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1. Voyager 1 Helps Solve Interstellar Medium Mystery

NASA's Voyager 1 spacecraft made history in 2012 by entering interstellar space, leaving the planets and the solar wind behind. But observations from the pioneering probe were puzzling with regard to the magnetic field around it, as they differed from what scientists derived from observations by other spacecraft.

A new study offers fresh insights into this mystery. Writing in the Astrophysical Journal Letters, Nathan Schwadron of the University of New Hampshire, Durham, and colleagues reanalyzed magnetic field data from Voyager 1 and found that the direction of the magnetic field has been slowly turning ever since the spacecraft crossed into interstellar space. They believe this is an effect of the nearby boundary of the solar wind, a stream of charged particles that comes from the sun.

"This study provides very strong evidence that Voyager 1 is in a region where the magnetic field is being deflected by the solar wind," said Schwadron, lead author of the study.

Researchers predict that in 10 years Voyager 1 will reach a more "pristine" region of the interstellar medium where the solar wind does not significantly influence the magnetic field.

Voyager 1's crossing into interstellar space meant it had left the heliosphere -- the bubble of solar wind surrounding our sun and the planets. Observations from Voyager's instruments found that the particle density was 40 times greater outside this boundary than inside, confirming that it had indeed left the heliosphere.

But so far, Voyager 1's observation of the direction of the local interstellar magnetic field is more than 40 degrees off from what other spacecraft have determined. The new study suggests this discrepancy exists because Voyager 1 is in a more distorted magnetic field just outside the heliopause, which is the boundary between the solar wind and the interstellar medium.

"If you think of the magnetic field as a rubber band stretched around a beach ball, that band is being deflected around the heliopause," Schwadron said.
In 2009, NASA’s Interstellar Boundary Explorer (IBEX) discovered a "ribbon" of energetic neutral atoms that is thought to hold clues to the direction of the pristine interstellar magnetic field. The so-called "IBEX ribbon," which forms a circular arc in the sky, remains mysterious, but scientists believe it is produced by a flow of neutral hydrogen atoms from the solar wind that were re-ionized in nearby interstellar space and then picked up electrons to become neutral again.

The new study uses multiple data sets to confirm that the magnetic field direction at the center of the IBEX ribbon is the same direction as the magnetic field in the pristine interstellar medium. Observations from the NASA/ESA Ulysses and SOHO spacecraft also support the new findings.

"All of these different data sets that have been collected over the last 25 years have been pointing toward the same meeting point in the field," Schwadron said.

Over time, the study suggests, at increasing distances from the heliosphere, the magnetic field will be oriented more and more toward "true north," as defined by the IBEX ribbon. By 2025, if the field around Voyager 1 continues to steadily turn, Voyager 1 will observe the same magnetic field direction as IBEX. That would signal Voyager 1's arrival in a less distorted region of the interstellar medium.

"It's an interesting way to look at the data. It gives a prediction of how long we'll have to go before Voyager 1 is in the medium that's no longer strongly perturbed," said Ed Stone, Voyager project scientist, based at the California Institute of Technology in Pasadena, who was not involved in this study.

While Voyager 1 will continue delivering insights about interstellar space, its twin probe Voyager 2 is also expected to cross into the interstellar medium within the next few years. Voyager 2 will make additional observations of the magnetic field in interstellar space and help scientists refine their estimates.

Voyager 1 and Voyager 2 were launched 16 days apart in 1977. Both spacecraft flew by Jupiter and Saturn. Voyager 2 also flew by Uranus and Neptune. Voyager 2, launched before Voyager 1, is the longest continuously operated spacecraft. Voyager 1 is the most distant object touched by human hands.

JPL, a division of Caltech, built the twin Voyager spacecraft and operates them for the Heliophysics Division within NASA’s Science Mission Directorate in Washington.

For more information about Voyager, visit: http://voyager.jpl.nasa.gov

Link to NASA video file

Source: NASA
Researchers are sifting through an avalanche of data produced by one of the largest cosmological simulations ever performed, led by scientists at the U.S. Department of Energy's (DOE) Argonne National Laboratory.

The simulation, run on the Titan supercomputer at DOE's Oak Ridge National Laboratory, modeled the evolution of the universe from just 50 million years after the Big Bang to the present day -- from its earliest infancy to its current adulthood. Over the course of 13.8 billion years, the matter in the universe clumped together to form galaxies, stars and planets; but we're not sure precisely how.

