CORNELL ASTRONOMICAL SOCIETY NEWSLETTER

ISSUE 4 • MAY 2022

LETTER FROM THE EDITORS

Greetings to our lovely readers! For the final edition of the newsletter this semester, we wanted to thank our incredible graduating seniors, Chase, Paul, and Jonathan! We would like to recognize the great work they have all done as officers in successfully carrying out decades-long CAS traditions like hosting exciting lectures, guiding underclassmen in their own observing journeys, and keeping the club running as we navigate another COVID year. But beyond that, we'd like to thank them for their infectious sense of humor. And we really mean *infectious*—the in-jokes keep getting more recursive and we don't know how to stop it. We wish you the best in your grad school journeys, and may you leave a wonderful wake of friends parroting your pretty good riffs wherever you go.

Love from Gillis, Ariel, Anthony, Stella, Justine, Kelly, Tim, Polina, Lucas, Shawn, Ben Shapiro, Ben JB, aaand Annika!

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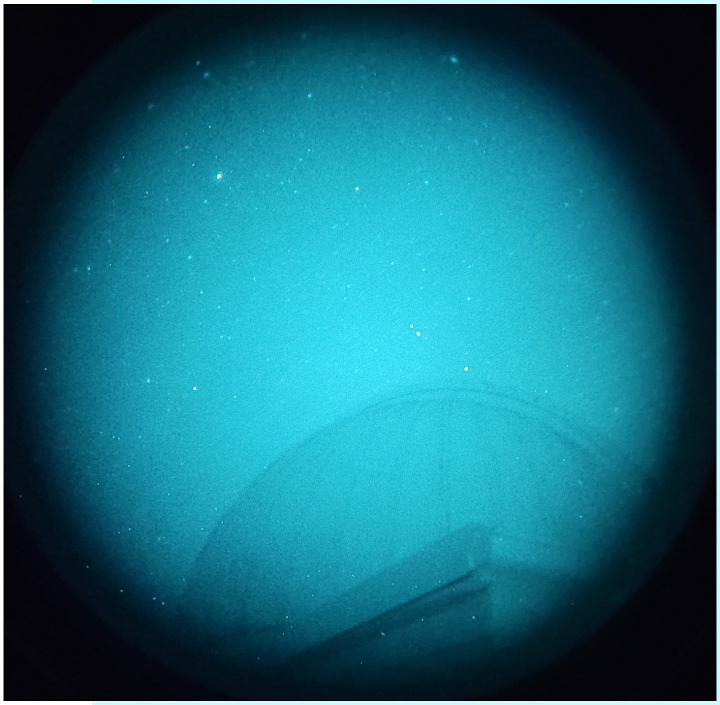
CAS UPDATE: A PLEASANT TRIP

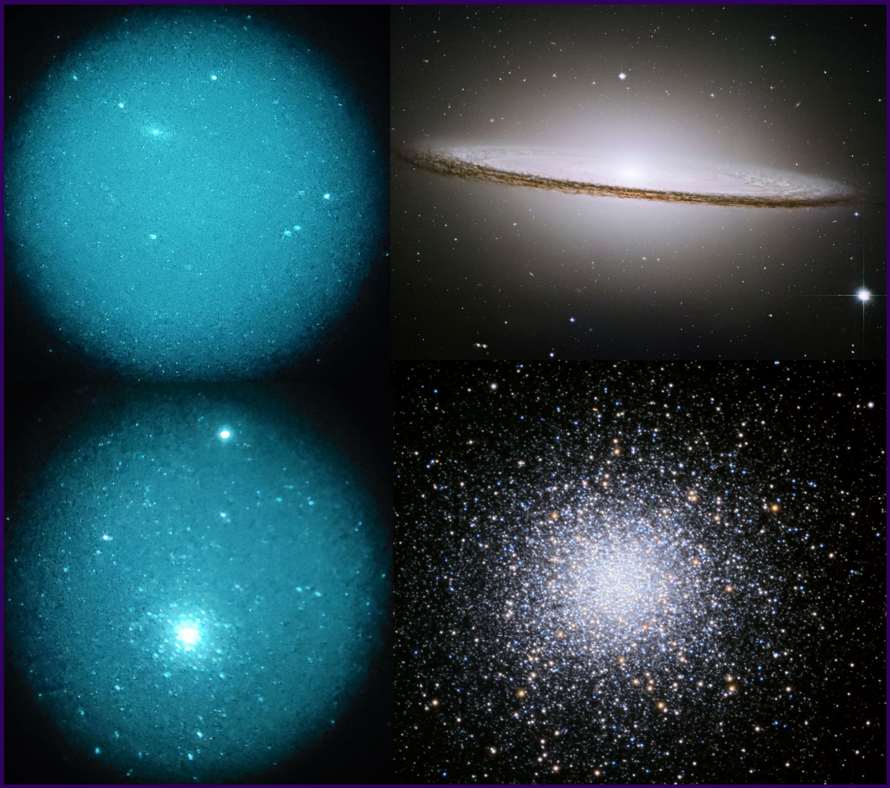
BY GILLIS LOWRY

On Saturday, April 23, the Cornell Astronomical Society was honored to receive a cloudless night sky in Ithaca. When the typical cover finally cleared around midnight, the visibility was good enough to warrant a trip to Mount Pleasant, where we set up a telescope outside the Hartung-Boothroyd Observatory (HBO).

Thanks to our bright idea to bring the night vision scope, and not much moisture in the atmosphere to distort our view, Saturday was the best night of the semester so far for gazing at and photographing deep-space objects.



Not an interstellar object—just the top of HBO



Our view compared with Hubble images: Sombrero Galaxy as a horizontal smudge (top) and M13 cluster in Hercules (bottom)
Credit: NASA/Hubble
Night vision images credit: Anthony Fine

To the left are the spoils of this semester-long war with clouds. Our first object, the Sombrero Galaxy, is a spiral galaxy seen edge-on from Earth, halfway between the star Spica and the constellation Corvus. The dark outer ring of intricate dust holds most of the galaxy's gas, and serves as its main star-forming region.

