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1. GRAVITY Instrument Breaks New Ground in Exoplanet Imaging

The GRAVITY instrument on ESO's Very Large Telescope Interferometer (VLTI) has made the first direct observation of an exoplanet using optical interferometry.

This method revealed a complex exoplanetary atmosphere with clouds of iron and silicates swirling in a planet-wide storm. The technique presents unique possibilities for characterising many of the exoplanets known today.

This result was announced today in a letter in the journal Astronomy and Astrophysics by the GRAVITY Collaboration [1], in which they present observations of the exoplanet HR8799e using optical interferometry. The exoplanet was discovered in 2010 orbiting the young main-sequence star HR8799, which lies around 129 light-years from Earth in the constellation of Pegasus.

Today's result, which reveals new characteristics of HR8799e, required an instrument with very high resolution and sensitivity. GRAVITY can use ESO's VLT's four unit telescopes to work together to mimic a single larger telescope using a technique known as interferometry [2]. This creates a super-telescope -- the VLTI -- that collects and precisely disentangles the light from HR8799e's atmosphere and the light from its parent star [3].

HR8799e is a 'super-Jupiter', a world unlike any found in our Solar System, that is both more massive and much younger than any planet orbiting the Sun. At only 30 million years old, this baby exoplanet is young enough to give scientists a window onto the formation of planets and planetary systems. The exoplanet is
thoroughly inhospitable -- leftover energy from its formation and a powerful greenhouse effect heat HR8799e to a hostile temperature of roughly 1000 °C.

This is the first time that optical interferometry has been used to reveal details of an exoplanet, and the new technique furnished an exquisitely detailed spectrum of unprecedented quality -- ten times more detailed than earlier observations. The team's measurements were able to reveal the composition of HR8799e's atmosphere -- which contained some surprises.

"Our analysis showed that HR8799e has an atmosphere containing far more carbon monoxide than methane -- something not expected from equilibrium chemistry," explains team leader Sylvestre Lacour researcher CNRS at the Observatoire de Paris - PSL and the Max Planck Institute for Extraterrestrial Physics. "We can best explain this surprising result with high vertical winds within the atmosphere preventing the carbon monoxide from reacting with hydrogen to form methane."

The team found that the atmosphere also contains clouds of iron and silicate dust. When combined with the excess of carbon monoxide, this suggests that HR8799e's atmosphere is engaged in an enormous and violent storm.

"Our observations suggest a ball of gas illuminated from the interior, with rays of warm light swirling through stormy patches of dark clouds," elaborates Lacour. "Convection moves around the clouds of silicate and iron particles, which disaggregate and rain down into the interior. This paints a picture of a dynamic atmosphere of a giant exoplanet at birth, undergoing complex physical and chemical processes."

This result builds on GRAVITY's string of impressive discoveries, which have included breakthroughs such as last year's observation of gas swirling at 30% of the speed of light just outside the event horizon of the massive Black Hole in the Galactic Centre. It also adds a new way of observing exoplanets to the already extensive arsenal of methods available to ESO's telescopes and instruments -- paving the way to many more impressive discoveries [4].

Notes

[1] GRAVITY was developed by a collaboration consisting of the Max Planck Institute for Extraterrestrial Physics (Germany), LESIA of Paris Observatory-PSL / CNRS / Sorbonne Université / Univ. Paris Diderot and IPAG of Université Grenoble Alpes / CNRS (France), the Max Planck Institute for Astronomy (Germany), the University of Cologne (Germany), the CENTRA-Centro de Astrofísica e Gravitação (Portugal) and ESO.

[2] Interferometry is a technique that allows astronomers to create a super-telescope by combining several smaller telescopes. ESO's VLTI is an interferometric telescope created by combining two or more of the Unit Telescopes (UTs) of the Very Large Telescope or all four of the smaller Auxiliary Telescopes. While each UT has an impressive 8.2-m primary mirror, combining them creates a telescope with 25 times more resolving power than a single UT observing in isolation.

[3] Exoplanets can be observed using many different methods. Some are indirect, such as the radial velocity method used by ESO's exoplanet-hunting HARPS instrument, which measures the pull a planet's gravity has on its parent star. Direct methods, like the technique pioneered for this result, involve observing the planet itself instead of its effect on its parent star.

