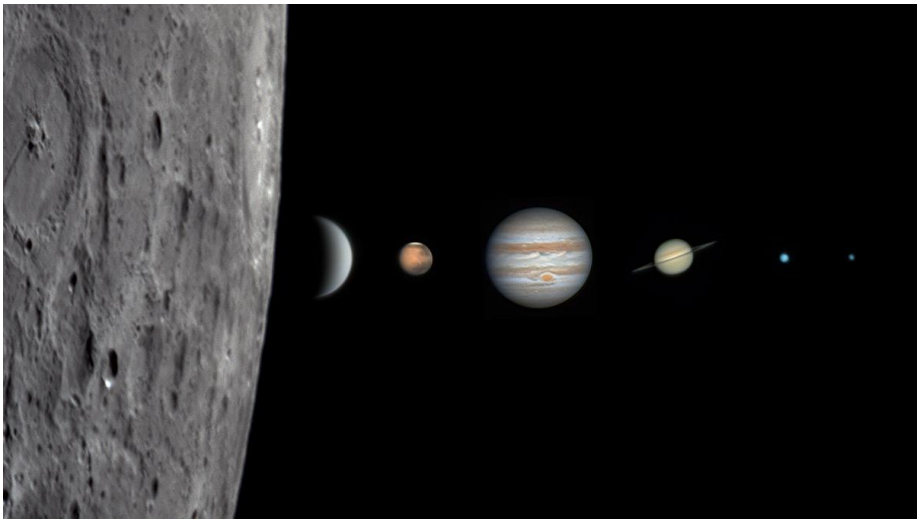
Education & Public Outreach
February 2025, Part 2b

Some Pictures:
The picture on the left is my first attempt to use a device to help attach a smartphone to the eyepiece of the telescope. Even with adjusting the brightness, the crescent Venus is overexposed in the camera. I need a Moon filter! The other two pictures are from the high school class that Laura Felix (GS Colorado, class of 2009). She teaches arithmetic, geometry, astronomy/cosmology, and music/harmonia. I think the middle picture is at the Chamberlin Observatory. I think the one on the right is the observatory at the Air Force Academy.

Planets to Scale:
Previously, I have mentioned the "grand alignment" of six planets the last week of January. The Moon joined the lineup at the very end of January. There is another alignment on February 28 when the Moon and Mercury join up (though Saturn will be very low in the sky). Taking advantage of seeing all the planets, French astrophotographer Gwenaël Blanck created image on the right by combining individual shots of each of the objects on Feb. 2 from Paris. These images were taken over a period of 80 minutes with the same magnification, so shows the planets to scale as was seen that night, their relative apparent sizes.



https://www.livescience.com/space/astronomy/parisian-photographer-produces-phenomenal-perfectly-proportioned-planetary-parade-portrait

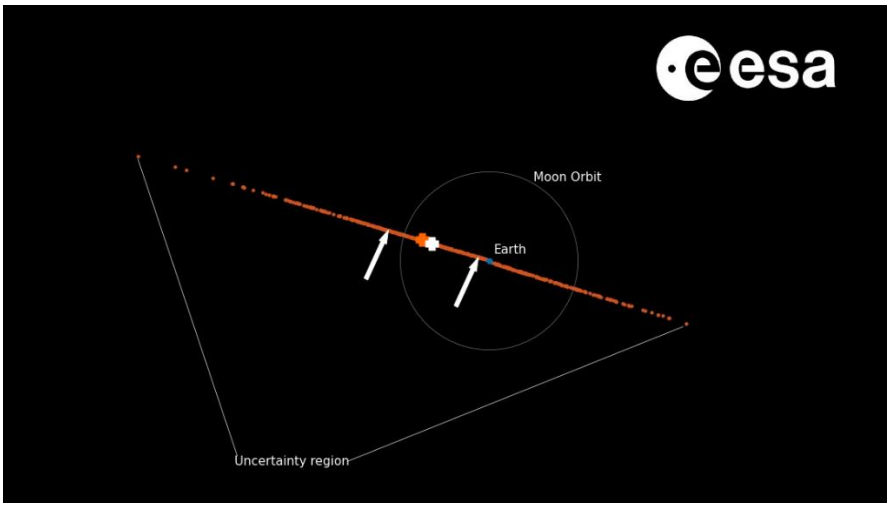
"Light" Pollution:
We always think of light pollution as being created by poor lighting by streetlights, security lights, and illuminated signs. However, there is a similar problem at radio wavelengths, "noise pollution" created by radio and TV transmissions, as well as by cell phones and communications satellites (especially the "noise" created by the electronics in the satellites). One of the people who receives this Newsletter is a legal advisor to the IAU's (International Astronomical Union) Policy Group of the Dark and Quiet Skies. In 2013, the

