

# Galactica

Astronomy and Space Science Magazine

## What's Inside?

SPACE Insights

Highlights From March

Moon Phases And Planet Visibility

What's Awaiting in April

Student's Corner

Historical Events Happened In April

April Born Legends

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.

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# 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 the 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, and 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 the 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, and professional organizations, government agencies, and space observatories

## CMD's Message



**Mr. Sachin Bamba,  
CMD, SPACE**

Space and Astronomy are 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 for students wherein they explore the real world of science, I wish for young students to let their ambitions soar and think big as they are the future of our country.

## CEO's Message



**Mr. Shivam Gupta,  
CEO & MD, SPACE**

Education is integral to humankind growth and it strongly contributes towards innovation and developments. Space is transforming India to provide better learning opportunities through Experiential and Hands-

on learning in the very niche field of Astronomy and Space Science. Our mission to build from the grassroots level is what drives us stronger and to impart science temperament so the next generation can be entrepreneurs, scientists & astronauts!

## SPACE INSIGHTS

# DISCOVER THE WONDERS OF THE NIGHT SKY "AN ASTRO NIGHT SKY TOURISM EVENT"



SPACE India collaborated with the National Science Centre, Ministry of Culture, and the Nehru Planetarium, New Delhi for the Astro Night Sky Tourism: A Sky Gazing Event at the Old Fort. Purana Qila, also known as Old Fort, is a historic site located in the heart of Delhi, India. The fort dates back to the 16th century and is a popular destination for tourists and locals alike.

On the 5th and 6th of March from 6:30 PM to 8:30 PM, a sky gazing event was held at Old Fort by SPACE India, where the general public was able to see the Moon, Planets, the Orion Nebula, and the Pleiades star cluster through Telescopes and Binoculars. Along with the observation of celestial objects, the event included various activities such as comet-making, rocket launches, and wandering through the solar system. Additionally, there were many fun games for kids of different ages.

The event began with a brief introduction to astronomy and the history of Purana Qila. Visitors were then led to the observation deck, which offered stunning views of the night sky. More than 500 people attended the event. Visitors were able to observe the craters on the moon, the Pleiades star cluster, and the Orion Nebula.

The Pleiades star cluster also known as the Seven Sisters is a group of stars that can be easily observed with the naked eye. It is located in the constellation Taurus and contains some 3,000 stars and lies about 444 light-years from Earth.

The Orion Nebula, on the other hand, is a diffuse nebula located in the constellation Orion. It is one of the brightest nebulae in the sky and is visible to the naked eye as a fuzzy patch of light. The Orion Nebula is also known as Messier 42 or M42, named after the French astronomer Charles Messier who cataloged it in the late 18th century.

The Astro Night Sky Tourism event is not only informative, and educational but also a fun and interactive experience. Visitors were able to explore the universe in a way that is not possible in their day-to-day lives. The event offered a unique opportunity to learn about astronomy and the cosmos while also enjoying the historic surroundings of Purana Qila.

The visitors were struck by a sense of humility upon realizing the vastness of the universe and the relatively small role that plays in it. They were particularly fascinated by the fact that celestial objects are located millions of kilometers away and that light from some of them can take many years to reach us. This realization helped put things into perspective and reminded them of the grandeur and age of the cosmos.

The event was a huge success, with kids beaming with excitement and wonder after looking at the moon up close. We witnessed surprise visitors when little kids and parents were wandering through the zoo near Old Fort and later out of excitement they joined us to witness the stars and planets through telescopes and binoculars.



# EXHIBITION AT CPS - GLOBAL

On 11th March 2023, Chennai Public School, Global, Anna Nagar conducted their annual exhibition - "**La Fenetre 2023**", Where the students exhibited their scientific models in various fields. like Physics, Chemistry, Biology, etc. The space club students demonstrated numerous activities including Safe solar observation using various methods, light painting, stomp rockets, weighing on different planets, and train like an astronaut. Students of all grades, teachers, and parents attended the event and enjoyed the exhibits.

Elementary kids particularly enjoyed the pop rocket and Comet making. They also enjoyed the tattoo station as they were excited to put on space-related removable tattoos. The audience was encouraged to make a comet while the club students explained the concept behind it. Solar observation using the 8-inch Dobsonian telescope gravitated the eyes of the spectators. Irrespective of age, everyone was fascinated to observe the sun and to spot the sunspots. Club students explained the types of telescopes and the use of solar filters.

On 17th March 2023, the school again conducted an exhibition '**Alohomora 2023**', where the elementary students exhibited theme-based projects.

LA  
FENETRE  
'23



# MONTHLY TELESCOPIC OBSERVATION

SPACE ARCADE team conducted their 3rd Monthly Telescopic Experience session on the 28th of March at two different places which are Delhi and Chennai respectively. People from various places joined the observation with their telescopes, binoculars, and other astronomical equipment to learn and experience the breathtaking view of the Moon! and planets such as Venus, and Mars. They also learned 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.







## HOLI AND WOMEN'S DAY CELEBRATION

Holi is one of the most prominent festivals in India, which is known for its vibrant colors! It caught our attention when we noticed that women's day and holi are on the same day. SPACE India was pleased to celebrate these two occasion together!

Holi is the symbol of colors, love, and peace so are our women, who bring joy, warmth, and harmony in SPACE with their affection and hard work.

Space decided to show their love and respect towards their Women with beautiful flowers, cards, and gifts which represents their different personality, and not only that Gujias was always there to add a sweet touch to Spacian's faces.

Along with it, we made our holi memorable with so many fun activities, organic colors, food, rain dance, and buckets of water! We ended our day with a lot of pictures on our phones and heart with a huge smile!





# Global Astronomy Month

Global Astronomy Month (GAM), is organized every year in April by SPACE India in collaboration with the International Organization Astronomers Without Borders (AWB), intending to unite enthusiasts worldwide in celebrating Astronomy following the motto – “One People, One Sky”. Throughout this month, SPACE offers a range of astronomy programs to the general public and students to promote astronomy worldwide.

All schools are encouraged to conduct or complete one or more of these astronomy events in April to popularize astronomy in their schools. Schools are requested to register all the events with SPACE a week before the conduction date and submit an event report within 3 days of completion of the event so that SPACE can publicize the event on GAM and elsewhere.

The compiled report of Global Astronomy Month for the whole month should be submitted **by 30th April 2023**. Out of the gamut of activities proposed this year, SPACE has selected activities under different categories for our associated schools. We encourage schools to conduct one or more activities for their students and submit the reports to SPACE. The reports will be further sent by us to GAM/AWB.

The complete list of activities is here:

- Astro Art Competition
- Astro Poetry Competition
- Mercury at Greatest Eastern Elongation
- Lyrids Meteor Shower
- Sun Day
- International Dark Sky Week
- Yuri's Night Celebration
- Earth Day Celebrations
- Aryabhata: Remembering India's First Artificial Satellite
- Celebrating the Hubble
- Globe at Night

For more details, regarding the events, date, and description, please visit website: <https://space-india.com/outreach/global-astronomy-month/>

Register your planned events here by 30th April 2023 - <https://docs.google.com/forms/d/e/1FAIpQLSfWL5fXV4oobgTi-eLfk8se6D4v3m0oITdIRqH0YSigvfBijw/viewform>

Share your contribution and experience with us and the world on various social media platforms using various hashtags.

Facebook: @SpaceIndiaEdu, #SPACEIndia, #GAM2023

Twitter: @Spacian, #SPACEIndia, @gam\_awb, #GAM2023

YouTube: Upload the video and share the link on Facebook and Twitter

## GALACTICA

Space India is proud to announce that we are the official Space and Astronomy Partner for Tech-Fest of IIT Delhi (TRYST-2023). Tech fests are always an exciting opportunity for everyone to learn and explore the most recent developments in science and technology. One such event that stands out is TRYST, IIT Delhi. TRYST is renowned for hosting various events, such as Guest Lectures, Workshops, and exhibitions where students can speak with professionals and gain knowledge. Participants from all over the country attend this festival, which is put on by the IIT Delhi student body.



Events like sunspot observation, where students could observe and learn about the activity on the sun's surface, were organized in collaboration with Space and the Astronomy club of IIT Delhi. The activity was a huge success and allowed students to learn by doing.



## Space Group Highlights

# TRYST



Students could participate in virtual reality simulations of space exploration VR exploration, another exciting event that Space organized at the TRYST festival. In addition to inviting schools to attend the TRYST festival and take in the various events and exhibitions, including talks by the Defense Research and Development Organization (DRDO) and an exhibition by the Indian Space Research Organization (ISRO), the event also featured the most recent developments in virtual reality technology. It gave students a taste of what it would be like to explore space.



The Auto Expo, where students could view and learn about the most recent advancements in the automotive industry, was another important attraction at the festival. Overall, the TRYST, IIT Delhi, was a great event that provided students with various opportunities to learn, explore, and interact with professionals in various fields. The events put on by Space were a great success, and the collaboration with Space and the IIT Delhi Astronomy club gave the festival a new dimension. The TRYST festival proves the value of encouraging innovation and creativity in students and motivating the following generation of scientists and technologists



# 2023



# 2023 STAR GAZING &

SPACE is proud to announce the stargazing and Astrophotography Trip - Messier Marathon 2023 was conducted on the 25th and 26th of March at two locations - Astroport, Sariska, and YMCA, Yelagiri Hills. It is an expedition where the participants spend the night under the pristine dark skies, observing and capturing the celestial jewels. The main ingredient of the event is the Messier Marathon, an annual observation event for amateur astronomers. The participants attempted to view all 110 Messier Objects. The objects are Deep Sky Objects(DSOs) which include Galaxies, Nebulae, and Star clusters. March is the only month when one can observe all 110 objects in a single night from Sunset to Sunrise.





# ASTRO PHOTOGRAPHY

## HIGHLIGHTS OF THE EXPEDITION

- Orientation to the night sky and basics of star gazing, Using sky maps and Planisphere.
- Constellation watch, Hands-on training on Telescopes and Binoculars.
- Introduction to Messier Catalog and planning for the observation.
- Messier Marathon: Hunt the 110 Messier objects from sunset to sunrise using a 200mm Dobsonian telescope.
- Planetary and Lunar observation.
- Basics of DSLR, Practical Astrophotography, and Smartphone Astrophotography Observation using a computerized telescope
- Observing and capturing Milkyway Galaxy.



# PROJECT PARIDHI

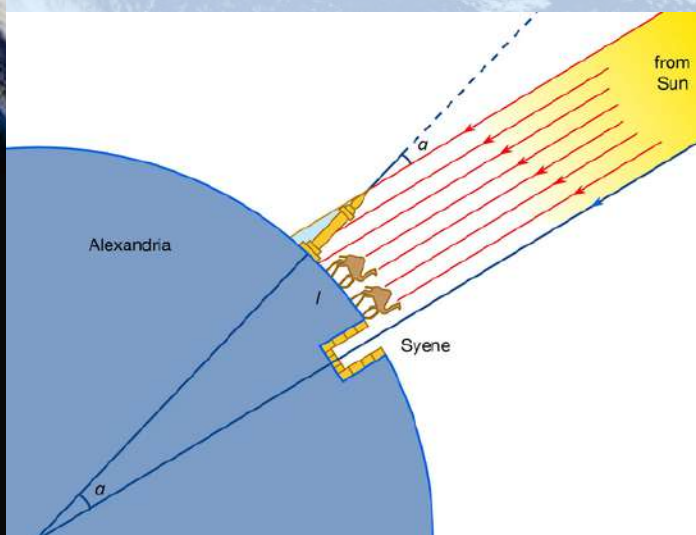
REPLICATING ERATOSTHENES ACTIVITY

LET'S MEASURE THE EARTH

SPACE India conducted an online event on "Project Paridhi" on 21st March 2023 for students of different schools. Project Paridhi is a flagship project of SPACE India to promote practical science education among students. As a part of this project, students measured the circumference of the Earth by observing the shadows formed by the sun in a day, a technique used by astronomer Eratosthenes 3000 years ago. Eratosthenes was a Greek mathematician, geographer, and astronomer who lived in the third century BC. Eratosthenes realized that the Sun's rays are vertical at noon on the summer solstice at the Egyptian city of Syene, while at the same time, they were slanting in Alexandria. Using this observation, he calculated the Earth's circumference to be about 39,375 kilometers, close to the currently accepted value of 40,075 kilometers, with an accuracy of 2%. The project was launched in 2010 to create awareness among Indians that science can be learned and practiced without the need for sophisticated equipment.

Project Paridhi was chosen to be carried out on March 21, 2023. This date is significant because it marks the vernal equinox when the Sun is directly overhead the equator. This date is important because it allows for more accurate measurements during the "shortest shadow experiment," which is a key component of Project Paridhi.

During the discussion, the students were introduced to the concept of the shortest shadow experiment; They learned that this experiment involves measuring the length of shadows cast by objects at different locations on the Earth's surface and using this information to calculate the Earth's circumference. The students were taught that this experiment could be conducted using simple tools such as tiny rods and basic mathematical concepts. (Image credits: Encyclopaedia Britannica)



VIRTUAL MEETING

## PROJECT PARIDHI

REPLICATING ERATOSTHENES ACTIVITY

LET'S MEASURE THE EARTH

21<sup>st</sup> MARCH 2023, TUESDAY

11:30 AM - 1:30 PM



Through this experiment, the students could gain a practical understanding of scientific concepts and the process of scientific inquiry without the need for complex equipment.

The students had an enjoyable time during the discussion on Project Paridhi and were able to clarify their doubts regarding the project. They found the discussion helpful and informative and were excited to learn more about the shortest shadow experiment. Overall, the students had a great time and were enthusiastic about participating in the project.

# HIGHLIGHTS APRIL 2023

## SCIENTISTS WARMING UP TO MOON DUST, EARTH'S PROPOSED SUN SHIELD, IS NOT COOL.

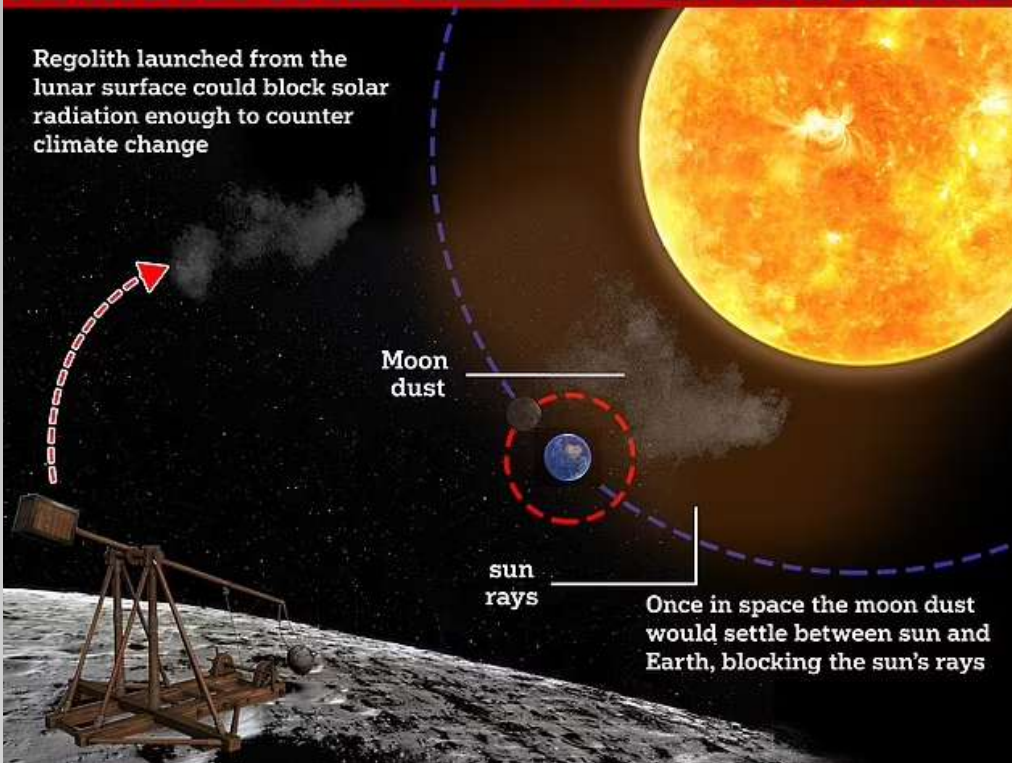
**Scientists proposed a massive moon dust shield to combat climate change. Could it really work? The best place to start looking at cooling the Earth might not be on the Moon.**

In a radical addition to last-ditch climate crisis solutions, three astrophysicists have proposed shooting Moon dust into the space between Earth and the Sun as a way to shield solar radiation if all goes to hell, according to a University of Utah-led study published in the peer-reviewed journal PLOS.

Researchers reckon sunlight could be dimmed by 1.8% which is equivalent to obscuring our local star six days in a year. If we "ballistically eject dust grains [mined] from the Moon's surface" towards a point in space called the first Lagrange point (L1).

Between any two orbital bodies – in this case Earth and the Sun – there are five Lagrangian Points where the gravitational forces effectively balance out, allowing objects like satellites to stay in place. The Earth-Sun L1 is a location about 1.5 km sunwards into Earth's orbit, where introducing a lunar debris sunscreen could help reduce temperatures back home. The idea – admittedly not the most outlandish solar geoengineering enterprise ever conceived by scientists is to let Moon dust linger in outer space long enough for it to slow global warming down and to replenish the blanket of lunar regolith when it runs out.

### MOON DUST COULD HELP STOP CLIMATE CHANGE



**Stratospheric aerosol injection (SAI), one of the most researched solar geoengineering approaches, is a theoretical proposal to spray tiny reflective particles into the stratosphere to reflect sunlight back into space and cool the planet Pexels**

## GALACTICA

Space mirrors, marine cloud brightening and stratospheric aerosol injection (SAI) are some well-studied, sci-fi-esque solutions that have previously captured the fascination of researchers and policymakers – some of whom are eerily warming up to sunlight reflection.

### **More trouble than it's worth**

Experts believe this approach, at best, is a last resort and, at worst, a “high-stakes gamble” given its unintended and potentially catastrophic consequences already known to us.

**"This Changes Everything: Capitalism vs the Climate"** There is a fundamental problem with sun-blocking: Not only does it breed further political inertia by creating the illusion that Moon dust would buy Earth more time in its fight against climate change, but the solution also falls short of mitigating carbon emissions – its underlying cause and intensifier.

For all its cooling properties, studies have found that this so called “Solar Radiation Management” fix is of little comfort to our fragile marine ecosystems that would still be under increasing pressure from threats like ocean acidification – the reduction in pH directly linked to coral bleaching – and ocean warming.

### **The case against solar geoengineering**

Last year, a group of 380 scientists signed an open letter asking world leaders to pledge against the moon shot proposal, citing the enormous risk that comes with an underwhelming increase in albedo – the ratio of sunlight reflected by a planet to the incoming solar radiation.

When interviewed about the research, eminent climate scientist at the University of Pennsylvania, Dr. Michael E. Mann told The Hill that while blocking sunlight would most likely achieve cooling, it could “manipulate our planetary environment in deep and fundamental ways.”



**“[The proposed] efforts to offset carbon dioxide-caused warming with sunlight reduction would yield a very different climate, perhaps one unlike any seen before in Earth’s history, with massive shifts in atmospheric circulation and rainfall patterns and possible worsening of droughts,” he explained.**

**- Michael E. Mann**

### **Political Pandora’s box**

Mining expeditions on the lunar surface, let alone the proposal of shooting Moon dust off into space, would be an inextricable web of bureaucracy – thanks to contradictory space policies.

The 1967 Outer Space Treaty recognises extraterrestrial resources as global commons, prohibiting the “appropriation” of any region of space.

Two of its depositories, the United States (USA) and Russia, have conveniently held back from signing the 1979 Moon Treaty, which forbids the use of lunar material for non-scientific purposes.

Then there’s NASA’s Artemis Accords, that grant extraction rights to private entities, and are not signed by Russia and China.

### **No substitute for decarbonization**

The most alarming argument against geo-engineering and by extension – Moon dust mining, is that it will disincentivise climate change mitigation efforts.

Coupled with non-binding national commitments to limit global warming to 1.5° C by 2100, this plays into the hands of the corporate-political collusion complicit in pushing policies that continue to undermine climate action and reinforce the delusion that technology will save us – except that we’d have long been incinerated if things stay business as usual.



# DARK ENERGY COULD LEAD TO A SECOND (AND THIRD AND FOURTH) BIG BANG, NEW RESEARCH SUGGESTS

Scientists have proposed a way that the universe could stop expanding, ending in a 'Big Crunch' that resets space and time as we know it. Will the universe end in a bang or a whimper? A pair of theoretical physicists have proposed a third path: perhaps the universe will never end.

In a study that attempts to define the nature of dark energy – a mysterious phenomenon thought to be causing the universe to expand faster and faster every moment – the physicists find that cosmic expansion isn't always a given. Rather, they write, dark energy may periodically "switch" on and off, sometimes growing the cosmos, sometimes shrinking it down until the conditions are right for a new Big Bang to occur – and for a new universe to be born.

## **The Great Escape**

Our universe is currently experiencing a phase of runaway expansion: the cosmos is getting bigger faster with every passing moment. Cosmologists do not understand the cause of this acceleration, which they name dark energy. If this acceleration persists, then our universe will eventually expand into oblivion, with all matter and radiation torn apart.

