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Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - University of Sharjah
Compiled by Dr. Ilias Fernini

Top News

IT Support Issam Jami
Designed by Mohamed Bakir

If the past is a guide, Hubble's new trouble won't doom the space telescope

A SPACE TELESCOPE IS BORN From the start, the Hubble Space Telescope (seen being released from the cargo bay of the space shuttle Discovery on April 25, 1990) has survived many potentially career-ending scares.

Hubble's in trouble again.

The 28-year-old space telescope, in orbit around the Earth, put itself to sleep on October 5 because of an undiagnosed problem with one of its steering wheels. But once more, astronomers are optimistic about Hubble's chances of recovery. After all, it's just the latest nail-biting moment in the history of a telescope that has defied all life-expectancy predictions.

There is one major difference this time. Hubble was designed to be repaired by astronauts on the space shuttle. Each time the telescope broke previously, a shuttle mission fixed it. "That we can't do anymore, because there ain't no shuttle," says astronomer Helmut Jenkner of the Space Telescope Science Institute in Baltimore, who is Hubble's deputy mission head.

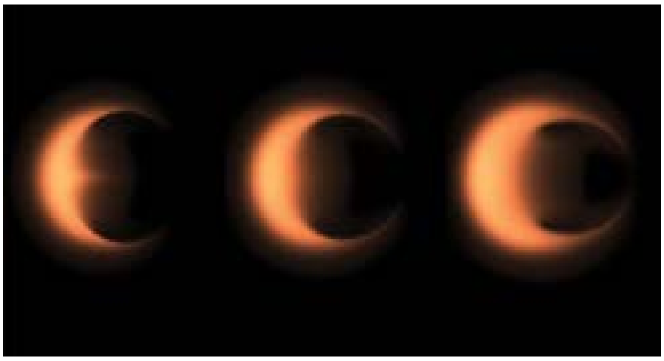
The most recent problem started when one of the three gyroscopes that control where the telescope points failed. That wasn't surprising, says Hubble senior project scientist Jennifer Wiseman of NASA's Goddard Space Flight Center in Greenbelt, Md. That particular gyroscope had been glitching for about a year. But when the team turned on a backup gyroscope, it didn't function properly either.

Astronomers are working to figure out what went wrong and how to fix it from the ground. The mood is upbeat, Wiseman says. But even if the gyroscope doesn't come back online, there are ways to point Hubble and continue observing with as few as one gyroscope.

"This is not a catastrophic failure, but it is a sign of mortality," says astronomer Robert Kirshner of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Like cataracts, he says, it's "a sign of aging, but there's a very good remedy."

While we wait for news of how Hubble is faring, here's a look back at some of its previous hiccups and repair missions. ...Read More...

'Einstein's Shadow' explores what it takes to snap a black hole's picture



Scientists hope to image a black hole's shadow (simulated) to reveal new secrets of gravity. The image expected according to the general theory of relativity (center) differs from that produced if other theories are correct (left and right).

Right now, a ragtag team of astronomers, assembled from institutes across the globe, may be peering in wonder at the first picture of a black hole's shadow. The quest to create such an image has involved a massive level of scientific coordination, combining data from telescopes at eight observatories scattered from the South Pole to Hawaii to the Atacama Desert in Chile. In Einstein's Shadow, journalist Seth Fletcher provides a twisting narrative of the project's inception and how it grew into a worldwide effort.

Called the Event Horizon Telescope, or EHT, the project is "the biggest telescope in the history of humanity," EHT director Shep Doeleman of the Harvard-Smithsonian Center for Astrophysics says in the book. EHT unifies far-flung radio telescopes through a technique called very long baseline interferometry, which involves combining the light waves spotted by each telescope to determine how the light adds up, through a process called interference. Using this technique, EHT can achieve resolution equivalent to picking out a doughnut on the moon. That extreme capability is what's needed to capture a picture of EHT's main target: the gigantic black hole at the center of the Milky Way.

EHT captured its first data in 2006, but has yet to produce an image of a black hole. After adding more telescopes and improving the technology, in April 2017, EHT took data aimed at capturing the silhouette of the Milky Way's central black hole. Those data are still being analyzed.

No one has ever directly seen a black hole, so scientists still debate the details of what black holes are like. A boundary known as an event horizon is thought to exist at the edge of each black hole. This border, beyond which nothing can escape, is what EHT is attempting to image.

