CORNELL ASTRONOMICAL SOCIETY NEWSLETTER

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LETTER FROM THE EDITOR

Greetings, readers, and I hope you're settling in nicely at Cornell! As we head through autumn, we have another newsletter for you all. In this edition, we'll give some book recommendations for cloudy nights, think back on our planet-observing all-nighter, and speculate on Europa missions to come. The CAS newsletter crossword also makes a return in this issue!

We've been busy these past few weeks at the Observatory, from attending Apple Fest, hosting an open house for the partial lunar eclipse last month, and even returning to HBO! Additionally, our Fall '24 Lecture Series has finally begun! Cornell Astronomy PhD student Francisco Blanco lectured about the theory behind gravitational waves and how to detect them. Cornell Astronomy professor Dong Lai discussed the extreme objects that form these gravitational waves the following week. Thanks to them both for their wonderful talks!

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Carl Sagan's birthday is coming up in just a few weeks, and Professor Shami Chatterjee will be delivering a lecture on a portion of his legacy: the Carl Sagan Institute and the search for extra-terrestrial life. Before that, we also have Irv's 102nd Anniversary lecture to look forward to, an online lecture delivered by Bart Fried, president of the Antique Telescope Society. I hope you'll enjoy these lectures!

Shane Kuo
Newsletter Editor-in-Chief

Aurora Borealis from the Fuertes Observatory
Credit: Erik Payton

THE CAS PLANETARY ALL-NIGHTER

BY TREYTON GRAHN & SHANE KUO

On the evening of September 2nd, CAS embarked on a mission to photograph every planet in one night. It's rare to have clear nights aligning with uncommon astronomical events, such as all 8 planets being visible in one night in Ithaca (usually, the clouds limit us to just one). Without further ado, we present what came of that night.

VENUS: 8:40 PM

Venus, 1x exposure with IPhone 11 Pro Max , Orion 100mm Tabletop Telescope
Credit: Treyton Grahn

Venus was the first planet that needed capturing. It had risen in the sky at around 08:00 AM that morning, but it was far too bright during the day to capture it. We were forced to try and capture it during the thin window between sunset and Venus becoming hidden by the nearby treeline. We were unable to obtain high-quality photos of Venus using Irv due to Venus being too close to the horizon once it was dark enough to view. This meant that we were forced to resort to setting up a Dobsonian telescope on a tabletop in an opening next to the observatory and taking a photo using a phone through the telescope's eyepiece.

The photo has quite poor resolution, and there is a visible dot in the center of the planet that appeared due to our inability to focus our finicky tabletop telescope on Venus in the few minutes we had before it disappeared behind the treeline. The dot, and the four-pointed star that's centered on it, are artifacts of the secondary mirror in the telescope we're using. As incoming light enters the telescope's aperture, part of it gets blocked by the secondary mirror that bounces light to the eyepiece. If not focused properly, you can see the mirror's characteristic shadow on any light source. The effects of the mirror and its support structure are even visible on perfectly focused telescopes, causing the distinct six-pointed cross that appears on JWST's images of stars and galaxies.

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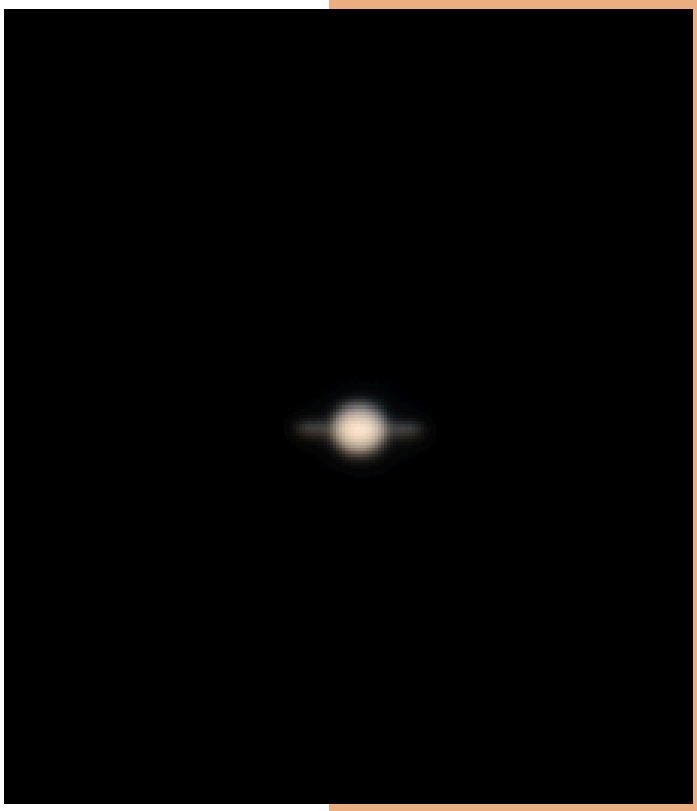
SATURN: 10:05 PM