The Hercules Globular Cluster, pictured below, is around one-third of the way from Vega to Arcturus in the sky. In 1974, the Arecibo Message was sent in its direction, but seeing as the cluster is a moving target 22,000 lightyears away, we aren't expecting an answer from any alien life among the cluster's hundreds of thousands of stars.

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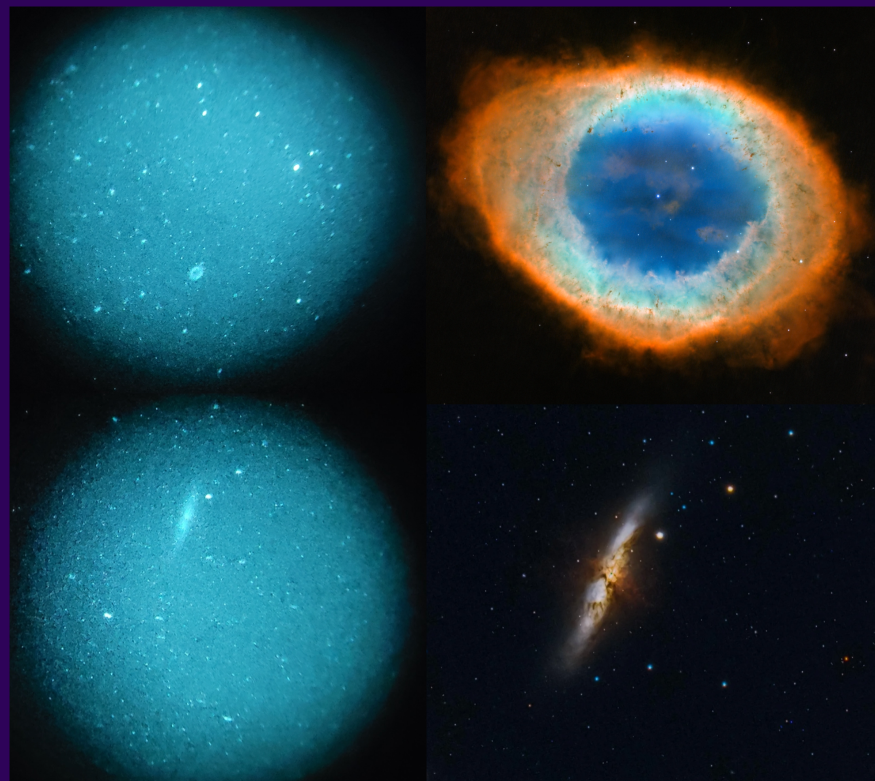
In the author's favorite constellation, Lyra, lies the Ring Nebula, an example of what spectacular death awaits stars with the mass of our Sun. Billowing out from the tiny white dwarf that remains of the star's core are colors assigned to layers of gas—deep blue helium, cyans of hydrogen and oxygen, and wispy red nitrogen and sulfur. From our telescope, we could see a definite ring shape formed by these elements!

The Cigar Galaxy on the bottom is actually one of a pair. The gravitational influence of its neighbor, Bode's Galaxy, makes Cigar a "starburst," with an unusually high rate of star formation, ten times greater at its core than the entire Milky Way.

All of these sights and more were magnified by our 15'' Newtonian reflector on a Dobsonian mount from Obsession Telescopes® (not sponsored). As our strongest light-collector—even more so than our beloved Irv at Fuertes—the Obsession can view objects as dim as 15.5 in magnitude, assuming a perfectly dark sky. The top of the telescope is held above the mirror by removable metal poles, giving the telescope an added benefit of being easily transported in the trunk of a car.

It was fortunate we had a car, too; Mount Pleasant was immensely windy. Around 2 a.m. we took apart the telescope, piled into the warm back seats, and made it home before moonrise.