Close to the event horizon, physics becomes utterly strange, with space and time warped by intense gravity. There, Einstein's general theory of relativity, which describes gravity, clashes with quantum mechanics, the theory of physics on small scales. Scientists are still unsure how to reconcile the two theories ...Read More...

How the seeds of planets take shape

File Illustration Only.

In theoretical research that could explain everything from planet formation to outflows from stars, to even the settling of volcanic ash, Caltech researchers have discovered a new mechanism to explain how the act of dust moving through gas leads to clumps of dust. While dust clumps were already known to play a role in seeding new planets and many other systems in space and on Earth, how the clumps formed was unknown until now.

Phil Hopkins, professor of theoretical astrophysics at Caltech, working with Jonathan (Jono) Squire, a former postdoctoral fellow at Caltech, began thinking about disturbances to dust moving through gas while studying how strong radiation from stars and galaxies drives dust-laden winds.

Hopkins says that it was previously assumed that dust was stable in gas, meaning the dust grains would ride along with gas without much happening, or they would settle out of the gas if the particles were big enough, as is the case with soot from a fire.

“What Jono and I discovered is that dust and gas trying to move with one another is unstable and causes dust grains to come together,” says Hopkins. “Soon we began to realize that these gas-dust instabilities are at play anywhere in the universe that a force pushes dust through gas, whether the forces are stellar winds, gravity, magnetism, or an electrical field.” The team’s simulations show material swirling together, with clumps of dust growing bigger and bigger.

“We actually started out studying dust-driven winds in space, but as we studied the problem, we noticed specific features of the instabilities that led us to think this was a more general phenomenon,” says Squire, who together with Hopkins has authored four articles on their new findings, one published in The Astrophysical Journal and three in Monthly Notices of the Royal Astronomical Society.

“From here, it kind of snowballed, since we were able to study lots of different systems - galaxies, stars, planet formation, the gas close to supermassive black holes, supernovas, et cetera - and confirm our intuition. It wasn’t a eureka moment but a series of eurekas that lasted about a week.” ...Read More...

Galactic archaeology

Artwork depicting the star “Pristine 221.8781 + 9.7844” which was formed from the material ejected by these first supernovas.

The star Pristine 221.8781+9.7844 is one of the oldest stars in the Milky Way. We know this because of its atmosphere. Just after the Big Bang the universe was full of hydrogen and helium with very little lithium there were no heavier elements because these are synthesized in the interiors of stars.

David Aguado’s view is that “As the atmosphere of the star we have analyzed is very poor in metals, we can say with confidence that this is one of the oldest objects in the Milky Way, and of course it is much older than the Sun” and he adds that “This star will help us to better understand certain features of the origin of the Milky Way and how the first stars formed”

To reach this conclusion detailed studies have been performed with the ISIS spectrograph on the William Herschel Telescope and with the IDS spectrograph on the Isaac Newton Telescope, both belonging to the Isaac Newton Group of Telescopes (ING) at the Roque de los Muchachos Observatory (Garafia, La Palma).

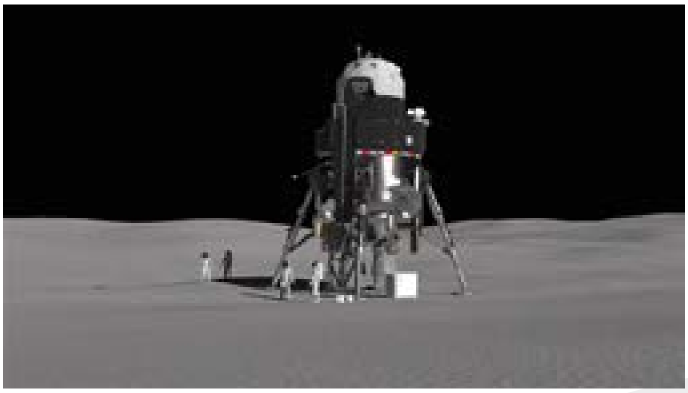
“The spectroscopic data with intermediate resolution obtain on the INT and the WHT, telescopes on La Palma have allowed us to show the low content of carbon, which is usually very abundant in this type of stars” explains Carlos Allende, a Professor at the IAC and one of the researchers in this project.

