



**SPACE**<sup>TM</sup>  
EMPOWERING LIFE

DECEMBER 2022

ISSUE XI

# Galactica

Astronomy and Space Science Magazine

**What's Inside?**

**SPACE Insights**

**Highlights From November**

**Moon Phases And Planet Visibility**

**What's Awaiting in December**

**Student's Corner**

**Historical Events Happened In December**

**Train Your Brain**

[www.space-global.com](http://www.space-global.com)

Galactica is a monthly magazine about astronomy & space science published by SPACE India targeting amateur astronomers. Each monthly issue includes astronomy news, space launches, what's up in the sky every month, events and announcements done by the space team, Astrophotographs and articles on astronomy & astrophysics submitted by the readers for the general audience, and the article about historical missions & events of astronomy and more. All of this comes in an easy-to-understand user-friendly style that's perfect for astronomers at any level.

# Team

## **Editor in Chief**

Sachin Bahmba

## **Assistant Editor**

Sruthi Suresh

## **Section Editors**

Ranadeep Das

Javed Alam

## **Editor**

Ranjith Kumar

## **Proof Reading**

Priyadharshini

## **Contributors**

iAstronomers

Space Students

This magazine contains original photos used with permission, as well as free-use images. All included photos are property of the author unless otherwise specified. If you are the owner of an image featured in this publication believed to be used without permission, kindly contact us.

# CONTENTS

Topics	Page no.
<b>About SPACE</b>	4
<b>SPACE Insights</b>	5
<b>Highlights of November 2022</b>	10
NASA's Artemis I Mission Breaks A Record	10
Evidence Of Ancient Mars Ocean Increases The Probability Of Past Life	11
From The Eyes Of Webb - November 2022	12
Hubble Space Telescope Offers Stunning View Clouded Out By A Future Star	20
A New Approach Might Help Scientists To See What's Inside A Neutron Star	21
Indian Rocket Launches EOS-06 Ocean-Studying Satellite And 8 Tiny Craft	22
<b>What's up in the sky - December 2022</b>	23
<b>Rocket launches in December 2022</b>	24
Pléiades Neo Satellites Are Ready To Join Rest Of Family	25
SpaceX Launches - December 2022	26
OneWeb Aims To Deploy A Record 40 Satellites In SpaceX Mission: Dec 8	27
HAKUTO-R Mission 1 Let's Go To The Moon	29
Virgin Orbit To Launch "Start Me Up", Amber-1 & Others	30
<b>Astronomical events - December 2022</b>	
Mars At Opposition: 08 December	32
Geminids Meteor Shower - 2022	33
The Winter Solstice	34
Mercury At Greatest Eastern Elongation	35
Conjunctions For The Month	36
Planetary Parade From Dec 22nd To 30th And Ursids Meteor Shower	37
<b>Student's Corner</b>	38
<b>Astrophotographs by Space Team</b>	43
<b>Historical events that happened in December</b>	44
<b>Train Your Brain</b>	47



## ABOUT SPACE



Legacy of  
22 years



Pioneer  
Organization



10000+  
Activities  
Developed



1000+  
Schools  
Associated



1M+  
Students  
Engaged



10k+  
Outreach  
Events



10+  
Cities  
Presence

**SPACE is the pioneer organization working towards development of science and astronomy in India. It aims to create a scientifically aware society and contribute to the technological and social development of the country. SPACE organization belongs to an astronomical league, diligently working towards development in astronomy and space science through astronomical tutorials, modules, curriculum for education requirements of schools & students in India. We constantly engage in offering introductory astronomy, science about space, astrophysics, telescopes and internet astronomy to masses.**

***Vision:** To popularize hands on space science & STEM Education through various fun filled pioneering concepts, services and programs.*

***Mission:** To develop and popularize space science & STEM Education in India and establish a global association with national & international space science agencies, societies, amateur, professional organisations, government agencies and space observatories.*

### CMD'S MESSAGE:



Mr. Sachin Bahmba  
CMD, Space.

**Space and Astronomy is the future for the young generation of our country. This is a great means to inculcate scientific temperament among the masses. Such astronomy sessions will provide a hands on learning platform to students wherein they explore the real world of science. I wish for the young students to let their ambitions soar and think big as they are the future of our country.**

# SPACE INSIGHTS

## CELEBRATIONS AT MAYOOR SCHOOL

Birthdays are some of the most celebrated events of our lives, especially for kids. And what's better way to rejoice this day than combining it with some astronomy!

Well, that's what we did. On November 18, 2022, we celebrated the birthday of Mr. Aveer S/o the Director of Mayoor School, Noida. It was not just a conventional birthday party. Instead, we set up our astronomy activities for all the kids as well as parents during the event. The celebration started with a huge hydro-rocket launch by the birthday boy and his father. After that, children and parents were made to experience their weights on different planets due to the varying gravity on them. While Jupiter made everyone become too self-conscious about their health, the Moon did not fail to bring a joy on their face with it's one-sixth the weight on Earth.

The excitement of the children went over the board when they were provided with the opportunity to launch their own stomp rockets. While they refueled themselves with the delicacies, we carried their inquisitiveness out into space by demonstrating the making of a comet using simple household materials. The fumes of dry ice emerging out of the comet exhilarated the children and took them off their seats. The intersection of the birthday and astronomy made the event one of its kind and a memorable one for everyone present over there.



Astronomy is the most ancient form of science and holds the potential to change the entire world right at the individual level. When people get to experience astronomical activities and observations, they realize the importance and essence of such technologies in taking humankind to the next contour. At the same time, they also realize their own value and place in this unfathomable and immense vastness of the universe. Merging a component of astronomy with such kind of events makes it not only an interesting and memorable one, but also achieves to develop a curiosity and a tendency to think above the horizon that our conventional education system draws before the students. Therefore, we encourage more schools and institutions to get in touch with us and try to conduct such exhibitions in their campuses, as it is the best way to instill the curiosity and scientific temperament needed to change the country as well as the world.

# MONTHLY TELESCOPIC OBSERVATION

SPACE ARCADE team conducted their 5th Monthly Telescopic Experience session on 5th of November at two different places which are Delhi and Chennai respectively. People from various places joined the observation with their own telescopes, binoculars and other astronomical equipment to learn and experience the breathtaking view of the Moon! They also learnt about different types of telescopes and cleared all their queries on the Alignment of various telescopes then did basic Astrophotography.

Everyone had their hands-on telescopic experience and enjoyed the view of the moon and its craters through the 8" Dobsonian telescope setup by Space team.



# KEFI EXPRESS 2022

We onboarded the "KEFI EXPRESS" on 15th November which is an initiative by Gateway International School, Padur (GISP) that seeks to inculcate integrated learning among its students. The expo revolves around the cultural heritage, art, and architecture of the state of Tamil Nadu, and the Union territory Jammu & Kashmir to educate the students on the recent alliance between the two (One India, Great India program). Although the expo was earth-based, the astronomy club students scored high in space with their models.

The club students made a magnificent dome depicting the night sky with 12 constellations. With the insights they got from our sessions, they elaborated on the facts about the stars and the constellations to the public. Rocketry and space enthusiasts made a working model of the satellite communication system using the joystick and other control buttons. Apart from this, the primary class students displayed models and charts on the solar system, constellations, etc

There were around 250 onlookers including parents and teachers who were eager to know about the most fascinating subject, Astronomy. They gained knowledge about the 130 EQ telescope and 8-inch Dobsonian telescope which we exhibited. The club students also explained the various astronomical items like the Curiosity rover, Moon buggy, etc, and demonstrated the Pop Rocket activity which was most loved by the kids. The parents and the students grasped the concept of constellations, zodiac signs, and the celestial sky using the planisphere and the zodiac wheel. Furthermore, we kindled people's curiosity by showing their weight on planets like Jupiter, Mercury, and also our Moon. The martian and astronaut cutouts along with a student dressed up as an Astronaut became the focal point of the whole expo.



# INTO THE NEW SPACESHIP

Together we are one! Space for all! After 16 faithful years at our Spaceship (office) and 22 years since inception, we took a leap into a more expansive, more vibrant & more exclusively located Spaceship on the very special day of Children's Day, 14th November, 2022.

A day that is special to all the Spacians because we believe in empowering young minds. The day was celebrated with much gusto, games and dancing. We also celebrated the November month birthdays with an absolutely delicious and beautiful looking cake followed by the Pizza party.





# SCIENCE EXPO AT 'DELHI PUBLIC SCHOOL'

An excellent method for getting pupils interested in learning new information is an exhibition. They get a curiosity for learning that would not otherwise be generated by sitting through tedious lectures. It gives students a platform to apply their scientific knowledge and produce the greatest idea possible. Additionally, it enables them to collaborate in groups and gain knowledge from one another. They collaborate by exchanging ideas and energizing one another to accomplish something novel. This enables the pupils to further develop their social and moral abilities and improves their ability to work as a team. On the occasion of annual function At Delhi Public School Greater Faridabad Various Moon missions were exploded in November 2022 by children in Classes V through VIII. Student's displayed their handmade models between 24th November to 1st of December.



Children engaged in practical exercises to help them comprehend the connection between our planet and its most well-known neighbor, the Moon. Students displayed models about the Apollo and Artemis missions, lunar settlements, and satellites like Chandrayaan 1 and 2. As they put up effort and craft their own models, students love learning through such presentations. They gain confidence and overcome stage anxiety when they do presentations at exhibitions since they are more accustomed to public speaking. These exhibits also assist children in acquiring a more scientific perspective on the issues and difficulties they encounter in life. Through these demonstrations, students put what they have learned in class into practice and get a taste for active learning. It transitions them from theoretical study to actual execution and gives them the chance to put their ideas to use in novel ways. Once their project has been turned from an idea, they present it to others and receive praise, which increases their confidence. As a result, these exhibits help kids become more self-assured, inventive, and future-ready, as well as lifelong learners. That is why we are encouraging students to participate in such activities.

# HIGHLIGHTS OF NOVEMBER 2022

## AT ITS HALFWAY POINT, NASA'S ARTEMIS I MISSION BREAKS A RECORD

**The spacecraft reached a point 268,563 miles away from Earth, farther than any other human-rated spacecraft has traveled.**

NASA's Orion spacecraft captured and sent back imagery of the Earth and Moon together as the spacecraft reached the farthest distance that it will travel away from our planet during the mission—268,563 miles, or about 432,210 kilometers. Earlier, the spacecraft beat a record set by the Apollo 13 mission.

Orion passed the milestone at 2.30 AM IST on November 29, day 13 of the mission, which is also its halfway point. The spacecraft is continuing to work as expected and continues its journey in a distant retrograde orbit, which takes it thousands of kilometers beyond the Moon.

According to NASA, it had originally planned to conduct an orbital maintenance burn on November 28 but deemed it unnecessary because Orion was already in a precise trajectory. The space agency says that 37.5 percent of the Artemis 1 mission's test objectives have either been completed or are in the process of being completed. Many of the remaining objectives will be evaluated during Orion's entry, descent, splashdown and recovery.



(A camera on the Orion spacecraft captured an image of the spacecraft, along with the Earth and Moon, on Nov. 28 as the spacecraft orbited the Moon in a distant retrograde orbit. Credit: NASA)

Based on the spacecraft's performance, mission managers are now exploring the option of adding seven more test objectives that will further characterize Orion's thermal performance and propulsion system to further reduce risk before future crewed missions.

In the meanwhile, the space agency's Exploration Ground Systems and the US Navy are beginning initial operations to recover the spacecraft once it splashes down in the Pacific ocean. The recovery team will conduct training operations at sea on November 29 as part of the final preparations for recovery.

"Artemis I has had extraordinary success and has completed a series of history-making events," NASA administrator Bill Nelson said in a press conference, pointing out that Orion was the first spacecraft designed to carry humans to enter a distant retrograde lunar orbit and that it has surpassed the record for the furthest distance traveled away from Earth by a human-rated spacecraft.

# EVIDENCE OF ANCIENT MARS OCEAN INCREASES THE PROBABILITY OF PAST LIFE

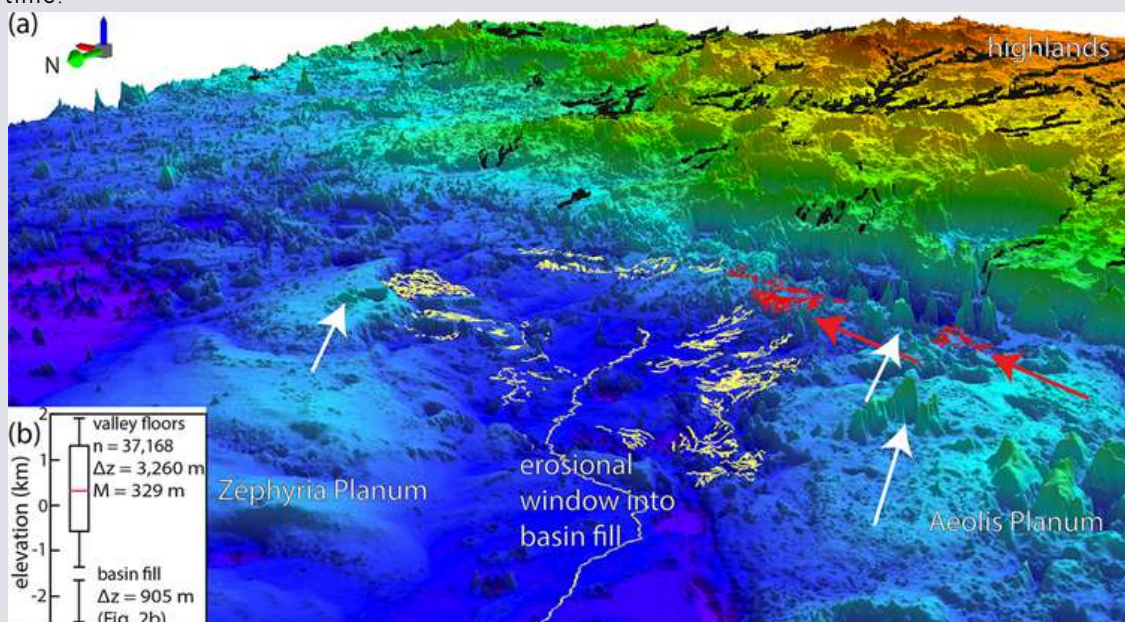
**"The existence of an ocean of this size means a higher potential for life."**

New maps of the topography of Mars provide evidence of the existence of an ocean on the planet in its ancient history, with implications for its ability to have once-supported life.

A map of the Martian region known as Aeolis Dorsa, a boundary that separates the elevated, cratered southern highlands of Mars from the planet's smooth northern lowlands strongly suggests a shoreline left by a massive ocean.

The map of the area reveals that the Red Planet once experienced sea-level rise consistent with a warm wet climate in stark contrast with the frozen and dry Martian landscape seen today.

"What immediately comes to mind as one the most significant points here is that the existence of an ocean of this size means a higher potential for life." Benjamin Cardenas, an assistant professor of geosciences at Penn State University and leader of the research, said in a statement. "It also tells us about the ancient climate and its evolution. Based on these findings, we know there had to have been a period when it was warm enough and the atmosphere was thick enough to support this much liquid water at one time."



A topography map of the Aeolis Dorsa region on Mars revealing evidence of an ancient ocean shoreline.

(Image credit: NASA/ DiBiase et al./Journal of Geophysical Research/Benjamin Cardenas / Penn State)

While planetary scientists are sure that Mars was once a much more watery planet than it is today, a debate has raged with regard to whether an ocean existed in the planet's northern hemisphere.

Cardenas and his colleagues were able to answer this question by using topological data to show evidence of a roughly 3.5 billion-year-old shoreline. One aspect of this geological feature was the substantial accumulation of sediments covering hundreds of thousands of square miles and with a thickness of around 3,000 feet (900 meters).

"The big, novel thing that we did in this paper was to think about Mars in terms of its stratigraphy and its sedimentary record," Cardenas said. "On Earth, we chart the history of waterways by looking at sediment that is deposited over time. We call that stratigraphy, the idea that water transports sediment and you can measure the changes on Earth by understanding the way that sediment piles up. That's what we've done here – but it's Mars."

The scientists used United States Geological Survey-developed software to assess map data of Mars collected by the Mars Orbiter Laser Altimeter (MOLA) aboard NASA's Mars Global Surveyor (MGS) spacecraft, which orbited the planet between 1996 and 2006.



(Stitched together from 28 images, this view from NASA's Curiosity Mars rover was captured after the rover ascended the steep slope of a geologic feature called "Greenheugh Pediment".)

# FROM THE EYES OF WEBB - NOVEMBER 2022

## WEBB'S NIRCAM INSTRUMENT SHOWS THE

### BEGINNING OF PROTOSTAR EVOLUTION

NASA's James Webb Space Telescope has revealed the once-hidden features of the protostar within the dark cloud L1527, providing insight into the beginnings of a new star. These blazing clouds within the Taurus star-forming region are only visible in infrared light, making it an ideal target for Webb's Near-Infrared Camera (NIRCam).