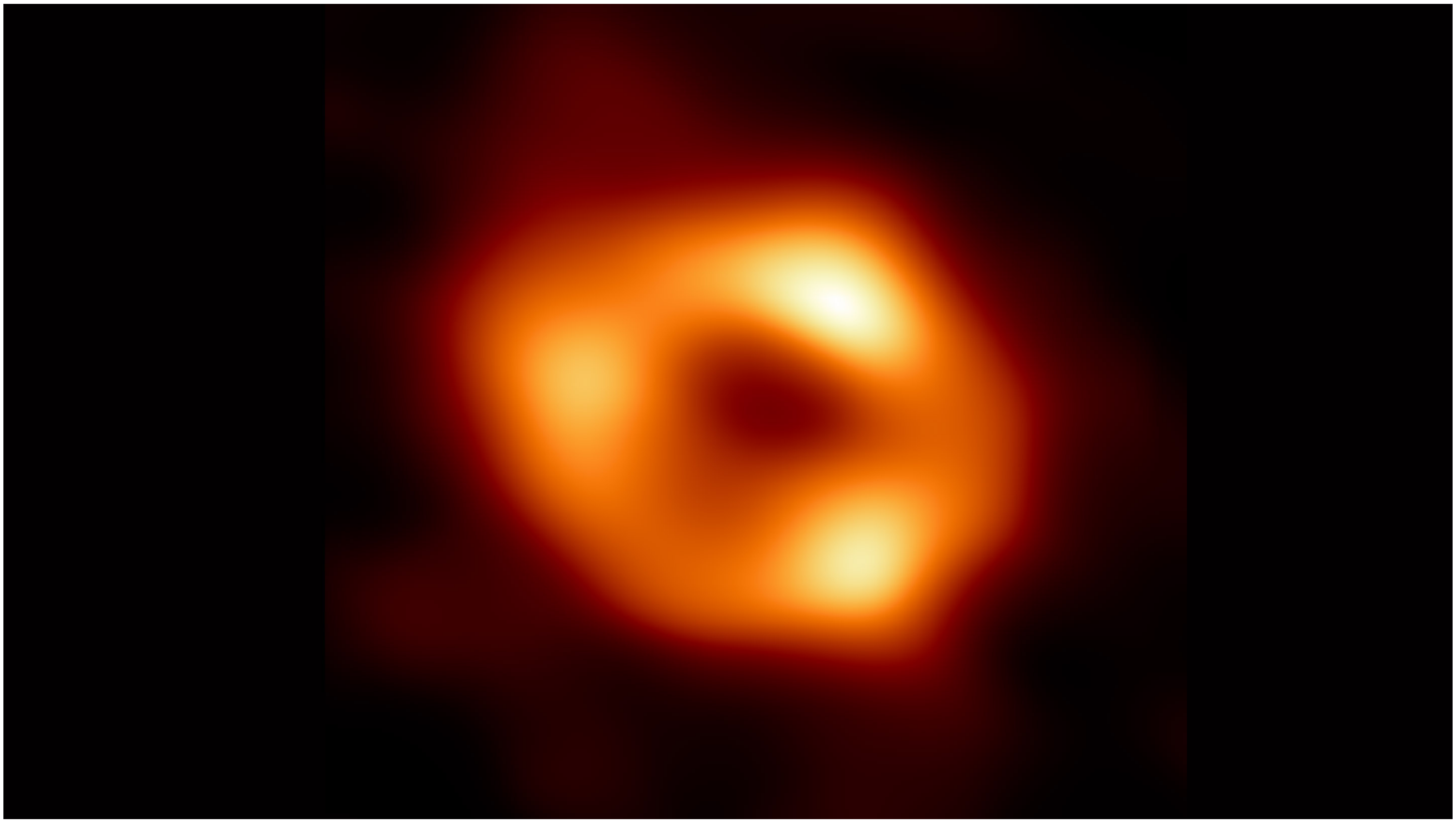


Ring Nebula (top) as a fuzzy donut in the bottom-center of the image, and Cigar Galaxy (bottom) | Credit: NASA/Hubble

CAS members Paul Russell (left) and Ben Jacobson-Bell (right) with the Obsession telescope

NEW IMAGE OF SAGITTARIUS A*

BY BEN JACOBSON-BELL



Sagittarius A, the black hole at the center of our galaxy* | Credit: EHT collaboration

This past Thursday, May 12, 2022, astronomers from the Event Horizon Telescope (EHT) collaboration revealed the second-ever photograph of a black hole—this time, one much closer to home.

Sagittarius A* (pronounced "A-star") is the black hole at the center of the Milky Way, more than four million times the mass of the Sun, yet no larger in radius than the orbit of Mercury. Few objects captivate the hearts and minds of astronomers and astronomy fans like a black hole, and from Karl Jansky's first detection of a radio-wave source in the constellation Sagittarius in the early 1930s to the observations of the surrounding stars that won Andrea Ghez and Reinhard Genzel a Nobel Prize in 2020, few black holes have claimed such widespread recognition as our closest supermassive neighbor.

The EHT's collection of the data back in 2017 took only five days, but the processing that led to the photograph ended up taking five years. Thousands of models and algorithms running on fragmented data collectively stitched together the image above, which shows microwave emission from the surrounding accretion of superhot gas in orange, encircling the shadow that represents a magnification and distortion of the event horizon. The cause of the three bright lobes around the emission ring is currently unknown,

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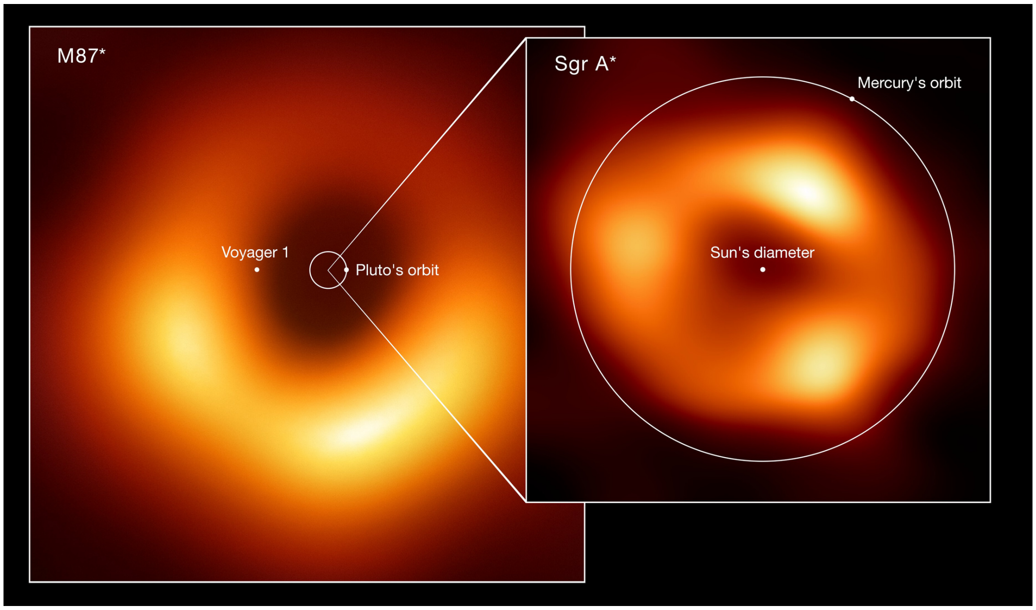
but the fact they exist at all stands as a testament to the black hole's dynamism. All that superhot gas completes an orbit around Sagittarius A* in a matter of days, drastically changing the picture even as a telescope is watching it.

The first photograph of a black hole, termed M87* for its position at the center of the galaxy M87, was released to a thunderous reception in April 2019. Why did the Sagittarius A* photograph take so much longer to surface?