The study of these very old stars, which have been catalogued and analysed in the Pristine survey, led from the Leibniz Institute of Astrophysics (Potsdam, Germany) and from the University of Strasbourg (France), help us to learn more about the state of the universe in its early days, just after the Big Bang.

To make the first detections of these stars, which are survivors from the first stages of the universe, and have pristine atmospheres, the team used a special colour filter on the Canada-France-Hawaii Telescope (CFHT) on the top of Mauna Kea (Hawaii).

In this study has been used high-resolution spectroscopy obtained with the UVES spectrograph in the VLT telescope (Paranal, ESO). ...Read More...

New moon lander would be a big step up from Apollo-era 'modules'



The reusable lander would be able to carry a four-person crew and 2,000 pounds of cargo.Courtesy Lockheed Martin

Before humans venture to Mars, NASA wants to send astronauts back to the moon — and aerospace giant Lockheed Martin has developed a new lunar lander concept designed to shuttle space flyers between a moon-orbiting space station and the cratered surface below.

Unveiled Oct. 3 at an international space conference in Bremen, Germany, the reusable lander would launch into space aboard NASA's next-generation Space Launch System rocket and dock with the agency's proposed Lunar Orbital Platform-Gateway.

This planned outpost is a small moon-orbiting space station that NASA aims to build in the 2020s to serve as a way station for missions to the moon, as well as Mars and other deep-space destinations.

Lockheed's lander would be able to carry a four-person crew and 2,000 pounds of cargo on lunar expeditions lasting up to two weeks — capabilities that far outstrip those of the Apollo-era "lunar modules," said Tim Cichan, a space exploration architect at Lockheed Martin Space Systems in Denver. Those single-use crafts carried two crew members to the moon for visits of less than a week — less than a single day in the case of the Apollo 11 astronauts, who were the first humans to set foot on the lunar surface.

"What is exciting and innovative is that these are reusable, unlike what we had during Apollo," Jack Burns, a professor of astrophysics at the University of Colorado, Boulder, said of the concept in an email to NBC News MACH. "The landers come down to the surface, potentially refuel using hydrogen and oxygen mined from water at the lunar poles and return to the Gateway."

Burns, who is unaffiliated with the Lockheed Martin initiative, called the new lander a "more efficient, cost-effective system that will make the lunar surface regularly accessible from the lunar Gateway."

Since the lander would depart for the moon from the Gateway, it would be able to reach any region .Read More...

Aussie telescope almost doubles known number of mysterious 'fast radio bursts'

Artist's impression of CSIRO's Australian SKA Pathfinder (ASKAP) radio telescope observing 'fast radio bursts' in 'fly's eye mode'. Each antenna points in a slightly different direction, giving maximum sky coverage. Credit: OzGrav, Swinburne University of Technology

Australian researchers using a CSIRO radio telescope in Western Australia have nearly doubled the known number of 'fast radio bursts'— powerful flashes of radio waves from deep space.

The team's discoveries include the closest and brightest fast radio bursts ever detected. Their findings were reported today in the journal Nature.

Fast radio bursts come from all over the sky and last for just milliseconds.

Scientists don't know what causes them but it must involve incredible energy—equivalent to the amount released by the Sun in 80 years.

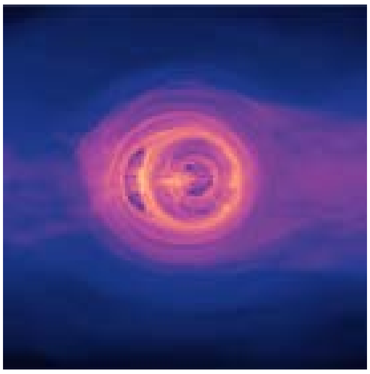
"We've found 20 fast radio bursts in a year, almost doubling the number detected worldwide since they were discovered in 2007," said lead author Dr. Ryan Shannon, from Swinburne University of Technology and the OzGrav ARC Centre of Excellence.

"Using the new technology of the Australia Square Kilometre Array Pathfinder (ASKAP), we've also proved that fast radio bursts are coming from the other side of the Universe rather than from our own galactic neighbourhood."

Co-author Dr. Jean-Pierre Macquart, from the Curtin University node of the International Centre for Radio Astronomy Research (ICRAR), said bursts travel for billions of years and occasionally pass through clouds of gas.

