

MARCH 2023 VOLUME 2 | ISSUE III

GGO GCUGO Astronomy and Space Science Magazine

What's Inside? SPACE Insights Highlights From February Moon Phases And Planet Visibility What's Awaiting in March Student's Corner Historical Events Happened In March March Born Legends Train Your Brain

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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.



Editor in Chief Sachin Bahmba

Assistant Editors

Sruthi Suresh Priyadharshini **Editor** Ranjith Kumar

Contributors

iAstronomers Space Students

Section Editor Mallika Tarannum

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ABOUT SPACE

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

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

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



Mr. Sachin Bahmba CMD, Space.

CMD'S MESSAGE:

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

SPACE INSIGHTS

ASTRO NIGHT SKY TOURISM: A SKY GAZING EVENT (GYAN PATH, RED FORT)

SPACE team in partnership with the National Science Centre, New Delhi, and the Nehru Planetarium, New Delhi took lead in the successfully conducting "Astro Night Sky Tourism - A Stargazing Event" on the evening of 5th and 6th February 2023 at the Gyan Path, Red Fort. The event was a part of the Azadi Ka Amrit Mahotsav, an initiative of the Government of India to celebrate and commemorate 75 years of independence and the glorious history of its people, culture, and achievements.

We are all part of the cosmos and long to know it better; in the same spirit, the goal of the program was to bring the joy of star gazing and astronomy to the common people. The space team led by Dr. Sachin Bahmba, founder of SPACE India, enthusiastically gave their best in conducting the event. Hundreds of visitors, including young kids, and even members of the iAstronomer club flocked to the venue. The general public was shown the mesmerizing sight of the Moon, Jupiter, Saturn, and Mars through 200mm Newtonian Reflector telescopes.





Space Group Highlights

The Pleiades star cluster presented а dazzling appearance. The visitor from the Oort cloud, Comet C/2022 E3 (ZTF) also hung close to the star Capella and was visible with averted vision through binoculars. It is a longperiod comet that was discovered by the Zwicky Transient Facility (ZTF) on 2 March 2022. The comet has a bright green glow around its nucleus, due to the effect of sunlight on diatomic carbon and cyanogen.

The comet nucleus was estimated to be about a kilometer in size, rotating every 8.5 to 8.7 hours. Its tails of dust and gas extended for millions of kilometers and, during January 2023, an anti-tail was also visible. Since its a long-period comet, it visits us every 50,000 years, which means that this comet was visible last by Neanderthals during the Upper Paleolithic period on Earth.

Visitors at the event were also treated to several astronomy activities, including Comet Making. Using dry ice and simple household materials, the comet-making activity was a big hit with kids and adults alike. The International Space Station also presented a bright visible pass to make the event special. The sight of the Moon rising behind the Red Fort is a memorable sight for those who witnessed or photographed it. The night sky enthralls and the Astronight Sky Event enthralled the visitors. Space thanks all its collaborators and the Ministry of Culture, under which the event was held. The space team looks forward to celebrating the next outreach

event and making it even bigger. We are happy to conduct the 'Astro Night Sky Tourism' event at one of the oldest and most famous monuments of India in association with SPACE India. The event was highly engaging and exciting for the public gathered at Red Fort who learned about Moon and other celestial bodies telescopic through observations and informative and fun-filled hands-on activities, said Dr. Rai Mehrotra, Senior Curator, National Science Centre"





OPEN HOUSE EXHIBITION AT SRM UNIVERSITY

The Department of Electronics and Instrumentation Engineering of SRM Institute of Science and Technology conducted an Open House Exhibition on February 6th and 7th. The event was organized in collaboration with the SRM foundation and Nagman instruments. Students from St. Mary's Matric HSS, Nandhivaram, SRM School Guduvanchery, and many more attended the exhibition. The students of the E&IE department exhibit their projects. Some of them used light sensors like Light-dependent Resistors to show automatic switching of street lights. An exhibit focused on generating electricity from Chlorophyll. The ROBOCON club presented Object follower, Wi-Fi Controlled Car, Smart Helmet, and many more flabergasting exhibits.

SPACE India exhibited the 8-inch Dobsonian Telescope, 130 EQ mount telescope, 76mm telescope, Celestial globe, and Hydrorockets, which caught the eyes of the audience. School students thoroughly enjoyed the presentations as they learned the basics of Astronomy through our activities. Students grasped the concept of gravity, by exploring their weights on different planets and our Moon. We received astounding feedback from the school and college students during the felicitation Ceremony.



MONTHLY TELESCOPIC Observation

SPACE ARCADE team conducted their 2nd Monthly Telescopic Experience session on 4th of February at two different places which are Delhi and Chennai respectively. People from various places joined the observation with their own telescopes, binoculars and other astronomical equipment to learn and experience the breathtaking view of the Moon! and planets such as Jupiter, Venus and Mars. They also learnt about different types of telescopes and cleared all their queries on the Alignment of various telescopes then did basic Astrophotography.

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





MARCH 2023



India celebrates National Science Day on February 28 every year to mark scientists' contributions towards the country's development. On this day, in 1928, Indian Physicists Sir CV Raman made an important discovery in the field of spectroscopy, which was later named after him - the Raman Effect, which gave Asia its first Nobel in the Sciences in 1930. Raman effect is the change in the wavelength of light that occurs when a light beam is deflected by molecules.

In 1986, the National Council for Science and Technology Communication (NCSTC) asked the Government of India to designate February 28 as National Science Day. The department initiated the program to trigger science popularization activities throughout the country and to disseminate scientific education about the current issues of science and technology amongst the country's citizens.

CELEBRATION AT NATIONAL PUBLIC SCHOOL, GOPALAPURAM

On 28th March 2023, at National Public School, Gopalapuram, National Science Day was celebrated and students showcased their talents with different projects and ideas. And the students of our space astronomy club showcased their learning through various activities to the school management as well as their fellow students.

Students displayed their learning from the astronomy club in their stalls, they set up astronomy tattoo stations where astronomy-related tattoos were made for fellow students. The Solar observation was done using the Dobsonian telescope with a solar filter. And they also set up many stalls like Stomp rockets, Pop rockets, Train like an Astronaut, Weigh themselves on different planets, Ring the planets, Directions during day time, Hands-on telescope, Crater making on the moon's surface, Fun with DSLR, Make a constellation, and finally, the National Science Day celebration was ended by Launching Hydro Rockets which were carried at the end of the session where the whole school participated by encouraging and creating an energetic atmosphere.



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Space Group Highlights





CELEBRATION AT UNISON WORLD SCHOOL, DEHRADUN

SPACE Indian organized an Astronomy camp at Unison World School, Dehradun on 28th February 2023 on account of the National Science Day Celebration. The day started with the Solar observation. The students observed the Sun using the Solar View Goggles and the 8-inch Dobsonian Telescope. The students learned the harmful effects of observing the Sun through the telescope without the Solar Filter. All the students and the teachers were amazed to observe the Sunspots. The session continued with the launching of Rockets as students prepared their own rockets from the waste plastic bottles for launching. The session was both informative and entertaining as they understood the science behind Rocket launching. The students were thrilled when they launched their Rockets.

The session concluded with an evening observation of the Moon and the Planets. More than 150 children participated in this event, and all had the astounding experience of observing the various features of the Moon. Students were fascinated to observe the four Galilean moons of the planet Jupiter. They were awe-struck to observe the brightest planet, Venus.

This event reminded us that we are connected to nature and we are made of stardust. The event inspired many students to pursue Astronomy and to know about the space.



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Space Group Highlights



A classroom with the ultimate view!



SALLY RIDE EARTHKA FEB 2023

Sally Ride EarthKAM is a NASA-sponsored project. EarthKAM means Earth Knowledge Acquired by Middle school students. It is an educational program that enables students to take pictures of their own planet from a digital camera on board the International Space Station (ISS) via a web interface. International Space Station is an artificial satellite where astronauts reside for various experiments based on micro-gravity. EarthKAM camera is to date a permanent payload on board the ISS and supports approximately four missions annually, one for each season. The recent mission was opened from the 14th to 17th Feb.

About this year:

We started this year with the first mission cycle of 2023, which is actually the 82nd Mission. A Three hour Sally Ride EarthKAM workshop was conducted in the schools. Students from Class 6 to 8 standard were selected to participate in this workshop. The workshop started with students using Google Earth to find a few locations of interest followed by a presentation about EarthKAM. Students have then demonstrated the use of the EarthKAM interface to request Earth's images by keeping various aspects such as orbital path, weather, location, and day/night preference in mind. After this, the students had an exciting time locating regions of their interest and putting up their requests. The workshop ended with the students writing Messages to Astronauts.







Six schools participated in this program while there were more than 150 students who participated through online sessions. From St. Martin Diocesan School, Delhi Cantt. Around 85 students attended the session and 143 students from Delhi Public School. Faridabad. Greater Around 200 from schools students in Surat participated in the event. In Chennai, 56 students of the National Public school, Gopalapuram enthusiastically took part in the program and captured amazing photos of our Earth.

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The highlights of the Program:

- At National Public School, the program was inaugurated by the Principal. In her welcome speech, she motivated the students to make use of this opportunity to study the earth, high above Space.
- A total of Three schools with around 300 Participants, participated in this mission, and Two Online sessions were conducted with around 150 students participated from different schools.

Sally Ride EArthKAM pictures captured by Students:



Abu Dhabi - United Arab Emirates by Delhi Public School, Greater Faridabad

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Thessaloniki, Greece, requested by B Tharun, National Public School

Desert, Africa requested by Virat,

Chad, Central Africa requested by C T Sriram, National Public School



Message to the Astronauts:

St. Martin Diocesan School, Delhi Cantt



- I hope you all are well and hope that your research is also good. Thank you for your contribution take care. Ananya Madaan (8E), Delhi Public School, Greater Faridabad.
- Hey Astronaut! What do you eat? I want to become like you an astronaut. St. Martin Diocesan School, Delhi Cantt.
- I hope you all have a safe journey and fly high. I have always wanted to fly to space I hope you all discover and do wonderful things sending you love!!! I had so much fun and it was a new experience. It was super cool to request images from ISS. - Srinidhi R R,8 D, National Public School Chennai.
- I wish to be an astronaut because I want to see space, I saw you all in videos and you all are my inspiration. One day I will be an astronaut, and I will join NASA I am putting in hard work for that day, so please continue to do amazing things I will watch all of you back on earth. Akshitha A,7C, National Public School, Chennai.
- Please continue to create and discover ways for us to enjoy space from earth and do more of these fun activities for us, Harshini K,6 A, National Public School, Chennai.

