Volume 49 Number 2 February 2023

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
February 26, 2022, 7:00PM
Baker Wetlands Discovery Center

Public Observing
February 26, 2022, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

Faculty Advisor
Dr. Jennifer Delgado email.

Newsletter Editor
Chuck Wehner email

Inside This Issue

Report From the Officers

By Rick Heschmeyer

The news feeds have been abuzz with a new comet, C2022 E3 (ZTF), for several weeks now.

Two addition viewing sessions have been scheduled for the first week of February. First, on Thursday, February 2, we will be observing from Rockhaven Park, a Corps of Engineers public area on the south side of Clinton Lake, starting at 8 PM. See the map for location.

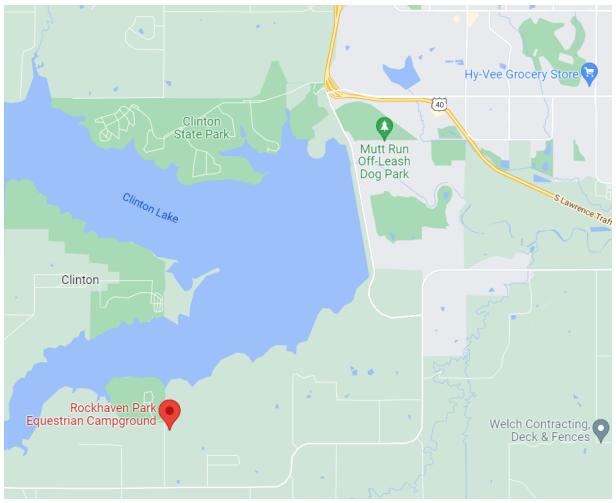
The second additional viewing session will take place on Sunday, February 5, at Baker Wetlands Discovery Center, again starting at 8 PM. Bring a telescope or binoculars and join us as we comet hunt this month!

For our February meeting on the 26th, we will be viewing the 2022 Critic's Choice Award-Winning documentary film "Good Night Oppy", as we had originally planned for January. The film tells the story of Opportunity, a rover that was sent to Mars for a 90-day mission but ended up surviving for 15 years, and the remarkable bond forged between Oppy and her humans millions of miles away.

The next Telescope Night at KU is scheduled for Thursday, February 9. Once the flyer is released, we will forward to everyone and post on our Facebook page.

As a reminder, our "PlanetPalooza" event with the Lawrence Public Library, is scheduled for Monday, April 3rd, from 7:30-9:00 PM. The location will be the roof of the Parking Garage next to the Library.

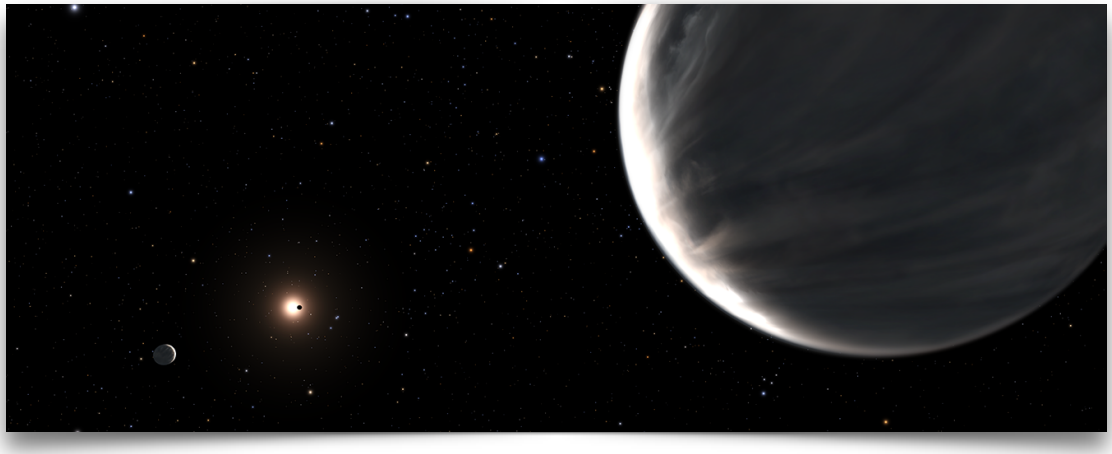
One final event to let you know about. Each year we participate in the Family Fun Day at the Baker Wetlands Discovery Center. When it's clear we offer safe solar observing. When it's not, like last year, we go to Plan B. Either way it's a fun event. This year's Family Fun Day will be Saturday, April 15th from 9 AM-Noon, so mark your calendars.