The protostar itself is hidden from view within the "neck" of this hourglass shape. An edge-on protoplanetary disk is seen as a dark line across the middle of the neck. Light from the protostar leaks above and below this disk, illuminating cavities within the surrounding gas and dust.

The clouds colored blue and orange in this representative-color infrared image are the outline cavities created as material which shoots away from the protostar and collides with surrounding matter. The colors themselves are due to layers of dust between Webb and the clouds. The blue areas are where the dust is thinnest. The thicker the layer of dust, the less blue light is able to escape, creating pockets of orange.

Webb also reveals filaments of molecular hydrogen that have been shocked as the protostar ejects material away from it. Shocks and turbulence inhibit the formation of new stars, which would otherwise form all throughout the cloud. As a result, the protostar dominates the space, taking much of the material for itself.



Despite the chaos that L1527 causes, it's only about 100,000 years old - a relatively young body. Given its age and its brightness in far-infrared light as observed by missions like the Infrared Astronomical Satellite, L1527 is considered a class 0 protostar, the earliest stage of star formation. Protostars like these, which are still cocooned in a dark cloud of dust and gas, have a long way to go before they become full-fledged stars. L1527 doesn't generate its own energy through nuclear fusion of hydrogen yet, an essential characteristic of stars. Its shape, while mostly spherical, is also unstable, taking the form of a small, hot, and puffy clump of gas somewhere between 20 and 40% the mass of our Sun.

As the protostar continues to gather mass, its core gradually compresses and gets closer to stable nuclear fusion. The scene shown in this image reveals L1527 doing just that. The surrounding molecular cloud is made up of dense dust and gas being drawn to the center, where the protostar resides. As the material falls in, it spirals around the center. This creates a dense disk of material, known as an accretion disk, which feeds material to the protostar. As it gains more mass and compresses further, the temperature of its core will rise, eventually reaching the threshold for nuclear fusion to begin.

The disk, seen in the image as a dark band in front of the bright center, is about the size of our solar system. Given the density, it's not unusual for much of this material to clump together - the beginnings of planets. Ultimately, this view of L1527 provides a window into what our Sun and the solar system looked like in their infancy.

# **JAMES WEBB SPACE TELESCOPE PEERS INTO LONELY DWARF GALAXY**

The most powerful space telescope currently operating has zoomed in on a lonely dwarf galaxy in our galactic neighborhood, imaging it in stunning detail.

At around 3 million light-years from Earth, the dwarf galaxy, named Wolf-Lundmark-Melotte (WLM) for three astronomers instrumental in its discovery, is close enough that the James Webb Space Telescope (JWST) can distinguish individual stars while still being able to study large numbers of stars simultaneously. The dwarf galaxy, in the constellation of Cetus, is one of the most remote members of the local galaxy group that contains our galaxy. Its isolated nature and lack of interactions with other galaxies, including the Milky Way, make WLM useful in the study of how stars evolve in smaller galaxies.

"We think WLM hasn't interacted with other systems, which makes it really nice for testing our theories of galaxy formation and evolution," Kristen McQuinn, an astronomer at Rutgers University in New Jersey and lead scientist on the research project, said in a statement from the Space Telescope Science Institute in Maryland, which operates the observatory. "Many of the other nearby galaxies are intertwined and entangled with the Milky Way, which makes them harder to study."



An image of the Wolf-Lundmark-Melotte dwarf galaxy captured by the JWST's Near-Infrared Camera. (Image credit: NASA, ESA, CSA, STScI, (Kristen McQuinn, Alyssa Pagan and Zolt Levay)

McQuinn pointed out a second reason WLM is an intriguing target: its gas is very similar to that of galaxies in the early universe, without any elements heavier than hydrogen and helium.

But whereas the gas of those early galaxies never contained heavier elements, the gas in WLM has lost its share of these elements to a phenomenon called galactic winds. These winds stem from supernovas, or exploding stars; because WLM has so little mass, these winds can push material out of the dwarf galaxy.

In the JWST image of WLM, McQuinn described seeing an array of individual stars at different points in their evolution with a variety of colors, sizes, temperatures and ages. The image also shows clouds of molecular gas and dust, called nebulas, which contain the raw material for star formation within WLM. In background galaxies, JWST can spot fascinating features like massive tidal tails, which are structures made of stars, dust and gas created by gravitational interactions between galaxies.

JWST's main goal in studying WLM is to reconstruct the dwarf galaxy's history of star birth. "Low-mass stars can live for billions of years, which means that some of the stars that we see in WLM today formed in the early universe," McQuinn said. "By determining the properties of these low-mass stars (like their ages), we can gain insight into what was happening in the very distant past."

The work complements the study of galaxies in the early universe that JWST is already facilitating, and it also allows the telescope's operators to check the calibration of the NIRCам instrument that captured the sparkling image. That's possible because both the Hubble Space Telescope and the now-retired Spitzer Space Telescope have studied the dwarf galaxy before, and scientists can compare the images.

"We're using WLM as a sort of standard for comparison to help us make sure we understand the JWST observations," McQuinn said. "We also want to make sure that we understand our stellar evolution models in the near-infrared."

## **HAUNTING PORTRAIT: NASA'S WEBB REVEALS DUST, STRUCTURE IN PILLARS OF CREATION**

In mid-infrared light, the Pillars of Creation appear otherworldly. NASA'S James Webb Space Telescope has delivered a scene that is large and lofty – and appears lit by flickering lanterns. A “ghost” haunts the crag in the lower left, gargoyle-like shape snarls toward the middle of the frame, and a dark horse’s head charges out of the edge of the second pillar. The creepiest of all? Newly formed stars take on the appearance of protruding, bloodshot eyes. And in the background, dust dances like heavy, ancient curtains being pulled shut. Here, there is no raven to whisper, “Nevermore,” to harken to the classic poem by Edgar Allan Poe.

Instead, dust in Webb’s image is like the dawn. It is an essential ingredient for star formation. Though cloaked, these pillars are bursting with activity. Newly forming stars hide within these dark gray chambers, and others, like red rubies, have jumped into view. Over time, Webb’s mid-infrared image will allow researchers to deeply explore the gas and dust in this region, and more precisely model how stars form over millions of years.



This is not an ethereal landscape of time-forgotten tombs. Nor are these soot-tinged fingers reaching out. These pillars, flush with gas and dust, enshroud stars that are slowly forming over many millennia. NASA'S James Webb Space Telescope has snapped this eerie, extremely dusty view of the Pillars of Creation in mid-infrared light – showing us a new view of a familiar landscape.

Why does mid-infrared light set such a somber, chilling mood in Webb’s Mid-Infrared Instrument (MIRI) image? Interstellar dust cloaks the scene. And while mid-infrared light specializes in detailing where dust is, the stars aren’t bright enough at these wavelengths to appear. Instead, these looming, leaden-hued pillars of gas and dust gleam at their edges, hinting at the activity within.

## GALACTICA

Thousands and thousands of stars have formed in this region. This is made plain when examining Webb's recent Near-Infrared Camera (NIRCam) image. In MIRI's view, the majority of the stars appear missing. Why? Many newly formed stars are no longer surrounded by enough dust to be detected in mid-infrared light. Instead, MIRI observes young stars that have not yet cast off their dusty "cloaks." These are the crimson orbs toward the fringes of the pillars. In contrast, the blue stars that dot the scene are aging, which means they have shed most of their layers of gas and dust.

Mid-infrared light excels at observing gas and dust in extreme detail. This is also unmistakable throughout the background. The densest areas of dust are the darkest shades of gray. The red region toward the top, which forms an uncanny V, like an owl with outstretched wings, is where the dust is diffuse and cooler. Notice that no background galaxies make an appearance – the interstellar medium in the densest part of the Milky Way's disk is too swollen with gas and dust to allow their distant light to penetrate.

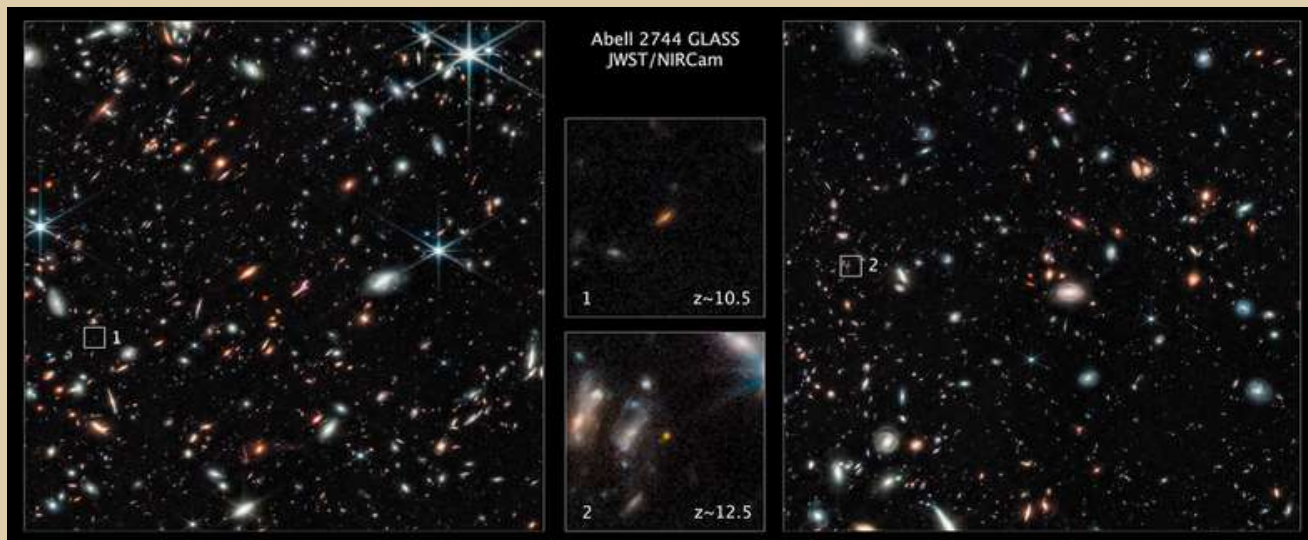
How vast is this landscape? Trace the topmost pillar, landing on the bright red star jutting out of its lower edge like a broomstick. This star and its dusty shroud are larger than the size of our entire solar system.

# **NASA'S WEBB DRAWS BACK CURTAIN ON UNIVERSE'S EARLY GALAXIES**

A few days after officially starting science operations, Webb propelled astronomers into a realm of early galaxies, previously hidden beyond the grasp of all other telescopes. Webb is now unveiling a very rich Universe where the first forming galaxies look remarkably different from the mature galaxies seen around us today.

Researchers have found two exceptionally bright galaxies that existed approximately 300 and 400 million years after the Big Bang. Their extreme brightness is puzzling to astronomers.

The young galaxies are transforming gas into stars as fast as they can and they appear compacted into spherical or disc shapes that are much smaller than our Milky Way galaxy. The onset of stellar birth may have been just 100 million years after the Big Bang, which happened 13.8 billion years ago.



The galaxy labeled (1) existed only 450 million years after the big bang. The galaxy labeled (2) existed 350 million years after the big bang. Both are seen really close in time to the big bang which occurred 13.8 billion years ago.

Two of the most distant galaxies seen to date are captured in these Webb pictures of the outer regions of the giant galaxy cluster Abell 2744. The galaxies are not inside the cluster, but many billions of light-years behind it. The galaxy featured in the image at the top center is extracted from the image on the left. It existed only 450 million years after the Big Bang.

The galaxy featured in the image at the bottom center is extracted from the image on the right. It existed 350 million years after the Big Bang.

Both galaxies are seen really close in time to the Big Bang which occurred 13.8 billion years ago. These galaxies are tiny compared to our Milky Way, being just a few percent of its size, even the unexpectedly elongated galaxy showcased in the top center image.

# NASA'S WEBB REVEALS AN EXOPLANET ATMOSPHERE AS NEVER SEEN BEFORE

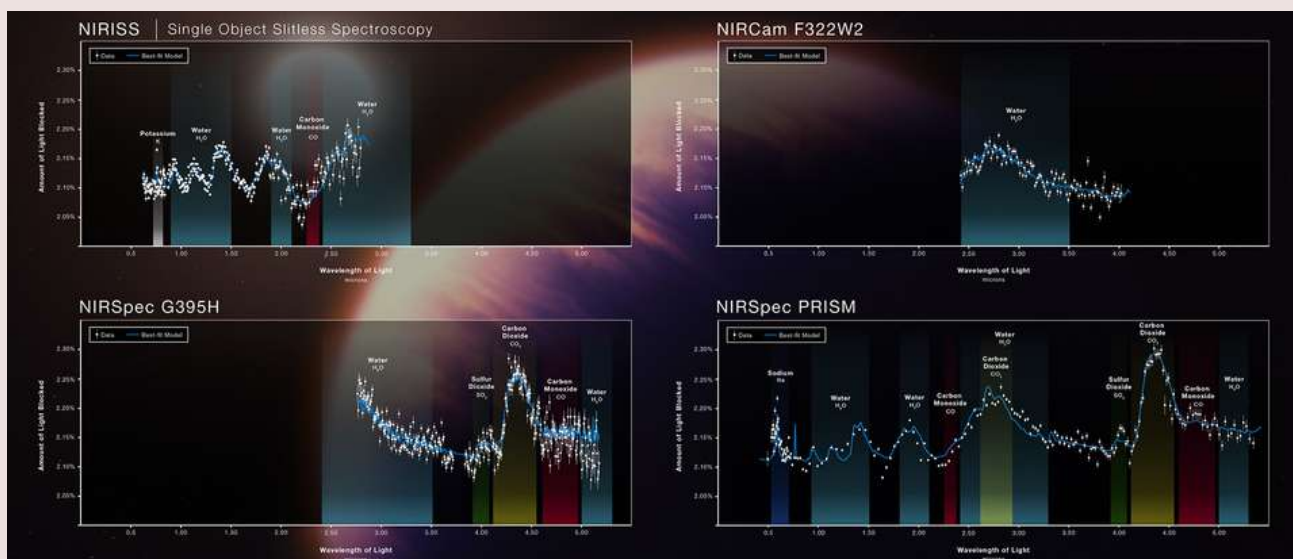


NASA's JWST provided the most detailed analysis of an exoplanet atmosphere ever with WASP-39 b analysis released in November 2022.

The telescope's array of highly sensitive instruments was trained on the atmosphere of WASP-39 b, a "hot Saturn" (a planet about as massive as Saturn but in an orbit tighter than Mercury) orbiting a star some 700 light-years away.

The findings bode well for the capability of Webb's instruments to conduct the broad range of investigations of all types of exoplanets – planets around other stars – hoped for by the science community. That includes probing the atmospheres of smaller, rocky planets like those in the TRAPPIST-1 system.

"We observed the exoplanet with multiple instruments that, together, provide a broad swath of the infrared spectrum and a panoply of chemical fingerprints inaccessible until [this mission]," said Natalie Batalha, an astronomer at the University of California, Santa Cruz, who contributed to and helped coordinate the new research. "Data like these are a game changer."



This graphic shows four transmission spectra from three of Webb's instruments operated in four instrument modes. At upper left, data from NIRISS shows fingerprints of potassium (K), water (H<sub>2</sub>O), and carbon monoxide (CO). At upper right, data from NIRCams shows a prominent water signature. At lower left, data from NIRSpect indicates water, sulfur dioxide (SO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), and carbon monoxide (CO). At lower right, additional NIRSpect data reveals all of these molecules as well as sodium (Na). (Credits: NASA, ESA, CSA, J. Olmsted (STScI))

The suite of discoveries is detailed in a set of five new scientific papers, three of which are in press and two of which are under review.

Among the unprecedented revelations is the first detection in an exoplanet atmosphere of sulfur dioxide (SO<sub>2</sub>), a molecule produced from chemical reactions triggered by high-energy light from the planet's parent star. On Earth, the protective ozone layer in the upper atmosphere is created in a similar way.

"This is the first time we see concrete evidence of photochemistry – chemical reactions initiated by energetic stellar light – on exoplanets," said Shang-Min Tsai, a researcher at the University of Oxford and lead author of the paper explaining the origin of sulfur dioxide in WASP-39 b's atmosphere.



