08 AU (my estimate). For comparison, Mercury orbits the Sun in 88 days and is 0.39 AU from the Sun. The orbital periods imply that the two exoplanets are very near a 3:2 orbital resonance (each time b goes around 3 times, c goes around 2 times). These two exoplanets are not unlike many other exoplanets, but very different from the planets in the Solar System, and they are also very different from each other, one rocky and the other with a thick atmosphere of unknown composition. They are great targets for JWST so that astronomers can learn more about them and why they are so different.

[https://www.spacedaily.com/reports/TOI\\_1453\\_system\\_hosts\\_contrasting\\_super\\_Earth\\_and\\_low\\_mass\\_sub\\_Neptune\\_999.html](https://www.spacedaily.com/reports/TOI_1453_system_hosts_contrasting_super_Earth_and_low_mass_sub_Neptune_999.html)

### ***Meteors, Meteorites, Asteroids, and Comets:***

As of March 24, 2025, there are 1,442,807 known minor planets (4,839 added since February 10. Of these, 773,916 are numbered (17,217). There are 4,580 known comets (11 added). Of these, 598 have good orbits and have been numbered. There are 38,101 (400 more) Near-Earth Objects (NEOs) and 123 Near-Earth Comets (no change). [A note: there are two sources for these numbers and they never agree exactly, even if they are updated the same day. JPL has more total asteroids by over 10 thousand and the IAU has more NEOs by a few hundred. I use JPL for total asteroids and IAU for total NEOs]. 682 NEOs have been discovered since the beginning of the year. A potentially hazardous asteroid is an asteroid whose orbit could bring it within 0.05 AU of Earth and is estimated to be at least 140 meters in diameter. However, many of these have orbits that are fairly-well characterized so there is little to no risk of their hitting Earth. The ESA lists just those that have some potential chance of hitting Earth, usually due to orbital uncertainties. This is why we observe them so that we can reduce these uncertainties. ESA’s “At Risk” list as of March 20, 2025, is 1,756 Near-Earth Objects (12 more).

### ***Asteroid Close Approaches:***

In the last 45 days (my last update), 15 asteroids have been **observed** to have come closer to the Earth than the distance to the Moon (LD) with estimated diameters from about 1.9 meters in diameter to about 31



meters in diameter (if high or low reflectivity, respectively). There were 16 additional asteroids observed that came as close as 1.0 to 2.0 times the distance of the Moon, with estimated diameters between 3.4 and 140 meters. In the next 60 days, no asteroids are **predicted** to come closer to us than the Moon and none between 1.0 and 2.0 times the distance to the Moon. I have not looked all of these up to determine when they were first observed, but most were first observed within days of their closest approaches, but some were not observed until after their close approaches.

Between February 20 (observed) and May 14 (predicted in the next 60 days), 18 asteroids with estimated diameters between about 60 meters and 510 meters in diameter have passed/will pass between 1.97 (overlap with the previous list) and 18.8 lunar distances of the Earth. Of the six large asteroids that have been **observed** to pass within 20 LD (0.05 AU) of the Earth between February 20 and March 8, four were discovered prior to this year (two in 2015, one in 2016, and one in 2018). Two were discovered in 2025 and both were first observed after their closest approaches to the Earth. Of the 12 asteroids that are **predicted** to pass within 20 LD (0.05 AU) of the Earth between March 26, 2025, and May 14, 2025, ten were discovered prior to 2025. One was discovered in 2002, one was discovered in 2007, one was discovered in 2008, three were discovered in 2011, two were discovered in 2014, one was discovered in 2022, and one was discovered in 2023. Finally, one asteroid was discovered in January that will make its closest approach, 9.6 times the distance to the Moon, on April 5 and one asteroid was discovered in February that will make its closest approach, 16.7 times the distance to the Moon, on April 6. Their estimated diameters are 350 to 800 meters and 80 to 180 meters, respectively. As I said in the February Newsletter, the first of these two, while it is large, this is the only close approach listed, so it is not on the European Space Agency's Risk List. It should be a good target before its closest approach, and fairly bright, but then it goes between the Sun and the Earth around the time of closest approach, so becomes unobservable. I suspect this will make the news between now and April.