Look forward to seeing everyone at our many upcoming events.

TWO EXOPLANETS MAY BE MOSTLY WATER, NASA'S HUBBLE AND SPITZER FIND

Hubblesite, december 15, 2022



A team led by researchers at the University of Montreal has found evidence that two exoplanets orbiting a red dwarf star are "water worlds," where water makes up a large fraction of the entire planet. These worlds, located in a planetary system 218 light-years away in the constellation Lyra, are unlike any planet found in our solar system.

The team, led by Caroline Piaulet of the at the University of Montreal, published a detailed study of this planetary system, known as Kepler-138, in the journal Nature Astronomy today.

Piaulet and colleagues observed exoplanets Kepler-138 c and Kepler-138 d with NASA's Hubble and the retired Spitzer space telescopes and discovered that the planets could be composed largely of water. These two planets and a smaller planetary companion closer to the star, Kepler-138 b, had been discovered previously by NASA's Kepler Space Telescope. The new study found evidence for a fourth planet, too.

Water wasn't directly detected at Kepler-138 c and d, but by comparing the sizes and masses of the planets to models, astronomers conclude that a significant fraction of their volume — up to half of it — should be made of materials that are lighter than rock but heavier than hydrogen or helium (which constitute the bulk of gas giant planets like Jupiter). The most common of these candidate materials is water.

"We previously thought that planets that were a bit larger than Earth were big balls of metal and rock, like scaled-up versions of Earth, and that's why we called them super-Earths," explained Björn Benneke , study co-author and professor of astrophysics at the University of Montreal. "However, we have now shown that these two planets, Kepler-138 c and d, are quite different in nature and that a big fraction of their entire volume is likely composed of water. It is the best evidence yet for water worlds, a type of planet that was theorized by astronomers to exist for a long time."

With volumes more than three times that of Earth and masses twice as big, planets c and d have much lower densities than Earth. This is surprising because most of the planets just slightly bigger than Earth that have been studied in detail so far all seemed to be rocky worlds like ours. The closest comparison, say researchers, would be some of the icy moons in the outer solar system that are also largely composed of water surrounding a rocky core.

"Imagine larger versions of Europa or Enceladus, the water-rich moons orbiting Jupiter and Saturn, but brought much closer to their star," explained Piaulet. "Instead of an icy surface, they would harbor large water-vapor envelopes."

Researchers caution the planets may not have oceans like those on Earth directly at the planet's surface. "The temperature in Kepler-138 d's atmosphere is likely above the boiling point of water, and we expect a thick dense atmosphere made of steam on this planet. Only under that steam atmosphere there could potentially be liquid water at high pressure, or even water in another phase that occurs at high pressures, called a supercritical fluid," Piaulet said.

In 2014, data from NASA's Kepler Space Telescope allowed astronomers to announce the detection of three planets orbiting Kepler-138. This was based on a

measurable dip in starlight as the planet momentarily passed in front of their star.

Benneke and his colleague Diana Dragomir, from the University of New Mexico , came up with the idea of re-observing the planetary system with the Hubble and Spitzer space telescopes between 2014 and 2016 to catch more transits of Kepler-138 d, the third planet in the system, in order to study its atmosphere.