DISCOVERY OF EARTH-SIZED PLANET RAISES HOPE FOR EXTRATERRESTRIAL LIFE

-Jyoti Chhokar, Educator, SPACE.

Earth-size planets have become a hot topic in the field of astronomy and astrophysics. These planets are so named because their size is similar to that of our own planet Earth. They are prime candidates for the search for life outside of our solar system.



This illustration shows the possible surface of TRAPPIST-1f, one of the newly discovered planets in the TRAPPIST-1 system. Scientists using the Spitzer Space Telescope and ground-based telescopes have discovered that there are seven Eearth-size planets in the system. Credits: NASA/JPL-Caltech

An Earth-size planet is a planet with a diameter that is within 25% of that of Earth's diameter. This means that these planets are relatively small in size compared to other planets in our galaxy, such as Jupiter or Saturn. They are also known as terrestrial planets, which means that they are composed mostly of rock and metal.

Scientists have discovered thousands of exoplanets, or planets that orbit stars outside of our solar system, and many of these planets are Earth-size or slightly larger. In fact, recent studies have suggested that there may be more Earth-size planets in the galaxy than previously thought.

The TRAPPIST-1 planetary system has been conceptualized by artists based on available data about their diameters, masses, and distances from the host star. Discovered through observations from NASA's Spitzer Space Telescope, the TRAPPIST (TRAnsiting Planets and Planetesimal's Small Telescope), and other ground-based observatories, the system consists of seven Earth-sized and terrestrial planets. Research published in 2017 in the journal Nature confirms their size and nature. The system orbits an ultra-cool dwarf star located in the Aquarius constellation, and its planets are situated very close to it. The system is named after the TRAPPIST telescope that first detected it.

One of the key factors that make Earth-size planets so interesting is their potential for hosting life. Scientists have long speculated that there may be other planets in the universe that harbour life, and Earth-size planets are seen as the most likely candidates for this possibility. This is because they have the right conditions for life as we know it, including the presence of liquid water, a stable climate, and a protective atmosphere.

The search for Earth-size planets is a challenging task, as these planets are difficult to detect due to their small size and low mass. However, recent advances in technology have made it easier to detect these planets.



This chart shows, on the top row, artist concepts of the seven planets of TRAPPIST-1 with their orbital periods, distances from their star, radii, and masses as compared to those of Earth. On the bottom row, the same numbers are displayed for the bodies of our inner solar system: Mercury, Venus, Earth, and Mars. Credit: NASA/JPL-Caltech/R. Hurt, T. Pyle (IPAC).

One method that astronomers use is the transit method, in which they observe the small dip in a star's brightness that occurs when a planet passes in front of it. Another method is the radial velocity method, in which astronomers look for small wobbles in a star's position that are caused by the gravitational pull of a planet. In recent years, several Earth-size planets have been discovered in the habitable zones of their host stars, which is the region around a star where temperatures are just right for liquid water to exist on the planet's surface.

These discoveries have sparked a renewed interest in the search for life beyond our solar system. In order to learn more about these planets there are also several upcoming space missions, such as the James Webb Space Telescope and the European Space Agency's ARIEL, that are expected to advance our knowledge of exoplanets by characterizing their atmospheres and searching for signs of life beyond our solar system.

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In conclusion, Earthsize planets are fascinating objects that have captured the imagination of scientists and the alike. Their public potential for hosting life makes them a prime target for the search for extraterrestrial life, and recent advances in technology have made it easier to detect them. As our understanding of these planets continues to grow, we may one day find that we are not alone in the universe.

HIGHLIGHTS OF FEBRUARY 2023

JUPITER RECLAIMS THE TITLE OF "PLANET WITH THE MOST NUMBER OF MOONS"

Jupiter isn't just the largest and most massive planet in the solar system — now, the gas giant also boasts the largest number of moons orbiting it after scientists discovered another 12 moons, bringing the behemoth's total up to 92.



Various groupings of Jovian moons with the newly discovered ones shown in bold. The 'oddball,' called Valetudo after the Roman god Jupiter's great-granddaughter, has a prograde orbit that crosses the

retrograde orbits. (Image credit: Roberto Molar-Candanosa, courtesy of Carnegie Institution for Science) The orbits of the 12 hitherto undiscovered moons of Jupiter have been published by the Minor Planet Center (MPC) operated by the Smithsonian Astrophysical Observatory. The dozen new moons represent a 15% increase in the planet's known moons. With these new discoveries, Jupiter seizes the record for "solar system planet with most moons" from the previous record holder, Saturn.

Scott Sheppard, an astronomer at the Carnegie Institute for Science in Washington, D.C., has submitted the observations of the Jovian system, which were taken between 2021 and 2022, for publication. The delay between observing the new moons and confirming them comes because astronomers had to track the rocks for a full orbit in order to ensure they were actually orbiting Jupiter.

And all of the new moons circle Jupiter far from its surface, taking more than 340 Earth days to complete an orbit of the gas giant. Of the 12 new moons, nine are particularly distant: The MPC estimates these nine moons to have orbits longer than 550 days. These moons are all also relatively small: only five of those nine moons are thought to have a diameter greater than 5 miles (8 km).

The nine particularly distant moons also have retrograde orbits, meaning that they circle the gas giant in the opposite direction of its rotation; the inner Jovian moons, in contrast, have "prograde" orbits in the same direction as the planet's rotation. The new moons' retrograde orbits imply that Jupiter's immense gravitational influence may have captured these moons, with the smaller ones possibly the remains of larger bodies broken apart by collisions.



May 2018 recovery images of Valetudo from Carnegie's Magellan telescope's at our Las Campanas Observatory in Chile. The moon can be seen moving relative to the steady state background of distant stars. Jupiter is not in the field but off to the upper left. (Image credit: Carnegie Institution for Science)

Thus far only one Jovian moon has been discovered between the Galilean moons and the Himalia group, Themisto, possibly due to the glare from the gas giant hiding smaller moons.

Further out at around 10 million miles (17 million km) from Jupiter are the Carpo group, named after Carpo, a Jovian moon Sheppard discovered in 2005. Before this clutch of discoveries, there was only one moon in this group besides Carpo itself, so the discovery of another doubled the population of this group.

The newly discovered prograde Jovian moons could make excellent targets for future missions that are set to make flybys of Jupiter, including the European Space Agency's JUICE mission set to launch in April and NASA's Europa Clipper set to launch in October 2024. Others of the newly found moons are in prograde orbits, suggesting they formed around Jupiter. These particular prograde orbiting moons are located in a middle swath of space with 13 other Jovian moons: closer to the planet than the outer retrograde moons but farther away than the large inner moons.

These prograde moons were tougher to spot than the outer retrograde Jovian moons. "The reason is that they are closer to Jupiter and the scattered light from the planet is tremendous," Sheppard told. The light reflected by Jupiter obscures these moons, so by 2000 astronomers had discovered only five of these moons. In the intervening two decades, only eight more of this group had been found.

Prograde Jovian moons outside of the Galilean moons fall into two groupings. The closest is the Himalia group, which is named after the fifth largest Jovian moon, Himalia. The group lies between 11 million to 12 million km from Jupiter and has a population of nine, two of which are among the new discoveries.



The orbits of newly discovered moons around Jupiter. (Image credit: MPC)

ASTRONOMERS FIND RARE STAR SYSTEM THAT WILL TRIGGER A KILONOVA

"A kilonova is the ultra-powerful, gold-producing explosion created by colliding neutron stars." Astronomers have identified the remnants of one such dud firecracker in SGR 0755-2933, a neutron star about 11,400 light-years from Earth in the southern constellation of Puppis. In new research, scientists say that earlier in its lifetime, this star transferred abnormally high amounts of mass to its binary companion – so much so that it was not left with enough material for an explosive death. Instead, it ended in a quiet "ultra-stripped" supernova, a rare cosmic event that leaves a super-dense remnant called a neutron star in its wake.

"This remarkable binary system is essentially a one-in-10-billion system," André-Nicolas Chené, an astronomer at the National Science Foundation's NOIRLab research center and a co-author of the new study, said in a statement.



An artist's depiction of a binary star system that will eventually end in two colliding neutron stars. (Image credit: CTIO/NOIRLab/NSF/AURA/J. da Silva/Spaceengine/M. Zamani)

The neutron star and its closely orbiting binary companion – a star that the researchers also predict will someday collapse to become a neutron star – mark the first clear example of a star system that will ultimately trigger a kilonova, a cosmic explosion during which two neutron stars merge.

Although a kilonova was first detected in 2017, astronomers then recorded only the aftermath of the event, thanks to observations of light and gravitational waves. The new research is the first time scientists have identified a binary star system that they know will end in a kilonova explosion.

Moreover, astronomers previously thought that only one or two such systems would exist in spiral galaxies like our Milky Way. Researchers of the latest study have now increased that estimate to 10, noting that these observations help them better understand the history, evolution and atypically calm deaths of stars in such systems.

"For quite some time, astronomers speculated about the exact conditions that could eventually lead to a kilonova," Chené said in the statement. "These new results demonstrate that, in at least some cases, two sibling neutron stars can merge when one of them was created without a classical supernova explosion."

The sibling star is massive, orbits the primary neutron star every 60 days, and has a name like a license plate: CPD-29 2176. Scientists behind the latest research studied this sibling star to understand the formation of the current star system, as well as what might unfold in its future.

"This is not just a simple binary system"

Clarissa Pavao, an undergraduate student at the Embry-Riddle Aeronautical University in Arizona, found the system while scouring data captured by the Cerro Tololo Inter-American Observatory in Chile. In particular, she was plotting the spectra of the sibling star, an analysis of how much light a star emits at particular wavelengths. After cleaning noise from the data, she noticed one simple line in the spectra that suggested the massive star had a highly circular orbit – an unusual feature in binary star systems.

This was a key finding that helped the team conclude that the primary neutron star ended as a dud supernova, the astronomers said. Usually, when one of the stars in a binary system burns through its hydrogen and nears the end of its main-sequence stage, it begins transferring mass to its companion star. The resulting end-of-life explosion often kicks companion stars out of the systems and into highly elliptical orbits.

But this did not seem to have occurred in the intriguing system. To better understand what might have happened at the end of SGR 0755-2933's life, waded astronomers through thousands of models that described binary star systems resembling the one they were studying. They only found two that matched.

The team then traced the star's history and concluded it behaved. for the most part, like any other massive star running out of fuel: Toward the end of its life, the star began transferring mass to its companion and dwindled into a low-mass star with a helium core, as scientists expected. In this process, however, the star lost so much mass that its endof-life supernova "didn't even have enough energy to kick the orbit into the more typical elliptical shape seen in similar binaries," Noel Richardson, an astronomer at Embry-Riddle and lead author of the new study, said in a statement.



