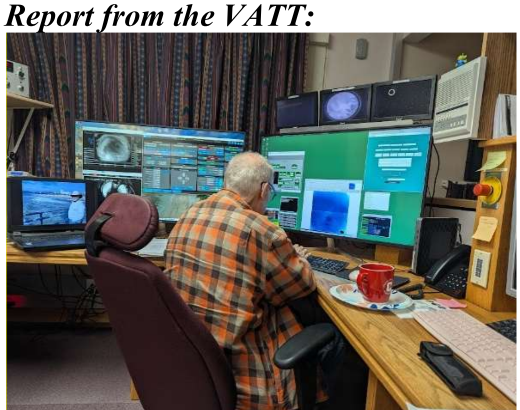
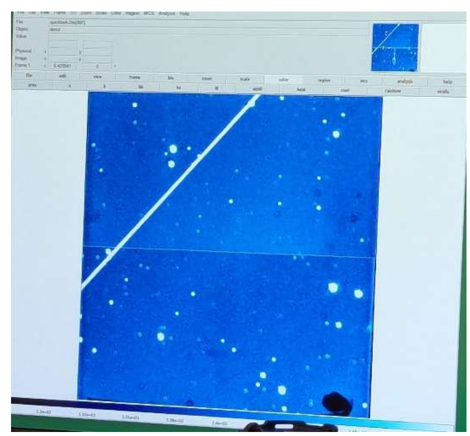
Education & Public Outreach
April 2025, Part 2

Pictures:

"Thank you and congratulations: Laurie Ansorg writes: Attached is some eye candy - Eta Carinae Nebula NGC3372. I took this at the Winter Star Party in January from Scout Key in Florida, about 24 degrees North, about as south as I could get in the continental U.S., and at the boundary from where your southern constellations article starts. I am part of this year's class of newly minted NASA Solar System Ambassadors! I'm still doing programming for Girl Scouts in at least two councils: Nation's Capital and Central Maryland. Usually this is for whole encampments, and larger events, and luckily with a cadre of scopes & operators from 1-2 clubs now so both the scouts and the amateur astronomers are getting more exposure and connections which is great for everyone." Look at the end for two more pictures!

Report from the VATT:





Across the top: Mark at the controls of the telescope; Robert analyzing an image, looking for the asteroid, and measuring its position; and Larry at the controls of the imaging camera and keep the logbook of observations. Bottom: a fisheye camera looking at the cloudy sky (along with trees) and an image with one of three or four satellites that photobombed our images.

I have been observing asteroids on the Vatican Advanced Technology Telescope (VATT) with my observing partners, Mark Trueblood and Robert Crawford, for nearly 10 years. The two observers before us are part of the Vatican Observatory Research Group (VORG). I am now on an advisory committee for this group, doing outreach (family science nights, Festival of Books, etc.), the Vatican Observatory mission: "The Vatican Observatory is an institution established by the Holy See [the Vatican] for astronomical research and public outreach to advance the scientific understanding of our universe." I do science on the VATT, and I do public outreach in support of the Vatican Observatory's mission.

There were three observing programs at the VATT from the end of March through the middle of April. Just before us on the VATT was Rev. Pavel (Paul) Gabor, S.J. He is the Vice Director of the Observatory and the Vice Director of the VORG. His main area of research is the study of extra solar planets. He was on the telescope (collaborating with Dr. Molly Simon and her student Fred Noguer) to observe the possible transit of TOI 1873.02 b, a Neptune-sized exoplanet with an orbital period of 900 days. The observations are now being analyzed. Rev. Jean-Baptiste Kikwaya Eluo, S.J. is an astronomer whose research areas include meteors, comets, and asteroids. He was on the telescope before Rev. Gabor and is observing, again, at the end of April. His long-term program is observing small Near-Earth Objects, determining their rotation rates and compositions**.**

We were at the VATT to observe recently discovered asteroids. Our observations help reduce the uncertainties in the orbits of these asteroids. Most of these asteroids are considered to be “potentially hazardous objects,” objects that could possibly, in the future, impact Earth. If their orbits are well-determined they can be taken off what is called the list of potential impactors. The one recent example of a potentially hazardous asteroid was 2024 YR4 (we did not get a chance to observe it) which now has a very small chance of hitting the Earth (one chance in 100,000) in 2032. However, it still has a 3.8% chance of hitting the Moon, 1 chance in 26. We had four observing nights, one was clouded out,1.5 nights were clear enough (often through thin clouds) and the 1.5 nights with the wind gusting to 35 to 40 miles an hour (too windy to open the dome). We observed seven asteroids and observed two of these on two different nights. For two, we made the last observations before they became too faint. For two others, we improved the asteroids’ sky uncertainty by a factor of 10 to 20 when they were next observed one to two days later.

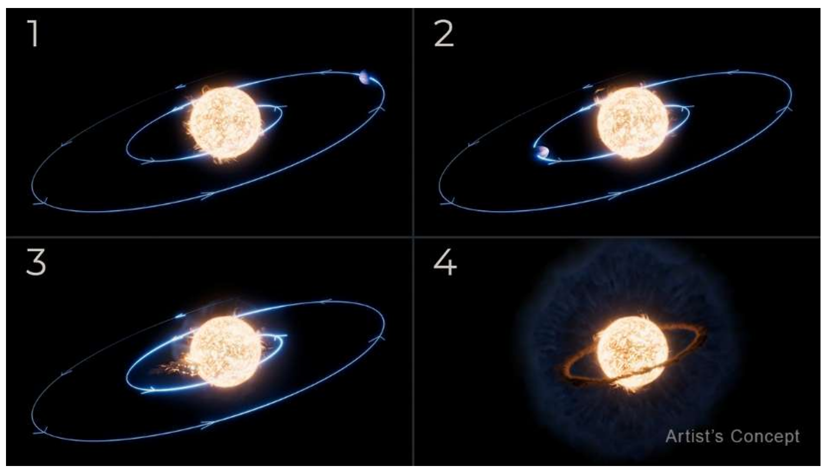
Astronomy in the News

JWST, Star Consuming Exoplanet:

In 2020, astronomers using the Zwicky Transient Telescope in Southern California observed a bright flash of visible light from a star 12,000 light-years away. While investigating this they found that the orbiting NEOWISE telescope had seen infrared emission from this star at least a year earlier. This emission implied the star was already surrounded by a disk of hot gas and dust. Initially, it was thought that the star was expanding into a red giant and had engulfed an explanet. However, astronomers using JWST’s NIRSpec and MIRI instruments have discovered something completely different. As illustrated in the images on the left, the astronomers found that the star is smaller than the Sun and has not yet gone into its red giant phase. Instead, of the star expanding to engulf the exoplanet, the exoplanet spiraled in and eventually crashed into the outer layers of the star.

