

Space News Update

– November 7, 2017 –

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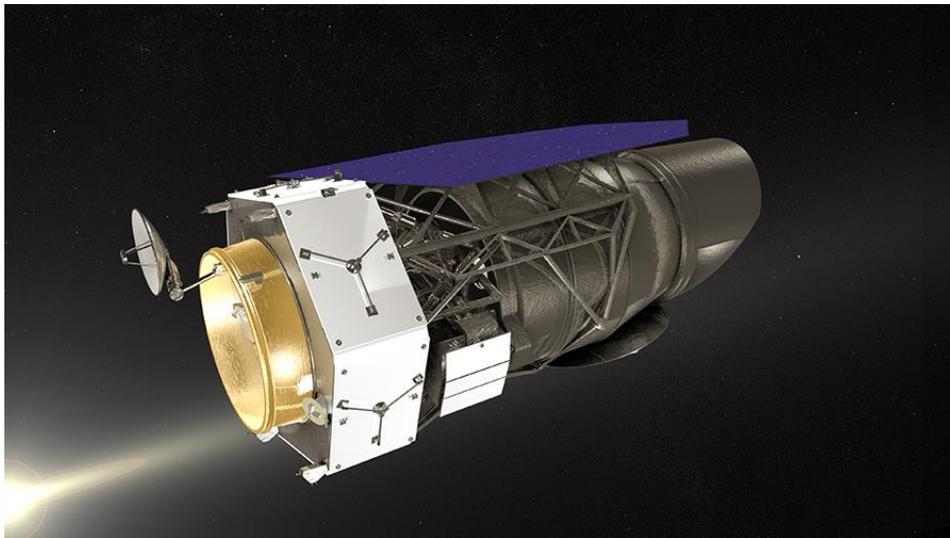
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1. WFIRST Astronomy Mission Faces Cuts to Contain Rising Costs



Artist's concept of the WFIRST observatory. Credit: NASA/GSFC

NASA has directed the team developing the Wide-Field Infrared Survey Telescope, a flagship astronomy mission set for launch in the mid-2020s to study dark energy and exoplanets, to reduce the observatory's scientific capabilities and keep it under a \$3.2 billion cost cap.

Fresh off their experience with cost growth on the James Webb Space Telescope, the huge observatory that precedes WFIRST in NASA's line of flagship-class space telescopes, officials do not want a repeat experience with the infrared surveyor that is just getting under development.

An independent technical, management and cost review panel set up by NASA earlier this year reported its findings last month, concluding that building, testing and launching the mission as currently envisioned will likely cost between \$3.9 billion and \$4.2 billion.

The head of the agency's science division directed officials Oct. 18 to look at ways to keep WFIRST's cost under \$3.2 billion.

"The bottom line is the current scope and complexity don't fit with the anticipated funds, so obviously something has to give," said Peter Michelson, chair of the physics department at Stanford University who served as co-chair of WFIRST's independent review panel. "That was the principle finding of the committee."

Originally envisioned as an observatory with primary mirror around 3.9 feet (1.2 meters) in diameter, WFIRST is now slated to use optics measuring nearly 7.9 feet (2.4 meters) across, the same size as the Hubble Space Telescope.

The bigger mirror was gifted to NASA in 2012 by the National Reconnaissance Office, the U.S. government's spy satellite agency. NASA decided to repurpose the optics for WFIRST, which was then projected to cost around \$1.6 billion. The larger telescope will give WFIRST the same sharp vision as Hubble, but with a field-of-view 100 times wider.

Mission planners also added a second instrument to WFIRST, a coronagraph designed to block light originating from nearby stars to detect the faint reflections from their planetary companions. Such an instrument has never flown in space before, but it could give astronomers a powerful new tool to gauge the habitability of exoplanets.

And managers decided to position WFIRST in a halo-type orbit around the L2 Lagrange point nearly a million miles (1.5 million kilometers) from Earth, affording it mostly-interrupted views of the universe. A previously-planned inclined geostationary orbit around 22,000 miles (36,000 kilometers) from Earth would have limited WFIRST's observing times.

The larger telescope and distant placement of WFIRST led to the requirement for a heavier, more expensive spacecraft, and a bigger rocket to launch it. Instead of launching on a basic, single-booster Atlas 5 or Falcon 9 rocket as initially planned, WFIRST now requires a triple-core Delta 4-Heavy or Falcon Heavy rocket because it will weigh more than 16,000 pounds (7.3 metric tons), plus on-board fuel.

“Normally, the saying goes that with every challenge, there are tremendous opportunities, said Orlando Figueroa, co-chair of the review panel and the former head of NASA’s Mars exploration program. “When someone gives you a telescope of a bigger size, with every opportunity come incredible challenges. This (also) opens the door for significantly greater science.”

WFIRST managers also decided to make the observatory serviceable, incorporating panels that could be opened in space to access internal instruments and avionics.