This wouldn't be the first period of runaway growth. In the earliest moments of the Big Bang, the energies and densities were so extreme that existing physics cannot cope – it predicts a singularity, a point of infinite density where the math breaks down. After that, the universe experienced a period of incredibly rapid expansion known as inflation, which is also poorly understood.

Astronomers have long wondered if these two phases of accelerated expansion – one in the earliest moments of the Big Bang and one in the present epoch – are connected to each other, and whether an entity that drives both of them avoids the problem of the big bang singularity.

**Dynamical demons**

To answer that, a pair of theoretical physicists published a study Feb. 7 in the preprint database arXiv(opens in new tab) which examined a model of the universe where dark energy has always played a role. Previous research modeled dark energy "switching on" at various times to drive cosmic expansion, but the new research proposes a more realistic model that includes matter and radiation.

They wanted to see if dark energy can avoid a Big Bang singularity, drive inflation, and accelerate the late universe. To avoid that initial singularity, the universe can't begin from a point of infinite density. Instead, the universe we live in would have to be one in an infinite series of repeated "Big Bounces."

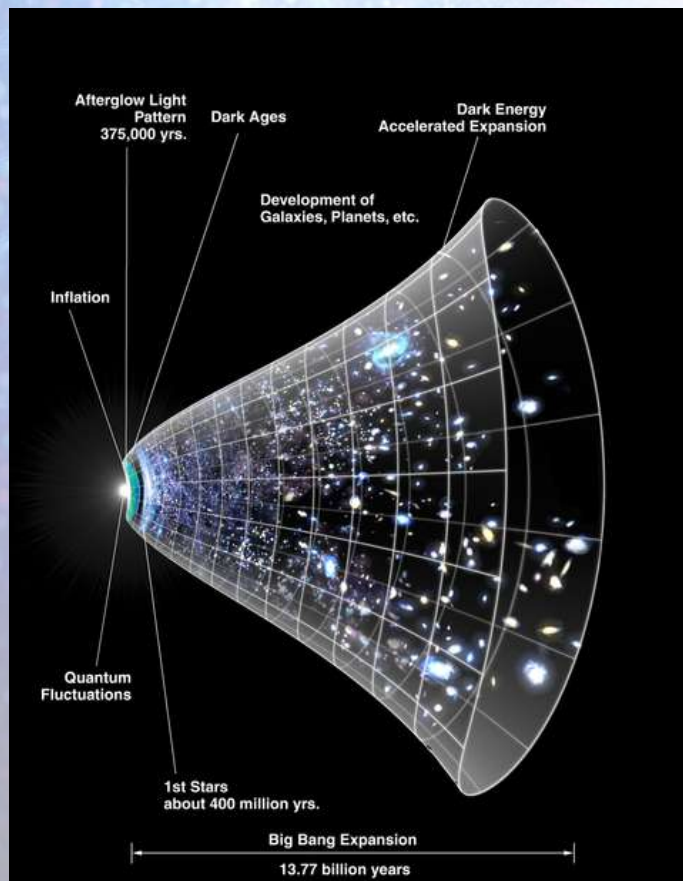
In this scenario, dark energy drives the universe until it reaches a certain size. But then the dark energy transforms itself, forcing the universe to contract. The cosmos then suffers a big crunch, but right before reaching a state of infinite density, dark energy turns around again, driving a period of incredibly rapid inflation and starting the cycle anew.

When an earthquake strikes, it triggers waves of energy that move through rock. These waves move at different speeds based on the kinds of minerals the rock is made of and whether the rock is more rigid or soft. Certain kinds of seismic waves can't move through liquid, so they bounce off a liquid layer. Studying the way seismic waves move through Earth can reveal what distinct layers exist deep below the planet's surface.

For example, scientists have previously used seismic waves to discover the churning, liquid iron of Earth's outer core, which creates the planet's magnetic field. Seismic waves have also revealed the inner core, which, despite the heat, remains solid under immense pressure.

In the new paper, the researchers "'observed, for the first time, seismic waves bouncing back and forth from a powerful earthquake to the other side of the globe, like ping-pong balls," study's lead author Thanh-Son Pham(opens in new tab), a geophysicist at the Australian National University in Canberra.

In particular, seismic waves from a magnitude 7.9 earthquake that struck near the Solomon Islands in 2017 reverberated across Earth's entire diameter several times. Seismic networks in the Alaskan Peninsula and European Alps helped the researchers see the reverberating waves, and these bouncing waves enabled the researchers to observe the two distinct layers within Earth's inner core.



The researchers found a model of dark energy that performed the trifecta. But crucially, matter and radiation could not be present in the extremely early universe, otherwise they spoiled inflation. Instead, matter and radiation had to appear just after inflation, as a portion of the dark energy decayed away, flooding the universe with light and matter.

While initially successful, the researchers weren't able to find a generic class of dark energy models that could always lead to the same results. Instead, they had to artificially put in a smaller value for the present-day accelerated expansion than quantum mechanics predicts in order to get the exact right outcome.

However, this new research does point in a promising direction, providing a viable platform for further exploring models like this. Humans are not necessarily destined to live in a cold, empty cosmos, because dark energy might behave differently in the far future. Only continued research will uncover our ultimate fate.

# PROVIDING POWER ON EARTH'S EVIL TWIN



**NASA and Advanced Thermal Batteries, Inc. (ATB) are developing a high-temperature battery system to power a long-lived lander on the Venus surface. Based on short-lived battery systems used for powering missiles, this new battery approach has demonstrated high-temperature operation for unprecedented periods of time, laying the foundation for a new paradigm in battery technology and for Venus landers.**

How do you make a battery that works for months in conditions that melt lead solder, boil electrolytes in battery cells, and are the equivalent of being a kilometer under water? NASA and Advanced Thermal Batteries, Inc. (ATB) have taken on this challenge to enable a long-lived lander for the Venus surface. The result is the first battery to demonstrate the capability to operate at Venus temperatures for an entire Venus solar day (~120 Earth-days).

This new technology employs unique chemistry and a resilient design that leverages an approach often used to power smart missiles. This battery system is still in development, but the results so far demonstrate that batteries capable of operating in environments as harsh as that of Venus can soon become a reality and may provide a new energy storage device for future exploration in harsh environments across the solar system.



Earth's sister planet, Venus, holds important scientific clues about our solar system, planets around other stars, and our home planet. Venus was the first planet that human-built spacecraft flew by, several missions have orbited around it, and short-duration landers have landed and operated on it. Yet there are still many important basic science questions that remain unanswered about this mysterious body because Venus poses significant challenges to acquiring the needed data, which cannot be overcome by traditional planetary spacecraft design approaches.

Venus is often called Earth's Evil Twin because it is about the same size as Earth and may be composed of similar material, but the surface conditions on Venus are extreme. On the Venus surface, temperatures reach approximately 465 degrees Celsius, which can melt lead in electrical circuits and cook standard batteries. The pressure at the Venus surface can reach 92 times what we experience on Earth (equivalent to what one would feel at nearly a kilometer under water). The Venus atmosphere is also reactive and can quickly impact many materials like copper that are used to construct traditional spacecraft. These extreme environmental conditions have limited the life of all Venus landers to date to approximately two hours or less, which does not allow in-situ data collection for a significant time.



1/3 scale developmental battery developed by Advanced Thermal Batteries, Inc. for LLISSE. Image Credit: Tom Miller, NASA GRC

## GALACTICA

A team from NASA Glenn Research Center, with support from other NASA centers and institutions is developing a small lander—the Long-Lived In situ Solar System Explorer (LLISSE)—to address the many challenges at the Venus surface and enable long-duration operations. LLISSE uses the latest advances in high-temperature systems and a novel concept of operations to allow operations on the surface of Venus for 60 days or longer while it collects science data and transmits it to a Venus orbiter. LLISSE is intended to be a ~10 kg lander carrying a suite of small sensors to measure winds, radiance, temperature, pressure, and abundances of key atmospheric chemical constituents. LLISSE will be a complete system with electronics, communications, and instrumentation—all of which will require a battery to operate.

Since there were no existing batteries that could meet LLISSE requirements, NASA and its collaborators had to develop one. Toward this end, ATB is conducting significant battery research and development efforts, including development of a long-life, molten salt battery with a low self-discharge rate for the LLISSE Venus lander. The goal is to develop a battery that can sustain 60 days of continuous discharge operation to support a bus operating at +25V and -25V in the harsh conditions on the Venus surface.



**Test battery hardware: High temperature thermal batteries adapted for the Venus surface. Image Credit: Dr. Michael Barclay, Advanced Thermal Batteries, Inc.**

Thermal batteries possess some of the highest power densities of any reserve battery technology. On Earth they are maintenance free, largely unaffected by severe dynamic environments, and have a proven history of high reliability. Furthermore, they can withstand long-term storage, retaining the ability to provide immediate power upon activation for over 20 years. These properties stem from the fact that thermal batteries utilize a high temperature electrolyte that is solid and inert at standard room temperature. On Venus, thermal batteries can utilize the ambient atmospheric conditions to heat the electrolyte and can remain operational without the need for pyrotechnics or thermal insulation.

Existing thermal battery electrochemistry, however, involves very high self-discharge (internal chemical reactions that use up battery life), so a thermal battery typically only lasts for hours on Venus. Direct adaption of thermal battery technology to enable Venus science objectives is difficult, as the available chemistries and designs can only enable hours of operation, not days or months. For this reason, modifications to battery chemistry and architecture are required to develop a long-lived battery for the Venus surface. ATB's battery development work to date has focused on lithium alloy anodes, metal sulfide cathodes, and alkali halide molten salt electrolytes, and the team has successfully reduced the internal battery reactions that govern self-discharge and reduce battery lifetime and capacity.

ATB has developed a battery that meets the targeted voltage range and has operated for 118 days, nearly twice the required lifetime. The battery contains 17 individual cells in series and specifically designed chemistry and structural materials to meet the requirements of the LLISSE mission.

Now that the core battery capabilities have been demonstrated, ongoing work at ATB is planned to optimize a robust design to survive shock and vibrational loads. Additional efforts will focus on a pressure vessel container and packaging aspects for the final batteries. It is expected that a complete prototype Venus battery system will be demonstrated in the next 18 months.

The battery technology, like other technologies in development for this long-lived Venus surface lander, has a range of other science applications including missions to explore Mercury or to descend into the atmospheres of gas giants. Furthermore, this technology may provide power where traditional systems cannot operate, such as high-temperature jet engines or harsh industrial environments.

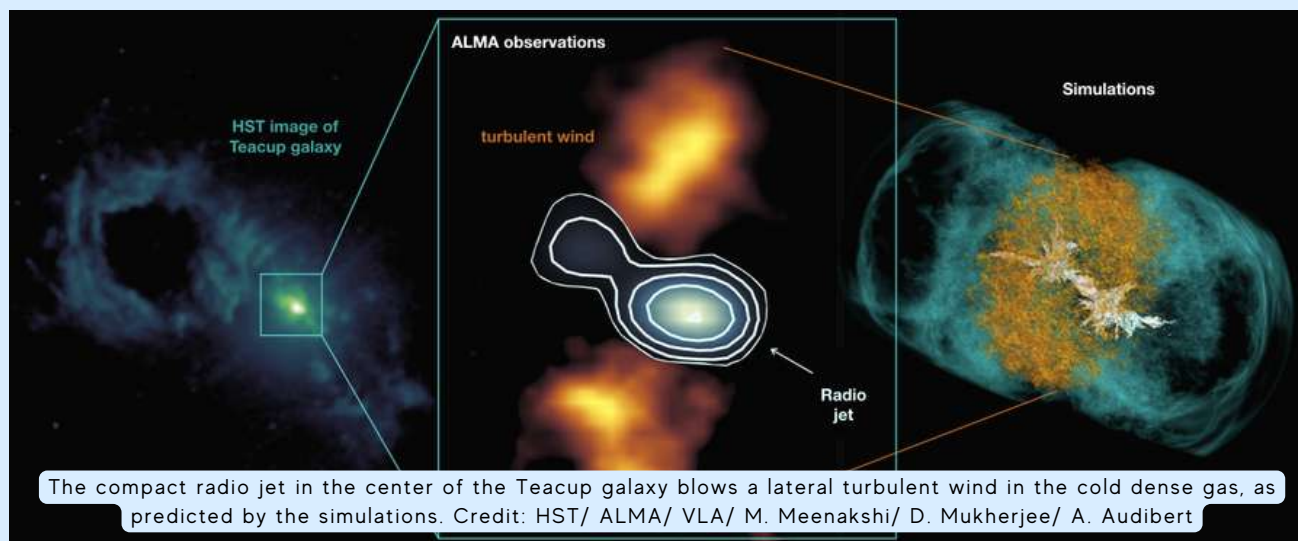
**"This recent battery technology demonstration, with improved architecture and low self-discharge electrochemistry, is a huge accomplishment that many may have not thought possible."**

**- Dr. Kevin Wepasnick, ATB Project Engineer**

# BLACK HOLE JETS ARE BLOWING BUBBLES IN THE TEACUP GALAXY

An international team of researchers has found evidence for a compact radio jet inducing turbulence and increasing gas temperature as it progresses through the interstellar medium of the Teacup galaxy. The study was led by Dr Anelise Audibert and Dr Cristina Ramos Almeida of the Instituto de Astrofísica de Canarias (IAC), Canary Islands, Spain, and involved co-authors Meenakshi and professor Dipanjan Mukherjee from the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, who, using results from their hydrodynamical simulations, provided the theoretical interpretation of the astronomical observations carried out using the Atacama Large millimetre or submillimetre Array (ALMA) telescope in Chile.

When matter falls into supermassive black holes in the centers of galaxies, it unleashes enormous amounts of energy and is called active galactic nuclei (or AGN). A fraction of AGN releases part of this energy as jets detectable in radio wavelengths that travel at velocities close to light speed. While the jet travels across the galaxy, it collides with the clouds and gas around it and in some cases may push this material away in the form of winds. However, which conditions preferentially trigger these winds to blow out the gas from galaxies are still poorly understood.



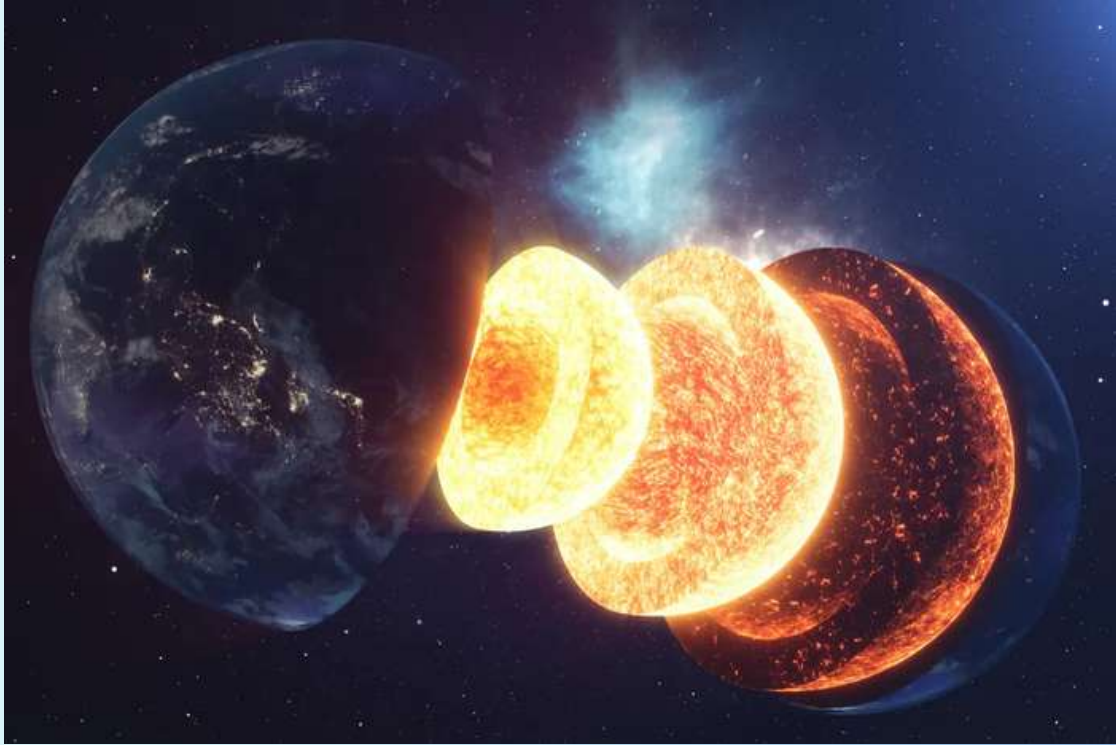
But not all jets are created equal – some are stronger and drastically change their surroundings by heating up the gas in their galaxies, stunting the galaxy's growth. Others are weaker, referred to as radio-quiet, but computer simulations suggest they still have shockingly large effects and an ability to push around nearby gas. "It was previously believed that low-power jets had a negligible impact on the galaxy," Christina Raos Almeida

The team's new observations from the Atacama Large Millimeter Array (ALMA) show, however, that at least in the Teacup – a radio-quiet galaxy named for its appearance that lies about 1.3 billion light-years from Earth – jets are moving, heating, and accelerating the galaxy's gas.

"Even in the case of radio-quiet galaxies, jets can redistribute and disrupt the surrounding gas, and this will have an impact on the galaxy's ability to form new stars," Almeida said. Much to the team's surprise, the biggest effects were actually perpendicular to the direction of the jets, instead of head-on. "This is caused by the shocks induced by the jet-driven bubble, which heats up and blows the gas," said study lead author and IAC astronomer Anelise Audibert in the press release. Turns out, even low-power jets have an impact – it just depends on where they're headed.

## 450-MILE-WIDE SOLID METAL BALL FORMS EARTH'S INNERMOST CORE, EARTHQUAKE WAVES REVEALED

**Scientists calculated the diameter of Earth's innermost core using earthquake waves that bounced through the planet 'like ping-pong balls.'**



Scientists have harnessed powerful waves from earthquakes to measure Earth's innermost layer and found that our planet's center is a 450-mile-wide (725 kilometers) ball of solid iron-nickel alloy.

Previously, many researchers believed that Earth had four distinct layers – the crust, the mantle, a liquid outer core, and a solid inner core. But in the past couple of decades, scientists have proposed that the inner core actually consists of two layers, referred to as the inner core and the innermost inner core.

Researchers looked at the earthquake, or seismic, wave data from all over the world to measure this innermost inner core. When an earthquake strikes, it triggers waves of energy that move through rock. These waves move at different speeds based on the kinds of minerals the rock is made of and whether the rock is more rigid or soft. Certain kinds of seismic waves can't move through the liquid, so they bounce off a liquid layer. Studying the way seismic waves move through Earth can reveal what distinct layers exist deep below the planet's surface.

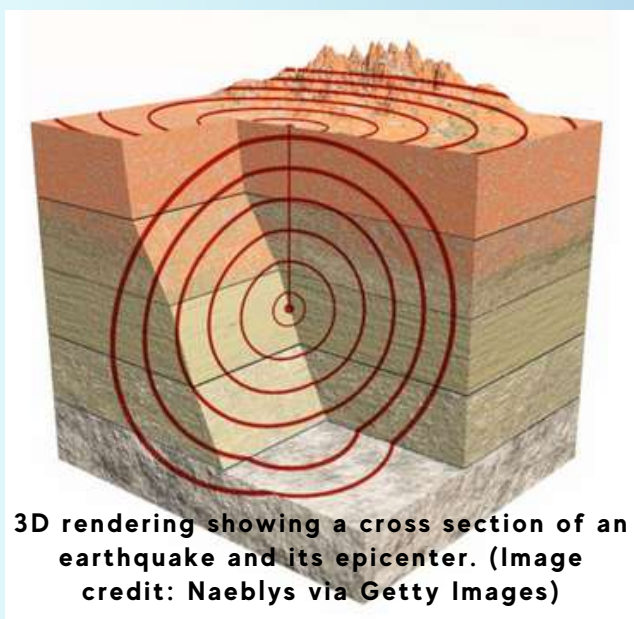
For example, scientists have previously used seismic waves to discover the churning, liquid iron of Earth's outer core, which creates the planet's magnetic field. Seismic waves have also revealed the inner core, which, despite the heat, remains solid under immense pressure.

In the new paper, the researchers "observed, for the first time, seismic waves bouncing back and forth from a powerful earthquake to the other side of the globe, like ping-pong balls," study's lead author Thanh-Son Pham, a geophysicist at the Australian National University in Canberra, told Live Science in an email.

In particular, seismic waves from a magnitude 7.9 earthquake that struck near the Solomon Islands in 2017 reverberated across Earth's entire diameter several times. Seismic networks in the Alaskan Peninsula and European Alps helped the researchers see the reverberating waves, and these bouncing waves enabled the researchers to observe the two distinct layers within Earth's inner core.

## GALACTICA

The researchers noted that when the earthquake waves traveled through the innermost core, in an area about 450 miles across, they moved at different speeds depending on the angle at which they were traveling. In the outer layer of the inner core, the waves moved the fastest from pole to pole and the slowest in an equatorial direction. In the innermost layer, meanwhile, the waves moved the slowest at an angle about 50 degrees away from Earth's axis.



**3D rendering showing a cross section of an earthquake and its epicenter. (Image credit: Naeblys via Getty Images)**

The different behavior of the waves moving through the outer layer of the inner core versus the innermost inner core suggests that although they may be chemically identical (made of an iron-nickel alloy), the crystal structures of these layers are different, Pham said.