I think that I have discussed observations of stars having heavy metals in their atmospheres, implying they had consumed, in the past, an exoplanet. This is the first time that such an event was seen as it happened.

https://webbtelescope.org/contents/news-releases/2025/news-2025-117.html



“This illustration depicts the sequence of events that took place over millions of years, based on observations from Webb’s MIRI (Mid-Infrared Instrument) and NIRSpec (NIR-Infrared Spectrograph).

Panel 1: The planet was about Jupiter-sized, and orbited very close to the star – even closer that Mercury’s orbit around our Sun.

Panel 2: The planet’s orbit slowly shrank, or decayed, over time, and the planet approached the star. It eventually started to graze the star’s atmosphere. As the planet was falling in, it smeared around the star.

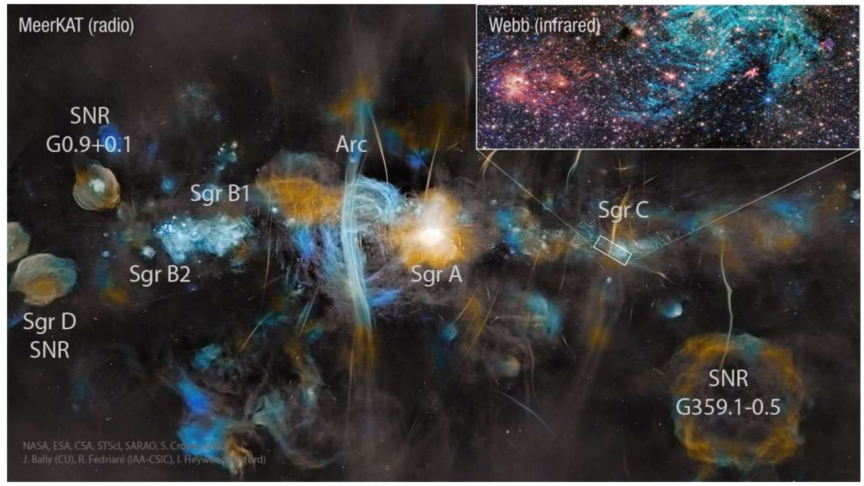
Panel 3: The planet was engulfed by the star completely, and blasted gas away from the outer layers of the star.

Panel 4: As that gas expanded and cooled off, the heavy elements in this gas condensed into cold dust over the next year. There is a

hot circumstellar disk of molecular gas closer to the star.”

JWST, Galactic Center:

I try not to do this too often, but the two descriptions from the Space Telescope Science Institute and Astronomy Picture of the Day are perfect.



“Labeling, compass arrows, and scale bars provide context for these MeerKAT and James Webb Space Telescope images. The star-forming region Sagittarius C, captured by the James Webb Space Telescope, is about 200 light-years from the Milky Way’s central supermassive black hole, Sagittarius A*.

“Huge vertical filamentary structures in the MeerKAT radio data echo those Webb captured on a smaller scale in the infrared, in a blue-green hydrogen cloud. Astronomers think the strong magnetic fields in the heart of the galaxy are shaping the filaments.

“The spectral index at the lower left shows how color was assigned to the radio data to create the image. On the negative end, there is non-thermal emission, stimulated by electrons spiraling around magnetic field lines. On the positive side, thermal emission is coming from hot, ionized plasma.

“For Webb, color is assigned by shifting the infrared spectrum to visible light colors. The shortest infrared wavelengths are bluer, and the longer wavelengths appear more red.”

“What's happening at the center of our galaxy? It's hard to tell with optical telescopes since visible light is blocked by intervening interstellar dust. In other bands of light, though, such as radio, the galactic center can be imaged and shows itself to be quite an interesting and active place. The featured picture shows an image of our Milky Way's center by the MeerKAT array of 64 radio dishes in South Africa. Spanning four times the angular size of the Moon (2 degrees), the image is impressively vast, deep, and detailed. Many known sources are shown in clear detail, including many with a prefix of Sgr, since the galactic center is in the direction of the constellation Sagittarius. In our galaxy's center lies Sgr A, found here in the image center, which houses the Milky Way's central supermassive black hole. Other sources in the image are not as well understood, including the Arc, just to the left of Sgr A, and numerous filamentary threads. The inset image shows a small patch recently imaged in infrared light with the James Webb Space Telescope to investigate the effects of magnetic fields on star formation.”

https://webbtelescope.org/contents/media/images/2025/115/01JQC49FHDYKY5WV5BH8BXSZFJ

https://apod.nasa.gov/apod/astropix.html [go to archive April 14]

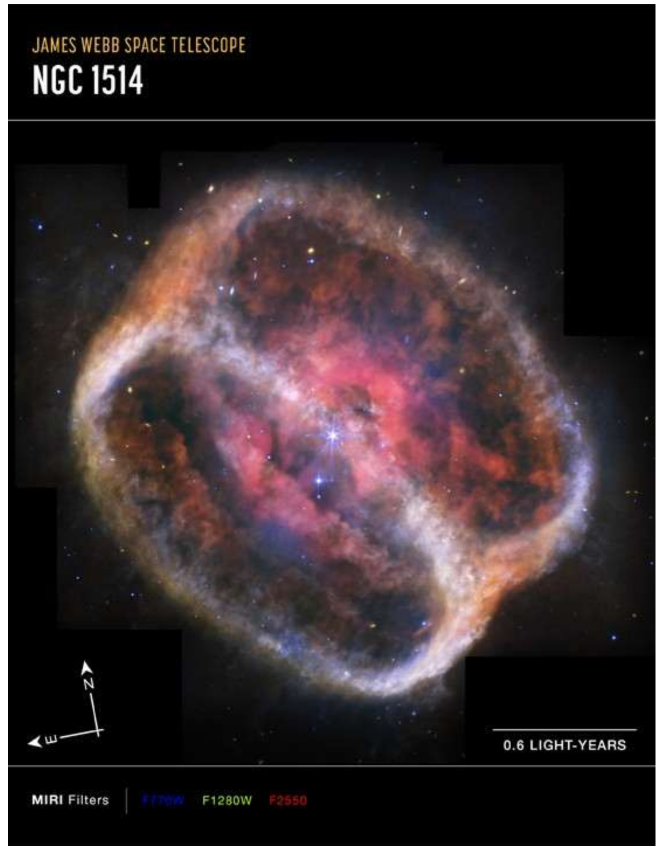
https://www.livescience.com/space/astronomy/space-photo-of-the-week-the-chaotic-heart-of-the-milky-way-like-youve-never-seen-it-before