### ***Ancient Crater in Australia:***

The Pilbara Craton in western Australia is one of the oldest regions of ancient crust found on Earth (the other is in south Africa). About four years ago, a group of geologists in Australia proposed that the Pilbara Craton was formed by an impact, rather than the result of magmatic movement from the interior of the Earth. In 2021, the group did an initial survey and then went back in 2024. In 2024, they confirmed their initial findings of shatter cones that date back to about 3.5 billion years ago. The implication that there was an asteroid impact the made a crater estimated to be 100 km (60 miles) in diameter. The shatter cones, the central uplift of the original crater, is all that remains. This would make it the oldest-known crater on Earth by more than a billion years! **Personal note:** I have no problem with the evidence for a large impact 3.5 billion years ago, the shatter cones prove the existence of the *asteroid/comet* impact. What I am not convinced of is their conclusion that this means that impacts created the continental plates. This crater is much smaller than the 300-kilometer-diameter Vredefort Crater in Africa or the 200-kilometer-diameter Chicxulub Crater in the Yucatán, neither one of which resulted in the creation of continental masses. Did the impact create the stable crust in the Pilbara region, or do we see a crater there (with many others around the world now long gone) because it fell in an crustal region?

<https://theconversation.com/earths-oldest-impact-crater-was-just-found-in-australia-exactly-where-geologists-hoped-it-would-be-250921>

<https://earthsky.org/earth/new-record-for-oldest-impact-crater-on-earth-australia/>



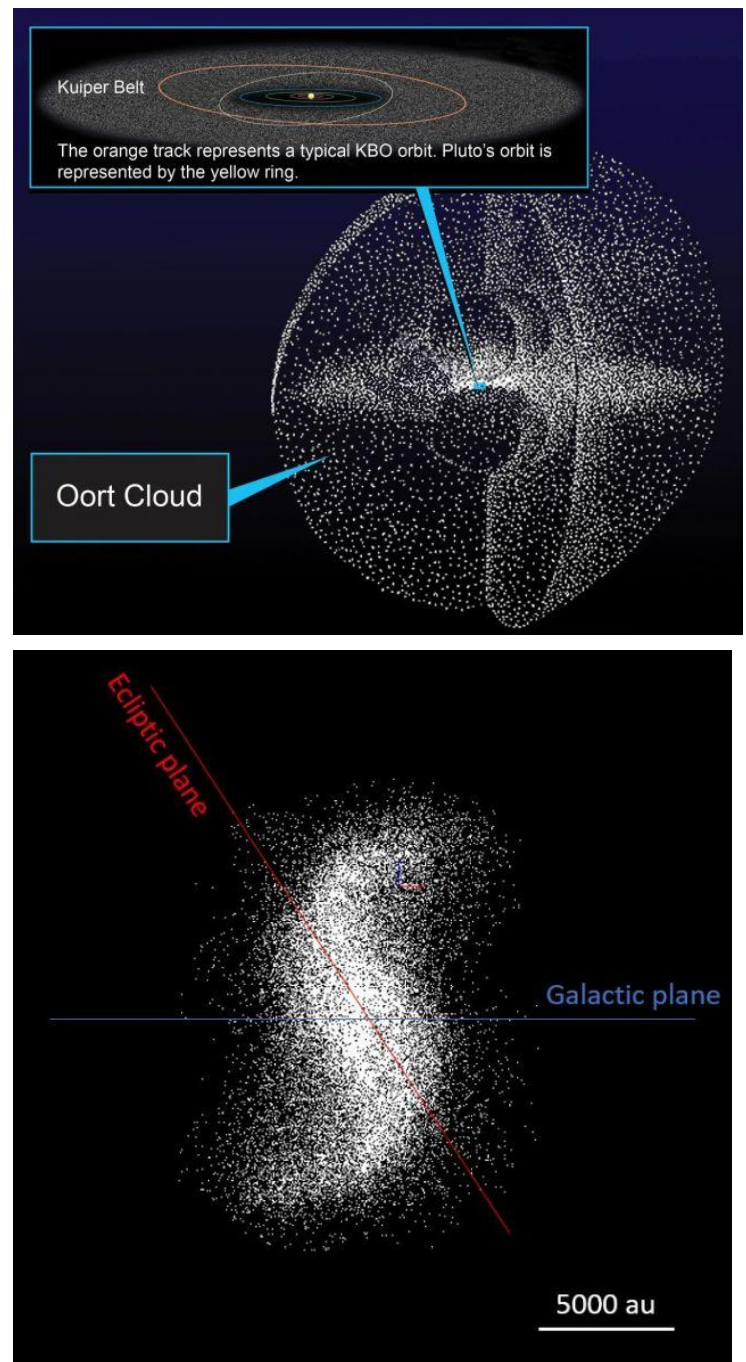
**An approximately one meter tall shatter cone ‘hut’, with the rolling hills of the Pilbara in the background. Chris Kirkland**