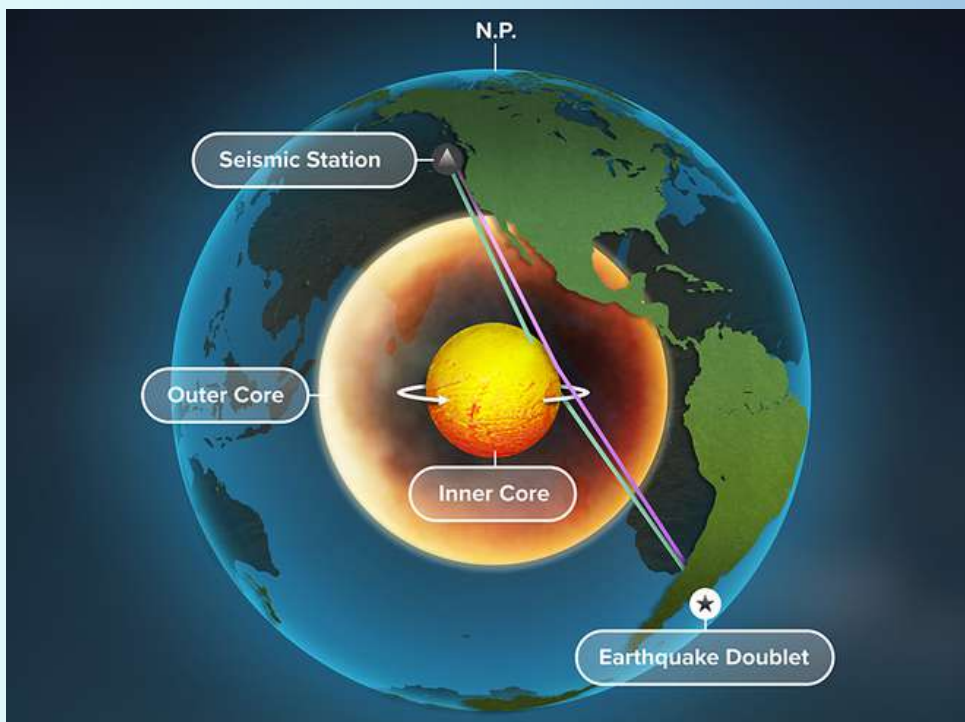
"This study strengthens the evidence for the existence of an internal metallic ball with a distinct texture from the outer shell of Earth's inner core," Pham said.

Earth's structure evolved as it cooled after the planet formed around 4.6 billion years ago. As Earth cooled, heavier elements, like iron and nickel, migrated inward, creating the inner and outer cores, while lighter elements like the silicon that makes up much of the rock at Earth's surface – rose.

The new view of Earth's innermost inner core could suggest that an event early in the planet's history affected its formation, and that idea could change what we know about when and how the inner core formed, Pham said.

However, there's currently no way to know what kind of event could have created the distinct layer within the inner core, or when, Pham said.. Scientists think that Earth's core formed about a billion years ago, but the details of the core's evolution are not well understood. So it's difficult to say when an event might have occurred that altered the innermost core. But as the global network of seismometers grows, more seismic data will likely help uncover more details about the inner core's growth.

"The exact timeline of the possible global event is wildly uncertain," Pham said. "Answering those questions could go a long way in understanding the Earth's evolution."



A new study of Earth's inner core used seismic data from repeating earthquakes, called doublets, to find that refracted waves, blue, rather than reflected waves, purple, change over time – providing the best evidence yet that Earth's inner core is rotating.

Graphic by Michael Vincent

## FROM THE EYES OF WEBB - MARCH 2023

### JWST CAPTURES RARELY SEEN PRELUDE TO SUPERNOVA


The rare sight of a Wolf-Rayet star – among the most luminous, most massive, and most briefly detectable stars known – was one of the first observations made by NASA's James Webb Space Telescope in June 2022. Webb shows the star, WR 124, in unprecedented detail with its powerful infrared instruments. The star is 15,000 light-years away in the constellation Sagitta. Massive stars race through their lifecycles, and only some of them go through a brief Wolf-Rayet phase before going supernova, making Webb's detailed observations of this rare phase valuable to astronomers. Wolf-Rayet stars are in the process of casting off their outer layers, resulting in their characteristic halos of gas and dust. The star WR 124 is 30 times the mass of the Sun and has shed 10 Suns' worth of material – so far. As the ejected gas moves away from the star and cools, cosmic dust forms and glows in the infrared light detectable by Webb.



The origin of cosmic dust that can survive a supernova blast and contribute to the universe's overall "dust budget" is of great interest to astronomers for multiple reasons. Dust is integral to the workings of the universe: It shelters forming stars, gathers together to help form planets, and serves as a platform for molecules to form and clump together - including the building blocks of life on Earth. Despite the many essential roles that dust plays, there is still more dust in the universe than astronomers' current dust-formation theories can explain. The universe is operating with a dust budget surplus.

Webb opens up new possibilities for studying details in cosmic dust, which is best observed in infrared wavelengths of light. Webb's Near-Infrared Camera (NIRCam) balances the brightness of WR 124's stellar core and the knotty details in the fainter surrounding gas.

The telescope's Mid-Infrared Instrument (MIRI) reveals the clumpy structure of the gas and dust nebula of the ejected material now surrounding the star. Before Webb, dust-loving astronomers simply did not have enough detailed information to explore questions of dust production in environments like WR 124, and whether the dust grains were large and bountiful enough to survive the supernova and become a significant contribution to the overall dust budget. Now those questions can be investigated with real data.



A Wolf-Rayet star and the nebula surrounding it captured by the Hubble Space Telescope. (Credit: NASA/ESA Hubble Space Telescope)

Stars like WR 124 also serve as an analog to help astronomers understand a crucial period in the early history of the universe. Similar dying stars first seeded the young universe with heavy elements forged in their cores - elements that are now common in the current era, including on Earth.

Webb's detailed image of WR 124 preserves forever a brief, turbulent time of transformation, and promises future discoveries that will reveal the long-shrouded mysteries of cosmic dust.

The James Webb Space Telescope is the world's premier space science observatory. Webb will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Webb is an international program led by NASA with its partners, ESA (European Space Agency), and CSA (Canadian Space Agency).

# JWST SEES THE SAME SUPERNOVA THREE TIMES IN AN EPIC GRAVITATIONAL LENS

This observation from the NASA/ESA/CSA James Webb Space Telescope features the massive galaxy cluster RX J2129. Due to Gravitational lensing, this observation contains three different images of the same supernova-hosting galaxy, which you can see in closer detail. Gravitational lensing occurs when a massive celestial body causes a sufficient curvature of spacetime to bend the path of light travelling past or through it, almost like a vast lens. In this case, the lens is the galaxy cluster RX J2129, located around 3.2 billion light-years from Earth in the constellation Aquarius. Gravitational lensing can cause background objects to appear strangely distorted, as can be seen by the concentric arcs of light in the upper right of this image.

Astronomers discovered the supernova in the triply-lensed background galaxy using observations from the NASA/ESA Hubble Space Telescope, and they suspected that they had found a very distant Type Ia supernova. These supernovae always produce a fairly consistent luminosity – at the same distance, one looks as bright as any other – which makes them particularly helpful to astronomers. As their distance from Earth is proportional to how dim they appear in the night sky, objects with known brightness can be used as 'standard candles' to measure astronomical distances.

The almost uniform luminosity of a Type Ia supernova could also allow astronomers to understand how strongly the galaxy cluster RX J2129 is magnifying background objects, and therefore how massive the galaxy cluster is. As well as distorting the images of background objects, gravitational lenses can cause distant objects to appear much brighter than they would otherwise. If the gravitational lens magnifies something with a known brightness, such as a Type Ia supernova, then astronomers can use this to measure the 'prescription' of the gravitational lens.

This observation was captured by Webb's Near-InfraRed Camera to measure the brightness of the lensed supernova. As part of the same programme, NIRSpectroscopy of the supernova was also obtained, which will allow comparison of this distant supernova to Type Ia supernovae in the nearby Universe. This is an important way to verify that one of astronomers' tried-and-tested methods of measuring vast distances works as expected.

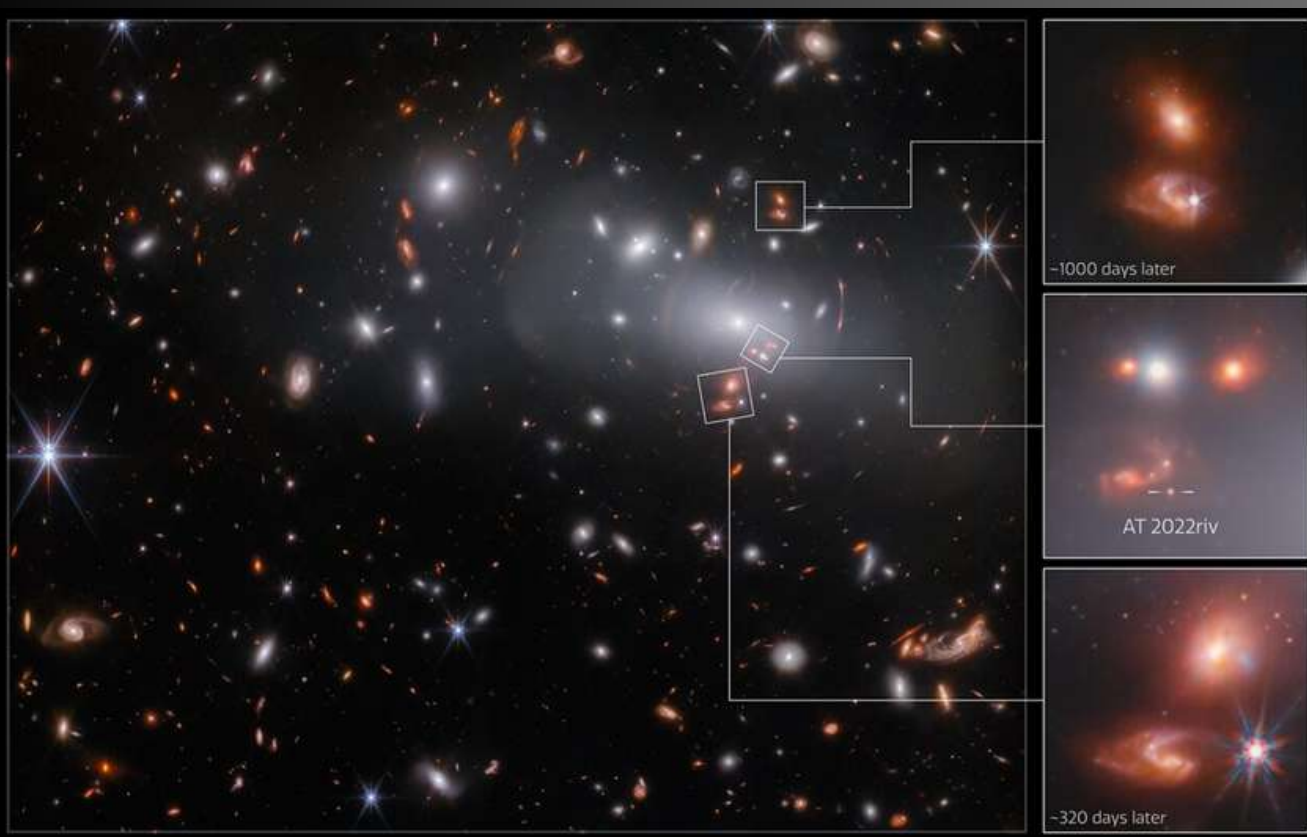
## GALACTICA

This observation from the NASA/ESA/CSA James Webb Space Telescope contains three different images of the same supernova-hosting galaxy, all of which were created by a colossal gravitational lens. Gravitational lensing occurs when a massive celestial body causes a sufficient curvature of spacetime to bend the path of light traveling past or through it, almost like a vast lens. In this case, the lens is the galaxy cluster RX J2129, located around 3.2 billion light-years from Earth in the constellation Aquarius. This annotated image of the cluster highlights the three images of the lensed galaxy, including the one where the supernova was detected.

Astronomers discovered the supernova in the triply-lensed background galaxy using observations from the NASA/ESA Hubble Space Telescope, and they suspected that they had found a very distant Type Ia supernova. These supernovae always produce a fairly consistent luminosity – at the same distance, one looks as bright as any other – which makes them particularly helpful to astronomers. As their distance from Earth is proportional to how dim they appear in the night sky, objects with known brightness can be used as 'standard candles' to measure astronomical distances.

The gravitational lens has created three lensed images of the background galaxy, which are not uniform in size, position or age. Because mass in the galaxy cluster is distributed unevenly, rays of light emitted by the supernova are bent by the lens in different amounts, and so they take longer or shorter paths to the viewer – resulting in separate images. The light that took the longest path gives us the oldest image of the galaxy, in which the supernova is still visible. The next image is of the galaxy as it appears roughly 320 days later than the first one, and the last image roughly 1000 days after the first. At both later points in time, the supernova has already faded from view.

The name for the transient is AT 2022riv. This observation was captured by Webb's Near-Infrared Camera to measure the brightness of the lensed supernova. As part of the same programme, NIRSpectroscopy of the supernova was also obtained, which will allow comparison of this distant supernova to Type Ia supernovae in the nearby Universe. This is an important way to verify that one of astronomers' tried-and-tested methods of measuring vast distances works as expected.



The main image shows a large elliptical galaxy, surrounded by many small similar galaxies in a cluster, and background stars and galaxies. Three smaller pull-outs show three lensed images of a background galaxy, close up. Credits: ESA/Webb, NASA & CSA, P. Kell

# NASA'S WEBB SPOTS SWIRLING, GRITTY CLOUDS ON REMOTE PLANET

Researchers observing with NASA's James Webb Space Telescope have pinpointed silicate cloud features in a distant planet's atmosphere. The atmosphere is constantly rising, mixing, and moving during its 22-hour day, bringing hotter material up and pushing colder material down. The resulting brightness changes are so dramatic that it is the most variable planetary-mass object known to date. The team, led by Brittany Miles of the University of Arizona, also made extraordinarily clear detections of water, methane, and carbon monoxide with Webb's data, and found evidence of carbon dioxide. This is the largest number of molecules ever identified all at once on a planet outside our solar system. Cataloged as VHS 1256 b, the planet is about 40 light-years away and orbits not one, but two stars over a 10,000-year period. "VHS 1256 b is about four times farther from its stars than Pluto is from our Sun, which makes it a great target for Webb," Miles said.

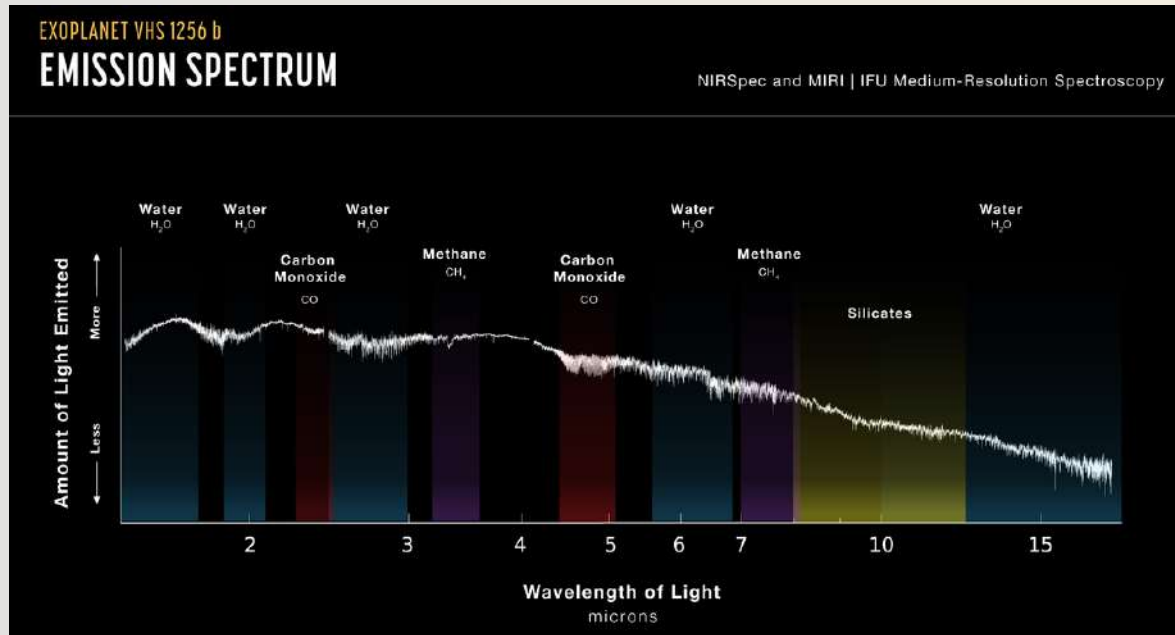


"That means the planet's light is not mixed with light from its stars." Higher up in its atmosphere, where the silicate clouds are churning, temperatures reach a scorching 1,500 degrees Fahrenheit. Within those clouds, Webb detected both larger and smaller silicate dust grains, which are shown on a spectrum. "The finer silicate grains in its atmosphere may be more like tiny particles in smoke," noted co-author Beth Biller of the University of Edinburgh in Scotland. "The larger grains might be more like very hot, very small sand particles."

VHS 1256 b has low gravity compared to more massive brown dwarfs, which means that its silicate clouds can appear and remain higher in its atmosphere where Webb can detect them. Another reason its skies are so turbulent is the planet's age. In astronomical terms, it's quite young. Only 150 million years have passed since it formed – and it will continue to change and cool over billions of years.

In many ways, the team considers these findings to be the first "coins" pulled out of a spectrum that researchers view as a treasure chest of data. In many ways, they've only begun identifying its contents. "We've identified silicates, but better understanding which grain sizes and shapes match specific types of clouds is going to take a lot of additional work," Miles said. "This is not the final word on this planet – it is the beginning of a large-scale modeling effort to fit Webb's complex data."

Although all of the features the team observed have been spotted on other planets elsewhere in the Milky Way by other telescopes, other research teams typically identified only one at a time. “No other telescope has identified so many features at once for a single target,” said co-author Andrew Skemer of the University of California, Santa Cruz. “We’re seeing a lot of molecules in a single spectrum from Webb that detail the planet’s dynamic cloud and weather systems.”



A research team led by Brittany Miles of the University of Arizona used two instruments known as spectrographs aboard the James Webb Space Telescope, one on its Near Infrared Spectrograph (NIRSpec) and another on its Mid-Infrared Instrument (MIRI) to observe a vast section of near- to mid-infrared light emitted by planet VHS 1256 b. They plotted the light on the spectrum, identifying signatures of silicate clouds, water, methane and carbon monoxide. They also found evidence of carbon dioxide.

Credits: Image: NASA, ESA, CSA, J. Olmsted (STScI); Science: Brittany Miles (University of Arizona), Sasha Hinkley (University of Exeter), Beth Biller (University of Edinburgh), Andrew Skemer (University of California, Santa Cruz).

The team came to these conclusions by analyzing data known as spectra gathered by two instruments aboard Webb, the Near-Infrared Spectrograph (NIRSpec) and the Mid-Infrared Instrument (MIRI). Since the planet orbits at such a great distance from its stars, the researchers were able to observe it directly, rather than using the transit technique or a coronagraph to take this data.

There will be plenty more to learn about VHS 1256 b in the months and years to come as this team and others continue to sift through Webb’s high-resolution infrared data. “There’s a huge return on a very modest amount of telescope time,” Biller added. “With only a few hours of observations, we have what feels like the unending potential for additional discoveries.”

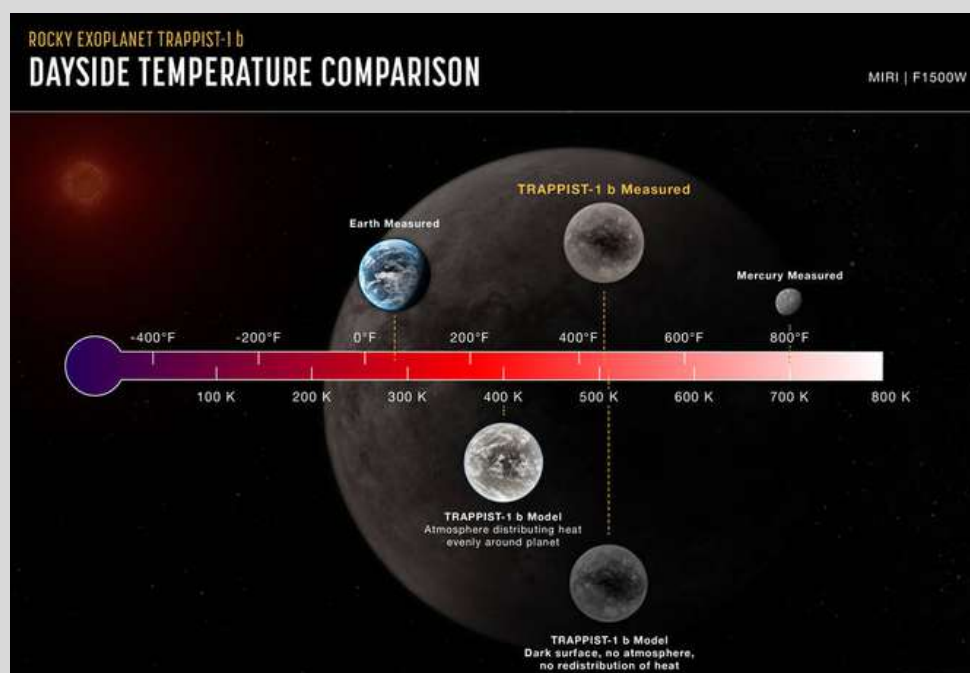
What might become of this planet billion of years from now? Since it’s so far from its stars, it will become colder over time, and its skies may transition from cloudy to clear. The researchers observed VHS 1256 b as part of Webb’s Early Release Science program, which is designed to help transform the astronomical community’s ability to characterize planets and the disks where they form.

