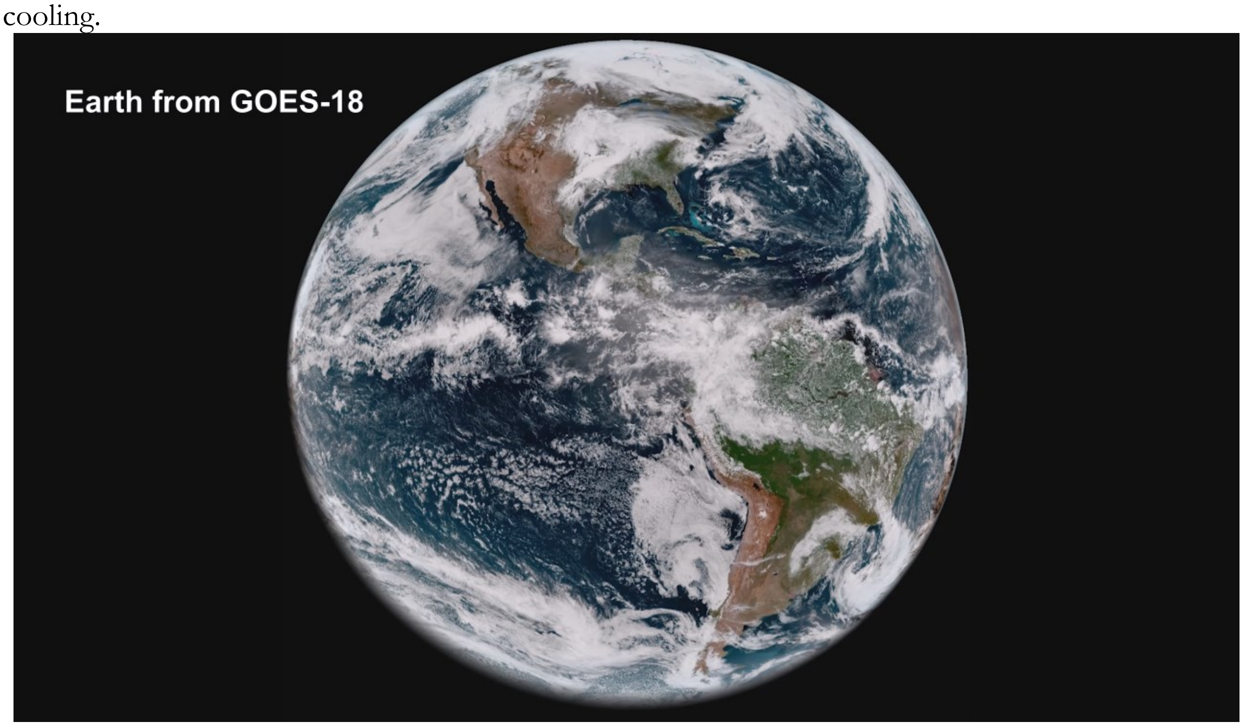
2022 Review

Introduction

In 2022, we finally saw the James Webb Space Telescope move into operational mode. Its early images and spectrometry are amazing. In this review, I have included a large number of them. It was also a very good year for the Hubble Space Telescope, and we have a number of those as well. We'll take our usual approach and start close to home and move out to the most distant objects ever studied. We have a new image of Earth. We crashed a satellite into an asteroid to change its orbit. Webb took a look at Mars, Jupiter and Neptune. We'll see a protostar; supernova; cosmic cliffs; pillars of creation; galaxy groups and more. We'll finish with a pair of overlapping galaxies that enable a deep study of interstellar dust. We'll end with the credits and links to the document with the text and pictures for this 2022 Review.

Earth from GEOS-18

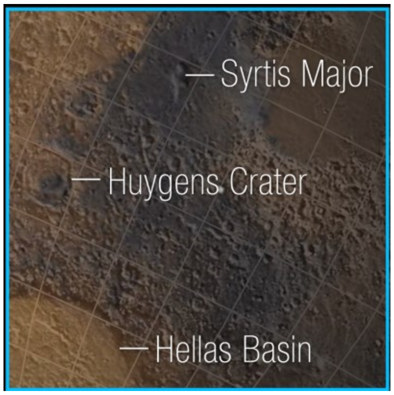
On May 11, 2022, the National Oceanic and Atmospheric Administration shared the first images of the Western Hemisphere from its Geostationary Operational Environmental Satellite designated GOES-18. Its Imager instrument captured this view of Earth. The satellite measures energy at different wavelengths along the electromagnetic spectrum to obtain information about the Earth's atmosphere, land, and oceans. Over time, this will help us determine if the Earth is warming or cooling.



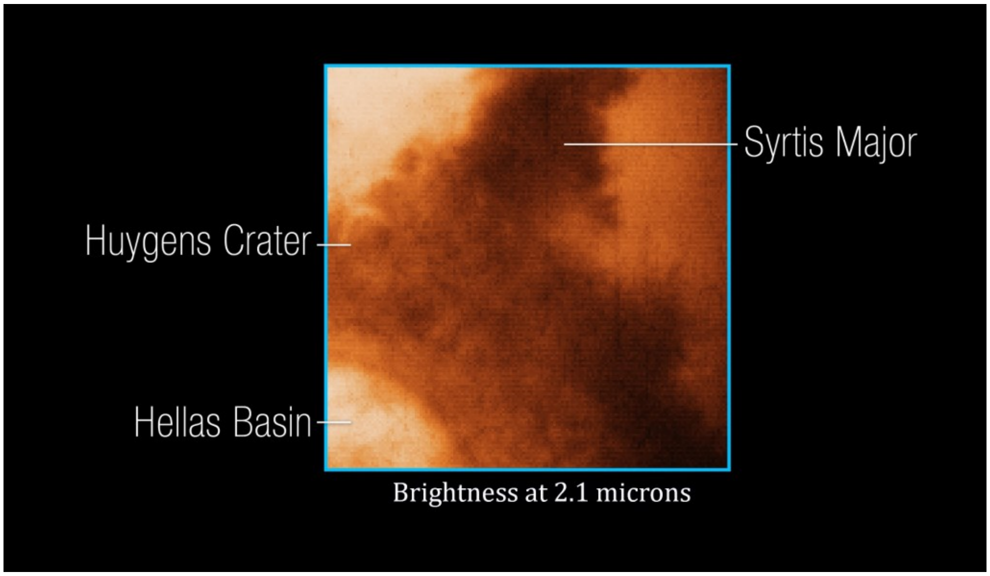
JWST Mars – Jupiter - Neptune

The James Webb Space Telescope took a look at three Solar System Planets in 2022 – Mars, Jupiter and Neptune. We'll start with Mars.

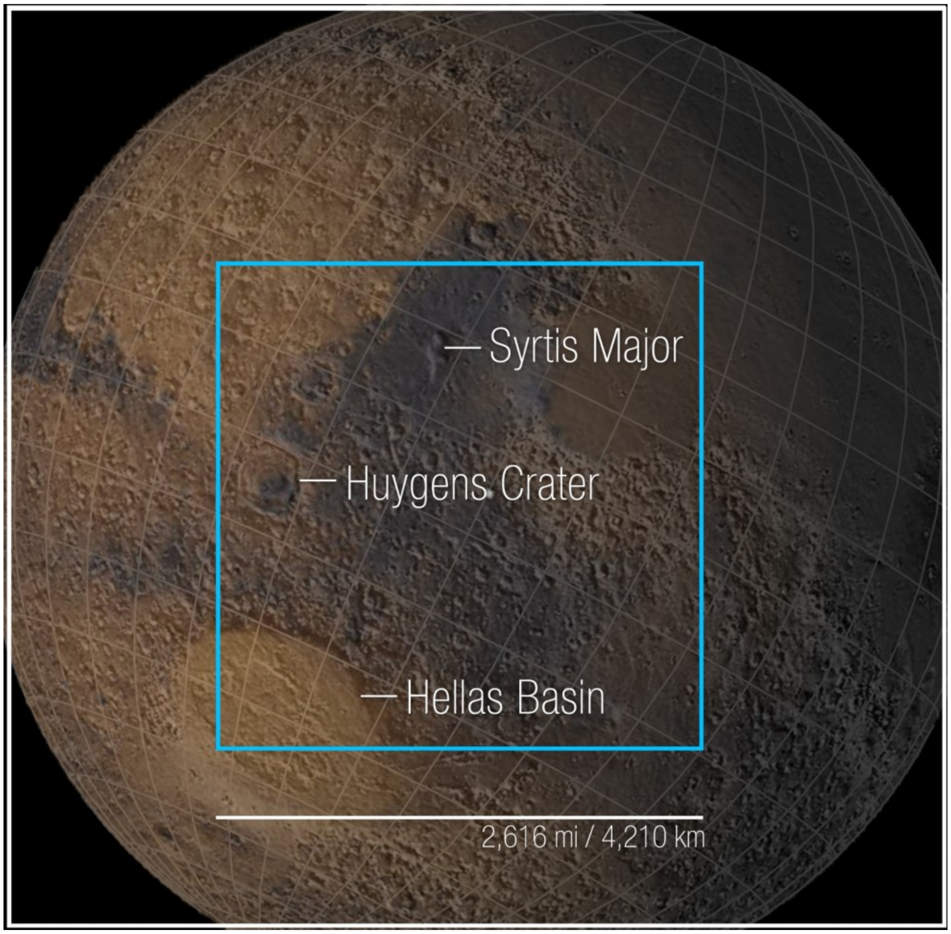
This image shows a small region of the planet's eastern hemisphere constructed via a surface reference map from NASA and the Mars Orbiter Laser Altimeter.



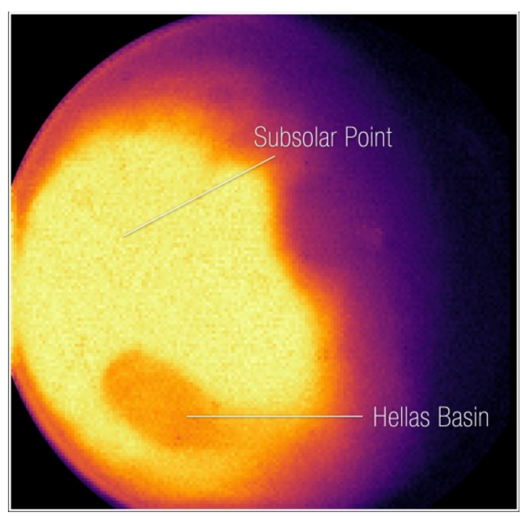
This is the same area at near-inferred light. At this wavelength, the image is dominated by reflected sunlight, and thus reveals surface details similar to those apparent in visible-light images. The rings of the Huygens Crater, the dark volcanic rock of Syrtis Major, and brightening in the Hellas Basin are all apparent in this image.