(An artist's depiction of the life of the star system CPD-29 2176. The system began as two large stars (1); a few million years ago one star became a neutron star after a weak supernova (4); in a few million years, the second star will also become a neutron star (6); eventually, the pair will collide and cause a kilonova (9)).

The dying star also did not have enough energy to kick its companion out of the system, which is why the two stars continue to have tight orbits, according to the study.

Marking the beginnings of precious heavy metals

In addition to learning more about kilonova events, the new research will help astronomers better understand the origins of some of the heaviest elements in our universe.

The quiet supernova occurred only a few million years ago, and astronomers expect the CPD-29 2176 system to remain as it is for at least one million years more. Their models show that, much like the primary neutron star, the sibling star too will then become an ultra-stripped supernova and eventually collapse into a neutron star.

Millions of years from now, the team predicts that the two neutron stars will spiral slowly toward each other in a cosmic dance, ultimately colliding in a kilonova explosion. Such explosions are known to be a source of immense quantities of heavy elements like platinum, xenon, uranium and gold "that get hurled into the universe," Richardson said.

CURIOSITY ROVER FINDS METALLIC METEORITE ON MARS

The iron-nickel space rock, nicknamed 'Cacao,' is about 1 foot (0.3 meters) wide.

Nasa's Curiosity rover has stumbled upon a strange metallic rock on Mars that may allow scientists to gain insights on the Red Planet's ancient past.

The rock, dubbed Cacao, measures about a foot across and appears to be an iron-nickel meteorite, according to the American space agency.

It was discovered in the "sulfate-bearing unit" - a region on Mars' Mount Sharp, the agency noted in a blog post on the discovery.

Nasa shared a high-resolution image of the rock that was stitched together from about 20 different individual photos taken by the rover. One of the images is a close-up of Cacao as viewed through Curiosity's ChemCam instrument. This reveals a part of the meteorite that was targeted by the ChemCam instrument's laser.



Nasa noted that this laser analysis involves zapping rocks and studying the resulting vapour to learn about the rock's composition. The rock's metallic hue can be seen as it stands out in contrast to the Red Planet's barren rust-coloured landscape.

"Rock. Rock. Rock. Rock. Rock. METEORITE! "It's not uncommon to find meteorites on Mars - in fact, I've done it a few times! But a change in scenery's always nice," said the Curiosity rover's official Twitter handle.

Nasa suspects the rock's site likely had a "big crater" in the ancient past. "Over time, erosion and other forces flatten the area around it, carving away everything but the hardest material," said another tweet in reply to a user who asked about any evidence of impact. The Curiosity rover has reportedly come across several such strange rocks in its decade-long exploration of the Red Planet.

In 2016, it found the "Egg Rock" also dubbed the "golf ball" and in 2014 it stumbled upon another 7-foot-long meteorite the Curiosity team named "Lebanon".

Earlier in 2005, the Opportunity rover made the discovery of the Heat Shield Rock, a meteorite that was the first such rock to ever be identified on the surface of another planet.

Generally such metallic meteorites landing on Earth's surface tend to rust away in a short span of geologic time, but due to little oxygen and moisture on Mars, these space rocks can remain lusturous for millions of years.

"There's no way to date these. But it could have been here millions of years!" pointed out the Curiosity rover's Twitter account on the new discovery.

FROM THE EYES OF WEBB - FEBRUARY 2023 JWST DISCOVERS WATER ICE AT RINGED ASTEROID CHARIKLO 'BY REMARKABLE LUCK'

In October 2022, the James Webb Space Telescope watched as Chariklo, a tiny ringed asteroid, eclipsed a star. This event, called an occultation, marked a first for Webb. At the month's end, Webb turned toward Chariklo again and notched another victory: For the first time, astronomers analyzing the telescope's data spotted clear signs of water ice, the presence of which was only hinted at until now. These observations will guide astronomers to better understand the nature and behavior of tiny bodies in the outer reaches of our solar system.



This illustration shows what the Centaur Chariklo and its rings could look like, based on our current understanding. (Image credit: NASA, ESA, CSA, Leah Hustak (STScI))

Although it is the largest of its kind, Chariklo is still too small and too far for even the mighty Webb to photograph directly. Instead, astronomers decided to study it through occultation, which is an indirect but powerful method to study small bodies like Chariklo. But the team did not know if and when a star – without which an occultation would not occur – would fall into Webb's field of view. This made Chariklo part of Webb's target of opportunity program: If the asteroid happened to cross in front of a star, the program would allow astronomers to temporarily interrupt the telescope's schedule to observe the event.

The team calculated only a 50% chance that Webb would spot a star bright enough with an interesting object like Chariklo crossing in front. After its launch in 2021, as Webb went through routine course corrections to hold it steady in its parking spot in space, the team continued predicting and revising its list of possible occultations. Late last year, astronomers ended up on the favorable side of that 50% when they discovered "by remarkable good luck" that Chariklo was on track to occult a star that also fell into Webb's view.

On Oct. 18, 2022, Chariklo and its system of two rings crossed in front of a star. Using Webb's nearinfrared camera (NIRCam), astronomers monitored the star's brightness for an hour. Resulting data showed two dips in the star's brightness as expected: When the asteroid's rings first hid the star as the eclipse began, and again when the last of its rings wrapped up the occultation.

"The shadows produced by Chariklo's rings were clearly detected," the team wrote in the statement, "demonstrating a new way of using Webb to explore solar system objects."

Objects like Chariklo are called centaurs, thanks to their hybrid nature. (Centaurs are mythological horse-human hybrids.) They look like asteroids but behave like comets – complete with visible tails. Their home, an unstable orbit between Jupiter and Neptune, hosts thousands of centaurs of varying shapes and sizes. As interesting as they are, their small size and vast distance make them difficult to study. The composition of even the biggest centaur, Chariklo which is still tiny at just 160 miles (250 km) in diameter and distant at a whooping 2 billion miles (3.2 billion km) from us – is poorly understood. Also, past research hinted at water ice somewhere in Chariklo's system, but had yet to conclusively detect it.



In this latest research, astronomers pointed Webb at Chariklo again. This time, they used the telescope's Near-infrared Spectrograph (NIRSpec) instrument to measure the sunlight reflected by Chariklo and its two rings. The resulting spectrum showed three absorption bands of water ice, marking the first clear indication of crystalline ice.

The presence of crystalline ice likely indicates that Chariklo is subject to constant bombardment, according to Dean Hines, an astronomer at the Space Telescope Science Institute in Maryland. "Because high-energy particles transform ice from crystalline into amorphous states, detection of crystalline ice indicates that the Chariklo system experiences continuous micro-collisions that either expose pristine material or trigger crystallization processes," Hines said in NASA's statement.

"Graphic showing the dimming effects of Chariklo's rings on a background star".



WEBB DETECTS EXTREMELY SMALL MAIN BELT ASTEROID

An asteroid roughly the size of Rome's Colosseum – between 300 to 650 feet (100 to 200 meters) in length – has been detected by an international team of European astronomers using NASA's James Webb Space Telescope. Their project used data from the calibration of the Mid-InfraRed Instrument (MIRI), in which the team serendipitously detected an interloping asteroid. The object is likely the smallest observed to date by Webb and may be an example of an object measuring under 0.6 miles (1 kilometer) in length within the main asteroid belt, located between Mars and Jupiter. More observations are needed to better characterize this object's nature and properties.

"We completely unexpectedly detected a small asteroid in publicly available MIRI calibration observations," explained Thomas Müller, an astronomer at the Max Planck Institute for Extraterrestrial Physics in Germany. "The measurements are some of the first MIRI measurements targeting the ecliptic plane and our work suggests that many new objects will be detected with this instrument."

hese Webb observations, published in the journal Astronomy and Astrophysics, were not designed to hunt for new asteroids - in fact, they were calibration images of the main belt asteroid (10920) 1998 BC1, which astronomers discovered in 1998. The observations were conducted to test the performance of some of MIRI's filters, but the calibration team considered them to have failed for technical reasons due to the brightness of the target and an offset telescope pointing. Despite this, the data on asteroid 10920 were used by the team to establish and test a new technique to constrain an object's orbit and to estimate its size. The validity of the method was demonstrated for asteroid 10920 using the MIRI observations combined with data from ground-based telescopes and ESA's Gaia mission.

n the course of the analysis of the MIRI data, the team found the smaller interloper in the same field of view. The team's results suggest the object measures 100-200 meters, occupies a very low-inclination orbit, and was located in the inner mainbelt region at the time of the Webb observations.

ASTERIOD

"Our results show that even 'failed' Webb observations can be scientifically useful, if you have the right mindset and a little bit of luck," elaborated Müller. "Our detection lies in the main asteroid belt, but Webb's incredible sensitivity made it possible to see this roughly 100-meter object at a distance of more than 100 million kilometers." The detection of this asteroid – which the team suspects to be the smallest observed to date by Webb and one of the smallest detected in the main belt – would, if confirmed as a new asteroid discovery, have important implications for our understanding of the formation and evolution of the solar system. Current models predict the occurrence of asteroids down to very small sizes, but small asteroids have been studied in less detail than their larger counterparts owing to the difficulty of observing these objects. Future dedicated Webb observations will allow astronomers to study asteroids smaller than 1 kilometer in size.

What's more, this result suggests that Webb will also be able to serendipitously contribute to the detection of new asteroids. The team suspects that even short MIRI observations close to the plane of the solar system will always include a few asteroids, most of which will be unknown objects.

In order to confirm that the object detected is a newly discovered asteroid, more position data relative to background stars is required from follow-up studies to constrain the object's orbit.

"This is a fantastic result which highlights the capabilities of MIRI to serendipitously detect a previously undetectable size of asteroid in the main belt," concluded Bryan Holler, Webb support scientist at the Space Telescope Science Institute in Baltimore, Maryland. "Repeats of these observations are in the process of being scheduled, and we are fully expecting new asteroid interlopers in those images."

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 the Canadian Space Agency.

Image Credits: ARTWORK: N. Bartmann (ESA/Webb), ESO/M. Kornmesser and S. Brunier, N. Risinger (skysurvey.org)

NASA'S WEBB UNCOVERS NEW DETAILS IN PANDORA'S CLUSTER

Astronomers have revealed the latest deep field image from NASA's James Webb Space Telescope, featuring never-before-seen details in a region of space known as Pandora's Cluster (Abell 2744). Webb's view displays three clusters of galaxies - already massive coming together to form a megacluster. The combined mass of the galaxy clusters creates a powerful gravitational lens, a natural magnification effect of gravity, allowing much more distant galaxies in the early universe to be observed by using the cluster like a magnifying glass.