"Each time this happens, the different wavelengths that make up a burst are slowed by different amounts," he said. ...Read More...

Video: The Glow of Spiraling Black Holes



This snippet of the black hole simulation moved through 360 degrees as viewed from the plane of the disk. NASA / Goddard Space Flight Center. (Click here to see the video)

Pairs of humongous black holes likely circle each other in the hearts of many galaxies, brought together over the eons by galaxy mergers. As they come within a fraction of a light-year of each other, they create ripples in the fabric of spacetime that undulate across the universe.

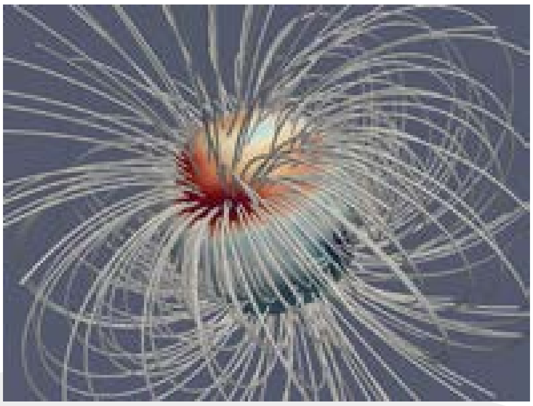
But they should also create bizarre light effects. Unlike the smaller black holes that scientists have "seen" merge with LIGO and Virgo (which have long eaten up any nearby gas), supermassive black hole binaries will be surrounded by disks of glowing gas heated by magnetic and gravitational forces. Each black hole will have its own disk; a second, bigger one will ring both, like a playpen around two girls in tutus, their hands linked as they spin around each other.

Simulations by Manuela Campanelli (Rochester Institute of Technology) and her colleagues previously showed that these three disks engage in an almost constant trading scheme, with gas sloshing between the two mini disks and filaments peeling off the circumbinary disk, either to latch onto a mini disk or be flung back to slam into the big ring. All these changes should create distinct signals — not in gravitational waves, but in light.

Reporting in the October 1st Astrophysical Journal, Stéphane d'Ascoli (RIT), Campanelli, and colleagues take the first step in understanding what the light emitted from these systems looks like. The researchers used the same simulation data as before, this time to figure out how light would look after traveling through the warped spacetime landscape created by the black holes' extreme gravity. Unfortunately they had to leave out the sloshing and peeling filaments to make things simpler, but they were able to create the stunning video below.

No technology in the foreseeable future will enable us to see supermassive black hole binaries this way. Instead, astronomers have to search for unique patterns in how the glow looks at different wavelengths, and how that emission changes with time. The new simulations indicate that the circumbinary disk, the accretion streams, and the mini disks all radiate primarily in ultraviolet. ..Read More...

Jupiter's bizarre magnetic field is unlike anything scientists have ever seen



The lines in this visualization of Jupiter's magnetic field show that the direction of the magnetic field and the density of the lines corresponds to the strength of the field.Moore et al. and Nature

"The main puzzle of our study is why Jupiter's field is so simple in one hemisphere and so complicated in the other."

If you thought Jupiter's Great Red Spot was odd, wait until you get a look at its magnetic field.

New data from Juno, a NASA space probe that's been orbiting Jupiter for the past two years, reveals that the gas giant has a field unlike that of any other planet.

While Earth's magnetic field is distributed symmetrically around the planet, Jupiter's is much stronger in the northern hemisphere than in the south. And whereas Earth's magnetic field lines converge rather neatly at the poles a bit like a giant bar magnet, Jupiter's field lines look helter-skelter on a map created from the data. The lines emanating from Jupiter's north return not to one point but to two: one near Jupiter's south pole and the other near its equator.

"Now we know that Jupiter's field is very different from Earth's field," Kimberly Moore, a graduate student in the Department of Earth & Planetary Sciences at Harvard University and the lead author of a paper describing the research, told NBC News MACH in an email. "The main puzzle of our study is why Jupiter's field is so simple in one hemisphere and so complicated in the other."

The scientists who conducted the research don't expect a quick solution to the puzzle.