Saturn was the next planet that we photographed. Saturn rose above the horizon at 07:49 PM, so by then, the sky was dark enough that we could photograph Saturn. We took 125 photos of the ringed planet at 250 ISO and a 1/10 second shutter speed using a Canon EOS 6D Mk II DSLR camera through Irv. If you're wondering what these numbers mean, the ISO measures light sensitivity; the higher your ISO, the more sensitive the camera is to light. However, this comes with a drawback. Higher ISOs are more likely to get false positives, increasing the noise of the image. Shutter speed represents how long the sensor on the camera is exposed to light. A longer shutter speed comes with better light sensitivity. It also runs the risk of motion blur from the telescope or camera moving compared to the stars. By taking over a hundred photos, we were able to reduce random noise and improve our image quality. With our longer total exposure time and better sensor, we could get higher-quality photos than a smartphone. Although it does take longer to stack the images, it is well worth it!



Saturn, 125x exposure with Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis, Erik Payton

NEPTUNE: 11:40 PM

Neptune rose at 10:13 PM as we were photographing Saturn. After it cleared the treeline about an hour or so later, we focused our attention on it and took 123 photos at 2000 ISO and a 3.2-second exposure time. As the planet is much dimmer and further away than Saturn, we needed to increase the light sensitivity of our DSLR to account for it. After stacking, we were even able to see Neptune's moon Triton!

Neptune and Triton, 123x exposure, Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor Telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis, Erik Payton

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Neptune, 123x exposure, Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor Telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis, Erik Payton

URANUS: 12:50 AM

Uranus would only rise above the horizon around 11:33 PM, an hour after Neptune. We needed to wait a while before Irv could capture the ice giant. Once it was high enough above the horizon to be visible above the surrounding trees, we pointed Irv in its direction and took 189 images at 40000 ISO and 1/10th second shutter speed. This higher ISO caused our image of the planet to be extremely noisy and overexposed (too bright to see much detail).

Uranus, 189x exposure, Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor Telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis

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Jupiter, 555x exposure, Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor Telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis

JUPITER: 01:20 AM

Jupiter rose around 11:53 PM, right behind Uranus. Once we finished photographing Uranus, we immediately went for Jupite, the planet we spent the most time pointing our telescopes at. Since the next planet was just beginning to rise above the horizon, we had ample time before it would appear over the treeline. We took 555 images of Jupiter while waiting for Mars to rise, using 250 ISO and a 1/30 second shutter speed.

MARS: 03:20 AM

The penultimate planet to this all-nighter was Mars. Although it rose at 12:37 AM, it would be some time before it was visible above the trees near Fuertes Observatory. Once it cleared the treeline, we set forth to photograph Mars, taking 423 images in the wee hours of the morning with 200 ISO and a 1/10th second shutter speed. For some members, this was the end of the road and they decided to go home to get at least a few hours of sleep before classes began the next morning. For others, the capturing of Mars meant it was time to wait for the final planet to make an appearance: Mercury.

Mars, 189x exposure, Canon EOS 6D Mk II, 12-inch Irving Porter Church Memorial Refractor Telescope
Credit: Marquice Sanchez-Fleming, Shane Kuo, Andrew Lewis

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MERCURY: 05:30 AM

Mercury would be quite difficult to get for similar reasons to Venus. Mercury rose at roughly 05:04 AM, leaving us little time before the sky would begin to brighten again before sunrise at 6:33 AM. Even worse, the direction Mercury was rising from was directly behind a tree when viewing from the observatory. If we wanted to have any chance at finding Mercury, it wouldn't be through Irv since the sky would be too bright by the time Mercury was high enough for Irv to view it. It'd also be difficult to see Mercury near the observatory since the sky would be too bright when Mercury rose above the treeline.