JWST, Planetary Nebula:

NGC 1514 is a planetary nebula that is about 1,500 light-years from us. It was discovered by William Herschel in 1790, nine years after he discovered the planet Uranus. Herschel, not knowing the true nature of these usually round, fuzzy objects, is credited with the first use of the term "planetary nebula," as they looked like planets. At the center of NGC 1514 is a binary pair of a white dwarf and a red giant (unresolved at the center of the nebula). It is the white dwarf as it evolved from a Main Sequence star to a red giant and then shed its outer layers leaving the white dwarf stellar remnant. The material that was shed off is what we now see as a planetary nebula. In this case, probably because of the interaction of the white dwarf and its companion, we are seeing the unusual hourglass shape of NGC 1514. The outer, asymmetric rings (the ends of the hourglass) were first seen by WISE (Wide-Field Infrared Survey explorer), but it took JWST to bring out the detail seen in the image on the right.

https://webbtelescope.org/contents/news-releases/2025/news-2025-118#heading-full-article

https://www.universetoday.com/articles/the-jwst-examines-a-complex-nebula

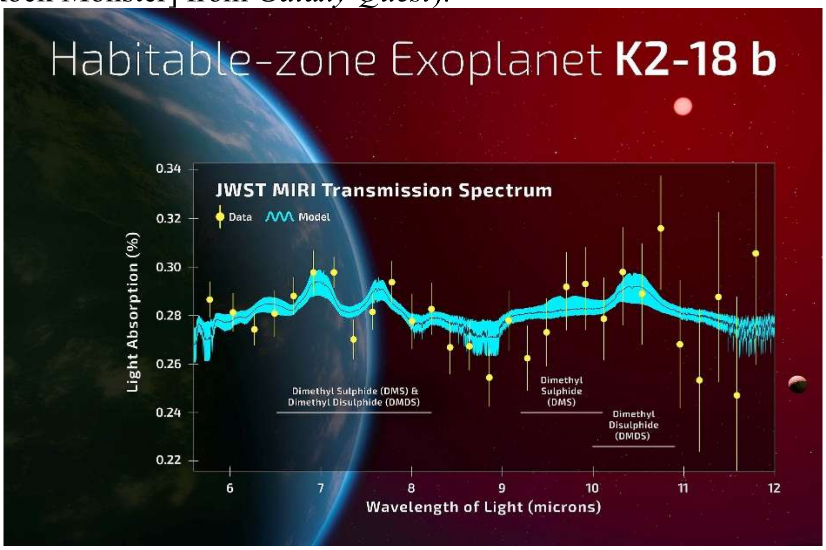


"The NASA/ESA/CSA James Webb Space Telescope has taken the most detailed image of planetary nebula NGC 1514 to date. A binary star lies at the nebula's center, and the new observations show how one of the central stars dominated the nebula's creation. Image Credit: NASA, ESA, CSA, STScI, Michael Ressler (NASA-JPL), Dave Jones (IAC)"

JWST, Possible Evidence of Life on Another World:

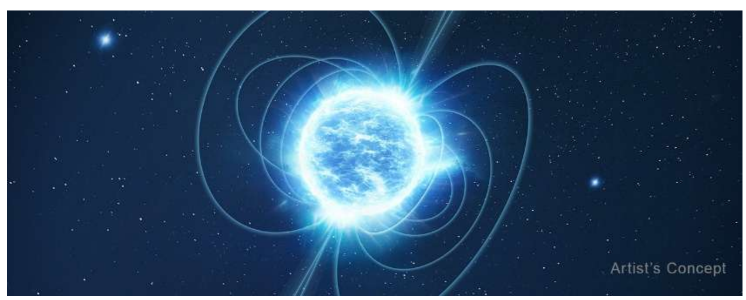
In 2015, the Kepler Space Telescope, in its extended mission, discovered an exoplanet orbiting the red dwarf star K2-18, 124 light-years from us. The exoplanet, K2-18b, was the first exoplanet found to be in the habitable zone of its star. Several years later, another explanet was discovered orbiting closer to the parent star. Both of these exoplanets are thought to be sub-Neptunes (masses between the Earth and Neptune, but with thick atmospheres, so closer to Neptune than Earth). Since its discovery, K2-18b has been extensively studied. Methane and carbon dioxide have been discovered in its atmosphere, but no ammonia. This detection and non-detection are consistent with the exoplanet being a hycean planet, a water world. The research highlighted here reports the detection of dimethyl sulfide (and possibly dimethyl disulfide). On

Earth, only biological processes are known to create dimethyl sulfide. Also, the molecule is short-lived, so such large quantities (20 times that of the Earth's atmosphere) imply that there must be a process that continually produces this molecule. The detection is weak, but the researchers are hoping that they can get more JWST telescope time to get a stronger detection of these molecules, the most convincing evidence for the existence of a least bacterial life on this exoplanet. I would like to emphasize that in the search for life, when looking for biological evidence, it is assumed that "life" is carbon based. We have no way of knowing what to look for if a lifeform is, say silicon-based. I have included examples above (the Horte from *Star Trek*, and Gorignak [Rock Monster] from *Galaxy Quest*).



https://www.earth.com/news/exoplanet-k2-18b-strongest-evidence-yet-of-extraterrestrial-life-discovered-webb/

HST, Magnetar Moving Through the Milky Way:



As I have explained before, a neutron star is the remnant of a mid-sized star that exploded as a supernova. Some neutron stars have extremely strong magnetic fields, a 100 trillion times stronger than the magnetic field of the Earth. They are typically 1.2 to 1.8 times the mass of the Sun and about 20 kilometers in diameter. SGR 0501-4516 was first detected in 2008 as the source of soft gamma rays (SGR)

SGR 0501-4516 is about 19,000 light-years from us and, thanks to over 10 years' observations by HST, appears to be moving relative to the stars in its neighbor, and specifically relative to a "nearby" supernova remnant that had been assumed to be the source of the magnetar. It is estimated to be about 20,000 years old and there are no other obvious sources of a supernova along that path. For this reason, it is concluded by the authors of this paper that SGR 0501-4516 was created by some other means, such as the collision of two smaller neutron stars or by a massive white dwarf in a binary system accreting material from orbiting star until the white dwarf became too massive, exploded as a type 1a supernova (but again no remnant material is seen) and collapses into a neutron star.