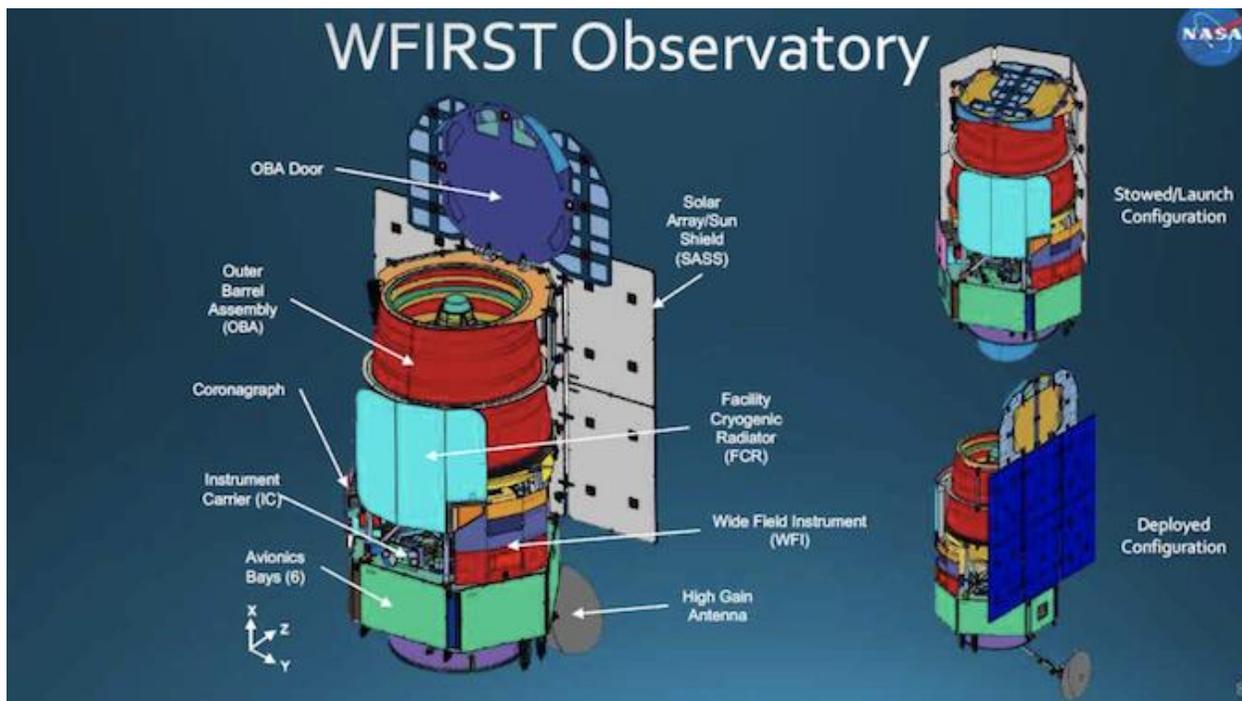
The high-resolution maps created by WFIRST will require a huge data archive and software to pick out the most promising data. Officials planned to create two science data centers — one in Maryland and one in California — to store the WFIRST archive.

NASA’s internal WFIRST cost estimate stands at \$3.6 billion, but reviewers pegged WFIRST’s projected cost at \$3.9 billion, a figure which includes additional reserves that could be applied to the mission if it runs into trouble.

The review board also suggested NASA reclassify WFIRST as a “Class A” mission, the agency’s most risk-averse mission classification, which is typically reserved for large-scale, costly strategic programs, such as JWST and the Mars 2020 rover. NASA currently considers WFIRST a “Class B” mission, which means managers would accept higher risks and make more compromises during development.

But Class B missions also give managers more flexibility and decision-making authority, so making WFIRST a Class A mission would add another \$250 million to \$300 million in cost, ballooning its total budget to around \$4.2 billion.

Thomas Zurbuchen, associate administrator for NASA’s science directorate, said he accepted the review panel’s findings. Zurbuchen told the director of the Goddard Space Flight Center that he believed “reductions in scope and complexity” are needed on WFIRST to keep it under a preset cost cap of \$3.2 billion, a budget ceiling set to ensure the rest of NASA’s astrophysics portfolio does not suffer from WFIRST overruns.

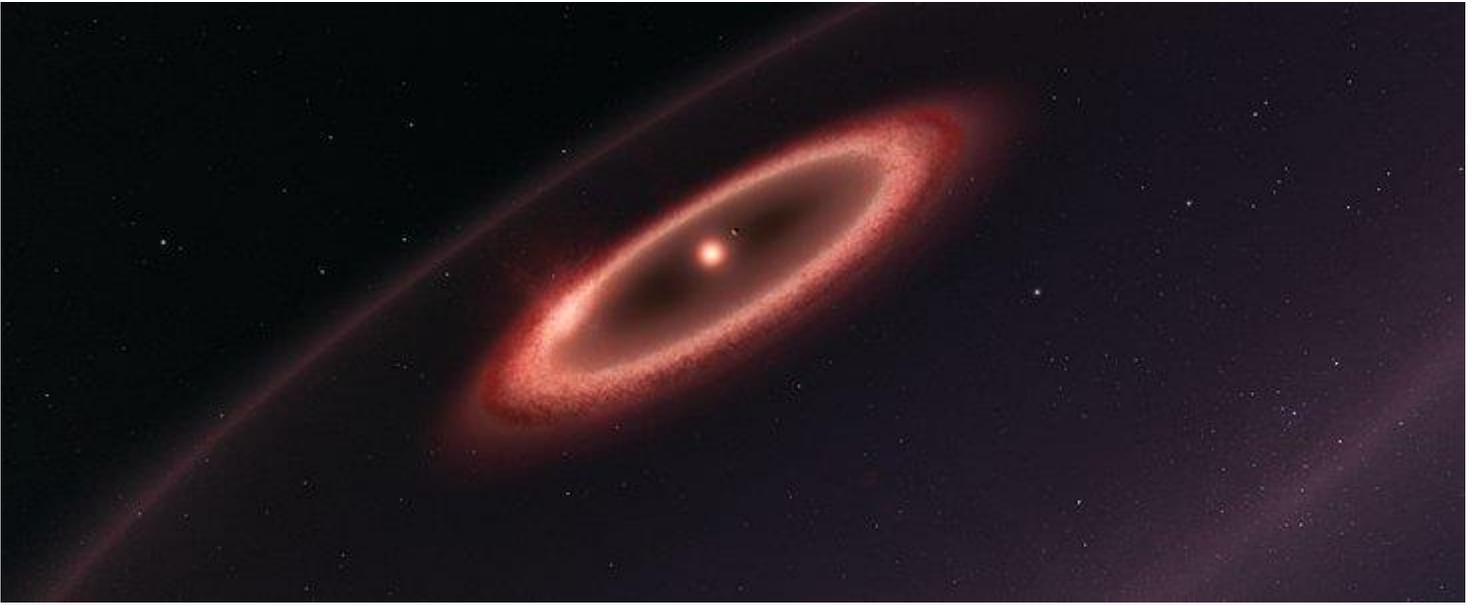


A diagram of the WFIRST observatory. Credit: NASA

Source: [Spaceflight Now](#)

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2. ALMA Discovers Cold Dust Around Nearest Star



Artist's impression of the dust belts around Proxima Centauri

The ALMA Observatory in Chile has detected dust around the closest star to the Solar System, Proxima Centauri. These new observations reveal the glow coming from cold dust in a region between one to four times as far from Proxima Centauri as the Earth is from the Sun. The data also hint at the presence of an even cooler outer dust belt and may indicate the presence of an elaborate planetary system. These structures are similar to the much larger belts in the Solar System and are also expected to be made from particles of rock and ice that failed to form planets.