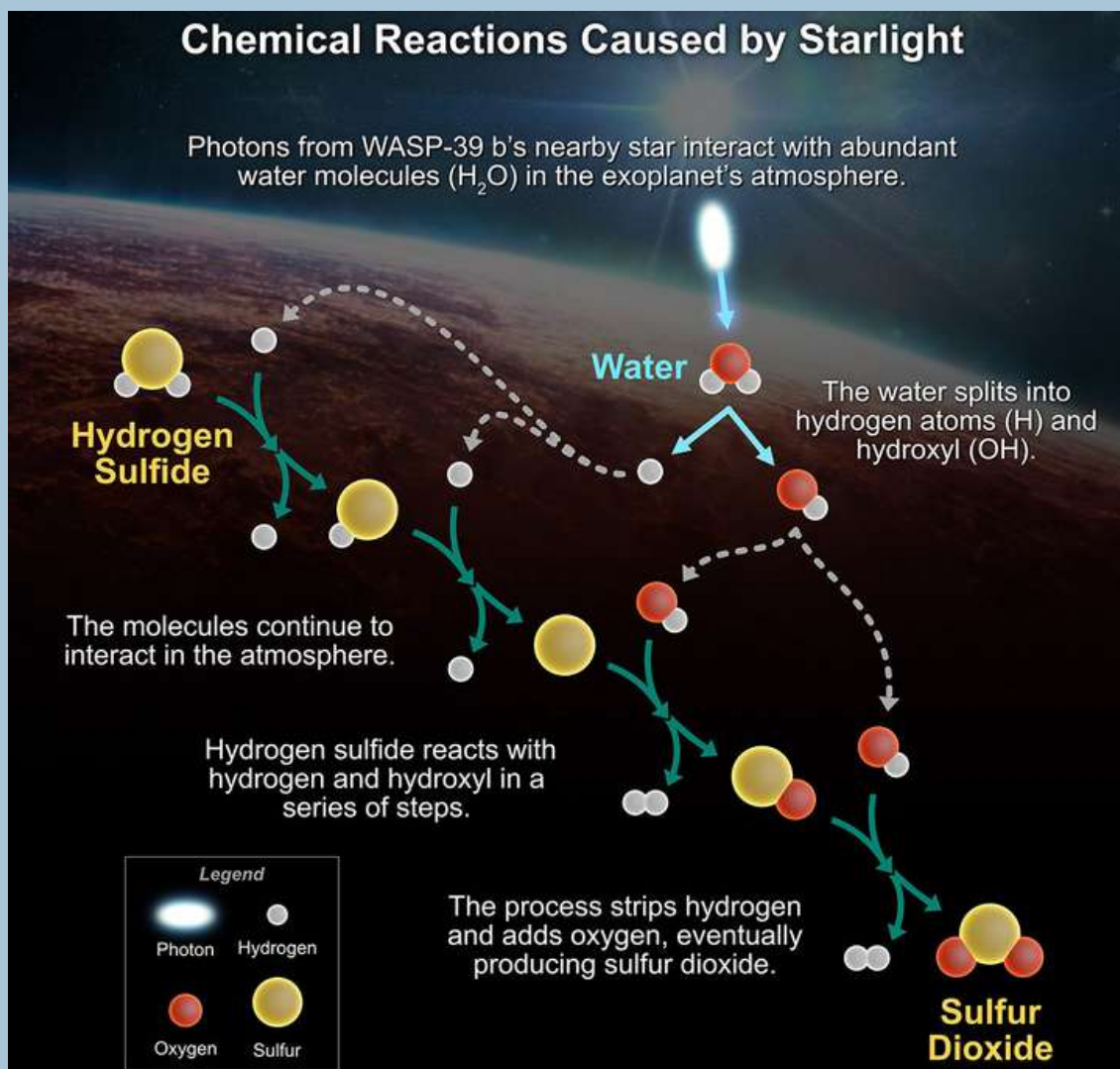
## GALACTICA

This led to another first: scientists applying computer models of photochemistry to data that requires such physics to be fully explained. The resulting improvements in modeling will help build the technological know-how to interpret potential signs of habitability in the future.

"Planets are sculpted and transformed by orbiting within the radiation bath of the host star," Batalha said. "On Earth, those transformations allow life to thrive."

The planet's proximity to its host star – eight times closer than Mercury is to our Sun – also makes it a laboratory for studying the effects of radiation from host stars on exoplanets. Better knowledge of the star-planet connection should bring a deeper understanding of how these processes affect the diversity of planets observed in the galaxy.

To see light from WASP-39 b, Webb tracked the planet as it passed in front of its star, allowing some of the star's light to filter through the planet's atmosphere. Different types of chemicals in the atmosphere absorb different colors of the starlight spectrum, so the colors that are missing tell astronomers which molecules are present. By viewing the universe in infrared light, Webb can pick up chemical fingerprints that can't be detected in visible light.



NASA's JWST made the first identification of sulfur dioxide in an exoplanet's atmosphere. Its presence can only be explained by photochemistry – chemical reactions triggered by high-energy particles of starlight. Photochemistry is essential to processes on Earth key to life like photosynthesis and the generation of our ozone layer. (Credits: NASA/JPL-Caltech/Robert Hurt; Center for Astrophysics-Harvard & Smithsonian/Melissa Weiss)

Other atmospheric constituents detected by the Webb telescope include sodium (Na), potassium (K), and water vapor ( $H_2O$ ), confirming previous space- and ground-based telescope observations as well as finding additional fingerprints of water, at these longer wavelengths, that haven't been seen before. In so precisely parsing an exoplanet atmosphere, the Webb telescope's instruments performed well beyond scientists' expectations and promise a new phase of exploration among the broad variety of exoplanets in the galaxy.

## SCIENTISTS DISCOVER LARGEST GAS CLOUD IN SPACE THAT'S 20 TIMES BIGGER THAN THE MILKY WAY

**Glowing in the Pegasus constellation are five apparently closely packed galaxies known as Stephan's Quintet, whispering the secrets of galactic evolution to scientists.**

Like all galaxies, these orbs started out as masses of atomic gas that clumped together and eventually collapsed in on themselves, forming what would become the stars that light them up. Each galaxy is made of millions of star clusters; four are actually interacting while one stands apart much closer to Earth.

Now, an international team of researchers using the Five-hundred-meter Aperture Spherical Telescope (FAST) in China, has found that Stephan's Quintet is shrouded in an atomic gas cloud 2 million light-years wide, or about 20 times the size of the Milky Way "This is the largest atomic gas structure ever found around a galaxy group," Xu Cong, an astronomer at the National Astronomical Observatories of the Chinese Academy of Sciences and lead author on the new research, said in a statement.



A map of the atomic hydrogen (HI) 21-cm line emission in the vicinity of Stephan's Quintet, a famous compact group of galaxies discovered in 1887, overlaid on a deep optical color image. (Image by NASA, ESA, CSA, and STScI)

The discovery presents a mystery and will require astronomers to rethink how gas behaves at the edges of galaxy groups, according to the researchers.

Because atomic hydrogen is free to float through galaxies more than other components of an atomic gas cloud, it scatters easily when objects in a galaxy interact with each other. The scattered hydrogen in Stephan's Quintet is a time capsule that can tell scientists about such events going back perhaps about a billion years.

The cloud is a particularly surprising find because astronomers would have expected ultraviolet light to change the nature of the hydrogen in the cloud. Ultraviolet light ionizes the atoms in an atomic gas cloud will ionize, meaning they will gain or lose electrons and end up charged. But the gas observed in Stephan's Quintet is not ionized.

The lack of ionization suggests that the gas could be left over from galactic formation. Far away from any stars, diffuse clouds of atomic hydrogen still exist on their own, which could make a case for them being by-products of interactions that formed a galaxy. It is also possible that the cloud surrounding Stephan's Quintet could have been released by an ancient crash between two of the galaxies. Although the explanation for the unionized gas still remains unknown, an answer could change what we think we know about how galaxies are born and continue to evolve.

# JWST COULD SEARCH FOR 'LAUGHING GAS' TO FIND ALIEN LIFE

The presence of nitrous oxide in the atmospheres of Earth-like exoplanets could be a signature of the presence of extraterrestrial life – according to a study done by researchers in the US led by Edward Schwieterman at the University of California, Riverside.

Using advanced computer models to support their proposal, the team believes that its work could offer important insights for exoplanet studies by current and future observatories – including the James Webb Space Telescope (JWST).

Astronomers know of more than 5000 exoplanets – which are planets that orbit stars other than the Sun and that number keeps growing. As telescopes improve, astronomers are getting better at determining the compositions of exoplanet atmospheres, and these measurements play an important role in the search for extraterrestrial life. This is done by making spectroscopic measurements on starlight that has passed through exoplanet atmospheres.

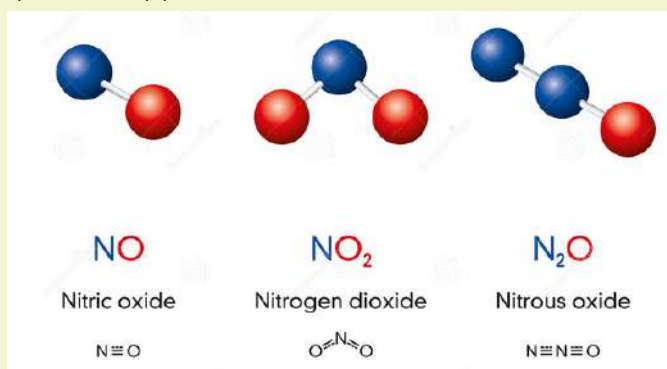
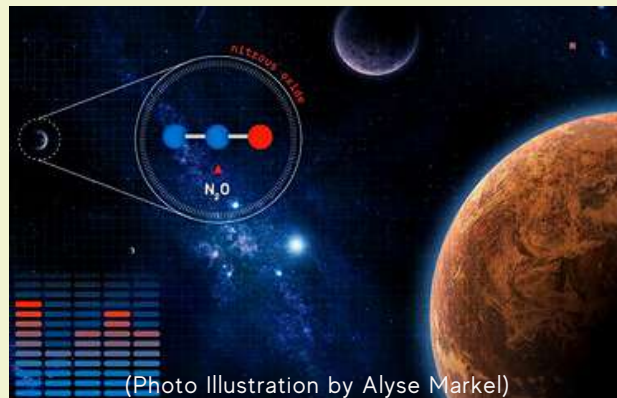
## In search of life

We have never seen life on another planet, so we do not know exactly how it would affect exoplanet atmospheres. Instead, astrobiologists identify chemicals in Earth's atmosphere that are associated with the presence of life and search for these "biosignatures".

This is where nitrous oxide (also known as laughing gas) comes in. While it is not especially common in Earth's atmosphere today, Schwieterman and colleagues suggest that the gas could have been abundant in previous eras of Earth's history.

Nitrous oxide is produced by some living organisms on Earth, so it is possible that it could present in the atmospheres of some exoplanets that harbour life. Here on Earth, however, there are natural processes that keep atmospheric nitrous oxide levels very low. However, on other planets an abundance of nitrous oxide could result from low levels of the metal catalysts and biological enzymes that break down the compound. Another possibility is that the stellar radiation received by some exoplanets is not as efficient as sunlight at destroying nitrous oxide. Indeed, nitrous oxide levels in such situations could be high enough to be observed by telescopes like the JWST.

Schwieterman's team explored this idea by developing a biogeochemical model that quantifies the likely abundance of nitrous oxide in the atmospheres of Earth-like exoplanets orbiting main sequence stars. By coupling their model to photochemical and spectral models, the researchers also calculated that nitrous oxide could build up to detectable levels within a range of atmospheric conditions. This could include the TRAPPIST-1 system, where as many as four planets appear to orbit within the habitable zone of their cold red dwarf host star.



Although nitrous oxide can also be produced by non-biological sources, such as lightning strikes, the team showed that the amounts of gas produced would be orders of magnitude lower than that produced by alien ecosystems. Based on their results, Schwieterman and colleagues hope that the JWST, along with other telescopes actively hunting for signs of life in exoplanetary atmospheres, will add nitrous oxide to the list of viable biosignatures – potentially bringing the discovery of extraterrestrial life a step closer.

# HUBBLE SPACE TELESCOPE OFFERS STUNNING VIEW CLOUDED OUT BY A FUTURE STAR

An image captured by the Hubble Space Telescope shows the dense core CB 130-3 as an orange blob obscuring the view of an infant star.

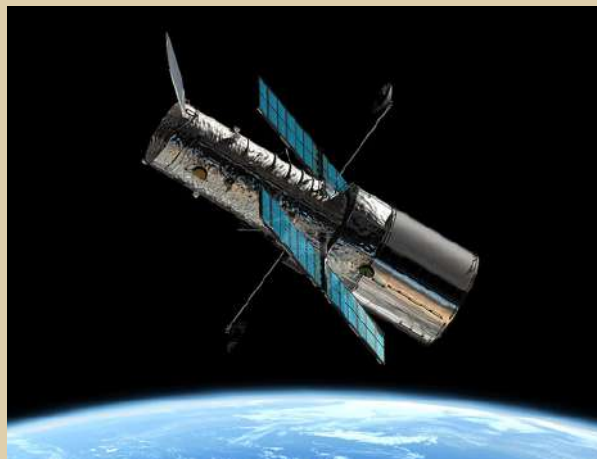


(Image credit: ESA/Hubble, NASA & STScI, C. Britt, T. Huard, A. Pagan)

A new image captured by the Hubble Space Telescope shows a molecular cloud of gas and dust that harbors a compact object that will soon become an infant star.

Located 652 light-years from Earth in the constellation of Serpens, CB 130-3 is what astronomers call a dense core, which is a compact agglomeration of gas and dust that acts as the building blocks for star formation, according to a statement from the European Space Agency (ESA), a partner on the Hubble Space Telescope mission. Dense cores such as CB 130-3 are the smallest and densest types of molecular clouds. These clouds are stellar nurseries that can be the birthplaces for multitudes of stars, both singularly and in binary pairs.

Many dense cores already contain young stars, while others demonstrate a slow inward contraction that precedes the cloud's complete gravitational collapse. Both types of dense cores have temperatures of around minus 440 degrees Fahrenheit (minus 262 degrees Celsius) and are usually elliptical.



During the gravitational collapse of these massive fields of cold gas, enough mass can accumulate in select locations to reach the high temperatures and extreme densities needed to kick-start the nuclear fusion that marks the birth of a star and that the star will sustain throughout its main-sequence lifetime.

The new Hubble image shows CB 130-3 resembling perhaps a glass of carrot juice spilled across a tablecloth of stars and galaxies. The image gives no hint of the budding star lurking within the molecular cloud as it teeters on the brink of becoming a fully-fledged stellar body.

However, other details about CB 130-3 are more obvious in the image, which astronomers captured using Hubble's Wide Field Camera 3. For instance, the image demonstrates that the density of the molecular cloud isn't constant. The outer edges of CB 130-3 can be seen as tenuous wisps of gas that simply blur background stars. In stark contrast, the material at the heart of the molecular cloud is so dense that it entirely blocks the light from background stars.

The gas and dust of CB 130-3 also impact the color of the stars behind it as well as their brightness. The stars seen through the thick material closer to the heart of CB 130-3 appear to have taken on a redder hue than those shining through less dense material at the outer edges of the structure.

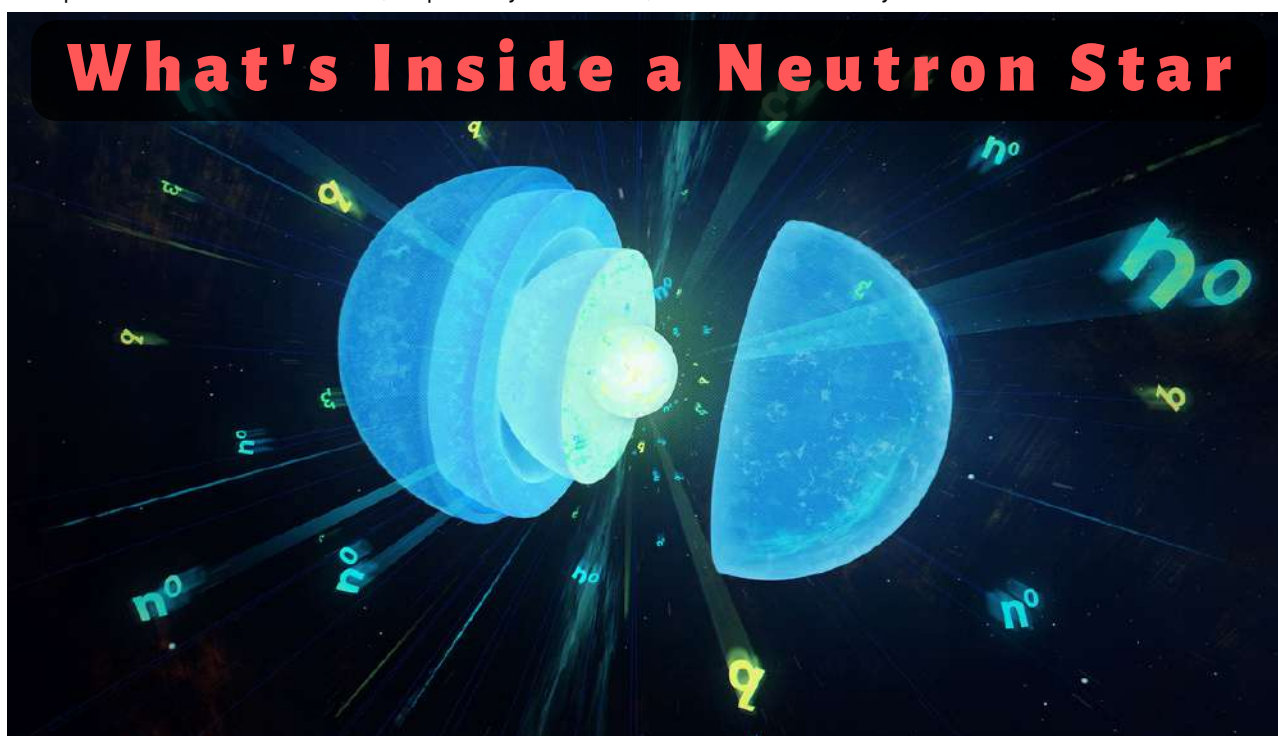
And this reddening is more than an interesting cosmetic effect. Astronomers can use the change in color to map the density of CB 130-3, granting them insight into the structure of this stellar nursery.