A new exoplanet in the system

The two possible water worlds, Kepler-138 c and d, are not located in the habitable zone, the area around a star where temperatures would allow liquid water on the surface of a rocky planet. But in the Hubble and Spitzer data, researchers additionally found evidence for a new planet in the system, Kepler-138 e, in the habitable zone.

This newly found planet is small and farther from its star than the three others, taking 38 days to complete an orbit. The nature of this additional planet, however, remains an open question because it does not seem to transit its host star. Observing the exoplanet's transit would have allowed astronomers to determine its size.

With Kepler-138 e now in the picture, the masses of the previously known planets were measured again via the transit timing-variation method, which consists of tracking small variations in the precise moments of the planets' transits in front of their star caused by the gravitational pull of other nearby planets.

The researchers had another surprise: they found that the two water worlds Kepler-138 c and d are "twin" planets, with virtually the same size and mass, while they were previously thought to be drastically different. The closer-in planet, Kepler-138 b, on the other hand, is confirmed to be a small Mars-mass planet, one of the smallest exoplanets known to date.

"As our instruments and techniques become sensitive enough to find and study planets that are farther from their stars, we might start finding a lot more of these water worlds," Benneke concluded.

The Hubble Space Telescope is a project of international cooperation between NASA and ESA. NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Maryland, conducts Hubble science operations. STScI is operated for NASA by the Association of Universities for Research in Astronomy, in Washington, D.C. ⁕

NASA's James Webb telescope discovers its first Earth-sized exoplanet

By Georgina Torbet

Theverge, January 12, 2023

This illustration reflects that exoplanet LHS 475 b is rocky and almost precisely the same size as Earth based on new evidence from NASA's James Webb Space Telescope.

LHS 475 b is a rocky exoplanet roughly the same size as Earth that orbits very close to a small, dim star. And for the first time, researchers are able to study the planet's atmosphere.

The James Webb Space Telescope has discovered its first new exoplanet, an Earth-sized rocky planet called LHS 475 b. Located just 41 light-years away, the planet orbits very close to a small, dim star, completing a full orbit in just two days.

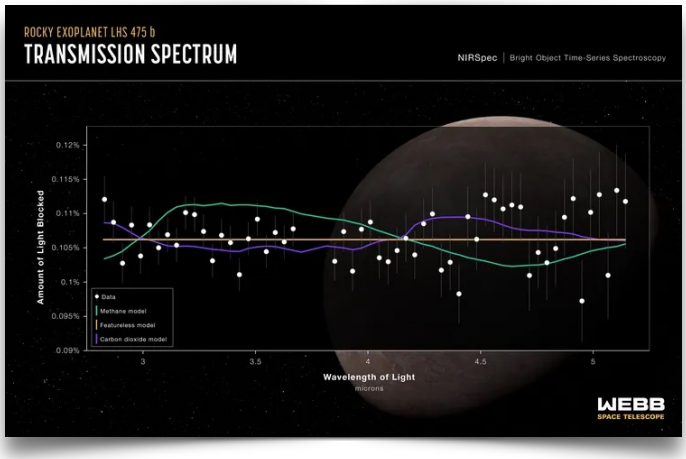
The discovery, presented at the American Astronomical Society (AAS) meeting on Wednesday, January 11th, is notable as most exoplanets discovered are typically large gas giants similar to Jupiter. It is harder for most telescopes to detect Earth-like planets because they are much smaller, at less than a tenth of the diameter.

The planet orbits very close to a small, dim star

Previous research with NASA's Transiting Exoplanet Survey Satellite, another space-based telescope that was launched in 2018 specifically to search for exoplanets, had indicated that there could possibly be a planetary candidate in this system. JWST was able

to confirm the planet's presence from observations made in August and September 2022.

The fact that JWST was able to detect this planet indicates it will be able to identify more Earth-like planets in the future. And even more than that, it should be able to detect their atmospheres — something other telescopes cannot do with planets of this size.