There are a few factors at play. Although M87* is around two thousand times farther away than Sagittarius A*, it's also around two thousand times bigger, resulting in a [pretty similar angular size]() of around 50 microarcseconds. However, looking at Sagittarius A* means looking straight through the Milky Way from the outskirts to the center, and with twenty-seven thousand lightyears of gas and dust in the way, that's no easy feat. The galaxy M87's location in the constellation Virgo, well away from the main part of the galactic plane, is substantially easier to observe. Combine that with M87*'s larger size, which causes patterns in the gas it accretes to change on much slower timescales, and the result is almost paradoxical: Sagittarius A*, by far the closest supermassive black hole to Earth, is actually substantially harder to analyze than its counterpart 55 million lightyears away.

Fun Fact: Per the no-hair theorem, a black hole can be described completely with only three parameters: mass; electrical charge; and angular momentum, or "spin." Sagittarius A*'s mass has been known for years thanks to observations of stars in its vicinity; and like most supermassive black holes, it is expected to be electrically neutral, since any charge it accumulates would rapidly be neutralized by the accretion of oppositely charged matter. Whether or not it had a spin, however, had long been a mystery.

Until now! The EHT paper published last Thursday confirmed that a spinning black hole (a so-called Kerr black hole) does indeed provide the best match for the properties observed by the collaboration in 2017. Further constraints on the magnitude of the spin merit investigation, but the fact that Sagittarius A* is likely a Kerr black hole is a momentous enough revelation on its own.



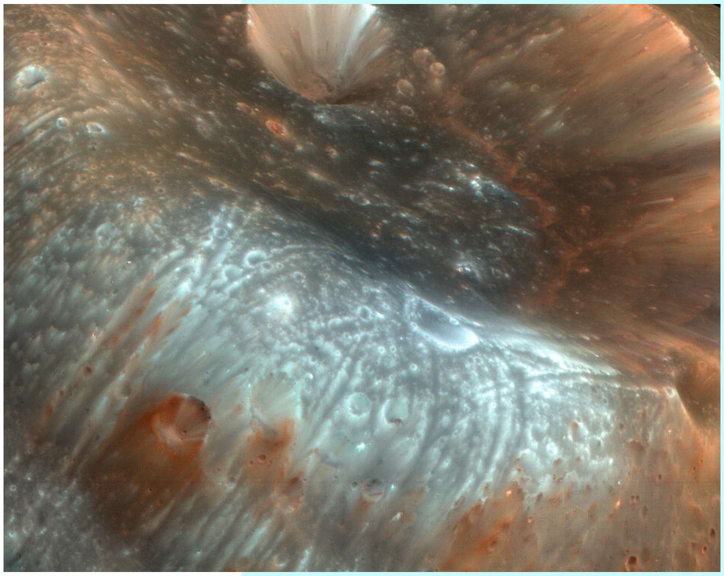
Comparison of M87 and Sgr A** | Credit: EHT collaboration

PHOBOS AND DEIMOS

BY JUSTINE SINGLETON

Picture this: It's a warm, clear night, and you are sitting on the beach. The stars are reflected in the cool water. You don't get in because it's probably too cold this late. Besides, you would rather just watch.

If you are at the ocean, you watch the serene movement of the waves and the slow changing of the tides. If you are at a lake or some other body of water, you remember that it still experiences tidal pull, even though the pull is so small that it doesn't move. As you watch the glint of stars and other celestial bodies from above and below, you recall that Earth and the Moon are not unique when it comes to tidal forces. Other planets and moons have them too. In planetary systems with multiple moons, they even pull on each other. On moons with subsurface oceans, this could lead to internal tidal flows and tidal heating. With or without water, tidal effects stretch planets and moons, often even affecting their orbits.



Crater Stickney on Phobos
Credit: NASA/JPL_Caltech/ University of Arizona

And then you remember. Phobos. The tiny moon of Mars is constantly inching closer to its planet due to tidal pull. The moon that in fifty million years would crumble to dust and turn into a ring. The doomed moon, fated to be washed away.

You're not quite sure how to feel about this. It seems weird to feel sentimental over a moon that is essentially a large rock. But the impending change seems important. A large, fundamental change in the sky you've lived under all your life. This change won't even happen in your lifetime, but you know it is coming.

You decide to try and think about it pragmatically. There are still so many unknowns about Phobos and its sibling moon, Deimos. For one thing, nobody is sure about their origins. Some scientists think they were captured asteroids, while others think they were formed from dust and debris. Then there are the markings on Phobos. Both moons have craters, but Phobos also has grooves across its surface, which has sparked several theories. Some think that they were caused by impact from the same object that created the Stickney crater, a distinctive crater on Phobos that is about six miles wide, almost half of the tiny moon's diameter. Others have suggested it is a sign of the tidal forces at work against it. The most recent explanation is that the impact that created

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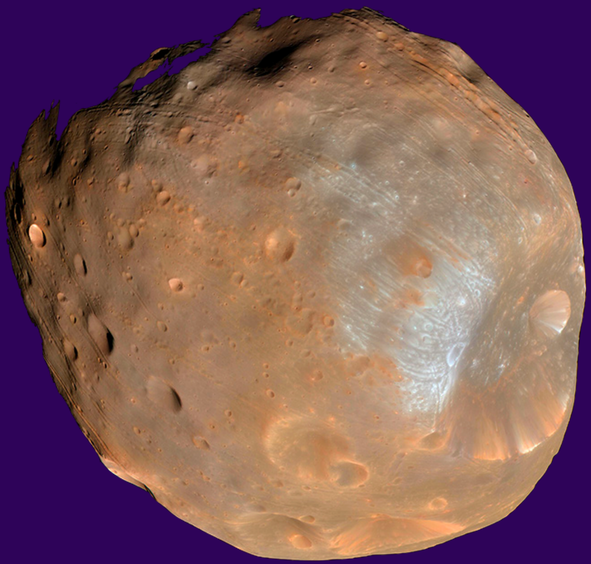
the Stickney crater knocked some boulders loose, and those rolling along the surface of Phobos created its unique grooves. You sigh. All this debate over a place a hundred times smaller than Earth's Moon.