# A NEW APPROACH MIGHT HELP SCIENTISTS TO SEE WHAT'S INSIDE A NEUTRON STAR

**Astrophysicists tested a potential approach to determining the state of the matter inside a neutron star, a tricky feat.**

When massive stars explode, they can collapse into extremely dense and mysterious objects known as neutron stars. But neutron stars are too far away and much too small for even the most powerful telescopes to look inside, so scientists want to find a way to figure out what a neutron star is made of. In new research, astrophysicists tested a potential approach to determining the state of the matter inside a neutron star. (More familiar states of matter are solid, liquid and gas.)

What scientists want to know is a neutron star's equation of state or EoS. This equation describes the properties of matter in an object or substance. But getting the precise measurements needed to solve this equation for a neutron star, especially its radius, has not been easy.



So the researchers tested whether they could simplify the effort by substituting another measurement for the neutron star's radius. They turned to what scientists call the peak spectral frequency of the gravitational waves – ripples in space-time that are emitted when neutron stars merge into one larger neutron star.

The glob of dense star stuff that remains after such a collision will spew out massive gravitational waves as it moves back and forth while rotating at breakneck speed. The signal from these waves can be picked up by the hypersensitive instruments of a gravitational wave observatory like the Laser Interferometer Gravitational-Wave Observatory (LIGO).

"At least in principle, the peak spectral frequency can be calculated from the gravitational wave signal emitted by the wobbling remnant of two merged neutron stars," Elias Most, an astrophysicist at the Institute for Advanced Study in New Jersey and co-author on the new research, said in a statement.

Until now, scientists assumed  $f_2$  could stand in for a neutron star's radius because the two values are often linked to each other. But that is not always the case, the new research determined. Instead, to make the substitution work, scientists must incorporate a second value related to the neutron star's mass and radius.

The researchers hope that this determination will help scientists shed light on a theory that the neutrons in the cores of these stars break down into even smaller subatomic particles, called quarks.

## INDIAN ROCKET LAUNCHES EOS-06 OCEAN-STUDYING SATELLITE AND 8 TINY CRAFT

An Indian rocket Polar satellite launch vehicle launched an ocean-observing satellite and eight tiny ride-along spacecraft on Saturday Nov. 26th 2022 at 11:55 a.m. India Standard Time from Satish Dhawan Space Centre, on India's southeast coast.

The four-stage, 146-foot-tall (44 meters) PSLV deployed the primary payload, Earth Observation Satellite-06 (EOS-06), just over 17 minutes after liftoff, about 462 miles (743 kilometers) above Earth.

The 2,463-pound (1,117 kilograms) EOS-06 is the third spacecraft in India's Oceansat series. The satellite will use three science instruments to monitor sea surface temperatures and other ocean characteristics for at least five years. EOS-06 also carries a fourth instrument that will help beam data back to Earth.

After dropping off EOS-06, the PSLV's upper stage performed a series of maneuvers, descending to deploy the eight small satellites at an altitude of about 323 miles (520 km). The first of these passengers was expected to separate about 114 minutes into flight, and last deployed roughly six minutes later.

ISRO's PSLV successfully launched the EOS-6 ocean observing satellite and eight smaller satellites from the Satish Dhawan Space Centre on Nov. 26, 2022. (Image credit: ISRO)



These piggyback crafts are a diverse bunch. For example, four of them are "Astrocast" CubeSats, spacecraft about the size of a loaf of bread that will demonstrate "internet of things" technology, according to an ISRO mission description.

Another one, called Anand, will "demonstrate the capabilities and commercial applications of [a] miniaturized Earth-observation camera" in low Earth orbit, ISRO officials added.

Saturday's mission marked the 56th PSLV flight. The rocket is India's medium-lifter, capable of delivering up to 3,650 pounds (1,750 kg) of payload to sun-synchronous polar orbit.

India also operates a heavy lifter called the Geosynchronous Satellite Launch Vehicle (GSLV), which can haul 17,640 pounds (8,000 kg) to low Earth orbit. The nation also just debuted its Small Satellite Launch Vehicle (SSLV), but things didn't go according to plan; the rocket failed to deliver its payloads to the proper orbit during its inaugural mission in August.

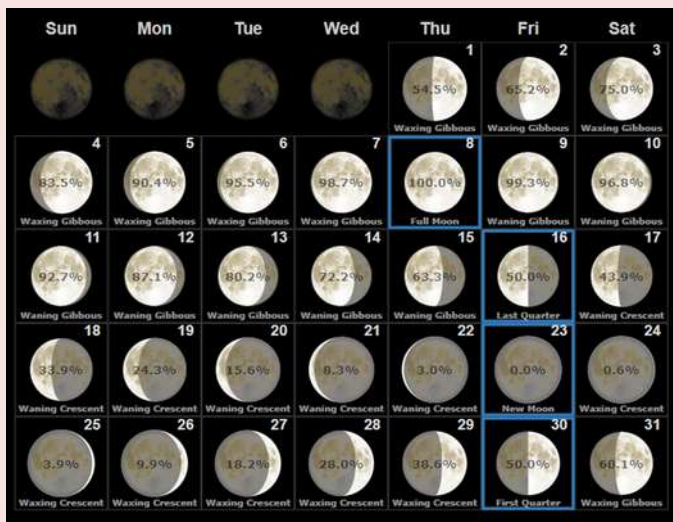
# WHAT'S UP IN THE SKY - DECEMBER 2022

## LUNAR CALENDAR

### IMPORTANCE OF MOON PHASES FOR STARGAZERS

One might wonder why it is important to refer to moon phases for star gazing. The reason is that the phases of the Moon reflect a great deal of illumination, and because the Moon is so close to us, it overrides the brightness of other celestial objects.

So, What Moon phase is best for stargazing? "The New Moon and the days immediately before and after the new moon (Crescent phases)" are among the best times for stargazing. Whereas the Remaining phases like Full Moon, waxing or waning gibbous, the first or third quarter Moon offers a time to zoom in and witness the features of the Moon.



## PLANETS VISIBILITY

### Mercury

Poor positioning at start but improving through the month, jostling with Venus in the evening twilight.



### Venus

Hidden in the sun's glare. Evening planet at the end of December.



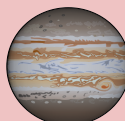
### Mars

Mars, a bright planet visible throughout the month, reaching opposition 8 December.



### Jupiter

Jupiter is easy to spot, brighter than all the stars. It's high in the east after sunset and sets earlier each night.



### Saturn

Saturn is high in the sky after sunset - golden in color, shining steadily, perfect for observing in the evening.



### Uranus

Well-placed evening planet shining at mag. +5.7.



### Neptune

Evening planet, close to Jupiter. Losing altitude by the end of the month.



## BRIGHT DEEP SKY OBJECTS

Messier 31, commonly known as the Andromeda galaxy is a barred spiral galaxy at approximately 2.5 million light-years from Earth. It is our next-door neighbor, with an apparent magnitude of 3.4. It is visible to the naked eye from Earth on moonless nights, even when viewed from areas with moderate light pollution.



Messier 39, also known as NGC 7092, is an open cluster of stars in the constellation of Cygnus. When observed in a small telescope at low power the cluster shows around two dozen members but is best observed with binoculars. It has a magnitude of 4.6 and spans an angular diameter of 32 arcminutes, about the full moon's size.

Messier 15, also designated NGC 7078 is a globular cluster in the constellation Pegasus. It is 12.5 billion years old, one of the oldest known globular clusters. It is one of the most densely packed globular clusters known in our galaxy. It has an enormous number of stars surrounding what may be a central black hole.



The Orion Nebula, designated as Messier 42, is a diffuse nebula situated in the Milky Way, being south of Orion's Belt in the constellation of Orion. It is one of the brightest nebulae visible to the naked eye in the night sky with an apparent magnitude of 4.0. It is 1,344 light-years away and is the closest region of massive star formation to Earth.

# ROCKET LAUNCHES IN DECEMBER 2022

## MAXAR-BUILT GALAXY 35 AND GALAXY 36 ARRIVE AT LAUNCH BASE FOR INTELSAT

Commercial launch services provider Arianespace and fleet operator Intelsat signed an agreement today for two launches of three satellites, Galaxy 35, Galaxy 36 and Galaxy 37, on Ariane 5 and Ariane 6 launch vehicles. The launch is scheduled for 2 a.m. IST from Kourou, French Guiana.

All three satellites will operate in the upper portion of the C-band spectrum, a range of wireless radio frequencies that is used for critical telecommunications and data connectivity around the world. With this mission, Intelsat will meet the accelerated C-band spectrum clearing timelines established by the U.S. Federal Communications Commission (FCC) earlier this year, in order to make the lower portion of the C-band spectrum available to mobile network operators to further the rollout of critical 5G services.

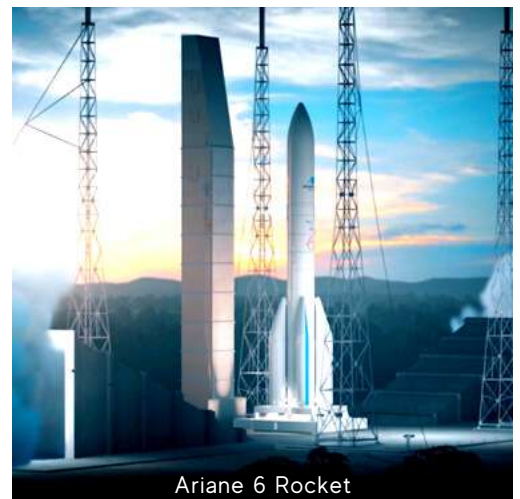
Maxar Technologies will build the three satellites, all using Maxar's industry-leading 1300-class platform, in its manufacturing facility in Palo Alto, California.



(Galaxy 35 (left) and Galaxy 36 (right) are shown here at Maxar's manufacturing facility in Palo Alto, California, ahead of shipment to launch base. These satellites will provide video distribution services to customers in the continental US) "We couldn't be more thrilled to sign this agreement to launch three payloads for Intelsat. It is a profound honor to see the perpetuation of this deep and lasting relationship with Intelsat while enabling the roll-out of 5G in the U.S. We are all the more honored that Intelsat has opted for an Ariane 6 vehicle for the first time," declared Stéphane Israël, CEO of Arianespace.

"Intelsat looks forward to continuing our longstanding partnership with Arianespace to launch these satellites, which are critical to accelerating the clearing of the C-Band spectrum and ensuring the U.S. maintains its leadership in 5G and other advanced telecommunications technologies," said Mike DeMarco, the Chief Services Officer of Intelsat.

**About Arianespace:** Arianespace uses space to make life better on Earth by providing launch services and solutions for all types of satellites (institutional and commercial) into all orbits. It has orbited more than 740 satellites since 1980, using its family of three launchers, Ariane, Soyuz, and Vega, from launch sites in French Guiana (South America) and Baikonur (Central Asia). Arianespace is headquartered in Evry, near Paris, and has a technical facility in Kourou at the Guiana Space Center, Europe's Spaceport in French Guiana, plus local offices in Washington, D.C., Tokyo, and Singapore. Arianespace is a subsidiary of ArianeGroup, which holds 74% of its share capital, with the balance held by 15 other shareholders from the European launcher industry.



Ariane 6 Rocket



# PLÉIADES NEO SATELLITES ARE READY TO JOIN REST OF FAMILY

**The Pléiades Neo 5 and 6 Earth observation satellites will launch aboard an Arianespace Vega-C rocket for Airbus from Kourou, French Guiana.**

Pléiades Neo is a very high-resolution optical constellation of four identical satellites phased at 90° from each other. The constellation provides continuity for the Pléiades mission, with enhanced performance in terms of accuracy, reactivity, and frequency. Fast tasking, high agility, and a huge volume of data are the main advantages of the mission. The constellation is manufactured, owned, and operated by Airbus Defence and Space.

Pléiades Neo 3, the first satellite in the constellation, was launched on 28 April 2021, followed by Pléiades Neo 4 on 16 August 2021. **Pléiades Neo 5 and 6 are planned to be launched on 21st December 2022.** The constellation remains operational.

The last two satellites of the Airbus-built owned and operated Pléiades Neo constellation are on track for launch later this year, following successful final tests in Toulouse's clean rooms.

Following the seamless parallel integration of both Pléiades Neo 5 and 6 satellites, and the successful conclusion of the environment (thermal vacuum, acoustic, vibration) test campaign, both final spacecraft are now ready to complete the Pléiades Neo constellation.

Both satellites are due to be launched simultaneously on the Vega C European launcher from Kourou, in French Guiana. To tackle this dual launch, the Airbus space engineers came up with a smart and efficient dispenser-free design, where the satellites are stacked on top of each other, linked only by a clamp band. This compact dispenser-free launch configuration saves volume and mass, as well as reducing cost. Simultaneously testing both satellites in their stacked launch configuration enabled significant time saving, with only four days needed to pass both the three axes Sine testing and the acoustic test.

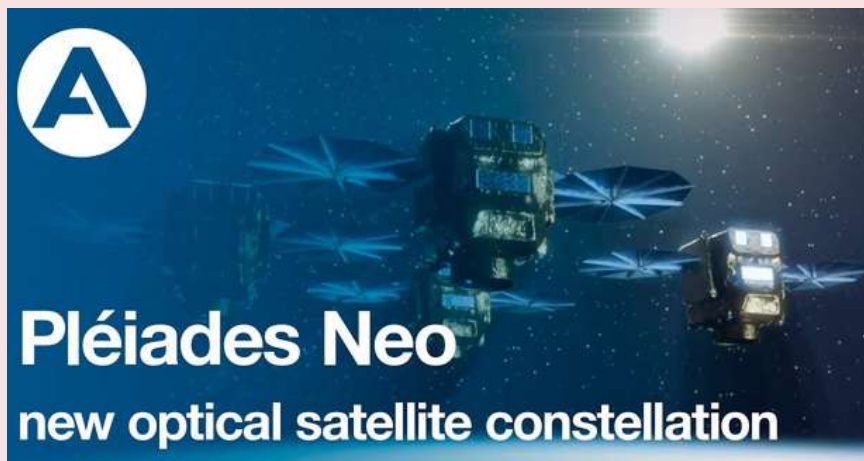
## Next-gen optical instrument

High resolution Pléiades Neo imagery offers an unmatched level of detail, including more visibility of small objects such as vehicles and road markings. This level of detection, recognition and identification provides more ground truth for image analysts and improves reliability for machine learning capabilities.

The constellation also will deliver higher geolocation accuracy and deeper spectral band information, allowing more insights to be derived for various applications, including the monitoring of strategic sites, commercial activities, maritime zones and the environment; along with mapping, infrastructure and urban development.

## Reshaping Earth observation-based services

In today's constantly changing environment where information is key, Pléiades Neo imaging enables fresh topographic mapping for many applications.



The satellites bring a significant level of information required for precise large-scale mapping in the military and civilian contexts up to 1:2000 scale, while the intraday revisit rate with the constellation's four identical satellites enables rapid acquisitions with frequent updates for any product layer. Additionally, Pléiades Neo's agility ensures multi-stereo acquisitions in one single pass which is essential in building topographic maps.

# SpaceX Launches - December 2022

## NASA'S SWOT MISSION NOW LAUNCHING IN DECEMBER BY SPACEX

NASA has selected Space Exploration Technologies (SpaceX) of Hawthorne, California, to provide launch services for SWOT. **Launch is targeted for December 15, 2022 on a SpaceX Falcon 9** rocket from Space Launch Complex 4E at Vandenberg Air Force Base in California. NASA's Launch Services Program at Kennedy Space Center in Florida will manage the SpaceX launch service.

**About the Mission:**

After considering the schedule for completion of the satellite build, transportation of the SWOT spacecraft from France to Vandenberg, and carrying out the remaining launch campaign tasks, the team determined that additional time was required to conduct these activities and prepare the satellite for launch.

SWOT is the first satellite mission that will survey nearly all water on Earth's surface. Its instruments will measure the height of water in the planet's lakes, rivers, reservoirs, and the ocean in higher definition than ever before. This will help to inform water equity and water management decisions, provide new insights into Earth's water and energy cycle, and help prepare communities for rising seas and changing coastlines in a warming climate.

