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1. Next Mars Rover Progresses Toward 2020 Launch

After an extensive review process and passing a major development milestone, NASA is ready to proceed with final design and construction of its next Mars rover, currently targeted to launch in summer of 2020 and arrive on the Red Planet in February 2021.

The Mars 2020 rover will investigate a region of Mars where the ancient environment may have been favorable for microbial life, probing the Martian rocks for evidence of past life. Throughout its investigation, it will collect samples of soil and rock, and cache them on the surface for potential return to Earth by a future mission.

"The Mars 2020 rover is the first step in a potential multi-mission campaign to return carefully selected and sealed samples of Martian rocks and soil to Earth," said Geoffrey Yoder, acting associate administrator of NASA's Science Mission Directorate in Washington. "This mission marks a significant milestone in NASA's Journey to Mars -- to determine whether life has ever existed on Mars, and to advance our goal of sending humans to the Red Planet."

To reduce risk and provide cost savings, the 2020 rover will look much like its six-wheeled, one-ton predecessor, Curiosity, but with an array of new science instruments and enhancements to explore Mars as never before. For example, the rover will conduct the first investigation into the usability and availability of Martian resources, including oxygen, in preparation for human missions.

Mars 2020 will carry an entirely new subsystem to collect and prepare Martian rocks and soil samples that includes a coring drill on its arm and a rack of sample tubes. About 30 of these sample tubes will be deposited at select locations for return on a potential future sample-retrieval mission. In laboratories on Earth, specimens from Mars could be analyzed for evidence of past life on Mars and possible health hazards for future human missions.
Two science instruments mounted on the rover’s robotic arm will be used to search for signs of past life and determine where to collect samples by analyzing the chemical, mineral, physical and organic characteristics of Martian rocks. On the rover’s mast, two science instruments will provide high-resolution imaging and three types of spectroscopy for characterizing rocks and soil from a distance, also helping to determine which rock targets to explore up close.

A suite of sensors on the mast and deck will monitor weather conditions and the dust environment, and a ground-penetrating radar will assess sub-surface geologic structure.

The Mars 2020 rover will use the same sky crane landing system as Curiosity, but will have the ability to land in more challenging terrain with two enhancements, making more rugged sites eligible as safe landing candidates.

"By adding what’s known as range trigger, we can specify where we want the parachute to open, not just at what velocity we want it to open," said Allen Chen, Mars 2020 entry, descent and landing lead at NASA’s Jet Propulsion Laboratory in Pasadena, California. "Thatshrinks our landing area by nearly half."

Terrain-relative navigation on the new rover will use onboard analysis of downward-looking images taken during descent, matching them to a map that indicates zones designated unsafe for landing.

"As it is descending, the spacecraft can tell whether it is headed for one of the unsafe zones and divert to safe ground nearby," said Chen. "With this capability, we can now consider landing areas with unsafe zones that previously would have disqualified the whole area. Also, we can land closer to a specific science destination, for less driving after landing."

There will be a suite of cameras and a microphone that will capture the never-before-seen or heard imagery and sounds of the entry, descent and landing sequence. Information from the descent cameras and microphone will provide valuable data to assist in planning future Mars landings, and make for thrilling video.

"Nobody has ever seen what a parachute looks like as it is opening in the Martian atmosphere," said JPL’s David Gruel, assistant flight system manager for the Mars 2020 mission. "So this will provide valuable engineering information."

Microphones have flown on previous missions to Mars, including NASA’s Phoenix Mars Lander in 2008, but never have actually been used on the surface of the Red Planet.

"This will be a great opportunity for the public to hear the sounds of Mars for the first time, and it could also provide useful engineering information," said Mars 2020 Deputy Project Manager Matt Wallace of JPL.

Once a mission receives preliminary approval, it must go through four rigorous technical and programmatic reviews - known as Key Decision Points (KDP) - to proceed through the phases of development prior to launch. Phase A involves concept and requirements definition, Phase B is preliminary design and technology development, Phase C is final design and fabrication, and Phase D is system assembly, testing and launch. Mars 2020 has just passed its KDP-C milestone.