[4] Recent exoplanet discoveries made using ESO telescopes include last year's successful detection of a super-Earth orbiting Barnard's Star, the closest single star to our Sun, and ALMA's discovery of young planets orbiting an infant star, which used another novel technique for planet detection.

Source:  Spaceref.com
Since the Wright brothers first took to the skies of Kill Devil Hills, North Carolina, Dec. 17, 1903, first flights have been important milestones in the life of any vehicle designed for air travel. After all, it's one thing to design an aircraft and make it fly on paper — or computer. It is quite another to put all the pieces together and watch them get off the ground.

In late January 2019, all the pieces making up the flight model (actual vehicle going to the Red Planet) of NASA's Mars Helicopter were put to the test.

Weighing in at no more than 4 pounds (1.8 kilograms), the helicopter is a technology demonstration project currently going through the rigorous verification process certifying it for Mars.

The majority of the testing the flight model is going through had to do with demonstrating how it can operate on Mars, including how it performs at Mars-like temperatures. Can the helicopter survive — and function — in cold temperatures, including nights with temperatures as low as minus 130 degrees Fahrenheit (minus 90 degrees Celsius)?

All this testing is geared towards February 2021, when the helicopter will reach the surface of the Red Planet, firmly nestled under the belly of the Mars 2020 rover. A few months later, it will be deployed and test flights (up to 90 seconds long) will begin — the first from the surface of another world.

"Gearing up for that first flight on Mars, we have logged over 75 minutes of flying time with an engineering model, which was a close approximation of our helicopter," said MiMi Aung, project manager for the Mars Helicopter at NASA's Jet Propulsion Laboratory in Pasadena, California. "But this recent test of the flight model was the real deal. This is our helicopter bound for Mars. We needed to see that it worked as advertised."

While flying helicopters is commonplace here on Earth, flying hundreds of millions of miles (kilometers) away in the thin Martian atmosphere is something else entirely. And creating the right conditions for testing here on Earth presents its own set of challenges.

"The Martian atmosphere is only about one percent the density of Earth's," said Aung. "Our test flights could have similar atmospheric density here on Earth — if you put your airfield 100,000 feet (30,480 meters) up. So you can't go somewhere and find that. You have to make it."
Aung and her Mars Helicopter team did just that in JPL's Space Simulator, a 25-foot-wide (7.62-meter-wide) vacuum chamber. First, the team created a vacuum that sucks out all the nitrogen, oxygen and other gases from the air inside the mammoth cylinder. In their place the team injected carbon dioxide, the chief ingredient of Mars' atmosphere.

"Getting our helicopter into an extremely thin atmosphere is only part of the challenge," said Teddy Tzanetos, test conductor for the Mars Helicopter at JPL. "To truly simulate flying on Mars we have to take away two-thirds of Earth's gravity, because Mars' gravity is that much weaker."

The team accomplished this with a gravity offload system — a motorized lanyard attached to the top of the helicopter to provide an uninterrupted tug equivalent to two-thirds of Earth's gravity. While the team was understandably concerned with how the helicopter would fare on its first flight, they were equally concerned with how the gravity offload system would perform.

"The gravity offload system performed perfectly, just like our helicopter," said Tzanetos. "We only required a 2-inch (5-centimeter) hover to obtain all the data sets needed to confirm that our Mars helicopter flies autonomously as designed in a thin Mars-like atmosphere; there was no need to go higher. It was a heck of a first flight."

The Mars Helicopter's first flight was followed up by a second in the vacuum chamber the following day. Logging a grand total of one minute of flight time at an altitude of 2 inches (5 centimeters), more than 1,500 individual pieces of carbon fiber, flight-grade aluminum, silicon, copper, foil and foam have proven that they can work together as a cohesive unit.

"The next time we fly, we fly on Mars," said Aung. "Watching our helicopter go through its paces in the chamber, I couldn't help but think about the historic vehicles that have been in there in the past. The chamber hosted missions from the Ranger Moon probes to the Voyagers to Cassini, and every Mars rover ever flown. To see our helicopter in there reminded me we are on our way to making a little chunk of space history as well."