Only Pandora's central core has previously been studied in detail by NASA's Hubble Space Telescope. By combining Webb's powerful infrared instruments with a broad mosaic view of the region's multiple areas of lensing, astronomers aimed to achieve a balance of breadth and depth that will open up a new frontier in the study of cosmology and galaxy evolution.



Astronomers estimate 50,000 sources of near-infrared light are represented in this image from NASA's James Webb Space Telescope. Their light has travelled through varying distances to reach the telescope's detectors, representing the vastness of space in a single image. Credits: NASA, ESA, CSA, I. Labbe (Swinburne University of Technology) and R. Bezanson (University of Pittsburgh). Image processing: Alyssa Pagan (STScI)

"The ancient myth of Pandora is about human curiosity and discoveries that delineate the past from the future, which I think is a fitting connection to the new realms of the universe Webb is opening up, including this deep-field image of Pandora's Cluster," said astronomer Rachel Bezanson of the University of Pittsburgh in Pennsylvania, co-principal investigator on the "Ultradeep NIRSpec and NIRCam ObserVations before the Epoch of Reionization" (UNCOVER) program to study the region.

Astronomer Ivo Labbe of the Swinburne University of Technology in Melbourne, Australia, coprincipal investigator on the UNCOVER program, said that in the lensing core to the lower right in the Webb image, which has never been imaged by Hubble, Webb revealed hundreds of distant lensed galaxies that appear like faint arced lines in the image. Zooming in on the region reveals more and more of them.

"Pandora's Cluster, as imaged by Webb, shows us a stronger, wider, deeper, better lens than we have ever seen before," Labbe said. "My first reaction to the image was that it was so beautiful, it looked like a galaxy formation simulation. We had to remind ourselves that this was real data, and we are working in a new era of astronomy now."

The UNCOVER team used Webb's Near-Infrared Camera (NIRCam) to capture the cluster with exposures lasting 4-6 hours, for a total of about 30 hours of observing time. The next step is to meticulously go through the imaging data and select galaxies for follow-up observation with the Near-Infrared Spectrograph (NIRSpec), which will provide precise distance measurements, along with other detailed information about the lensed galaxies' compositions, providing new insights into the early era of galaxy assembly and evolution. The UNCOVER team expects to make these NIRSpec observations in the summer of 2023.

PANDORA'S CLUSTER | ABELL 2744



Images of Pandora's Cluster, Abell 2744, captured by Webb's Near-Infrared Camera (NIRCam).

In the meantime, all of the NIRCam photometric data has been publicly released so that other astronomers can become familiar with it and plan their own scientific studies with Webb's rich datasets. "We are committed to helping the astronomy community make the best use of the fantastic resource we have in Webb," said UNCOVER co-investigator Gabriel Brammer of the Niels Bohr Institute's Cosmic Dawn Center at the University of Copenhagen. "This is just the beginning of all the amazing Webb science to come."

The imaging mosaics and catalog of sources on Pandora's Cluster (Abell 2744) provided by the UNCOVER team combine publicly available Hubble data with Webb photometry from three early observation programs: JWST-GO-2561, JWST-DD-ERS-1324, and JWST-DD-2756.

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GALACTICA <u>NASA'S WEBB REVEALS INTRICATE NETWORKS</u> OF GAS AND DUST IN NEARBY GALAXIES

Researchers using NASA's James Webb Space Telescope are getting their first look at star formation, gas, and dust in nearby galaxies with unprecedented resolution at infrared wavelengths. The data has enabled an initial collection of 21 research papers that provide new insight into how some of the smallest-scale processes in our universe – the beginnings of star formation – impact the evolution of the largest objects in our cosmos: galaxies.

The largest survey of nearby galaxies in Webb's first year of science operations is being carried out by the Physics at High Angular resolution in Nearby Galaxies (PHANGS) collaboration, involving more than 100 researchers from around the globe. The Webb observations are led by Janice Lee,



The images from Webb's Mid-Infrared Instrument (MIRI) reveal the presence of a network of highly structured features within these galaxies – glowing cavities of dust and huge cavernous bubbles of gas that line the spiral arms. In some regions of the nearby galaxies observed, this web of features appears built from both individual and overlapping shells and bubbles where young stars are releasing energy.



University in Baltimore, Maryland. "We are directly seeing how the energy from the formation of young stars affects the gas around them, and it's just remarkable," said Erik Rosolowsky of the University of Alberta, Canada.



Gemini Observatory is chief scientist at the National Science Foundation's NOIRLab and affiliate astronomer at the University of Arizona in Tucson. The team is studying a diverse sample of 19 spiral galaxies, and in Webb's first few months of science operations, observations of five of those targets – M74, NGC 7496, IC 5332, NGC 1365, and NGC 1433 – have taken place. The results are already astounding to astronomers. "The clarity with which we are seeing the fine structure certainly caught us by surprise," said team member David Thilker of Johns Hopkins

"Areas which are completely dark in Hubble imaging light up in exquisite detail in these new infrared images, allowing us to study how the dust in the interstellar medium has absorbed the light from forming stars and emitted it back out in the infrared, illuminating an intricate network of gas and dust," said team member Karin Sandstrom of the University of California, San Diego.

The high-resolution imaging needed to study these structures has long evaded astronomers – until Webb came into the picture.

"The PHANGS team has spent years observing these galaxies at optical, radio, and ultraviolent wavelengths using NASA's Hubble Space Telescope, the Atacama Large Millimeter/Submillimeter Array, and the Very Large Telescope's Multi Unit Spectroscopic Explorer," added team member Adam Leroy of the Ohio State University. "But, the earliest stages of a star's lifecycle have remained out of view because the process is enshrouded within gas and dust clouds."

Webb's powerful infrared capabilities can pierce through the dust to connect the missing puzzle pieces.

For example, specific wavelengths observable by MIRI (7.7 and 11.3 microns) and Webb's Near-Infrared Camera (3.3 microns) are sensitive to emission from polycyclic aromatic hydrocarbons, which play a critical role in the formation of stars and planets. These molecules were detected by Webb in the first observations by the PHANGS program.

Studying these interactions at the finest scale can help provide insights into the larger picture of how galaxies have evolved over time.



"Thanks to the telescope's resolution, for the first time we can conduct a complete census of star formation, and take inventories of the interstellar medium bubble structures in nearby galaxies beyond the Local Group," Lee said. "That census will help us understand how star formation and its feedback imprint themselves on the interstellar medium, then give rise to the next generation of stars, or how it actually impedes the next generation of stars from being formed."

The research by the PHANGS team is being conducted as part of General Observer program 2107. The team's initial findings, comprised of 21 individual studies, were recently published in a special focus issue of The Astrophysical Journal Letters. "Because these observations are taken as part of what's called a treasury program, they are available to the public as they are observed and received on Earth," said Eva Schinnerer of the Max Planck Institute for Astronomy in Heidelberg, Germany, and leader of the PHANGS collaboration.

The PHANGS team will work to create and release data sets that align Webb's data to each of the complementary data sets obtained previously from the other observatories, to help accelerate discovery by the broader astronomical community.



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NASA'S CAPSTONE MOON PROBE BOUNCES BACK FROM 11-DAY COMMUNICATIONS GLITCH

After the spacecraft rebooted itself, communications got back to normal.

NASA engineers had a nearly two-week battle with a space probe refusing to respond to commands. CAPSTONE, an experimental spacecraft at the moon meant to test an orbit for NASA's planned Gateway space station, did not listen to communications from Earth for 11 days, the agency said in a blog post Wednesday (Feb. 8).

"The spacecraft remained overall healthy and on-course throughout the issue, sending telemetry data back to Earth," the agency said of CAPSTONE's issue, which began on Jan. 26. The spacecraft rebooted itself on Monday (Feb. 6), however, restoring its ability to listen to commands from home.

That's not the first time CAPSTONE (short for "Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment") encountered drama on its mission, showing how challenging it is to run a cubesat-sized mission in deep space near the moon.



CAPSTONE launched just fine atop a Rocket Lab Electron booster on June 28, 2022, on behalf of NASA with spacecraft operators at Advanced Space and Terran Orbital. The team lost contact with the probe on July 4 during a stage separation maneuver, however.

Sorting that issue only took a day, but another glitch occurred two months later during an engine burn to correct the spacecraft's trajectory. That problem briefly forced the spacecraft into a protective safe mode as a result.

Once engineers found the valve causing this issue, they managed to get the probe back on track to be the first-ever cubesat at the moon on Nov. 13, 2022. Since then, NASA officials reported on Wednesday, CAPSTONE has finished more than 12 near-rectilinear halo orbits as a pathfinder for Gateway. That's double the original manifest of six.

The orbit allows for a close approach to the potentially water-rich moon's south pole, making landings easier for the Artemis program that may put astronauts there as soon as 2025 with Artemis 3. It is fortuitous that CAPSTONE reached its orbit, as another small NASA spacecraft called Lunar Flashlight had to abandon that task this week following several propulsion issues en route.

As a technology demonstration mission, CAPSTONE is expected to run into trouble every once in a while. Other, smaller glitches have occurred with the spacecraft during its lunar sojourn – but the mission remains on track for now.

CAPSTONE was supposed to perform a navigation test, developed by Advanced Space, to use data between at least two spacecraft for firming up a satellite's location where GPS is not available.

The long-running NASA Lunar Reconnaissance Orbiter was ready for the test and received the signal, but CAPSTONE was unable to get the "crosslink ranging measurements" it needed from the returned signal, NASA officials said. More tests are planned for this navigation system in the coming weeks.



ISRO's SSLV bounced back nicely from an August 2022 failure.

A new Indian rocket successfully delivered three satellites to orbit on Feb 9, bouncing back from its failed debut flight in August 2022.

The Small Satellite Launch Vehicle (SSLV) lifted off from India's Satish Dhawan Space Centre Thursday at 10:48 p.m. EST (0348 GMT and 9:18 a.m. local time on Feb. 10), carrying the Indian Space Research Organisation's (ISRO) EOS-07 Earth-observation satellite and two ride-along cubesats skyward.

By 15.5 minutes later, the 112-foot-tall (34 meters) rocket had deployed all three spacecraft into their designated 280-mile-high (450 kilometers) circular orbits, and mission team members were exchanging smiles and handshakes in the control room.

"With the successful launch of the SSLV-D2/EOS-07 mission, ISRO now has a new credible member in its launch vehicle family," a commentator said on the agency's livestream just after the satellites deployed. "Congratulations to team ISRO!"

GALACTICA SOUTH KOREA'S DANURI PROBE CAPTURES PHASES OF EARTH

NASA's ShadowCam is also aboard Danuri, bringing new insight into dark lunar craters.