"Since Mars 2020 is leveraging the design and some spare hardware from Curiosity, a significant amount of the mission’s heritage components have already been built during Phases A and B," said George Tahu, Mars 2020 program executive at NASA Headquarters in Washington. "With the KDP to enter Phase C completed, the project is proceeding with final design and construction of the new systems, as well as the rest of the heritage elements for the mission."

Source: JPL
2. Chandra Finds Evidence for Violent Stellar Merger

Gamma-ray bursts, or GRBs, are some of the most violent and energetic events in the universe.

Although these events are the most luminous explosions in the universe, a new study using NASA's Chandra X-ray Observatory, NASA's Swift satellite and other telescopes suggests that scientists may be missing a majority of these powerful cosmic detonations.

Astronomers think that some GRBs are the product of the collision and merger of two neutron stars or a neutron star and a black hole. The new research gives the best evidence to date that such collisions will generate a very narrow beam, or jet, of gamma rays. If such a narrow jet is not pointed toward Earth, the GRB produced by the collision will not be detected.

Collisions between two neutron stars or a neutron star and black hole are expected to be strong sources of gravitational waves that could be detected whether or not the jet is pointed towards the Earth. Therefore, this result has important implications for the number of events that will be detectable by the Laser Interferometry Gravitational-Wave Observatory (LIGO) and other gravitational wave observatories.
On September 3, 2014, NASA's Swift observatory picked up a GRB -- dubbed GRB 140903A due to the date it was detected. Scientists used optical observations with the Gemini Observatory telescope in Hawaii to determine that GRB 140903A was located in a galaxy about 3.9 billion light-years away, relatively nearby for a GRB.

The large panel in the accompanying graphic is an illustration showing the aftermath of a neutron star merger, including the generation of a GRB. In the center is a compact object -- either a black hole or a massive neutron star -- and in red is a disk of material left over from the merger, containing material falling towards the compact object. Energy from this infalling material drives the GRB jet shown in yellow. In orange is a wind of particles blowing away from the disk and in blue is material ejected from the compact object and expanding at very high speeds of about one tenth the speed of light.

The image on the left of the two smaller panels shows an optical view from the Discovery Channel Telescope (DCT) with GRB 140903A in the middle of the square and a close-up X-ray view from Chandra on the right. The bright star in the optical image is unrelated to the GRB.

The gamma-ray blast lasted less than two seconds. This placed it into the "short GRB" category, which astronomers think are the output from neutron star-neutron star or black hole-neutron star collisions eventually forming either a black hole or a neutron star with a strong magnetic field. (The scientific consensus is that GRBs that last longer than two seconds result from the collapse of a massive star.)

About three weeks after the Swift discovery of GRB 140903A, a team of researchers led by Eleonora Troja of the University of Maryland, College Park (UMD), observed the aftermath of the GRB in X-rays with Chandra. Chandra observations of how the X-ray emission from this GRB decreases over time provide important information about the properties of the jet.

Specifically, the researchers found that the jet is beamed into an angle of only about five degrees based on the X-ray observations, plus optical observations with the Gemini Observatory and the DCT and radio observations with the National Science Foundation's Karl G. Jansky Very Large Array. This is roughly equivalent to a circle with the diameter of your three middle fingers held at arm's length. This means that astronomers are detecting only about 0.4% of this type of GRB when it goes off, since in most cases the jet will not be pointed directly at us.

Previous studies by other astronomers had suggested that these mergers could produce narrow jets. However, the evidence in those cases was not as strong because the rapid decline in light was not observed at multiple wavelengths, allowing for explanations not involving jets.

Several pieces of evidence link this event to the merger of two neutron stars, or between a neutron star and black hole. These include the properties of the gamma-ray emission, the old age and the low rate of stars forming in the GRB's host galaxy and the lack of a bright supernova. In some previous cases strong evidence for this connection was not found.