**Mission Development Timeline**

SWOT was one of 15 missions listed in the 2007 National Research Council Decadal Survey of Earth science missions that NASA should implement in the subsequent decade. In its earliest stages, the mission underwent Concept Studies (Pre-Phase A) and Concept & Technology Development (Phase A).

In early 2015, SWOT entered Phase B, Preliminary Design & Technology Completion. In 2016, SWOT was approved for implementation and thus entered Phase C (Final Design & Fabrication).

To learn more about SWOT's latest progress towards launch, visit the Flight Systems and Ground Systems pages. To learn about the airborne instrument making measurements similar to those that will be made in space by SWOT to prepare for the hydrology post-launch Cal/Val, visit the AirSWOT page.



LIFECYCLE PHASES	Approval for Formulation	FORMULATION		Approval for Implementation	IMPLEMENTATION		
	Pre-Phase A: Concept Studies	Phase A: Concept & Technology Development	Phase B: Preliminary Design & Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly, Integration & Test, Launch & Checkout	Phase E: Operations & Sustainment	Phase F: Closeout

SWOT will launch in Phase D. Approximately the first six months after launch, it will be in a "fast-sampling" phase with a 1-day repeat orbit at an altitude of 857 km (532.5 mi). This initial period will focus on achieving calibration and validation objectives while studying rapidly changing phenomena. Members of the international ocean science community may participate in this phase by creating programs to deploy In situ assets in the regions covered by the SWOT fast-sampling orbit. This will provide a global series of experiments with fine-scale ocean campaigns, as well as ground-based data for comparison with SWOT's daily 2-D sea surface height data. The fast-sampling phase will end with an increase in the observatory's altitude to 891 km (553.6 mi).

Phase E (Operations & Sustainment), nominally lasting three years, will have a 21-day repeat orbit to balance global coverage and frequent sampling. This non-sun-synchronous orbit was chosen to minimize tidal aliasing and ensure coverage of major water bodies on land. SWOT's 120-km-wide (~75-mi-wide) swath will result in overlapping measurements over most of the globe with an average revisit time of 11 days.

# **ONEWEB AIMS TO DEPLOY A RECORD 40 SATELLITES IN SPACEX MISSION: DEC 8**

SpaceX is set to launch 40 OneWeb internet communication satellites atop its Falcon 9 Block 5 rocket. Lifting off from Launch Complex 39A, at the Kennedy Space Center, in Florida, the OneWeb 15 mission will place satellites into a polar orbit, which will raise to a 1,200 km polar orbit. OneWeb 15 will boost the number of satellites launched to 494.

## **What Is OneWeb?**

OneWeb is a planned satellite internet constellation with the goal of providing internet coverage to the entire globe. Similar to SpaceX's Starlink, the OneWeb constellation aims to deliver semi-low-latency internet to locations where ground-based internet is unreliable or unavailable.

OneWeb plans to have 648 satellites in its constellation, providing them with the 600 satellites needed for global coverage and an additional 48 on-orbit spares in case a satellite fails. These satellites are in a 1,200 km low-Earth polar orbit, which is significantly lower than the global internet services available today. The current satellite internet solutions orbit 35,786 km above the Earth, in geostationary orbit. However, the orbit of OneWeb's satellites is still significantly higher than the ~550 km orbit that SpaceX's Starlink satellites use. OneWeb is expecting the final 648 satellite constellation to provide download speeds of roughly 50 Mb/s.

The constellation consists of 18 orbital planes, with 36 satellites in each plane. However, in May 2020, OneWeb submitted an application to the FCC, requesting to increase its constellation size to 48,000 satellites. OneWeb has also announced that the second generation of the OneWeb network will be a global navigation satellite system (GNSS), like GPS.



**Artist depiction of a OneWeb satellite**  
(Credit: TechCrunch)

## **What Is Falcon 9 Block 5?**

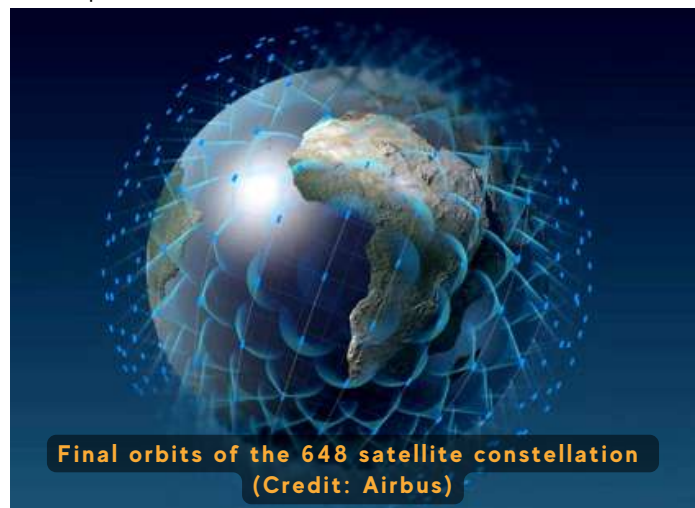
The Falcon 9 Block 5 is SpaceX's partially reusable two-stage medium-lift launch vehicle. The vehicle consists of a reusable first stage, an expendable second stage, and, when in payload configuration, a pair of reusable fairing halves.

## **What Is A OneWeb Satellite?**

Each OneWeb satellite has a compact design and a mass of 147.5 kg. The satellites are each equipped with a Ku-band antenna, operating between 12 and 18 GHz. One interesting note is that these satellites will use a slightly abnormal frequency, eliminating interference with satellites in geostationary orbit.

The OneWeb satellites were built by OneWeb Satellites, which is a joint venture between OneWeb and Airbus.

The satellites are designed to deorbit after 25 years safely. However, this leaves many concerned as this orbital region is already the most crowded with space debris.



**Final orbits of the 648 satellite constellation**  
(Credit: Airbus)

# SPACEX | FALCON 9 BLOCK 5 | EROS-C3



SpaceX is scheduled to launch a Falcon 9 rocket as part of the EROS-C3 mission. The launch window for the Earth Science mission is on 12th December 2022 12:28 IST from Vandenberg SFB, CA, USA. Don't miss this exciting rocket launch!

### **Mission: EROS-C3**

Israeli Earth Observation satellite with 38 cm resolution in panchromatic mode and 76 cm resolution in multi-spectral mode, covering a swath of ~12.5 km. The satellite is similar to OPTSAT-3000 built by Israel Aerospace Industries (IAI) for the Italian Defense Ministry.

### **Rocket: Falcon 9**

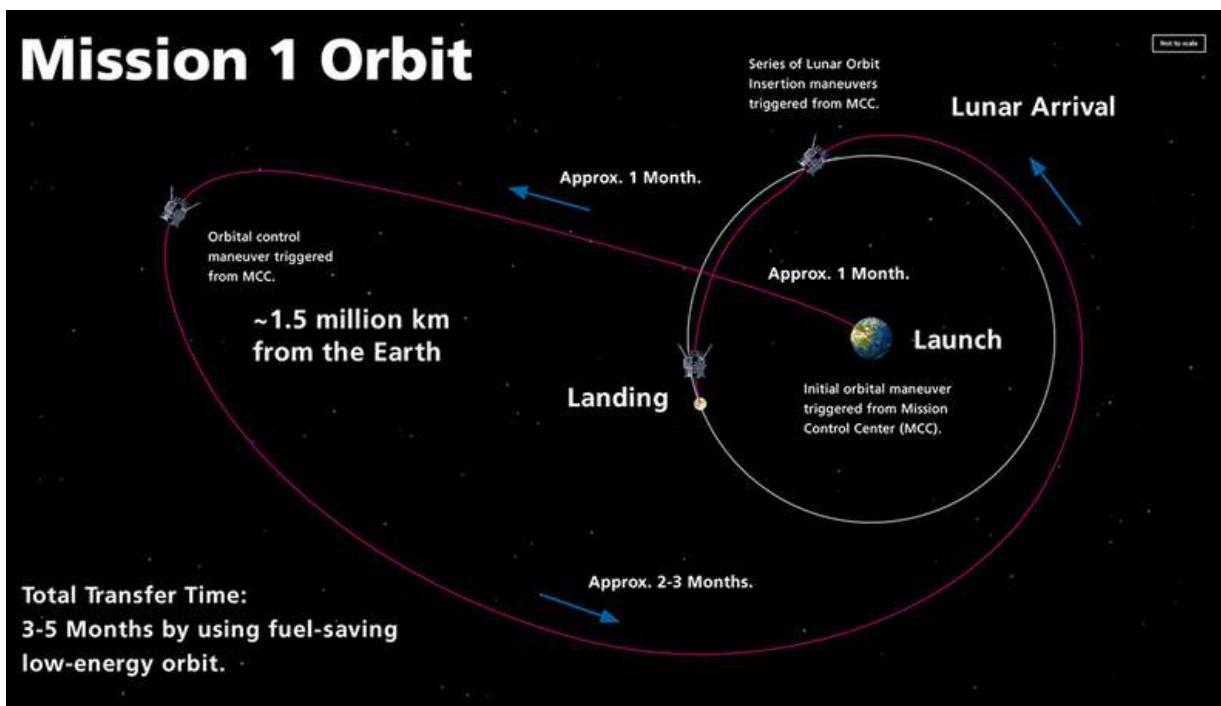
Falcon 9 is a two-stage rocket designed and manufactured by SpaceX for the reliable and safe transport of satellites and the Dragon spacecraft into orbit. The Block 5 variant is the fifth major interval aimed at improving upon the ability for rapid reusability.

# HAKUTO-R MISSION 1 LET'S GO TO THE MOON

The first mission will perform a soft landing on the Moon. This will be the first privately-led Japanese mission to land on the lunar surface.

## Mission Outline

Going to the Moon is not easy, in order for Mission 1 of the HAKUTO-R program to succeed, various hurdles have to be overcome.



## Series 1 Lander

The Series 1 Lander has been optimized for light weight, small size and reliability, aiming to succeed in the first commercial lunar landing.

# STARLINK SATELLITE SERIES

Starlink Group 2-2 | Group 2-4 | Group 4-24 | Group 4-37 | Group 5-1

SpaceX will launch five more batches of Starlink satellites in the month of December for their high-speed low earth orbit internet constellation on Falcon 9 Block 5 rocket from Space Launch Complex 4, Vandenberg Space Force Base, California.

A satellite constellation is a group of satellites that work in conjunction for a common purpose. Currently, SpaceX plans to form a network of 11,716 satellites; however, in 2019 SpaceX filed an application with the Federal Communication Commission for permission to launch and operate an additional 30,000 satellites as part of phase 2 of Starlink. To put this number of satellites into perspective, this is roughly 20 times more satellites than were launched before 2019.



# Virgin Orbit to launch “Start Me Up”, Amber-1 & Others

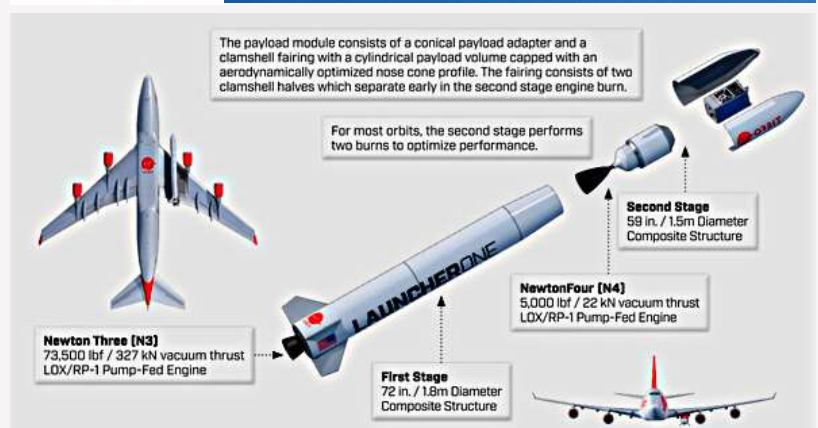
Virgin Orbit is sending several payloads to orbit onboard its air-launched rocket, LauncherOne, from the UK for the first time. This will be the first orbital launch from anywhere in Western Europe. Russia’s Plesetsk Cosmodrome is in Eastern Europe, not Asia. **The launch date is currently targeted for December 14, 2022.**

## What Is “Start Me Up”?

“Start Me Up” is the first orbital launch from the United Kingdom. Although the UK did develop its own orbital launch capability with the Black Arrow program, that rocket flew from the Woomera test range in Australia. The mission name is a tribute to the Rolling Stones song (previously used for the “launch” of Windows 95). Virgin Orbit names all of its missions after song titles that are on the Virgin Records catalogue.

Virgin Orbit will send a number of satellites into orbit on this launch. The Start Me Up manifest includes:

- **IOD-3 AMBER (aka IOD-3)** Developed by Satellite Applications Catapult and Horizon Technologies and built by AAC Clyde Space, all based in the UK, IOD-3 Amber is expected to be the first of more than 20 Amber satellites to provide space-based Maritime Domain Awareness (MDA) data to users.
- **Prometheus-2** Two cubesats owned by the UK Ministry of Defense’s (MOD) Defense Science and technology laboratory Dstl. These satellites, co-funded with Airbus Defence and Space who are designing them jointly with In-Space Missions, will support MOD science and technology activities both in orbit and on the ground through the development of ground systems focused at Dstl’s site near Portsmouth.
- **CIRCE (Coordinated Ionospheric Reconstruction CubeSat Experiment)** is part of a joint mission between the UK’s Defense Science and Technology Laboratory and the US Naval Research Laboratory.
- **DOVER** Developed by RHEA Group in the UK, it is the company’s first satellite in its 30-year history. The satellite is being co-funded through the European Space Agency’s Navigation Program and built by Open Cosmos of the United Kingdom. DOVER is a SmallSat that was created as a pathfinder for resilient global navigation satellite systems.
- **ForgeStar-0** Developed by Space Forge of Wales, the satellite is a fully returnable and reusable platform to enable in-space manufacturing. This launch will be the first for the company’s ForgeStar platform and will test future returns from space technology.
- **AMAN:** Oman’s first orbital mission, it is a single earth observation satellite meant to demonstrate the future feasibility of a larger constellation and was developed after a memorandum of understanding among the Sultanate of Oman, Polish Small Satellite manufacturer and operator SatRev, Poland originated AI data analytics specialists TUATARA, and Omani based merging technology innovator ETCO. The agreement includes additional planned small satellites, including this, the first in Oman’s history.



- **STORK-6** is the next installment of Polish Small Satellite manufacturer and operator SatRev’s STORK constellation. Virgin Orbit previously launched two spacecraft in this constellation on a previous launch and looks forward to continuing to launch SatRev’s STORK spacecraft in the future.



### Rocket Lab's Electron Rocket Set For December Launch

NASA's Wallops Flight Facility will support the launch of Rocket Lab USA's first Electron rocket from Virginia at 6 p.m. EST, Friday, Dec. 9.

**Mission Overview:** The mission, named "Virginia is for Launch Lovers," will deploy radio frequency monitoring satellites for HawkEye 360. The 59-foot-tall Electron rocket will lift off from Launch Complex 2 at Virginia Space's Mid-Atlantic Regional Spaceport on Wallops Island.

The launch window for the mission is 6 to 8 p.m. The backup launch days are Dec. 10 to 20.

With this mission, NASA is helping foster a growing low-Earth space economy and continues Wallops' 35-year history of support to the commercial launch industry.

The launch may be visible, weather permitting, to residents throughout much of the east coast of the United States.

Viewing locations on Chincoteague Island include Robert Reed Park on Main Street or Beach Road spanning the area between Chincoteague and Assateague Islands. The Virginia, Maryland and Delaware Atlantic beaches also provide good viewing locations. The NASA Visitor Center at Wallops will be open for this launch.

**\*\*Note: Launch dates of missions are scheduled to be launched in December 2022 but may subject to change.**

# ASTRONOMICAL EVENTS - DECEMBER 2022

## MARS AT OPPOSITION: 08 DECEMBER

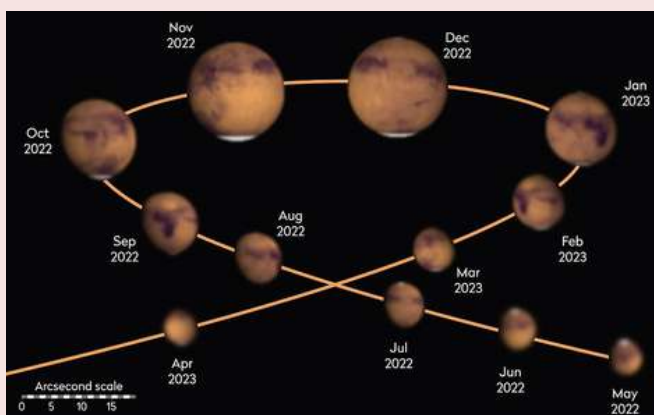
### *Best day to observe Mars*

#### What is Opposition?

Opposition is the planetary equivalent of a full Moon. When a planet is close to the Earth, and on the opposite side of the Earth to the Sun, we say that planet is in opposition. In the same way that sunlight is fully reflected during the full Moon phase in the lunar cycle, the sunlight that shines on the planet is also fully reflected.