# NASA'S WEBB MEASURES THE TEMPERATURE OF A ROCKY EXOPLANET

An international team of researchers has used NASA's James Webb Space Telescope to measure the temperature of the rocky exoplanet TRAPPIST-1 b. The measurement is based on the planet's thermal emission: heat energy given off in the form of infrared light detected by Webb's Mid-Infrared Instrument (MIRI). The result indicates that the planet's dayside has a temperature of about 500 kelvins and suggests that it has no significant atmosphere.

This is the first detection of any form of light emitted by an exoplanet as small and as cool as the rocky planets in our solar system. The result marks an important step in determining whether planets orbiting small active stars like TRAPPIST-1 can sustain atmospheres needed to support life. It also bodes well for Webb's ability to characterize temperate, Earth-sized exoplanets using MIRI.

"These observations take advantage of Webb's mid-infrared capability," said Thomas Greene, an astrophysicist at NASA's Ames Research Center and lead author of the study said, "No previous telescopes have had the sensitivity to measure such dim mid-infrared light."



**Credits: Illustration: NASA, ESA, CSA, J. Olmsted (STScI); Science: Thomas Greene (NASA Ames), Taylor Bell (BAERI), Elsa Ducrot (CEA), Pierre-Olivier Lagage (CEA)**

"There are ten times as many of these stars in the Milky Way as there are stars like the Sun, and they are twice as likely to have rocky planets as stars like the Sun," explained Greene. "But they are also very active – they are very bright when they're young, and they give off flares and X-rays that can wipe out an atmosphere."

Co-author Elsa Ducrot from the French Alternative Energies and Atomic Energy Commission (CEA) in France, who was on the team that conducted earlier studies of the TRAPPIST-1 system, added, "It's easier to characterize terrestrial planets around smaller, cooler stars. If we want to understand habitability around M stars, the TRAPPIST-1 system is a great laboratory. These are the best targets we have for looking at the atmospheres of rocky planets."

## Detecting an Atmosphere (or Not)

Previous observations of TRAPPIST-1 b with the Hubble and Spitzer space telescopes found no evidence of a puffy atmosphere but were not able to rule out a dense one. One way to reduce uncertainty is to measure the planet's temperature.

## "Rocky Planets Orbiting Ultracool Red Dwarfs"

In early 2017, astronomers reported the discovery of seven rocky planets orbiting an ultracool red dwarf star (or M dwarf) 40 light-years from Earth. What is remarkable about the planets is their similarity in size and mass to the inner, rocky planets of our own solar system. Although they all orbit much closer to their star than any of our planets orbit the Sun – all could fit comfortably within the orbit of Mercury – they receive comparable amounts of energy from their tiny star.

TRAPPIST-1 b, the innermost planet, has an orbital distance about one hundredth that of Earth's and receives about four times the amount of energy that Earth gets from the Sun. Although it is not within the system's habitable zone, observations of the planet can provide important information about its sibling planets, as well as those of other M-dwarf systems.

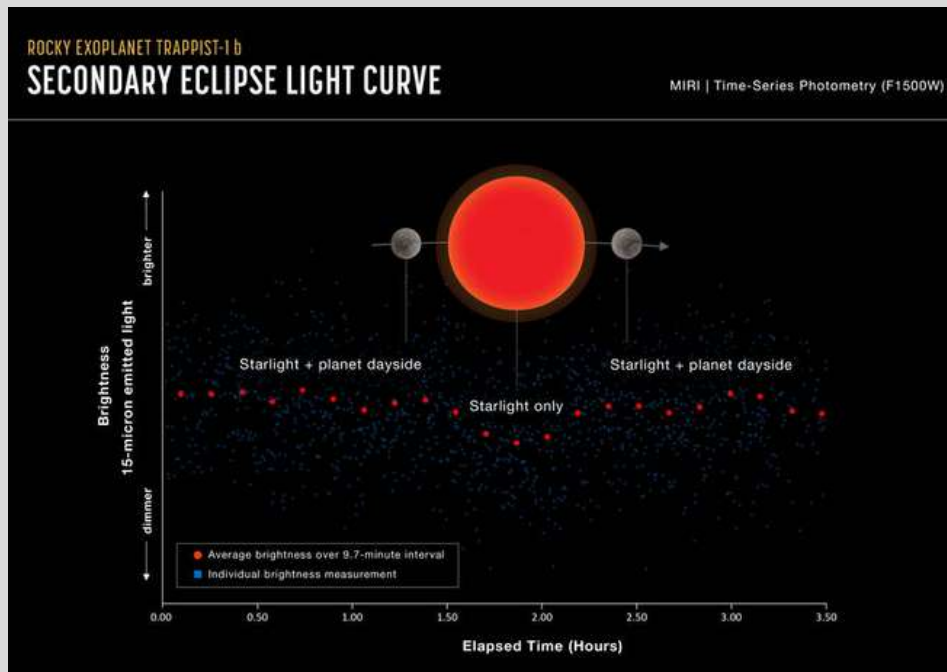
## GALACTICA

"This planet is tidally locked, with one side facing the star at all times and the other in permanent darkness," said Pierre-Olivier Lagage from CEA, a co-author on the paper. "If it has an atmosphere to circulate and redistribute the heat, the dayside will be cooler than if there is no atmosphere."

The team used a technique called secondary eclipse photometry, in which MIRI measured the change in brightness from the system as the planet moved behind the star. Although TRAPPIST-1 b is not hot enough to give off its visible light, it does have an infrared glow.

By subtracting the brightness of the star on its own (during the secondary eclipse) from the brightness of the star and planet combined, they were able to successfully calculate how much infrared light is being given off by the planet.

### Measuring Minuscule Changes in Brightness:



Webb's detection of a secondary eclipse is itself a major milestone. With the star more than 1,000 times brighter than the planet, the change in brightness is less than 0.1%.

"There was also some fear that we'd miss the eclipse. The planets all tug on each other, so the orbits are not perfect," said Taylor Bell, the post-doctoral researcher at the Bay Area Environmental Research Institute who analyzed the data. But it was just amazing: The time of the eclipse that we saw in the data matched the predicted time within a couple of minutes."

**Credits: Illustration: NASA, ESA, CSA, J. Olmsted (STScI); Science: Thomas Greene (NASA Ames), Taylor Bell (BAERI), Elsa Ducrot (CEA), Pierre-Olivier Lagage (CEA)**

The team analyzed data from five separate secondary eclipse observations. "We compared the results to computer models showing what the temperature should be in different scenarios," explained Ducrot. "The results are almost perfectly consistent with a blackbody made of bare rock and no atmosphere to circulate the heat. We also didn't see any signs of light being absorbed by carbon dioxide, which would be apparent in these measurements."

This research was conducted as part of Webb Guaranteed Time Observation (GTO) program 1177, which is one of eight programs from Webb's first year of science designed to help fully characterize the TRAPPIST-1 system. Additional secondary eclipse observations of TRAPPIST-1 b are currently in progress, and now that they know how good the data can be, the team hopes to eventually capture a full phase curve showing the change in brightness over the entire orbit. This will allow them to see how the temperature changes from the day to the nightside and confirm if the planet has an atmosphere or not.

The James Webb Space Telescope is the world's premier space science observatory. Webb will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Webb is an international program led by NASA with its partners, ESA (European Space Agency), and CSA (Canadian Space Agency). MIRI was contributed by NASA and ESA, with the instrument designed and built by a consortium of nationally funded European Institutes (the MIRI European Consortium) and NASA's Jet Propulsion Laboratory, in partnership with the University of Arizona.

## THE ARTEMIS III SPACESUIT PROTOTYPE FOR THE MOON SURFACE MISSION LAUNCHED

**When NASA sends the first astronauts to explore near the lunar South Pole, moonwalkers will wear spacesuits provided by Axiom Space. NASA selected the company to develop the modern suits for the Artemis III mission and participated in activities when the first prototype was revealed Wednesday during an event at Space Center Houston in Texas.**

Helping take a step forward in the agency's goal to build a robust economy at the Moon by working with commercial service providers, Axiom Space hosted the event for students and media to ask questions and get a close-up look at the spacesuit.

"NASA's partnership with Axiom is critical to landing astronauts on the Moon and continuing American leadership in space. Building on NASA's years of research and expertise, Axiom's next generation spacesuits will not only enable the first woman to walk on the Moon, but they will also open opportunities for more people to explore and conduct science on the Moon than ever before," said NASA Administrator Bill Nelson. "Our partnership is investing in America, supporting America's workers, and demonstrating another example of America's technical ingenuity that will position NASA and the commercial space sector to compete and win in the 21st century."

Artemis III will land astronauts, including the first woman, on the Moon to advance long-term lunar exploration and scientific discovery, and inspire the Artemis Generation. NASA selected Axiom Space to deliver the moonwalking system, including the spacesuit, for the mission. Called the Axiom Extravehicular Mobility Unit, or AxEMU, the spacesuit builds on NASA's spacesuit prototype developments and incorporates the latest technology, enhanced mobility, and added protection from hazards at the Moon.

NASA chose to use a commercial services contract for development of the new spacesuit, whereby NASA purchases moonwalking services from Axiom Space. Under this model, the company is encouraged to pursue other commercial customers for their moonwalking services. This mutually beneficial approach helps bolster an emerging commercial market and grants NASA the right to use the data and technologies developed under the contract for future exploration efforts.



The next-generation spacesuit as designed by Axiom Space is a modular design, ready for a diverse astronaut corps. (Image credit: Axiom Space)





Using innovative technologies, the new Axiom Space spacesuit will enable exploration of more of the lunar surface than ever before.

(Image credit: Axiom Space)

"NASA is leading the way in enabling a growing space economy by leveraging industry capabilities and NASA's expertise to provide moonwalking services as safely, effectively, and efficiently as possible," said Lara Kearney, manager of NASA's Extravehicular Activity and Human Surface Mobility program. NASA established the foundation for the AxEMU with the agency's Exploration Extravehicular Mobility Unit (xEMU) prototype development efforts that advanced spacesuit designs for multiple destinations. Axiom Space used the experience, expertise, and data behind the xEMU as a basis for the design and development of the AxEMU, including advancements in technology, training, astronaut feedback on comfort and maneuverability, and compatibility with other NASA systems. Leaning on NASA's prior development efforts is helping Axiom Space reduce technical and schedule risk. NASA experts defined the technical and safety standards by which the spacesuits will be built, and Axiom Space agreed to meet these key agency requirements.

The AxEMU features the range of motion and flexibility needed to explore more of the lunar landscape, and the suit will fit a broad range of crew members, accommodating at least 90 percent of the US male and female population. Axiom Space will continue to apply modern technological innovations in life support systems, pressure garments, and avionics as development continues.

Axiom Space is responsible for the design, development, qualification, certification, and production of flight training spacesuits and support equipment, including tools, to enable the Artemis III mission. The company will test the suit in a spacelike environment prior to the mission. NASA maintains the authority for astronaut training, mission planning, and approval of the service systems.

Following Artemis III, the agency will compete future Artemis mission services under the Exploration Extravehicular Activity Services (xEVAS) contract. NASA is using the contract to meet the agency's spacewalking needs for both the Moon and the International Space Station. The agency recently awarded a task order to Collins Aerospace, who is also competing within the xEVAS contract, to develop new spacesuits for astronauts to wear during spacewalks on the space station. Both vendors will compete for future spacewalking and moonwalking services task orders.

Through Artemis, NASA will land the first woman and the first person of color on the Moon, paving the way for a long-term, sustainable lunar presence to explore more of the lunar surface than ever before and prepare for future astronaut missions to Mars.

# LVM3 M3/ONEWEB INDIA-2 MISSION ACCOMPLISHED SUCCESSFULLY

On Mar 26, 2023, ISRO's LVM3 launch vehicle, in its sixth consecutive successful flight placed 36 satellites belonging to OneWeb Group Company into their intended 450 km circular orbit with an inclination of 87.4 degrees. With this, NSIL has successfully executed its contract to launch 72 satellites of OneWeb to Low Earth Orbit.

The vehicle took off with a total payload of 5,805 kg at 09:00:20 hours local time from the second launch pad at SDSC-SHAR, Sriharikota. It gained the required altitude of 450 km in about nine minutes of flight, achieved satellite injection conditions in the eighteenth minute, and began injecting the satellites in the twentieth minute.

The C25 stage performed a sophisticated maneuver to repeatedly orient itself in orthogonal directions and inject satellites into precise orbits with defined time gaps to avoid collision of the satellites. 36 satellites were separated in 9 phases, in a batch of 4.

OneWeb confirmed the acquisition of signals from all 36 satellites. This mission marked OneWeb's second satellite deployment from India, highlighting the strong partnership with NSIL and ISRO. It was OneWeb's 18th launch bringing the total of OneWeb's constellation to 618 satellites.

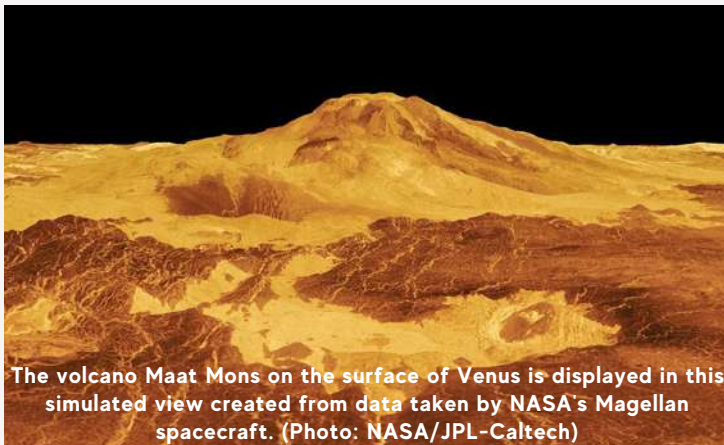


# "OLD DATA, NEW FIND" 'ACTIVE VOLCANO' ON VENUS

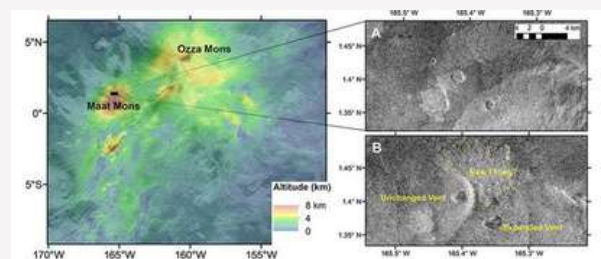
**Eruption spotted in 30-year-old data from Magellan mission.**

A new analysis of archival radar images taken around three decades ago has found direct geological evidence of recent volcanic activity on the surface of Venus, also known as Earth's twin, for the first time. Researchers have observed a volcanic vent changing its shape and getting bigger in size in around eight months, the National Aeronautics and Space Administration (NASA) said.

The new findings are described in a study, 'Surface changes observed on a Venusian volcano during the Magellan mission', published in the journal *Science* last week. The research has been carried out by Robert Herrick of the Geophysical Institute, University of Alaska Fairbanks (USA), and Scott Hensley of Jet Propulsion Laboratory (JPL), California Institute of Technology (USA). For years, scientists have known that numerous volcanoes cover Venus but there wasn't any evidence up till now to show if any one of them is still active.



The volcano Maat Mons on the surface of Venus is displayed in this simulated view created from data taken by NASA's Magellan spacecraft. (Photo: NASA/JPL-Caltech)



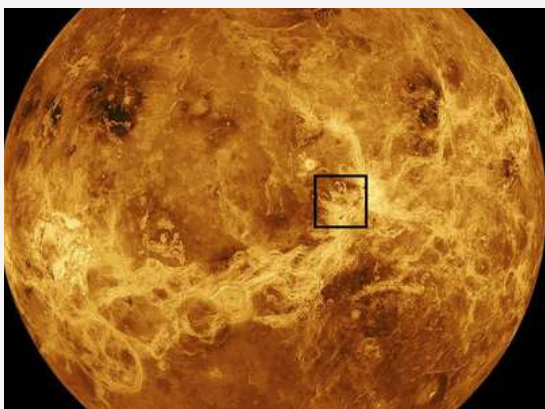
Altitude data for the Maat and Ozza Mons region on the Venus surface is shown at left, with the area of study indicated by the black box. At right are the before (A) and after (B) Magellan observations of the expanded vent on Maat Mons, with possible new lava flows after an eruptive event.

*Credits: Robert Herrick/UAF*

## What are the findings?

Scientists made the new discovery by pouring over images of Venus taken by NASA's Magellan spacecraft between 1990 and 1992. During their examination, they looked at the planet's Atla Regio area, where two of the biggest volcanoes of Venus, Ozza Mons and Maat Mons, are located. Herrick noticed a vent situated on the north side of a domed shield volcano that is part of the larger Maat Mons volcano that changed significantly in shape and size between February and October 1991.

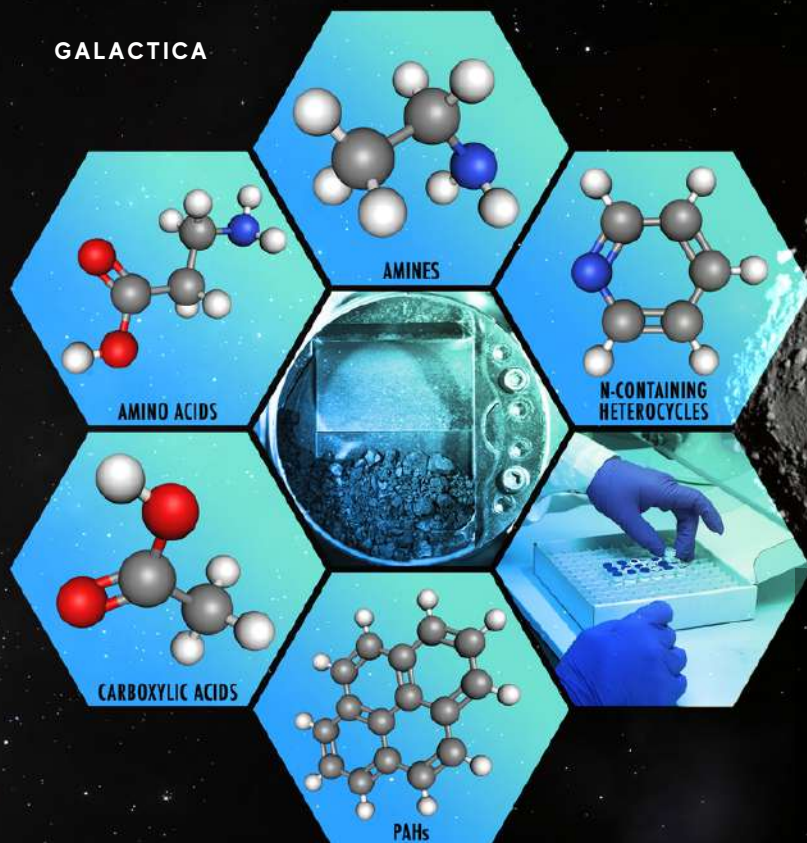
The paper said in the February radar image, this vent appeared nearly circular and deep with steep walls, covering 2.6 sq km of area. However, in the images that were taken eight months later, the same vent had become irregular in outline, shallower and nearly filled while covering about 3.9 sq km. This indicated an eruption or flow of magma beneath the vent.



This annotated, computer-simulated global map of Venus's Maat Mons, the volcano that has exhibited signs of a recent eruption, is within the black square near the planet's equator.

The new findings didn't come easily as Herrick had to analyse Magellan spacecraft's radar images for hundreds of hours – these images are reportedly of much lower resolution than images taken by the cameras attached to spacecraft today and are also relatively coarse. Moreover, during its mission, Magellan also changed its viewing geometry each time it flew over Venus.

As volcanoes act like windows to provide information about a planet's interior, the new findings take scientists a step further to understand the geological conditions of not just Venus but also other exoplanets. Apart from this, the findings give us a glimpse of what more is to come regarding Venus as in the next decade, three new Venus missions would be launched, including the European EnVision orbiter and NASA's DAVINCI and VERITAS missions. Herrick is part of both EnVision and VERITAS missions.



## ORGANIC MOLECULES ON ASTEROID RYUGU

Organic molecules have been detected in samples collected by Japan's Hayabusa2 mission from the near-Earth asteroid Ryugu. "When researchers analyzed the samples, collected from two different locations on the asteroid, they found uracil, one of the building blocks of RNA, as well as vitamin B3, or niacin (a key cofactor for metabolism in living organisms).

Uracil is a nucleobase, or a nitrogen-containing compound. It's one of five nucleobases in DNA and RNA, the proteins and molecules that contain genetic information and instructions crucial for the cells of living organisms.