New studies have suggested that such mergers could be the production site of elements heavier than iron, such as gold. Therefore, the rate of these events is also important to estimate the total amount of heavy elements produced by these mergers and compare it with the amounts observed in the Milky Way galaxy.

Source:  SpaceRef  

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3. Black Hole Makes Material Wobble Around It

The European Space Agency's orbiting X-ray observatory, XMM-Newton, has proved the existence of a "gravitational vortex" around a black hole. The discovery, aided by NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) mission, solves a mystery that has eluded astronomers for more than 30 years, and will allow them to map the behavior of matter very close to black holes. It could also open the door to future investigations of Albert Einstein's general relativity.

Matter falling into a black hole heats up as it plunges to its doom. Before it passes into the black hole and is lost from view forever, it can reach millions of degrees. At that temperature it shines X-rays into space.

In the 1980s, pioneering astronomers using early X-ray telescopes discovered that the X-rays coming from stellar-mass black holes in our galaxy flicker. The changes follow a set pattern. When the flickering begins, the dimming and re-brightening can take 10 seconds to complete. As the days, weeks and then months progress, the period shortens until the oscillation takes place 10 times every second. Then, the flickering suddenly stops altogether.

The phenomenon was dubbed the Quasi Periodic Oscillation (QPO). "It was immediately recognized to be something fascinating because it is coming from something very close to a black hole," said Adam Ingram, University of Amsterdam, the Netherlands, who began working to understand QPOs for his doctoral thesis in 2009.

During the 1990s, astronomers had begun to suspect that the QPOs were associated with a gravitational effect predicted by Einstein's general relativity: that a spinning object will create a kind of gravitational vortex.

"It is a bit like twisting a spoon in honey. Imagine that the honey is space and anything embedded in the honey will be "dragged" around by the twisting spoon," explained Ingram. "In reality, this means that anything orbiting a spinning object will have its motion affected." In the case of an inclined orbit, it will
"precess." This means that the whole orbit will change orientation around the central object. The time for the orbit to return to its initial condition is known as a precession cycle.

In 2004, NASA launched Gravity Probe B to measure this so-called Lense-Thirring effect around Earth. After painstaking analysis, scientists confirmed that the spacecraft would turn through a complete precession cycle once every 33 million years.

Around a black hole, however, the effect would be much more noticeable because of the stronger gravitational field. The precession cycle would take just a matter of seconds or less to complete. This is so close to the periods of the QPOs that astronomers began to suspect a link.

Ingram began working on the problem by looking at what happened in the flat disc of matter surrounding a black hole. Known as an accretion disc, it is the place where material gradually spirals inwards towards the black hole. Scientists had already suggested that, close to the black hole, the flat accretion disc puffs up into a hot plasma, in which electrons are stripped from their host atoms. Termed the hot inner flow, it shrinks in size over weeks and months as it is eaten by the black hole. Together with colleagues, Ingram published a paper in 2009 suggesting that the QPO is driven by the Lense-Thirring precession of this hot flow. This is because the smaller the inner flow becomes, the closer to the black hole it would approach and so the faster its Lense-Thirring precession cycle would be. The question was: how to prove it?

"We have spent a lot of time trying to find smoking gun evidence for this behavior," said Ingram.

The answer is that the inner flow is releasing high-energy radiation that strikes the matter in the surrounding accretion disc, making the iron atoms in the disc shine like a fluorescent light tube. The iron releases X-rays of a single wavelength -- referred to as "a spectral line."

Because the accretion disc is rotating, the iron line has its wavelength distorted by the Doppler effect. Line emission from the approaching side of the disc is squashed -- blue shifted -- and line emission from the receding disc material is stretched -- red shifted. If the inner flow really is precessing, it will sometimes shine on the approaching disc material and sometimes on the receding material, making the line wobble back and forth over the course of a precession cycle.