These kinds of simulations help scientists understand dark energy, a form of energy that affects the expansion rate of the universe, including the distribution of galaxies, composed of ordinary matter, as well as dark matter, a mysterious kind of matter that no instrument has directly measured so far.

Intensive sky surveys with powerful telescopes, like the Sloan Digital Sky Survey and the new, more detailed Dark Energy Survey, show scientists where galaxies and stars were when their light was first emitted. And surveys of the Cosmic Microwave Background, light remaining from when the universe was only 300,000 years old, show us how the universe began -- "very uniform, with matter clumping together over time," said Katrin Heitmann, an Argonne physicist who led the simulation.

The simulation fills in the temporal gap to show how the universe might have evolved in between: "Gravity acts on the dark matter, which begins to clump more and more, and in the clumps, galaxies form," said Heitmann.

Called the Q Continuum, the simulation involved half a trillion particles -- dividing the universe up into cubes with sides 100,000 kilometers long. This makes it one of the largest cosmology simulations at such high
resolution. It ran using more than 90 percent of the supercomputer. For perspective, typically less than one percent of jobs use 90 percent of the Mira supercomputer at Argonne, said officials at the Argonne Leadership Computing Facility, a DOE Office of Science User Facility. Staff at both the Argonne and Oak Ridge computing facilities helped adapt the code for its run on Titan.

"This is a very rich simulation," Heitmann said. "We can use this data to look at why galaxies clump this way, as well as the fundamental physics of structure formation itself."

Analysis has already begun on the two and a half petabytes of data that were generated, and will continue for several years, she said. Scientists can pull information on such astrophysical phenomena as strong lensing, weak lensing shear, cluster lensing and galaxy-galaxy lensing.

The code to run the simulation is called Hardware/Hybrid Accelerated Cosmology Code (HACC), which was first written in 2008, around the time scientific supercomputers broke the petaflop barrier (a quadrillion operations per second). HACC is designed with an inherent flexibility that enables it to run on supercomputers with different architectures.

Details of the work are included in the study, "The Q continuum simulation: harnessing the power of GPU accelerated supercomputers," published in August in the Astrophysical Journal Supplement Series by the American Astronomical Society. Other Argonne scientists on the study included Nicholas Frontiere, Salman Habib, Adrian Pope, Hal Finkel, Silvio Rizzi, Joe Insley and Suman Bhattacharya, as well as Chris Sewell at DOE's Los Alamos National Laboratory.

This work was supported by the DOE Office of Science (Scientific Discovery through Advanced Computing (SciDAC) jointly by High Energy Physics and Advanced Scientific Computing Research) and used resources of the Oak Ridge Leadership Computing Facility (OLCF) at Oak Ridge National Laboratory, a DOE Office of Science User Facility. The work presented here results from an award of computer time provided by the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program at the OLCF.

Argonne National Laboratory seeks solutions to pressing national problems in science and technology. The nation's first national laboratory, Argonne conducts leading-edge basic and applied scientific research in virtually every scientific discipline. Argonne researchers work closely with researchers from hundreds of companies, universities, and federal, state and municipal agencies to help them solve their specific problems, advance America's scientific leadership and prepare the nation for a better future. With employees from more than 60 nations, Argonne is managed by UChicago Argonne, LLC for the U.S. Department of Energy's Office of Science.

The U.S. Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time. For more information, visit the Office of Science website.

Source: Spaceref.com

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NASA Spots the ‘Great Pumpkin’: Halloween Asteroid a Treat for Radar Astronomers

NASA scientists are tracking the upcoming Halloween flyby of asteroid 2015 TB145 with several optical observatories and the radar capabilities of the agency's Deep Space Network at Goldstone, California. The asteroid will fly past Earth at a safe distance slightly farther than the moon's orbit on Oct. 31 at 10:01 a.m. PDT (1:01 p.m. EDT). Scientists are treating the flyby of the estimated 1,300-foot-wide (400-meter) asteroid as a science target of opportunity, allowing instruments on "spacecraft Earth" to scan it during the close pass.

Asteroid 2015 TB145 was discovered on Oct. 10, 2015, by the University of Hawaii's Pan-STARRS-1 (Panoramic Survey Telescope and Rapid Response System) on Haleakala, Maui, part of the NASA-funded Near-Earth Object Observation (NEOO) Program. According to the catalog of near-Earth objects (NEOs) kept by the Minor Planet Center, this is the closest currently known approach by an object this large until asteroid 1999 AN10, at about 2,600 feet (800 meters) in size, approaches at about 1 lunar distance (238,000 miles from Earth) in August 2027.