South Korea's first moon mission is now fully operational and unveiling new views of the Earth and moon from lunar orbit. The Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, arrived in low lunar orbit in mid-December and delivered a first batch of stunning images in January.

The spacecraft has been quietly continuing its science work since then. The Korea Aerospace Research Institute (KARI) released a new set of Danuri images via Twitter Feb. 12, showing detailed views of Vallis Rheita, taken on Jan. 5, Mare Imbrium (Jan. 10), Oceanus Procellarum (Jan. 13) and a series of images showing the phases of Earth, as seen from lunar orbit.



The spacecraft is also carrying the NASA-funded ShadowCam instrument, which is designed to peer into craters on the moon whose floors do not receive direct sunlight.

ShadowCam is derived from cameras aboard NASA's Lunar Reconnaissance Orbiter but is 200 times more light-sensitive, allowing it to pick up light reflected off crater walls and peaks to provide unprecedented views into permanently shadowed regions, or PSRs.

ShadowCam has snapped a series of images of Shackleton Crater at the lunar south pole, revealing a detailed view of the permanently shadowed wall and floor of the crater. The tests are designed to calibrate and test the camera's functionality as part of an operational checkout period that will conclude before the end of February, according to NASA.

High-resolution images collected by ShadowCam could provide clues about lunar evolution, water trapped as ice in shadowed regions, and even assist site selection for crewed Artemis missions, according to NASA.



Images of the permanently shadowed wall and floor of the moon's Shackleton Crater captured by the Lunar Reconnaissance Orbiter Camera (LROC) (left) and ShadowCam (right), which is flying on South Korea's Danuri moon orbiter. Each panel shows an area that is 5,906 feet (1,800 meters) wide and 7,218 feet (2,200 m) tall. (Image credit: NASA/KARI/ASU)

TASK COMPLETE! PERSEVERANCE MARS ROVER SNAPS PHOTO OF FILLED SAMPLES

Perseverance has recorded the 10-sample Three Forks cache for posterity.



An annotated version of the portrait captured by NASA's Perseverance rover on Jan. 31, 2023 shows the location of the 10 sample tubes in the Three Forks depot. The "Amalik" sample closest to the rover was about 3 meters away; the "Mageik" and "Malay" samples farthest away were approximately 60 meters from the rover. (Image credit: NASA/JPL-Caltech/ASU/MSS)



NASA's Perseverance Mars rover has recorded the first-ever off-Earth sample depot for posterity.

Perseverance built that depot on a patch of Martian ground called Three Forks over the course of five weeks beginning on Dec. 21, 2022. The cache contains 10 sealed titanium sample tubes, which a joint NASA-European Space Agency (ESA) campaign may end up bringing home to Earth a decade from now.

On Jan. 31, the car-sized rover took a series of photos to commemorate its recent work. Mission team members have now stitched together 368 of those images into a panorama, which shows the location of all 10 cached tubes. Perseverance and its tiny ride-along cousin, the Ingenuity helicopter, landed on the floor of Mars' 28-milewide (45 kilometers) Jezero Crater in February 2021.

The rover has two main tasks: Hunt for signs of past Mars life inside Jezero, which hosted a big lake and a river delta billions of years ago, and collect samples for future return to Earth.

The baseline sample-return architecture calls for Perseverance to deliver its sealed tubes to a rocket-equipped NASA lander, which will then launch them to Mars orbit. An ESA-built Earth Return Orbiter will snag them up there and haul the samples back to Earth, perhaps as early as 2033.

The orbiter and lander are scheduled to launch in 2027 and 2028, respectively. Perseverance is in good condition today, but there's no guarantee it will be healthy enough to do this ferry work five or six years from now – and that's where the Three Forks depot comes in. If Perseverance is out of the picture, two Ingenuity-like helicopters that will launch with the sample-retrieval lander will fetch the depot tubes one by one.

Perseverance brought 43 titanium tubes to Mars. Thirty-eight of these are designed to be filled with drilled rock cores or scooped dirt samples, while the other five are "witness tubes" that will help mission team members sniff out possible contaminants from Earth in the Martian material.

The rover has sealed three of its five witness tubes and 18 of its 38 sample tubes to date. Of those sample tubes, 15 are filled with drilled rock cores, two contain loose dirt and one is an "atmospheric sample" the result of Perseverance's failed first-ever sample-collecting attempt, which went awry because its target rock was too crumbly to produce a good rock core.



When black holes collide and merge to form even more massive black holes, this violent process sends ripples surging through the very fabric of space. A new model indicates how these gravitational waves interact with each other as they spread through space-time, the unification of space and time popularized by Albert Einstein's theory of special relativity.

By presenting a clearer picture of how black hole collisions set space-time "ringing," the model could indicate how scientists on Earth can learn more about the events that launch them using gravitational wave detectors such as the Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO made the first detection of gravitational waves from merging black holes in 2015, with the signal going on to be named GW150914.

Previously when physicists have modeled black hole mergers and the gravitational waves they send through space, they have only done so with linear mathematics, without considering how these waves influence or interact with each other as they propagate outwards. By taking these interactions into account, a team of researchers believes they can model black hole collisions greater in detail, revealing what are known as nonlinear effects and putting general relativity to the test when it comes to black holes.

The key to this new supercomputer model, created by the Simulating eXtreme Spacetimes (SXS) team, is simulating these collisions and gravitational waves in more detail to reveal these non-linear effects.

Linear vs nonlinear gravitational wave models

Mitman gave an analogy to describe the difference between linear and nonlinear gravitational wave models.

"Imagine there are two people on a trampoline. If they jump gently, they shouldn't influence the other person that much. That's what happens when we say a theory is linear," explained. "But if one person starts bouncing with more energy, then the trampoline will distort, and the other person will start to feel their influence. "This is what we mean by nonlinear: The two people on the trampoline experience new oscillations because of the presence and influence of the other person."

In the new simulations, the black hole collisions produce new types of waves, with Mitman saying that digging deeper under the larger gravitational waves reveals additional new waves with their own unique frequency.



"Supercomputers are needed to carry out an accurate calculation of the entire signal: The inspiral of the two orbiting black holes, their merger, and the settling down to a single quiescent remnant black hole," Teukolsky said. "The new nonlinear treatment of this phase will allow more accurate modeling of the waves and eventually new tests of whether general relativity is, in fact, the correct theory of gravity for black holes."

The SXS team hopes that the findings will set the stage for the next generation of gravitational wave detections which should deepen our understanding of this phenomenon first predicted in 1915 but only detected 100 years later, and of gravity in general.

"INDIA TESTS RECOVERY OF SPACECRAFT For Gaganyaan Mission"

The recent Gaganyaan recovery practice runs simulated different ocean conditions. (Image credit: ISRO) On Tuesday (Feb. 7), the Indian Space Research Organisation (ISRO), India's national space agency, resumed a series of tests needed to perfect procedures and hardware for its Gaganyaan human spaceflight program. The agency collaborated with the Indian Navy to recover a mock crew module from a closed pool, it said Wednesday (Feb. 8) in a press release.

The tests are being carried out at the Water Survival Test Facility, a location owned by the Indian Navy in Kochi (previously called Cochin), which is a city in southwest India. The stateof-the-art facility "simulates different sea state conditions, environmental conditions and day/night conditions," according to ISRO.

ISRO has long been testing the hardware that will fly astronauts on Gaganyaan missions. The agency validated the program's launch vehicle in 2014 and its launch abort and crew escape systems in 2018, before the coronavirus pandemic halted astronaut training, adding to the program's setbacks. ISRO slowly bounced back in 2021 with tests of engines, solid rocket boosters and parachutes.

In the latest tests in a controlled environment at Kochi, scientists have begun nailing down operations to recover the Gaganyaan module and its crew after they splash down in the ocean at mission's end. For now, scientists are using a mockup called the Crew Module Recovery Model (CMRM), which simulates details of the real one upon touchdown on water, including its mass, dimensions and center of gravity, the agency said.

Kochi, part of the coastal state of Kerala, touches the Bay of Bengal and offers an open sea where the agency will likely test its crew modules in the coming months.

ISRO said these tests also train the recovery teams and flight crew, who will work in coordination during reentry and landing to wrap up the week-long Gaganyaan orbital mission. Similarly, NASA's team practiced nine such tests using a mockup of its Orion capsule before being certified to recover the real spacecraft from the Pacific Ocean after the uncrewed Artemis 1 mission landed last December. The recovery efforts for Gaganyaan's crew and crew module will be led by the Indian Navy with contributions from several other government organizations involved with the mission, the agency said.

WHAT'S UP IN THE SKY - MARCH 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

Best at the end of the month in the evening sky. Near to Jupiter on 28th March.

Venus

Lovely evening planet. Close to Jupiter in the first week of March. Its close to moon on 24th March.

Mars

Declining evening planet, well presented but fading and shrinking. Mars is near the open cluster M35 on 30th March.



Jupiter Evening planet near Venus in early March. Near Mercury on 28th March.

ry on 28th Ma



Saturn

Poorly located morning planet, unlikely to be seen this month as it is near to sun throughout this month.

Uranus

Deteriorating evening planet, losing altitude throughout the month. Uranus is near Venus on 30th March.

Neptune Too close to the Sun to be seen this month.



BRIGHT DEEP SKY OBJECTS

The Messier 45 (M45), also known as the Pleiades or Seven Sisters, is a bright open star cluster located in the constellation Taurus, the Bull. The Pleiades cluster has an apparent magnitude of 1.6 and lies at an average distance of 444 light years from Earth. Finding M45 is easy, the cluster is positioned about 14 degrees northwest of orange giant star Aldebaran (mag. +0.9), the brightest star in Taurus.





Messier 35 (M35) is a large open star cluster located in the northern constellation Gemini. The cluster consists of several hundred stars. The beautiful open cluster M35 reaches its highest position in the sky, due south, around 20:00 UT. The cluster is just visible to the naked eye, and a real treat through binoculars or a small scope.

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 included as the 44th entry 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 MARCH 2023

GOOD LUCK, HAVE FUN!

Relativity Space is scheduled to launch a Terran 1 rocket as part of the Good Luck, Have Fun (Maiden Flight) mission. The launch is scheduled on 03/08/2023 18:00 UTC for the Test Flight mission launching from Cape Canaveral, FL, USA.

The Terran 1 is an expendable launch vehicle under development that will consist of two stages. The first stage will use nine Aeon 1 engines, while the second stage will use a single Aeon 1 engine. The rocket is designed to deploy and resupply constellations and is manufactured primarily with 3D printing.

Agency: Relativity Space

Relativity Space is an American aerospace manufacturing company headquartered in Los Angeles, California. It was founded in 2015 by Tim Ellis and Jordan Noone. Relativity Space is developing manufacturing technologies, launch vehicles, and rocket engines for commercial orbital launch services.