Murchison Widefield Array in the Australian desert, detected a stray signal that was clearly from a TV transmitter. This radio interference required the scientists at the time to throw out the observations being made. However, in this recent research, radio scientists set out to see if they could characterize the signal and isolate it. At that point, they could remove the "noise" and recover the data. In this way, in the future, they would have the ability to get rid of the noise in other contaminated observations (has happened several times since 2013 and is a continuing problem). Analyzing the signal (timing at different points on the radio array and the change over time), they were able to determine the original source of the signal and determine that what they saw was a TV transmission that was reflected off a moving object, an airplane. The scientists were able to determine the altitude and speed of the plane. Having accomplished this, the scientists, in the future, will be able to remove, or at least reduce, the noise created by similar events.

https://www.sciencealert.com/mystery-of-weird-signal-detected-in-the-australian-desert-finally-solved

Astronomy in the News

2024 YR4 Update:



I am writing this on Sunday February 23. The most recent observations were made last night by the Canada-France-Hawaii Telescope on Mauna Kea. The good news is that asteroid 2024 YR4 is no longer a threat for hitting the Earth in 2032. As I have said before, you can picture the Earth and the asteroid as being a train and car, respectively. The orbit of the Earth (the tracks) is known accurately. The orbit of the asteroid (the road) has some uncertainty, but not very large (you know where the track is, and you know where the road is). The train is on schedule (ha), so you know when it will cross the road, but you do not know when you, in the car, will cross the tracks. For the asteroid, the biggest uncertainty is the location of the asteroid in its orbit. Soon after its discovery, the asteroid's position was not known to better than about 8 million kilometers. By mid-February (a week ago), this had decreased to about 1.3 million kilometers (the long orange line in the above image. With a nominal distance of 0.8 times the distance to the Moon (the orange cross). All of this time the potential closest distance to the Earth was always under 1,000 km (where the orbits intersect). As of today, nominal position has shrunk to about 267,000 km (0.7 times the distance to the Moon), but the uncertainty is only about 200,000 kilometers, so the Earth is outside distance uncertainty. The timing uncertainty is about +/- 4 hours as the asteroid will be moving about 13 km/sec relative to the Earth. I hope you do not drive that fast! As of Tuesday, February 25, the chances of hitting the Earth have dropped to 1 in 20,000.

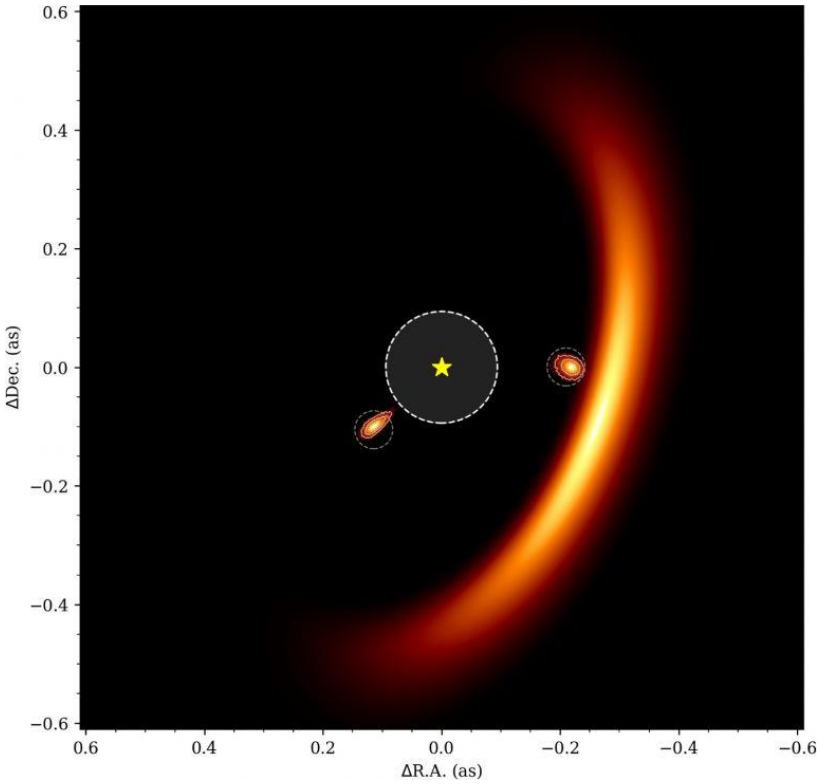
The interesting news is that the chance of hitting the Moon is now about 3%. The timing for impacting the Moon is +/- 3 hours, so, as you can see from the image on the right, there is a 3-minute window in the 4 hours for the asteroid to hit the Moon!