You remember reading that Japan was planning a mission to both moons to answer all these lingering questions. If all goes well, it should launch in a couple of years. Somehow, it doesn't feel like enough. For a moment, you picture yourself on Phobos, the sand underneath your fingertips turning to regolith, the surface mixture of rock and dust. Phobos has almost no surface gravity, so in real life you could hardly sit on its surface, but this is your imagination. This moon completes a full orbit around Mars in a third of a Martian day, so you would be traveling relatively quickly. Its speed is part of what leads to its doom. It travels so fast that from Mars's perspective it appears to be going backwards in retrograde, causing it to spiral inward instead of outward like most moons. You feel the dust and grit in your hands. Some think the soil on Phobos could be holding some molecules left over from when Mars shed its atmosphere. Another mystery for Japan to solve, you think to yourself.

You wonder if you would be able to see Deimos from the surface of Phobos. It probably depends on where they are in their orbits at the time. Will Deimos be visible from Phobos fifty million years from now, when it reaches the end? You're not sure. All you know is it will move toward its doom, closer and closer, as surely as the tides. Maybe it has done this before. Maybe not. Maybe they really are just captured asteroids.

You stand up and dust off your blanket or towel. As you fold it up, your eyes search for Mars, a red speck in the deep black sky. Once you find it, you imagine what it will look like with the rings that will be formed from Phobos. Would you be able to see them with the naked eye? You start the walk back. All you leave behind are footprints. Those, too, will be washed away as the tides flow in and out, in and out.



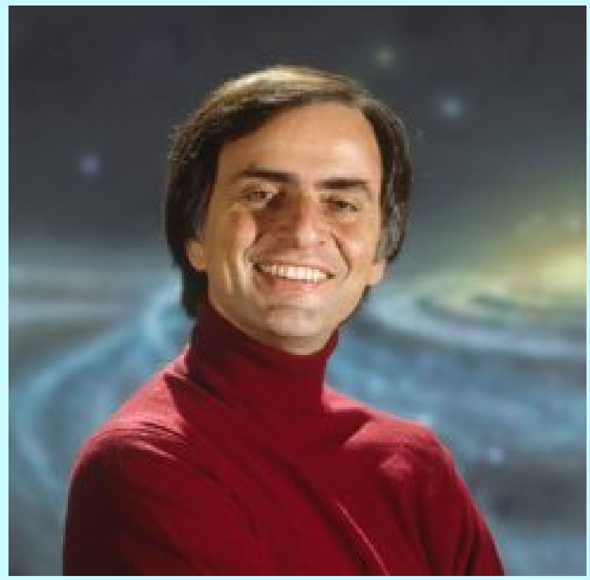
EVERYWHERE THAT UNIVERSE

BY JOHN CIARDI

Even wisteria, sufficiently looked at,
will do for a galaxy. Nebulae
coil and flare on the trellises
of invisible principle much as these
gnarls and bursts grow to a house
they obliterate. With care then,
with waiting for a leaf to turn,
you may see the lives take place
in the great gaps of the system.
As at the porch corner there,
that nest full of raging fluffs,
half bald yet, who work mouths
the size of their entire heads
up into space. A nest of birds
is a nest of flames leaping,
novas of the insatiable energy.
Only the mercies of size save us
imagine fledglings the size of rhinos
and full of just such rages–
what would a man do then
for the courage to look thoughtfully
into the throat of principle there
behind any leaf his waiting turns?

SPACE TRIVIA

Which mammalian noise did Carl Sagan imitate in episode eleven of the original *Cosmos* (1980) series?



Carl Sagan
Credit: Tony Korody / Sygma / Corbis

Answer:

Whale!

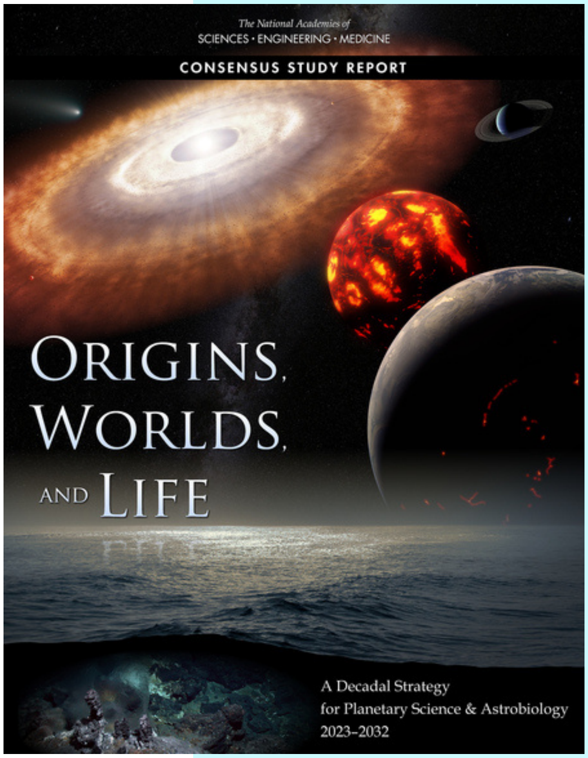
Trivia and poem selected by Gillis Lowry

TOP MISSIONS OF THE PLANETARY SCIENCE DECADAL

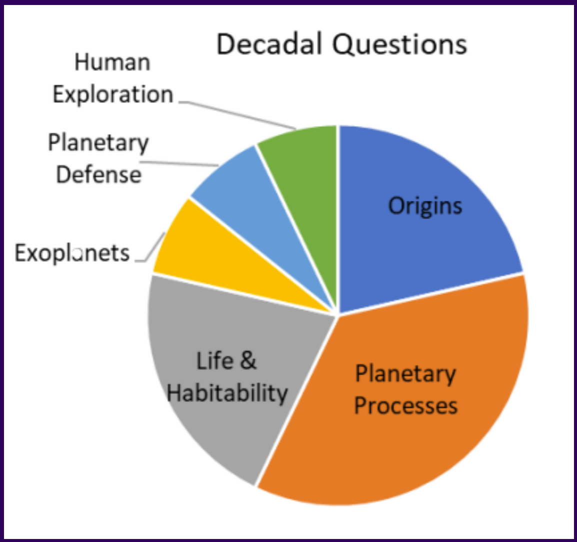
BY ANNIKA DEUTSCH

Every ten years, NASA charters the National Academy of Sciences (NAS) via Congress to complete extensive studies, called decadal surveys, of various fields in the physical sciences. The purpose of these surveys is to highlight current scientific questions within each field and to recommend mission plans to try and answer them.