"All superior planets - the term describing planets with larger orbits than Earth - reach opposition, but the improvement in visibility is particularly dramatic for 'nearby' Mars," he says.

Only those planets that are beyond Earth's orbit can be in opposition: Mars, Jupiter, Saturn, Uranus and Neptune. Because Mercury and Venus orbit the Sun inside the path of Earth's orbit, they can never be in opposition. This is because the Earth will never be situated between them and the Sun.



**Mars will reach opposition on 8 December 2022**, when it will be at its brightest for the year, essentially creating a 'full' Mars. The Red Planet comes closest to Earth a week earlier, on 1 December. At this time, Mars will be just 81.45 million kilometers away from the Earth.

Opposition can occur at any point along Mars' orbit, so the distance between Earth and Mars can vary year on year. If you remember the 2003 opposition, then you'll also remember it was the closest approach in a whopping 60,000 years!

At opposition, Mars' **constellation is Taurus the Bull**.

Its opposition brightness is **magnitude -1.9** (maximum brightness for 2022). At this point, although Mars is brighter than all the stars, it still won't be as bright as Venus or Jupiter.



(Graphic showing the apparent changes in size as Mars enters into opposition on 8 December 2022. Image by In The Sky/ NASA/ Hubble Space Telescope)

#### The Moon and Mars close together on December 8, 2022

On the night of the Mars opposition, you'll be able to see another celestial event - a conjunction of the Moon and Mars. The Full Moon will pass 0°32' from the Red Planet in the constellation Taurus.

Observers from Northern America, Europe, and Northern Africa are especially lucky as they will also have a chance to witness a lunar occultation of Mars on the same night. At the time of the occultation, the Moon will pass in front of Mars, completely covering it.

**The next opposition of Mars will occur only in 2025.**





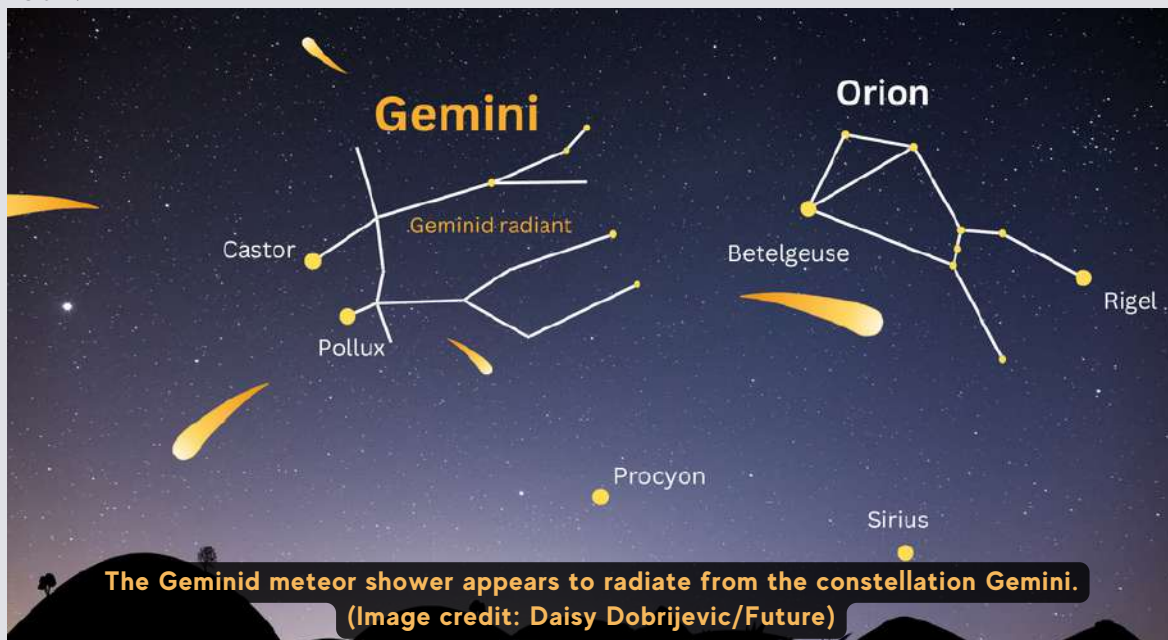
# GEMINIDS METEOR SHOWER - 2022

The Geminids are considered to be one of the most spectacular meteor showers of the year, with the possibility of sighting around 120 meteors per hour at its peak, which is on December 14 or 15, depending on your time zone.

The shower owes its name to the constellation Gemini because the meteors seem to emerge from this constellation in the sky.

## An Asteroid Meteor Shower

Unlike most other meteor showers, the Geminids are not associated with a comet but with an asteroid: the 3200 Phaethon. The asteroid takes about 1.4 years to orbit the Sun.



## How to See the Geminids

You don't need any special equipment or a lot of skills to view a meteor shower. Even though all you really need is a clear sky, lots of patience, and our handy Interactive Meteor Shower Sky Map with a visibility conditions meter to see a meteor shower, the following tips can help maximize your shooting star viewing experience.

- Find a secluded viewing spot, away from the city lights. Once at the venue, your eyes may take 15 to 20 minutes to get used to the dark.
- Dress for the weather, and make sure you are comfortable, especially if you plan to stay out long. Bring a blanket or a comfortable chair with you—meteor watching can be a waiting game.
- Once you have found your viewing spot, lie down on the ground and look at the sky. You can use our Interactive Meteor Shower Sky Map or the table above to find the direction of the radiant; the higher the radiant is above the horizon, the more meteors you are likely to see.
- Meteor showers appear to originate from the radiant, but meteors can appear in any part of the sky.



# THE WINTER SOLSTICE

**There are two solstices every year: one in June and one in December. The December solstice (December 21) marks the shortest day north of the equator and the longest day in the south.**

## Sun Reaches Most Southerly Point

The December solstice is the moment the Sun is directly above the Tropic of Capricorn in the Southern Hemisphere. This is the **southernmost latitude** it reaches during the year. After the solstice, it begins moving north again.

## Why Is It Called a "Solstice?"

During the course of a year, the subsolar point—the spot on the Earth's surface directly beneath the Sun—slowly moves along a north-south axis. Having reached its northernmost point at the June solstice, it starts moving southward until it crosses the equator on the day of the September equinox. At the December solstice, which marks the southernmost point of its journey, it stops again to start its journey back toward the north.

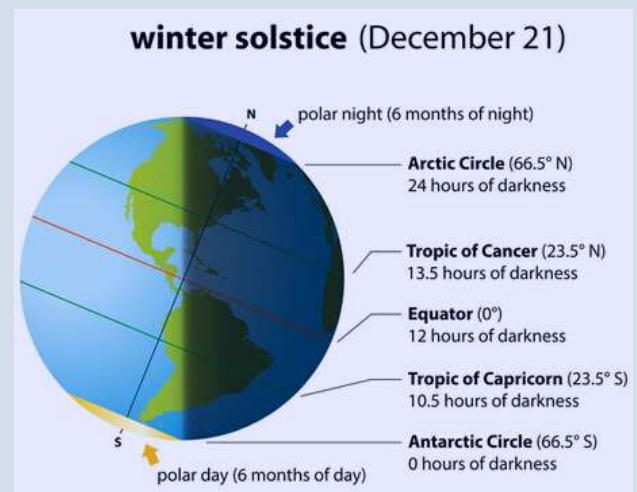
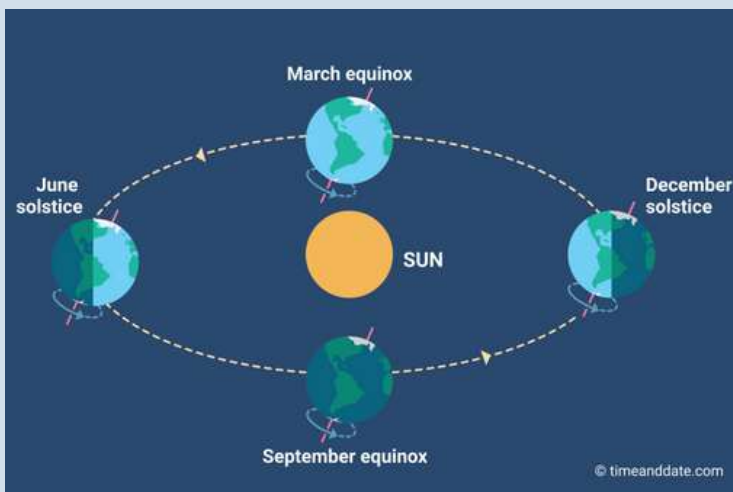
This is how the solstices got their name: the term comes from the Latin words *sol* and *sistere*, meaning "Sun" and "to stand still".

Initially, the naming arose from observations of how the Sun's apparent path across the sky changes slightly from one day to the next, which is caused by the same process as the subsolar point's movement described above.

In the months leading up to the December solstice, the position of sunrise and sunset creeps southward. On the day of the solstice, it reaches its southernmost point. After that, the daily path of the Sun across the sky begins to creep northward again.

## Sunrise and Sunset Times Lag Behind

The shortest day of the year is commonly associated with the latest sunrise and earliest sunset of the year. However, in most locations, the earliest sunset happens a few days before the solstice, while the latest sunrise occurs some days after it.



## Why Does the Sun Move North and South?

The subsolar point moves north and south during the year because the Earth's axis is tilted at an angle of about 23.4° in relation to the ecliptic, an imaginary plane created by Earth's path around the Sun. In June, the Northern Hemisphere is tilted toward the Sun, and the subsolar point is north of the equator. As the Earth travels toward the opposite side of its orbit, which it reaches in December, the Southern Hemisphere gradually receives more sunlight, and the subsolar point travels south.

## Why Does the Date Vary?

The date of the equinoxes and solstices varies because a year in our calendar does not exactly match the length of the tropical year—the time it takes the Earth to complete an orbit around the Sun.

Today's Gregorian calendar has 365 days in a common year and 366 days in a leap year. However, our planet takes about 365.242199 days to orbit the Sun. This means that the timing of the equinoxes and solstices slowly drifts apart from the Gregorian calendar, and the solstice happens about 6 hours later each year. Eventually, the accumulated lag becomes so large that it falls on the following date.

To realign the calendar with the tropical year, a leap day is introduced (nearly) every four years. When this happens, the equinox and solstice dates shift back to the earlier date again.

Other factors influencing the timing of the equinoxes and solstices include variations in the length of a tropical year and in the orbital and daily rotational motion of the Earth, such as the "wobble" in the Earth's axis (precession).

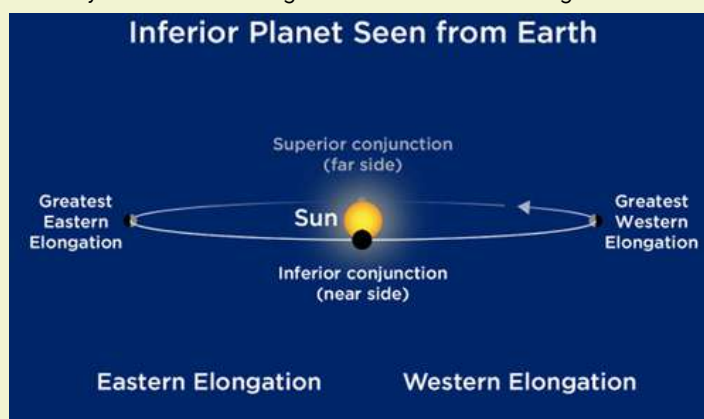
# MERCURY AT GREATEST EASTERN ELONGATION

## *Best day to observe Mercury*

### Greatest Eastern Elongation

On Dec 21, 2022 Mercury will reach its greatest separation from the Sun in its 2022 evening apparition. It will be shining at magnitude  $-0.6$  but afterwards brightens for the rest of December. At greatest elongation, Mercury is farthest from the sunset for this evening apparition, and 20 degrees from the sun in the evening sky.

Through a telescope, Mercury appears 60% illuminated, in a waxing gibbous phase. Mercury is having its fourth evening apparition for 2022. Wow! In fact, start looking for Mercury in the evening sky the second week of December. It will reach greatest elongation on December 21, 2022. As a bonus, Mercury will be 5 degrees away from dazzling Venus that evening.

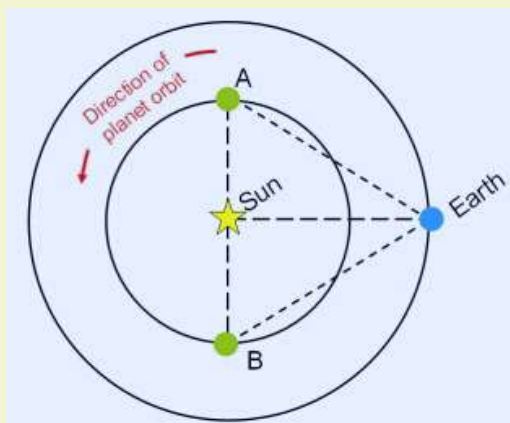


### What's Elongation

Astronomers use the word elongation to describe the angular distance – the distance on the sky's dome – between the sun and one of the inner planets in our solar system, Mercury or Venus. Elongations are measured in degrees eastward or westward of the sun. Greatest elongations signal the best time to observe one of the inner planets. At greatest elongation, Venus or Mercury is typically farthest from the sun's glare.

### A comparison of Elongations

As a matter of fact, not all of Mercury's greatest elongations are created equal. Indeed, some are greater than others. Ultimately, the farthest from the sun that Mercury can ever appear on the sky's dome is about 28 degrees. And the least distance, comparatively, is around 18 degrees. Also, elongations are better or worse depending on the time of year they occur.



The position of an inferior planet at greatest western elongation (position A) and greatest eastern elongation (position B). In both cases, the elongation measured is less than 90 degree.

In 2022, the Southern Hemisphere had the best evening elongation of Mercury in August and the Northern Hemisphere had the best evening apparition in April.

In the autumn for either hemisphere, the ecliptic – or path of the sun, moon and planets makes a narrow angle to the horizon in the evening. But it makes a steep slant, nearly perpendicular, in the morning. So, in autumn from either hemisphere, morning elongations of Mercury are best. Then, Mercury appears higher above the horizon and farther from the glow of the sun. However, evening elongations in autumn are harder to see. But, in the spring for either hemisphere, the situation reverses.

### **The December Mercury elongation is decent for both hemispheres**

Yet for this December elongation of Mercury, neither hemisphere is really favored for viewing the elusive planet. Overall, it's a decent apparition for both hemispheres.

# CONJUNCTIONS FOR THE MONTH

**Conjunction** - Occasionally two or more objects meet up with each other in our sky. Astronomers use the word conjunction to describe these meetings. Technically speaking, objects are said to be in conjunction in that instant when they have the same right ascension on our sky's dome. Practically speaking, objects in conjunction will likely be visible near each other for some days.

The word conjunction comes from Latin, meaning to join together. Maybe you remember the old Conjunction Junction cartoons from the 1970s. In language, conjunctions relate to clauses brought together in sentences with words like and. In astronomy, conjunctions relate to two or more objects brought together in the sky.

An astronomical conjunction describes a few different types of meetings. The first two types we're describing here - inferior and superior conjunctions - involve the sun and thus can't be seen.

## Conjunction of Moon with Mars

On **December 8, 2022**, Moon and Mars will be close to each other in the late evening and can be seen throughout the night. The Moon & Mars will be at a mag. of -12.74 & -1.87 respectively.



## Close encounter of Moon and Saturn

On **December 26, 2022**, Moon and Saturn will be very close to together in Early night sky. The Moon is at a magnitude of -10.65, and Saturn at a magnitude of 0.82.



## Conjunction of Moon and Jupiter

**Date: 29th December**, Moon will have a closer approach with the Jupiter. The Moon is at a magnitude of -11.83, and Jupiter at a magnitude of -2.24. They will be in the western direction as night begins and will cross the sky throughout the night.



## Conjunction of Venus and Mercury

On **December 29**, Venus and Mercury appear very close to each other. They will be in the southwest direction just before sunset. The Venus is at a magnitude of -3.80, and Mercury will be at a magnitude of 0.53.



# PLANETARY PARADE FROM DEC 22ND TO 30TH

This December, the bright planet Jupiter and the next best bright planet Saturn will be very close together, almost 40 degrees apart in the night sky. Both planets will be about halfway up the southern sky during evening twilight. Since Jupiter is very bright, it is easy to spot. If you look at two hand spans to the right of Jupiter, then you will find Saturn.

We are lucky to spot not only Jupiter and Saturn, but other planets like Mercury, Mars, and Venus as well in the night sky. As per the name, Venus and Mercury will be visible only for a short time in the evening, but Jupiter, Saturn, and Mars will be visible throughout the night. Depending on what day you are viewing, Mercury will be a dimmer dot either just to the left of, above or to the right of Venus. If you can see Mercury and Venus, you can also see Saturn up and to the left of Venus.