https://www.stsci.edu/contents/news-releases/2025/news-2025-010.html

https://science.nasa.gov/missions/hubble/nasas-hubble-tracks-a-roaming-magnetar-of-unknown-origin/

Perseverance, Dust Devil on Mars:

Dust devils are common on Earth (we get lots of them in Tucson), but they are also common on Mars. On January 25, Perseverance Mars Rover made a video of two dust devils merging. Perseverance scientist said, "Convective vortices — aka dust devils — can be rather fiendish. These mini-twisters wander the surface of Mars, picking up dust as they go and lowering the visibility in their immediate area. If two dust devils happen upon each other, they can either obliterate one another or merge, with the stronger one consuming the weaker. If you feel bad for the little devil in our latest video, it may give you some solace to know the larger perpetrator most likely met its own end a few minutes later. Dust devils on Mars only last about 10 minutes."

Martian dust devil captured by NASA's Mars Reconnaissance Orbiter. Credit: NASA/JPL-Caltech/Univ. of Arizona

https://www.universetoday.com/articles/perseverance-watched-a-dust-devil-eat-another

https://www.nasa.gov/missions/mars-2020-perseverance/perseverance-rover/perseverance-rover-witnesses-one-martian-dust-devil-eating-another/

***Curiosity on Mars, the Carbon Cycle: ***

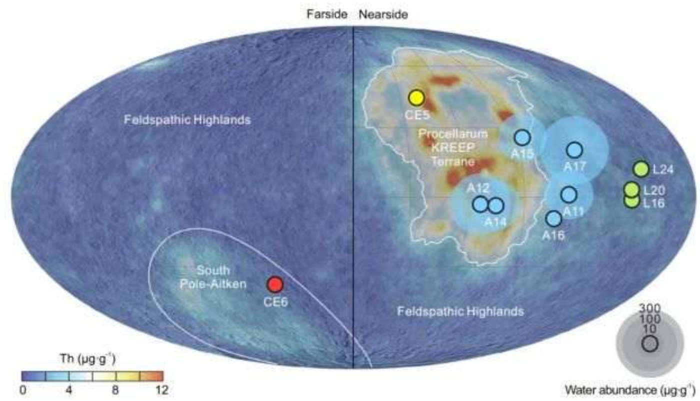
The Curiosity Rover has been studying the floor of Gale Crater and its central peak for more than 12 years. Gale Crater is 154 km (96 miles) in diameter. The rover has traveled 34.3 km (21.3 miles) during this time and is now ascending Mount Sharp, the crater's central peak. Gale Crater appears to be an ancient dry riverbed and Mount Sharp is surrounded by what appears to be layers of sediment left over from the ancient lake. Among other investigations, Curiosity can drill into the surface and analyze the mineral properties of the samples. A team of geologists has re-examined drill samples taken several years ago. In three out of four samples, they found the mineral siderite (iron carbonate), pure crystalline siderite. While carbonates have been found in small patches (as seen from space) and in some meteorites, this is the first time that this carbonate has been seen over a large area on the slopes of Mt. Sharp in sedimentary layers. These findings imply that, about 3.5 billion years ago, there was sufficient atmospheric carbon dioxide to keep Mars warm enough for liquid water and for Mars to have a carbon cycle with the atmosphere interacting with the surface rocks that were ultimately deposited as sediment on the lake bottom.

The Ubajara drillsite in Gale crater. (NASA/JPL-Caltech/MSSS)

https://www.sciencealert.com/curiosity-finds-first-in-situ-evidence-of-carbon-cycle-on-ancient-mars

Chang'e-6, Far Side Water:

The Chinese's sixth lunar lander, Chang'e-6, landed on the far side of the Moon in May of 2024 and returned to Earth with 1.9 kilograms (4.25 pounds) of rock samples from the South Pole-Aitken mare basin on the far side. The research discussed below provides evidence that the lunar far side mantle is drier than the near side mantle. The scientists studied several mineral samples and found that the material excavated from the far-side mantle has a very low water content, only 1.0 to 1.5 micrograms of water per gram of rock. Nearside samples have ranged from 1 to 200 micrograms per gram of rock. The first two online reports below are both by the same author, but the second a little more technical than the first. The last online report is a little more careful in reporting the research results. It notes that some of the nearside samples had low water content. The report also gives a possible reason for the low water content, noting that it is possible that the formation of the South Pole-Aitken itself could have caused the low reading. Also, one model for the higher levels of radioactive material on the nearside, lunar kreep (K, potassium, REE, rare earth elements, and P, phosphorous), may be due to the creation of the South Pole-Aitken forcing these elements to migrate toward the nearside. It is possible that this also happened with the water-bearing minerals. [I have never been clear as to how this process works].



A map showing where lunar samples were collected, and the water abundance estimates based on them. (Chinese Academy of Sciences)

https://www.spacedaily.com/reports/Drier_far_side_of_the_Moon_deepens_understanding_of_lunar_evolution_999.html

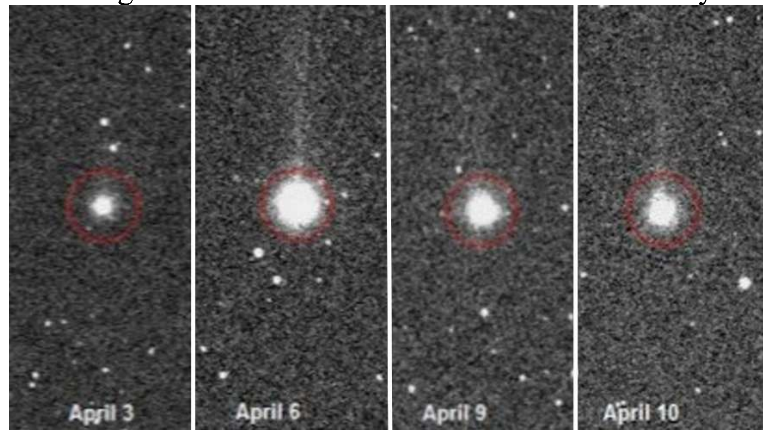
https://www.spacedaily.com/reports/Chinese_study_reveals_lower_water_content_in_lunar_farside_mantle_999.html

https://www.sciencealert.com/striking-evidence-of-water-imbalance-on-the-moon-hints-at-a-collision

Comet Update:

First you see it and then you don't. That seems to happen a lot with comets. More often than not, we hear about the "brightest comet of the year," only to be disappointed by what we see. Comet C/2025 F2 (SWAN) was discovered independently by three citizen scientists looking at public domain images from the Solar Wind ANisotropies (SWAN) camera on the Sun-staring SOHO spacecraft. The image on the left was taken by Dan Bartlett on April 14. The image on the right was taken by Mike Olason on April 17. The comet appears to have faded. Is the comet disintegrating as it approaches the Sun. It is closest to the Sun on May 1 (50 million km, 31 million miles, within the orbit of Mercury) and a day later, it will be about 0.96 AU (144 million km, 90 million miles) from Earth.