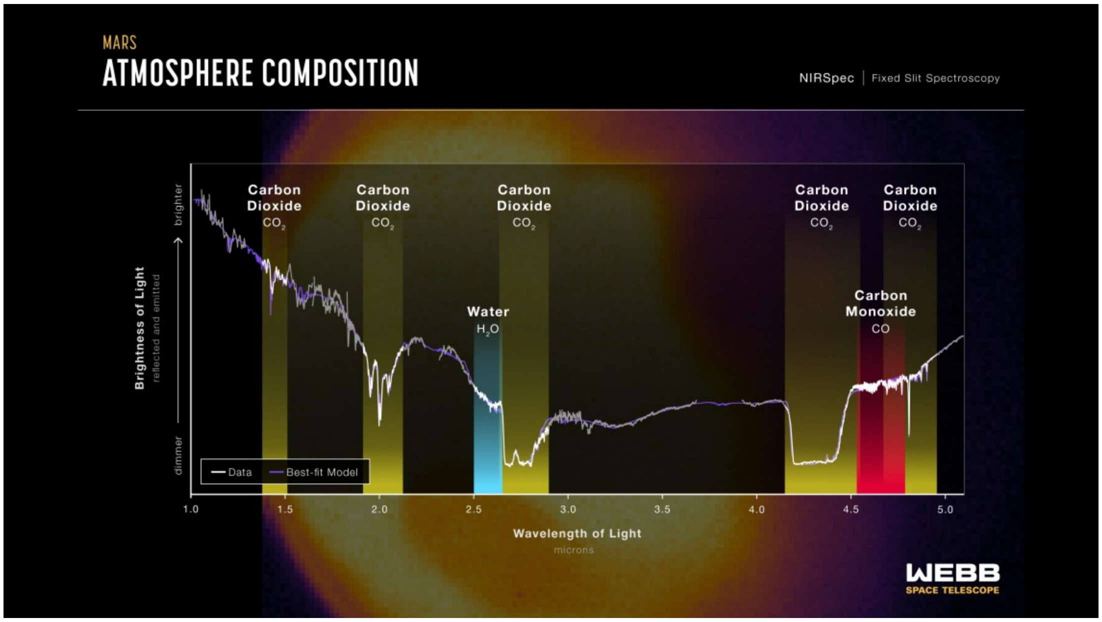
Here's a larger area.



At mid-inferred, the image shows light given off by the planet as it loses heat. The brightest region is where the Sun is nearly overhead. It decreases toward the polar regions. The northern region was experiencing winter when the data for this image was taken.



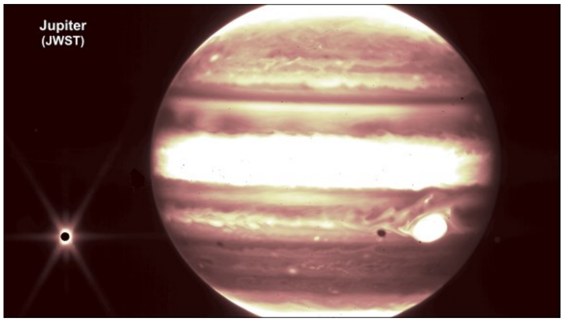
Webb's first near-infrared spectrum of Mars reveals chemical and physical properties of Mars' surface and atmosphere. Data are shown in white, with a best-fit model in purple. The spectrum is dominated by reflected sunlight. The spectral dips appear at specific wavelengths where light is absorbed by molecules in Mars' atmosphere, specifically carbon dioxide, carbon monoxide, and water. Other details reveal information about dust, clouds, and surface features.



JWST Jupiter

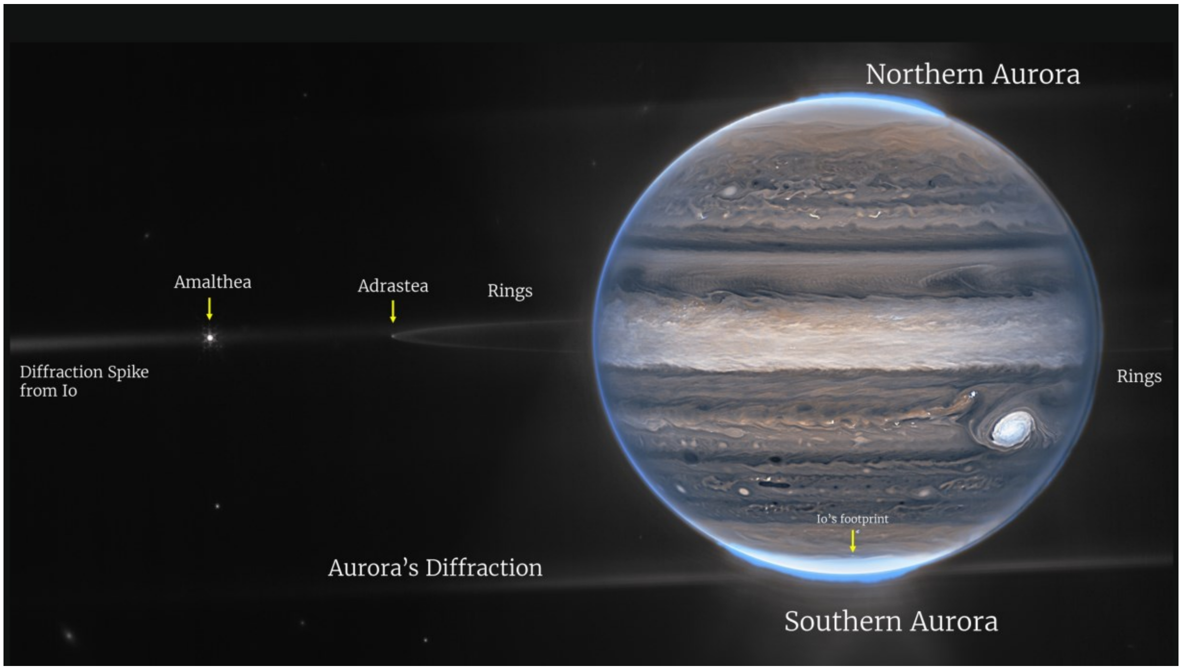
Here's Webb's near infrared view of Jupiter. It shows distinct bands that encircle the planet as well as the Great Red Spot.

Clearly visible to the left is Europa, a moon with a probable ocean below its thick icy crust, and the target of NASA's forthcoming Europa Clipper mission that will drill into the crust to reach the ocean. You can see Europa's shadow to the left of the Great Red Spot. The spot appears white in this view, as do other clouds, because they reflect a great deal of sunlight.



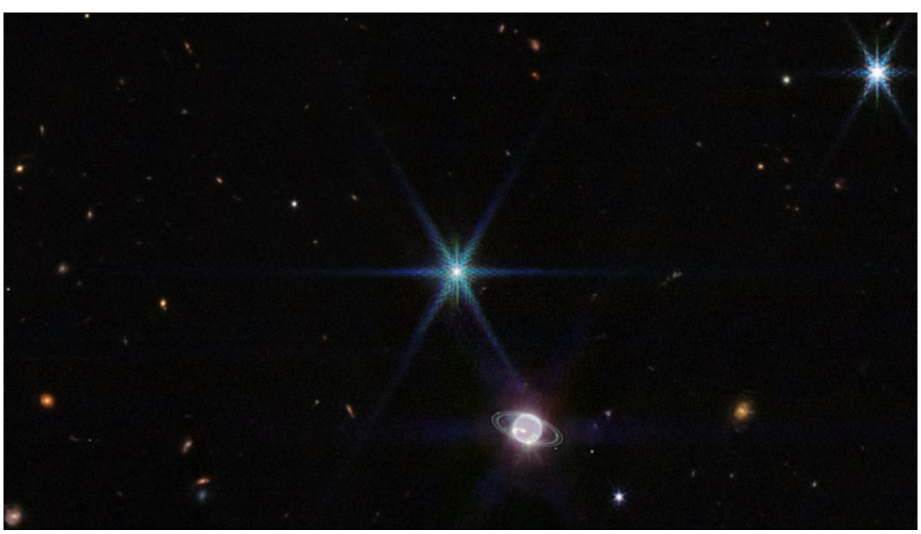
Here's another image produced by three specialized infrared filters that showcase details of the planet. Since infrared light is invisible to the human eye, the light has been mapped onto the visible spectrum. Generally, the longest wavelengths appear redder and the shortest wavelengths appear bluer. In this view, you can see auroras extending to high altitudes above both the northern and southern poles. Note the diffraction spike from the southern aurora. You can even see Jupiter's faint rings. They are a million times fainter than the planet. On the left we have a diffraction spike from

Jupiter's moon Io, and near the south pole we have Io's tiny shadow. The image also includes the two very small moons named Amalthea and Adrastea.

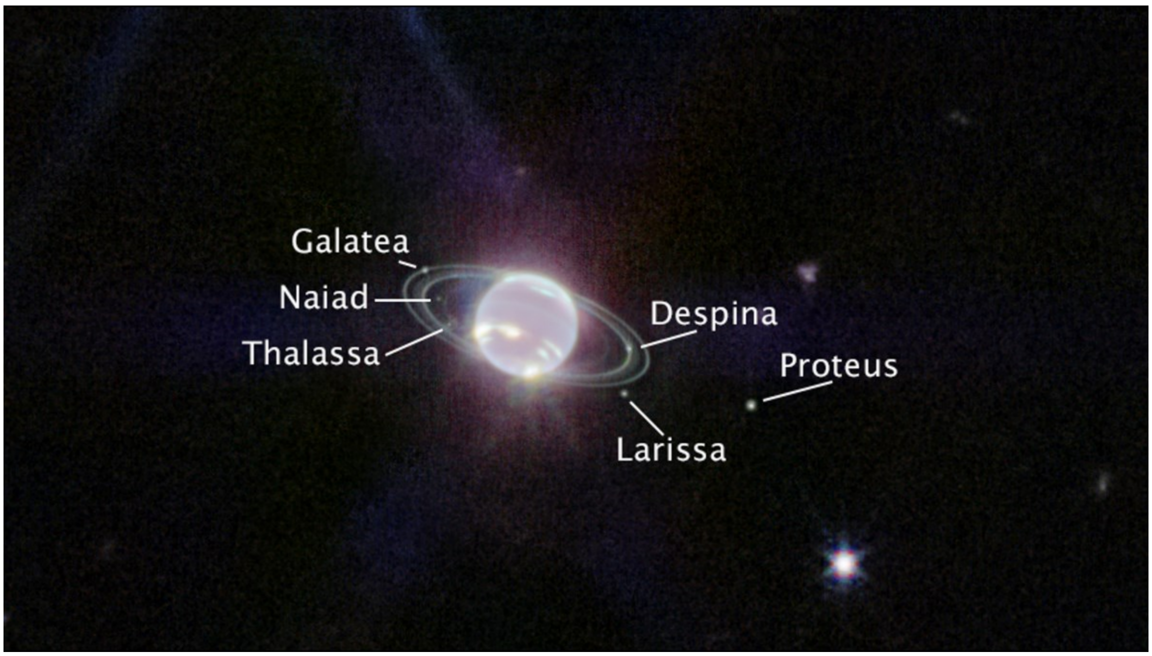


Neptune

Here we are zooming into an image of Neptune and Triton taken on July 12, 2022. Triton is the very bright point of light with the signature diffraction spikes seen in many of Webb's images. Covered in a frozen sheen of condensed nitrogen, Triton reflects an average of 70 percent of the sunlight that hits it. Triton orbits Neptune in an unusual backward (retrograde) orbit, leading astronomers to speculate that this moon was originally a Kuiper belt object that was gravitationally captured by Neptune. Additional Webb studies of Triton are planned in the coming year.