Seeing this wobbling is where XMM-Newton came in. Ingram and colleagues from Amsterdam, Cambridge Durham, Southampton and Tokyo applied for a long-duration observation that would allow them to watch the QPO repeatedly. They chose black hole H 1743-322, which was exhibiting a four-second QPO at the time. They watched it for 260,000 seconds with XMM-Newton. They also observed it for 70,000 seconds with NASA's NuSTAR X-ray observatory.

"The high-energy capability of NuSTAR was very important," Ingram said. "NuSTAR confirmed the wobbling of the iron line, and additionally saw a feature in the spectrum called a 'reflection hump' that added evidence for precession."

After a rigorous analysis process of adding all the observational data together, they saw that the iron line was wobbling in accordance with the predictions of general relativity. "We are directly measuring the motion of matter in a strong gravitational field near to a black hole," says Ingram.

This is the first time that the Lense-Thirring effect has been measured in a strong gravitational field. The technique will allow astronomers to map matter in the inner regions of accretion discs around black holes. It also hints at a powerful new tool with which to test general relativity.

Einstein's theory is largely untested in such strong gravitational fields. So if astronomers can understand the physics of the matter that is flowing into the black hole, they can use it to test the predictions of general relativity.
relativity as never before - but only if the movement of the matter in the accretion disc can be completely understood.

"If you can get to the bottom of the astrophysics, then you can really test the general relativity," says Ingram. A deviation from the predictions of general relativity would be welcomed by a lot of astronomers and physicists. It would be a concrete signal that a deeper theory of gravity exists.

Larger X-ray telescopes in the future could help in the search because they are more powerful and could more efficiently collect X-rays. This would allow astronomers to investigate the QPO phenomenon in more detail. But for now, astronomers can be content with having seen Einstein's gravity at play around a black hole.

"This is a major breakthrough since the study combines information about the timing and energy of X-ray photons to settle the 30-year debate around the origin of QPOs. The photon-collecting capability of XMM-Newton was instrumental in this work," said Norbert Schartel, ESA Project Scientist for XMM-Newton.

More information

The results reported in this article are published in the Monthly Notices of the Royal Astronomical Society.

The European Space Agency's X-ray Multi-Mirror Mission, XMM-Newton, was launched in December 1999. The largest scientific satellite to have been built in Europe, it is also one of the most sensitive X-ray observatories ever flown. More than 170 wafer-thin, cylindrical mirrors direct incoming radiation into three high-throughput X-ray telescopes. XMM-Newton's orbit takes it almost a third of the way to the moon, allowing for long, uninterrupted views of celestial objects.

NuSTAR is a Small Explorer mission led by Caltech in Pasadena and managed by NASA's Jet Propulsion Laboratory, also in Pasadena, for NASA's Science Mission Directorate in Washington.

For more information about NuSTAR, visit http://www.nasa.gov/nustar, http://www.nustar.caltech.edu

Source: JPL
The Night Sky

Friday, July 15

• Look south during and after twilight. The Moon, Saturn, and Antares form a roughly vertical stack there, as shown above. Mars blazes off to their right. Watch them all tilt westward until they set around 2 to 3 a.m.

Saturday, July 16

• Venus-Mercury conjunction challenge: About 15 minutes after sunset, use binoculars to look for Venus just above the west-northwest horizon — with fainter Mercury only ½° above it. Venus is currently magnitude –3.9, and Mercury is –1.0, so you may be able to detect at least Venus naked-eye once you locate them in binoculars. Good luck.

Sunday, July 17

• Right after dark, the bright waxing gibbous Moon stands over the top of the Sagittarius Teapot, which rests nearly level. Can you see it through the moonlight? Shield your eyes from the Moon itself. The Teapot is about the size of your fist at arm's length, with its handle to the left and its spout to the right.

Monday, July 18

• Arcturus shines as the brightest star high in the west these evenings, pale yellow-orange. The kite pattern of its constellation, Bootes, extends upper right from it. Off to Arcturus's right in the northwest glitters the Big Dipper.