Proxima Centauri is the closest star to the Sun. It is a faint red dwarf lying just four light-years away in the southern constellation of Centaurus (The Centaur). It is orbited by the Earth-sized temperate world Proxima b, discovered in 2016 and the closest planet to the Solar System. But there is more to this system than just a single planet. The new ALMA observations reveal emission from clouds of cold cosmic dust surrounding the star.

The lead author of the new study, Guillem Anglada [1], from the Instituto de Astrofísica de Andalucía (CSIC), Granada, Spain, explains the significance of this find: "*The dust around Proxima is important because, following the discovery of the terrestrial planet Proxima b, it's the first indication of the presence of an elaborate planetary system, and not just a single planet, around the star closest to our Sun.*"

Dust belts are the remains of material that did not form into larger bodies such as planets. The particles of rock and ice in these belts vary in size from the tiniest dust grain, smaller than a millimeter across, up to asteroid-like bodies many kilometers in diameter [2].

Dust appears to lie in a belt that extends a few hundred million kilometers from Proxima Centauri and has a total mass of about one hundredth of the Earth's mass. This belt is estimated to have a temperature of about -230 degrees Celsius, as cold as that of the Kuiper Belt in the outer Solar System.

There are also hints in the ALMA data of another belt of even colder dust about ten times further out. If confirmed, the nature of an outer belt is intriguing, given its very cold environment far from a star that is cooler and fainter than the Sun. Both belts are much further from Proxima Centauri than the planet Proxima b, which orbits at just four million kilometers from its parent star [3].

Guillem Anglada explains the implications of the discovery: *"This result suggests that Proxima Centauri may have a multiple planet system with a rich history of interactions that resulted in the formation of a dust belt. Further study may also provide information that might point to the locations of as yet unidentified additional planets."*

Proxima Centauri's planetary system is also particularly interesting because there are plans — the Starshot project — for future direct exploration of the system with microprobes attached to laser-driven sails. A knowledge of the dust environment around the star is essential for planning such a mission.

Co-author Pedro Amado, also from the Instituto de Astrofísica de Andalucía, explains that this observation is just the start: *"These first results show that ALMA can detect dust structures orbiting around Proxima. Further observations will give us a more detailed picture of Proxima's planetary system. In combination with the study of protoplanetary discs around young stars, many of the details of the processes that led to the formation of the Earth and the Solar System about 4600 million years ago will be unveiled. What we are seeing now is just the appetizer compared to what is coming!"*

Notes:

[1] In a cosmic coincidence, the lead author of the study, Guillem Anglada shares his name with the astronomer who led the team that discovered Proxima Centauri b, Guillem Anglada-Escudé, himself a co-author of the paper in which this research is published, although the two are not related.

[2] Proxima Centauri is quite an old star, of similar age to the Solar System. The dusty belts around it are probably similar to the residual dust in the Kuiper Belt and the asteroid belt in the Solar System and the dust that creates the Zodiacal Light. The spectacular discs that ALMA has imaged around much younger stars, such as HL Tauri, contain much more material that is in the process of forming planets.

[3] The apparent shape of the very faint outer belt, if confirmed, would give astronomers a way to estimate the inclination of the Proxima Centauri planetary system. It would appear elliptical due to the tilt of what is assumed to be in reality a circular ring. This would in turn allow a better determination of the mass of the Proxima b planet, which is currently known only as a lower limit.