The ultimate aim of much current exoplanet research is to understand the atmospheres around exoplanets. In order to better understand whether certain planets are habitable, astronomers need to study their atmospheres, as this can have a profound impact on factors like surface temperature.

"Over the next few years, and ultimately decades, the search for life on exoplanets will fundamentally rely on the detailed characterization of exoplanet atmospheres," said lead researcher Jacob Lustig-Yaeger of the Johns Hopkins University Applied Physics Laboratory at the AAS meeting. "And the first step on this journey is simply to detect the presence of exoplanet atmospheres."

"The search for life on exoplanets will fundamentally rely on the detailed characterization of exoplanet atmospheres."

Even though JWST should be able to detect exoplanet atmospheres, the task remains challenging. Exoplanets are much smaller than stars and give off much less light, so they are rarely detected directly. Instead, astronomers study host stars and look for small deviations in their brightness or motion, which indicate the presence of a planet orbiting them.

Given these conditions, JWST will likely only be able to detect atmospheres of rocky planets orbiting very small stars called red dwarfs, Lustig-Yaeger explained. In some ways, that is good for hunting for habitable planets, as these rocky worlds are similar in size to Earth. However, these types of planets orbit much closer to their stars than Earth orbits the sun, and so are much hotter. When a planet gets that close to its host star, it can have its atmosphere stripped away by the star's heat and radiation.

In the case of the recently discovered exoplanet LHS 475 b, JWST observed two transits (in which the planet passes in front of its host star, causing a temporary and very small dip in the star's brightness), which both confirmed that the planet was present and allowed the team to work out its radius.

They also used a method called transmission spectroscopy to look at its atmosphere, and although they weren't able to confirm exactly what the atmosphere was, they were able to rule out various options. The findings show that the planet doesn't have a hydrogen-dominated atmosphere like Jupiter or a pure methane atmosphere. It could possibly have a thick carbon dioxide atmosphere like Venus, or it could have no atmosphere at all — having had its atmosphere stripped away by its star.

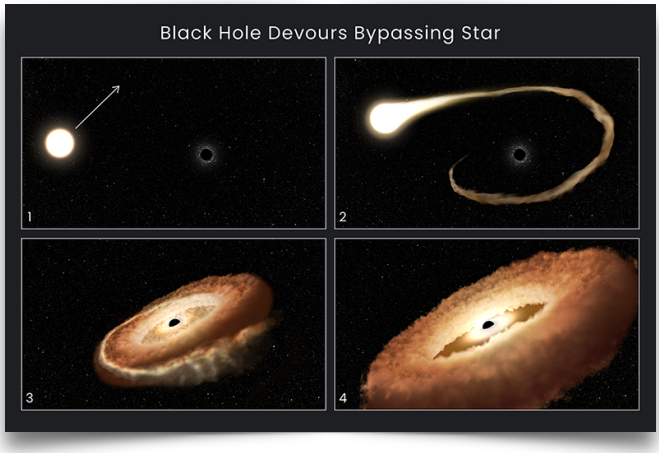
"The observatory's data are beautiful."

"The observatory's data are beautiful," said fellow researcher Erin May in a statement. "The telescope is so sensitive that it can easily detect a range of molecules, but we can't yet make any definitive conclusions about the planet's atmosphere."

The research team has another observation of the planet planned using JWST this summer, which should help them learn more. And the research demonstrates just how powerful a tool JWST is for learning about exoplanets: "Even though we don't detect an atmosphere in this case, our measurements meet the sensitivity requirements to be able to detect the atmospheres of Earth-sized planets. So it's a really exciting time," Lustig-Yaeger said. "We're just starting to scratch the surface of what is possible with JWST." ☼

HUBBLE FINDS HUNGRY BLACK HOLE TWISTING CAPTURED STAR INTO DONUT SHAPE

HUBBLESITE, JANUARY 12, 2023



A DEEP GRAVITATIONAL SINKHOLE SWALLOWS UNLUCKY BYPASSING STAR

Black holes have such a voracious gravitational pull that they even swallow light. This makes them hungry monsters lurking in the eternal darkness. There's no escape if you happen to stumble across one in the inky blackness of space. That's no worry for astronauts who have yet to travel farther than the Moon. But entire stars can face that peril if they wind up in the wrong place at the wrong time.