The Mars Helicopter project at JPL in Pasadena, California, manages the helicopter development for the Science Mission Directorate at NASA Headquarters in Washington.

The Mars Helicopter will launch as a technology demonstrator with the Mars 2020 rover on a United Launch Alliance Atlas V rocket in July 2020 from Space Launch Complex 41 at Cape Canaveral Air Force Station, Florida. It is expected to reach Mars in February 2021.

The 2020 rover will conduct geological assessments of its landing site on Mars, determine the habitability of the environment, search for signs of ancient Martian life, and assess natural resources and hazards for future human explorers. Scientists will use the instruments aboard the rover to identify and collect samples of rock and soil, encase them in sealed tubes, and leave them on the planet's surface for potential return to Earth on a future Mars mission.

The Mars 2020 project at JPL in Pasadena, California, manages rover development for the Science Mission Directorate at NASA Headquarters. NASA's Launch Services Program, based at the agency's Kennedy Space Center in Florida, is responsible for launch management.

For more information about NASA's Mars missions, go to https://www.nasa.gov/mars

Source: NASA
After drawing both praise and skepticism, the team of astronomers who discovered NGC 1052-DF2 - the very first known galaxy to contain little to no dark matter - are back with stronger evidence about its bizarre nature.

Dark matter is a mysterious, invisible substance that typically dominates the makeup of galaxies; finding an object that’s missing dark matter is unprecedented, and came as a complete surprise.

"If there's one object, you always have a little voice in the back of your mind saying, 'but what if you're wrong?' Even though we did all the checks we could think of, we were worried that nature had thrown us for a loop and had conspired to make something look really special whereas it was really something more mundane," said team leader Pieter van Dokkum, Sol Goldman Family Professor of Astronomy at Yale University.

Now, van Dokkum's team has not one, but two, new studies supporting their initial observations, demonstrating that dark matter is in fact separable from galaxies.

Team members include Roberto Abraham, Professor of Astronomy and Astrophysics at the University of Toronto, Aaron Romanowsky, Associate Professor of Physics and Astronomy at San Jose State University, Charlie Conroy, Professor of Astronomy at Harvard University, and Shany Danieli, a graduate student at Yale University.

"The fact that we're seeing something that's just completely new is what's so fascinating," said Danieli, who first spotted the galaxy about two years ago. "No one knew that such galaxies existed, and the best thing in the world for an astronomy student is to discover an object, whether it's a planet, a star, or a galaxy, that no one knew about or even thought about."
In the first study, the team confirmed their initial observations of NGC 1052-DF2, or DF2 for short, which show dark matter is practically absent in the galaxy. Using W. M. Keck Observatory's Keck Cosmic Web Imager (KCWI), they gathered more precise measurements and found that the globular clusters inside the galaxy are indeed moving at a speed consistent with the mass of the galaxy's normal matter. If there were dark matter in DF2, the clusters would be moving much faster.

"KCWI is unique because of the combination of its large survey area," said lead author Danieli. "The instrument not only allows us to see the whole galaxy at once, its high spectral resolution also enables us to measure the mass accurately. There is no other instrument in the world that has those two properties!"

In the second study, the team used Keck Observatory's Low Resolution Imaging Spectrometer (LRIS) to find another galaxy devoid of dark matter, named NGC 1052-DF4, or DF4 for short.

"Discovering a second galaxy with very little to no dark matter is just as exciting as the initial discovery of DF2," said van Dokkum, who is the lead author on the DF4 paper. "This means the chances of finding more of these galaxies are now higher than we previously thought. Since we have no good ideas for how these galaxies were formed, I hope these discoveries will encourage more scientists to work on this puzzle."

The team's results are published in The Astrophysical Journal Letters; the first study appears in today's issue, while the second study appears in the March 20th issue.

Like DF2, DF4 belongs to a relatively new class of galaxies called ultra-diffuse galaxies (UDGs). They are as large as the Milky Way but have between 100 to 1000 times fewer stars, making them appear fluffy and translucent, therefore difficult to observe.