JWST

Forming Exoplanets, Revisited:

We have written about the five-million-year-old star system PDS 70 before, most recently last month with the detection of water and carbon dioxide in the atmosphere of 70b. Now, JWST has made it first observations of this young system. As can be seen in the image on the right, JWST sees extended dust clouds around PDS 70b and 70c. This implies that they are still forming as they are still accreting material from around them. In addition, they appear to confirm the existence of a third exoplanet in orbit around the star.

https://www.sciencealert.com/astronomers-reveal-our-best-glimpse-yet-of-planets-being-born

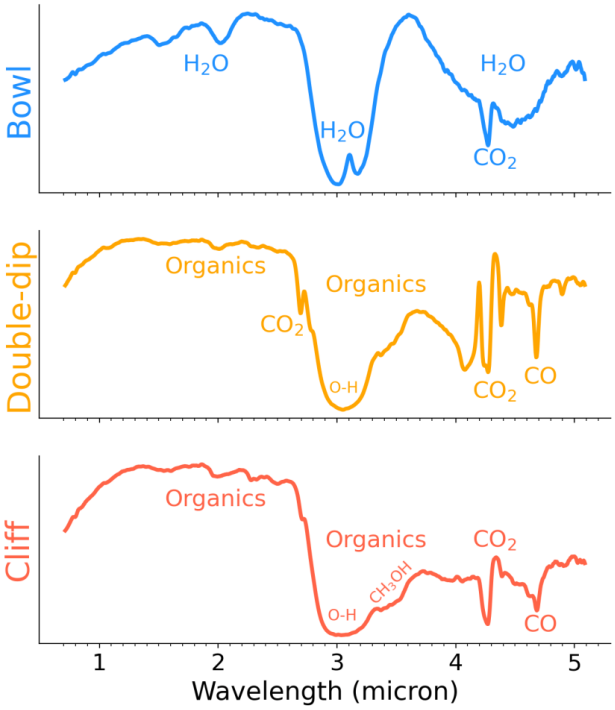


"This image from the study shows PDS 70 and its two planets with circumplanetary disks. The disks indicate that the planets are still growing by accumulating material, likely gas, from their disks. The larger orange feature is part of the larger disk surrounding the star and the planets. (Blakely et al. 2025)"

TNO Compositions:

I think that we reported on a preliminary version of this last year, but this seems to be an update that reflects the final published version of the research.

Astronomers have used the NIRSpec instrument (the NIRCam spectrometer to obtain reflectance spectra of 75 Neptunian Objects (TNOs) in the Kuiper belt. They have been able to divide these objects into three groups based on the types of ices found on them. The Bowl and Double-dip classes are TNOs that formed closer into the Sun and have lost some or most of the most volatile ices. The Cliff class has retained more volatile ices and organics, implying that they formed and remained in a colder region of the Kuiper belt.



Spectra for the three TNO spectral classes identified for the first time using data from NASA's James Webb Space Telescope. The heavy solid line in each panel is the average of over a dozen TNO spectra within each class. Prominent features in each spectrum are highlighted and/or labeled with the name of the molecule, or class of materials, responsible for absorbing at those wavelengths. Credit: Adapted from Pinilla-Alonso et al. 2024.

https://blogs.nasa.gov/webb/2025/02/12/nasas-webb-reveals-the-ancient-surfaces-of-trans-neptunian-objects/

JWST, Active Black Hole:

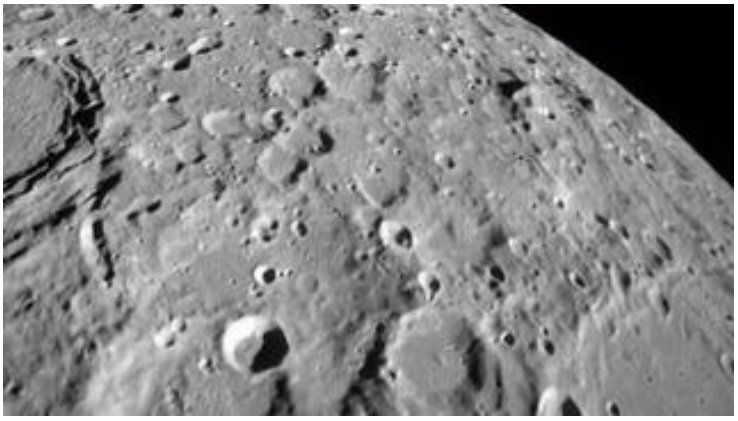
Sagittarius A* is the supermassive black hole at the center of our galaxy. It has a mass of about 4 million times that of the Sun. Astronomers have observed this black hole for a total of 48 hours over the last year. They have found that the black hole has flares, ones that are short and faint, and others that are longer and brighter. The researchers have come up with theories for what is causing them. The faint flares are caused

by turbulence in the accretion disk that surrounds the black hole. The bright flares are caused by "magnetic reconnection events—a process where two magnetic fields collide, releasing energy in the form of accelerated particles." On the Sun, magnetic reconnection events are related to solar flares and coronal mass ejections.

https://webbtelescope.org/contents/news-releases/2025/news-2025-110.html

Next Moon Lander:

A private company, Firefly, is about to attempt a landing on the Moon in early March. The lander is called, Blue Ghost, and is now in orbit around the Moon. The image on the right is from a video of the spacecraft as it orbits the Moon. As far as I can tell, the whole orbiter will land. The is the first of 10 landers that Firefly is contracted by NASA to carry out research on the Moon. The next two landers are scheduled for 2026 and 2028.



https://www.space.com/space-exploration/launches-spacecraft/blue-ghost-moon-lander-lowers-its-orbit-to-fly-closer-to-the-lunar-surface-video

Exoplanet Update:

As of February 26, 2025 (last update), there are 7,416 confirmed extra-solar planets (23 since January 10, my last update) orbiting 5,088 stars (13 more), with 1,035 star systems (5 more) having more than one exoplanet orbiting them. In addition, there are 2,375 candidate (unconfirmed) exoplanets (16 more) orbiting 2,074 stars (11 more), with 140 stars (2 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 232 star systems with exoplanets orbiting one of the stars and there are 29 star systems with 37 exoplanets orbiting both stars in the binary system. Three star systems have three exoplanets orbiting both stars.

Exoplanet Winds:

WASP-127 b is an exoplanet orbiting a solar-type star 500 light-years from us. It orbits the star at a distance of 0.048 AU (one-eighth the distance of Mercury from the Sun) with an orbital period of 4.2 days. It is one of the least dense exoplanets with a diameter of about 1.3 times that of Jupiter, but only about 0.16 times the mass of Jupiter. Astronomers have been able to measure the exoplanet's atmospheric wind speed. On one side of the disk as we view it, the winds are coming toward us and on the other side, they are moving away from us. In the way, astronomers have been able to measure the wind speed at 33,000 km/hr (20,000 miles/hr). In our Solar System, Neptune has the highest-known wind speeds. The winds on WASP-127 b are nearly 20 times faster.