"The trajectory of 2015 TB145 is well understood," said Paul Chodas, manager of the Center for Near Earth Object Studies at NASA's Jet Propulsion Laboratory, Pasadena, California. "At the point of closest approach, it will be no closer than about 300,000 miles -- 480,000 kilometers or 1.3 lunar distances. Even though that is relatively close by celestial standards, it is expected to be fairly faint, so night-sky Earth observers would need at least a small telescope to view it."

The gravitational influence of the asteroid is so small it will have no detectable effect on the moon or anything here on Earth, including our planet's tides or tectonic plates.

The Center for NEO Studies at JPL is a central node for NEO data analysis in NASA's Near-Earth Object Observation Program and a key group involved with the international collaboration of astronomers and scientists who keep watch on the sky with their telescopes, looking for asteroids that could be a hazard to impact our planet and predicting their paths through space for the foreseeable future.

"The close approach of 2015 TB145 at about 1.3 times the distance of the moon's orbit, coupled with its size, suggests it will be one of the best asteroids for radar imaging we'll see for several years," said Lance Benner, of JPL, who leads NASA's asteroid radar research program. "We plan to test a new capability to obtain radar images with two-meter resolution for the first time and hope to see unprecedented levels of detail."

During tracking, scientists will use the 34-meter (110-foot) DSS 13 antenna at Goldstone to bounce radio waves off the asteroid. Radar echoes will in turn be collected by the National Radio Astronomy Observatory's Green Bank Telescope in Green Bank, West Virginia, and the National Astronomy and Ionosphere Center's...
Arecibo Observatory, Puerto Rico. NASA scientists hope to obtain radar images of the asteroid as fine as about 7 feet (2 meters) per pixel. This should reveal a wealth of detail about the object’s surface features, shape, dimensions and other physical properties.

“The asteroid's orbit is very oblong with a high inclination to below the plane of the solar system,” said Benner. “Such a unique orbit, along with its high encounter velocity -- about 35 kilometers or 22 miles per second -- raises the question of whether it may be some type of comet. If so, then this would be the first time that the Goldstone radar has imaged a comet from such a close distance.”

NASA’s Near-Earth Object Observations Program detects, tracks and characterizes asteroids and comets passing within 30 million miles of Earth using both ground- and space-based telescopes. The NEOO Program, sometimes called "Spaceguard," discovers these objects, characterizes the physical nature of a subset of them, and predicts their paths to determine if any could be potentially hazardous to our planet. There are no known credible impact threats to date -- only the ongoing and harmless in-fall of meteoroids, tiny asteroids that burn up in the atmosphere.

JPL hosts the Center for Near-Earth Object Studies for NASA's Near-Earth Object Observations Program within the agency's Science Mission Directorate. JPL is a division of the California Institute of Technology in Pasadena.

More information about asteroids and near-Earth objects is at:


Source: NASA
The Night Sky

Friday, October 30

• Sometime around 7 or 8 p.m., depending on where you live in your time zone, bright Capella is exactly as high in the northeast as Fomalhaut is in the south.

• On Saturday (North American date), the quarter-mile asteroid 2015 TB145 passes 1.3 lunar distances from Earth. It will reach 10th or 11th magnitude (100 times too faint to see with the unaided eye) as it crosses the northern sky of the early-morning hours. See our article and chart: Close-in Asteroid Offers Halloween Treat.

A webcast of the flyby: Gianluca Masi has marshaled a network of observers to provide real-time views via his Virtual Telescope Project. Watch the webcast starting at 0:00 UT October 31st, which is 8:00 p.m. Friday October 30th EDT.

Saturday, October 31

• The waning gibbous Moon this Halloween doesn't rise until around 9 p.m. (depending on where you are). Once the Moon is well up, look for Orion far to its right, and Gemini's Castor and Pollux off to its left.

• Daylight-saving time ends at 2 a.m. Sunday morning. Clocks fall back an hour (for most of North America).

• In Sunday's dawn, Venus has drawn to within 1.1° of little Mars, even closer than shown above. Mars is only 1/250 as bright. They'll appear closest together on the mornings of Monday and Tuesday, November 2nd and 3rd.