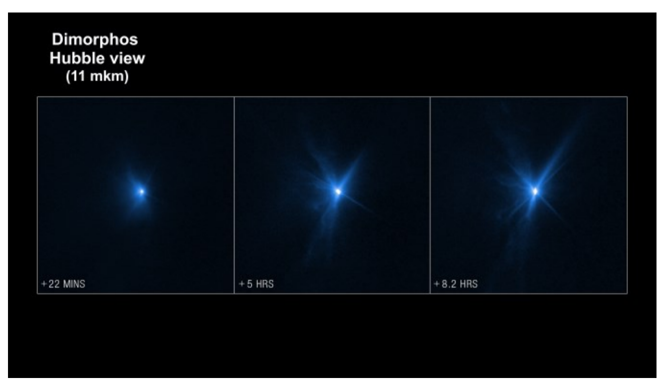
Here we see six of Neptune's 14 known moons. Webb's new image of Neptune also captures details of the planet's turbulent, windy atmosphere. Neptune itself is blue in visible light due to its gaseous methane content. But it is not blue in Webb's near infrared view. Here we have a clear view of Neptune's rings. [A previously-known vortex at the southern pole is evident in Webb's view, but for the first time Webb has revealed a continuous band of high-latitude clouds surrounding it.]



Didymos – 11 million km (6.8 million miles) at time of collision

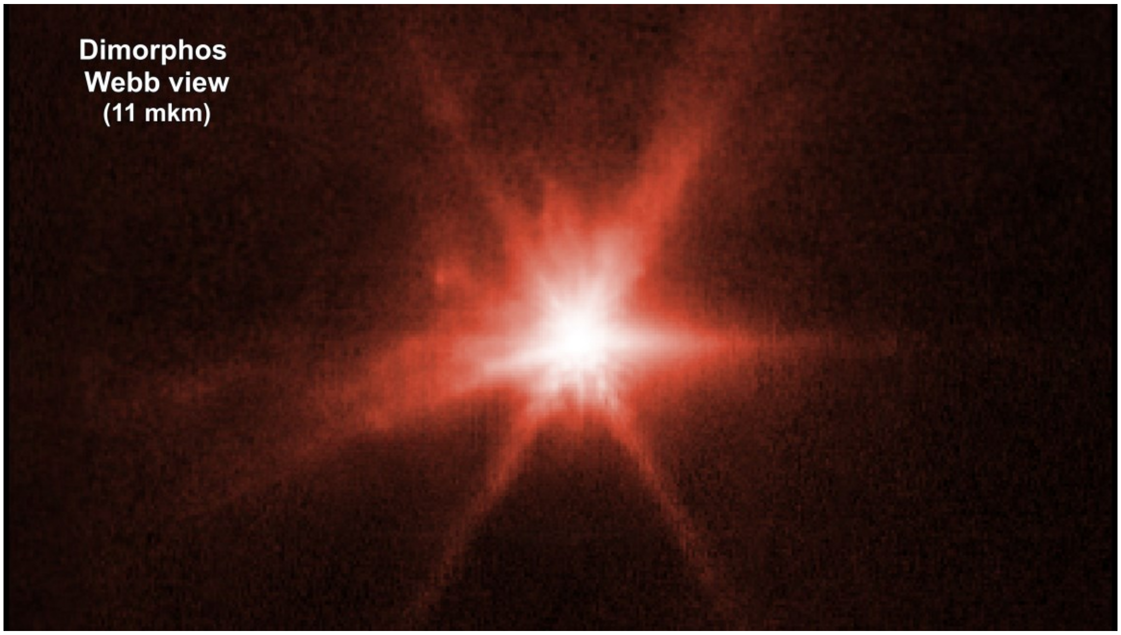
On September 26, 2022, NASA's Double Asteroid Redirection Test (DART for short) intentionally crashed into Dimorphos, the asteroid moonlet in the double-asteroid system of Didymos.

DART was traveling at nearly 24,000 km/hr (that's 15,000 miles per hour) at the point of impact. It was the world's first test of the kinetic impact mitigation technique, using a spacecraft to deflect an asteroid to modify the object's orbit. It's a test to increase our knowledge about diverting any asteroids heading our way in the future.

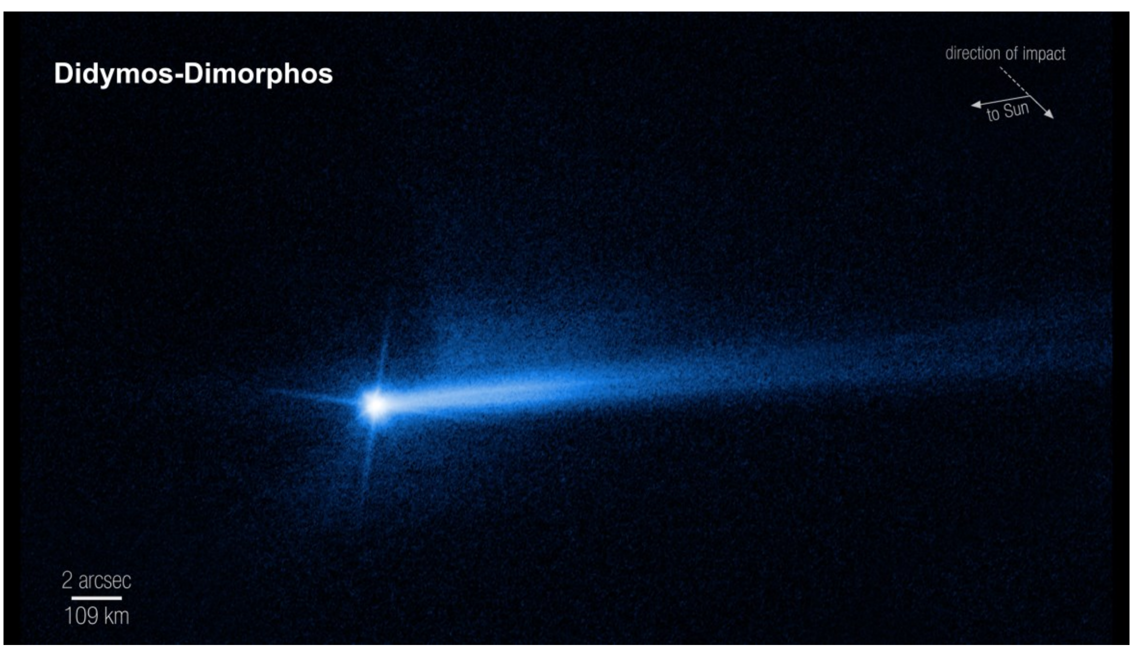


The James Webb and the Hubble Space Telescopes captured the event. Here's Hubble's images, taken 22 minutes, 5 hours, and 8.2 hours after impact. They show expanding plumes of ejecta that appear as rays stretching out from the body of the asteroid. Here's how it looked from Webb.

Combined Hubble/Webb analysis will allow scientists to gain knowledge about the nature of the surface of Dimorphos, how much material was ejected by the collision, how fast it was ejected, and the distribution of particle sizes in the expanding dust cloud.



Repeated observations from Hubble over the weeks following the impact show that the ejected material has expanded and faded in brightness. This was expected. What's surprising is that the tail fades into a double-tail. This behavior is common for comets and active asteroids, but was not expected for this asteroid system.



Protostar L1527 – 460 ly

Here we are zooming into a dark nebula LDN 1527. Dark nebulae like this one contain dense dust clouds that can collapse into stars. We covered how this works in the "How Old Are Stars" chapter of the "How Old Is It" video book. The visible light created by the forming stars cannot penetrate the dust clouds. But infrared light can.

Here's the James Webb infrared camera image of protostar L1527 inside this dark cloud nebula. The collapsing cloud triggers high temperatures at the dense center and forms a protoplanetary disk around the core. Here the disk is seen edge-on. The protostar itself is hidden from view within the 'neck' of this hourglass shape. Light from the protostar leaks out the right and left of this disc, illuminating cavities within the surrounding gas and dust. The distance from end to end is 19 thousand times the distance from the Earth to the Sun.

The region's most prevalent features, the blue and orange clouds, outline cavities created as material ejected by the protostar collides with the surrounding matter. The blue areas are where the dust is thinnest. In the thicker layers of dust, less blue light is able to escape, creating pockets of orange.

This protostar is a relatively young body at about 100,000 years old. Given its age and its brightness in far-infrared light, it is considered to be in the earliest stage of star formation. Its mass is somewhere between 20% and 40% of the mass of our Sun. It doesn't yet generate its own energy through the fusion of hydrogen. Protostars like these, which are still cocooned in a dark cloud of dust and gas, have a long way to go before they become fully-fledged stars.

Wolf-Rayet 140 – 5,000 ly

We covered Wolf-Rayet stars in our 2020 review with our look at WR 124. A Wolf-Rayet star is an O-type star, with at least 25 times more mass than our Sun, that is nearing the end of its hydrogen burning phase. Near the end, a Wolf-Rayet star generates powerful winds that push huge amounts of gas into space.

A new image from Webb reveals a remarkable binary star system with one of them being a Wolf-Rayet star known as Wolf-Rayet 140. It shows at least 17 concentric dust rings emanating from the pair of stars. Actually, the star system forms shells of dust, not rings. But what we see is the light reflected at the edges from our point of view.

Each ring was created when the two stars came close together and their stellar winds collided, compressing the gas and forming dust. The stars' orbits bring them together about once every eight years. We're looking at over a century of dust production from this system.

These stars are great sources for galactic dust. The most common element found in stars, hydrogen, can't form dust on its own. But Wolf-Rayet stars eject more complex elements like carbon. The heavy elements in the wind cool as they travel into space and are then compressed where the winds from both stars collide.

We'll cover 'dust', a critically important component of star and planet formation, in depth later in this 2022 Review when we get to the VV191 galaxy pair.

Pillars of Creation   6,500 ly

Here's a 1995 Hubble view of the Eagle Nebula, a 20 light years wide star forming region 6,500 ly away. Inside the Eagle, there are a number of spectacular pillar-like formations. These dark structures are columns of cool interstellar hydrogen gas and dust where new stars form.

Here we are homing in on a particularly interesting set appropriately named "Pillars of Creation". This is the Hubble view from 2015. The tallest pillar is about 4 light-years long from base to tip. The visible light from stars inside the brown clouds cannot be seen because of the thick dust. The blue background comes from less dense clouds which are obscuring many of the stars in the overall region.

Here's Webb's near infrared view taken in 2022. At infrared wavelengths, star light from the inside can penetrate pillar dust enable us to see the stars inside and behind the dust. When knots with sufficient mass form, they begin to collapse under their own gravity, slowly heat up, and eventually form new stars. The wavy structures at the surface of some pillars are the ejected material from these stars. Note the crimson glow near the peaks of the second and third pillars. This comes from energetic hydrogen molecules streaming from new stars. These young stars are estimated to be only a few hundred thousand years old.