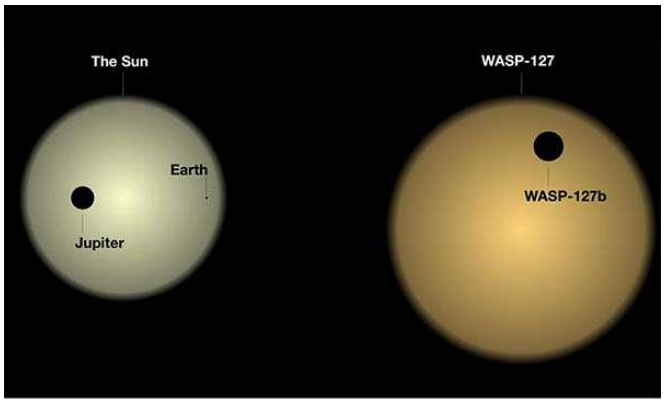


Illustration from the Space Daily article

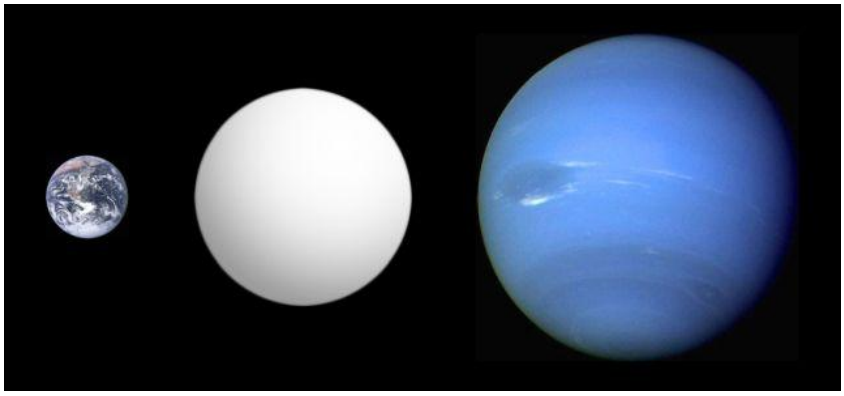
https://www.spacedaily.com/reports/Extreme_supersonic_winds_detected_on_distant_exoplanet_999.html

https://www.universetoday.com/170549/supersonic-winds-blowing-on-an-extreme-exoplanet/

https://www.sciencealert.com/record-shattering-20000-mph-winds-detected-on-wild-alien-planet

Super-Venus:

GJ 1214 is a red dwarf star that is 47 light-years from us. In 2022, the IAU approved the name of this star (named by a team from Kenya) as Orkaria. "Orkaria refers to the red ochra commonly donned by your Maa warriors during cultural ceremonies and alludes to the color of GJ 1214). Orkaria is orbited by an exoplanet, GJ 1214 b, that has been named Enaiposha, "first used by the Maa community to refer to large bodies of water such as lakes and sea. 'Enaiposha' is also an expression of awe at the tumultuous nature of a large amount of water."



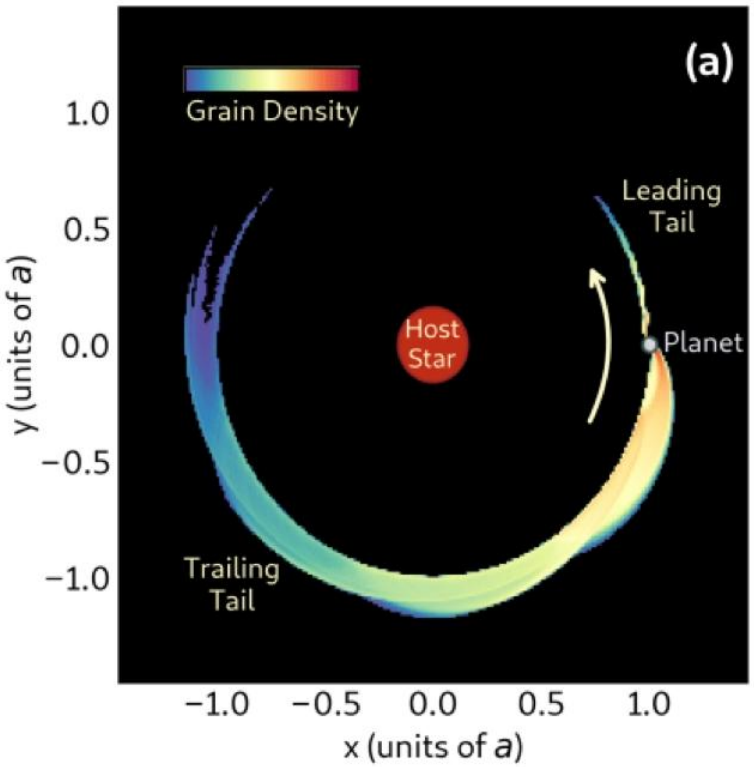
"A size comparison between Earth (left), Enaiposha (middle), and Neptune (right). (Aldaron/Wikimedia Commons, CC BY-SA 3.0)"