Sunday, November 1

• Before and during dawn Monday, Brilliant Venus and faint orange Mars are separated by just 0.8° — less than a fingertip at arm's length. Jupiter looks on from above. In a telescope, Venus is a dazzling white half-moon 22 arcseconds from top to bottom. Mars is a tiny orange blob just 4 arcseconds in diameter.

Monday, November 2

• The last-quarter Moon rises around 11 p.m. tonight, in dim Cancer far below Pollux and Castor. Spot Procyon well to the Moon's upper right. The Moon is exactly last-quarter at 7:24 a.m. Tuesday the 3rd EST.

• Before and during dawn Tuesday, Venus and Mars are in conjunction 0.7° apart, with Jupiter above them.

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)*

**Monday, November 2**

10 a.m., Crew News Conference on the 15th Anniversary of the Start of Human Occupancy of the Space Station (Starts at 10:05am) (all channels)

**Tuesday, November 3**

12:30 p.m., ISS Expedition 45 In-Flight Interviews with Fox News Channel’s “Fox and Friends” and the CBS Evening News with Scott Pelley with ISS Commander Scott Kelly of NASA (Starts at 12:25 pm) (all channels)

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

- Oct 30 - Progress MS-5 Soyuz-U Launch (International Space Station 66P)
- Oct 30 - European Summer Time Ends - Set Clock Back 1 Hour (European Union)
- Oct 30 - Venus Passes 3.0 Degrees From Saturn
- Oct 30 - Comet 30P/Reinmuth At Opposition (2.012 AU)
- Oct 30 - Comet 79P/du Toit-Hartley At Opposition (3.543 AU)
- Oct 30 - Comet 231P/LINEAR-NEAT At Opposition (3.672 AU)
- Oct 30 - Asteroid 21459 Chrisrussel Closest Approach To Earth (1.357 AU)
- Oct 30 - Asteroid 4252 Godwin Closest Approach To Earth (2.054 AU)
- Oct 30 - Asteroid 4999 MPC Closest Approach To Earth (2.061 AU)
- Oct 30 - Centaur Object 20461 Dioretsa At Opposition (27.633 AU)
- Oct 30 - Asteroid 21459 Chrisrussel Closest Approach To Earth (1.357 AU)
- Oct 30 - Asteroid 4252 Godwin Closest Approach To Earth (2.054 AU)
- Oct 30 - Asteroid 4999 MPC Closest Approach To Earth (2.061 AU)
- Oct 30 - Centaur Object 20461 Dioretsa At Opposition (27.633 AU)
- Oct 31 - Comet 2P/Encke Closest Approach To Earth (1.301 AU)
- Oct 31 - Apollo Asteroid 164121 (2003 YT1) Near-Earth Flyby (0.035 AU)
- Oct 31 - Aten Asteroid 3753 Cruithne Closest Approach To Earth (0.511 AU)
- Oct 31 - Asteroid 443 Photographica Closest Approach To Earth (1.276 AU)
- Oct 31 - Asteroid 2866 Hardy Closest Approach To Earth (1.561 AU)
- Oct 31 - Asteroid 1489 Attila Closest Approach To Earth (2.550 AU)
- Oct 31 - 80th Anniversary (1936), 1st Successful Rocket Engine Test in Pasadena, California (JPL's Beginnings)
- Nov 01 - Cassini, Distant Flyby of Telesto & Polydeuces
- Nov 01 - Comet 221P/LINEAR At Opposition (2.791 AU)
- Nov 01 - Apollo Asteroid 2006 KC Near-Earth Flyby (0.086 AU)
- Nov 01 - Asteroid 73491 Robmatson Closest Approach To Earth (1.728 AU)
- Nov 01 - Asteroid 12818 Tomhanks Closest Approach To Earth (1.749 AU)
- Nov 01 - Asteroid 13801 Kohlhase Closest Approach To Earth (1.933 AU)
- Nov 01 - Kuiper Belt Object 2014 UM33 At Opposition (43.002 AU)
- Nov 01 - Cassini, 75th Anniversary (1941), Ansel Adams Takes Moonrise Photo Over Hernandez, New Mexico
- Nov 02 - Cassini, Orbital Trim Maneuver #463 (OTM-463)
- Nov 02 - Comet 225P/LINEAR Closest Approach To Earth (0.999 AU)
- Nov 02 - Comet P/2005 S3 (Read) Perihelion (2.821 AU)
- Nov 03 - Taurids Meteor Shower Peak
- Nov 03 - Comet C/2015 T2 (PANSTARRS) At Opposition (6.014 AU)
- Nov 03 - Atten Asteroid 2012 XS111 Near-Earth Flyby (0.077 AU)
- Nov 03 - Asteroid 4321 Zero Closest Approach To Earth (1.249 AU)
- Nov 03 - Asteroid 70783 Kenwilliams Closest Approach To Earth (1.276 AU)
- Nov 03 - Asteroid 6824 Mallory Closest Approach To Earth (1.525 AU)
- Nov 03 - Asteroid 6128 Lasorda Closest Approach To Earth (1.931 AU)
- Nov 03 - Asteroid 9446 Cicero Closest Approach To Earth (2.512 AU)
- Nov 03 - Asteroid 1712 Angola Closest Approach To Earth (2.563 AU)
- Nov 03 - Neptune Trojan 2006 RJ103 At Opposition (29.293 AU)