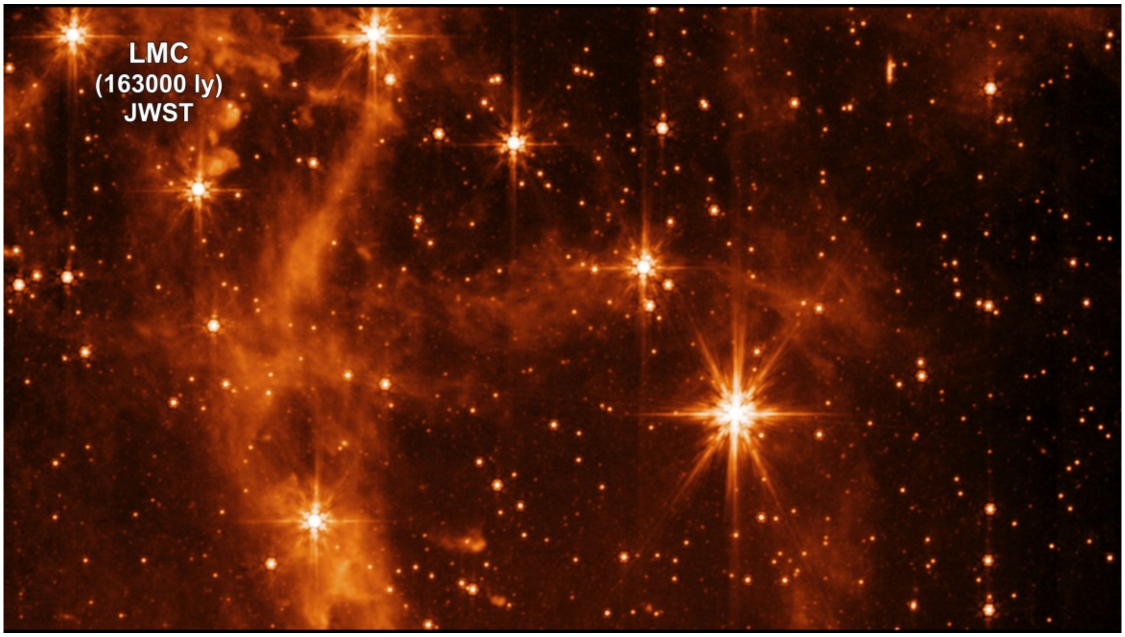
Webb's new view of the Pillars of Creation will help researchers revamp models of star formation by identifying far more precise star populations, along with the quantities of gas and dust in the region. With is information, they will begin to build a clearer understanding of how stars form over millions of years.

James Webb 1st Release collage

Here's a collage of James Webb's first release images. For a deeper look, see the "James Webb 1st Release" video https://youtu.be/ICrvQtOMlcc.

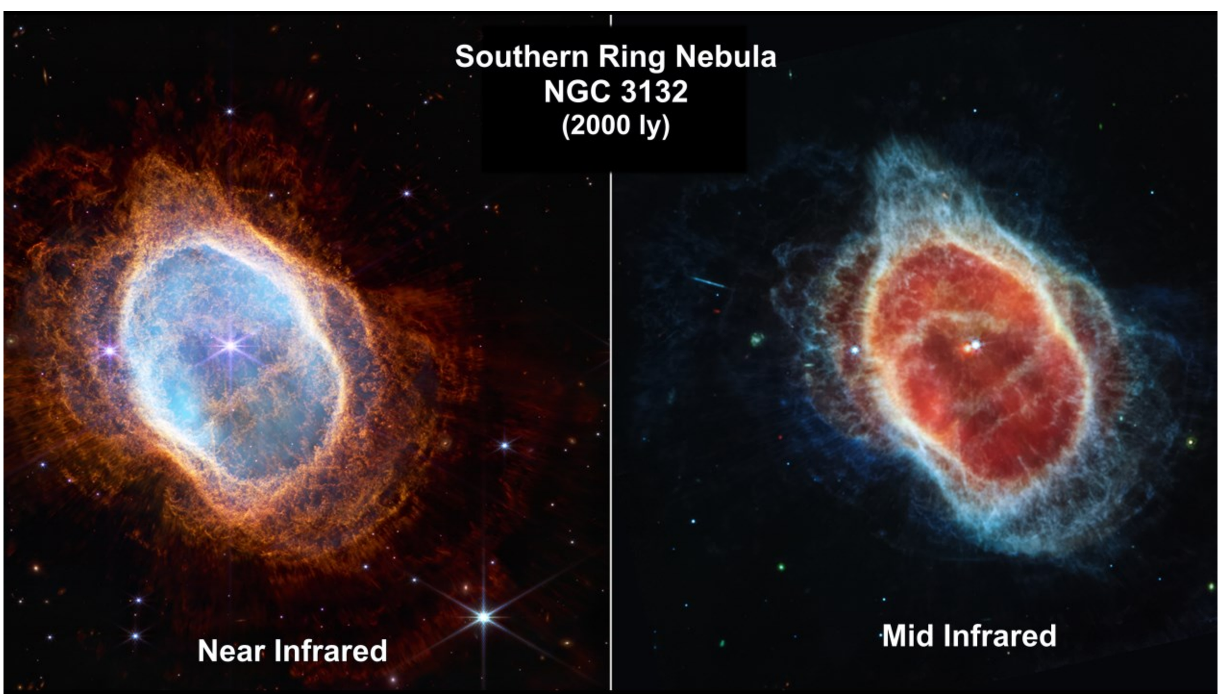
LMG – Spitzer vs Webb 163,000 ly

Here's a Spitzer infrared space telescope image of some stars in the Large Magellanic Cloud dwarf galaxy orbiting the Milky Way. Now we're morphing this into the image taken by Webb's Mid-Infrared Instrument during a test. As you can see, Webb, with its significantly larger primary mirror and improved detectors, allows us to see the infrared sky with significantly improved clarity, enabling even more discoveries.



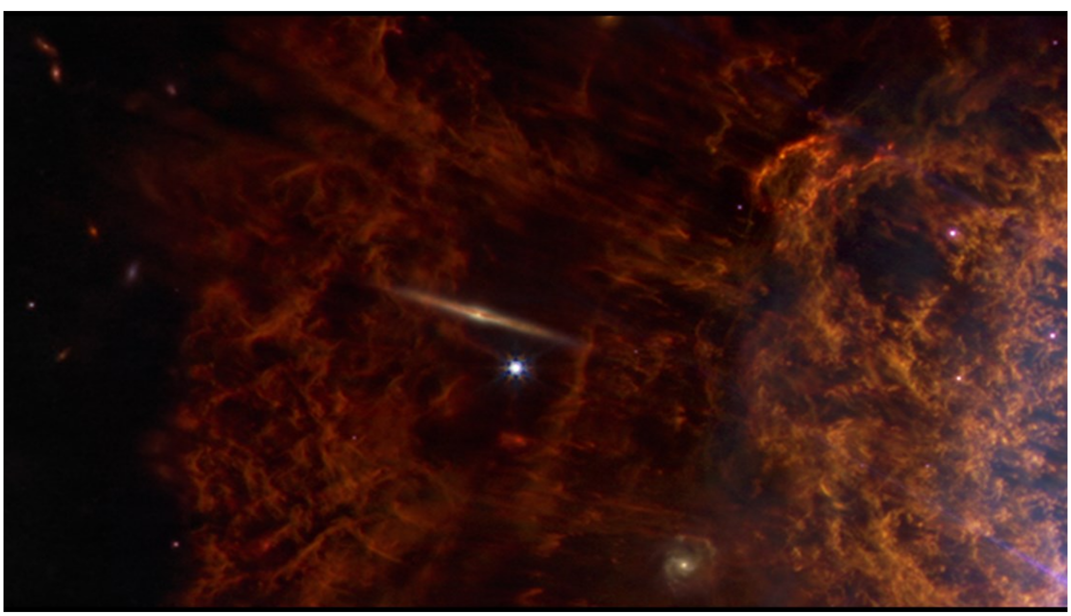
Southern Ring Nebula, NGC 3132 – 2,000 ly

Here we are zooming into the Southern Ring Planetary Nebula 2,000 light years away. The Southern Ring has a binary star system at its center. One is a white dwarf. The brighter star in both images has not yet run out of fuel. It closely orbits the dimmer white dwarf, impacting the distribution of the ejected material.



Pairing Webb's infrared images with existing data from the European Space Agency's Gaia observatory, researchers were able to precisely pinpoint the mass of the central star before it created the nebula. Their calculations show the central star was nearly three times the mass of the Sun before it ejected its layers of gas and dust. After those ejections, it measured only 60 percent of the mass of the Sun.

This is not only a crisp image of a planetary nebula – it also shows us objects in the vast distances of space behind it. Note the bright angled line at the upper left. It's a faraway galaxy seen edge-on.

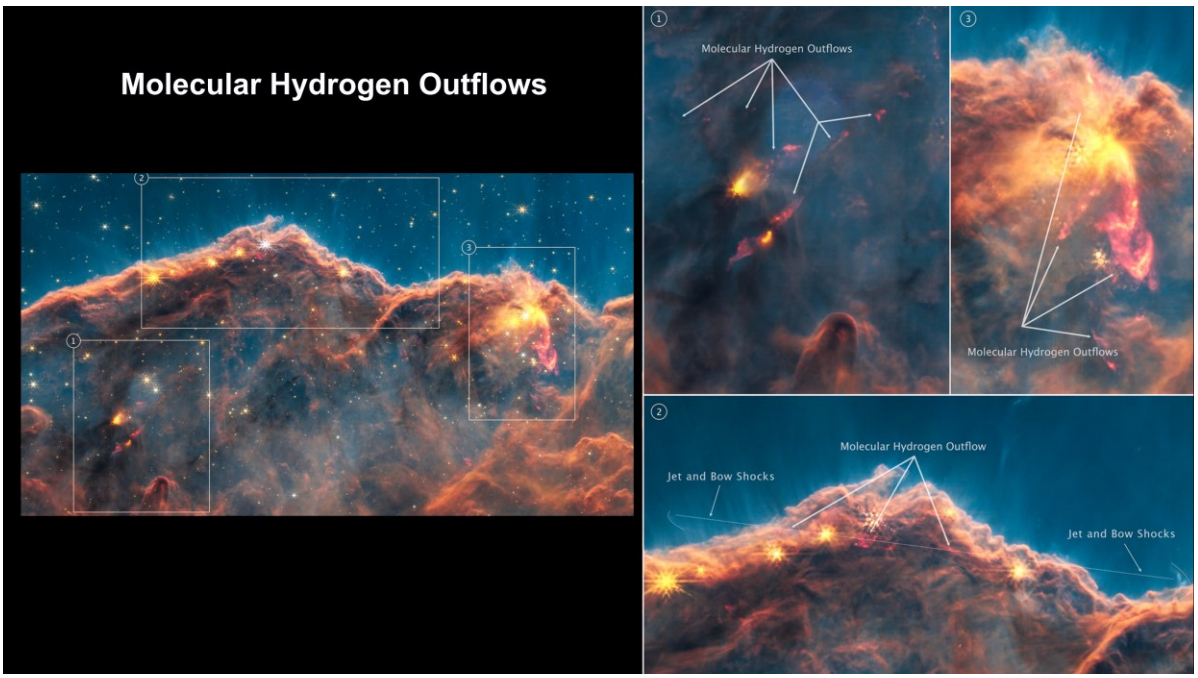


Cosmic Cliffs NGC 3324 – 7,600 light years

Here's Hubble's view of NGC 3324 called the 'Cosmic Cliffs' located at the northwest corner of the Carina Nebula.

As we transition to the Webb near-infrared image, we begin to see hundreds of previously hidden stars of many sizes.