This left us two options: find Mercury through a telescope from a place where trees would not be in the way, or get lucky and spot Mercury through the treeline using a Dobsonian telescope as we did with Venus. Most members opted for the second option, and time ticked away with no sight of Mercury. Some members tried finding Mercury with binoculars away from the observatory but with no luck. The sky became brighter and brighter with no sight of Mercury until it became too bright to find reasonably. Mercury had evaded us.

A REFLECTION: THE WEEKS AFTER

Unfortunately, we couldn't capture all seven non-Earth planets in one night because of Mercury's proximity to the sun. However, we could still capture six of the seven. We greatly enjoyed doing this and took many photos in the process. For many of us at the all-nighter, this was our first time attempting to do astrophotography with the setup we had, and we made many mistakes that decreased the quality of our images. We overestimated the ISO we needed to take pictures of many planets, causing them to appear too bright and losing us some of the finer details. We also did not use an intervalometer that would take photos automatically, so pressing the shutter button on the camera also contributed to the motion blur in some of these images. As people were still walking on the dome and near the telescope while we took pictures, they caused the telescope and camera to vibrate and made the images shake as well. Perhaps in the future, we may reattempt this and succeed, both in taking pictures of all the planets and improving the quality of our astrophotographs. For that, only time will tell. With this planetary all-nighter in the books, the real challenge began: staying awake in classes that morning!

ASTRONOMERS READING LIST

BY JILLIAN EPSTEIN

FICTION

Project Hail Mary, Andy Weir
(Recommended by Haonan Gong)

You should definitely read it! It's about an astronaut who finds himself stranded on a spacecraft in the middle of space, with no idea how he got there. It follows him as he regains his memory and figures out a way back home. It has many problems that the astronaut must find clever physics-based solutions to; even the classic pendulum comes into play! This is one of the only books of recent memory that I can remember sitting almost all day just continually reading. I couldn't put it down!

The Murderbot Diaries, Martha Wells
(Recommended by Haonan Gong)

Science fiction worldbuilding heaven. It follows an SEC (Security) unit, deployed to protect human researchers on remote planets, who goes rogue. There are currently nine books in the series, and all of them are short novels, the longest one is 300 pages and the first book is less than 100 pages. It is very fast-paced and has a lot of action, but in little moments throughout there are some really good worldbuilding elements that are wonderfully integrated into the story.

17776: What Football Will Look Like in the Future, Jon Bois

Unlike the others, this story is an online, multi-media experience. In my opinion, it is best read with minimal knowledge going in. However, if you need some details, humans are immortal and satellites are sentient. Hyjinx (mostly football-related) ensue. Search up "17776" and click the first link. All I am going to say: trust me.

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The Hitch-Hiker's Guide to the Galaxy, Douglas Adams

A classic for a reason. This five-part series is hilarious, often nonsensical, and all the better for it. This book is one of the few books that has truly made me laugh out loud while reading. It's hard to really describe what this series is about, but I am going to give it a try: a middle-aged man is suddenly thrown into a space adventure when Earth is destroyed by a galactic construction crew. There is no true science here, just entertainment.

Every Soul a Star, Wendy Mass

Definitely aimed at tweens more than college students, but a touching story about a girl whose family runs a campground that lines up perfectly with a coming solar eclipse. Surprisingly, this is where I first heard about the search for extraterrestrial life and why astronomers use red light while observing.

Exit Black, Joe Pitkin
(Recommended by Haonan Gong)

Set in a not-so-far future where the first space tourism opens for the few millionaires and billionaires rich enough to pay for it. It is a hostage situation on a space station where no help can be found, and one biophysicist who needs to figure out how to escape.

The Three-Body Problem, by Cixin Liu
(Recommended by Dylan Jackaway)

Jumping back and forth between the settings of China during the Cultural Revolution and the interconnected present-day world, The Three-Body Problem follows a team of scientists working to uncover evidence of extraterrestrial influence on Earth, but said extraterrestrials always seem two steps ahead of them. The first installation of a trilogy, this novel depicts humanity's at first gradual and then sudden awakening to the reality of an unforgiving universe and the exigencies of survival, which I would highly recommend for people drawn to the intersection of science fiction, murder mystery, and political drama. The Three-Body Problem was also adapted into a popular Netflix series earlier this year, which has been renewed for a second season.