Source: JPL Space Calendar
Food for Thought

Exploring the Seas, Thanks to Space

An underwater robot initially built to help astronauts train for life in weightlessness is now being tested in the Mediterranean Sea. One day, robots like this may carry out sophisticated missions on our ocean floors, from finding lost aircraft black boxes to mining minerals or maintaining the sites of ancient pirate shipwrecks.

In space stations, robots are playing an increasingly important role. These days, if an astronaut needs to carry out a minor fix, it might well be that a mechanical arm hands them their tools.

But human–robot teamwork in weightlessness can be tricky. If the astronaut is unused to working with a mechanical arm, the tool might go floating off.

So when ESA decided to build a robot assistant they wanted a way for astronauts to practise grasping tools proffered in space – before ever leaving Earth.

Working with Italy's Thales Alenia Space, ESA built a replica – the Eurobot Wet Model – and put it in a swimming pool for astronauts gain experience with the robot in weightlessness.

With experience developing robotic manipulators, Italian company Graal Tech came onboard to help. Their robot has three limbs, each of which does double duty as a walking leg or a grasping arm.

Next, they covered the robot with floatation devices. “We had to add a lot of ‘fat,’ to each single arm,” said Graal Tech’s Alessio Turetta. “In the end it looked like the Michelin Man.”

While this created a robot with neutral buoyancy in each and every part, it was too fat and difficult to manoeuvre.

To solve this, the team tinkered with its movement pattern. They introduced a ‘crab walk’ that gave the limbs all the room they needed. It worked: Graal Tech’s robot has been used ever since by astronauts practising in the pool at ESA’s European Astronaut Centre in Cologne, Germany.

From space to under the sea

Working in space led the company to take to the seas. After the ESA project ended, in 2006, Graal Tech capitalised on the underwater expertise.

Most existing underwater robots on the market are hydraulic. While they offer strength, they have relatively little fine control. Graal Tech’s is electric-powered, however, capable of both fine movement and targeted actions.
“We realised that our ESA astronaut robot technology was good enough to commercialise,” said Alessio. With the help of European Commission funding, they did just that.

One of the first requests came from Giuseppe Casalino, robotics professor at the University of Genoa in Italy. He wanted to prototype a robot that might one day scour the ocean’s floor for archaeological items or even a blackbox from a lost aircraft.

He liked the electrical arms developed for the Eurobot Wet Model because of their ability to perform precise tasks, without compromising too much on strength.

Source: ESA
Space Image of the Week

Hubble View: Smoke Ring for a Halo

**Explanation:** Two stars shine through the center of a ring of cascading dust in this image taken by the NASA/ESA Hubble Space Telescope. The star system is named DI Cha, and while only two stars are apparent, it is actually a quadruple system containing two sets of binary stars.

As this is a relatively young star system it is surrounded by dust. The young stars are molding the dust into a wispy wrap.

The host of this alluring interaction between dust and star is the Chamaeleon I dark cloud — one of three such clouds that comprise a large star-forming region known as the Chamaeleon Complex. DI Cha's juvenility is not remarkable within this region. In fact, the entire system is among not only the youngest but also the closest collections of newly formed stars to be found and so provides an ideal target for studies of star formation.

**Image credit:** ESA/Hubble & NASA, Acknowledgement: Judy Schmidt

**Text credit:** European Space Agency

Source: [NASA Image of the Day](https://sci.esa.int/archive acquisition)