Tuesday, July 19

• Full Moon (exact at 6:57 p.m. EDT). The Moon rises around sunset. As the Moon climbs higher and the stars come out, look for Altair high to its upper left.

Source: Sky & Telescope

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ISS Sighting Opportunities

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Sighting information for other cities can be found at NASA’s Satellite Sighting Information

NASA-TV Highlights
(all times Eastern Daylight Time)

- **8 p.m., Friday, July 15** - Replay of Building the Next Rover to the Red Planet (all channels)
- **8 a.m., 10 p.m., Saturday, July 16** - Replay of Building the Next Rover to the Red Planet (all channels)
- **2 p.m., 4 p.m. (replay), 8 p.m., Saturday, July 16** - SpaceX CRS-9 Mission Managers Pre-Launch Briefing (all channels)
- **5:30 p.m., Saturday, July 16** - Coverage of the Launch of the ISS Progress 64 Cargo Craft (launch scheduled at 5:41 p.m. EDT) (all channels)
- **8 a.m., 10 p.m., Sunday, July 17** - Replay of the SpaceX CRS-9 Mission Managers Pre-Launch Briefing (all channels)
- **1 p.m., Sunday, July 17** - Replay of Building the Next Rover to the Red Planet (all channels)
- **3 p.m., Sunday, July 17** - SpaceX/Dragon CRS-9 “What’s On Board” Science Briefing (all channels)
- **5 p.m., 8 p.m., Sunday, July 17** - Replay of the SpaceX/Dragon CRS-9 “What’s On Board” Science Briefing (all channels)
- **11:30 p.m., Sunday, July 17** - Coverage of the Launch of the SpaceX/Dragon CRS-9 Cargo Flight to the ISS (launch scheduled at 12:44 a.m. EDT on Monday, July 18) (NTV-1 (Public), NTV-3 (Media))
- **2 a.m., 8 a.m. (replay) Monday, July 18** - SpaceX/Dragon CRS-9 Post-Launch News Conference (NTV-1 (Public), NTV-3 (Media))
- **7:30 p.m., Monday, July 18** - Docking of the ISS Progress 64 Cargo Craft to the ISS (docking scheduled at 8:22 p.m. ET) (Starts at 7:45 p.m.) (NTV-1 (Public), NTV-3 (Media))
- **8 a.m., Tuesday, July 19** - ISS Expedition 48 In-Flight Event for JAXA and Japanese Media with Flight Engineer Takuya Onishi (NTV-1 (Public), NTV-3 (Media))
- **2 p.m., Tuesday, July 19** - Live Coverage of “Viking at 40 Symposium NASA’s First Soft Landing to Humans on Mars” - Viking Program History Panel (NTV-1 (Public))

Watch NASA TV on the Net by going to the NASA website.  