Enaiposha orbits Orkaria at a distance of 0.015 AU with an orbital period of 1.58 days. Given its size, it was thought to be either a mini-Neptune with a deep, thick atmosphere similar to Neptune, or a super-Earth, possibly a water world. The observations reported here have now come up with an alternative, a super-Venus. The model that best fits the observations is an atmosphere dominated by metals at lower altitudes with a relatively small amount of hydrogen. At higher altitudes, the atmosphere consists of a haze dense with aerosols, as well as carbon dioxide.

https://www.sciencealert.com/new-kind-of-planet-unlike-anything-in-our-solar-system-discovered

Exoplanets Falling Apart:

The link below represents the results of observations of two Ultra-Short-Period exoplanets (USP), one of which was previously known. BD+05 4868 is a binary star system with a K-class star (about 0.7 times the mass of the Sun) and a smaller M-dwarf star (about 0.5 times the mass of the Sun) separated by about 130 AU. The system is about 12 billion years old. The K star is orbited by an exoplanet, (discovered recently by TESS) with an orbital period of 30.5 hours at a distance of 0.02 AU. The transits of this exoplanet are significantly extended, which the authors model as a Moon-mass exoplanet that is in the process of vaporizing (essentially a rocky comet) at a rate of about 1 Earth mass in 100 million years, i.e., the exoplanet will be "gone" in about 2 million years. In the second paper, the authors have used JWST (NIRCam) to observe the exoplanet K2-22b, another USP, with an orbital period of 9.1 hours and at a distance of 1.3 million kilometers. This was discovered several years ago by the Kepler mission. Four transits were observed by JWST, two had strong signals and two were very weak. The authors interpreted this a periodic outgassing from the exoplanet. Again, the mass of the exoplanet is about the same as the Moon. The primary spectral features seen are consistent with silicates from the mantle of the vaporizing exoplanet. However, NO and/or carbon dioxide is seen. The researchers interpret this as gases originating from a hydrated mantle or possibly a subsurface ocean that is now exposed on the surface as the exoplanet evaporates.



"This figure from the team's modelling illustrates some of their findings. The planet is not to scale in this image, but the host star is. (Hon et al. 2025.)"

https://www.universetoday.com/170626/exoplanets-seen-falling-apart/

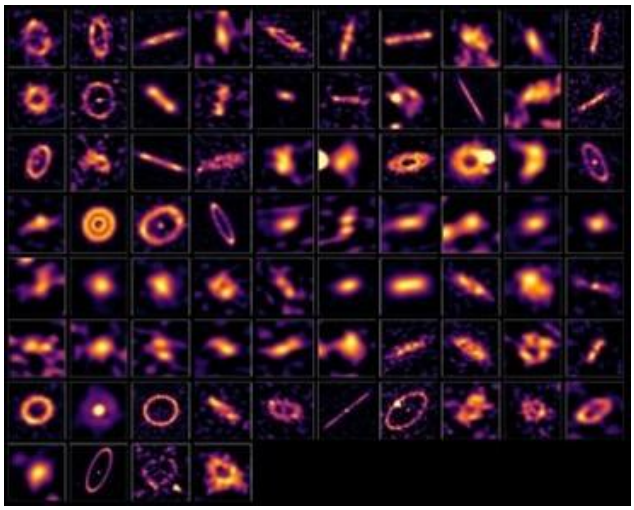
Small Exoplanet:

PSR J0337+1715 is a millisecond pulsar that is about 4,200 light-years from us. It is about 1.4 times the mass of the Sun and has a diameter of about 10 km. It rotates about 366 times a second. It is in a three-star (technically, none are stars) system. A 0.2-solar mass white dwarf orbits the pulsar once in 1.6 days. A 0.4 solar mass white the pulsar and white dwarf in about 327 days at a distance of about 1 AU. While modeling the motions of these three "dead" stars, the researchers noticed that there was an additional wobble that they could not, at first, explain. The arrival time of electromagnetic pulses from the pulsar can be measured to a few microseconds, so a wobble of less than a kilometer can be detected. What the researchers found was that the center of mass of the pulsar and the two white dwarfs was being affected by a fourth object, a distant exoplanet. What best fits all of the observations is an exoplanet (probably a closer to a dwarf exoplanet) with a mass less then that of the Moon with an orbital period of 8 years.

https://earthsky.org/space/smallest-exoplanet-pulsar-psr-j03371715/

Trillions and Trillions of Comets:

Astronomers have used two radio telescope arrays, ALMA (Atacama Large Millimeter Array, Chile) and SMA (Submillimeter Array, Mauna Kea, Hawaii) to image 74 "planetesimal belts." These are belts that range from 10s to 100s of AU from the stars that they orbit. While the telescopes cannot detect exocomets directly, what they can observe is thermal emission from pebble-sized particles made of ice and rock that are created by collisions among the large number of exocomets that reside in these belts. Some of the structure within these belts may mean that there are protoplanets forming in them.