"We're just starting to work out the possible answers," said Scott Bolton, the principal investigator of the Juno mission and a co-author of the paper, which was published Sept. 5 in the journal Nature. "Whatever's going on inside Jupiter isn't like what's going on inside other planets."

Earth's magnetic field is believed to result from the circulation of liquid iron in our planet's outer core; as this electrically conductive material moves about ...Read More...

Scientists Across the Globe Are Hunting for Pure Randomness

Credit: Shutterstock

You take the interstate to get home and rely on the water utility for a drink. But have you ever felt the need for some publicly available randomness?

Governments and researchers around the world think you might, with projects in the works to produce public sources, or “beacons,” of randomness. From quantum-physics experiments to distributed projects that anyone with a laptop could help produce, a wide range of efforts aim to bring randomness to your fingertips.

Publicly available randomness helps ensure online security, free elections and fair immigration practices — and may even help address deep questions about the nature of the universe. But producing these randomness beacons — secure, truly random numbers that the public can trust — poses huge challenges, sending researchers into the quantum realm and beyond in search of fundamentally unpredictable phenomena. Here’s why scientists see randomness as a public utility — and how they’re trying to make a mess for your sake.

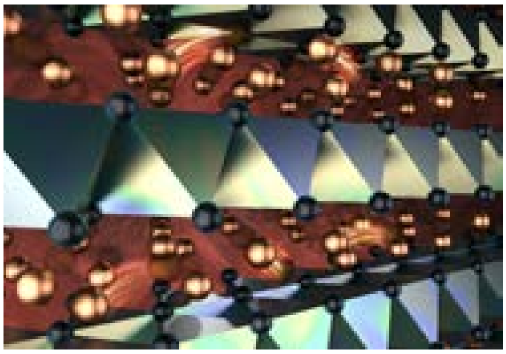
What counts as random?

We’ve all experienced it, but may not know exactly what it is: Randomness is the level of disorder and unpredictability in a system.True, pure randomness is fundamentally unpredictable, said physicist Krister Shalm, who leads quantum experiments for the U.S. National Institute of Standards and Technology (NIST). For instance, if you watched a source of truly random numbers forever, over time, your odds of getting any given number would be the same. (Randomness differs slightly from the related term entropy, which is a numerical measure of disorder.)

Why would anyone want to increase disorder in the world? It turns out, public sources of randomness can aid in a number of tasks, from safeguarding complex cryptography to shuffling card decks in online games, said Ewa Syta, a computer scientist at Trinity College in Connecticut.

“Public randomness is used in ... any kind of system that requires some way to make a decision ... to do anything where you want some fair way to agree upon things,” Syta told Live Science. “Basically, what public randomness gives you is a way to implement a fair coin toss.” ...Read More...

Copper ions flow like liquid through crystalline structures



An artistic rendition of the intriguing superionic crystalline structure of CuCrSe2, which has copper ions that move like liquid between solid layers of chromium and selenium, giving rise to useful electrical properties. Credit: Oak Ridge National Laboratory/ Jill Hemman

Materials scientists have sussed out the physical phenomenon underlying the promising electrical properties of a class of materials called superionic crystals. A better understanding of such materials could lead to safer and more efficient rechargeable batteries than the current standard-bearer of lithium ion.

Becoming a popular topic of study only within the past five years, superionic crystals are a cross between a liquid and a solid. While some of their molecular components retain a rigid crystalline structure, others become liquid-like above a certain temperature, and are able to flow through the solid scaffold.

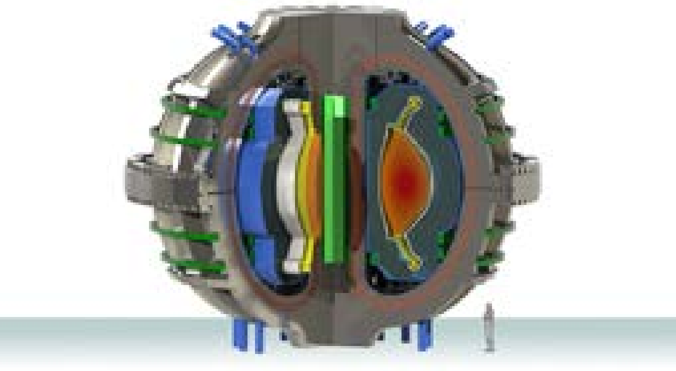
In a new study, scientists from Duke University, Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL) probed one such superionic crystal containing copper, chromium and selenium (CuCrSe2) with neutrons and X-rays to determine how the material’s copper ions achieve their liquid-like properties. The results appear online on Oct. 8 in the journal Nature Physics.