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Contact by Carl Sagan, with contributions from Ann Druyan
(Recommended by Dylan Jackaway)

Set in the lead-up to the turn of the 21st century, Contact follows the journey of Eleanor Arroway, a SETI researcher who one day receives a signal from an alien civilization, and is thrust into the spotlight of the international scientific and political worlds as a result. Distilling much of Sagan's philosophy on humanity's potential and place in the cosmos, this novel offers a profoundly optimistic message for our modern society, and I would highly recommend it to anyone interested in pondering the big questions. Contact was also adapted into a movie in 1997.

NON-FICTION

A Brief History of Time, Stephen Hawking

Stephen Hawking's book, and therefore required to be on this list. Full disclosure: I was not able to finish it when I tried to read it in high school. However, it started off very public-friendly, and I believe everyone should at least read the first chapter.

Time Travel in Einstein's Universe, J. Richard Gott

It is difficult to explain how much this book changed me. General relativity was what first got me interested in astronomy, and this book dove in and didn't hold anything back. Definitely required a bit of physics knowledge to follow, but I read it as a freshman, so it is very doable.

The Black Hole Survival Guide, Janna Levin

Short and sweet. This book is almost a beach read with its cute drawings and simple way of explaining one of the most complex objects in the universe. At just over 100 pages, I recommend this to everyone.

A City on Mars, Kelly and Zach Weinersmith
(Recommended by Connor Rosenthal)

Two married scientists dare to ask: can we REALLY send people to live in space? A funny exploration of the physical, biological, social, and legal obstacles to interplanetary life.

EUROPA ICE DRILLING: A GLIMPSE AT AN ALIEN WORLD

BY SHANE KUO

Jupiter has captured our imaginations since ancient times. As the fourth brightest object in the night sky, behind only the sun, the moon, and Venus, it is fitting that the ancient Romans named it after the king of their gods and that Galileo pointed his telescopes to Jupiter for some of his first observations. He noticed how Jupiter appeared wider than the other planets and stars, and observed the four Galilean moons: Io, Europa, Ganymede, and Callisto. This paved the way for wide acceptance of the sun-centered model of the Solar System and gave us a first look at an alien world. Almost four hundred years after Galileo's discoveries, the NASA flagship mission named after him entered the Jovian system and found evidence of oceans under Europa's icy surface. These oceans are liquid due to the stretching and squishing of Jupiter's immense gravity. On Earth, life as we know it could not exist without water. Finding it in our cosmic backyard was a good sign for if humans could answer the question, "Are we alone?". As our telescopes were just starting to notice alien worlds around different stars, it's poetic that we'd find the first potential signs of life on the very first one we discovered.

Europa Clipper with its instrumental suite in JPL's High Bay 1
Credit: NASA/JPL-Caltech

This coming month, NASA plans to follow up on the Galileo mission with the launch of the Europa Clipper and see if Europa can truly harbor life. It carries a scientific suite to produce high-quality maps of Europa's surface in many different wavelengths of light and find what its plumes are made of to detect chemicals produced by life. It will use ice-penetrating radar to map out the thickness of Europa's icy surface and determine the properties of its underground ocean. The detailed and precise data it will collect about the shape of Europa's surface will help select where any future landers on Europa will land.

If Europa Clipper finds that the ice covering Europa's underground oceans is relatively thin, the next step may be to send a probe to Europa that will drill through the ice sheet and explore the ocean below. Such a probe can verify how many biosignatures, or chemicals made by living things, exist in Europa's oceans. Even though satellites can fly through Europa's plumes and get samples from its ocean, such a method won't give the sheer amount of data that an actual subsurface probe could bring. These probes are also shielded from the harsh radiation belts around Jupiter by kilometers of ice and water, which can lengthen the mission beyond what an orbiter could do.