### *Oort Cloud Shape:*

A region of icy bodies surrounding the Solar System that were ejected by the Jupiter and Saturn during the formation of the Solar System was proposed in the early 1950s. While we do not see these objects directly, this region is the source of all long-period comets, so it has to exist. This Oort cloud (or Öpik–Oort cloud) is now theorized to have two components. The exact dimensions (I have put upper estimates in parentheses) and the number of icy bodies are uncertain. It is estimated to contain hundreds of billions (or more) icy bodies, potential future comets. The Inner Oort cloud is a torus extending from 1,000 AU (2,000 AU) out to 10,000 AU (20,000 AU). The spherical Outer Oort cloud extends from 10,000 AU (20,000 AU) out to 100,000 AU (200,000 AU). The outer extent of the Oort cloud represents the limits of the gravitational influence of the Sun. However, the Outer Oort cloud is less stable and is subject to the forces within the Milky Way, along with passing stars that alter the orbits of these icy bodies, giving us our long-period comets. The researchers took observations of long-period comets and then ran models on a supercomputer for the 4.6 billion years of the Solar System, including the effects of the gravitational effects of the entire galaxy. They conclude that the Inner Oort cloud has a spiral shape, similar the the Milky Way Galaxy, is 15,000 light-years in diameter (this is smaller than previous estimates) and is tilted 30 to the plane of the ecliptic (the influence of the disk of the Milky Way galaxy).

<https://www.sciencealert.com/surprise-spiral-shape-revealed-in-the-darkness-surrounding-the-solar-system>