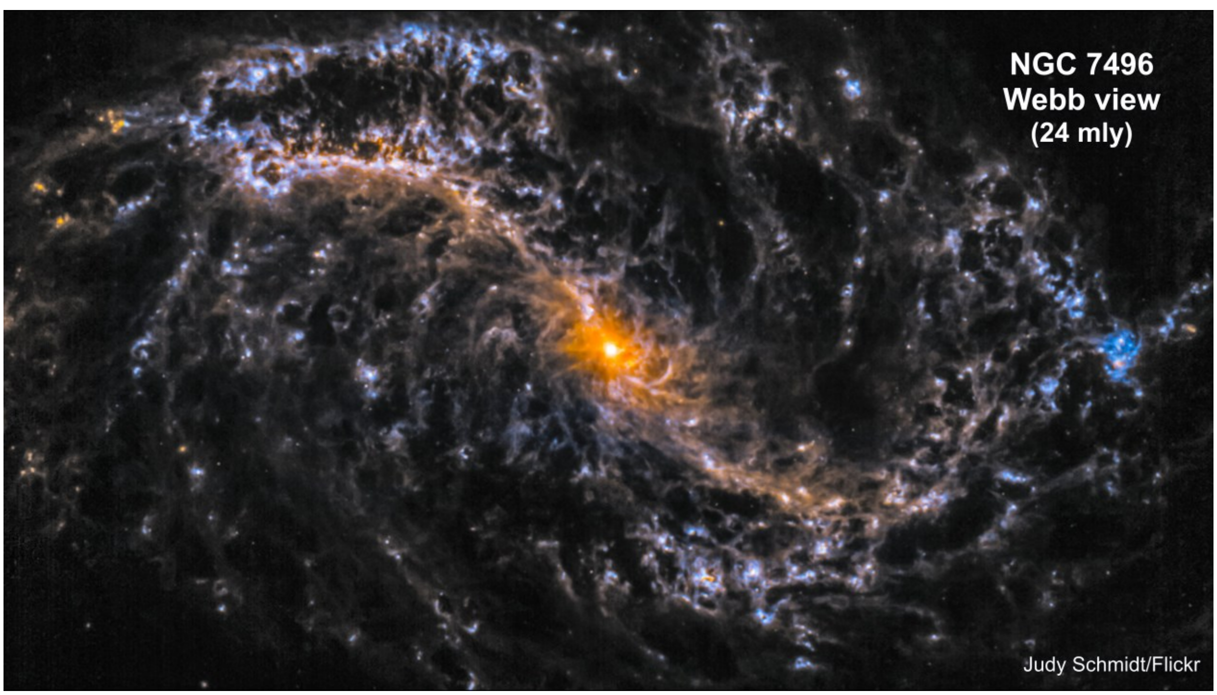
These insets highlight three regions of the Cosmic Cliffs with particularly active molecular hydrogen outflows. Molecular hydrogen is a vital ingredient for making new stars and an excellent tracer of the early stages of their formation. As young stars gather material from the gas and dust that surround them, most also eject a fraction of that material back out again from their polar regions in jets and outflows. What we're seeing here is the molecular hydrogen getting swept up and excited by these jets.



NGC 7496 - 24 mly

This image from Hubble released in May 2022 shows the barred spiral galaxy NGC 7496, which lies over 24 million light-years away.

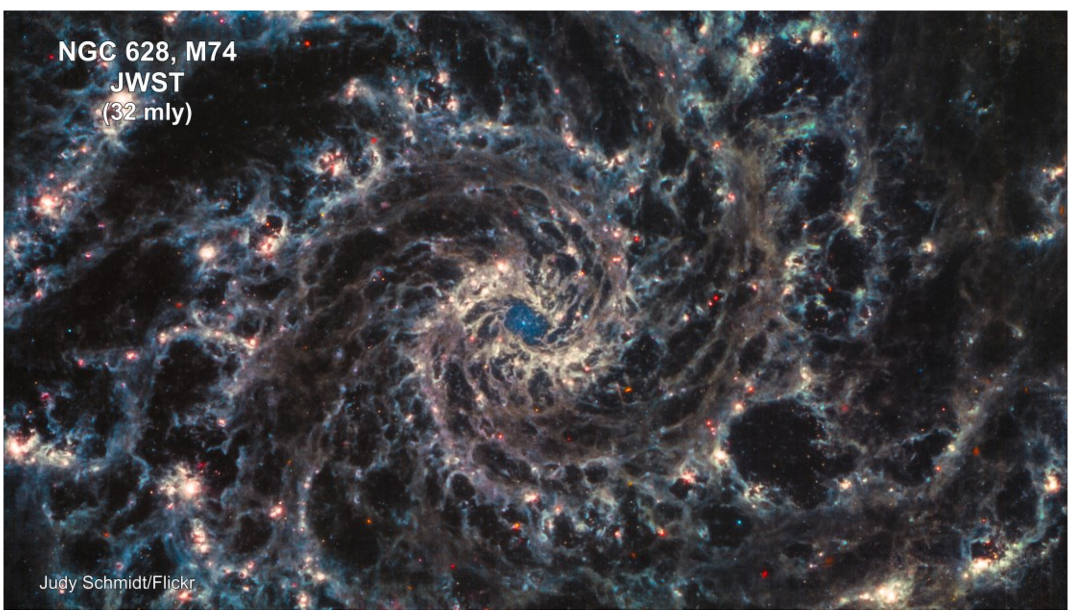
As we transition to the Webb view, we can see that it still picks up the glowing gas, but also shows much more detail.



Phantom Galaxy M74, NGC 628 – 32 mly

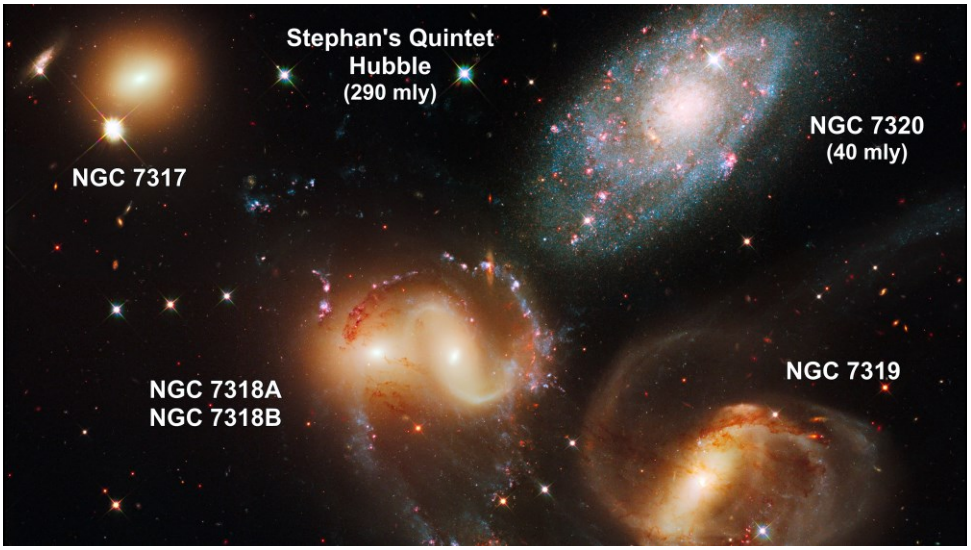
Here we are zooming into a Hubble image of M74, (also known as the Phantom Galaxy). It's a stunning example of a "grand-design" spiral galaxy that is viewed by Earth observers nearly face-on.

Here we see the Webb view. The galaxy's spiral arms are rich with star-forming gas seeded with young and emerging stars.



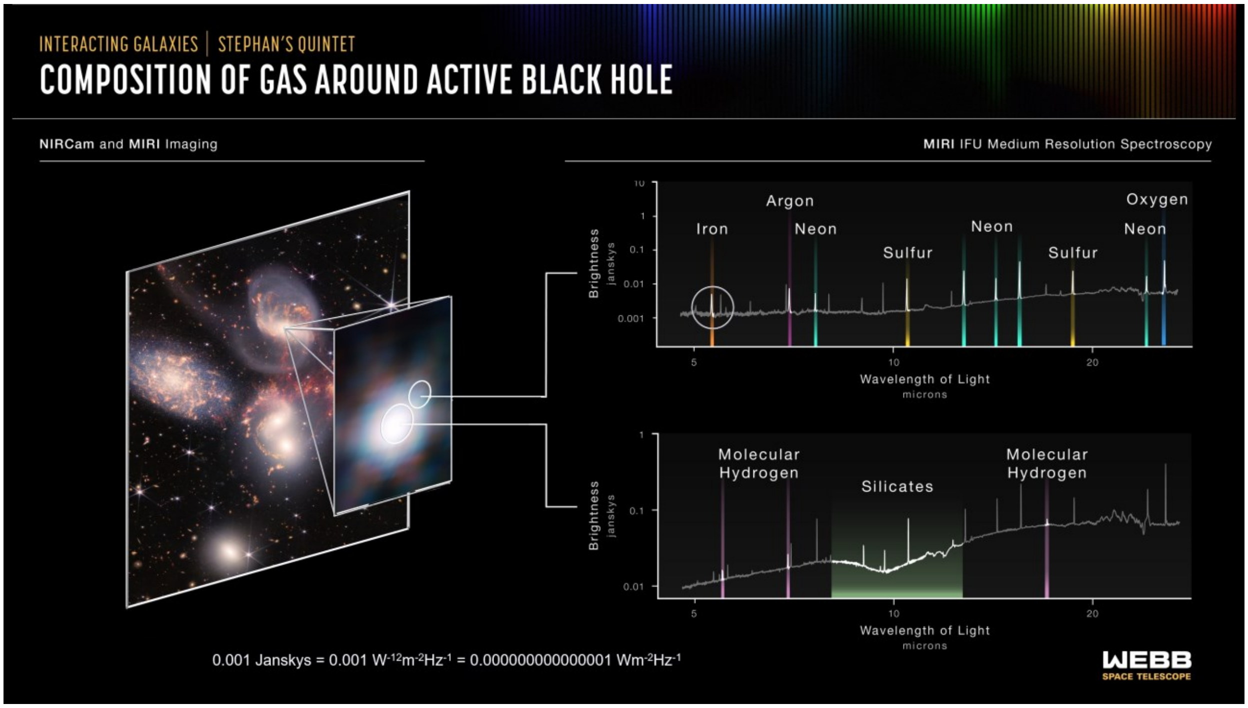
Stephan's Quintet – 290 mly

Here we are zooming into a Hubble image of the Stephan's Quintet.



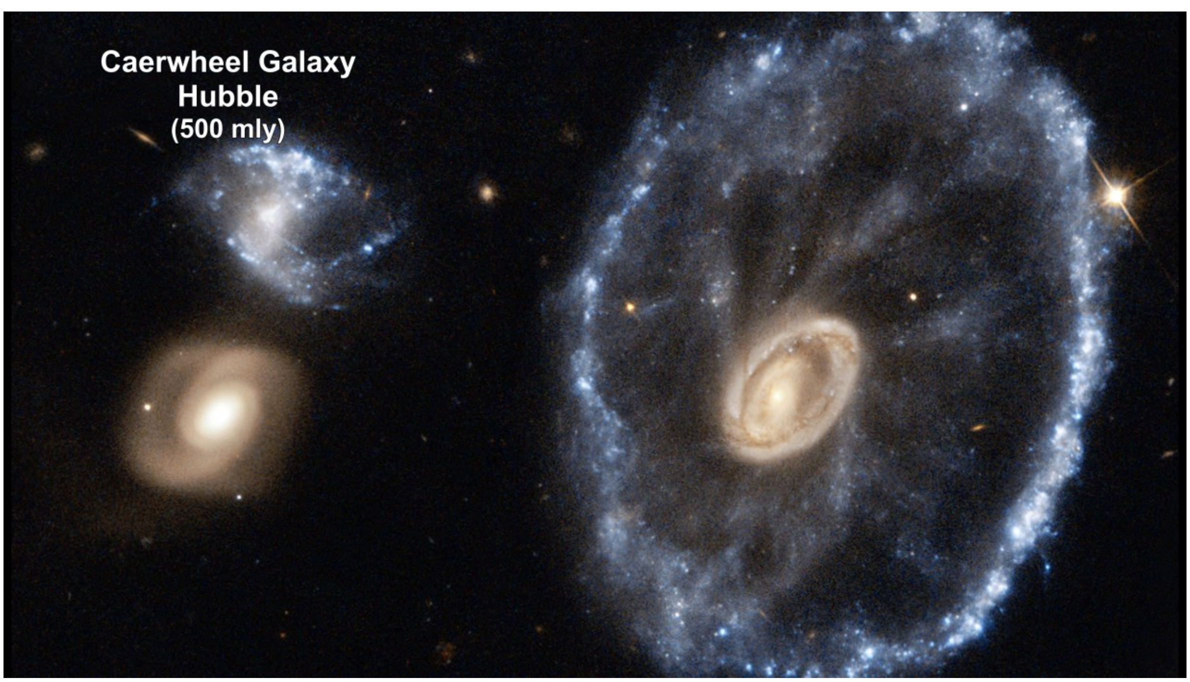
Here's the Webb image. At the center of NGC 7319, there is a supermassive black hole around which the galaxy is rotating.