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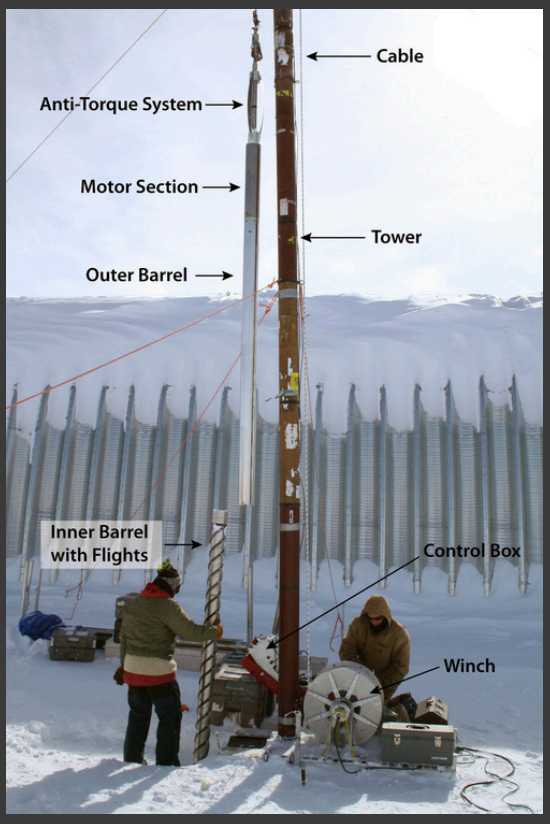
To imagine how a Europa lander could drill through Europa's thick ice, we can look at how we drill through ice on Earth's poles. On Earth, trying to drill through ice sheets near the poles has many challenges. Drills must be able to work in freezing weather at far-away locations. This makes it hard to use heavy machinery and stops the drills from using the electric grid for power. Because a drill has to remove material from a borehole, it must be able to operate inside the material it drills or remove it from the borehole. As Europa is much further and colder than the poles, limits on power, temperature, and energy are even harsher.

Many recent ice sheet boreholes to the bottom of polar ice sheets have used rotary drilling, which uses spinning blades to cut the ice. This method allows scientists to remove ice cores, which are used to understand how the glaciers and climate evolved over millions of years. Other methods inspired by drilling on rocks use a rigid drill pipe that spins a drillbit at the bottom of the borehole. However, this creates shards of ice that can build up and clog the drillbit if not flushed out of the borehole with liquid. These methods both need heavy machines designed for warmer climates and large human crews. These techniques are thus not useful in drilling through Europa's ice shelf because any probes to Europa must be both light and fully automated. Launching heavy machinery to Europa would be too expensive. Controlling the probe remotely would be impossible because signals can only travel at the speed of light, and it would take over an hour to see the results of any command. Other rotary drilling methods that work better on ice shelves, such as the cable-suspended electro-mechanical drill, are too complicated to fit in a mission to the outer solar system.

Although getting an ice core from Europa would provide a wealth of scientific data, the limits on the mass and volume for a Europa mission make this impossible until better launch systems are invented. The main focus of a Europa borehole is to obtain data from underneath the ice. On Earth, scientists often use thermal drilling on boreholes that don't need to collect ice cores. These thermal drills use jets of hot water to melt the ice. Any meltwater left in the borehole is pumped out so the hot water can melt more ice. A probe that uses thermal drills to melt through Europa's ice autonomously is more feasible. As it descends, it will unroll a wire that transfers power and data. It will also expel any leftover impurities or particles from the melting process. However, as Europa is extremely cold, much of the probe's heat is lost to the ice. Allowing the melted ice to refreeze on top of the probe would make this even worse, which means that such a probe would require a surface station that can pump the meltwater out of the borehole. Because Europa's gravity is much lower than Earth's, it's easier to pump water out of a borehole on Europa than on Earth.



Example of a coring electromechanical drill, with labeled components
—Credit: Joseph Souney, University of New Hampshire