Just a few weeks ago, on April 19, 2022, the third-ever Planetary Science and Astrobiology Decadal Sur-vey was released. The publication, which is over five hundred pages long, explains the scientific questions found to be of highest priority to the field within the next decade. It assesses the current state of the pro-fession and recommends a comprehensive program of NASA missions based upon multiple different budget scenarios, as well as research and analysis by major institutions in the field.



New Planetary Science Decadal Cover | Credit: NAS



Distribution of priority science questions by topic | Credit: NAS

The Planetary Science Decadal is organized by a steering group and six panels, each of which focuses on a specific Solar System body (or category of bodies) of interest. Two of these panels, Ocean Worlds & Dwarf Planets and Giant Planet Systems, were chaired by professors at Cornell: Alex Hayes and Jonathan Lunine respectively.

For the survey of 2023–2032, four key scientific themes were identified: Origins, Worlds and Processes, Life and Habitability, and Exoplanets. These themes include ques-tions like “How and when did giant planet systems origi-nate?”, “How did impacts and dynamics shape planetary systems?”, and “What more can we learn about solid body atmospheres, exospheres, magnetospheres, and cli-mate evolution?” These questions and several others in-formed the NAS’s mission plan recommendations.

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After over five hundred white papers, more than a hundred panel meetings, and talks from over three hundred guest speakers, the steering group identified the highest-priority large-scale mission, known as a Flagship mission, of this decade to be the Uranus Orbiter and Probe. The utility of such a mission is readily apparent from the survey's science questions: little is known about ice giants, largely because unlike Jupiter and Saturn, neither Uranus nor Neptune has ever received a dedicated mission, having only ever been explored in brief flybys from Voyager 2 in the 1980s.

Sending a mission to Uranus will allow for a deeper study of impacts, like the one that may have resulted in Uranus's extreme axial tilt. The mission will also enable further study of planetary ring formation, and provide an up-close look at yet another satellite system—Uranus is orbited by at least twenty-seven moons.

Diagram of the science goals of a Uranus mission
Credit: NAS

Uranus as imaged by Voyager 2 during its brief flyby in 1986 | Credit: NASA

Studying an ice giant will also further the study of gas giants and exoplanets. Ice giants are thought to be planets that got "stuck" in the second phase of gas giant formation, and many known exoplanets are ice giants or super Earths that cannot be as well understood as Jupiter-like exoplanets. Even the ice giants in our own Solar System remain mostly a mystery to us. The decision to go to Uranus over Neptune, meanwhile, was mostly due to the shorter timescale and our current technical readiness.

In addition to the Uranus Orbiter and Probe, the Decadal Survey identified the second-highest-priority Flagship mission as the Enceladus Orbilander. Enceladus, a moon of Saturn known to have a global subsurface liquid water ocean, is one of the top candidates for habitable locations closer to home. A major portion of this decade's science questions were concerned with habitability—a better understanding of what makes a body habitable would have huge implications for one of the primary goals of all exoplanet study: identifying habitable worlds beyond our Solar System.

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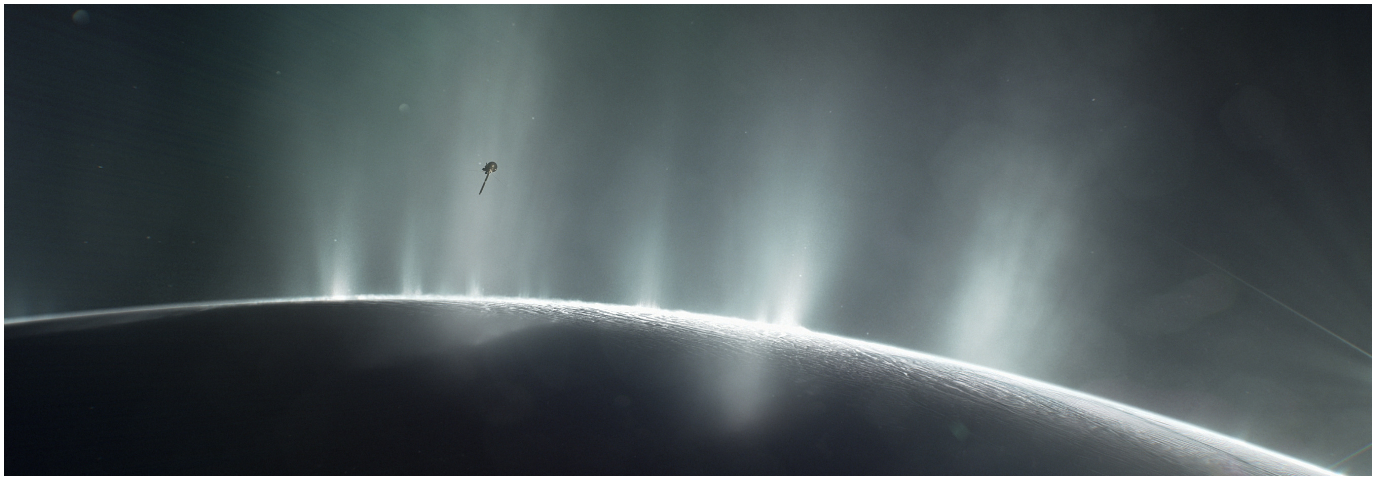


Illustration of Cassini flying through Enceladus's plumes | Credit: NASA/JPL-Caltech

In its famous early-century mission to Saturn, the Cassini mission flew through one of Enceladus's famed plumes—massive jets that spray out water and other ocean material from beneath the icy moon's crust—and identify the presence of organic matter. However, Cassini was not equipped with the right instrumentation to perform an in-depth study of Enceladus. While we know that it has a potentially habitable subsurface ocean, there are still many burning questions that motivate us to send a dedicated orbiter and lander to this moon. The detection of a separate instance of life within our Solar System would indicate that, rather than being an anomaly in our universe, life is commonplace, and would hugely motivate the search for life around stars beyond our Sun.