Ironically, the lack of dark matter in these UDGs strengthens the dark matter theory. It proves that dark matter is a substance that is not coupled to 'normal' matter, as both can be found separately. The discovery of these galaxies is difficult to explain in theories that change the laws of gravity on large scales as an alternative to the dark matter hypothesis.

This shocking discovery drew some criticism when the team first announced their results in March of 2018.

"It was a little stressful at times," said van Dokkum. "On one hand, this is how the scientific process is supposed to work; you see something interesting, other people disagree, you obtain new data, and in the end you learn more about the universe. On the other hand, although the majority of the critiques were constructive and polite, not all of them were. Every time a new critique came out we had to scramble and figure out if we had missed something."

Van Dokkum says he's proud of his team for pulling together in those tough moments. Their hard work has paid off, with the universe cooperating and giving more reason to look for other UDGs like DF2 and DF4.

Danieli is leading a wide area survey with the Dragonfly Telephoto Array (DTA) to look for more examples in a systematic way, then observe candidates again using the Keck telescopes.

"We hope to next find out how common these galaxies are and whether they exist in other areas of the universe," said Danieli. "We want to find more evidence that will help us understand how the properties of these galaxies work with our current theories. Our hope is that this will take us one step further in understanding one of the biggest mysteries in our universe – the nature of dark matter."

Source: Phys.org
The Night Sky

Friday, March 29

• In the western sky after dusk, orange Mars is passing just 3° from the delicate, blue-white Pleiades cluster this evening through Sunday evening.

Saturday, March 30

• Castor and Pollux shine together very high in the south after dark, very far upper left of Mars and Aldebaran. Pollux is slightly the brighter of these Gemini "twins."

Draw a line from Castor through Pollux, follow it farther lower left by a big 26° (about 2½ fist-widths at arm's length), and you're at the dim head of Hydra, the Sea Serpent. In a dark sky it's a subtle but distinctive star grouping, about the size of your thumb at arm's length. Binoculars show it easily through light pollution.

Continue the line farther by a fist and a half and you hit Alphard, Hydra's 2nd-magnitude orange heart.

Another way to find the head of Hydra: It's almost midway from Procyon to Regulus.

Sunday, March 31

• High above the Big Dipper late these evenings, nearly crossing the zenith, are three pairs of dim naked-eye stars, all 3rd or 4th magnitude, marking the Great Bear's feet. They're also known as the Three Leaps of the Gazelle, from early Arab lore. They form a long line roughly midway between the bowl of the Big Dipper and the Sickle of Leo; see the evening constellation chart in the center of the April Sky & Telescope.

According to Arab lore, the gazelle was drinking at a pond — the big, dim Coma Berenices star cluster — and bounded away when startled by a flick of Leo's nearby tail, Denebola. Leo, however, seems quite unaware, facing the other way.

• A dawn challenge: About 30 minutes before sunrise Monday morning, scan just above the east-southeast horizon for the thin crescent Moon to the right of Venus. Bring binoculars if you have them.

Monday, April 1

• The huge, bright Winter Hexagon is still in view just after dark, filling the sky to the southwest and west. Start with brilliant Sirius in the southwest, the Hexagon's lower left corner. High above Sirius is Procyon. From there look even higher for Pollux and Castor, rightward from Castor to Menkalinan and bright Capella, lower left from there to Aldebaran, lower left to Rigel at the bottom of Orion, and back to Sirius.

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

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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)

Friday, March 29

TBD, Coverage of ISS Expedition 59 U.S. Spacewalk # 53 (spacewalk begins at TBD; will last appx. 6 ½ - 7 hours; spacewalkers are TBD) (all channels)