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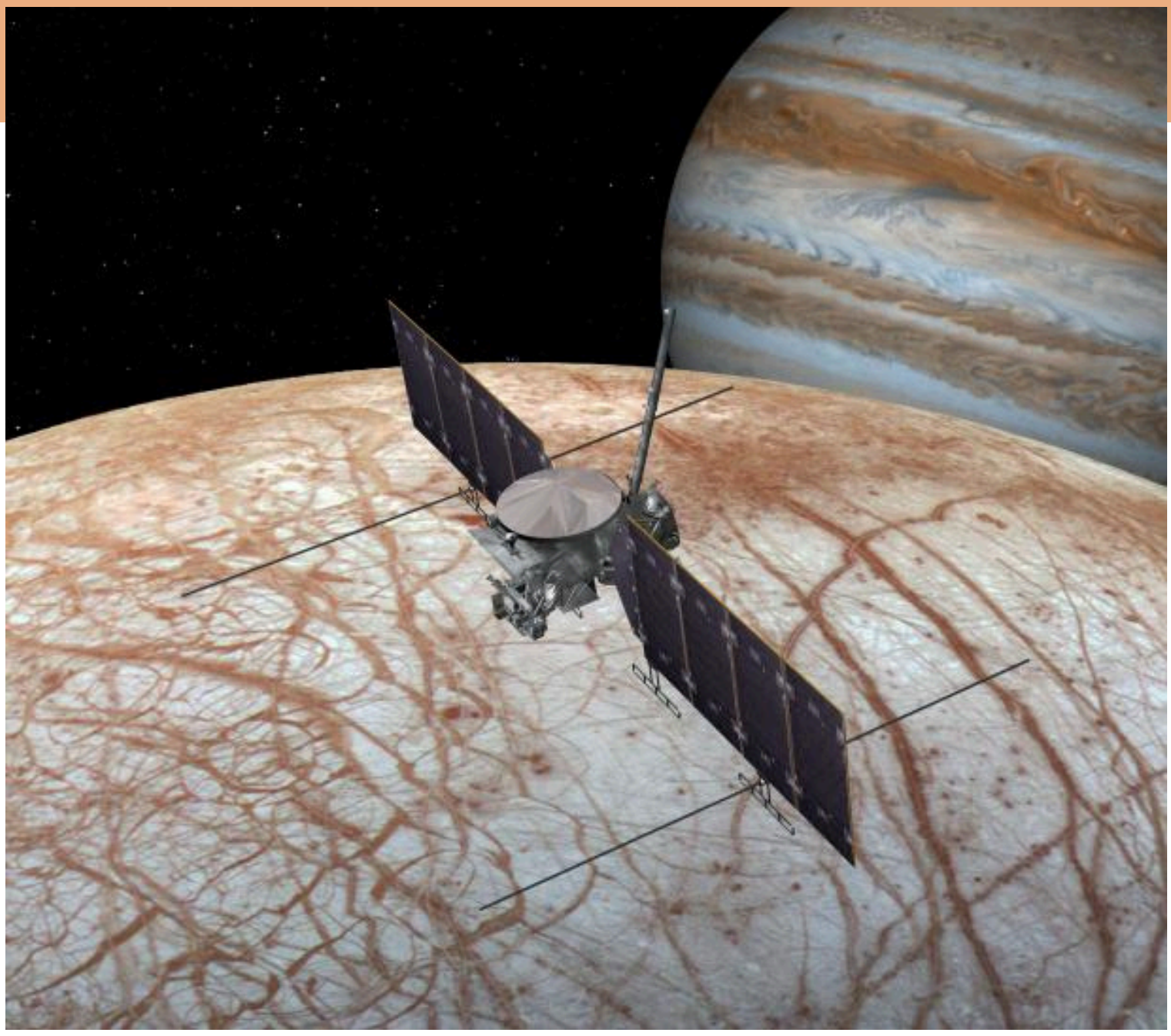
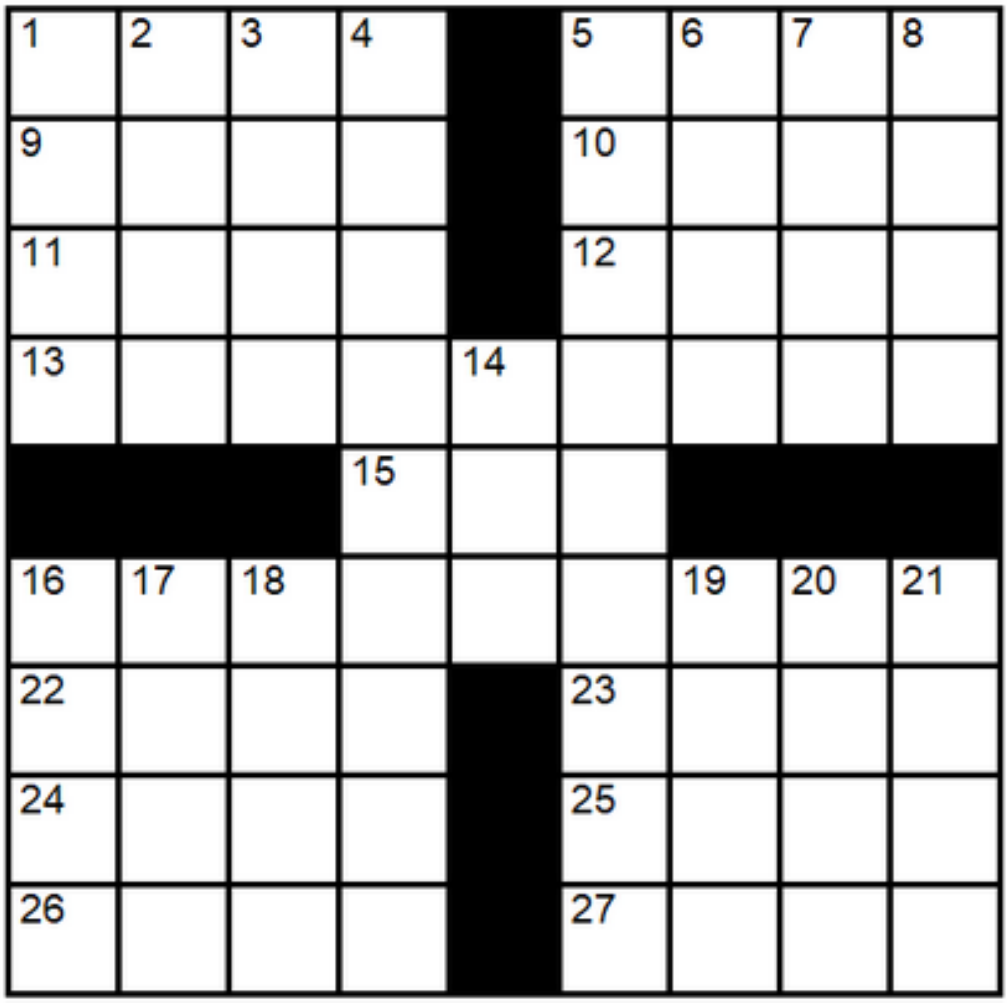
Although the prospect of sampling Europa's underground ocean may be exciting, we should recognize and minimize contamination risks while drilling. Lake Vostok is a subglacial lake buried under almost four kilometers of ice and has over five thousand cubic kilometers of water. In 2011, a joint team involving Russia, France, and the United States drilled a borehole just above Lake Vostok, which uncovered microbes. This likely meant that many unique microorganisms lived in the Lake, isolated from the rest of the Earth for millennia. However, the borehole was held open with kerosene. The Russian team continued drilling the kerosene-filled borehole, allowing the lake water to mix with 60 tons of drill fluid before freezing. This disrupted the pristine lake environment and contaminated the samples. Europa's oceans have been protected by kilometers of ice for billions of years, and any missions should take great precautions to preserve this pristine environment for future generations.