(Image credit: ALMA (ESO/NAOJ/NRAO)/SMA/ L. Matrà et al.)

https://www.spacedaily.com/reports/Astrophysicists_reveal_structure_of_exocomet_belts_around_74_nearby_stars_999.html

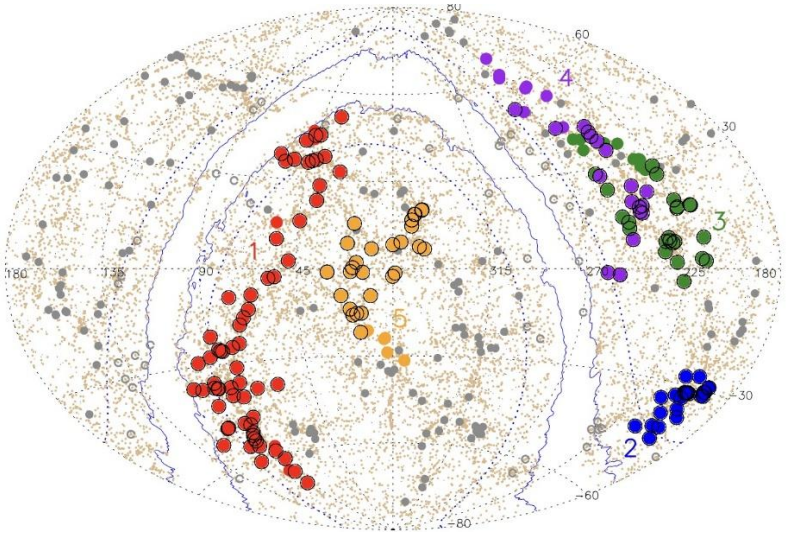
https://www.space.com/the-universe/comets/trillions-of-comets-discovered-orbiting-alien-planet-systems-image

Stars and Galaxies:

Galaxy Megastructures:

The distribution of galaxies in the Universe is not uniform. Astronomers are continually for clusters and superclusters of galaxies as they try to understand how the Universe formed and has evolved. "Astronomers have found the largest structure in the Universe so far, named Quipu after an Incan measuring system. It contains a shocking 200 quadrillion solar masses."

https://www.universetoday.com/170765/astronomers-find-the-largest-structure-in-the-universe-and-name-it-quipu/



This image shows five newly-discovered superstructures. Quipu (red) is the largest structure ever found in the Universe. The others are Shapley (blue), Serpens-Corona Borealis (green), Hercules (purple) and Sculptor-Pegasus (beige). Image Credit: Bohringer et al. 2025.

White Dwarf Orbiting Black Hole:

The galaxy 1ES 1927+654 is a galaxy 275 million light-years from us. Its supermassive black hole (about 1 million solar masses) emits at X-rays as well as in the visible and UV, so it is classified as an active galactic nucleus, a black hole with an accretion disk. Researchers have been monitoring the galaxy at UV, visible, and X-ray wavelengths since before 2017. Between 2017 and 2018, the nucleus first faded and then brightened to about 20 to 40 times its original brightness (I assume depending on the wavelength one is looking at) and then started to fade again. In 2022, it was seen to flash (a 10% increase in brightness for a short period of time), with a period of 18 minutes. Over the next two years, the time between flashes decreased from 18 minutes to just over 7 minutes. Astronomers have now modeled this with a close-orbiting white dwarf that is orbiting closer and closer to the event horizon (drag in the accretion disk?). In its elliptical orbit, as it gets closest to the black hole's event horizon each orbit, it loses material to the black hole, which gives the white dwarf a small boost. Eventually, this boost will be enough to keep the white dwarf from continuing to spiral into the black hole, moving it farther from total destruction.

https://www.sciencealert.com/strange-flashes-could-be-signs-of-closest-object-seen-near-a-black-hole