Ryugu is a carbon-rich, diamond-shaped asteroid that measures about 3,000 feet (1 kilometer) wide. Hayabusa2 was the first mission to return a subsurface sample from an asteroid to Earth.

The Japanese Aerospace Exploration Agency mission collected one sample from the asteroid's surface in February 2019, then fired a copper "bullet" into the asteroid to create a 33-foot (10-meter) wide impact crater. A sample was collected from this crater in July 2019. Then, Hayabusa2 flew by Earth and dropped the sample off in Australia in December 2020.

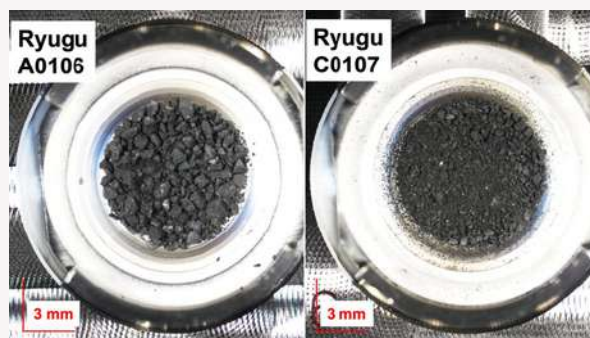
In earlier analyses, researchers detected amino acids and other molecules in Ryugu's samples, while uracil and niacin have also been found in meteorites that landed on Earth.

"Scientists have previously found nucleobases and vitamins in certain carbon-rich meteorites, but there was always the question of contamination by exposure to the Earth's environment," said lead study author Yasuhiro Oba, associate professor at Hokkaido University in Japan, in a statement. "Since the Hayabusa2 spacecraft collected two samples directly from asteroid Ryugu and delivered them to Earth in sealed capsules, contamination can be ruled out."

### Building blocks of life in space

The researchers discovered the molecules when they soaked particles collected from Ryugu in hot water and analyzed the results using different observational methods, such as liquid chromatography and mass spectrometry. Scientists worked with samples collected from two different sites on the near-Earth asteroid Ryugu. Then, the team detected the signatures of uracil, niacin and other organic compounds containing nitrogen. "Other biological molecules were found in the sample as well, including a selection of amino acids, amines and carboxylic acids, which are found in proteins and metabolism, respectively.

Together, the findings from Ryugu's samples so far add to the increasing evidence that the building blocks of life originated in space and were originally delivered to Earth billions of years ago by meteorites.



## HUBBLE MONITORS CHANGING WEATHER AND SEASONS AT JUPITER AND URANUS

Images of Uranus taken by the Hubble Space Telescope between 2014 and 2022 reveal a smoggy cap growing around the planet's north pole. Hubble Space Telescope reveals how weather slowly changes on these giant, distant planets. Unlike Earthly weather which changes from day to day, atmospheric conditions on planets in the outer solar system are fairly stable. These planets receive very little sunlight and take years to decades to complete one orbit around the sun. Still, when scientists compare Hubble Space Telescope images of these planets captured several years apart, they see that their atmospheres are, in fact, alive.

A prominent string of alternating storms is visible, forming a "vortex street". This is a wave pattern of nested anticyclones and cyclones, locked together like in a machine with alternating gears moving clockwise and anticlockwise. If the storms get close enough to each other, in the very unlikely event of a merger, they could build an even larger storm, potentially rivaling the current size of the Great Red Spot. The staggered pattern of anticyclones and cyclones prevents individual storms from merging. Activity is also seen interior to these storms; in the 1990s Hubble didn't see any cyclones or anticyclones with built-in thunderstorms, but these storms have sprung up in the last decade. Strong color differences indicate that Hubble is seeing different cloud heights and depths as well.



2022



2023

Jupiter's legendary Great Red Spot takes center stage in this view. Though this vortex is big enough to swallow Earth, it has actually shrunk to the smallest size it has ever been over observation records dating back 150 years. Jupiter's icy moon Ganymede can be seen transiting the giant planet at the lower right. Slightly larger than the planet Mercury, Ganymede is the largest moon in the solar system. It is a cratered world with a mainly water-ice surface with apparent glacial flows driven by internal heat. This image is smaller in size because Jupiter was 81,000 miles farther from Earth when the photo was taken. This image was taken on January 6, 2023. (Image credit: NASA, ESA, STScI, Amy Simon, Michael H. Wong.)

This is a Hubble view of Uranus taken in 2014, seven years after the northern spring equinox when the Sun was shining directly over the planet's equator. Multiple storms with methane ice-crystal clouds appear at mid-northern latitudes above the planet's cyan-tinted lower atmosphere. Hubble photographed the ring system edge-on in 2007, but the rings are seen starting to open up seven years later in this view. At this time, the planet had multiple small storms and even some faint cloud bands. Image credit: NASA, ESA, STScI, Amy Simon, Michael H. Wong, Image processing: Joseph DePasquale.



2014



2022

As seen in 2022, Uranus' north pole shows a thickened photochemical haze that looks similar to the smog over cities. Several little storms can be seen near the edge of the polar haze boundary. Hubble has been tracking the size and brightness of the north polar cap and it continues to get brighter year after year. Astronomers are disentangling multiple effects - from atmospheric circulation, particle properties, and chemical processes - that control how the atmospheric polar cap changes with the seasons. At the Uranian equinox in 2007, neither pole was particularly bright. As the northern summer solstice approaches in 2028 the cap may grow brighter still, and will be aimed directly toward Earth, allowing good views of the rings and north pole; the ring system will then appear face-on. This image was taken on November 10, 2022.

# CHINA PLANS TO USE PARACHUTES TO CONTROL ITS ROCKET DEBRIS PROBLEM

**China is finalizing testing of a parachute system to help control falling rocket debris downrange.**

Falling rocket boosters from Chinese orbital launches from inland launch centers have caused issues in recent years as the country ramps up its space activities.

The China Aerospace Science and Technology Corporation (CASC), which makes the country's Long March rockets, is now close to finalizing the design of parachutes and related subsystems to bring rocket boosters down much more accurately.

The parachute system will be used to recover side boosters attached to China's Long March 3B, 3C, and 2F rockets. CASC is also looking at recovering payload fairings, which protect spacecraft on their way up through the atmosphere before being jettisoned.

In the booster's process of falling, we open the parachute and use its gliding control performance to reduce the original landing area of 30 to 90 kilometers [18 to 56 miles] to a relatively smaller area, so that the booster will drop on a designated place," Teng Haishan, deputy chief engineer of the No. 508 Institute of China Academy of Space Technology (CAST).

"We also make the landing area into a landing bed by adding cushioning, making it soft as a mattress," Teng added. "As a result, the booster will be completely recyclable without any damage."



The development is designed to minimize the risk of injury and damage downrange from China's inland launch sites and lower the cost of launches by reducing the need to implement precautions such as evacuating inhabited areas ahead of launches.

Teng said that if the recovery system is put into use, about 1.7 billion yuan (about \$249 million U.S.) can be saved annually.

China's rate of orbital launches has multiplied over the past decade. The country conducted 15 launches in 2013 and last year attempted 64 launches, making safety and cost even bigger issues.

Launches of the Long March 3B rocket from Xichang in southwest China in particular caused several debris incidents in recent years.

China's three first spaceports were built during the Cold War and were constructed deep inland for security reasons. The result, decades later, is the threat of launch debris falling downrange.

The country has, however, in the last decade established a coastal spaceport at Wenchang, also allowing China to launch newer, bigger rockets. Wenchang is now being expanded to host commercial launches.

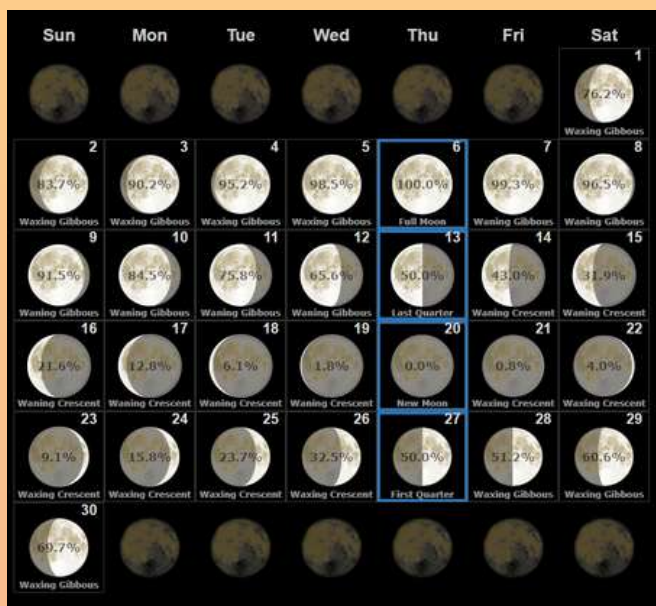
# WHAT'S UP IN THE SKY - APRIL 2023

## 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

Evening planet, best at the start and middle of April. Sets two hours after sunset on 11 April.



### Venus

Brilliant evening object, setting four hours after sunset at month end. Near the Pleiades on 11 April.



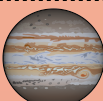
### Mars

Fading evening planet, Small when seen with a telescope.



### Jupiter

Jupiter is in conjunction with the Sun on 11 April and not visible this month.



### Saturn

Saturn is a morning object, but it is not well-placed and is unlikely to be seen.



### Uranus

Poorly located evening planet. 4° from Mercury on 19 April but tricky to see.



### Neptune

Neptune is a morning object but lost in the dawn twilight, so not visible.



## BRIGHT DEEP SKY OBJECTS

The Hercules Cluster in the constellation Hercules also known as M13 is considered to be the finest globular cluster in the northern half of the heavens. It's found in a star pattern called the Keystone a lopsided square between the two brightest stars of northern spring and summer, Vega and Arcturus.



The M81 and M82 galaxies are a pair of galaxies located in the constellation, Ursa Major. M81 (Bode's Galaxy) is a spiral galaxy that lies 11.8 million light-years away, while M82 (The Cigar Galaxy) is an irregular galaxy at roughly the same distance away from Earth.

M44 also known as the Praesepe or the Beehive cluster is an open cluster spanning some 15 light-years, M44 holds 1,000 stars or so and covers 1.5 degrees on the sky in the constellation Cancer. Described as a faint cloud long before being in Charles Messier's catalog, the cluster was not resolved into its individual stars until telescopes were available.



M41 is a stunning, large bright open cluster located in the constellation of Canis Major. Of the many clusters in Canis Major, it's the stand out object and the constellation's only Messier object, but easy to find since it's positioned just four degrees south of Sirius. With an apparent mag. of +4.5, the cluster is visible to the naked eye. It covers 39 arc minutes of apparent sky.

# ROCKET LAUNCHES IN APRIL 2023

## ARIANE 5 • JUICE

Arianespace will use an Ariane 5 ECA rocket, designated VA260, to launch the European Space Agency's Jupiter Icy Moons Explorer mission, or JUICE. The JUICE spacecraft, built by Airbus, will make detailed observations of the giant gas planet and its three large ocean-bearing moons – Ganymede, Callisto and Europa – with a suite of remote sensing, geophysical and in situ instruments. JUICE will enter orbit around Jupiter in July 2031. This will mark the penultimate launch of Europe's Ariane 5 rocket.

### JUICE IS AN ESA-LED MISSION

- NASA has contributed one instrument (UVS) and hardware for two European-provided instruments (RIME, PEP).
- JAXA has contributed hardware for various European-provided instruments (RPWI, GALA, PEP).
- ISA has contributed hardware for one European-provided instrument (3GM).

Juice will reach space on an Ariane 5 from Europe's Spaceport in French Guiana.

It has 10 scientific instruments including one experiment and one radiation monitor.

### Juice will:

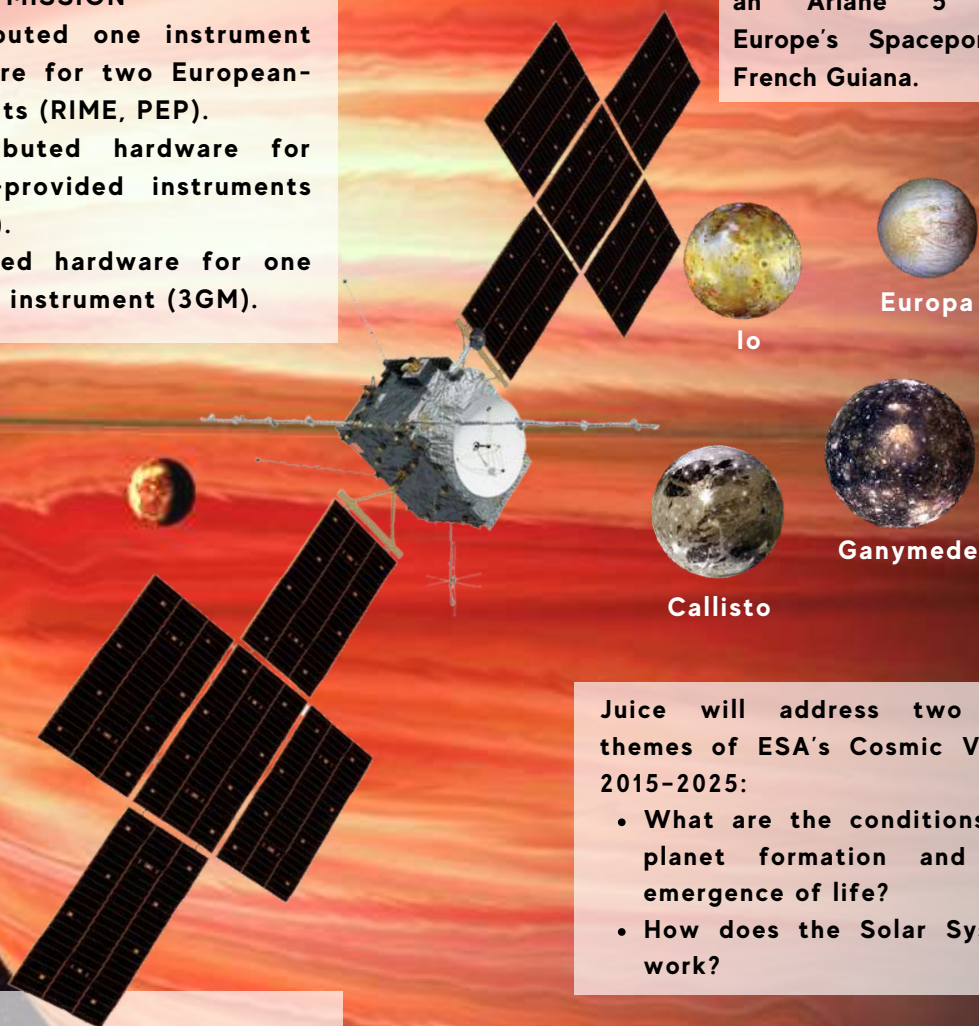
- Explore Jupiter's icy moons - in particular huge, magnetized, water-rich Ganymede.
- Investigate Jupiter's complex environment in-depth.
- Study the Jupiter system as an archetype for gas giants across the Universe.

Juice will address two key themes of ESA's Cosmic Vision 2015-2025:

- What are the conditions for planet formation and the emergence of life?
- How does the Solar System work?

### Juice will be the first spacecraft to:

- Perform a lunar-Earth gravity assist.
- Change orbit from another planet to one of its moons (Jupiter to Ganymede).
- Orbit a moon other than our own.





ESA's Jupiter Icy Moons Explorer, Juice, will make detailed observations of the giant gas planet and its three large ocean-bearing moons - Callisto, Europa, and in particular Ganymede - with a suite of ten unique science instruments, one experiment and one radiation monitor.

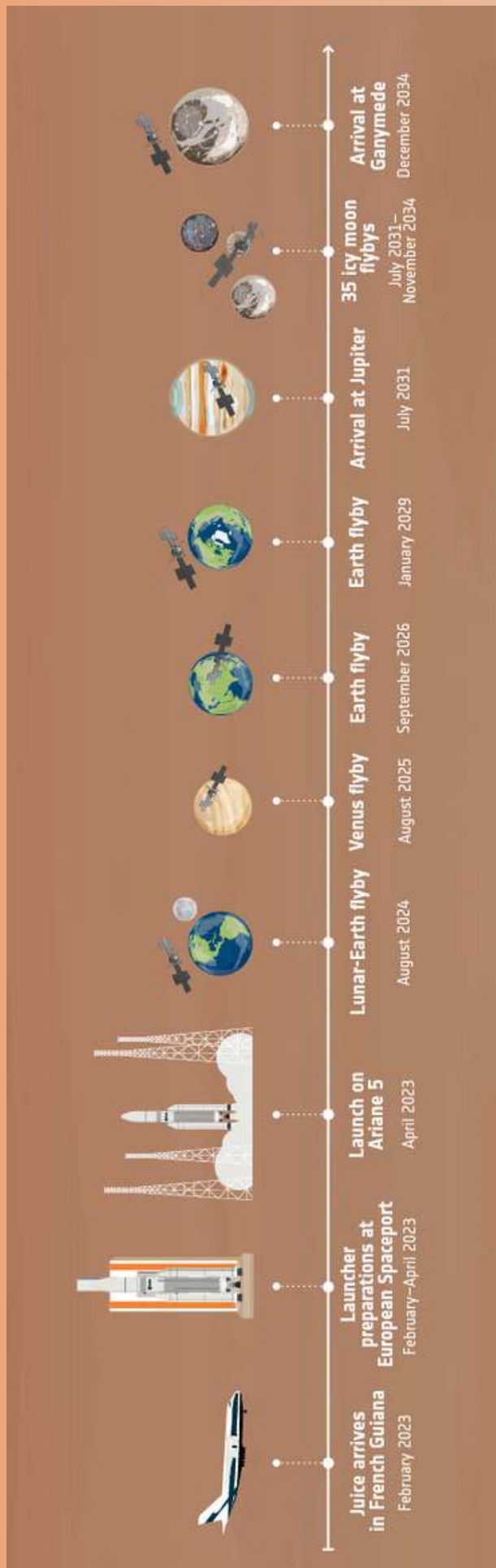
The mission will characterize these moons as both planetary objects and possible habitats. It will also explore Jupiter's complex environment in depth, and study the wider Jupiter system as an archetype for gas giants across the Universe.

Juice will complete a number of Solar System firsts. It will be the first spacecraft ever to orbit a moon other than our own - Jupiter's largest moon Ganymede. And en route to Jupiter it will perform the first ever lunar-Earth gravity assist to save propellant.

Juice will be the last ESA mission to launch on an Ariane 5 from ESA's Spaceport in Kourou, before Ariane 6 takes over.



Juice will carry ten state-of-the-art instruments, including the most powerful remote sensing, geophysical, and in situ payloads ever flown to the outer Solar System. Nine of the instruments are led by European partners, and one by NASA. Juice also includes an experiment called PRIDE, which will perform precise measurements using radio telescopes on Earth. (Image credits: NASA/JUICE launch kit).





India's Polar Satellite Launch Vehicle, or PSLV, will launch the TeLEOS 2 satellite for Singapore. TeLEOS 2 was built in Singapore by ST Electronics, and carries an all-weather synthetic aperture radar Earth observation payload.

## PSLV TELEOS-2

The Indian Space Research Organisation (ISRO) is the space agency of the Government of India headquartered in the city of Bangalore. Its vision is to "harness space technology for national development while pursuing space science research and planetary exploration." The Polar Satellite Launch Vehicle (PSLV) is an expendable medium-lift launch vehicle designed and operated by the Indian Space Research Organisation (ISRO). It was developed to allow India to launch its Indian Remote Sensing (IRS) satellites into sun-synchronous orbits, a service that was, until the advent of the PSLV in 1993, commercially available only from Russia. PSLV also launches small size satellites into Geostationary Transfer Orbit (GTO).

The satellite is built on a bus based on the TeLEOS 1 optical earth observation satellite and is to operate in conjunction with this satellite. TeLEOS 2 carries a made-in-Singapore Synthetic Aperture Radar (SAR) payload capable of providing 1 m resolution data. It will be equipped with a 500 Giga Bytes onboard recorder for recording the data captured and a high-speed 800 Mbps downlink.

Building on the successful completion and launch of TeLEOS-1, Singapore's first made-in-Singapore commercial Earth Observation Satellite, this development is designed to further propel the growth of Singapore's space industry and strengthen ST Electronic's

While TeLEOS-1, with an electro-optical payload, provides up to six daylight imaging opportunities daily along the equatorial belt, TeLEOS-2 will be equipped with a SAR payload providing 24x7 day and night, all-weather imaging opportunities. Customers will be able to use the complementary imagery services provided by ST Electronic's electro-optical and SAR satellites.

To further widen its market reach and expand its value-added services in addressing the growing demand for services relating to maritime security, ST Electronics has also signed a Memorandum of Understanding with Collecte Localisation Satellites (CLS), a subsidiary of the French Space Agency (CNES). (Image credits: ISRO)

# DELTA IV HEAVY TO LAUNCH NROL-68



**A United Launch Alliance (ULA) Delta IV Heavy rocket is launching the NROL-68 mission for the National Reconnaissance Office (NRO). Liftoff will occur from Space Launch Complex-37 (SLC-37) at Cape Canaveral Space Force Station, Florida.**

**Mission Overview:**

When the United States needs eyes and ears in critical places where no human can reach be it over the most rugged terrain or through the most hostile territory it turns to the NRO. The NRO is the Intelligence Community agency responsible for developing, acquiring, launching, and operating America’s reconnaissance satellites, as well as operating associated data processing facilities in support of national security.