About the rocket:

A 3D-printed rocket is once again fully assembled at the launch pad ahead of its debut mission. Relativity Space put together the stages of its expendable Terran 1 rocket, a two-stage smalllift vehicle, on the launch pad for "final ground tests" ahead of its debut flight, CEO Tim Ellis shared. "We are vertical again!!" tweeted Ellis about Terran 1, which is rumored to be launching as soon as this month from Cape Canaveral Space Force Station in Florida providing these tests go to plan The company's rocket is 85 percent 3D-printed by mass and is said to be "the largest 3D printed object to exist and to attempt orbital flight" by the company. Eventually, they plan to create Terran 1 rockets that are 95 percent 3D-printed. The nine Aeon engines on the first stage of the rocket, along with the Aeon Vac engine on the second, are also all 3D-printed. They will use liquid oxygen as well as liquid natural gas, which is a rare combination in the industry. (Image Credits: Trevor Mahlmann)



OLYMP-K #2

Secretive payload, reportedly known as Olymp-K or Luch, is a geostationary satellite built and launched for the Russian Ministry of defence and the Russian Intelligence agency FSB.

The Proton-M Briz-M was manufactured by Khrunichev State Research and Production Space Center. Proton-M Briz-M has 60 successful launches and 6 failed launches with a total of 66 launches. The rocket is a family of Proton / UR-500 of length 53 m, diameter: 7.4 m. The launch Mass is estimated to be 712 T and the Low Earth Orbit Capacity is 21000 kg.

About the Space center:

Khrunichev State Research and Production Space Center is a Moscow-based producer of spacecraft and space-launch systems, including the Proton and Rokot rockets, and is currently developing the Angara rocket family. The Proton launch vehicle launches from Baikonur and Rokot launches from Baikonur and Plesetsk. Angara will launch from Plesetsk and Vostochny.

The company's history dates back to 1916 when an automobile factory was established at Fili, a western suburb of Moscow. It soon switched production to airplanes and during World War II produced Ilyushin II-4 and Tupolev Tu-2 bombers. A design bureau, OKB-23, was added to the company in 1951. In 1959, the company started developing intercontinental ballistic missiles, and later spacecraft and space launch vehicles. The company designed and produced all Soviet space stations, including Mir.

OKB-23, renamed to Salyut Design Bureau, became an independent 1993, company in 1988. In the Khrunichev Plant and the Salyut Design Bureau were joined again to form Khrunichev State Research and Production Space Center. In the 1990s, the company entered the International Launch Services joint venture to market launches its Proton rocket. on Khrunichev subsequently became а successful launch service provider in the international space launch market.

About the Olymp Satelltie:

The payload of the Proton return-toflight mission is known as Luch or Olymp (Olimp). It is known that the satellite was developed and manufactured by ISS Reshetnev for operation by the Russian Ministry of Defence. Like many MOD missions, details on the Olymp satellite are not made available to the public. In an article published by the Russian Newspaper "Kommersant," the actual operator of the satellite or at least part of its payload is the Russian intelligence agency FSB (Federal Security Service of the Russian Federation).



An image of the Proton vehicle which successfully returned after delivering a secret Olymp satellite (Image credits: ROSCOSMOS)

UK'S ONEWEB INTEGRATES WITH INDIA'S – LVM 3

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A batch of 36 satellites for the OneWeb satellite constellation, which is intended to provide global Internet broadband service for individual consumers. The constellation is planned to have around 648 microsatellites (of which 60 are spares), around 150 kg each, operating in Ku-band from low Earth orbit.

The GSLV Mk III was manufactured by Indian Space Research Organization with the first launch on 2017-06-05. GSLV Mk III has 4 successful launches and 0 failed launches with a total of 4 launches. The Geosynchronous Satellite Launch Vehicle Mark III is a three-stage medium-lift launch vehicle developed by the Indian Space Research Organisation (ISRO). It is designed to launch satellites into geostationary orbit and is intended as a launch vehicle for crewed missions under the Indian Human Spaceflight Programme.

Engineers have completed the integration of the 36 OneWeb satellites with the Launch Vehicle Mark-III (LVM-III) to Low Earth Orbit. The satellites, part of the UK's internet constellation, will be launched on India's heaviest launch vehicle in mid-March.

The Indian Space Research Organisation has confirmed the launch. 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."

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An ISRO GSLV-II rocket will launch the IRNSS-1J (NVS-01) mission. The launch date is currently targeted for March 2023 (UTC).

The NVS, previously IRNSS, the constellation is not a global positioning constellation, like GPS, GLONASS, Galileo, or Beidou-3, but a regional one, similar to the Chinese Beidou-1 and 2, or the Japanese QZSS, serving only the Indian sub-continent. IRNSS satellites have two payloads: a navigation payload and CDMA ranging payload in addition to a laser retro-reflector. The payload generates navigation signals at L5 and S-band. The design of the payload makes the IRNSS system interoperable and compatible with Global Positioning System (GPS) and Galileo systems. The satellite is powered by two solar arrays, which generate up to 1,660 watts, and has a lifetime of ten years.

The national space agency of India, the Indian Space Research Organization (ISRO), carries out duties of space-based applications, space exploration, and the advancement of associated technology.

It is one of the world's only six national space agencies with full launch capability, cryogenic engine deployment, extraterrestrial mission launching, and huge fleets of man-made satellite operations. Since then, ISRO has successfully developed several medium-lift launch vehicles, rocket engines, satellite systems, and networks that have allowed the organization to launch numerous deep space initiatives for space travel in addition to hundreds of domestic and international satellites. The GAGAN and NAVIC satellite navigation systems run by ISRO are the world's biggest constellation of remote-sensing satellites.

Geosynchronous Satellite Launch Vehicle Mark II (GSLV Mk II) is the largest launch vehicle developed by India, which is currently in operation. This fourth-generation launch vehicle is a three-stage vehicle with four liquid strap-ons. The indigenously developed cryogenic Upper Stage (CUS), which is flight proven, forms the third stage of GSLV Mk II. Since January 2014, the vehicle has achieved four consecutive successes.

SpaceX Launches - March 2023

SPACEX FALCON 9 - CREW -6

On Thursday, March 2 at 12:34 a.m. ET (12:34 UTC), Falcon 9 will launch Dragon's sixth operational human spaceflight mission (Crew-6) to the International Space Station from Launch Complex 39A (LC-39A) at NASA's Kennedy Space Center in Florida.

Dragon will autonomously dock with the space station on Friday, March 3 at approximately 1:17 a.m. ET (6:17 UTC). Follow Dragon and the crew's flight below.

During their time in the orbiting laboratory, the crew will conduct over 200 science experiments and technology demonstrations in areas such as life and physical sciences to advanced materials, technology development, in-space production

applications, and even student-led research.

Mission: TO THE SPACE STATION

On its flight to the International Space Station, Dragon executes a series of burns that position the vehicle progressively closer to the station before it performs final docking maneuvers, followed by pressurization of the vestibule, hatch opening, and crew ingress.

Crew members:

The SpaceX Crew Dragon spacecraft Endeavour, going to carry NASA astronauts Stephen Bowen, commander; Warren Hoburg, pilot; and mission specialists UAE (United Arab Emirates) astronaut Sultan Alneyadi and Roscosmos cosmonaut Andrey Fedyaev to the International Space Station. Designated Crew 6, the mission marks the sixth long-term ISS team that NASA has flown aboard SpaceX since the private rocket venture founded by Musk began sending American astronauts to orbit in May 2020.



The four crew members who comprise NASA's SpaceX Crew-6 mission are seated inside the SpaceX Dragon spacecraft during a training session at the company's headquarters in Hawthorne, California. (Photo credit: SpaceX).

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FALCON 9 • STARLINK 2-7

What's This All Mean?

SpaceX's Starlink Group 2-7 mission will launch 51 Starlink v1.5 satellites atop a Falcon 9 rocket. The Falcon 9 will lift off from Space Launch Complex 4 East (SLC-4E), at the Vandenberg Space Force Base, in California, United States. Starlink Group 2-7 will mark the 74th operational Starlink mission, boosting the total number of Starlink satellites launched to 4,053, of which ~3,756 will still be in orbit around the Earth once launched. Starlink Group 2-7 will mark the fifth launch to the second Starlink shell.

What Is The Starlink Satellite?

Each Starlink v1.5 satellite has a compact design and a mass of 307 kg. SpaceX developed a flat-panel design, allowing them to fit as many satellites as possible into the Falcon 9's 5.2-meter wide payload fairing. Due to this flat design, SpaceX is able to fit up to 60 Starlink satellites and the payload dispenser into the second stage, while still being able to recover the first stage. This is near the recoverable payload capacity of the Falcon 9 to LEO, around 16 tonnes.

What Is Starlink?

Starlink is SpaceX's internet communication satellite constellation. The low-Earth orbit constellation delivers fast, lowlatency internet service to locations where groundbased internet is unreliable, unavailable, or expensive. The first phase of the constellation consists of five orbital shells. Starlink is currently available in certain regions, allowing anyone in approved regions to order or preorder.



As small as each Starlink satellite is, each one is packed with high-tech communication and cost-saving technology. Each Starlink satellite is equipped with four phased array antennas, for high bandwidth and low-latency communication, and two parabolic antennas. The satellites also include a star tracker. which provides the satellite with data, attitude ensuring precision in broadband communication.

After 28 launches SpaceX achieved near-global coverage, but version 1 of the constellation will not be complete until all five shells are filled. Once Starlink generations 1 and 2 are complete, the venture is expected to profit \$30-50 billion annually. This profit will largely finance SpaceX's ambitious Starship program, as well as Mars Base Alpha. Each Starlink v1.5 satellite is also equipped with an inter-satellite laser communication system. This allows each satellite to communicate directly with other satellites, not having to go through ground stations. This reduces the number of ground stations needed, allowing coverage of the entire Earth's surface, including the poles.



SpaceX's Dragon will deliver new science investigations, supplies, and equipment for the international crew, including the final two experiments comprising the National Institutes for Health and International Space Station National Laboratory's Tissue Chips in Space initiative. 27th commercial resupply services mission to the International Space Station operated by SpaceX. The flight will be conducted under the second Commercial Resupply Services contract

Cargo Dragon 2 brings supplies and payloads, including critical materials to directly support science and research investigations that occur onboard the orbiting laboratory.