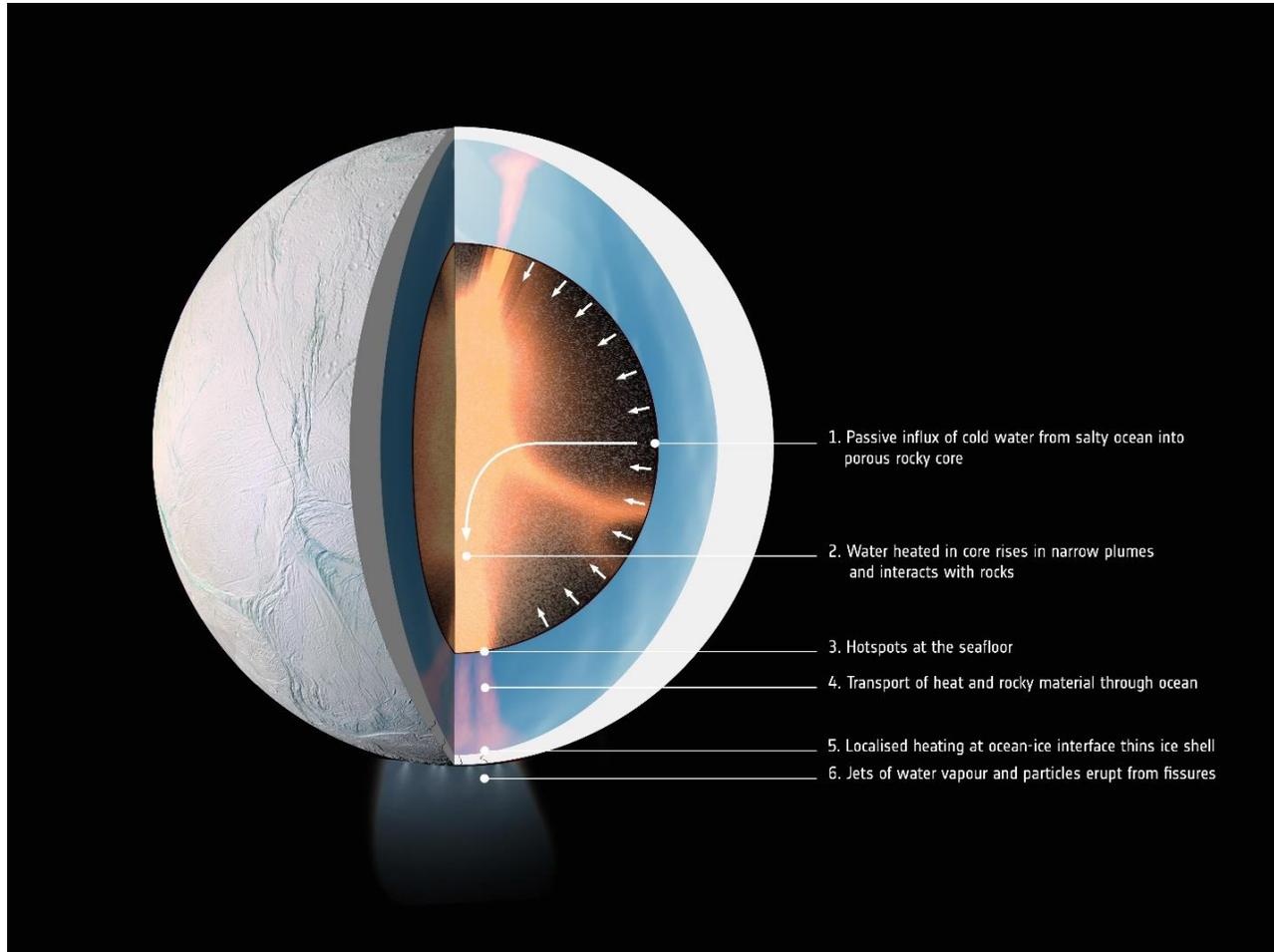
This research was presented in a paper entitled "ALMA Discovery of Dust Belts Around Proxima Centauri", by Guillem Anglada et al., to appear in *Astrophysical Journal Letters*.

The team is composed of Guillem Anglada (Instituto de Astrofísica de Andalucía (CSIC), Granada, Spain [IAA-CSIC]), Pedro J. Amado (IAA-CSIC), Jose L. Ortiz (IAA-CSIC), José F. Gómez (IAA-CSIC), Enrique Macías (Boston University, Massachusetts, USA), Antxon Alberdi (IAA-CSIC), Mayra Osorio (IAA-CSIC), José L. Gómez (IAA-CSIC), Itziar de Gregorio-Monsalvo (ESO, Santiago, Chile; Joint ALMA Observatory, Santiago, Chile), Miguel A. Pérez-Torres (IAA-CSIC; Universidad de Zaragoza, Zaragoza, Spain), Guillem Anglada-Escudé (Queen Mary University of London, London, United Kingdom), Zaira M. Berdiñas (Universidad de Chile, Santiago, Chile; IAA-CSIC), James S. Jenkins (Universidad de Chile, Santiago, Chile), Izaskun Jimenez-Serra (Queen Mary University of London, London, United Kingdom), Luisa M. Lara (IAA-CSIC), Maria J. López-González (IAA-CSIC), Manuel López-Puertas (IAA-CSIC), Nicolas Morales (IAA-CSIC), Ignasi Ribas (Institut de Ciències de l'Espai (IEEC-CSIC), Bellaterra, Spain), Anita M. S. Richards (JBCA, University of Manchester, Manchester, United Kingdom), Cristina Rodríguez-López (IAA-CSIC) and Eloy Rodríguez (IAA-CSIC).

Source: [European Southern Observatory](#)

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3. Heating Ocean Moon Enceladus for Billions Of Years



Enough heat to power hydrothermal activity inside Saturn's ocean moon Enceladus for billions of years could be generated through tidal friction if the moon has a highly porous core, a new study finds, working in favour of the moon as a potentially habitable world.

A paper published in *Nature Astronomy* today presents the first concept that explains the key characteristics of 500 km-diameter Enceladus as observed by the international Cassini spacecraft over the course of its mission, which concluded in September.

This includes a global salty ocean below an ice shell with an average thickness of 20–25 km, thinning to just 1–5 km over the south polar region. There, jets of water vapor and icy grains are launched through fissures in the ice. The composition of the ejected material measured by Cassini included salts and silica dust, suggesting they form through hot water – at least 90°C – interacting with rock in the porous core.

These observations require a huge source of heat, about 100 times more than is expected to be generated by the natural decay of radioactive elements in rocks in its core, as well as a means of focusing activity at the south pole.

The tidal effect from Saturn is thought to be at the origin of the eruptions deforming the icy shell by push-pull motions as the moon follows an elliptical path around the giant planet. But the energy produced by tidal friction in the ice, by itself, would be too weak to counterbalance the heat loss seen from the ocean – the globe would freeze within 30 million years.

As Cassini has shown, the moon is clearly still extremely active, suggesting something else is happening.

“Where Enceladus gets the sustained power to remain active has always been a bit of mystery, but we've now considered in greater detail how the structure and composition of the moon's rocky core could play a key role in generating the necessary energy,” says lead author Gaël Choblet from the University of Nantes in France.

In the new simulations the core is made of unconsolidated, easily deformable, porous rock that water can easily permeate. As such, cool liquid water from the ocean can seep into the core and gradually heat up through tidal friction between sliding rock fragments, as it gets deeper.

Water circulates in the core and then rises because it is hotter than the surroundings. This process ultimately transfers heat to the base of the ocean in narrow plumes where it interacts strongly with the rocks. At the seafloor, these plumes vent into the cooler ocean.

One seafloor hotspot alone is predicted to release as much as 5 GW of energy, roughly corresponding to the annual geothermal power consumed in Iceland.