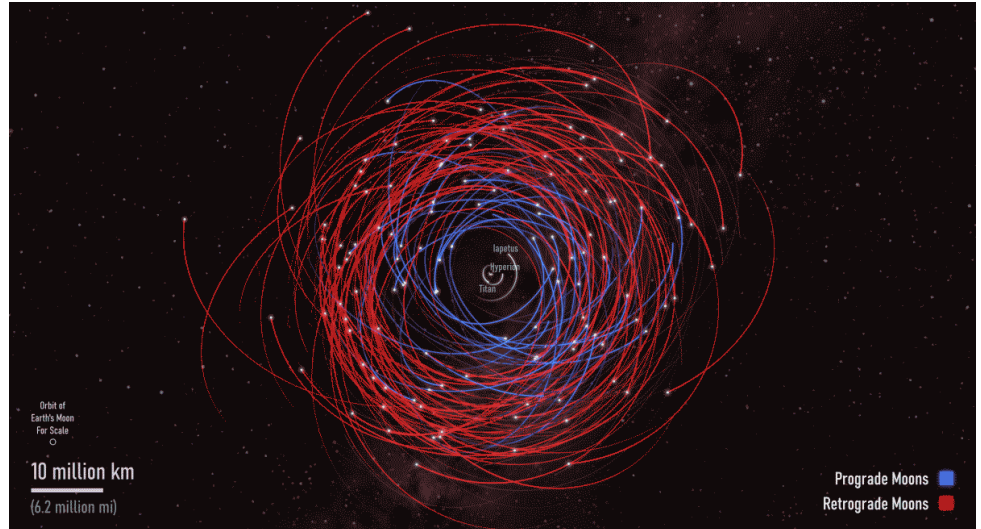
### *Moons and Rings:*

As of March 22, 2025 (last update), there are 416 moons (satellites) orbiting six planets (128 more, all Saturn satellites, new and confirmed). As of March 22, 2025 (last update), there are 575 asteroids, dwarf planets, Centaurs, and Trans-Neptunian Objects with companions (13 more than the last update on January 24 ). There are 557 binary systems (13 more), 16 triple systems (same), 1 quadruple (130 Elektra), and 1 sextuple system (Pluto), for a total of 584 companions (2 more). To break this down, 107 Near-Earth Objects (3 more) have companion moons (5 have 2 moons, same), 35 Mars-Crossing Asteroids (one more) have companion moons (1 with 2 moons), 283 Main Belt Asteroids (9 more) have companion moons (1 with 3 moons, 8 with two moons, and 1 with 1 moon and rings; 1 also has dual asteroid/comet designation), 8 Trojan Asteroids have companion moons (same), and 142 Outer Solar System Objects (dwarf planets, Centaurs, and Trans-Neptunian Objects) (same) have companion moons (2 with 2 moons, 1 with 5 moons). There are 4 TNOs and Centaurs with moons that have or are suspected to have rings (1 more) and 1 with

rings but no moons. For those of you doing the Solar System Classification activity, this is a good example of how there is overlap among planets, dwarf planets, and asteroids as to how we classify them based on characteristics (moons and rings in this case). The one discovery highlighted below does not seem to be counted in this list, as it is still tentative. It should be noted that, even with the discovery of 128 new Saturn moons, there are more satellites/moons of asteroids than there are of planets, 584 vs. 416. There are also more asteroids with rings than there are planets with rings, 5 vs. 4.

### *Saturn's Moons:*

Between 2019 and 2021, astronomers made observations that yielded an initial 64 new moons (satellites) of Saturn. New observations were made in 2023 that confirmed the original 64 moons and added an additional 64 to make a total of 128 moons that have been officially recognized by the International Astronomical Union. Saturn now has 274 known moons. The image on the right shows the orbits of these new moons. The research paper that is referenced is an analysis of the initial 64 moons that were discovered. Most of these are in retrograde orbits and appear to have originated in a recent breakup of a larger moon.



I will note that it is difficult to directly capture passing comets/asteroids and that it is more likely that the original larger moon may have made one or more close approaches before being captured (sometimes breaking up in the process). Astronomers see similar families of moons orbiting Jupiter. Comet Shoemaker-Levy/9 is an example of a comet that got close to Jupiter, broke up and orbited once or twice before getting too close and impacted Jupiter's atmosphere. The last link is for the Press Release for the discovery of the 128 moons.

<https://earthsky.org/space/128-new-saturn-moons-discovered>

<https://www.universetoday.com/articles/whoa-astronomers-found-128-new-moons-orbiting-saturn>

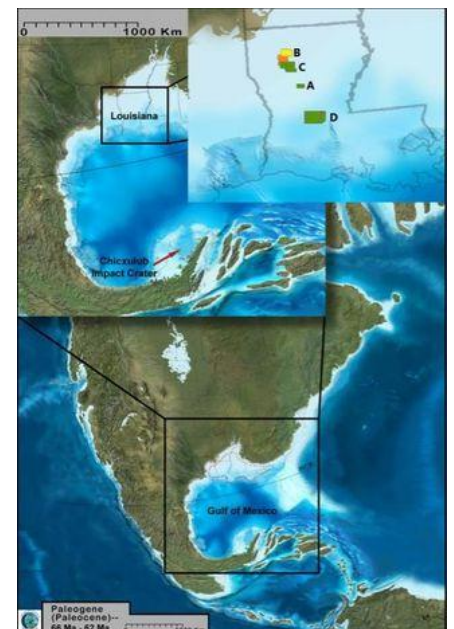
<https://phas.ubc.ca/2025-discovery-more-saturnian-moons>