Artist's Rendition of the Europa Clipper spacecraft orbiting Europa
Credit: NASA/JPL

MINI CROSSWORD

BY CHRISTOPHER BROWN



Across

1. Frequent flier in summer
5. 20th-century art movement exemplified by Duchamp and Arp
9. ____ of Man
10. F1 Driver for Alpine
11. Amber-colored medication container
12. Where one may "go," menus acento
13. The A in R.A., one of two coordinates for telescopes
15. Metadata that helps a site get featured (abbr.)
16. Type of reflecting telescope named for the author of the Principia
22. Persian poet Khayyam to whom the Rubaiyat is attributed
23. Playwright William of Picnic
24. Brando's Corleone
25. Upon the apex of
26. Briefing header, in brief
27. Faux pas, informally

Down

1. Dramatic persona, as applied to singers such as Mariah Carey
2. Major Egyptian goddess
3. Lab for high-energy physics study in Menlo Park, CA
4. Telescope manufacturer with brands such as AstroMaster and TravelScope
5. Class of 16-across telescopes, examples of which include Fuertes' "Bob"
6. Antioxidant berry often paired with blueberries
7. "__ __ harm," as sworn by physicians
8. Synonym of shortly, or an unidentified forum user, in internet slang
14. Keanu Reeves' character opposite Carrie-Ann Moss' Trinity
16. PBS series with an appropriate title for this puzzle's theme
17. Release, as light from a star
18. Unit of power equivalent to one Joule per second
19. "____ the jaws of Death," as the Light Brigade rode in an 1854 Tennyson poem
20. Suffix for Hex or Non
21. Discourse around these types of "babies" swelled on social media in 2022

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Sources for “Europa Ice Drilling: A Glimpse at an Alien World”

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Image Credit:NASA/JPL-Caltech , Joseph Souney, University of New Hampshire, NASA/JPL

Cornell Astronomical Society (CAS) is a student-run non-profit organization founded in 1972.

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