Watch NASA TV on the Net by going to the [NASA website](#).
Space Calendar

- Mar 29 - Moon Occults Saturn
- Mar 29 - Moon Occults Dwarf Planet Pluto
- Mar 29 - Comet 138P/Shoemaker-Levy Closest Approach To Earth (2.693 AU)
- Mar 29 - Apollo Asteroid 2019 FW Near-Earth Flyby (0.021 AU)
- Mar 29 - Amor Asteroid 7480 Norwan Closest Approach To Earth (1.071 AU)
- Mar 29 - Asteroid 4825 Ventura Closest Approach To Earth (1.629 AU)
- Mar 29 - Amor Asteroid 3988 Huma Closest Approach To Earth (1.756 AU)
- Mar 29 - Amor Asteroid 4954 Eric Closest Approach To Earth (1.918 AU)
- Mar 29 - Amor Asteroid 2202 Pele Closest Approach To Earth (2.340 AU)
- Mar 29 - Seminar: Black Holes as Blobs on a Black Brane, Barcelona, Spain
- Mar 29 - 45th Anniversary (1974), Mariner 10, 1st Mercury Flyby
- Mar 29-30 - 35th Jim Isenberg Pacific Coast Gravity Meeting, Logan, Utah
- Mar 30 - Earth Hour
- Mar 30 - Comet 169P/NEAT At Opposition (2.529 AU)
- Mar 30 - Comet 193P/LI NEAR-NEAT At Opposition (3.695 AU)
- Mar 30 - Asteroid 7175 Janegoodall Closest Approach To Earth (1.945 AU)
- Mar 30 - Institute of Physics (IOP) Ireland Spring Meeting: A Climage of Change, Westmeath, Ireland
- Mar 30 - Jean-Francois Pilatre de Rozier’s 265th Birthday (1754)
- Mar 31 - European Summer Time - Set Clock Ahead 1 Hour (European Union)
- Mar 31 - Moon Occults Asteroid 21 Lutetia
- Mar 31 - Asteroid 211 Isolda Occults HIP 54910 (6.8 Magnitude Star)
- Mar 31 - Apollo Asteroid 163081 (2002 AG29) Near-Earth Flyby (0.099 AU)
- Mar 31 - Asteroid 46610 Besixdouz Closest Approach To Earth (1.665 AU)
- Mar 31 - Asteroid 11881 Mirstation Closest Approach To Earth (2.036 AU)
- Apr 01 - EMISAT/ Lemur-2/ BlueWalker 1/ M6P/ Danu Pathfinder PSLV Launch
- Apr 01 - Tianlian-2 01 CZ-3B/G2 Launch
- Apr 01 - Comet P/2018 A5 (PANSTARRS) At Opposition (3.671 AU)
- Apr 01 - Asteroid 3 Juno Occults TYC 0707-00569-1 (11.7 Magnitude Star)
- Apr 01 - Aten Asteroid 2014 FK38 Near-Earth Flyby (0.059 AU)
- Apr 01 - Asteroid 6735 Madhatter Closest Approach To Earth (1.235 AU)
- Apr 01 - Aten Asteroid 326290 Akhenaten Closest Approach To Earth (1.298 AU)
- Apr 01 - Asteroid 2866 Hardy Closest Approach To Earth (2.432 AU)
- Apr 01 - Asteroid 2041 Lancelot Closest Approach To Earth (2.621 AU)
- Apr 01 - Binary Jupiter Trojan 617 Patroclus At Opposition (4.928 AU)
- Apr 01 - Centaur Object 31824 Elatus At Opposition (15.293 AU)

Source: JPL Space Calendar
Food for Thought

The Voyage to Interstellar Space

By all means, Voyager 1 and Voyager 2 shouldn't even be here. Now in interstellar space, they are pushing the limits of spacecraft and exploration, journeying through the cosmic neighborhood, giving us our first direct look into the space beyond our star.

But when they launched in 1977, Voyager 1 and Voyager 2 had a different mission: to explore the outer solar system and gather observations directly at the source, from outer planets we had only seen with remote studies. But now, four decades after launch, they've journeyed farther than any other spacecraft from Earth; into the cold, quiet world of interstellar space.

Originally designed to measure the properties of the giant planets, the instruments on both spacecraft have spent the past few decades painting a picture of the propagation of solar events from our Sun. And the Voyagers' new mission focuses not only on effects on space from within our heliosphere — the giant bubble around the Sun filled up by the constant outflow of solar particles called the solar wind — but from outside of it. Though they once helped us look closer at the planets and their relationship to the Sun, they now give us clues about the nature of interstellar space as the spacecraft continue their journey.