Such seafloor hotspots generate ocean plumes rising at a few centimeters per second. Not only do the plumes result in strong melting of the ice crust above, but they can also carry small particles from the seafloor, over weeks to months, which are then released into space by the icy jets.

Moreover, the authors' computer models show that most water should be expelled from the moon's polar regions, with a runaway process leading to hot spots in localised areas, and thus a thinner ice shell directly above, consistent with what was inferred from Cassini.

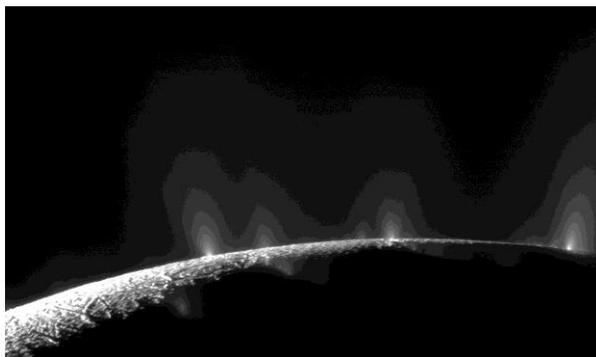
“Our simulations can simultaneously explain the existence of an ocean at a global scale due to large-scale heat transport between the deep interior and the ice shell, and the concentration of activity in a relatively narrow region around the south pole, thus explaining the main features observed by Cassini,” says co-author Gabriel Tobie, also from the University of Nantes.

The scientists say that the efficient rock–water interactions in a porous core massaged by tidal friction could generate up to 30 GW of heat over tens of millions to billions of years.

“Future missions capable of analyzing the organic molecules in the Enceladus plume with a higher accuracy than Cassini would be able to tell us if sustained hydrothermal conditions could have allowed life to emerge,” says Nicolas Altobelli, ESA's Cassini project scientist.

A future mission equipped with ice-penetrating radar would also be able to constrain the ice thickness, and additional flybys – or an orbiting craft – would improve models of the interior, further verifying the presence of active hydrothermal plumes.

“We'll be flying next-generation instruments, including ground-penetrating radar, to Jupiter's ocean moons in the next decade with ESA's Juice mission, which is specifically tasked with trying to understand the potential habitability of ocean worlds in the outer Solar System,” adds Nicolas.



This mosaic was created from two high-resolution images that were captured by the narrow-angle camera when NASA's Cassini spacecraft flew past Enceladus and through the jets on Nov. 21, 2009.

Credits: NASA/JPL/Space Science Institute

Source: [ESA](#)

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The Night Sky

Tuesday, November 7

- Algol should be at its minimum brightness, magnitude 3.4 instead of its usual 2.3, for a couple hours centered on 10:56 p.m. Eastern Standard Time.

Wednesday, November 8

- Now that the Moon is out of the sky in early to mid-evening, the big Silver Coin Galaxy, NGC 254 in Sculptor, awaits you. It's 7° south of 2nd-magnitude Beta Ceti (locate this star with Monday's entry above). Seven degrees is a little more than the width of a typical binocular's field of view.
- The galaxy is large and diffuse, so a really dark sky is a big help. Under good sky conditions binoculars show it easily.

Thursday, November 9

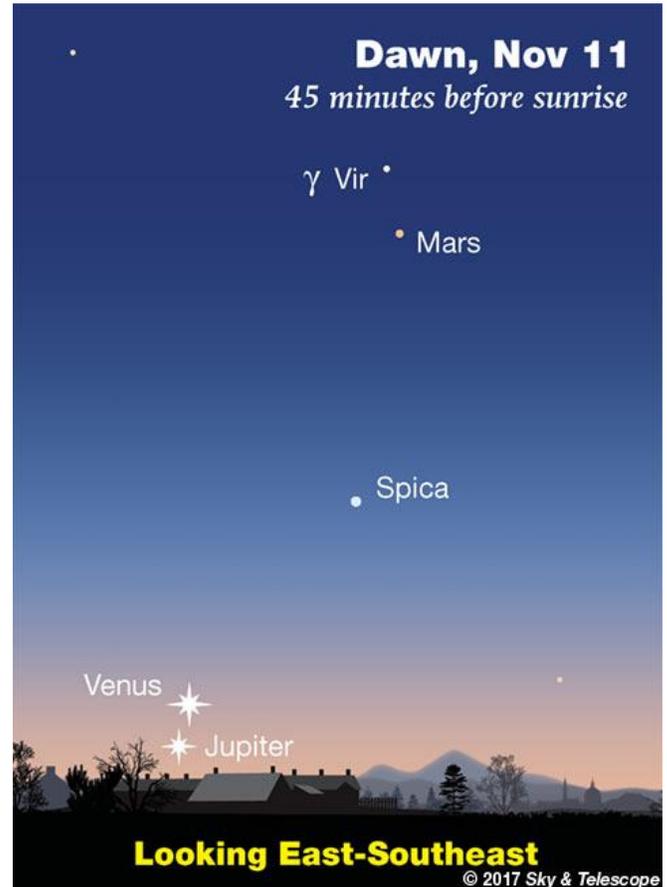
- The last-quarter Moon rises tonight around 10 or 11 p.m. standard time, in the east-northeast below Pollux and Castor in Gemini. Use them to tell where on the horizon to watch for it!
- Happy 83rd birthday, Carl Sagan (November 9, 1934 – December 20, 1996). If only.

Friday, November 10

- Plan for this now: In broad daylight on Saturday morning the Moon, just past last quarter, occults Regulus for much of North America. You'll need a telescope and very clear air. The star disappears on the Moon's bright limb and reappears from behind the dark limb.
- • Algol should be at its minimum brightness, magnitude 3.4 instead of its usual 2.3, for a couple hours centered on 7:45 p.m. Eastern Standard Time.