This one is 'active' meaning significant quantities of material are falling into it. The spectrum, from the black hole's outflow, shows a region filled with hot, ionized gases, including iron, argon, neon, sulphur and oxygen as denoted by the peaks at given wavelengths.



Cartwheel Galaxy – 500 mly

Here's a Hubble view of the Cartwheel Galaxy a ring galaxy around 500 million light-years away.



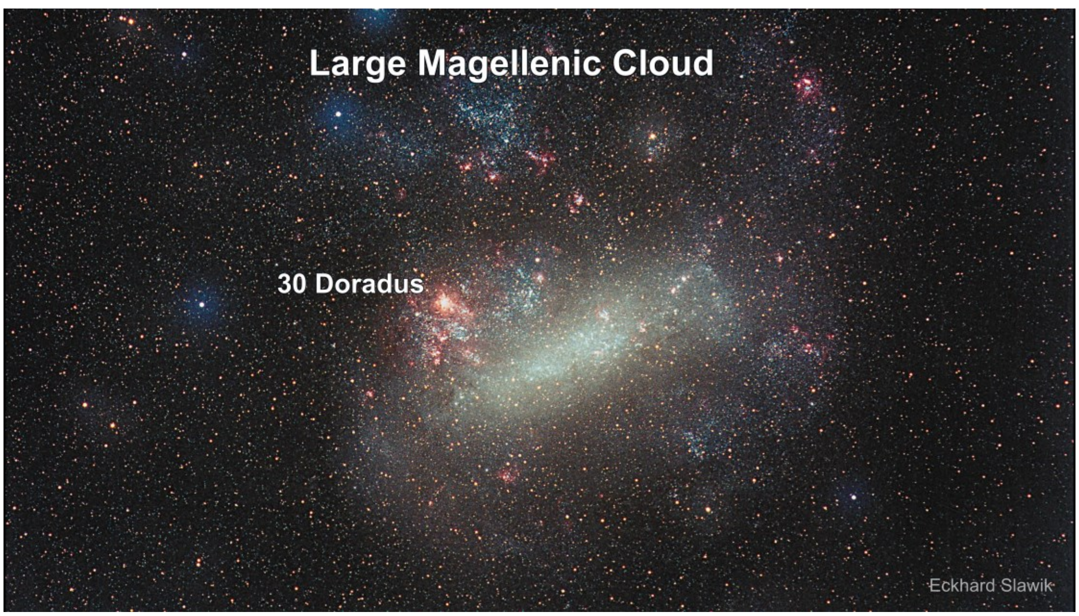
Here's Webb's combined image from both the near-infrared and mid-infrared cameras. The galaxy has two rings: a bright inner ring and a surrounding, colorful outer ring. These two rings have been expanding outwards from the center of the collision for around 440 million years.

Here's a look at the galaxy from just the mid-infrared camera.

Tarantula Nebula – 161,000 ly

30 Doradus

Here's a stellar region called 30 Doradus in the Large Magellanic Cloud, a dwarf galaxy orbiting the Milky Way. It contains millions of young stars including the most massive stars ever seen, weighing more than 100 times the mass of our Sun. No known star-forming region in our galaxy is as large or as prolific as 30 Doradus.

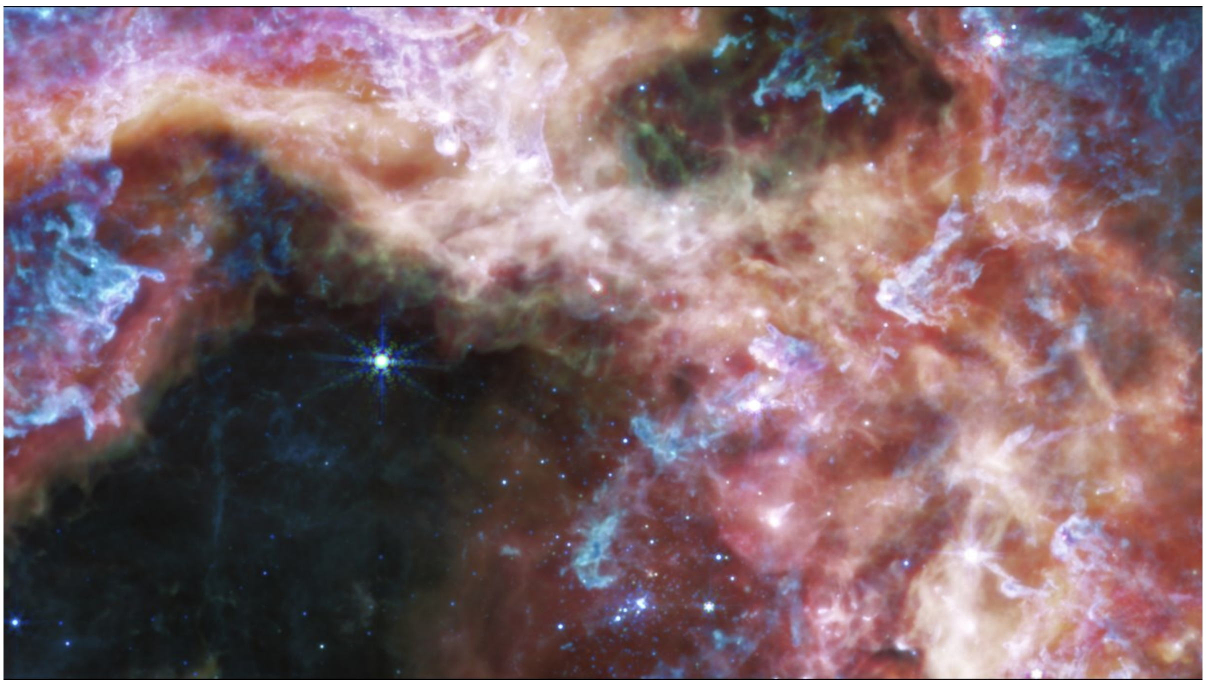


Tarantula Nebula

Here, with Hubble's closer look, we see the Tarantula Nebula. Early astronomers gave it this nickname because its glowing filaments resembled spider legs.

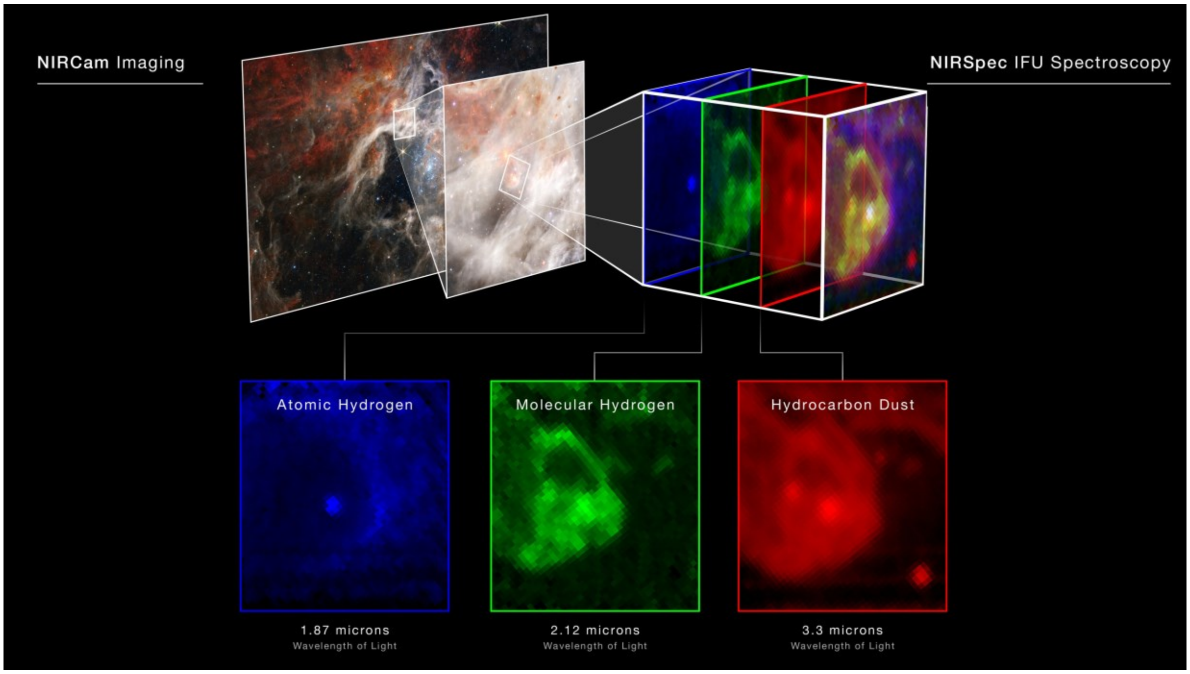
Here's the way it looks with the JWST. The nebula's cavity centered in the image has been hollowed out by blistering radiation from a cluster of pale blue massive young stars. Only the densest surrounding areas of the nebula resist erosion by these stars' powerful stellar winds. Scattered among them are still-embedded stars. They appear red because they have not yet pushed out the dust they are forming in. Farther from the core region of hot young stars, cooler gas takes on a rust color. The gas in this area of the nebula is rich with complex hydrocarbons that will one-day form new stars.

Here we're transitioning to the mid infrared view. Hot stars fade, and the cooler gas and dust glow. Abundant hydrocarbons light up the surfaces of the dust clouds, shown in blue and purple. Much of the nebula takes on a more ghostly, diffuse appearance because mid-infrared light is able to show more of what is happening deeper inside the clouds. Still-embedded protostars pop into view within their dusty cocoons, including a bright group at the very top edge of the image, left of center. Other areas appear dark, like in the lower-right corner of the image. This indicates the densest areas of dust in the nebula.



Webb's Near-Infrared Spectrograph was used to examine an interesting region of the nebula that looked like a young star blowing out a bubble in its surrounding gas.

The spectrograph found the signature of atomic hydrogen (shown in blue) in the star itself but not immediately surrounding it. The spectra show that, space outside the "bubble," is actually "filled" with molecular hydrogen (green) and complex hydrocarbons (red). This indicates that the bubble is actually the top of a dense pillar of dust and gas that is being blasted by radiation from the cluster of massive young stars to its lower right. This harsh stellar wind is breaking apart molecules outside the pillar, but inside they are preserved. This star inside is still too young to be clearing out its surroundings with its own stellar wind. Without Webb's resolution at infrared wavelengths, the discovery of this star formation in action would not have been possible.