However, in early April, Mike Olason took the sequence of images of the comet in some sort of outburst. Maybe the comet has just settled down from the outburst. The first article proposes a cryovolcano for the cause of the outburst, but it could also have been due to a landslide of the comet, something that has been seen before on other comets. The comet moves into the evening sky at the very end of April, so it may be visible (or not) shortly after the Sun sets. If it is visible, you will most likely need binoculars or a small telescope to see it. I will try to keep you updated.



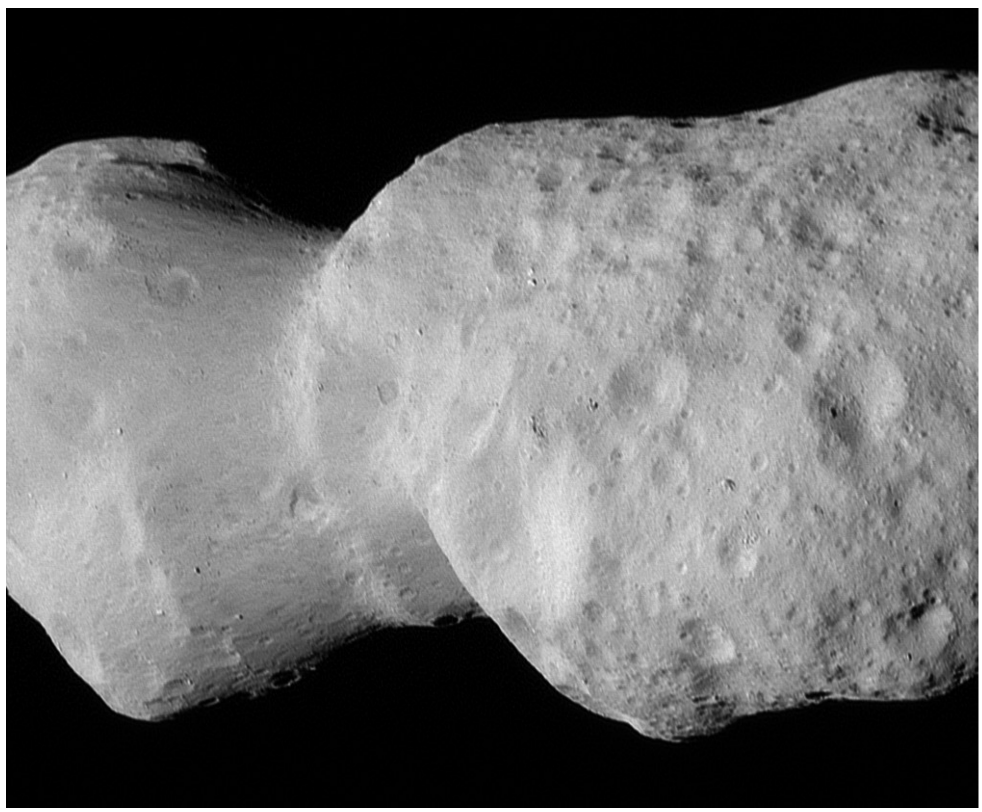
https://www.livescience.com/space/comets/newly-discovered-comet-swan-just-erupted-with-a-bright-icy-burst-is-it-a-cold-volcano

https://apod.nasa.gov/apod/ap250418.html

https://earthsky.org/space/new-comet-swan25f-april-2025-how-to-see-it/

Lucy Update:

When I started writing this on April 21, the Lucy spacecraft, on April 20, had flown by its second main belt asteroid, 52246 Donaldjohanson, but no images had been released. I stopped to attend our regular Monday Asteroid Lunch and in the middle of it, NASA released the first images of the asteroid and a short video. So, this became our topic of discussion! Previously, the Lucy spacecraft had flown by 152830 Dinkinesh in 2023, where it discovered its contact binary satellite Selam. For comparison, 152830 Dinkinesh is 790 meters in diameter and 52246 Donaldjohanson was estimated to have a mean diameter of about 3.9 km. I think the actual mean diameter is closer to 4.6 km (8 x 3.5 x 3.5 km). If you watch the video, the motion that you are seeing is the motion of the spacecraft as it flies by the asteroid. The asteroid has a rotational period of 251 hours, a slow rotator! I am sure that we will hear more about this asteroid in the coming days and see more images. Unfortunately, the video cuts off before the closest approach (1,000 km, 600 miles) because the camera would have been pointed too close to the Sun. The asteroid is clearly what is called a contact binary, where two asteroids have come together. This has been seen with other small asteroids and some comets. The "neck" of the asteroid is smoother than the two lobes. Again, this has been seen before. The neck area is "downhill." The spinning asteroid causes the lobes to have lower gravity. There is evidence of some landslides that would make the neck have a less cratered (younger) surface. Look at the shadows, there appear to be some small rocks on the surface (if not bad pixels).



https://science.nasa.gov/image-article/nasas-lucy-spacecraft-images-asteroid-donaldjohanson/

https://skyandtelescope.org/astronomy-news/meet-asteroid-donaldjohanson/

Meteors, Meteorites, Asteroids, and Comets:
As of April 21, 2025, there are 1,445,287 known minor planets (2,480 added since March 24). Of these, 793,066 773,916 are numbered (19,150 more). There are 4,582 known comets (2 added). Of these, 598 have good orbits and have been numbered. There are 38,315 (214 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]. 896 NEOs have been discovered since the beginning of the year. A potentially hazardous asteroid is an asteroid whose orbit could bring it with 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 1,776 Near-Earth Objects (20 more).