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Space Calendar

- **Jul 15** - Comet 279P/La Sagra Perihelion (2.159 AU)
- **Jul 15** - Comet 103P/Hartley Closest Approach To Earth (2.232 AU)
- **Jul 15** - Apollo Asteroid 1566 Icarus Closest Approach To Earth (0.655 AU)
- **Jul 15** - 55th Anniversary (1961), Comet 147P/Kushida-Muramatsu Leaves Jupiter Orbit
- **Jul 15** - Donna Shirley's 75th Birthday (1941)
- **Jul 15 -** Progress MS-3 Soyuz U Launch (International Space Station 64P)
- **Jul 15** - Mercury Passes 0.5 Degrees From Venus
- **Jul 15** - Comet 47P/Ashbrook-Jackson Closest Approach To Earth (2.376 AU)
- **Jul 15** - Comet 69P/Taylor At Opposition (4.115 AU)
- **Jul 16** - Amor Asteroid 2016 NK33 Near-Earth Flyby (0.029 AU)
- **Jul 16** - Apollo Asteroid 2009 BD Closest Approach To Earth (0.442 AU)
- **Jul 16** - Asteroid 12426 Racquetball Closest Approach To Earth (1.381 AU)
- **Jul 16** - Asteroid 6042 Chesirecat Closest Approach To Earth (1.520 AU)
- **Jul 16** - Asteroid 84225 Verish Closest Approach To Earth (1.696 AU)
- **Jul 16** - Asteroid 7645 Pons Closest Approach To Earth (1.724 AU)
- **Jul 16** - Asteroid 63163 Jerusalem Closest Approach To Earth (1.729 AU)
- **Jul 16** - Amor Asteroid 153591 (2001 SN263) (2 Moons) Closest Approach To Earth (1.972 AU)
- **Jul 16** - 5th Anniversary (2011), Dawn, Asteroid Vesta Orbit Insertion
- **Jul 16** - Giuseppe Piazzi's 270th Birthday (1746)
- **Jul 17** - Cassini, Orbital Trim Maneuver #453 (OTM-453)
- **Jul 17** - Asteroid 5050 Doctorwatson Closest Approach To Earth (1.457 AU)
- **Jul 17** - 5th Anniversary (2011), Artemis P2, Moon Orbit Insertion
- **Jul 18** - Dragon CRS-9/IDA 2 Falcon 9 Launch (International Space Station)
- **Jul 18** - Comet P/2005 W4 (SOHO) Closest Approach To Earth (0.739 AU)
- **Jul 18** - Comet 56P/Slaughter-Burnham Perihelion (2.508 AU)
- **Jul 18** - Comet P/2010 D1 (WISE) Closest Approach To Earth (2.928 AU)
- **Jul 18** - Comet P/2011 W2 (Rinner) At Opposition (4.045 AU)
- **Jul 18** - Amor Asteroid 2016 MK Near-Earth Flyby (0.044 AU)
- **Jul 18** - Asteroid 184011 Andypuckett Closest Approach To Earth (1.280 AU)
- **Jul 18** - Asteroid 67085 Oppenheimer Closest Approach To Earth (1.668 AU)
- **Jul 18** - Asteroid 2597 Arthur Closest Approach To Earth (2.023 AU)
- **Jul 18** - Asteroid 1655 Comas Sola Closest Approach To Earth (2.220 AU)
- **Jul 18** - Asteroid 671 Carnegia Closest Approach To Earth (2.276 AU)
- **Jul 18** - 5th Anniversary (2011), Tissint Meteorite Fall in Morocco (Mars Meteorite)
- **Jul 18** - 50th Anniversary (1966), Gemini 10 Launch (John Young & Michael Collins)
- **Jul 18** - John Glenn's 95th Birthday (1921)
- **Jul 19** - Comet 73P-AW/Schwassmann-Wachmann Perihelion (1.024 AU)
- **Jul 19** - Asteroid 7169 Linda Closest Approach To Earth (0.847 AU)
- **Jul 19** - Asteroid 3192 A’Heam Closest Approach To Earth (1.697 AU)
- **Jul 19** - Asteroid 2266 Tchaikovsky Closest Approach To Earth (2.845 AU)
- **Jul 19** - Edward Pickering's 170th Birthday (1846)

Source: JPL Space Calendar
Astronomers announced this week the sharpest results yet on the properties of dark energy. Hundreds of scientists, among them Marcos Pellejero Ibáñez and Jose Alberto Rubiño from the Instituto de Astrofísica de Canarias (IAC), and other Spanish institutions as the Instituto de Ciencias del Cosmos from the University of Barcelona (ICCUB) and the Instituto de Física Teórica (UAM-CSIC) from the Sloan Digital Sky Survey III (SDSS-III), collaborated to make the largest-ever, three-dimensional map of distant galaxies. The scientists then used this map to make one of the most precise measurements yet of the dark energy currently driving the accelerated expansion of the Universe.

"We have spent a decade collecting measurements of 1.2 million galaxies over one quarter of the sky to map out the structure of the Universe over a volume of 650 cubic billion light years," says Dr. Jeremy Tinker of New York University, a co-leader of the scientific team that led this effort. "This map has allowed us to make the best measurements yet of the effects of dark energy in the expansion of the Universe. We are making our results and map available to the world."