The NRO uses a variety of satellites to meet mission needs—from small sats to more traditional, larger satellites. This allows the NRO to pursue a hybrid architecture designed to provide global coverage against a wide range of intelligence requirements, carry out research and development efforts, and assist emergency and disaster relief efforts in the U.S. and around the world. The NRO never loses focus on whom they are working to protect: our nation and its citizens.

(Credits: Rocketbuilder.com).

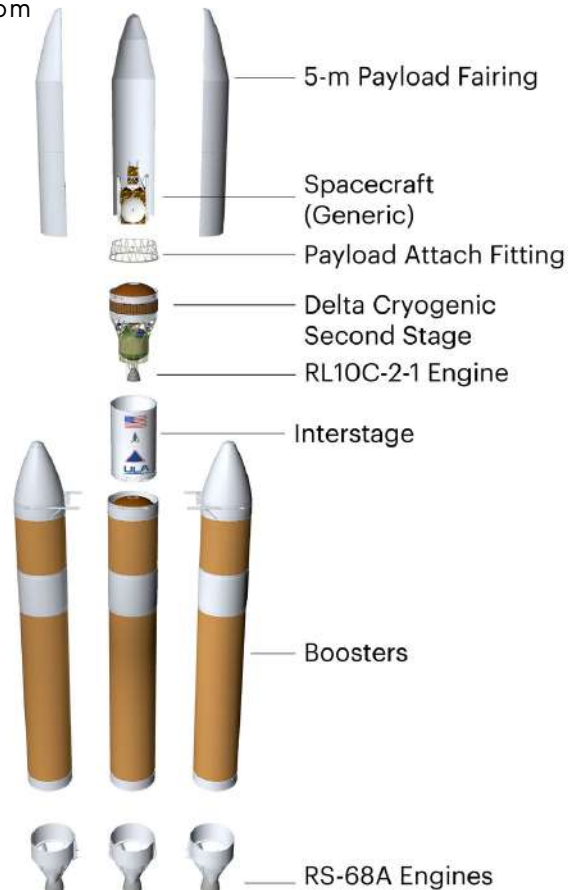
**Payload fairing(PLF)**

The payload fairing (PLF) is a metallic tri-sector (three-piece shell), 5-meter diameter fairing.

The PLF encapsulates the spacecraft to protect it from the launch environment on the ascent. The vehicle’s height, with the 65-ft (19.8-m) long PLF, is approximately 235 ft (71.6 m).

**Delta Cryogenic Second Stage (DCSS)**

The Delta Cryogenic Second Stage is a cryogenic liquid hydrogen/liquid oxygen-fueled vehicle, powered by a single RL10C-2-1 engine that produces 24,750 lbs (110.1 kilo-Newtons) of thrust. The DCSS propellant tanks are structurally rigid and constructed of formed aluminum plates, spun-formed aluminum domes, and aluminum ring forgings. The tanks are insulated with spray-on insulation and helium-purged insulation blankets. An equipment shelf attached to the aft dome of the DCSS liquid oxygen tank provides the structural mountings for vehicle electronics.



# ANTARES • NG-19



**A Northrop Grumman Antares rocket will launch the CRS2 NG-19 (Cygnus) mission. The launch date is currently targeted for April 21, 2023 (UTC).**

A Northrop Grumman Antares rocket will launch the 20th Cygnus cargo freighter on the 19th operational cargo delivery flight to the International Space Station. The mission is known as NG-19. The rocket will fly in the Antares 230+ configuration, with two RD-181 first-stage engines and a Castor 30XL second-stage. This will be the final flight of an Antares 230+ rocket before a redesign with new U.S.-made engines.

Antares known during early development as Taurus II is an expendable launch system developed by Orbital Sciences Corporation (now part of Northrop Grumman Innovation Systems after Northrop Grumman acquired Orbital ATK) and the Yuzhnoye Design Bureau to launch the Cygnus spacecraft to the International Space Station as part of NASA's COTS and CRS programs. Able to launch payloads heavier than 5,000 kg (11,000 lb) into low-Earth orbit, Antares is the largest rocket operated by Orbital ATK. Antares launches from the Mid-Atlantic Regional Spaceport and made its inaugural flight on April 21, 2013.

Northrop Grumman Space Systems designs build and deliver space, defense, and aviation-related systems to customers around the world. They acquired Orbital ATK in 2018 along with its launchers and ongoing missions.

The NG-19 launch will be the last of the current version of the Antares rocket as Northrop works with Firefly Aerospace on a new version that does away with the Ukrainian-built first stage and Russian engines. While that new Antares vehicle is in development, Northrop plans to launch three Cygnus spacecraft on SpaceX Falcon 9 rockets. (Credits: NASA)

# SpaceX Launches - April 2023

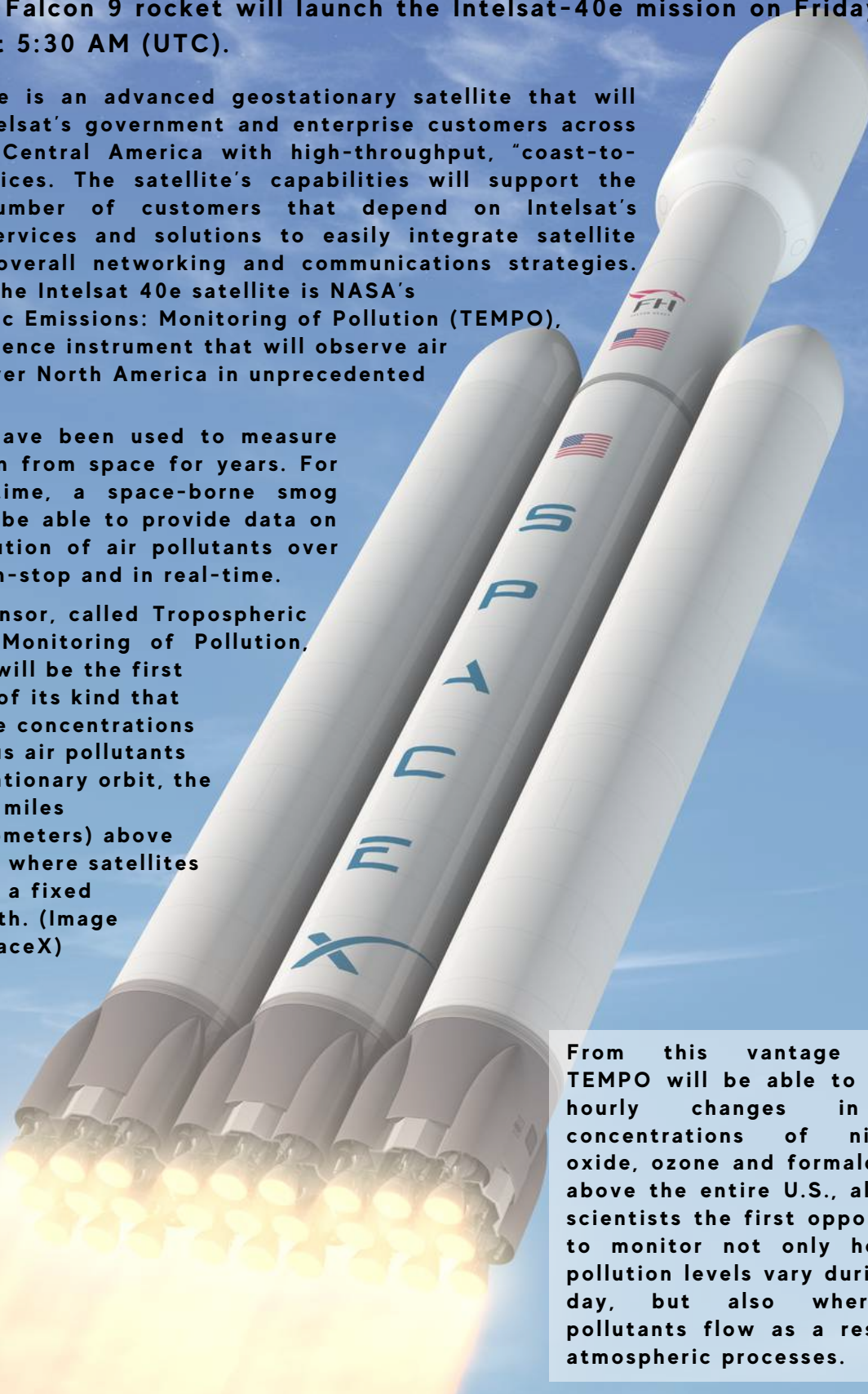
## **FALCON 9 • INTELSAT 40E/TEMPO**

A SpaceX Falcon 9 rocket will launch the Intelsat-40e mission on Friday, April 7, 2023, at 5:30 AM (UTC).

Intelsat 40e is an advanced geostationary satellite that will provide Intelsat's government and enterprise customers across North and Central America with high-throughput, "coast-to-coast" services. The satellite's capabilities will support the growing number of customers that depend on Intelsat's managed services and solutions to easily integrate satellite into their overall networking and communications strategies. Hosted on the Intelsat 40e satellite is NASA's Tropospheric Emissions: Monitoring of Pollution (TEMPO), an Earth science instrument that will observe air pollution over North America in unprecedented detail.

Satellites have been used to measure air pollution from space for years. For the first time, a space-borne smog sensor will be able to provide data on the distribution of air pollutants over America non-stop and in real-time.

The new sensor, called Tropospheric Emissions: Monitoring of Pollution, or TEMPO, will be the first instrument of its kind that will measure concentrations of dangerous air pollutants from geostationary orbit, the ring 22,000 miles (36,000 kilometers) above the equator where satellites remain over a fixed spot on Earth. (Image Credits: SpaceX)



From this vantage point, TEMPO will be able to detect hourly changes in the concentrations of nitrogen oxide, ozone and formaldehyde above the entire U.S., allowing scientists the first opportunity to monitor not only how air pollution levels vary during the day, but also where air pollutants flow as a result of atmospheric processes.

# **FALCON** **HEAVY** **VIASAT-3** **AMERICAS**

A SpaceX Falcon Heavy rocket will launch the ViaSat 3 Americas mission on Saturday, April 8, 2023, at 10:25 PM (UTC).

The ViaSat-3 class of Ka-band satellites is expected to provide vastly superior capabilities in terms of service speed and flexibility for a satellite platform. The first two satellites will focus on the Americas and Europe, the Middle East, and Africa (EMEA), respectively, with the third satellite planned for the Asia Pacific (APAC) region, completing Viasat's global service coverage. Each ViaSat-3 class satellite is expected to deliver more than 1 terabit per second of network capacity and to leverage high levels of flexibility to dynamically direct capacity to where customers are located.

Each Viasat-3 aims to provide more than one terabit a second of broadband capacity from geostationary orbit (GEO) – three times faster than the operator's ViaSat-2 satellite that launched in 2017.

The first ViaSat-3 will focus on covering the Americas. The second, targeting Europe, the Middle East, and Africa, remains on schedule for a launch in the summer of 2023. The company plans to deploy the third ViaSat-3 covering the Asia Pacific region six months later.

"We selected SpaceX as they continue to demonstrate their commitment to advancing space technologies" Dave Ryan, Viasat's president of space systems, said in a statement. "Their proven technology is both powerful and efficient enough to thrust a ViaSat-3 spacecraft close to geostationary orbit." (Credits: SpaceX, Viasat Inc.)





# TRANSPORTER 7 LAUNCH BY FALCON 9

A SpaceX Falcon 9 rocket will launch the Transporter 7 mission, a rideshare flight to a sun-synchronous orbit with numerous small microsattellites and nanosatellites for commercial and government customers. The Falcon 9's first stage booster will return to Landing Zone 4 at Vandenberg.

Transporter 7 mission is a flight to a sun-synchronous orbit with dozens of small microsattellites and nanosatellites for commercial and government customers

It is a dedicated rideshare mission by SpaceX. SpaceX's Small Sat Rideshare Program provides small satellite operators with regularly scheduled, dedicated Falcon 9 rideshare missions to SSO for ESPA class payloads for as low as \$275,000 per mission, which includes up to 50kg of payload mass.

**The engine of this spaceflight:** The Merlin engine is a rocket engine developed by SpaceX that uses a combination of rocket-grade kerosene and liquid oxygen as fuel. It is designed to provide high thrust and reliability for use in the company's Falcon 9 and Falcon Heavy rockets. The Merlin 1D engine represents a significant improvement over its predecessor, Merlin 1C. It features a number of enhancements that make it more powerful, reliable, and efficient. The engine produces 190,000 pounds of thrust at sea level and 210,000 pounds of thrust in vacuum, which is more than 50% greater than the Merlin 1C engine.

The improved performance of the Merlin 1D engine is due to a number of factors. It has a higher chamber pressure, which allows for more efficient combustion and higher thrust. It also has an expanded nozzle, which allows for better expansion of exhaust gasses and higher thrust in a vacuum. In addition, the engine features a more advanced turbopump that can deliver more fuel and oxidizer to the combustion chamber at a faster rate. (Credits: SpaceX)

# ASTRONOMICAL EVENTS - APRIL 2023

## LYRIDS METEOR SHOWER

### When to watch in 2023:

Late evening April 21 until dawn April 22 - or late evening April 22 until dawn April 23 will be best. The predicted peak is 1:06 UTC on April 23. That is 6.36 AM on April 23. And the peak of the Lyrids is narrow.

**Radiant:** Rises before midnight, highest in the sky at dawn.

**Nearest moon phase:** In 2023, new moon falls on April 20. There will be no moon in the sky during the peak mornings for 2023's Lyrid meteor shower.

**Duration of shower:** April 14 to April 30.

### Peak:

22-23 Apr in India.

Up to 18 meteors per hour.

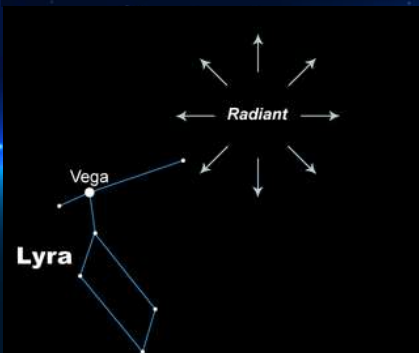
**Expected meteors at peak, under ideal conditions:** In a dark sky with no moon, you might see 10 to 15 Lyrids per hour. The Lyrids are known for uncommon surges that can sometimes bring rates of up to 100 per hour!

### Parent Comet:

C/1861 G1 (Thatcher).

### Where:

In both Hemispheres.



### About the Lyrid meteor shower parent comet

Most meteor showers are caused by debris from a passing comet. For the Lyrids, the comet is named Comet Thatcher. Astronomers first noticed this comet in 1861, around the time of its last perihelion, or closest point to the sun. It takes 417 years to go around the sun once. Its path brings it within the Earth's orbit, then it goes really far away. How far? It goes to a distance of 110 astronomical units (AU). That's 110 times farther from the sun than we are. So Comet Thatcher is now far away, still traveling outward, away from our sun. It'll reach its farthest point from the sun around the year 2283 and then begin its return trip.

The Lyrid meteor shower - spawned by this comet - seems to outburst, or produce an unexpectedly large number of meteors, every 60 years. The next Lyrid outburst is due in 2042. The outbursts happen because of the planets' reshaping the long trail of comet debris left behind by Comet Thatcher in its long orbit. This debris is what intercepts Earth's orbit yearly, to create the meteor shower.

### Discovery of Comet Thatcher

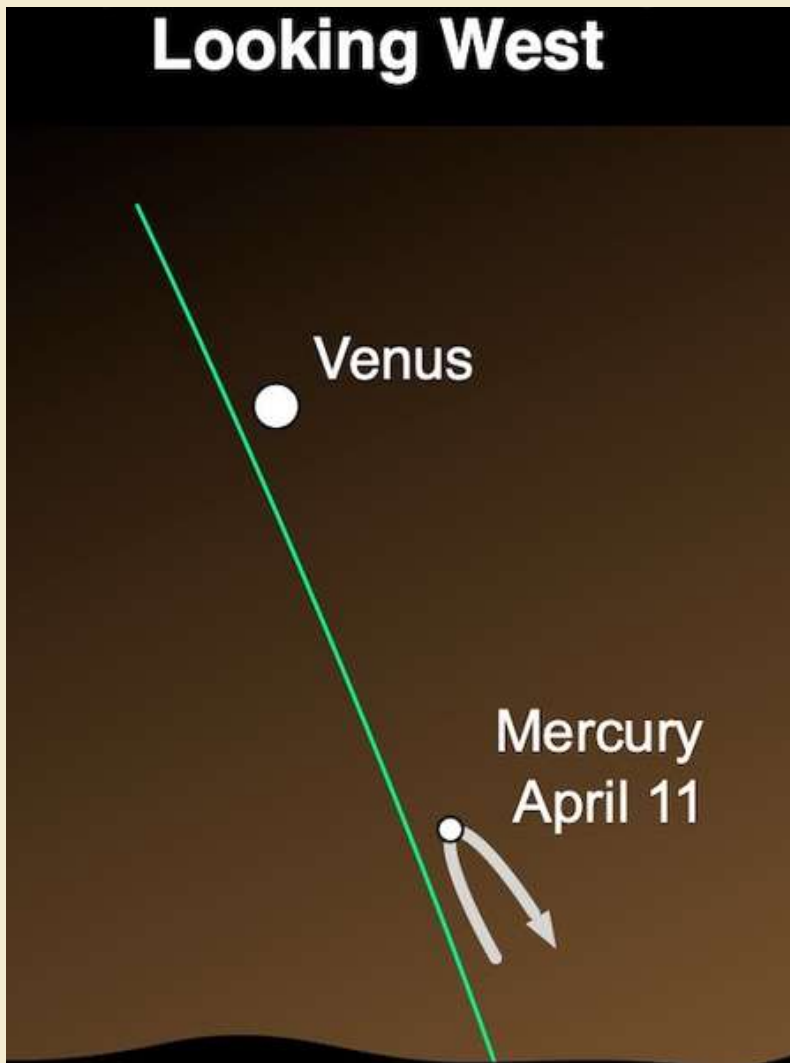
Alfred E. Thatcher from New York City discovered this comet - now officially C/1861 G1 (Thatcher) - on April 5, 1861. At that time the comet was in the direction of our sky's north polar region, toward what we see as the constellation Draco. Alfred Thatcher was using a 4.5-inch-diameter (11cm) refracting telescope, magnifying 30 times. The comet was shining at magnitude 7.5, fainter than the unaided eye can see. But over the next few weeks, as the comet approached both the sun and the Earth, it brightened considerably. It became visible to the eye and remained so until it disappeared into the evening twilight in early June 1861.



# MERCURY AT GREATEST ELONGATION EAST

Mercury will reach its greatest separation from the Sun in its Mar-Apr 2023 evening apparition. It will be shining brightly at mag -0.0.

From Delhi, this apparition will not be one of the most prominent and tricky to observe, reaching a peak altitude of 18° above the horizon at sunset on 12 Apr 2023.



Mercury will fade rapidly towards the end of the apparition as it heads towards inferior conjunction when it will pass between the Earth and Sun. At inferior conjunction, the planet turns its unilluminated side towards the Earth, and so appears as a thin, barely illuminated crescent.

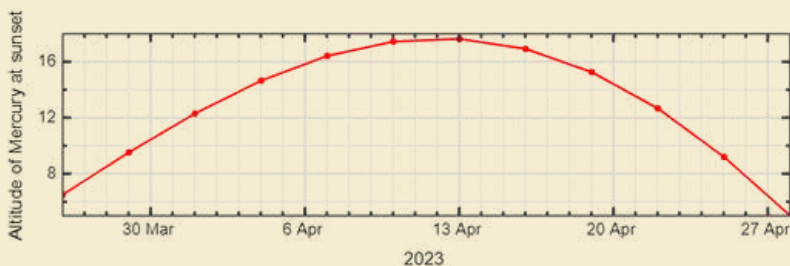
Since Mercury can only ever be observed in the twilight, it is particularly difficult to find when it is in a thin crescent phase. Thus, it will be significantly easier to see in the days before it reaches its highest point in the sky than in the days after.

**Where to look:** Look for Mercury in the sunset direction, as soon as the sky begins to darken. If you can't see it, try sweeping for Mercury with binoculars. It might surprise you, and pop into view.

**When to look:** Mercury begins this evening apparition the last few days of March. However, it fades rapidly after elongation and it'll disappear from view about the 3rd week of the month. Also, a very thin waxing crescent moon will be near Mercury, low on the horizon on April 21, and may guide you to it around 30 minutes after sunset.

**Greatest elongation:** Is at 12.21 AM on April 12, 2023. The greatest elongation, though it occurs at midnight but, it will be visible the next day after sunset as well.