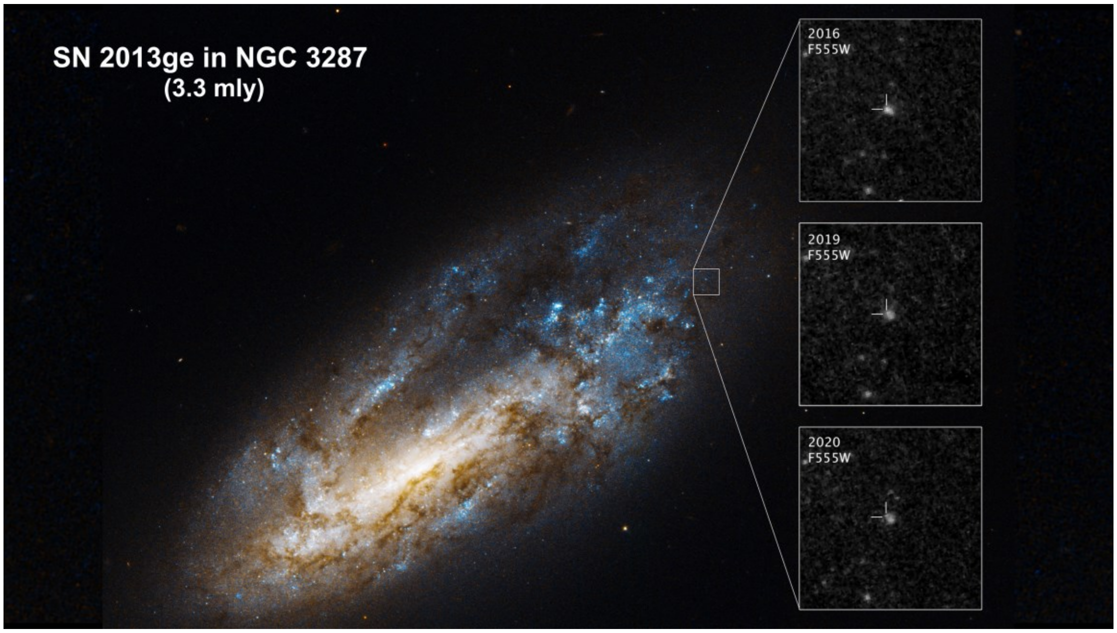


One of the reasons the Tarantula Nebula is interesting to astronomers is that the nebula has a similar type of chemical composition as the gigantic star-forming regions observed at an earlier epoch when the cosmos was only a few billion years old and star formation was at its peak. Webb will provide astronomers the opportunity to compare and contrast observations of star formation in the Tarantula Nebula with the telescope's deep observations of distant galaxies from the actual era of peak star formation.

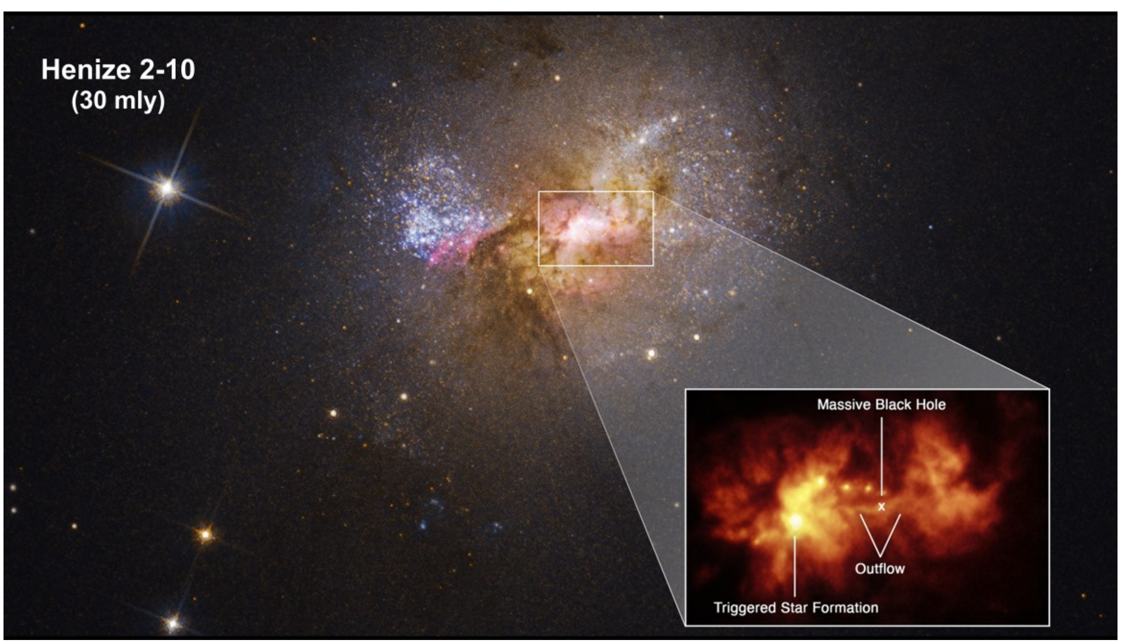
Supernova 2013ge in NGC 3287 – 3.3 mly

A research team used Hubble to study the region of supernova (SN) 2013ge in the NGC 3287 galaxy 3.3 mly away. They saw the light of the supernova fading over time from 2016 to 2020—but another nearby source of ultraviolet light at the same position maintained its brightness. This underlying source of ultraviolet emission is thought to be a surviving binary companion to SN 2013ge.

The discovery is a first for a particular type of supernova—one in which a star is stripped of its entire outer gas envelope before exploding. Normally Hydrogen is found in the outermost layer of a star. When no hydrogen is detected in the aftermath of the supernova, that means it was stripped away before the explosion occurred. The cause of the hydrogen loss had been a mystery until these new Hubble observations provided the evidence for the theory that an unseen companion star siphoned off the gas envelope from its partner star before it went supernova.



Henize 2-10 Black Hole – 30 mly
Here we have the black hole at the center of the dwarf galaxy Henize 2-10, 30 million light-years away. This galaxy contains only one-tenth the number of stars found in our Milky Way. What's unique here is that this black hole is located near a star-forming region with an outflow of gas moving at about 1.6 million km per hour (or 1 million miles per hour) towards the region. This flow is imbedded with a large number of new stars. This is the opposite effect of what's seen in larger galaxies, with larger black holes, where material flowing away and into surrounding gas, heats the gas to the point where new star formation is not possible.



Galaxy Group Arp143 – 191 mly

Here we see two interacting galaxies collectively called Arp 143, 191 mly away. Astronomers suggest that the galaxies passed through each other, igniting the uniquely shaped star-formation in NGC 2445, where there are thousands of new stars. Galaxy NGC 2444 is pulling gas from NGC 2445. This is forming the unusual triangle shape. Stars no older than 1 million to 2 million years are forming closer to the center of NGC 2445. Hubble reveals some individual stars. They are the brightest and most massive in the galaxy. Most of the brilliant blue clumps are groupings of stars. The pink blobs are giant, young star clusters still enshrouded in dust and gas.

Hickson Compact Group 40 – 300 mly

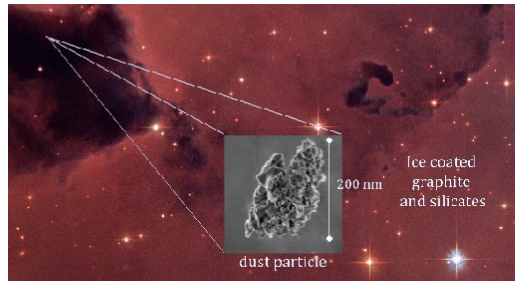
Here's a Hubble look at an unusual close-knit collection of five galaxies, called the Hickson Compact Group 40. It includes three spiral-shaped galaxies, an elliptical galaxy and a lenticular (lens-like) galaxy. The whole group could fit within a region of space that is less than twice the diameter of our Milky Way's stellar disc. At current closing velocities, it is calculated that these galaxies will collide and merge to form a single giant elliptical galaxy, in about 1 billion years.

Though over 100 such compact galaxy groups have been catalogued in sky surveys going back several decades, the Hickson Compact Group 40 is one of the most densely packed. Observations suggest that such tight groups may have been more abundant in the early Universe and provided fuel for powering quasars.

Dust in VV191b – 695 mly

Dust –Interstellar dust in our galaxy is critically important for calculating intrinsic star luminosity to get its distance. Dust is also what enables star formation by acting as a catalyst for producing molecular gas. And dust is the only galaxy content that we can use to accurately calculate the galaxy's rotation curve - that's star velocities as at different distances from the galactic center. The Milky Way's rotation curve is one of the reasons scientists proposed the existence of dark matter.

The dust is made of thin, highly flattened flakes of graphite and silicate (that's carbon and rock-like minerals) coated with water ice. Each dust flake is roughly the size of the wavelength of blue light or smaller. The dust is probably formed in the cool outer layers of red giant stars and dispersed in the red giant winds and planetary nebulae.



The dust absorbs and scatters the light that passes through it with blue being scattered more than red. The further the light has to travel, the more of this dust it encounters, and the dimmer and redder it gets. Astronomers call this 'extinction'. Due to this extinction effect, stars in the galactic disc can lose half their luminosity every 3,000 light years.

It wasn't until we could measure the amount of dust between us and the stars that we could accurately use standard candles to determine how far away they were. It was the astronomer Robert Trumpler who first quantified this phenomenon in the 1930s. In fact, it has been said that the increased understanding of dust marked the beginning of modern astronomy.

Here's an image of two overlapping galaxies named VV191 discovered years ago by the Galaxy Zoo project that has attracted over 400,000 volunteers, who have performed over 11 million galaxy classification tasks since it started in 2007. Now, Hubble and Webb have teamed up for a study of the galaxy pair to better understand the spiral galaxy's dust. The galaxy pair is particularly useful for dust studies because the background elliptical has its brightest region right behind the edge of the outermost dust lanes in the spiral. In such a configuration, the properties of the dust in the foreground spiral galaxy can be measured to very low dust densities.

[One of the issues with this galaxy alignment is that they could be close enough to each other to generate gravitational interference that would impact dust analysis. For some as yet unknown reason, redshift measurements have been inconsistent. One survey has the elliptical at z = 0.051 (695 mly) and the spiral at z = 0.037 (516 mly). That would put one 179 mly between them – too far to be interacting. Other surveys have them much closer together. But, thanks to Webb's detail, we see that the outer spiral arms in the foreground galaxy are completely undisturbed by the background galaxy. So, the assumption is that they are not gravitationally 'interacting'.]

A wide range of electromagnetic wavelengths were used to construct the image with ultraviolet and visible light from Hubble and near-inferred light from Webb. This light from the elliptical galaxy [VV191a] suffers extinction as it passes through the dust in the spiral galaxy [VV191b]. Astronomers map the extinction and determine its dependence on the wavelength.