### *Planets:*

#### *Asteroid Megaripples:*

66 million years ago, an asteroid impacted what is now the Yucatan Peninsula. The Chicxulub impact created a crater estimated to have been about 180 km in diameter and caused the extinction of the dinosaurs and other animals. Its effect was far-reaching as the impactor landed in shallow water and created a huge tsunami. At that time, Louisiana was a shallow sea. Geologists used seismic data (from oil exploration) to uncover regions where the tsunami caused megaripples of the sea bed. These ripples are up to 16 meters (50 feet) high and are separated by as much as 600 meters (2,000 feet). The map on the right shows the covered region and what this part of the region looked like 66 million years ago.

<https://www.livescience.com/planet-earth/geology/52-foot-high-megaripples-from-asteroid-that-killed-dinosaurs-mapped-deep-beneath-louisiana-in-3d>

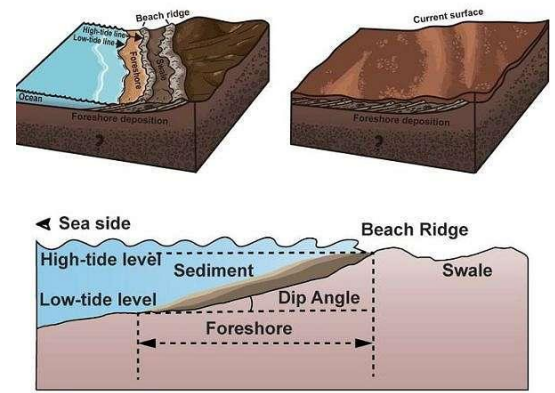
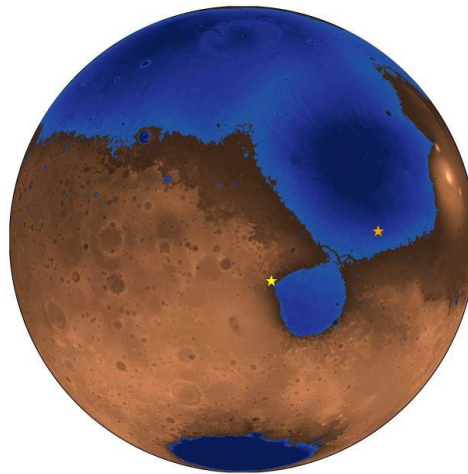


**“Map showing the locations where researchers identified megaripples using seismic surveys.”**



### ***Ocean-Front Property on Mars:***

In any field of science, we build our knowledge based on prior discoveries. This is the case here. The Chinese rover, Zhurong, went to Utopia Planitia (leftmost yellow star) based on the results of prior missions, including the Perseverance Rover (right yellow star). They were able to use ground-penetrating radar to discover evidence of an ancient shoreline several



hundred feet below the surface. This is important verification of the existence of a once vast ocean (filling an ancient impact feature?) in Mars' northern hemisphere, 3.8 to 4.1 billion years ago. While they were able to verify this shoreline (and tidal effects) over nearly 2 kilometers (1.2 miles), the idea and the extent of the ancient ocean dates back to the 1970s with the first global images of Mars from the Viking orbiters. One of the first detailed papers came out in 1990, which showed evidence of shorelines and the extent of the ocean (the blue above).

<https://www.sciencealert.com/ancient-beaches-found-on-mars-reveal-the-red-planet-once-had-oceans>

[https://www.spacedaily.com/reports/Ancient\\_beaches\\_testify\\_to\\_long\\_ago\\_ocean\\_on\\_Mars\\_999.html](https://www.spacedaily.com/reports/Ancient_beaches_testify_to_long_ago_ocean_on_Mars_999.html)