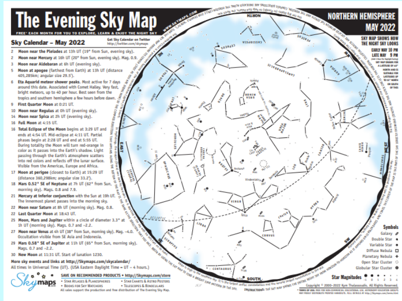
If NASA follows the NAS's recommended program, we can look forward to both of these missions proceeding once Mars Sample Return and Europa Clipper have reached relatively advanced stages of development. Carrying out these four missions simultaneously is no small task. The survey highlighted that continued work on Mars Sample Return in particular should carry on without compromise, and returning samples from a body beyond our own Moon is a feat of engineering requiring time and, more importantly, money.

While it may be a few years (or longer) until the Uranus Orbiter and Probe and Enceladus Orbilander get their day in the sunshine, Jonathan Lunine, Professor of Astronomy and Physical Sciences at Cornell and chair of the Giant Planet Systems panel, says that there's a lot to be excited for. "[To] see both Uranus and Enceladus as top Flagships in the survey is exciting. The Uranus mission will explore a planetary system that will be every bit as exciting as those of Jupiter and Saturn. Uranus is distant, exotic, and we know so little about it and its moons. The first systems-level exploration of an ice giant will be amazing. And to search for life in the ocean material jetted onto the surface of Enceladus could produce one of the most important discoveries in the history of science—the first detection of life elsewhere."

The Planetary Science and Astrobiology Decadal Survey 2023–2032 is a large and comprehensive study of the entire field and includes discussion of many topics beyond what was brought up in this article. To learn more about the whole survey, you can check out this overview on the NAS website.

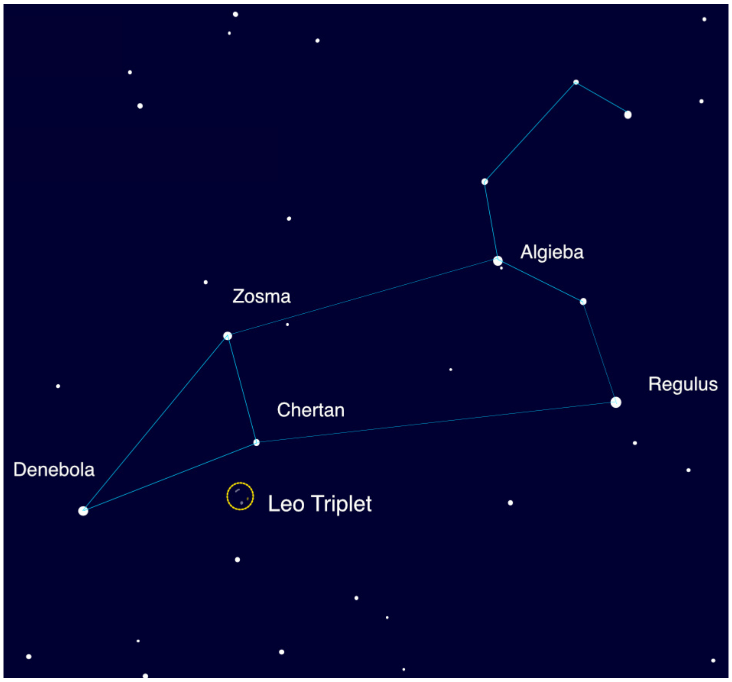
MAY SKY MAP

Scan the QR code at right to view this month's evening sky map, courtesy of skymaps.com.