Asteroid Close Approaches:
In the last 30 days, 17 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 20 meters in diameter (if high or low reflectivity, respectively). There were 12 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 64 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 March 26 (observed) and June 17 (predicted in the next 60 days), 22 asteroids with estimated diameters between about 60 meters and 990 meters in diameter have passed/will pass between 2.75 and 19.2 lunar distances of the Earth. Of the 10 large asteroids that have been **observed** to pass within 20 LD (0.05 AU) of the Earth between March 26 and April 16, seven were discovered prior to this year (one in each of the years 2005, 2007, 2011 (we observed this one the night of April 14), 2014, 2015, 2022, and 2023). Two were discovered in 2025 and one was first observed after its closest approach to the Earth. Of the 12 asteroids that are **predicted** to pass within 20 LD (0.05 AU) of the Earth between April 22, 2025, and June 17, 2025, nine were discovered prior to 2025. One was discovered in 2000, one was discovered in 2002, two were discovered in 2003, one was discovered in 2008, three were discovered in 2011, and one was discovered in 2014. Three were discovered in 2025, all before their closest approaches to Earth. We observed one of them on the night of April 14. Of the 155 asteroids that were seen or are predicted to come within 20 lunar distances of the Earth (about 0.05 AU), we observed five of them (including the two large ones already mentioned). The two other asteroids we observed were just outside the range of the list (within 0.058 AU of the Earth).

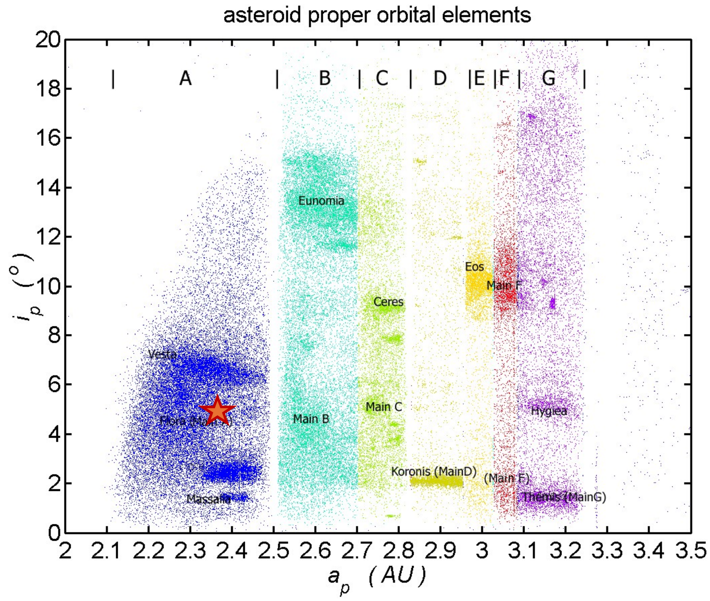
Carbonaceous Meteorites:


Six years ago, a carbonaceous chondritic meteorite fell in Agua Zarcas, Costa Rica. Meteoriticists were surprised that so much of the original meteoroid/small asteroid had survived passage through the atmosphere. It was estimated that the meteoroid (estimated to be less than a meter in diameter) survived Earth entry was in part due to the strength of the meteoroid. It appears not to have experienced any impacts since it was blasted off the surface of a Main Belt asteroid about 2 million years ago. Its slow speed relative to typical entry velocities and its coming nearly straight down probably contributed to it survival. On a personal note, I have studied carbonaceous chondrites for 30 years and never heard them called mudballs. They are clays and not "muddy."

https://earthsky.org/space/aguas-zarcas-mudball-meteorites-costa-rica

https://www.seti.org/press-release/pinball-world-asteroids-mudball-meteorite-avoided-collisions

A Brief Lesson on Asteroid Families and Contact Binaries:
I am doing this to help put 52246 Donaldjohanson into context (it has ended up not too brief). Asteroid families are asteroids that can be grouped by their orbital elements, usually semi-major axis (a, mean distance from the Sun) vs. inclination. In most cases, these families are created when there is a collision between two asteroids that breaks up and slightly disburses the debris from the collision (smaller asteroids). These asteroids may have similar compositions (if the parent asteroid was homogeneous) or they represent the crust, mantle, or core of a differentiated asteroid. They could also represent a mixture of the two impacting bodies. Donaldjohanson is a member of the Erigone Family. Its largest member is 163 Erigone and there are about 1,800 asteroids in the Family. The family is thought to be the result of a collisional breakup about 150 million years ago. About 100 members of this asteroid family have had their visible spectra measured. While their spectra vary, they all appear to have spectra similar to carbonaceous chondritic meteorites and thus contain hydrated minerals and carbon (primarily C-type and B-type asteroids). The albedo (reflectance) of Donaldjohanson had been estimated to be about 0.1 (reflecting 10% of the light, so gray in appearance, darker than the initial images show), but the asteroid appears to be larger than predicted, implying that the albedo is likely to be less, though not as dark as Bennu and Ryugu (less than 5%).



"Asteroid families become visible as distinct concentrations when asteroids are plotted in the proper orbital element space (i_p vs a_p). Some prominent families are the Vesta, Eunomia, Koronis, Eos, and Themis family located in different (colorized) regions of the asteroid belt."*

About 20% to 30% of the Near-Earth Objects (NEOs) are contact binaries. There appears to be a similar percentage in the Kuiper belt. I have not seen a number for Main Belt asteroids. We have not visited many small Main Belt asteroids, so it would be hard to make a prediction. If one goes by the NEOs, then the number of small Main Belt asteroids that are contact binaries could be similar to the NEOs. This is not my area of expertise, but from what I have read, if you have a binary asteroid system, many of them will eventually become tidally locked so that their rotation rates will be the same as the rate at which they revolve around each other. Once that happens, tidal and other forces will make them get closer and closer until they collide. However, the speed of the collision will be only millimeters per second, so they will just touch each other and stick, as we see with 52246 Donaldjohanson.

*The original uploader was Dreg743 at English Wikipedia. This diagram was created by Piotr Deuar using data for 96944 minor planets, which was obtained from the AstDys site. Data was dated March 2005, calculation was by Z. Knezevic and A. Milani. - Transferred from en.wikipedia to Commons.