Jupiter is up and to the left of Saturn, and an orange Mars is low in the northeast sky – giving you a chance to view all five naked-eye visible planets at the same time! The Moon also joins this planetary alignment between December 22 – 30.



Place: Chennai / Date: 26th December / Time: 6.30PM

## URSIDS METEOR SHOWER



### What is it?

Meteors are debris that enters our planet's atmosphere at speeds of up to 70 km per second, vaporizing and causing the streaks of light we call meteors. Ursids meteors appear to radiate from near the Beta Ursae Minoris (Kochab) in the constellation Ursa Minor. However, the actual source of the shooting stars is a stream of debris left behind by comet 8P/Tuttle.

### When does it happen?

The Ursid meteor shower occurs around the time of the winter solstice, that is, on the 22nd and 23rd of December, so we have maximum hours of darkness for stargazing! This year, the shower occurs on New Moon, so conditions are extremely favorable.

### How to see it?

They can be seen with the naked eye so there's no need for binoculars or a telescope. The meteors can be seen in all parts of the sky, but if we trace the paths that the meteors take, they seem to originate from the Ursa Minor constellation. We can see almost 10 showers per hour.



# STUDENT'S CORNER

## *Journey through the eyes of Voyager 1*

Sourajit Mandal

iAstronomer member.

The solar system is an exciting place. It is a place where we can see all kinds of unexpected things. No one can ever know about all the things that take place in our solar system. We still do not know anything about the outer planets in our solar system except from the information given to us by the two most amazing flyby missions till date, the Voyager missions.

In 1977, the planets had aligned in an exceedingly rare configuration that occurs only once in 176 years. This configuration was propitious for the two flyby missions. This alignment of the planets allowed the Voyager missions to go from planet to planet accelerating as they entered the gravitational attraction of one.

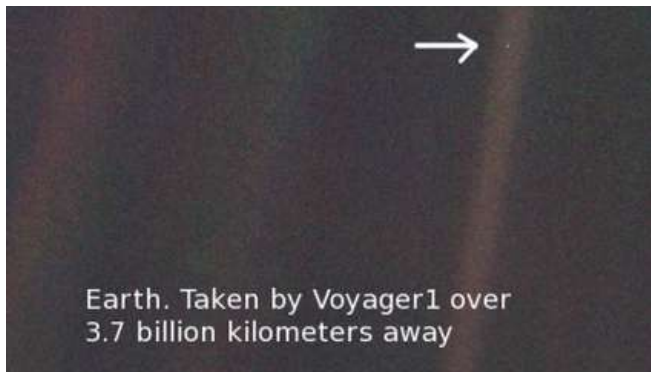
The Voyager 1 was launched on 5th September 1977. Its first click was a one frame click of the Earth and Moon at 11.66 million kilometers. It showed us its amazing capabilities.

Next its, Jupiter flyby started on January 1979. It was an amazing opportunity for scientists to study Jupiter. It came closest to Jupiter on 5th March of the same year. In total it took 19000 pictures of the planet and its moons. It also took many scientific measurements which were of extreme importance to scientists. Its greatest discovery was of active volcanoes on Io. It was the first time that active volcanism was seen in other bodies of the solar system. It was also seen that Io was the primary source of matter to the magnetosphere of the Jovian system. Sulfur, Oxygen, and Sodium, erupted from the volcanoes of Io and sputtered off the surface by impact of high-energy particles. They were detected at the outer edge of the magnetosphere.



After Jupiter, Voyager 1 had its Saturn flyby starting on November 1980. It discovered many things about Saturn along with the amazing pictures. It was found that about 7 percent of the volume of Saturn's upper atmosphere is Helium, while all the rest is Hydrogen. Wind speeds of about 1800 km/h was also measured at the equator of Saturn. With the flyby of Saturn, the primary mission of Voyager 1 was complete.

## GALACTICA



After 10 whole years, on valentine's day 1980, at a distance of 6 billion kilometers, Voyager 1 was instructed to turn its camera towards Earth for one last time.

The picture it clicked was the farthest picture of Earth till date, the "Pale blue dot".

There is no better description of the 0.12-pixel image of the Earth than Carl Sagan in his book Pale Blue Dot: A Vision of the Human Future in Space.

"That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every 'superstar,' every 'supreme leader,' every saint and sinner in the history of our species lived there on a mote of dust suspended in a sunbeam. The Earth, is a very small stage on the vast, cosmic arena."

On 14th December 2004, at the distance of 14 billion kilometers, Voyager 1 crossed the termination shock, the boundary marking one of the outer limits of sun's influence and is one boundary to the solar system.

Next on 25th August 2012, it crossed the heliosphere. The heliosphere is like the outermost atmospheric layer of the Sun. On the same day, Voyager 1 crossed the heliopause. The heliopause is the boundary between solar wind and interstellar wind, where the pressure of the two winds is in balance. This balance in pressure causes the solar wind to turn back and flow down the tail of the heliosphere. With this Voyager 1 was the first to reach interstellar space.



The Voyager carries a phonograph record. The record has sounds and images chosen to show the diverse culture of life here on Earth. It also shows the exact location of the Earth in respect to some of the brightest and biggest stars in case some intelligent extraterrestrial life form finds them.

With the current speed of about a million miles a day, Voyager 1 spacecraft won't enter the Oort Cloud for about 300 years. Also, it would not exit the Oort cloud for about 30,000 years. The Oort Cloud is a spherical layer of frozen objects that surrounds our Sun, a star, and is thought to be found between 2,000 and 100,000 astronomical units (AU) from the Sun.

Voyager 1 will still be there when our planet will be no more. So, wherever the Voyager will go, it will have an amazing story to tell. And the story will be... "We existed".

# Journey through the eyes of Voyager 2

Sourajit Mandal

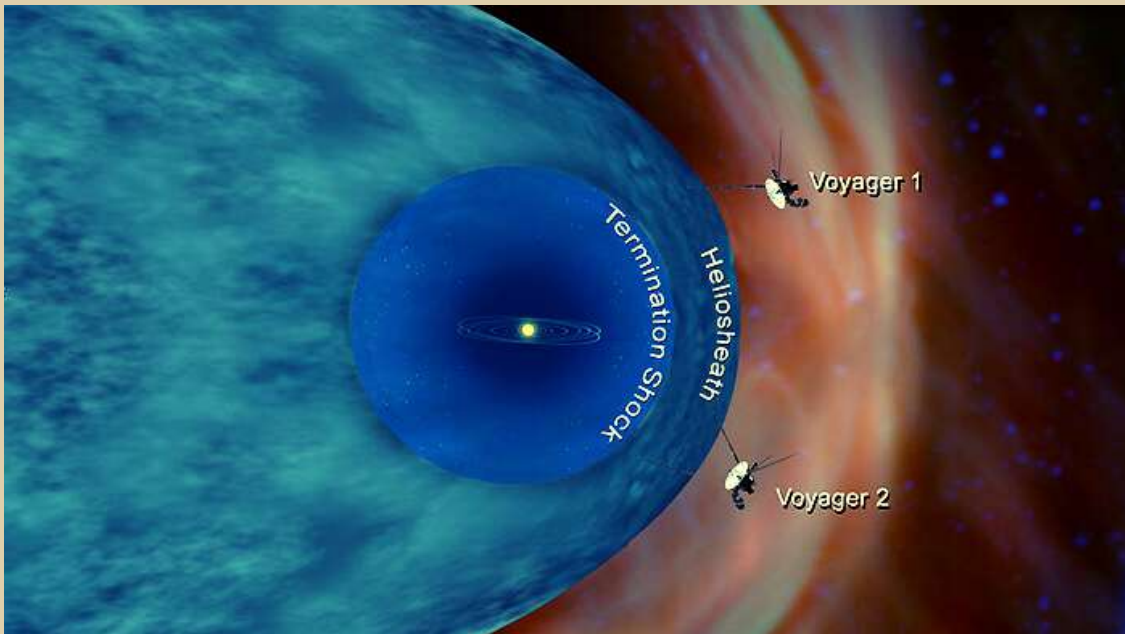
iAstronomer member.



The Voyager 2 was launched on 20th August 1977. It was the first satellite to fly past four planets in a row- Jupiter, Saturn, Uranus, and Neptune. Also, it was the first and only satellite to fly past the outer planets- Uranus and Neptune.

Voyager 2 crossed the asteroid belt between Mars and Jupiter between 10th December 1977 and 21st October 1978. In April 1978, its primary radio receiver failed, and it has been using its backup radio receiver ever since.

Its first Jupiter flyby started on 24th April 1979 sending back its first images and taking the first scientific measurements. During its inbound journey it studied many moons of Jupiter like Callisto, Ganymede, Europa, and Amalthea. Its closest distance to Jupiter was about 5,60,000kms from its cloud tops only. In its outbound journey, it studied Io and conducted a 10-hour volcano watch of the moon. This confirmed Voyager 1's finding of active volcanic activity on Io. It also revealed that the Great red spot was a complex storm system. It took many pictures of smaller storms on Jupiter too. High resolution pictures of the moon Europa revealed extensive irregular markings on its surface showing a frozen crust and a deep ocean underneath. Voyager 2 confirmed the existence of thin ring surrounding the planet. It discovered the previously unknown moon Adrastea orbiting Jupiter just outside its rings. In total it returned 17000 pictures of the planet and its satellites.

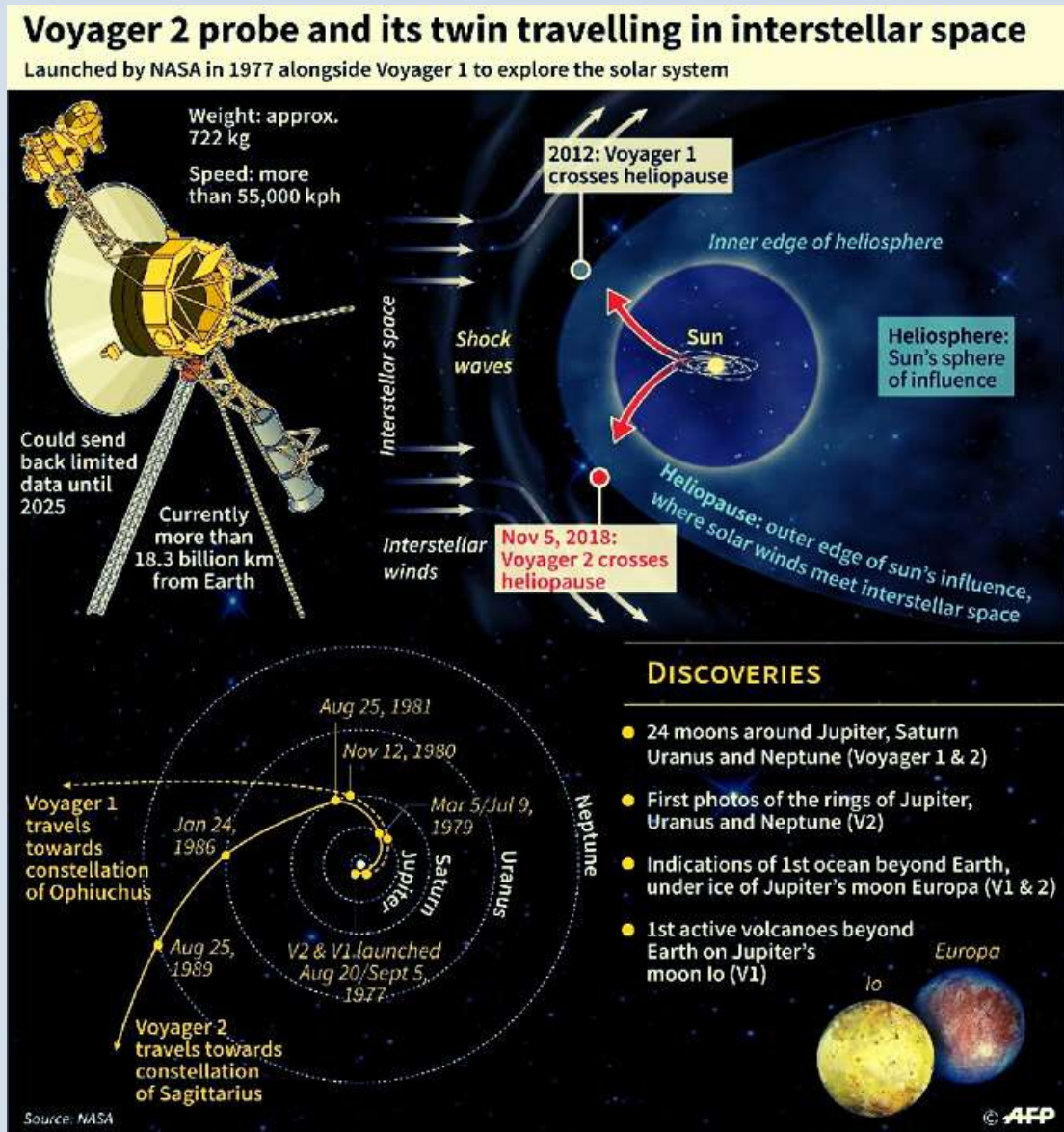


Voyager 2 came closest to Saturn on 26th August 1981. While passing Saturn, the satellite gathered a lot of information on Saturn's atmosphere. The north pole of Saturn was found to be 10 Kelvin cooler than the equator. It also found out hexagonal storms on Saturn which was later confirmed by Nasa's Cassini mission. With this, Voyager 2 was given a go-ahead to explore the Uranian system.



## GALACTICA

Voyager 2 came closest to Uranus within 81,500 kilometers on 24th January 1986. It radioed thousands of images along with many other scientific data of the planet—its moons, its rings, the atmosphere, and magnetic fields. The images of the 5 largest moons of Uranus showed a complex geologic past. The cameras also detected 11 previously unknown moons. It studied a lot about its rings along with discovering 2 new rings altogether. It showed that its rotation is 17 hours and 14 minutes. Its temperature is same on the equator as well as on the poles. Also, it found that the Uranian magnetic field is both large and unusual.



Voyager 2's next encounter was with Neptune on 25 August 1989. It went only 4,950 kilometers above Neptune's north pole. This was the closest encounter it had with any planet after its launch from Earth 12 years earlier. Just 5 hours later, it was the only 40,000 kilometers away from its largest moon Triton. It is the only spacecraft that has gone and studied Neptune till now.

With the Neptune flyby, Voyager 2's primary mission was complete. After this event, Voyager 2 started to move towards interstellar space.

In 2008, Voyager 2's main instruments were put off for saving power. Its magnetometer is still working and sending information back to us. It is estimated that it will send us information for 20 more years.

Voyager 2 has done a fantastic job in new scientific discoveries. Now, it will continue its journey across the vastness of cosmos discovering things, forever. And it will also have a story to tell. A story about us. The story will be..." We existed."

# CAPTURES FROM SPACE ASSOCIATED ASTRONOMERS



Sequence of Total Lunar Eclipse  
by Pranav Guru, iAstronomer member.



Daksh Rathi, iAstronomer member.



Nethra E J, iAstronomer member.



Sourajit Mandal,  
iAstronomer member.



Venkata Emani,  
iAstronomer member.



Jupiter with Galilean moons  
by Pareesa Dudia,  
Astronomy Club Student.

# ASTROPHOTOGRAPHS BY SPACE



The above Milkyway galaxy arm picture was captured by Senior Educator of SPACE Mr. Ranjith Kumar.



Polar star trail captured by Senior Educator of SPACE Mr. Yogesh Kumar Joshi.



Star trail captured by Educator of SPACE Mr. Ranadeep Das.



The Gas giants planets Jupiter and Saturn captured by Mr. Neeraj Ladia, CEO, Gnomon Astrotech Pvt Ltd.

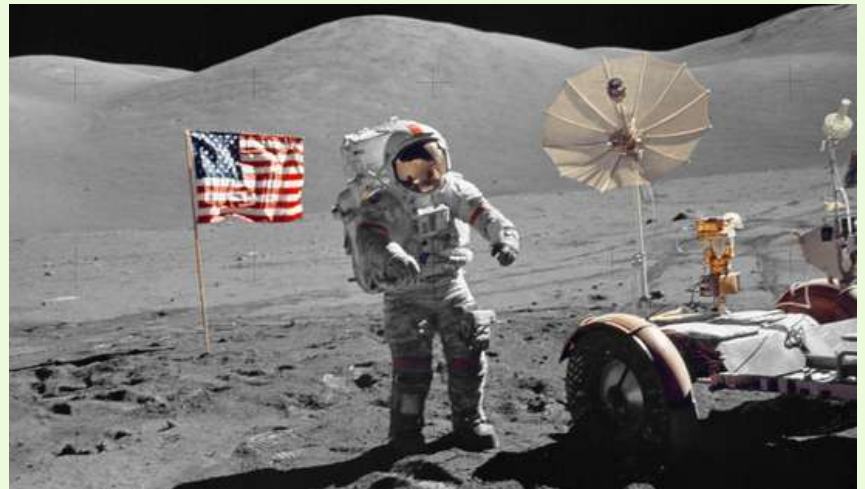
# HISTORICAL EVENTS HAPPENED IN DECEMBER

## Who took the first blue marble photo of Earth?

The most iconic image of the Earth is the one that looks like a blue marble. But can you believe that this is the first-ever taken photo of the earth as a full sphere? It's been fifty years since the image was taken but we still use this everywhere from newspapers, and magazines to websites and social media handle to show earth. To see the earth as a sphere we need to go almost 20,000 miles away from earth and only 24 humans have gone that far. NASA sent 9 Apollos to the moon from 1968 to 1972, but only in the last mission (Saturn V launched on 7th Dec 1972), they saw the round Earth.