Saturday, November 11

- Vega is the brightest star in the west in early evening. Its little constellation Lyra extends to the left. Somewhat farther left, by about a fist and a half at arm's length from Vega, is 3rd-magnitude Albireo, the beak of Cygnus. This is one of the finest and most colorful double stars for small telescopes.



By the end of the week, Jupiter is creeping up on Venus from below.

ISS Sighting Opportunities (from Denver)

Date	Visible	Max Height	Appears	Disappears
Wed Nov 8, 5:52 AM	1 min	10°	10° above N	10° above NNE
Thu Nov 9, 5:01 AM	< 1 min	10°	10° above N	10° above N
Fri Nov 10, 5:44 AM	3 min	13°	10° above NNW	10° above NE
Sat Nov 11, 4:53 AM	< 1 min	11°	11° above NNE	10° above NNE

Sighting information for other cities can be found at [NASA's Satellite Sighting Information](#)

NASA-TV Highlights (all times Eastern Time Zone)

Wednesday, November 8

- 9:30 a.m. - ISS Expedition 53 Educational In-Flight Event with the Pole Green Elementary School in Mechanicsville, Virginia and ISS Commander Randy Bresnik and Flight Engineers Joe Acaba and Mark Vande Hei of NASA (starts at 9:45 a.m.) (all channels)

Friday, November 10

- 11 a.m. - Orbital ATK CRS-8 Cargo Resupply Mission Pre Launch News Conference (all channels)
- 3 p.m. - Orbital ATK CRS-8 Cargo Resupply Mission What's on Board Briefing (all channels)

Saturday, November 11

- 7 a.m., - Coverage of the Launch of the Orbital ATK Antares/Cygnus on the CRS-8 Mission to the ISS (Launch scheduled at 7:37 a.m. ET) (all channels)
- 9 a.m. - Coverage of the Solar Array Deployment on the Orbital ATK Cygnus Cargo Craft (all channels)

Watch NASA TV online by going to the [NASA website](#).

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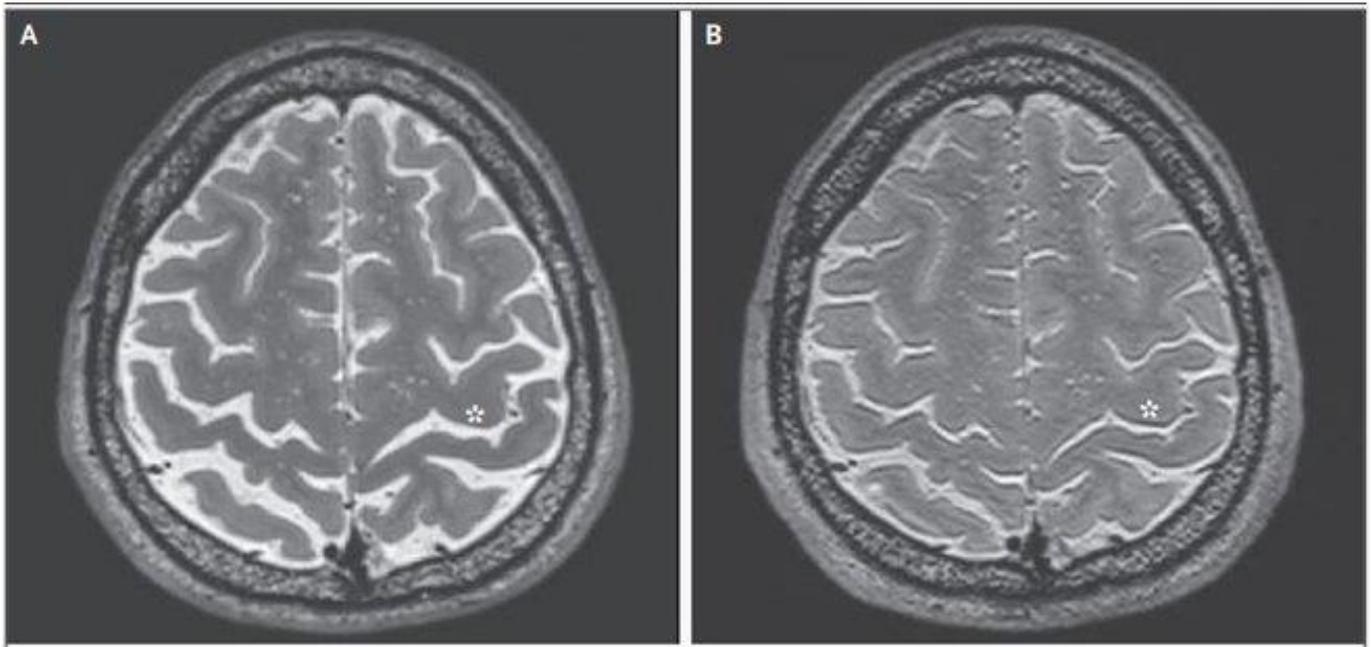
- **Nov 07 - [MN35-13 Vega Launch](#)**
- Nov 07 - [Asteroid 4825 Ventura](#) Closest Approach To Earth (0.947 AU)
- Nov 07 - [Asteroid 991 McDonald](#) Closest Approach To Earth (2.093 AU)
- Nov 07 - [Symposium on Space Elevators](#), London, United Kingdom
- Nov 07 - [Colloquium: Earth's Earliest Evolution - Fire From Above, Fire From Below](#), Tucson,
- Nov 08 - [Comet 73P-U/Schwassmann-Wachmann](#) At Opposition (2.236 AU)
- Nov 08 - [Comet 73P-AA/Schwassmann-Wachmann](#) Closest Approach To Earth (2.932 AU)
- Nov 08 - [Comet 87P/Bus](#) At Opposition (3.629 AU)
- Nov 08 - [Aten Asteroid 2340 Hathor](#) Closest Approach To Earth (0.532 AU)
- Nov 08 - [Asteroid 5049 Sherlock](#) Closest Approach To Earth (0.927 AU)
- Nov 08 - [Asteroid 6560 Pravdo](#) Closest Approach To Earth (1.616 AU)
- Nov 08 - [Asteroid 469 Argentina](#) Closest Approach To Earth (2.561 AU)
- Nov 08 - [The Isaac Newton Lecture: The Standard Model of Cosmology](#), London, United Kingdom
- Nov 08 - [Lectures: Mars - Man or Machine?](#), Hatfield, United Kingdom
- Nov 08 - [Colloquium: Venus - the Forgotten, Mysterious Planet](#), Greenbelt, Maryland
- Nov 08 - [Galaxy Forum Hawaii 2017](#), Kamuela, Hawaii
- Nov 09 - [Comet P/2016 G1 \(PANSTARRS\)](#) At Opposition (1.503 AU)
- Nov 09 - [Comet 31P/Schwassmann-Wachmann](#) Closest Approach To Earth (3.105 AU)
- Nov 09 - [Apollo Asteroid 2017 TZ3](#) Near-Earth Flyby (0.026 AU)
- Nov 09 - [Amor Asteroid 2017 SL2](#) Near-Earth Flyby (0.055 AU)
- Nov 09 - [Asteroid 5392 Parker](#) Closest Approach To Earth (1.513 AU)
- Nov 09 - [Apollo Asteroid 6239 Minos](#) Closest Approach To Earth (1.666 AU)
- Nov 09 - [EconSpace Summit: A New Space Age](#), Seattle, Washington
- Nov 09 - [Lecture: Globular Clusters - Mysteries Inside an Enigma](#), Ithaca, New York
- Nov 10 - [Apollo Asteroid 2017 UL7](#) Near-Earth Flyby (0.055 AU)
- Nov 10 - [Amor Asteroid 2017 UN7](#) Near-Earth Flyby (0.067 AU)
- Nov 10 - [Amor Asteroid 2017 UA43](#) Near-Earth Flyby (0.077 AU)
- Nov 10 - [Asteroid 19482 Harperlee](#) Closest Approach To Earth (2.595 AU)
- Nov 10 - [Asteroid 3202 Graff](#) Closest Approach To Earth (2.740 AU)
- Nov 10 - [Standing up for Science Media Workshop](#), Warsaw, Poland
- Nov 10 - [Royal Astronomical Society Ordinary Meeting](#), London, United Kingdom
- Nov 10 - [Meeting: Solar Orbiter - Synergy between Observations and Theory](#), London, United Kingdom
- Nov 10 - [Meeting: The Initial Mass Function - From Top to Bottom](#), London, United Kingdom
- Nov 10 - [Lecture: Once Explorers; Always Explorers - Europe's Role in Space Exploration](#), Bristol, United Kingdom
- Nov 10-11 - [Conference: New Worlds 2017](#), Austin, Texas
- Nov 10-11 - [117th Topical Symposium of The New York State Section of The American Physical Society/2017 Fall Meeting of The Astronomical Society of New York: Gravitational Waves](#), Schenectady, New York