The Falcon 9 Block 5 was manufactured by SpaceX with the first launch on 2018-05-11. Falcon 9 Block 5 has 150 successful launches and 0 failed launches with a total of 150 launches. Falcon 9 is a two-stage rocket designed and manufactured by SpaceX for the reliable and safe transport of satellites and the Dragon spacecraft into orbit. The Block 5 variant is the fifth major interval aimed at improving upon the ability for rapid reusability. The Falcon 9 first stage will attempt to land on an ASDS after this flight.

Autonomous Spaceport Drone Ship - ASDS

An autonomous spaceport drone ship (ASDS) is an ocean-going vessel derived from a deck barge, outfitted with station-keeping engines and a large landing platform. Construction of such ships was commissioned by aerospace company SpaceX to allow for recovery of rocket first-stages at sea for high-velocity missions which do not carry enough fuel to return to the launch site after lofting spacecraft onto an orbital trajectory.

About SpaceX

with NASA.

Space Exploration Technologies Corp., known as SpaceX, is an American aerospace manufacturer and space transport services company headquartered in Hawthorne, California. It was founded in 2002 by entrepreneur Elon Musk with the goal of reducing space transportation costs and enabling the colonization of Mars. SpaceX operates from many pads, on the East Coast of the US they operate from SLC-40 at Cape Canaveral Space Force Station and historic LC-39A at Kennedy Space Center.

ONEWEB 17 -FALCON 9

A SpaceX Falcon 9 rocket will launch the OneWeb-17 mission on Thursday, March 9, 2023, at 7:05 PM (UTC).

A batch of 48 satellites for the OneWeb satellite constellation, which is intended to provide global Internet broadband service for individual consumers. The 17th flight is dedicated to the OneWeb high-speed Internet constellation. The initial constellation consists of 648 satellites. Later, the constellation could be expanded to more than 900 satellites depending on demand. OneWeb is expected to begin customer demonstrations in 2022, then provide a global, 24-hour service in 2023.

The satellites in the OneWeb constellation are approximately 150 kg (330 lb) in mass, a bit smaller than the 2015 design estimate of 150-200 kg (330-440 lb). The 648 operational satellites are to operate in 12 near-polar orbit planes at 1,200 km (750 mi) altitude, at 86.4° orbital inclination. Initially, 18 orbital planes with 49 satellites per plane were planned, requiring 882 satellites plus some spares, but improved satellite coverage capability allowed this to be reduced to 12 planes of 49 satellites requiring 588 satellites plus some on-orbit spares. The first-generation satellites do not have inter-satellite data links, so will only provide a useful service when also in the range of a gateway ground station.

Falcon 9 is a reusable, two-stage rocket designed and manufactured by SpaceX for the reliable and safe transport of people and payloads into Earth orbit and beyond. Falcon 9 is the world's first orbital-class reusable rocket.



Reusability allows SpaceX to refly the most expensive parts of the rocket, which in turn drives down the cost of space access.

OneWeb (legally Network Access Associates Ltd) is a communications company that aims to build broadband satellite Internet services. The company is headquartered in London and has offices in Virginia, US, and a satellite manufacturing facility in Florida – Airbus OneWeb Satellites – that is a joint venture with Airbus Defence and Space. The company was formerly known as WorldVu Satellites Ltd.

ASTRONOMICAL EVENTS - MARCH 2023 THE GREAT CONJUNCTION OF VENUS AND JUPITER

Jupiter

Venns 🔺

Astronomically speaking, a conjunction is when two astronomical objects appear close to each other in the sky, as seen from our view on Earth. Conjunctions are most widely associated with planets, but they can also occur with any two astronomical objects, including asteroids, moons, stars, and of course, the Sun.

When is the best time to see the Venus-Jupiter conjunction?

On 1 and 2 March, Venus and Jupiter will be less than one degree apart in the sky. That's equivalent to the width of your pinkie when held out at arm's length. When distances get this small, a degree is subdivided further into arcminutes, and there are 60 arcminutes in one degree. Venus and Jupiter will appear 39 arcminutes apart on 1 March at their closest approach, and 45 arcminutes apart the evening after on 2 March.

Why is the Venus-Jupiter conjunction so special?

Although we won't see another Great Conjuntion until 2040, that is – a conjunction between the two gas giants, Jupiter and Saturn, the Venus-Jupiter conjunction this week should offer spectacular views, if the clouds cooperate.

As the two brightest planets in the night sky, they are visible to the naked eye without binoculars and are easily distinguishable even for the casual observer.

The brightness of the planets is denoted by something astronomers call 'apparent magnitude'. Simply put, the smaller the number, the brighter that object is. If the object has an apparent magnitude of less than 0, then it's really bright. During the conjunction of Venus and Jupiter, the apparent magnitude of each planet will determine how bright they appear relative to each other.

Venus is typically the brighter of the two planets, with an average apparent magnitude of around -4.2, while Jupiter has an average apparent magnitude of around -2.0. (For comparison, a full Moon has an average apparent magnitude of -12.74, and the Sun is -26.7.) This means that Venus will appear much brighter than Jupiter during the conjunction, however, they should both be discernible to the naked eye in the early evening sky.

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MARCH EQUINOX - 2023



Why do they happen?

The equinoxes and solstices are caused by Earth's tilt on its axis and ceaseless motion in orbit. You can think of an equinox as happening on the imaginary dome of our sky, or as an event that happens in Earth's orbit around the sun.

Did the sun set quickly?

The fastest sunsets and sunrises of the year happen at the equinoxes. We're talking here about the length of time it takes for the whole sun to sink below the horizon.

More effects of Equinox

In the Northern Hemisphere, the March equinox brings earlier sunrises, later sunsets and sprouting plants. Meanwhile, you'll find the opposite season - later sunrises, earlier sunsets, chillier winds, dry and falling leaves - south of the equator.

Do we have 12 hrs of Day and 12 hrs of Night??

Αt the equinox, Earth's two hemispheres are receiving the sun's rays equally. Night and day are often said to be equal in length. In fact, the word equinox comes from the Latin aequus (equal) and nox (night). For our ancestors, whose timekeeping was less precise than ours, day and night likely did seem equal. But today know it's we not exactly so.

The Earth during equinox



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GALACTICA 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 Jupiter. On **Mar 2, 2023.** the brightest planet will appear very close to the planet Jupiter. The pair will be close from the early evening. They will be in the western direction. Venus is at a magnitude of -3.86 and Jupiter has a magnitude of -1.94



Conjunction of Moon with Pleiades.

On Mar 26, 2023. Moon and Pleiades star cluster will appear very close to each other in the early evening. They will be in the Western direction. Moon is at a magnitude of -11.15, Pleiades is at a magnitude of 1.59. The pair will be visible till 10.30 PM.



Conjunction of Moon and Venus.

On **Mar 24, 2023**, Moon and the planet Venus appear very close to each other in the early evening, right after sunset. They will be in the Western direction. Moon is at a magnitude of -10.14, Venus will be at a magnitude of 3.91.



Conjunction of Moon, and Mars.

On **Mar 28, 2023,** Moon and the planet Mars will appear very close to each other in the late evening. They will be in the western direction. Moon is at a magnitude of -11.71, and the planet Mars is at a magnitude of 0.92. The pair will be visible till late night.



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STUDENT'S CORNER

'Black hole stars' were they real?

Sourajit Mandal iAstronomer member

Black hole stars may have been the largest to exist in the entire universe. They were brighter than galaxies. They were much bigger than the biggest stars that exist today (or will exist in the future). They had a black hole in their core as well.

Black hole stars could only exist at the very beginning of the universe for a very short time (about 0.5 billion years after the big bang).During the beginning of the universe, it was much hotter and denser than it is now. Dark matter played a crucial role. It formed huge, massive structures known as dark matter haloes. They pulled up so much hydrogen that the mass of the hydrogen could add up to millions of suns. Matter began to accumulate in these locations.



As it grew, its gravitational pull increased, making it grow even faster. Soon, nuclear fusion started, and a star was born. As the universe was much smaller than it is now and the gas clouds were so massive, the stars continued to grow to unbelievable proportions. Crushed by gravity, its core grew hotter and hotter, but to no avail. Under the enormous mass, the core of the star goes supernova. The star is shaken by the tremendous explosion. Even though a supernova has taken place, the star does not die. This is because the star is too massive. The star now has a blackhole in its core. Even though the black hole that forms is tiny, it quickly grows by taking in matter from the star.

The star starts to be eaten from the inside. For the next few million years, the star gets eviscerated from within. As the blackhole got bigger, it ate everything quicker, heating up the star and making it even bigger. The intense magnetic field at its core spews out plasma jets from the black hole's core. This also marks the star's end. The remains of the stars blow up in an enormous explosion. The explosion also reveals a humongous black hole with a mass of up to 100,000 suns.

Black hole stars can explain the greatest mysteries of the universe: supermassive black holes. These blackholes just do not fit in our calculations. Even if blackholes collide with each other, they cannot form massive blackholes so quickly. Black-hole stars can solve this mystery. If they form so early, then it could make them the seeds for supermassive blackholes. If we can prove the existence of black hole stars with the James Webb telescope, we will be able to solve one of the greatest mysteries we do not know the answer to. This can also be the next breakthrough we have in this field!

CHANDRAYAAN : INDIAS LUNAR SPACE PROGRAMME AND ITS PLAN

Daksh Rathi iAstronomer member

The Chandrayaan also known as the Indian Lunar Exploration Programme is an ongoing series of outer space missions by the Indian Space Research Organization (ISRO). The programme incorporates lunar orbiter, impactor, soft lander and rover spacecraft. The name of the programme is from Sanskrit candrayāna. It consists of total 6 planned missions to the moon.

The Chandrayaan (Indian Lunar Exploration Programme) programme is a multiple mission programme. As of September 2019, one orbiter with an impactor probe has been sent to the Moon, using ISRO's workhorse PSLV rocket. The second spacecraft consisting of orbiter, soft lander and rover was launched on 22 July 2019, by using a GSLV Mk III rocket. In a podcast from AT, VSSC director S. Somanath stated that there will be a Chandrayaan-3 and more follow up missions in Chandrayaan Program. The Chandrayaan-3 mission is expected to launch in 2023.

CHANDRAYAAN - 1

Chandrayaan-1, launched on 22 October 2008 aboard a PSLV-XL rocket, was a big success for ISRO as the Moon Impact Probe, a payload on board the Chandrayaan-1 spacecraft, discovered water on the Moon. Apart from discovering water the Chandrayaan-1 mission performed several other tasks such as mapping and atmospheric profiling of the Moon.

CHANDRAYAAN-2

Chandrayaan-2 was launched on 22 July 2019 aboard a GSLV Mk III rocket. The spacecraft was successfully put into lunar orbit on August 20, 2019 but the lander was lost while attempting to land on 6 September 2019. The orbiter is operational, collecting scientific data and is expected to function for 7.5 years.