Moons and Rings:
As of April 21, 2025 (last update), there are 416 moons (satellites) orbiting six planets (no change). As of April 12, 2025 (last update), there are 578 asteroids, dwarf planets, Centaurs, and Trans-Neptunian Objects with companions (3 more than the last update on March 22). There are 560 binary systems (3 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, 108 Near-Earth Objects (1 more) have companion moons (5 have 2 moons, same), 35 Mars-Crossing Asteroids (same) have companion moons (1 with 2 moons), 285 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

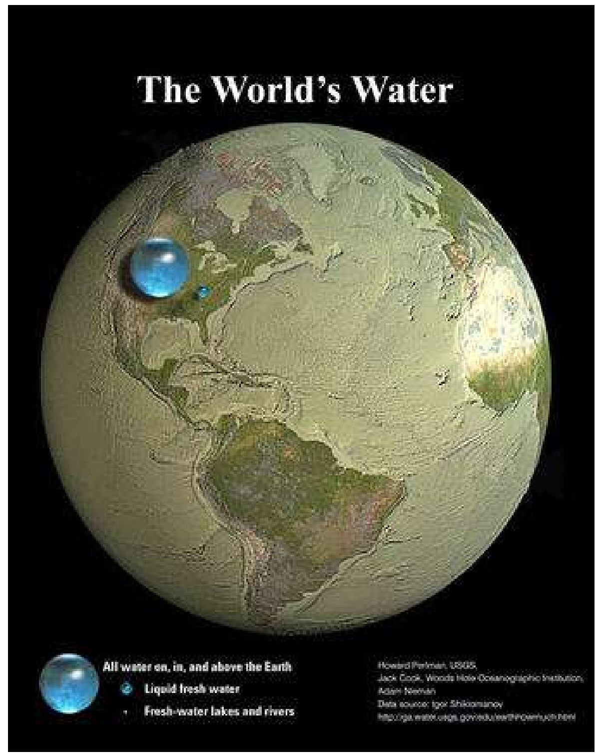
or are suspected to have rings (same) and 1 with rings but no moons. For those of you doing the Solar System Classification activity, this is a good example of how there is overlap among planets, dwarf planets, and asteroids as to how we classify them based on characteristics (moons and rings in this 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, 578 vs. 416. There are also more asteroids with rings than there are planets with rings, 5 vs. 4. I should note that someone on the Minor Planet Listserv has just announced the discovery of a satellite orbiting a TNO which would not have made this list yet.

Planets:

Earth's Original Water:

Earth has water, but where did that water come from? There are two major theories. One theory is that the water is "original," with the water being supplied by the protoplanetary bodies that came together to create the Earth. The other is that the original water was lost when a Mars-sized body, given the name Theia, impacted the Earth and created the Moon. After that event, the Earth was still being impacted by asteroids and comets, and it is these later impacts that brought the water we see today on the Earth. The authors of this research paper propose that the Earth was able to retain its original water. They examined a class of meteorites called enstatite chondrite meteorites that they say are similar in composition to the material that initially formed the Earth and thought to be too dry to have contributed to Earth's present water. The scientists found that these meteorites contain much more hydrogen than previously thought and that this hydrogen could have reacted with the oxygen in the existing silicate rocks to form the water we have on Earth. This is an example of two "camps" that disagree with how we got our water (I am in the camp of carbonaceous asteroids and comets bringing the water), so this is an issue that may never get resolved. I am including an interesting graphic. While carbonaceous chondrites can contain as much as 22% by mass water and comets are mostly water ice, the graphic on the right shows, visually, how little water there is on Earth—0.023% of the Earth is water in all forms. So, it would not take a lot of asteroids and comets to bring Earth its water (or to have been retained from its original water).

https://www.sciencealert.com/origins-of-earths-water-may-not-be-as-complicated-as-we-thought

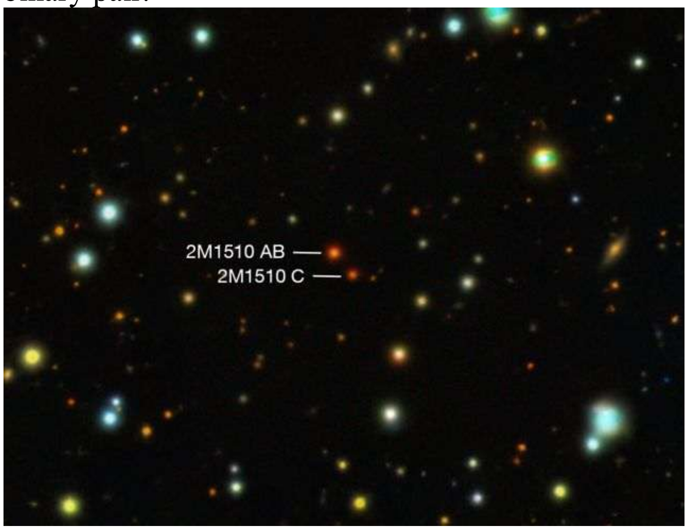


"Spheres showing:(1) All water (largest sphere over western U.S., 860 miles (1,385 km) in diameter)(2) Fresh liquid water in the ground, lakes, swamps, and rivers (mid-sized sphere over Kentucky, 169.5 miles (272.8 km) in diameter), and (3) Fresh-water lakes and rivers (smallest sphere over Georgia, 34.9 miles (56.2 km) in diameter). Credit: Howard Perlman, USGS; globe illustration by Jack Cook, Woods Hole Oceanographic Institution (©); and Adam Nieman."

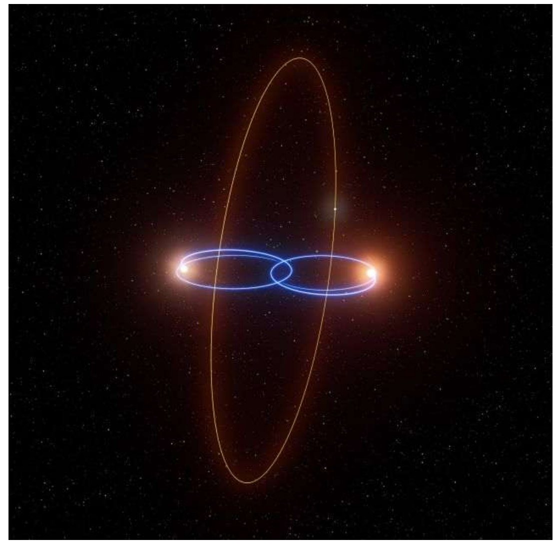
Exoplanet Update:

As of April 22, 2025 (last update), there are 7,458 confirmed extra-solar planets (16 since April 1, my last update) orbiting 5,116 stars (12 more), with 1,038 star systems (same) having more than one exoplanet orbiting them. In addition, there are 2,397 candidate (unconfirmed) exoplanets (20 more) orbiting 2,099 stars (19 more), with 142 stars (3 more) having more than one exoplanet orbiting them. Most of these candidate exoplanets are likely to be real but need to be confirmed by more detailed ground-based observations or other techniques. There are 728 star systems with exoplanets orbiting one of the stars (4 more) and there are 31 star systems with 39 exoplanets orbiting both stars in the binary system. Three star systems have three exoplanets orbiting both stars.