LEO: WHAT IT IS AND HOW TO FIND IT

BY LUCAS LAWRENCE



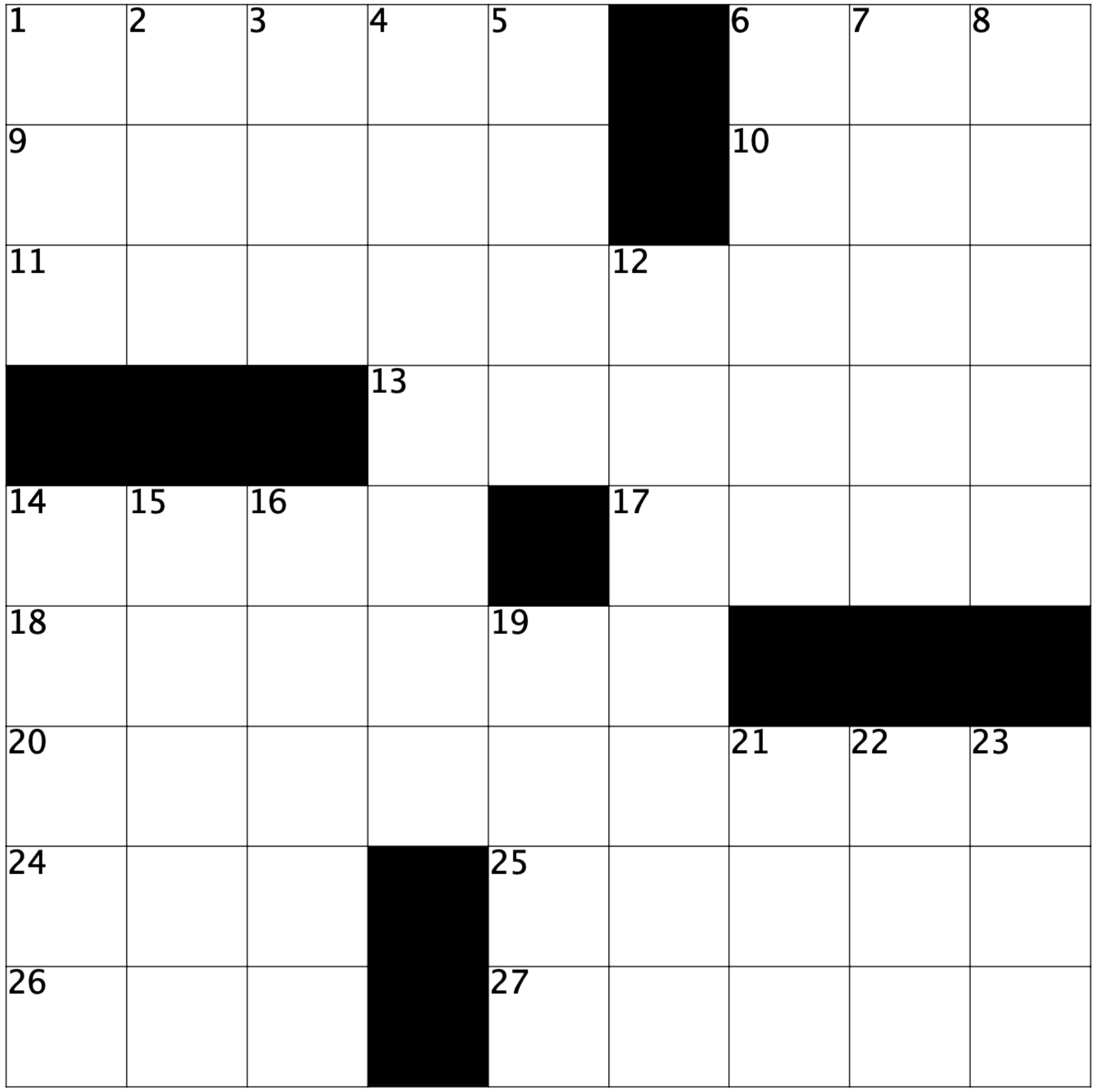
The constellation Leo and the Leo Triplet
Credit: [NASA]

One of the most prominent constellations in Ithaca's spring sky is Leo the Lion, famous among astronomers and astrologists alike. Leo contains Regulus, one of the brightest stars in the night sky. Above Regulus lies a group of stars forming a sickle shape, which has been identified as the mane of a lion by countless cultures both ancient and modern. Accordingly, Leo is known by many names, from the Sanskrit Simha, to the Babylonian UR.GU.LA, to the Persian Shir, all of which roughly translate to lion. In Greek mythology, Leo represents the vicious Nemean Lion, slain by Hercules as one of his Twelve Labors.

Fortunately for any aspiring stargazers, Leo is fairly easy to see here in Ithaca. To locate it, look towards the southern half of the night sky and search for a bright star with a sickle above it. Once you find it, you should be able to make out the rest of Leo's body, and you will hopefully be able to see why so many people in history looked up and saw a mighty lion. If you are still having trouble finding Leo, have no fear: you can also look to the easily identifiable Big Dipper for assistance. First, find the Big Dipper in the northern sky, then find the two stars on the left of the Big Dipper's "cup." Draw a line between these two in your head, and follow the line towards the south. This imaginary line will lead you directly to Leo.

Fun Fact: Leo contains the Leo Triplet, a group of three galaxies (M65, M66, and NGC 3628) that appear close together, but are each about 35 million lightyears away from Earth.

BY BEN JACOBSON-BELL



ACROSS

1. Actress and activist Jane

6. Sounds of understanding

9. Personal assistants

10. Spelling ___

11. Subject of photographs released in April 2019 and May 2022(!)

13. Like always

14. Romanian ruler known as "the Impaler"

17. Longings

18. Star at the end of the Big Dipper's handle

20. Cornell Professor of Astronomy who unwittingly popularized the phrase "billions and billions"

24. "I love," in Latin

25. Turn an ___

26. Common Japanese honorific

27. Suffix with poly-

DOWN

1. Super-duper

2. Stir-fry staple

3. No-tell contract

4. Ten-year survey created by the National Academy of Sciences

5. Requests

6. On top of

7. Figure in Greek mythology whose face "launched a thousand ships"

8. Prophets

12. Prime times?

14. Cows: Sp.

15. Alpaca relative

16. Ohio city where LeBron James and Stephen Curry were born

19. Words of understanding

21. Obtain

22. Had dinner, say

23. Neither's partner

CAS UPDATE: NEW OFFICERS

Hello dear readers! We would like to give a quick update on the status of CAS!

We had our annual elections on Friday, May 13th, 2022! There were lovely speeches from all candidates, who all had great goals and plans for the future of the club. There were also suggestions about amending the Club's Constitution to add a new officer position, but no amendments were made that night.

We have four new officers for the 2022-23 school year! Annika Deutsch will be the new President! Taking on the role of Vice President is Anthony Fine, with Ben Jacobson-Bell as Treasurer, and Gillis Lowry as Outreach Coordinator! To our new club officers, we wish you success and have fun!

With love,
2021-22 Officers
Chase Funkhouser, Paul Russell, Ariel Marxena Baksh, and Jonathan Gomez Barrientos

CREDITS

CAS Officers

Chase Funkhouser, president
Paul Russell, vice president
Ariel Marxena, treasurer
Jonathan Gomez, outreach coordinator
Phil Nicholson, faculty advisor

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Special thanks

Anthony Fine for taking night vision images
John Ciardi
Jonathan Lunine

Sources for "Phobos and Deimos":

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Image credit NASA:

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Sources for "Top Missions of the Planetary Science Decadal":

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

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