“When CuCrSe2 is heated above 190 degrees Fahrenheit, its copper ions fly around inside the layers of chromium and selenium about as fast as liquid water molecules move,” said Olivier Delaire, associate professor of mechanical engineering and materials science at Duke and senior author on the study. “And yet, it’s still a solid that you could hold in your hand. We wanted to understand the molecular physics behind this phenomenon.”

To probe the copper ions’ behavior, Delaire and his colleagues turned to two world-class facilities: the Spallation Neutron Source at Oak Ridge and the Advanced Photon Source at Argonne. Each machine provided a unique piece of the puzzle.

By pinging a large sample of powdered CuCrSe2 made at Oak Ridge with powerful neutrons, the researchers got a wide-scale view of the material’s atomic structure and dynamics, revealing both the vibrations of the stiff scaffold of chromium and selenium atoms as well as the random jumps of copper ions within. ...Read More...

Novel design could help shed excess heat in next-generation fusion power plants



The ARC conceptual design for a compact, high magnetic field fusion power plant. The design now incorporates innovations from the newly published research to handle heat exhaust from the plasma. Credit: ARC rendering by Alexander Creely

A class exercise at MIT, aided by industry researchers, has led to an innovative solution to one of the longstanding challenges facing the development of practical fusion power plants: how to get rid of excess heat that would cause structural damage to the plant.

The new solution was made possible by an innovative approach to compact fusion reactors, using high-temperature superconducting magnets. This method formed the basis for a massive new research program launched this year at MIT and the creation of an independent startup company to develop the concept. The new design, unlike that of typical fusion plants, would make it possible to open the device's internal chamber and replace critical components; this capability is essential for the newly proposed heat-draining mechanism.

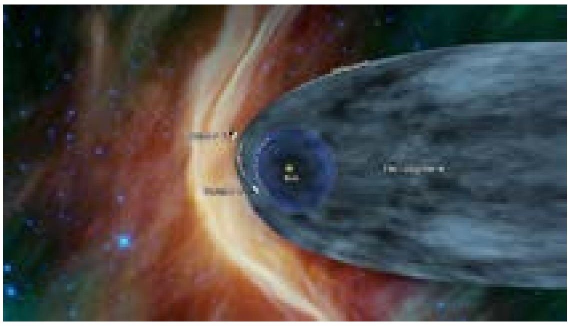
The new approach is detailed in a paper in the journal Fusion Engineering and Design, authored by Adam Kuang, a graduate student from that class, along with 14 other MIT students, engineers from Mitsubishi Electric Research Laboratories and Commonwealth Fusion Systems, and Professor Dennis Whyte, director of MIT's Plasma Science and Fusion Center, who taught the class.

In essence, Whyte explains, the shedding of heat from inside a fusion plant can be compared to the exhaust system in a car. In the new design, the "exhaust pipe" is much longer and wider than is possible in any of today's fusion designs, making it much more effective at shedding the unwanted heat. But the engineering needed to make that possible required a great deal of complex analysis and the evaluation of many dozens of possible design alternatives.

Taming fusion plasma

Fusion harnesses the reaction that powers the sun itself, holding the promise of eventually producing clean, abundant electricity using a fuel derived from ...Read More...

Voyager 2 spacecraft approaches interstellar space



The image shows the heliosphere that wraps around the Sun, its planets and far beyond. The heliosheath is the outermost later of the heliosphere, and is where Voyager 2 is traveling through to get it to interstellar space.
NASA/JPL-Caltech

When it comes to space exploration, no one has the Voyager missions beat. On October 5, NASA reported that their Voyager 2 spacecraft is nearing our heliosphere's outer borders, and could soon enter interstellar space. Data shows that the probe is detecting more and more cosmic rays from outer space – indicating a slow escape from the sun's stellar bubble. If all goes as planned, the craft will follow in the footsteps of Voyager 1 and become the second human-made object to ever visit the interstellar medium.