The environment they explore is colder, subtler and more tenuous than ever before, and yet the Voyagers continue on, exploring and measuring the interstellar medium, a smorgasbord of gas, plasma and particles from stars and gas regions not originating from our system. Three of the spacecraft's 10 instruments are the major players that study how space inside the heliosphere differs from interstellar space. Looking at this data together allows scientist to piece together our best-yet picture of the edge of the heliosphere and the interstellar medium. Here are the stories they tell.

The Magnetometer

On the Sun Spot, we have been exploring the various instruments on Voyager 2 one at a time, and analyzing how scientists read the individual sets of data sent to Earth from the far-reaching spacecraft. But one instrument we have not yet talked about is Voyager 2's Magnetometer, or MAG for short.

During the Voyagers' first planetary mission, the MAG was designed to investigate the magnetospheres of planets and their moons, determining the physical mechanics and processes of the interactions of those magnetic fields and the solar wind. After that mission ended, the Voyager spacecraft studied the magnetic
field of the heliosphere and beyond, observing the magnetic reach of the Sun and the changes that occur within that reach during solar activity.

Getting the magnetic data as we travel further into space requires an interesting trick. Voyager spins itself around, in a calibration maneuver that allows Voyager to differentiate between the spacecraft's own magnetic field — that goes along for the ride as it spins — and the magnetic fields of the space it's traveling through.

The initial peek into the magnetic field beyond the Sun's influence happened when Voyager 1 crossed the heliopause in 2012. Scientists saw that within the heliosphere, the strength of the magnetic field was quite variable, changing and jumping as Voyager 1 moved through the heliosphere. These changes are due to solar activity. But once Voyager 1 crossed into interstellar space, that variability was silenced. Although the strength of the field was similar to what it was inside the heliosphere, it no longer had the variability associated with the Sun's outbursts.

This graph shows the magnitude, or the strength, of the magnetic field around the heliopause from January 2012 out to May 2014. Before encountering the heliopause, marked by the orange line, the magnetic strength fluctuates quite a bit. After a bumpy ride through the heliopause in 2012, the magnetic strength stops fluctuating and begins to stabilize in 2013, once the spacecraft is far enough out into the interstellar medium.

In November 2018, Voyager 2 also crossed the heliopause and similarly experienced quite the bumpy ride out of the heliopause. Scientists are excited to see how its journey differs from its twin spacecraft.

Scientists are still working through the MAG data from Voyager 2, and are excited to see how Voyager 2's journey differed from Voyager 1.

The Cosmic Ray Subsystem
Much like the MAG, the Cosmic Ray Subsystem — called CRS — was originally designed to measure planetary systems. The CRS focused on the compositions of energetic particles in the magnetospheres of Jupiter, Saturn, Uranus and Neptune. Scientists used it to study the charged particles within the solar system and their distribution between the planets. Since it passed the planets, however, the CRS has been studying the heliosphere’s charged particles and — now — the particles in the interstellar medium.

The CRS measures the count rate, or how many particles detected per second. It does this by using two telescopes: the High Energy Telescope, which measures high energy particles (70MeV) identifiable as interstellar particles, and the Low Energy Telescope, which measures low-energy particles (5MeV) that originate from our Sun. You can think of these particles like a bowling ball hitting a bowling pin versus a bullet hitting the same pin — both will make a measurable impact on the detector, but they’re moving at vastly different speeds. By measuring the amounts of the two kinds of particles, Voyager can provide a sense of the space environment it’s traveling through.

Scientists compared data from Voyager 1 with its 2012 crossing of the heliopause to watch for clue for when Voyager 2 would cross. In November 2018, the first clues came from the Cosmic Ray Subsystem!

These graphs show the count rate — how many particles per second are interacting with the CRS on average each day — of the galactic ray particles measured by the High Energy Telescope (top graph) and the heliospheric particles measured by the Low Energy Telescope (bottom graph). The line in red shows the data from Voyager 1, time shifted forward 6.32 years from 2012 to match up with the data from Voyager around November 2018, shown in blue.