CHANDRAYAAN - 3

In November 2019, ISRO officials stated that a new lunar lander mission was being studied for launch in November 2020. This new proposal is called Chandrayaan-3 and it would be a re-attempt to demonstrate the landing capabilities needed for the Lunar Polar Exploration Mission proposed in partnership with Japan for 2024. This spacecraft configuration would not include launching an orbiter and would have a lander, rover, and a propulsion module, behaving like a communications relay satellite with mission costing ₹250 crore with additional launch costs of ₹365 crore for GSLV Mk III. This third mission would land in the same area as the second one. As of April 2022, Chandrayaan-3 is expected to launch in 2023.

CHANDRAYAAN - 4

The next mission will be the Lunar Polar Exploration Mission or Chandryaan-4, suggested to be launched in 2025 India is collaborating with Japan in this mission but the mission is not yet defined. It will be a lander-rover mission near lunar pole to perform on site sampling and analysis of collected lunar material and demonstrate lunar night survival technologies.

CHANDRAYAAN - 5

The mission has been suggested for time frame of 2025-30. It will include a landerbased rotary percussive drilling in lunar soil up to a depth of 1~1.5 meters and analysis of cut using instruments. A volcanically and tectonically active area on near side of the moon will be selected for experiment.

CHANDRAYAAN - 6

The mission has been suggested for time frame of 2030-35. It will include drilling of lunar soil followed and return samples to earth.



SATELLITES AND ROVERS

Nikhilesh Balamurali

iAstronomer member

Satellites are intentionally placed in the orbit of any outer space objects. Satellites are usually used in many fields such as television, phone calls, scientific research, weather forecasting, etc.

The satellites when landing on planets release a small car kind of structure called the ROVER. These are small vehicles sent to study the surface of the planets and the Moon.

Rovers are usually created to land on other planets like Mars, Moon, and Venus. They are used to collect data on the planets and send the information back to Earth. They take samples like soil, liquid, rocks, gases, etc. They are most commonly used in space exploration

IMPORTANT ROVERS AND SATELLITE:

InSight

The Mars rover InSight was launched on 5 May 2018 and landed on the surface of mars on 26 November 2018, it was launched in an Atlas V rocket, and recently started dying in 2022, its last contact was on December 15, 2022.

Chandrayaan-1

Chandrayaan-1, India's first mission to Moon, was launched successfully on October 22, 2008, from SDSC SHAR, Sriharikota. The Chandrayaan-1 discovered the presence of water (H2O) and hydroxyl (OH)

Chandrayaan-2

On August 20, 2019, the Chandrayaan-2 successfully launched into the moon's orbit, and on September 02, 2019, the Vikram lander separated from the orbiter in preparation for landing. Trace amounts of Manganese, Chromium, and Sodium were found by Chandrayaan-2. It also found out that the top surface extends up to 3-4 meters in depth.

Starlink

Starlink is a bunch of satellites launched by SpaceX, the plan is to place thousands of satellites in the LEO, it will sort of form a constellation, It will beam internet signals from satellites to the transceivers at Earth which will broadcast directly into your Starlink router. Starlink is available in Antarctica too. Starlink will provide a faster internet speed and low-latency broadband internet across the globe.

My power's really low, so this may be the last image I can send. Don't worry about me though: my time here has been both productive and serene. If I can keep talking to my mission team, I will - but I'll be signing off here soon. Thanks for staying with me".

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ASTROPHOTOGRAPHS BY SPACE



Milkyway Arm Captured by Mr. Ranjith Kumar, Senior Educator, SPACE.

Conjunction of Moon with Venus and Jupiter Captured by Mr. Yogesh, Asst. Education Incharge, SPACE.





Albert Einstein

Albert Einstein was born on 14 March in the year 1879 in Württemberg, Germany. He was educated at the Swiss Federal Institute of Technology in Zurich. Einstein was a theoretical physicist who discovered and invented major theories of Physics. Albert Einstein received honorary doctorate degrees in science and philosophy. His works were recognized across the world and in 1921, Einstein won the prestigious Nobel Prize for Physics significant work for his on the photoelectric effect. Some inventions and contributions of Einstein are Avogadro's Number, the Quantum Theory of Light, the General Theory of Relativity, the Special Theory of Relativity, The Photoelectric Effect, Wave-Particle Duality, Brownian movement, the relationship between mass and energy, Bose-Einstein Condensate, and many more.

Kalpana Chawla

Kalpana Chawla (17 March 1962 – 1 February 2003) was an Indian-born American astronaut and aerospace engineer who was the first woman of Indian origin to go to space. She first flew on Space Shuttle Columbia in 1997 as a mission specialist and primary robotic arm operator. Her second flight was on STS-107, the final flight of Columbia, in 2003. Chawla was one of the seven crew members who died in the Space Shuttle Columbia disaster when the spacecraft disintegrated during its re-entry into the Earth's atmosphere on 1 February 2003. Chawla was posthumously awarded the Congressional Space Medal of Honour, and several streets, universities, and institutions have been named in her honor.



HISTORICAL EVENTS HAPPENED IN MARCH



Pioneer 4 launched on March 3, 1959, by NASA was the last of five American lunar probes launched as part of a series during the International Geophysical Year. Its design was very similar to Pioneer 3, but a key difference was the addition of a monitor to measure the voltage of the main radio transmitter. A mechanism was on board to slow the spin-stabilized vehicle from its initial spin of 480 rpm down to 11 rpm about 11 hours after launch. Although it did not achieve its primary objective to photograph the Moon during a close flyby, **Pioneer 4 became the first U.S. spacecraft to reach Earth's escape velocity.**

In shorts

- Pioneer 4 was launched by the U.S. to photograph the Moon during a close flyby. It didn't achieve its goal but became the first U.S. spacecraft to reach Earth's escape velocity.
- Pioneer 4 passed the Moon at a range of about 37,000 miles (60,000 kilometers) instead of the planned 20,000 miles (32,000 kilometers).
- The spacecraft sent back excellent data about the Van Allen Belts.



Dr. James Van Allen looks at the cone-shaped Pioneer probe before it was plated with gold and painted with stripes to maintain temperature during flight. Image Credit: NASA/JPL

The spacecraft passed by the Moon at a range of about 37,000 miles (60,000 kilometers) instead of the planned 20,000 miles (32,000 kilometers). The closest approach to the Moon was at 10:24 UT on March 4, 1959, about 41 hours after launch. Pioneer 4's tiny radio transmitted information for 82 hours before contact was lost at a distance of about 407,000 miles (655,000 kilometers) from Earth-the greatest tracking distance for a human-made object to date. The probe eventually entered heliocentric orbit becoming the first American spacecraft to do so. Scientists received excellent data from the spacecraft that suggested the intensity of the upper belt of the Van Allen Belts had changed since Pioneer 3 (probably attributable to a recent solar flare) and that there might be a third belt at a higher altitude.

COMET SHOEMAKER-LEVY 9 DISCOVERED!

Comet Shoemaker-Levy 9 was discovered by Carolyn and Gene Shoemaker and David Levy in a photograph taken on Mar. 18, 1993, with the 0.4-meter Schmidt telescope at Mt. Palomar. The appearance was most unusual in that the comet appeared as a dense, linear bar about 1' long and oriented roughly east-west; no central condensation was observable, but a fainter, wispy 'tail' extended north of the bar and to the west.



Hubble image shows an impact site where one of the fragments of Comet Shoemaker-Levy 9 collided with Jupiter.Credits: NASA and H. Hammel, MIT

NASA had spacecraft in position to watch - for the first time in history - a collision between two bodies in the solar system. NASA's Galileo orbiter (then still en route to Jupiter) captured unprecedented direct views as the string of fragments smashed into Jupiter's cloud tops. The impacts started on July 16, 1994, and ended on July 22, 1994.

The "freight train" of fragments smashed into Jupiter with the force of 300 million bombs. atomic The fragments created huge plumes that were 1,200 to 1,900 miles (2,000 to 3,000 kilometers) high and heated the atmosphere to temperatures as hot as 53,000 to 71,000 degrees Fahrenheit (30,000 to 40,000 degrees Celsius). Shoemaker-Levy 9 left dark, ringed scars that were eventually erased by Jupiter's winds.

The collision also left dust floating on the top of Jupiter's clouds. By watching the dust spread across the planet, scientists were able to track highaltitude winds on Jupiter for the first time. When comet Shoemaker-Levy 9 was discovered in 1993, it already had been torn into more than 20 pieces traveling around Jupiter in a two-year orbit. Further observations revealed the comet (believed to be a single body at the time) had made a close approach to Jupiter in July 1992 and had been torn apart by tidal forces resulting from the planet's powerful gravity. The comet was thought to have been orbiting Jupiter for about a decade before its demise.

The disruption of a comet into multiple fragments was rare, and observing a captured comet in orbit about Jupiter was even more unusual, but the biggest and rarest revelation was that the fragments were going to smash into Jupiter.



This composite is assembled from separate images of Jupiter and comet Shoemaker-Levy 9, as imaged by the NASA/ESA Hubble Space Telescope in 1994. Credit: NASA



On March 25, 1655, Saturn 's largest moon Titan was discovered by astronomer and physicist Christiaan Huygens. Titan is considered the most Earth-like moon discovered so far and the second largest in the solar system. Titan is the largest moon of Saturn and the second-largest natural satellite in the Solar System. It is the only moon known to have a dense atmosphere and is the only known object in space other than Earth on which clear evidence of stable bodies of surface liquid has been found. Titan is one of the seven gravitationally rounded moons in orbit around Saturn and the second most distant from Saturn of those seven. Frequently described as a planet-like moon, Titan is 50% larger (in diameter) than Earth's Moon and 80% more massive. It is the second-largest moon in the Solar System after Jupiter's moon Ganymede and is larger than the planet Mercury, but only 40% as massive.



Titan was the first known moon of Saturn, and the sixth known planetary satellite (after Earth's moon and the four Galilean moons of Jupiter). Titan orbits Saturn at 20 Saturn radii. From Titan's surface, Saturn subtends an arc of 5.09 degrees, and if it were visible through the moon's thick atmosphere, it would appear 11.4 times larger in the sky, in diameter, than the Moon from Earth, which subtends 0.48° of arc.



Titan is primarily composed of ice and material, which is likely rocky differentiated into а rocky core surrounded by various layers of ice, including a crust of ice and а subsurface layer of ammonia-rich liquid water. Much as with Venus before the Space Age, the dense opaque atmosphere prevented understanding of Titan's surface until the Cassini-Huygens mission in 2004 provided new information, including the discovery of liquid hydrocarbon lakes in Titan's polar regions.

MARCH 2023

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

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