Voyager's long haul

Voyager 2's mission has been long and strenuous, to say the least. It's traveled about 11 billion miles (17.7 billion kilometers) from Earth since it launched in 1977, and spent three decades cruising through space before finally reaching the outermost layer of our heliosphere – the massive bubble, created by the sun's solar wind, that encompasses the Sun, its planets and regions far beyond their orbits.

Since it reached this remote region, called the heliosheath, in 2007, researchers have been patiently waiting for it to pass through the heliopause – the threshold that separates the heliosphere and interstellar space. And based on recent data, Voyager 2 is starting to make some headway.

Signals from space

In August, researchers noted that there was a five percent increase in the cosmic rays detected by the craft's Cosmic Ray Subsystem, as well as its Low-Energy Particle instrument. Made up of mainly protons, electrons and atomic nuclei, cosmic rays blast through space at nearly the speed of light, and are thought to be ejected during powerful supernova explosions.

It's believed that the heliosphere blocks a lot of these rays from reaching our solar system, but as you travel closer to the edge and the barrier starts ...Read More...

Special Read:

Soyuz astronauts' emergency descent was a harrowing, high-G ordeal

An image of the failed Oct. 11, 2018, launch from the ground near Baikonur Cosmodrome in Kazakhstan. Credit: Bill Ingalls/NASA

A Russian Soyuz rocket carrying two crew members to the International Space Station malfunctioned shortly after launch early Thursday morning, forcing the space flyers to make an emergency return to Earth – what's known in aerospace circles as a ballistic re-entry.

NASA astronaut Nick Hague and Russian cosmonaut Alexey Ovchinin are said to be in good condition after their capsule landed safely near the city of Dzhezkazgan in Kazakhstan. But their unexpected trip home was a tumultuous one marked by periods of intense G-forces.

"What 'ballistic' means is basically an unguided, uncontrolled free fall," said Scott Kelly, a former NASA astronaut who made four trips to space, including two aboard the Soyuz.

In a ballistic re-entry, the capsule falls at a steeper angle than a spacecraft normally takes when returning to Earth. That unusual trajectory causes the capsule to decelerate rapidly as a result of increased friction with the atmosphere – but rapid deceleration means the crew is subjected to unusually strong G-forces.

In today's emergency, Hague and Ovchinin experienced G-forces six to seven times Earth's gravity, Reid Wiseman, NASA's deputy chief astronaut, told reporters Thursday at a press briefing.

In addition to decelerating rapidly, the space flyers' capsule spun slowly as it fell, Wiseman said, giving it a measure of aerodynamic stability as it plunged through the atmosphere.

"It's like shooting a bullet out of a rifle barrel," he said, before deadpanning that the forces the astronauts experienced were "not insignificant." At seven Gs, a 180-pound astronaut weighs 1,260 pounds.

There has been no word yet from Hague or Ovchinin about what the experience was like. But Peggy Whitson, a retired NASA astronaut who survived a ballistic re-entry in a Soyuz capsule in 2008, described the experience as a harrowing one in an interview with The Houston Chronicle later that year.

"I felt my face getting pulled back," she said of the re-entry, in which she was subjected to 8 Gs for about 60 seconds while her capsule plummeted 400,000 feet. "It was hard to breathe, and you kind of have to breathe through your stomach, using your diaphragm instead of expanding your chest."

Under normal conditions, astronauts aboard Soyuz capsules experience about 4.5 Gs during re-entry, Kelly said – and even that is a notoriously violent event. "The way I describe it," he said, "it's like going over Niagara Falls in a barrel while you're on fire." ...Read More...

This Week's Sky at a Glance - Oct. 13-19, 2018

Oct 15	Mo	07:01 21:26	Moon-Saturn: 2° S Moon South Dec.: 21.2° S
Oct 16	Tu	06:32 22:02	Mercury-Venus : 6.2° N First Quarter
Oct 17	We	16:03 23:16	Moon Descending Node Moon Apogee: 404200 km
Oct 18	Th	17:01	Moon-Mars: 2.2° S

SCASS Lecture on Oct. 17, 2018

Title: Plunging Matter into Compact Objects: Accretion in X-ray Binaries.
Lecturer: Dr. Antonios Manousakis (UoS/SCASS)

Date: Wednesday, Oct. 17, 2018
Time: 14:00 - 15:00
Location: SCASS Conference Room