CRS data from Voyager 2 on Nov. 5, 2018, showed the interstellar particle count rate of the High Energy Telescope increasing to count rates similar to what Voyager 1 saw then leveling out. Similarly, the Low Energy Telescope shows a severe decrease in heliospheric originating particles. This was a key indication that Voyager 2 had moved into interstellar space. Scientists can keep watching these counts to see if the composition of interstellar space particles changes along the journey.
The Plasma Instrument

The Plasma Science instrument, or PLS, was made to measure plasma and ionized particles around the outer planets and to measure the solar wind's influence on those planets. The PLS is made up of four Faraday cups, an instrument that measures the plasma as it passes through the cups and calculates the plasma's speed, direction and density.

The plasma instrument on Voyager 1 was damaged during a fly-by of Saturn and had to be shut off long before Voyager 1 exited the heliosphere, making it unable to measure the interstellar medium's plasma properties. With Voyager 2's crossing, scientists will get the first-ever plasma measurements of the interstellar medium.

Scientists predicted that interstellar plasma measured by Voyager 2 would be higher in density but lower in temperature and speed than plasma inside the heliosphere. And in November 2018, the instrument saw just that for the first time. This suggests that the plasma in this region is getting colder and slower, and, like cars slowing down on a freeway, is beginning to pile up around the heliopause and into the interstellar medium.

And now, thanks to Voyager 2's PLS, we have a never-before-seen perspective on our heliosphere: The plasma velocity from Earth to the heliopause.

These three graphs tell an amazing story, summarizing a journey of 42 years in one plot. The top section of this graph shows the plasma velocity, how fast the plasma across the heliosphere is moving, against the distance out from Earth. The distance is in astronomical units; one astronomical unit is the average distance between the Sun and Earth, about 93 million miles. For context, Saturn is 10 AU from Earth, while Pluto is
about 40 AU away.

The heliopause crossing happened at 120 AU, when the velocity of plasma coming out from the Sun drops to zero (seen on the top graph), and the outward flow of the plasma is diverted — seen in the increase in the two bottom graphs, which show the upwards and downward speeds (the normal velocity, middle graph) and the sideways speed of the solar wind (the tangential velocity, bottom graph) of the solar wind plasma, respectively. This means as the solar wind begins to interact with the interstellar medium, it is pushed out and away, like a wave hitting the side of a cliff.

Looking at each instrument in isolation, however, does not tell the full story of what interstellar space at the heliopause looks like. Together, these instruments tell a story of the transition from the turbulent, active space within our Sun's influence to the relatively calm waters on the edge of interstellar space.

The MAG shows that the magnetic field strength decreases sharply in the interstellar medium. The CRS data shows an increase in interstellar cosmic rays, and a decrease in heliospheric particles. And finally, the PLS shows that there's no longer any detectable solar wind.

Now that the Voyagers are outside of the heliosphere, their new perspective will provide new information about the formation and state of our Sun and how it interacts with interstellar space, along with insight into how other stars interact with the interstellar medium.

Voyager 1 and Voyager 2 are providing our first look at the space we would have to pass through if humanity ever were to travel beyond our home star — a glimpse of our neighborhood in space.

Related links:

- Video: "NASA Science Live: Going Interstellar"
- Explore Voyager 2 data on "The Sun Spot" blog

Source: NASA
Space Image of the Week

GC 1333: Stellar Nursery in Perseus

Explanation  NGC 1333 is seen in visible light as a reflection nebula, dominated by bluish hues characteristic of starlight reflected by interstellar dust. A mere 1,000 light-years distant toward the heroic constellation Perseus, it lies at the edge of a large, star-forming molecular cloud. This striking close-up spans about two full moons on the sky or just over 15 light-years at the estimated distance of NGC 1333. It shows details of the dusty region along with telltale hints of contrasty red emission from Herbig-Haro objects, jets and shocked glowing gas emanating from recently formed stars. In fact, NGC 1333 contains hundreds of stars less than a million years old, most still hidden from optical telescopes by the pervasive stardust. The chaotic environment may be similar to one in which our own Sun formed over 4.5 billion years ago.

Image Credit & Copyright: Steve Milne, Barry Wilson - Processing: Steve Milne

Source: APOD

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