Mercury will show up in the evening sky the last few days of March. What's more, it'll reach its greatest elongation on April 12, 2023. As a bonus, Mercury is near dazzling Venus in the evening sky. Also, it pairs up with Jupiter on March 27, but finding them may be difficult because they are low on the horizon. By the way, this is the best Mercury elongation of the year for the Northern Hemisphere. Credits: Earthsky.org



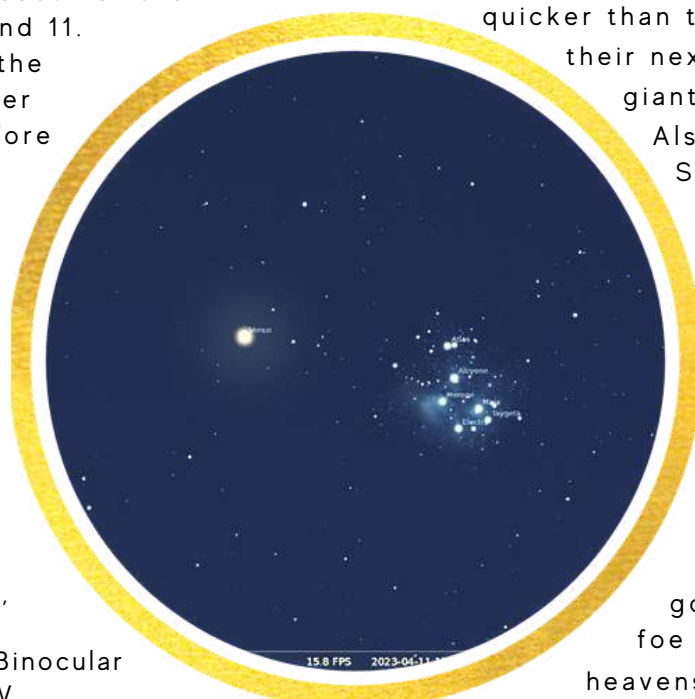


## VENUS, THE PLANET OF LOVE, VISITS THE SEVEN SISTERS

April 9 through 12, the “evening star,” Venus, will conjunct the Pleiades Star Cluster. This event will be easy for beginners to find in the sky with the bright planet nestled between the constellations Hyades and Taurus. Venus will pass 2.5 degrees south of the Pleiades on April 10 and 11. The best time to see the conjunction is just after sunset, both days, before the objects dip below the western horizon.

Conjunctions of Venus and the Pleiades happen yearly, but the planet passes through the cluster only once every eight years. This rarer event last occurred on April 3, 2020, and will happen again on April 3, 2028.

The view as seen from Binocular #11:Jenopatem 10x 50 W. Magnification 10x(0.17D). Exit pupil - 5mm. FOV - 7.3 degrees. (Credits:Stellarium)



The Pleiades and other similar so-called open clusters or galactic clusters are used as benchmarks for the ages of stars. The cluster has many blue stars, indicating a younger age. That is, bright blue stars tend to consume their nuclear fuels

quicker than the sun and morph into their next stellar stages as red giants and red supergiants.

Also known as the “Seven Sisters” and Messier 45, the object derives its English name from Greek legend. The Pleiades are the seven daughters of the Titan god Atlas and the ocean nymph Pleione.

During an ancient war, Atlas rebelled against Zeus, the king of the gods, who sentenced his foe to forever hold up the heavens on his shoulders. The sisters were so sad that Zeus allowed them a place in the sky in order to be close to their father.

Use a binocular to spot the planet and the star cluster in the same field of view. With or without a binocular this is a wonderful scene, especially as the sky darkens further. Venus sets 205 minutes after sunset with the end of twilight occurring 90 minutes earlier, though do not wait until the planet and the star cluster are too low in the sky.

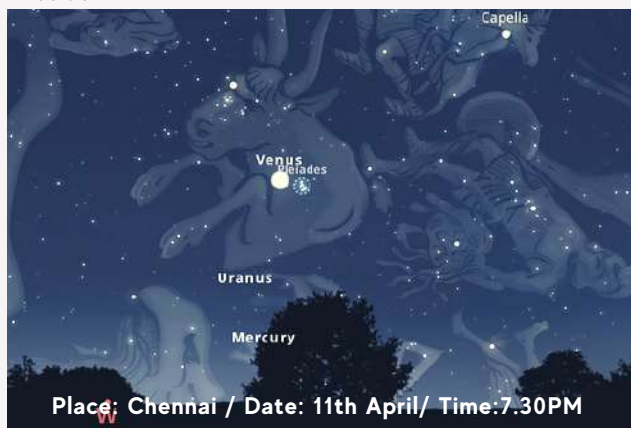
# CONJUNCTIONS FOR THE MONTH

**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 Venus and Pleiades.

On **Apr 11, 2023**, the brightest planet will appear very close to the star cluster Pleiades. The pair will be seen together in the early evening. They will be in the western direction. Venus is at a magnitude of -3.95 and Pleiades has a magnitude of -1.59.



Place: Chennai / Date: 11th April / Time: 7.30PM

## Conjunction of Moon, and Saturn.

On **Apr 16, 2023**, Moon and the planet Saturn will appear very close to each other in the early morning. They will be in the eastern direction. Moon is at a magnitude of -11.07, and the planet Mars is at a magnitude of 1.01.



Place: Chennai / Date: 16th April / Time: 4.30AM

## Conjunction of Moon and Venus.

On **Apr 23, 2023**, Moon and the planet Venus appear very close to each other in the early evening, right after the sunset. They will be in the Western direction. Moon is at a magnitude of -10.17, Venus will be at a magnitude of -3.99.



Place: Chennai / Date: 23rd April / Time: 7.30PM

## Conjunction of Moon with Mars.

On **Apr 26, 2023**, Moon and the planet Mars will appear very close to each other in the evening. They will be in the Western direction. Moon is at a magnitude of -11.50, Mars is at a magnitude of 1.29.



Place: Chennai / Date: 26th April / Time: 8.30PM

# STUDENT'S CORNER

## WORMHOLES

**Sourajit Mandal**

**iAstronomer member**

Have you ever wondered about traveling at the speed of light? Light is extremely fast, isn't it? It would take a second to orbit the earth along the equator 7.5 times at the speed of light. It would take only around 3.11 minutes to travel to Mars at that speed. We could reach the sun in just 8.3 minutes! That's a great speed, isn't it? Well... it is not. Compared to the size of the universe, that speed is nothing. It would take you 4 whole years to reach our nearest star. It would take you thousands of years to cross only our own galaxy with that speed. Umm... too slow.

Perhaps we will never be able to cross the galaxy. Or maybe, we can! Wormholes are a connection between widely separated regions of space and time. They can make you reach any place in the entire universe in a very short time. Imagine two points-A and B on a sheet of paper. The shortest path possible between them is a straight line. Until... you fold the paper and make the points touch each other. Now the shortest path possible is directly from A to B! That is what a wormhole basically is. A wormhole folds the entire space-time and connects the two points together.

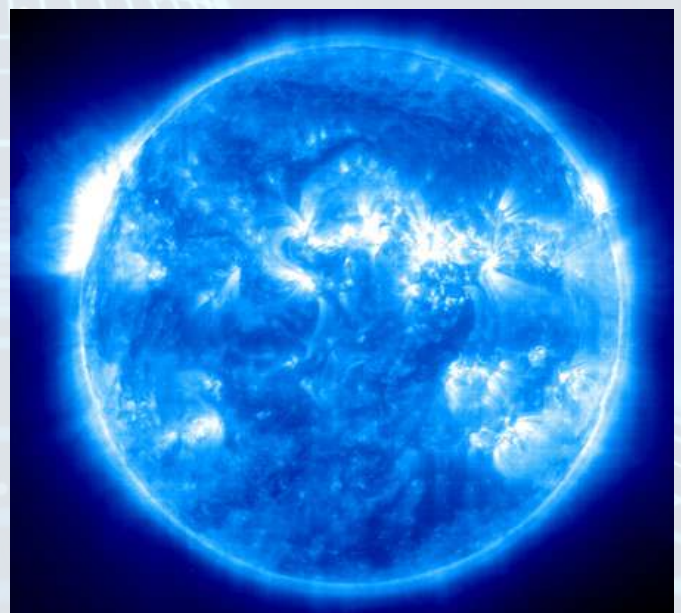
But is it even possible to make a wormhole? Yes- a group of physicists at Caltech have created a holographic quantum wormhole with the use of quantum computers. In 1997, physicist Juan Maldacena along with physicist Lenard Susskind proposed that a connection between two black holes via a wormhole is mathematically equivalent to the quantum entanglement of two particles. So, by creating a configuration of entangled particles we are also creating something equivalent to a wormhole. This does not mean that the physicists created a physical wormhole in space-time. Rather, the physicists, using a quantum computer, manipulated quantum entangled particles in space-time that simulated the behavior of a wormhole. The hologram of the wormhole the physicists created was quantum. But still, it was a great leap towards creating wormholes that can take you anywhere in the universe. Maybe, one day we can reach anywhere in the entire universe in under seconds. But till then we have a long way to go!

## WHAT IF THE SUN WAS A BLUE STAR??

**Vetrivel T**

**iAstronomer member**

Like any visible light, sunlight contains all colors of the rainbow. But how we see a star depends on how hot the star is. The coolest stars in the universe of about 1,750 C and emit more red light, while the hottest stars have temperatures over 40,000 C and looker bluer. Our sun has a surface temperature of 6,000 C. So, it emits an almost equal amount of blue and red wavelengths. If you could see the sun from space, it would appear white. Yeah, hang on a second. It isn't yellow? The sun appears yellow to you because of Earth's nitrogen-rich atmosphere. Red light and yellow light have longer wavelengths and can reach your eyes easier. Blue light has a short wavelength and scatters more, giving the sky its blue color. But if our Sun was a blue star, you'd never get to see a spectacular orange sunset again. Oh, and also you'd get fries instantly.



Let's take a look at a couple of bright blue stars that we know of. On the cooler end of the blue star spectrum is Rigel, the brightest in the Orion constellation. Its surface temperature is about 11,000 C. Rigel's diameter is 79 times larger than our star's. If our Sun was that large, it would swallow Mercury. And temperatures on Earth would increase immensely. If we imagine our Sun on the higher end of the blue star spectrum, it could be like Eta Carinae. With surface temperatures of 40,000 C, this star is over six times hotter than the Sun. If our Sun was that hot, it would be five million times brighter than it is today. Violent ejections of plasma would scorch our planet regularly. And the Sun would drench us in lethal amounts of UV radiation. There's no way you could survive the heat. Ok, let's imagine that your body was super resistant to this extreme heat. There would still be that enormous amount of UV radiation to deal with.

A star like Eta Carinae has a live fast, die young lifestyle. At its young age of about 3 million years, it's already nearing the end of its fuel supply. It could explode into a supernova sometime within the next 100,000 years. The earliest life on our planet dates back to about 3.7 billion years ago. At that point, our Sun was already 800 million years old. Back then, if the Sun burned as hot and bright as Eta Carinae, it would have exploded as a supernova hundreds of millions of years before there was life anywhere nearby. So, our lives seem better with the Sun burning at its current temperature.

## **GANYMEDE, THE BIGGEST MOON**

**S. Shree Vishwajith**  
Club student

Ganymede is the largest moon in our solar system. This largest moon was discovered by the Italian astronomer Galileo Galilei on 7th January 1610. The German astronomer Simon Marius also discovered this moon independently and named it Ganymede in Greek mythology. This moon has a diameter of about 5,270 km and is also larger than the planet Mercury and the dwarf planet Pluto. Ganymede's composition is roughly half rock and half ice by mass. The interior of the Ganymede consists of an iron-rich core with a radius of 1,500 km and is surrounded by a rocky lower mantle which is covered with a layer of ice about 700 km thick. Its iron core also produces a magnetic field that is one percent stronger than earth's magnetic field.

In the year 1996, the Spacecraft named "Galileo Spacecraft", launched by NASA discovered that the moon which has its own magnetic field is Ganymede. It is also discovered that Ganymede's magnetic field is possibly formed by convection within its liquid iron core and also formed by the tidal forces of Jupiter. This magnetic field also causes auroras around the north and south poles of the moon.

Such auroras look like glowing light with hot and electrified gas. As the Ganymede is closer to Jupiter, the change in the magnetic field of Jupiter causes changes in the auroras of Ganymede. This satellite could store more salt water than Earth.

With the help of the Hubble Space Telescope, researchers have traced that there is a thin oxygen atmosphere found on Ganymede. Based on the temperature during the daytime which falls between the level of -297 degrees F and -171 degrees F, they have also identified that Ganymede may be the coldest satellite on the planet Earth. Ganymede is coldest because of the absence of a dense atmosphere to observe the heat from the sunlight as compared to the range of sunlight received by the Earth.

# VAINU BAPPU OBSERVATORY: A WINDOW TO THE UNIVERSE

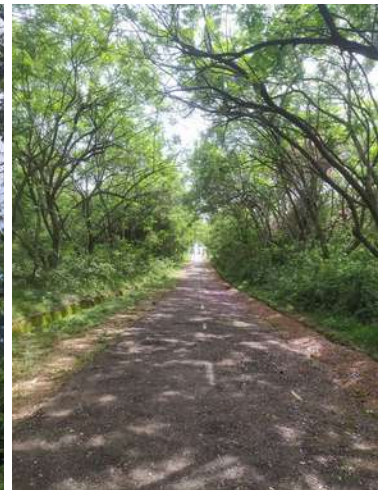
Nikhilesh Balamurali  
iAstronomer member

The Vainu Bappu Observatory is an astronomical observatory located in the town of Kavalur, near the city of Vellore, in the southern Indian state of Tamil Nadu. The observatory is named after the renowned Indian astronomer and astrophysicist Vainu Bappu, who played a crucial role in establishing modern-day Indian astrophysics. The observatory was established in 1968 under the auspices of the Indian Institute of Astrophysics, and its primary aim was to conduct research in the field of astrophysics and to provide a platform for Indian scientists to engage in cutting-edge astronomical research. The Vainu Bappu Observatory is located on the top of a hill in the Eastern Ghats, at an altitude of 725 meters above sea level. This location provides an excellent environment for astronomical observations, with minimal light pollution and a clear view of the night sky. The observatory has several telescopes, including a 2.3-meter telescope, which is the largest telescope in Asia at the time of its installation in 1986.

This telescope was used for several important astronomical discoveries, including the discovery of a new type of star known as the hot subdwarf. The 2.3-meter telescope is a Ritchey-Chrétien type telescope, which is a type of reflecting telescope with a flat secondary mirror. This design allows for a large field of view, which is essential for studying objects such as galaxies and clusters of stars. The telescope is equipped with several scientific instruments, including a spectrograph, which is used to study the properties of stars and galaxies. The telescope is also equipped with a high-speed camera, which is used to study objects such as asteroids and comets. In addition to the 2.3-meter telescope, the Vainu Bappu Observatory also has a 1.3-meter telescope used for spectroscopic observations of stars and galaxies.

This telescope is equipped with a high-resolution spectrograph, which is used to study the chemical composition of stars and the properties of interstellar gas. The observatory also has a 0.7-meter telescope, which is used for photometric observations of variable stars and monitoring the brightness of active galactic nuclei.

The observatory regularly conducts workshops and training programs for students and teachers, promoting an interest in astronomy and encouraging young people to pursue careers in science. The observatory also organizes public lectures and sky-watching sessions, where visitors can observe celestial objects through telescopes and learn about the latest astronomical discoveries. In conclusion, the Vainu Bappu Observatory is a premier astronomical observatory in India, named after one of the most distinguished Indian astronomers. The observatory is equipped with state-of-the-art telescopes and scientific instruments, and it has played a crucial role in the advancement of Indian astrophysics. The observatory's commitment to education and public outreach has helped to popularize astronomy in India and has inspired countless young people to pursue careers in science. It is a type of reflector telescope.



# LAIKA, FIRST ANIMAL TO SPACE

Navya Kiran  
SUMMER CAMP STUDENT



We all very well know who the first man was to go into Earth's orbit. He was Yuri Gagarin. But do you know who the first animal in space was? In this short passage, I will tell you all about our hero, Laika. Laika, a lady dog was the first living being and animal to travel into low Earth orbit.

After the well-deserved success of Sputnik 1 on October 1957, the Soviet leader Nikita Khrushchev wanted a satellite to be launched on November 7, 1957, the Fortieth anniversary of the October Revolution. The building of a new sophisticated satellite had already started but would not have been built by December. Nikita wanted his engineers to build a "Space Spectacular", a satellite that would repeat the triumph of Sputnik 1. It was decided that a dog would be sent instead of Humans. The building of the satellite started on 10th October, which meant they had less than 4 weeks. So, it was a complete rush building that satellite. The satellite had life-supporting systems. It had an oxygen generator, plenty of food (in jelly form), a special fan designed to keep the dog warm, and a fitted bag to remove waste in the seven-day trip. An electrocardiogram would also be attached to the dog to calculate its heart rate.

Then the search for stray dogs began. The Soviet Union chose Moscow stray dogs as they were strong and were able to bear the cold weather. Laika was a 5kg 3-year-old mongrel. People gave her various names like Zuchkha and Limonchick, but the Soviet Union named her Laika because it was the Russian name for several breeds of dog. Just one day before the launch, Vladimir Yazdovsky took Laika to his home and allowed her to play with his children. He said, "Laika has very less time to live. So, I had to do something nice for her."

Finally, the much-awaited day came. Laika was groomed and put into a fancy space suit. They put Laika into Sputnik 2 and started the countdown. 3...2...1- BOOM!! With a loud thud, Sputnik 2 set off into the blue sky. The scientists knew that Laika won't be able to survive, and that's why there was no excitement on the faces of anyone.

Scientists checked the update about the satellite. And they found out that one of Sputnik 2's parts has not been released! She saw the jelly food in a distance and ate it all up. The part that had not been released was causing extreme heat. Feeling sleepy, she lay down to sleep. But, she never woke up. There were envelopes made for her. Stamps were made with her name and photo on them. Even statues were made for the extraordinary young mongrel. This mission was a learning for us humans, through which we got to know after some tests that though animals wouldn't survive in space, humans have that kind of tolerance, and thus it was clear that humans can survive in space.

# VISUAL ARTS FROM SPACE ASSOCIATED ASTRONOMERS



Shree Viswajith, Club student



Daksh Rathi, Club student



Jwala Ravisankaranand, Club student



Pranjal Sharma



Vetrivel T, lastronomer



Avyukt k Iyer, lastronomer



Prem Sahana A, lastronomer



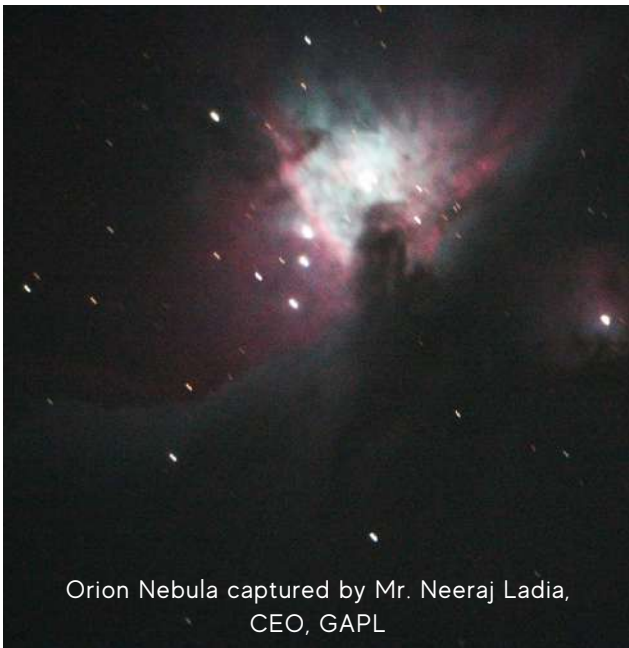
# ASTROPHOTOGRAPHS BY SPACE



Milkyway captured by Mr. Ankur Chabra, Educator, SPACE



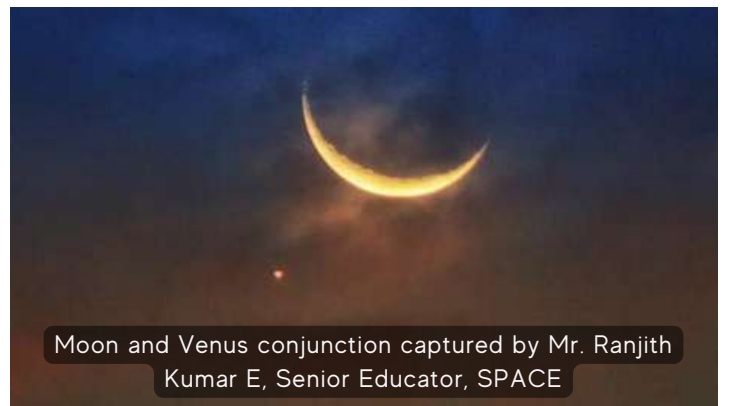
Moon and Venus Conjunction, Mr. Neeraj Ladia, CEO, GAPL



Orion Nebula captured by Mr. Neeraj Ladia, CEO, GAPL



Star trail captured by Mr. Ranjith Kumar E, Senior Educator, SPACE



Moon and Venus conjunction captured by Mr. Ranjith Kumar E, Senior Educator, SPACE



Star trail captured by Mr. Yogesh Joshi, Asst. Educator incharge, SPACE



Star trail captured by Mr. Ankur Chabra, Educator, SPACE



**APRIL 14, 1629**

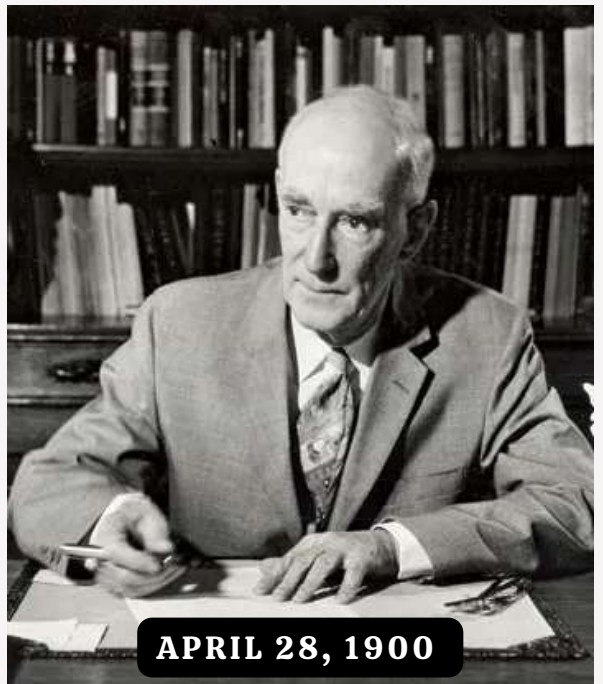
## Christiaan Huygens

Christiaan Huygens born **April 14, 1629**, in the Hague—died July 8, 1695, The Hague), a Dutch mathematician, astronomer, and physicist, who founded the wave theory of light, discovered the true shape of the rings of Saturn and made original contributions to the science of dynamics—the study of the action of forces on bodies. Around 1654 he devised a new and better way of grinding and polishing lenses. Using one of his own lenses, Huygens detected, in 1655, the first moon of Saturn. The following year he discovered the true shape of the rings of Saturn. Using his improved telescope, he distinguished the stellar components of the Orion nebula in 1656. His interest, as an astronomer, in the accurate measurement of time then led him to his discovery of the pendulum as a regulator of clocks.