Source: [JPL Space Calendar](#)

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Food for Thought

Study Unveils Changes in the Brain during Extended Missions in Space



An MRI of an astronaut's brain before (panel A) and after (panel B) a long-duration spaceflight. Credit: The New England Journal of Medicine ©2017

It's been 55 years since NASA astronaut John Glenn successfully launched into space to complete three orbits aboard the Friendship 7 Mercury spacecraft, becoming the first American to orbit the Earth. The evolution of spaceflight, advancements in science and technologies and the progress of public-private commercial partnerships with companies such as Space X and Blue Horizons have strengthened NASA's goals and the public's confidence to move forward in discovery and human exploration.

More people today are poised to explore space than ever before; those who do will experience the effects of microgravity on the human body. Recognizing the need for data related to those effects, MUSC neuroradiologist Donna Roberts, M.D., conducted a study titled "Effects of Spaceflight on Astronaut Brain Structure as Indicated on MRI," the results of which will be featured in the Nov. 2 issue of the *New England Journal of Medicine*.

"Exposure to the space environment has permanent effects on humans that we simply do not understand. What astronauts experience in space must be mitigated to produce safer space travel for the public," said Roberts.

While living and working in space can be exciting, space is a hostile environment and presents many physiological and psychological challenges for the men and women of America's space program. For example, NASA astronauts have experienced altered vision and increased pressure inside their heads during spaceflight aboard the International Space Station. These conditions can be serious problems for astronauts, particularly if they occur in low-earth orbit aboard the International Space Station or far from Earth, such as on an exploration mission to Mars.

To describe these symptoms, NASA coined the term visual impairment intracranial pressure syndrome, or VIIP syndrome for short. The cause of VIIP syndrome is thought to be related to the redistribution of body fluid toward the head during long-term microgravity exposure; however, the exact cause is unknown. Given safety

concerns and the potential impact to human exploration goals, NASA has made determining the cause of VIIP syndrome and how to resolve its effects a top priority.

Roberts is an associate professor of radiology in the Department of Radiology and Radiological Sciences at the Medical University of South Carolina (MUSC). Before attending medical school at MUSC, she worked at NASA Headquarters in Washington, D.C. Working with NASA's Space Life Sciences Division in the early 1990s, she was already aware of the challenges astronauts faced during long-duration spaceflights. She was concerned about the lack of data describing the adaptation of the human brain to microgravity and proposed to NASA that magnetic resonance imaging (MRI) be used to investigate the anatomy of the brain following spaceflight.

Roberts suspected subtle anatomical changes in the brains of astronauts during spaceflight might be contributing to the development of VIIP syndrome, based on her earlier work. From 2001 to 2004, Roberts led a three-year NASA-funded bed rest study, collaborating with other life sciences researchers at the University of Texas Medical Branch in Galveston. A South Carolina native, Roberts had just completed a two-year neuroradiology fellowship at the University of California at San Francisco.

For this study, she examined the brains and muscular responses of participants who stayed in bed for 90 days, during which time, they were required to keep their heads continuously tilted in a downward position to simulate the effects of microgravity.