The three men atop the rocket were Eugene Cernan, the Commander of Apollo 17; Harrison Schmitt, the Lunar Module Pilot, and Ron Evans, the Command Module Pilot. Schmitt discovered volcanic rocks that proved to be the oldest samples returned from the moon, while Cernan was the last man to walk there, an exit he dignified with humility and grace we can all be proud of.

At five hours and a few minutes into the flight of Apollo 17 one of the crewmen looked out the window and snapped a picture - actually four pictures, no more than a minute apart, changing the exposure after the first one. The second snap yielded the sharper image that's become famous. But whoever did it said nothing on the radio or to their crewmates about it. It's possible they did it instinctively, hardly thinking about it because none of them thought to mention it for weeks.



View of the Earth as seen by the Apollo 17 crew - astronaut Eugene A. Cernan, commander; astronaut Ronald E. Evans, command module pilot; and scientist-astronaut Harrison H. Schmitt, lunar module pilot traveling toward the moon. This translunar coast photograph extends from the Mediterranean Sea area to the Antarctica South polar ice cap. This is the first time the Apollo trajectory made it possible to photograph the South polar ice cap. Almost the entire coastline of Africa is clearly visible. The Arabian Peninsula can be seen at the Northeastern edge of Africa. (Credits: NASA)

It wasn't until the flight returned safely ten days later, that the film was processed - the first photograph of the whole, fully illuminated, astonishingly beautiful Earth. It created an immediate sensation, printed on the front page of nearly every newspaper on the planet, the image of our world as we had never seen it before.

After the picture became famous all three remembered seeing that remarkable sight and each was pretty sure they had snapped the shot. NASA policy is to credit the entire crew for all mission photography, so there is no official position. But, five decades later, arguments are still going on about who clicked the picture

# FIRST EVER LANDING ON ANOTHER PLANET

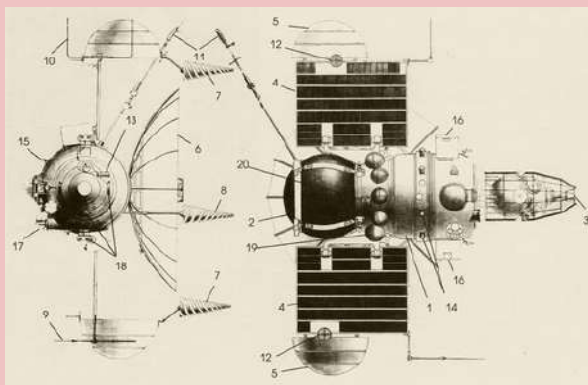


Venera Probe (Credits: NASA)

They were only able to send us information for a short time because the extremely high temperature and pressure on the surface of Venus melted and crushed the landers. This meant engineering a machine to endure pressures of 180 atmospheres and temperatures of 540° C (1,004° F).

Venera 7 was constructed as a single spherical shell using titanium and lined with shock-absorbing materials. This, the Soviets hoped, would enable the lander to survive the landing and remain on Venus, from where it could continue to relay new information about its surroundings.

Slipping into the nightside atmosphere on December 15 of that year, Venera 7 deployed its 2.5-sq-m (26.9-sq-ft) parachute at an altitude of 60 km (37 mi) with the intention of drifting safely down to the surface. Six minutes in, the parachute ripped. Twenty-nine minutes later, the probe smashed into the surface of Venus at a speed of around 60 km/h (37.3 mph), which was not part of the plan, but not entirely fatal to the mission either.



A 1962 diagram of the Venera probe and the landing sequence for the Soviet Union's Venera spacecraft (Credits: NASA)

Forty-five years ago on August 17, the then-Soviet Union launched Venera 7, a spacecraft that would eventually become the first probe ever to send data from the surface of Venus. Venera, (Russian for Venus), was the name given to the series of space probes the Soviet Union built between 1961 and 1984 to study Venus, both its surface environment and atmosphere. This meant some were designed to observe it from afar and some were designed to land on the planet's surface, a feat that had never been accomplished at the program's outset.

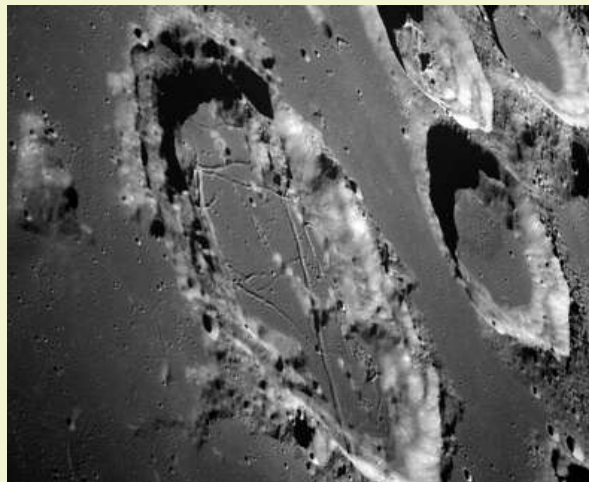
On December 15, 1970, an unmanned Soviet spacecraft, Venera 7, became the first spacecraft to land on another planet. Data revealed a temperature of around 475° C (878° F) at the surface, along with a pressure of 92 bar and wind speeds of 2.5 meters per second (5.6 mph). It sent data for 23 minutes before melting.



# CHRISTMAS IN THE MOON'S ORBIT!



Astronauts Frank Borman, Jim Lovell, and William Anders and the earthrise picture of the Earth clicked by William Anders. (Credits: NASA)  
The Apollo 8 mission was a critical step toward achieving President John F. Kennedy's goal of landing a man on the moon. It was launched on 21 December 1968, the shortest day of the year, but for the astronauts of Apollo 8, it would be one of the longest of their lives. It was the first manned space mission to leave Earth orbit and travel to another celestial body. Astronauts Frank Borman, Jim Lovell, and William Anders logged a record number of firsts in December of 1968 with Apollo 8's successful launch, execution, and recovery.



- The first manned flight of the Saturn V rocket.
- The first manned space mission to leave earth orbit.
- First humans to directly see the dark side of the moon.
- First humans to see Earth from beyond low Earth orbit.
- The first manned launch from the John F. Kennedy Space Center.
- First successful launch and recovery of humans into deep space.

The purpose of the mission was to study and take pictures of the moon's surface. The three astronauts began the day sitting on top of an untested rocket about to travel further from Earth than any human had been before. But it wasn't originally intended to go that far. The mission brief was initially to stay in low-Earth orbit and practice maneuvering with a lunar lander. But minding the space race, NASA took a drastic decision to send men on a powerful rocket, Saturn V, which had never been tested on a crewed launch.

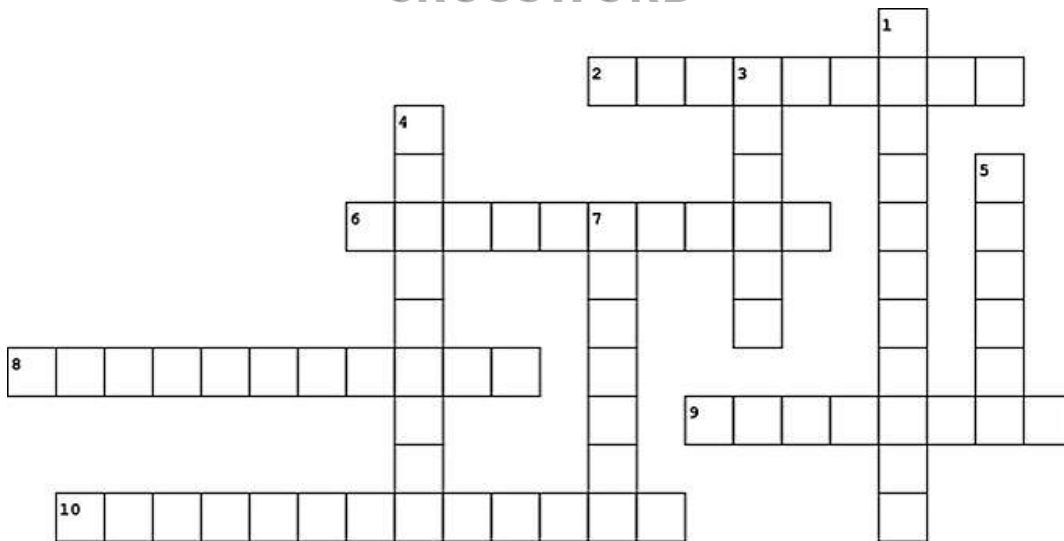
On Christmas Eve, 1968, over 1 billion people around the world were able to watch a grainy black and white TV picture and hear the scratchy voices of three men over 250,000 miles away describing the alien world outside their windows. William Anders said after the mission's successful return.

*William Anders said , " We came all this way to explore the Moon, and the most important thing is that we discovered the Earth", after the mission's successful return.*

It took almost three days for the astronauts to reach the moon and 20 hours to make ten lunar orbits. They returned to Earth with a successful splashdown in the Pacific on 27 December 1968. In addition to achieving a historic and important space-travel milestone, Apollo 8 also became known for the famous "Earthrise" photo that the astronauts captured. It was the first time humans saw what our planet looks like from space.

# TRAIN YOUR BRAIN

## CROSSWORD



Across

Down

- |   |  |
|---|--|
| <p>3. Name of the first confirmed interstellar comet?</p> <p>6. The only Indian who has a comet and an asteroid named after him?</p> <p>7. What's the name of the parent comet which is responsible for The Lyrids Meteor Shower?</p> <p>8. The parent comet for the famous Perseids Meteor Shower?</p> <p>9. Who discovered the second periodic comet which has the shortest orbital period?</p> | <p>1. The space rock which crashed on Jupiter in July 1994?</p> <p>2. The first rover to land on a comet?</p> <p>4. A region in the space where long period comets originate?</p> <p>5. A comet which has the longest period of orbit around the Sun (~70,000 years).</p> <p>7. Name of the celestial object which was visited by Stardust probes and The Deep impact mission.</p> |
|---|--|

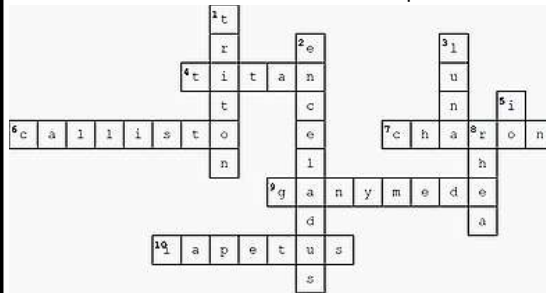
## ASTRONOMY WORD PUZZLE

Find the names of some of the famous Comets from the mixed letters and mark them.

Y	N	K	H	E	T	K	B	I	H	D	S	H	B
H	A	R	T	L	E	Y	E	K	A	C	H	H	E
E	T	L	C	T	A	W	N	E	H	T	O	Y	S
G	E	E	S	T	M	I	E	Y	A	U	E	A	U
H	H	S	C	U	E	U	T	A	L	A	M	K	O
W	E	S	T	T	B	N	T	S	L	A	A	U	H
L	T	H	H	T	M	E	E	E	E	E	K	T	E
A	A	A	O	F	C	O	K	K	Y	F	E	A	R
A	L	L	H	I	N	W	S	I	T	C	R	K	O
E	E	E	I	W	A	I	N	T	U	H	L	E	M
S	N	B	I	S	U	S	U	A	T	I	E	K	H
E	C	O	T	B	G	E	H	N	E	R	V	O	N
U	K	P	T	M	H	E	E	O	T	O	Y	S	Y
Y	E	P	C	T	T	S	C	D	R	N	E	O	P

- HALLEY
- WEST
- SWIFT TUTTLE
- MCNAUGHT
- MOREHOUSE
- CHIRON
- NEOWISE
- ENCKE
- SHOEMAKER LEVY
- HYAKUTAKE
- BIELA
- BENETTE
- HARTLEY
- DONATI
- HALE BOPP
- IKEYA SEKI

Answers for last month puzzles.



K	E	P	M	C	U	R	I	O	S	I	T	Y	T
M	I	S	G	R	U	A	M	A	S	C	O	T	R
Y	O	P	P	O	R	T	U	N	I	T	Y	N	N
N	E	A	Y	U	T	U	A	H	W	R	N	I	C
M	T	N	G	P	R	A	G	Y	A	N	I	M	Y
A	A	S	P	I	R	I	T	P	G	O	M	A	N
N	N	S	O	J	O	U	R	N	E	R	O	R	D
M	O	O	N	B	U	G	G	Y	A	R	M	S	O
E	C	N	A	R	E	V	E	S	R	E	P	O	H
E	R	O	W	D	R	A	N	B	O	A	O	K	K
N	T	T	I	A	N	W	E	N	O	O	E	H	O
R	A	R	G	N	O	R	U	H	Z	N	A	O	N
Y	S	V	E	N	E	R	A	H	O	I	D	D	U
I	U	O	M	I	N	E	R	V	A	G	M	U	L

\*\*Answers for this month puzzles will be shared in next magazine.

**BRAHMAND**  
A Flight of Knowledge

# iASTRONOMER

World's Largest Online Astronomy Club

**Inclusions:-**

-  **STEM Based Live Sessions by Astronomers**
-  **100+ Events & Interactions With Astronauts, Astronomers & Physicists**
-  **Access To Robotic Telescopes, Virtual Astronomical Observatories & Astrophotography**
-  **Profile Building For Admissions In Foreign Universities**
-  **Participation In National & International Opportunities By NASA, ESA & ISRO**
-  **Develop Scientific Temperament & Spirit of Enquiry**
-  **E-certification**

**Enrol Now, Open For All Age Groups**

[www.space-india.com](http://www.space-india.com) ☎ +91 95991 91909



**For Joining iAstronomer course visit - <https://learn.spaceindia.com/courses/iastronomer>**

**For Astronomy related products & equipment's visit - <https://spacearcade.in/>**

**Buy astronomical products from us**



**SPACE ARCADE**  
WWW.SPACEARCADE.IN  
A unit of SPACE Group of Companies  
One-stop solution of all your Astronomical Equipment needs



**ASTRO BINOCULARS**

**CELESTRON SKYMASTER 15X70**  
PRISM SYSTEM: BAK4 PRISM  
PRISM GLASS: BAK-4  
APERTURE: 70MM  
EXIT PUPIL: 4.7MM  
MAGNIFICATION: 15X  
ANGULAR FOV: 6.4 Deg




**CELESTRON SKYMASTER 20K80**  
PRISM SYSTEM: BAK4 PRISM  
PRISM GLASS: BAK-4  
APERTURE: 80MM  
EXIT PUPIL: 4MM  
MAGNIFICATION: 20X  
ANGULAR FOV: 3.7 Deg



**CELESTRON SKYMASTER 25X100**  
PRISM SYSTEM: BAK4 PRISM  
PRISM GLASS: BAK-4  
APERTURE: 100MM  
EXIT PUPIL: 4MM  
MAGNIFICATION: 25X  
ANGULAR FOV: 3 Deg

1 | [www.spacearcade.in](http://www.spacearcade.in) For all other models, availability and current pricing, please visit website.

**REFRACTOR TELESCOPES**




**SPACE LAUNCHER 60MM**  
TYPE: REFRACTOR  
MOUNT: ALT-AZ  
APERTURE: 60MM  
FOCAL LENGTH: 700MM

**CELESTRON POWERSEEKER 80EQ**  
TYPE: REFRACTOR  
MOUNT: EQ  
APERTURE: 80MM  
FOCAL LENGTH: 800MM

**SPACE PROBE 80EQ**  
TYPE: REFRACTOR  
MOUNT: EQ  
APERTURE: 80MM  
FOCAL LENGTH: 800MM

**REFLECTOR TELESCOPES**



**SPACE LAUNCHER 76MM**  
TYPE: REFLECTOR  
MOUNT: ALT-AZ  
APERTURE: 76MM  
FOCAL LENGTH: 700MM

**KSON 80MM NEWTONIAN**  
TYPE: REFLECTOR  
MOUNT: ALT-AZ  
APERTURE: 80MM  
FOCAL LENGTH: 800MM

**BRESSER 127EQ NEWTONIAN**  
TYPE: REFLECTOR  
MOUNT: EQ  
APERTURE: 127MM  
FOCAL LENGTH: 800MM

2 | [www.spacearcade.in](http://www.spacearcade.in) For all other models, availability and current pricing, please visit website.

## Brands