# Happy Birthday

## Jan Oort

Jan Oort, in full Jan Hendrik Oort, (born **April 28, 1900**, Franeker, Netherlands—died November 5, 1992, Leiden), Dutch astronomer who was one of the most important figures in 20th-century efforts to understand the nature of the Milky Way Galaxy. In the early 1950s, Oort used radio astronomy to determine that the Sun is about 30,000 light-years from the center of the galaxy and takes 225 million years to complete an orbit around it. The discovery in 1951 of the 21-cm radio waves provided him with a new method for mapping the spiral structure of the galaxy. In 1950 Oort proposed that comets with very long periods originate from a vast cloud of small bodies that orbit the Sun at a distance of about one light-year. The existence of this region, which was named the Oort Cloud, eventually came to be accepted by most astronomers.



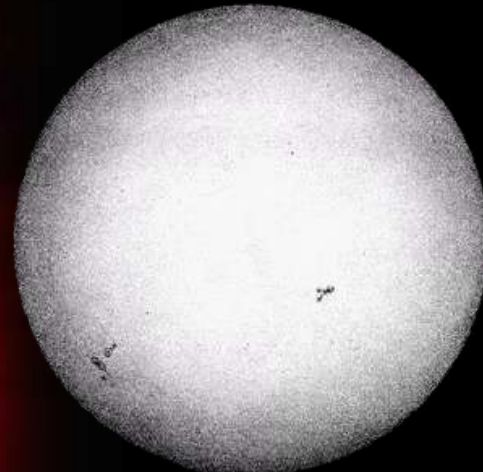
**APRIL 28, 1900**

# HISTORICAL EVENTS HAPPENED IN APRIL

## HEY SUN! SAY CHEESE!!



In 1845, five years after Dr. J. W. Draper captured the first photograph of the full moon, French physicists Leon Foucault and Louis Fizeau made the first successful photograph of the sun. Photography was in its infancy and the widespread use of photography in astronomy was still decades away when Fizeau and Foucault turned their camera toward the brightest object in Earth's sky. In a major technological feat at the time, the pair pointed their camera at Earth's star; after an exposure of just 1/60th of a second, the photo was made. Working with similar tools as Draper, the duo created a daguerreotype about 4.7 inches in diameter.



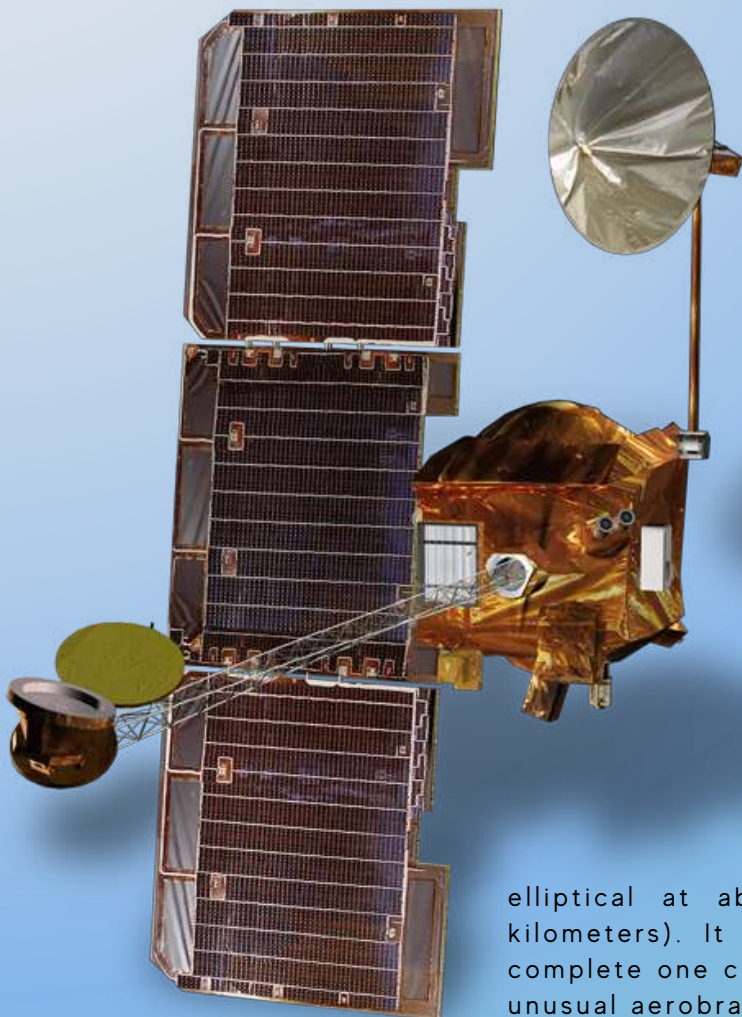
One of the first pictures ever taken of the sun by Leon Foucault and Louis Fizeau, 1845

The naked eye, of course, cannot see the sun in all its glory during the day, but instead witnesses, at best, partial bursts at sunrise or sunset. To see the entire, brilliant sphere at once, as the early viewers of Foucault and Louis Fizeau's 1845 picture did, was an utterly new experience for most. More than 160 years ago, their seemingly simple black and white photo was remarkable for depicting our sun not as an overwhelming, ungraspable celestial body, but as another star in the sky. Our star in the sky. Visible on its surface are sunspots – areas of intense magnetic activity that are also impossible to see with the naked eye.

A few years later, Fizeau and Foucault were both experimenting with methods to determine the speed of light. Fizeau, bouncing a beam of light off a mirror and through a cogged wheel, determined a speed of 313,000 kilometers per second.

# NASA'S MARS ODYSSEY

NASA's Mars Odyssey holds the record for the longest continually active spacecraft in orbit around a planet other than Earth. It's been in orbit since Oct. 24, 2001. The spacecraft's main mission is to investigate the Martian environment and to provide key information on hazards future explorers might face.



The spacecraft was first launched as part of NASA's revamped Mars Exploration Program, which was originally approved in 1993, then restructured in October 2000 after the failures associated with the "faster, better, cheaper" approach. Mars Odyssey was designed to investigate the Martian environment, providing key information on its surface and the radiation hazards future explorers might face. The goal was to map the chemical and mineralogical makeup of Mars as a step to detecting evidence of past or present water and volcanic activity on Mars.

The spacecraft also was designed to act as a relay for future landers and did so for the Mars Exploration Rovers (Spirit and Opportunity), the Mars Science Laboratory, and the Phoenix lander.

About 200 days after launch, at 02:38 UT Oct. 24, 2001, Mars Odyssey successfully entered orbit around Mars after a 20-minute, 19-second engine burn. The initial orbit was highly

elliptical at about 170 × 16,665 miles (272 × 26,818 kilometers). It would take the spacecraft 18.6 hours to complete one circuit. The spacecraft then implemented an unusual aerobraking maneuver that used the planet's

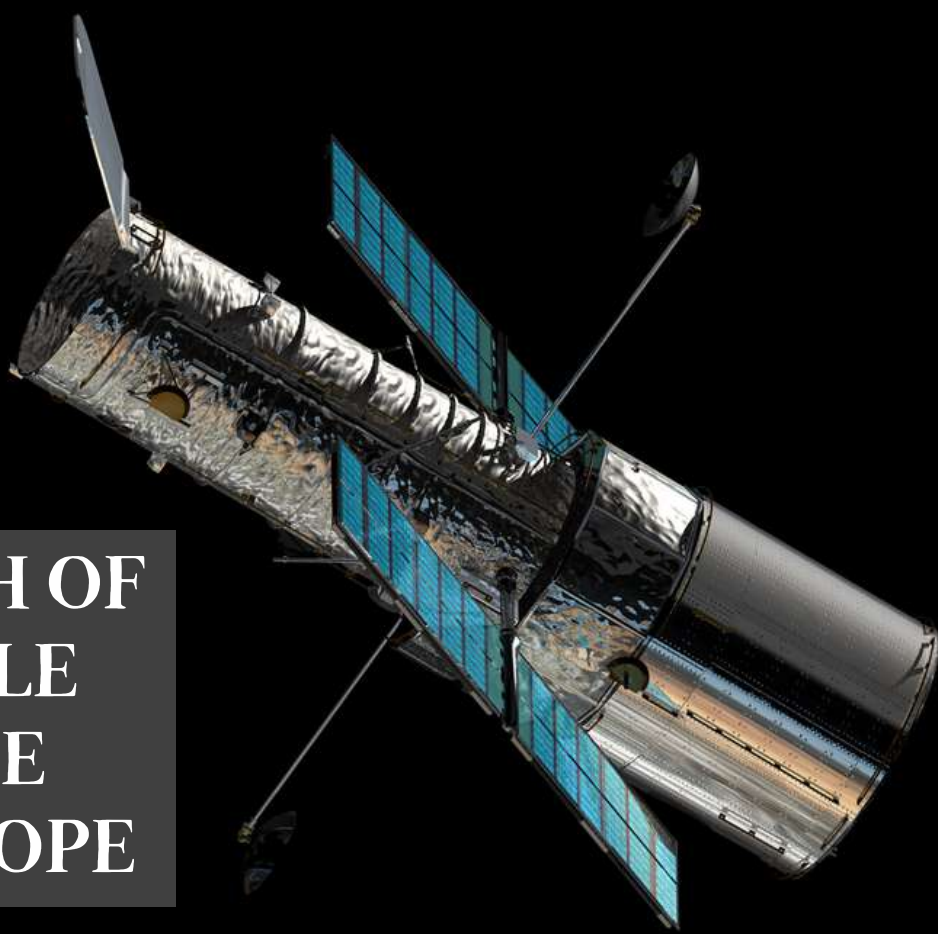
atmosphere to gradually bring the satellite closer to the Martian surface on every succeeding orbit. This process saved an estimated 440 pounds (200 kilograms) of propellant.

By July 2010, NASA was able to announce that Mars Odyssey's camera had helped construct the most accurate global map of Mars ever, using 21,000 images from the THEMIS instrument. These pictures have been smoothed, matched, blended, and cartographically controlled to make a giant mosaic available to users online. On Dec. 15, 2010, Mars Odyssey claimed the record for the longest operating spacecraft on Mars, with 3,340 days of operation. By mid-2016, the THEMIS instrument had returned more than 208,000 images in visible-light wavelengths and more than 188,000 in thermal-infrared wavelengths. (Credits: NASA)

Images of Mars captured by THEMIS instrument. It returned more than 2 million images



# LAUNCH OF HUBBLE SPACE TELESCOPE



The Hubble Space Telescope is a large telescope in space. It was launched into orbit by space shuttle Discovery on April 24, 1990. Hubble orbits about 535 kilometers (332 miles) above Earth. It is the length of a large school bus and weighs as much as two adult elephants. It is a Cassegrain reflector telescope which travels about 8 Kilometers per second.

Hubble takes sharp pictures of objects in the sky such as planets, stars and galaxies. Hubble has made more than one million observations. These include detailed pictures of the birth and death of stars, galaxies billions of light years away, and Shoemaker Levy comet pieces crashing into Jupiter's atmosphere. It also captured the Aurora's of the planet.

The Hubble Space Telescope sees primarily visible light, as well as some infrared and ultraviolet radiation.

## What Makes Hubble Different From Telescopes on Earth?

Earth's atmosphere alters and blocks the light that comes from space. Hubble orbits above Earth's atmosphere, which gives it a better view of the universe than telescopes have at ground level.



An image of Eagle Nebula also called as "pillars of Creation" as captured by HST.

## Where Did the Name Hubble Come From?

Hubble is named after an American astronomer, Edwin Powell Hubble. He made important discoveries in the early 1900s. His work helped show that the universe is expanding.

## What Are Hubble's Most Important Discoveries?

Images taken by "Wide field Camera" of Hubble have helped scientists estimate the age and size of the universe. Scientists believe the universe is almost 14 billion years old. Hubble has helped scientists understand how planets and galaxies form. Hubble has detected black holes, which suck in everything around them, including light. The telescope has played a key role in the discovery of dark energy, a mysterious force that causes the universe to expand faster and faster as time goes on.

## Error in the mirror?

During its first three years Hubble suffered from what is known as spherical aberration. Spherical aberration is an optical defect. The problem was caused by a faulty measuring device used during the process of polishing the mirror and was corrected in the year 1993.

# GALAXY EVOLUTION EXPLORER (GALEX)



The Galaxy Evolution Explorer (GALEX) is an orbiting space telescope observing galaxies in ultraviolet light across 10 billion years of cosmic history. A Pegasus rocket launched GALEX into orbit at 8 a.m. EDT on April 28th, 2003. Although originally planned as a 29-month mission, the NASA Senior Review Panel in 2006 recommended that the mission lifetime be extended.

GALEX's observations are telling scientists how galaxies, the basic structures of our Universe, evolve and change. Additionally, GALEX observations are investigating the causes of star formation during a period when most of the stars and elements we see today had their origins.

Led by the California Institute of Technology, GALEX is conducting several first-of-a-kind sky surveys, including an extra-galactic (beyond our galaxy) ultraviolet all-sky survey. During its mission GALEX will produce the first comprehensive map of a Universe of galaxies under construction, bringing us closer to understanding how galaxies like our own Milky Way were formed.

GALEX is also identifying celestial objects for further study by ongoing and future missions and GALEX data now populates a large, unprecedented archive available to the entire astronomical community and the general public.

Scientists would like to understand when the stars that we see today and the chemical elements that make up our Milky Way galaxy were formed. With its ultraviolet observations, GALEX is filling in one of the key pieces of this puzzle.

## Some of the major discoveries by GALEX:



Located 6,300 light-years away in the constellation Hercules, the Blue Ring Nebula is thought to be

a short-lived phase after the merger of two stars. (Credits: NASA)



This image from NASA's Galaxy Evolution Explorer (GALEX) shows Messier 94, also known as NGC 4736, in ultraviolet light. It is located 17 million light-years away in the constellation Canes Venatici. (Credits: Cosmotography.com)

This image from NASA's GALEX shows NGC 4565, one of the nearest and brightest



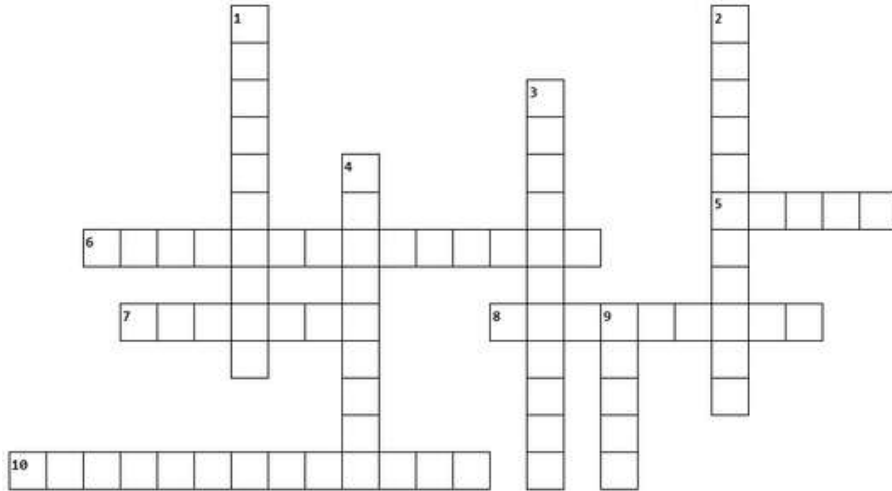
galaxies not included in the famous list by 18th-century comet hunter Charles Messier. (Credits: Paddy Gilliland)



This composite of the giant barred spiral galaxy NGC 6872 combines visible light images from the European Southern Observatory's Very Large Telescope with far-ultraviolet (1,528 angstroms) data from NASA's GALEX and 3.6-micron infrared data acquired by NASA's Spitzer Space Telescope. A previously unsuspected tidal dwarf galaxy candidate (circled) appears only in the ultraviolet, indicating the presence of many hot young stars. IC 4970, the small disk galaxy interacting with NGC 6872, is located above the spiral's central region. (Credits: ESO/VLT)

# TRAIN YOUR BRAIN

## CROSSWORD



### ACROSS

- 5. Hubble space telescope discovered two moons of which dwarf planet?
- 6. Who is the first person to remove the wide field camera during the HST repair mission?
- 7. Hubble captured the aurora of which planet?
- 8. What is the name of the camera installed in the Hubble telescope?
- 10. What is the name of the comet falling into Jupiter planet as captured by HST?

### DOWN

- 1. What type of reflector telescope is the Hubble space telescope?
- 2. The Hubble telescope was named after which astronomer?
- 3. HST can detect light in visible, infrared, and \_\_\_\_\_?
- 4. What was the aberration in the HST mirror, which was later corrected in the year 1993?
- 9. The speed with which HST orbits the earth is? (in kilometers per second)

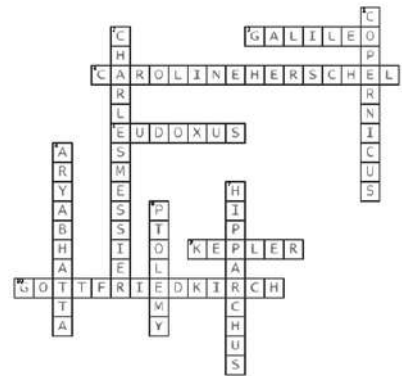
## ASTRONOMY WORD PUZZLE

Find the names of the famous Open star clusters from the mixed letters and mark them.

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

- BUTTERFLY
- EAGLE NEBULA
- CAROLINE
- WISHING WELL
- WILD DUCK
- OMICRON VELORUM
- COMA
- PTOLEMY
- TRAPEZIUM
- WHITE ROSE
- JEWEL BOX
- PLIADES
- PEARL
- BEEHIVE
- HYADES

Answers for last month puzzles.



A	A	A	I	R	A	A	C	E	V	N	L	S	R
L	R	N	E	U	A	L	A	U	A	A	U	A	E
A	N	I	T	E	I	L	A	E	L	P	T	S	A
G	R	R	G	I	C	E	A	A	O	P	S	R	T
B	L	L	E	E	P	S	N	O	L	E	I	N	
R	P	A	N	I	L	A	A	P	O	L	L	U	X
A	R	A	G	E	V	C	A	D	S	Y	N	D	A
R	O	R	L	I	P	A	C	H	E	R	N	A	R
C	C	A	S	T	O	R	E	R	G	U	S	S	R
T	Y	A	L	D	E	B	A	R	A	N	B	I	T
U	O	U	S	E	R	A	T	N	A	R	A	R	T
R	N	G	R	E	G	U	L	U	S	T	A	I	C
U	O	S	S	E	S	I	P	L	L	T	T	U	R
S	L	A	E	E	H	L	U	A	V	R	T	S	U

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

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**CELESTRON SKYMASTER 75X70**  
PRISM SYSTEM: HOBBED PRISM  
PRISM GLASS: BAK-4  
APERTURE: 70MM  
EXIT PUPIL: 4.7MM  
MAGNIFICATION: 15X  
ANGULAR FOV: 6.4 Deg

**CELESTRON SKYMASTER 20X80**  
PRISM SYSTEM: HOBBED PRISM  
PRISM GLASS: BAK-4  
APERTURE: 80MM  
EXIT PUPIL: 4MM  
MAGNIFICATION: 20X  
ANGULAR FOV: 5.7 Deg

**CELESTRON SKYMASTER 25X100**  
PRISM SYSTEM: POWED PRISM  
PRISM GLASS: BAK-4  
APERTURE: 100MM  
EXIT PUPIL: 4MM  
MAGNIFICATION: 25X  
ANGULAR FOV: 5 Deg

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**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: 600MM

**REFLECTOR TELESCOPES**

**SPACE LAUNCHER 70MM**  
TYPE: REFLECTOR  
MOUNT: ALT-AZ  
APERTURE: 70MM  
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: 650MM

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