Unusual Exoplanet Orbit:
2M1510 is a star system 120 light-years from us. It is comprised of two brown dwarfs, an eclipsing binary (2M1520AB), about 0.06 AU apart (one-sixth the distance of Mercury from the Sun) and orbits in 21 days. They are both about 40 times the mass of Jupiter. There is a third, lower mass brown dwarf that orbits about 250 AU away from the binary pair. The researchers have modeled this system and have detected, with radial velocity measurements, an exoplanet that is in a polar orbit around 2M1510AB. It has an orbital period of 100 days at a distance of about 0.2 AU. Its mass is about 10 times the mass of the Earth. The system is only about 45 million years old. Wikipedia notes that there may be another Jupiter-mass object that orbits at a distance of 4 AU from the binary pair.



The two brown dwarfs as imaged by the DESI survey. (DESI Legacy Survey/D. Lang/Perimeter Institute)



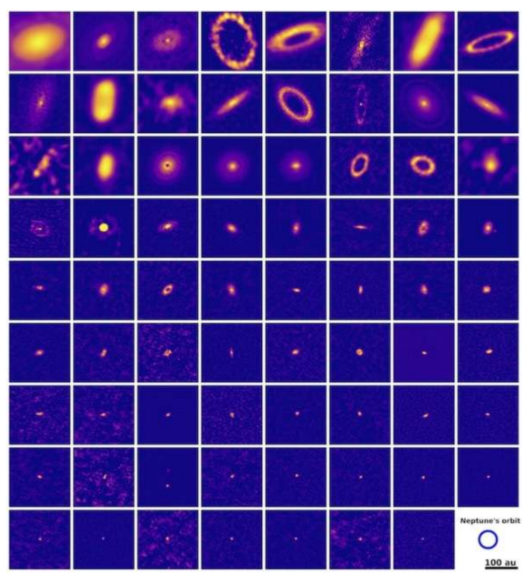
An illustration of the configuration of the 2M1510 system. (ESO/L. Calçada)

https://www.sciencealert.com/a-quirk-of-light-has-revealed-the-weirdest-planetary-system-yet

ALMA, Protoplanetary Disks:
Astronomers used the Atacama Large Millimeter/Submillimeter Array to image planet-forming regions in the Lupus star-forming region which is 400 light-years from us. There are 73 known protoplanetary discs, mostly around red dwarf stars. They found that 2/3 of the discs have radii less than 30 AU, the distance of Neptune from the Sun. The masses of these small disks range from 0.3 to about 26 times the mass of the Sun, implying that the exoplanets that are likely to be forming in them will be no larger than a few times the mass of the Earth, no Jupiter-sized planets.

https://www.universetoday.com/articles/many-protoplanetary-disks-arent-much-bigger-than-earths-orbit

https://earthsky.org/space/birthplaces-of-new-planets-protoplanetary-disks-lupus-alma

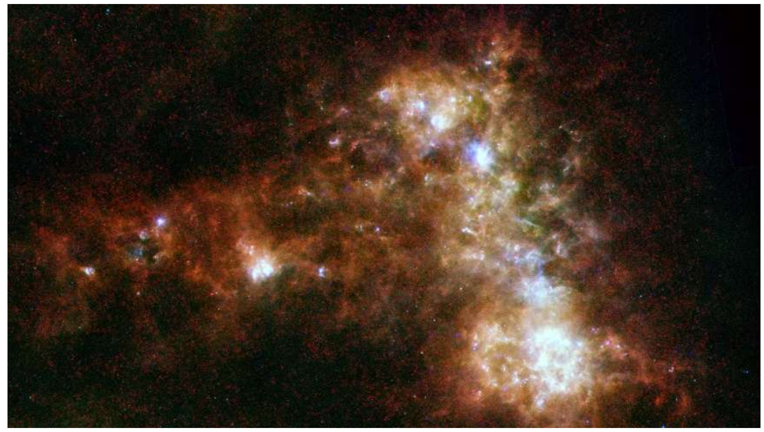


"These are the 73 protoplanetary disks – or planet-forming disks – that the Atacama Large Millimeter/submillimeter Array (ALMA) observed in the Lupus region. Two of the images contain binary stars. New research shows that such disks – the birthplaces of new planets – come in a much wider range of sizes than previously thought. The size of Neptune's orbit is shown at the bottom right for scale. AU means astronomical unit. One AU is the average distance from the sun to Earth. Image via Guerra-Alvarado et al./"

Stars and Galaxies:

Small Magellanic Cloud:

“The Large Magellanic Cloud and the Small Magellanic Cloud from the European Southern Observatory’s Paranal Observatory in Chile. They are 2 small galaxies orbiting our large, spiral Milky Way galaxy. New research indicates that the Large Magellanic Cloud is ripping its smaller neighbor to shreds. Image via J. Colosimo/ ESO (CC BY 4.0).”



“A photo of the Small Magellanic Cloud captured by the Herschel Space Observatory. (Image credit: Universal History Archive/Universal Images Group via Getty Images)”

The Small Magellanic Cloud (SMC) is a dwarf galaxy and a satellite galaxy of the Milky Way. It is about 200,000 light-years from us and is visible only from the Southern Hemisphere. Using detailed data from the Gaia spacecraft which was able to chart the positions of stars in the SMC, astronomers have determined that the SMC is interacting with its larger neighbor the Large Magellanic Cloud (LMC).

https://www.livescience.com/space/astronomy/astronomers-are-shocked-to-find-our-galaxys-nearest-neighbor-is-being-torn-to-shreds

https://earthsky.org/space/small-magellanic-cloud-is-being-destroyed-by-larger-neighbor/

Two More Pictures:

These were just taken (the morning of April 24). The first is a 4x picture of the eastern sky a few minutes before 5:00 am Tucson time. The Moon, Venus, and Saturn. The second picture taken just after 5:00 am is a cropped image that shows just Venus (brightest) and Saturn with Mercury just visible in the low left corner.