These new measurements were carried out by the Baryon Oscillation Spectroscopic Survey (BOSS) program of SDSS-III. Shaped by a continuous tug-of-war between dark matter and dark energy, the map revealed by BOSS allows astronomers to measure the expansion rate of the Universe and thus determine the amount of matter and dark energy that make up the present-day Universe. A collection of papers describing these results was submitted this week to the Monthly Notices of the Royal Astronomical Society.

BOSS measures the expansion rate of the Universe by determining the size of the baryonic acoustic oscillations (BAO) in the three-dimensional distribution of galaxies. The original BAO size is determined by pressure waves that travelled through the young Universe up to when it was only 400,000 years old (the Universe is presently 13.8 billion years old), at which point they became frozen in the matter distribution of the Universe. The end result is that galaxies are preferentially separated by a characteristic distance, that astronomers call the acoustic scale. The size of the acoustic scale at 13.4 billion years ago has been exquisitely determined from observations of the cosmic microwave background from the light emitted when the pressure waves became frozen. Measuring the distribution of galaxies since that time allows astronomers to measure how dark matter and dark energy have competed to govern the rate of expansion of the Universe.
To measure the size of these ancient giant waves to such sharp precision, BOSS had to make an unprecedented and ambitious galaxy map, many times larger than previous surveys. At the time the BOSS program was planned, dark energy had been previously determined to significantly influence the expansion of the Universe starting about 5 billion years ago. BOSS was thus designed to measure the BAO feature from before this point (7 billion years ago) out to near the present day (2 billion years ago).

The map also reveals the distinctive signature of the coherent movement of galaxies toward regions of the Universe with more matter, due to the attractive force of gravity. Crucially, the observed amount of infall is explained well by the predictions of general relativity. This agreement supports the idea that the acceleration of the expansion rate is driven by a phenomenon at the largest cosmic scales, such as dark energy, rather than a breakdown of our gravitational theory.

**New methodology**

Marcos Pellejero Ibañez, doctoral student at the IAC, and José Alberto Rubiño, researcher at the same center, along with Chia-Hsun Chuang, from the Leibniz Institute for Astrophysics, have devised a new method for extracting cosmological BOSS data. Considering the cosmic microwave background and three-dimensional map of galaxies from BOSS to infer the cosmological parameters with minimal assumptions about dark energy, tested different models of the dark energy and confirmed that the used in the last 18 years, based on Einstein's cosmological constant, fits naturally.

"While it is computationally complex, we have shown that it is possible to do a thorough analysis combining these two cosmological observations and using increasingly complex evolutionary models of the Universe", explains Pellejero. Rubiño also adds that "the combination of these two sets of exceptional data (the Planck satellite and BOSS) has also enabled us to establish the best cosmological bounds about the sum of the masses of the three families of neutrinos and their relative contribution to the overall density of matter".

Source: [EurekAlert](https://www.eurekalert.org)
Explanation: Moving from top to bottom in the frame near the center of this sharply detailed color composite, thin, bright, braided filaments are actually long ripples in a cosmic sheet of glowing gas seen almost edge-on. The shock wave plows through interstellar space at over 500,000 kilometers per hour. Cataloged as NGC 2736, its elongated appearance suggests its popular name, the Pencil Nebula. The Pencil Nebula is about 5 light-years long and 800 light-years away, but represents only a small part of the Vela supernova remnant. The Vela remnant itself is around 100 light-years in diameter, the expanding debris cloud of a star that was seen to explode about 11,000 years ago. Initially, the shock wave was moving at millions of kilometers per hour but has slowed considerably, sweeping up surrounding interstellar material. In the narrowband, wide field image, red and blue-green colors track the characteristic glow of ionized hydrogen and oxygen atoms.

Source: Astronomy Picture of the Day