Here are the major steps in the dust analysis:

1. First, the original image is used to determine the observe light intensity.

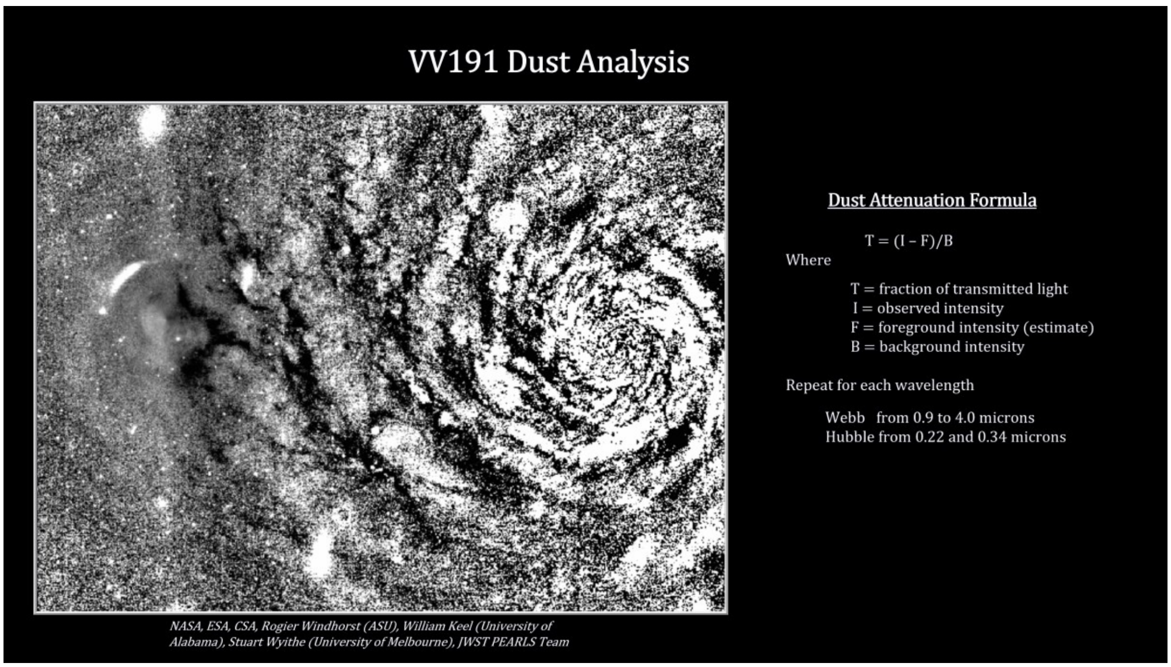
2. Next, a smooth and symmetric model for the foreground spiral is used to figure the foreground galaxy's light intensity.

3. Then a model for the background elliptical's light intensity is developed from light not passing through the spiral.

4. And lastly these models are combined to get the derived light transmission map.

This is repeated for six available light wavelengths from Webb and Hubble filers. The wavelengths were chosen to trace the way the dust extinction falls off toward longer wavelengths, which is affected both by the sizes of the interstellar dust grains and how strongly they are clumped together.

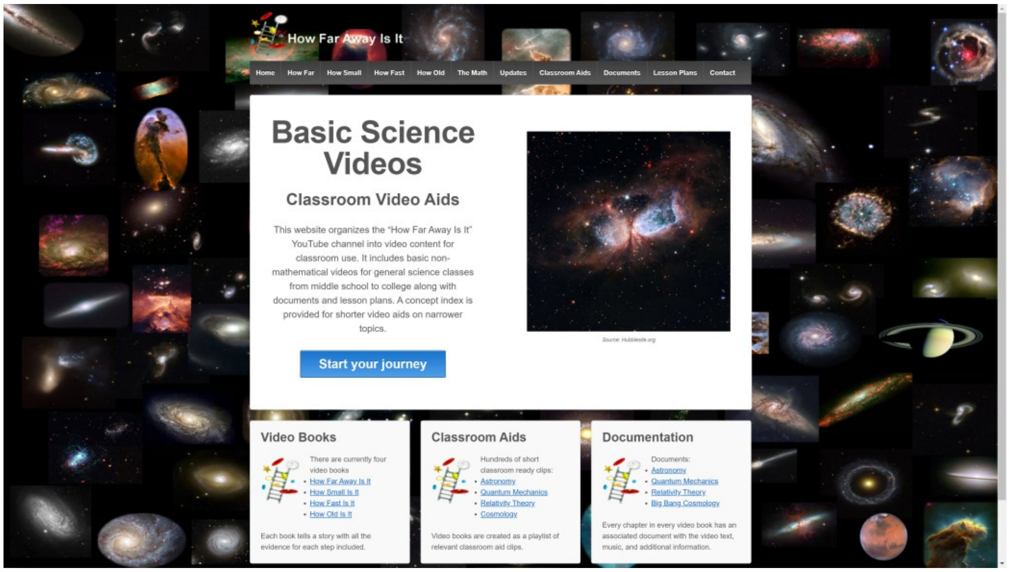
What they found is that the light extinction in this distant galaxy is behaving very much like it works in our part of the Milky Way. This was a bit unexpected because VV191b is twice the size of the Milky Way, and we are examining its outermost spiral features. It looks like dust is the same everywhere.



There's one other none-dust related item in this image.

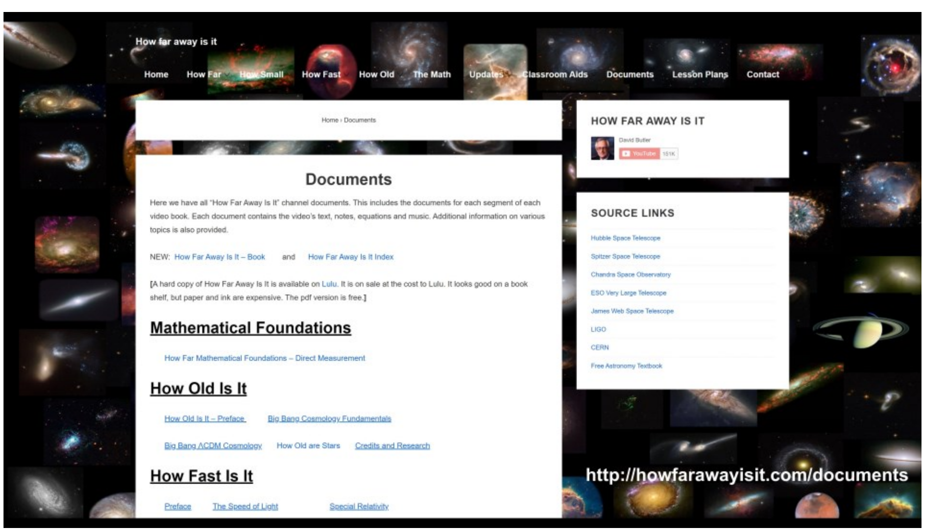
Note the faint red arc in the inset at 10 o'clock. This is a very distant galaxy over 10 billion light-years away [z ≈ 3.2], whose appearance is warped by gravitational lensing. It's duplicate appears as a dot – at 4 o'clock. These images of the lensed galaxy are so faint and so red that they went unrecognized in Hubble data, but are unmistakable in Webb's near-infrared image.

Credits and Research
Here are the links to Hubble and Webb sites, whitepapers and other locations where I found the information contained in this 2022 review. These are also the places where you can begin to do your own research.



https://howfarawayisit.com/

And don't forget. Every video has a document on the howfarawayisit.com website containing all the text and pictures. Download and translate as needed. In closing, I want to thank Jonathan Onstead for his excellent editing. And I want to thank everyone for all the great comments and questions posted on my videos. I read them all. Keep them coming, and thanks for watching.



http://howfarawayisit.com/documents/

Credits

Earth from GEOS-18

https://www.nasa.gov/image-feature/earth-from-orbit-noaa-debuts-first-imagery-from-goes-18

JWST Mars

https://webbtelescope.org/contents/media/images/01GCW1EQ0GNDYECND5NPKGQN27

JWST Jupiter

https://blogs.nasa.gov/webb/2022/07/
https://blogs.nasa.gov/webb/2022/08/

Neptune

https://www.nasa.gov/feature/goddard/2022/new-webb-image-captures-clearest-view-of-neptune-s-rings-in-decades

Didymos

https://esawebb.org/videos/weic2215a/
https://hubblesite.org/contents/news-releases/2022/news-2022-056.html#section-id-2

Protostar L1527

https://esawebb.org/news/weic2219/?lang
https://telescopius.com/pictures/view/134752/deep_sky/by-didier_micoud?from=dso&dso_id=16711

Southern Ring Nebula, NGC 3132

https://webbtelescope.org/contents/news-releases/2022/news-2022-059.html

Wolf-Rayet

https://www.flickr.com/photos/nasawebbtelescope/52423252335/in/album-72177720301006030/
https://www.nasa.gov/feature/jpl/star-duo-forms-fingerprint-in-space-nasa-s-webb-finds

Pillars of Creation

https://webbtelescope.org/contents/news-releases/2022/news-2022-052.html

LMG – Spitzer vs Webb

https://www.flickr.com/photos/nasawebbtelescope/52061788279/in/album-72177720296737701/
https://blogs.nasa.gov/webb/2022/
https://blogs.nasa.gov/webb/2022/05/09/miris-sharper-view-hints-at-new-possibilities-for-science/

Cosmic Cliffs NGC 3324

https://webbtelescope.org/contents/news-releases/2022/news-2022-057.html#section-id-2

Tarantula Nebula

https://esawebb.org/images/weic2212a/

Supernova 2013ge in NGC 3287

https://hubblesite.org/contents/news-releases/2022/news-2022-011.html#section-id-2

NGC 7496

https://esahubble.org/images/potw2222a/

Henize 2-10 Black Hole

https://hubblesite.org/contents/news-releases/2022/news-2022-002.html

Galaxy Group Arp143

https://hubblesite.org/contents/news-releases/2022/news-2022-010.html

Stephan's Quintet

https://www.flickr.com/photos/50785054@N03/52211586681/

Hickson Compact Group 40

https://esahubble.org/news/heic2205/?lang

Cartwheel Galaxy

https://esahubble.org/images/potw1036a/

Dust in VV191b

https://webbtelescope.org/contents/early-highlights/webb-hubble-team-up-to-trace-interstellar-dust-within-a-galactic-pair.html
https://webbtelescope.org/files/live/sites/webb/files/home/webb-science/early-highlights/_documents/2022-503-vv191-galaxies/2208.14475-Webbs-PEARLS-dust-attenuation-gravitational-lensing-in-VV191.pdf

Milky Way Dust

https://youtu.be/l3EgFnZUqhI

JWST – Alignment picture

https://www.nasa.gov/press-release/nasa-s-webb-reaches-alignment-milestone-optics-working-successfully

LMG – Spitzer vs Webb

https://www.flickr.com/photos/nasawebbtelescope/52061788279/in/album-72177720296737701/
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https://blogs.nasa.gov/webb/2022/05/09/miris-sharper-view-hints-at-new-possibilities-for-science/

The Carina Nebula NGC 3324

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Southern Ring Nebula, NGC 3132

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M74

https://www.sciencealert.com/new-webb-images-of-spiral-galaxies-are-so-beautiful-we-could-cry

Cartwheel Galaxy – 500 mly

https://esawebb.org/news/weic2211/?lang

Music

Rachmaninoff - Symphony No. 2 in E Minor, Op. 27: 3. Adagio; Sofia Philharmonic Orchestra; Emil Tabakov; from the album "Sergei Rachmaninoff: Symphony No. 2 in E Minor, Op. 27" 2011

Rachmaninov - Piano Concerto No 2 in C minor; from the album "The Most Relaxing Classical Music" 1993