Using functional MRI, Roberts evaluated brain neuroplasticity, studying the brain's motor cortex before, during and after long-term bed rest. Results confirmed neuroplasticity in the brain occurred during bed rest, which correlated with functional outcomes of the subjects.

As Roberts evaluated the brain scans, she saw something unusual. She noted a "crowding" occurrence at the vertex, or top of the brain, with narrowing of the gyri and sulci, the bumps and depressions in the brain that give it its folded appearance. This crowding was worse for participants who were on longer bed rest in the study.

Roberts also saw evidence of brain shifting and a narrowing of the space between the top of the brain and the inner table of the skull. She questioned if the same thing might be happening to the astronauts during spaceflight.

In further studies, Roberts acquired brain MRI scans and related data from NASA's Lifetime Surveillance of Astronaut Health program for two groups of astronauts: 18 astronauts who had been in space for short periods of time aboard the U.S. Space Shuttle and 16 astronauts who had been in space for longer periods of time, typically three months, aboard the International Space Station. Roberts and her team then compared the brain images of the two groups of astronauts.

Roberts and study investigators evaluated the cerebrospinal fluid (CSF) spaces at the top of the brain and CSF-filled structures, called ventricles, located at the center of the brain. In addition, the team paired the preflight and postflight MRI cine clips from high-resolution 3-D imaging of 12 astronauts from long-duration flights and six astronauts from short-duration flights and looked for any displacement in brain structure.

Study results confirmed a narrowing of the brain's central sulcus, a groove in the cortex near the top of the brain that separates the parietal and frontal lobes, in 94 percent of the astronauts who participated in long-duration flights and 18.8 percent of the astronauts on short-duration flights. Cine clips also showed an upward shift of the brain and narrowing of the CSF spaces at the top of the brain among the long-duration flight astronauts but not in the short-duration flight astronauts.

Her findings concluded that significant changes in brain structure occur during long-duration space flight. More importantly, the parts of the brain that are most affected - the frontal and parietal lobes - control movement of

the body and higher executive function. The longer an astronaut stayed in space, the worse the symptoms of VIIP syndrome would be.

Roberts compared these findings with a similar medical syndrome experienced by women called idiopathic intracranial hypertension (IIH), which affects young, overweight women who present with symptoms similar to VIIP syndrome: blurry vision and high intracranial pressure with no known cause. A common treatment for IIH is to perform a lumbar puncture, whereby CSF is drained using a needle placed in the lower back - a procedure performed by a neuroradiologist such as Roberts. Presently, there is no protocol to perform a lumbar puncture in a microgravity environment.

To further understand the results of the study, Roberts and the team plan to compare repeated postflight imaging of the brains of astronauts to determine if the changes are permanent or if they will return to baseline following some time back on Earth. With NASA's Mars expedition mission set to launch in 2033, there's an urgency for researchers such as Roberts to collect more data about astronauts and understand the basics of human space physiology.

A journey to Mars can take three to six months, at best. In order to reduce travel time between the Earth and Mars, the two planets need to be aligned favorably, which occurs approximately every two years.

During this two-year time period, crew members would remain on Mars, carrying out exploration activities. The gravity on Mars is approximately one-third that of Earth. Considering travel to and from Mars, along with the time on the surface, the Martian expedition crew would be exposed to reduced gravity for at least three years, according to Roberts. What would that do to the human body? Could a human even survive that long in a reduced gravity environment?

NASA astronaut Scott Kelly spent 340 days living and working aboard the International Space Station, and astronaut Peggy Whitson recently completed a 288-day mission in space. To date, the longest continuous time in space was 438 days, a record held by Russian cosmonaut Valery Polyakov.

"We know these long-duration flights take a big toll on the astronauts and cosmonauts; however, we don't know if the adverse effects on the body continue to progress or if they stabilize after some time in space," Roberts said. "These are the questions that we are interested in addressing, especially what happens to the human brain and brain function?"

Study co-author and Department of Radiology and Radiological Science colleague Michael Antonucci, M.D., agreed. "This study is exciting in many ways, particularly as it lies at the intersection of two fascinating frontiers of human exploration - space and the brain."

"We have known for years that microgravity affects the body in numerous ways," he continued.

"However, this study represents the most comprehensive assessment of the impact of prolonged space travel on the brain. The changes we have seen may explain unusual symptoms experienced by returning space station astronauts and help identify key issues in the planning of longer-duration space exploration, including missions to Mars."

Roberts hopes to continue to collect long-term follow-up data on the astronauts already being studied. In addition, she is participating in a new bed rest study in Cologne, Germany, collaborating with Racheal Seidler, Ph.D., of the University of Florida and the German Space Agency. The study simulates astronauts living aboard the International Space Station, while being exposed to higher levels of carbon dioxide. Carbon dioxide scrubbers aboard the International Space Station clean and filter the air systems throughout the spacecraft, but some CO₂ remains. Roberts will evaluate the blood flow to the brain, brain structure and other changes among study subjects.

Space Image of the Week



Thor's Helmet Emission Nebula

Image Credit & Copyright: Adam Block, Mt. Lemmon SkyCenter, U. Arizona

Explanation: This helmet-shaped cosmic cloud with wing-like appendages is popularly called Thor's Helmet. Heroically sized even for a Norse god, Thor's Helmet spans about 30 light-years across. In fact, the helmet is more like an interstellar bubble, blown as a fast wind -- from the bright star near the center of the bubble's blue-hued region -- sweeps through a surrounding molecular cloud.

This star, a Wolf-Rayet star, is a massive and extremely hot giant star thought to be in a brief, pre-supernova stage of evolution. Cataloged as NGC 2359, the emission nebula is located about 12,000 light-years away toward the constellation of the Big Dog (Canis Major).

The sharp image, made using broadband and narrowband filters, captures striking details of the nebula's filamentary gas and dust structures. The blue color originates from strong emission from oxygen atoms in the nebula.

Source: [NASA APOD](#)

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