Hubble astronomers got a front row seat to such an interstellar demolition derby when they were alerted to a flash of high-energy radiation from the core of a galaxy 300 million light-years away. Like a police officer arriving quickly at the scene of an accident, Hubble vision was trained on the mayhem before the collision was over. Hubble is too far away to see the doomed star getting sucked in. Instead, Hubble astronomers took the fingerprints of starlight coming from the mishap. These spectra tell a forensic story of a star falling into a cosmic blender. It was shredded, and pulled toward the black hole like a piece of stretched taffy. This process formed a donut-shaped ring of gas around the black hole with superheated gas bleeding out in every direction. About 100 insatiable black holes have been observed to date.

Black holes are gatherers, not hunters. They lie in wait until a hapless star wanders by. When the star gets close enough, the black hole's gravitational grasp violently rips it apart and sloppily devours its gasses while belching out intense radiation.

Astronomers using NASA's Hubble Space Telescope have recorded a star's final moments in detail as it gets gobbled up by a black hole.

These are termed "tidal disruption events." But the wording belies the complex, raw violence of a black hole encounter. There is a balance between the black hole's gravity pulling in star stuff, and radiation blowing material out. In other words, black holes are messy eaters. Astronomers are using Hubble to find out the details of what happens when a wayward star plunges into the gravitational abyss.

Hubble can't photograph the AT2022dsb tidal event's mayhem up close, since the munched-up star is nearly 300 million light-years away at the core of the galaxy ESO 583-G004. But astronomers used Hubble's powerful ultraviolet sensitivity to study the light from the shredded star, which include hydrogen, carbon, and more. The spectroscopy provides forensic clues to the black hole homicide.

About 100 tidal disruption events around black holes have been detected by astronomers using various telescopes. NASA recently reported that several of its high-energy space observatories spotted another black hole tidal disruption event on March 1, 2021, and it happened in another galaxy. Unlike Hubble observations, data was collected in X-ray light from an extremely hot corona around the black hole that formed after the star was already torn apart.

"However, there are still very few tidal events that are observed in ultraviolet light given the observing time. This is really unfortunate because there's a lot of information that you can get from the ultraviolet spectra," said Emily Engelthaler of the Center for Astrophysics | Harvard & Smithsonian (CfA) in Cambridge, Massachusetts. "We're excited because we can get these details about what the debris is doing. The tidal event can tell us a lot about a black

hole." Changes in the doomed star's condition are taking place on the order of days or months.

For any given galaxy with a quiescent supermassive black hole at the center, it's estimated that the stellar shredding happens only a few times in every 100,000 years.

This AT2022dsb stellar snacking event was first caught on March 1, 2022 by the All-Sky Automated Survey for Supernovae (ASAS-SN or "Assassin"), a network of ground-based telescopes that surveys the extragalactic sky roughly once a week for violent, variable, and transient events that are shaping our universe. This energetic collision was close enough to Earth and bright enough for the Hubble astronomers to do ultraviolet spectroscopy over a longer than normal period of time.

"Typically, these events are hard to observe. You get maybe a few observations at the beginning of the disruption when it's really bright. Our program is different in that it is designed to look at a few tidal events over a year to see what happens," said Peter Maksym of the CfA. "We saw this early enough that we could observe it at these very intense black hole accretion stages. We saw the accretion rate drop as it turned to a trickle over time."

The Hubble spectroscopic data are interpreted as coming from a very bright, hot, donut-shaped area of gas that was once the star. This area, known as a torus, is the size of the solar system and is swirling around a black hole in the middle.

"We're looking somewhere on the edge of that donut. We're seeing a stellar wind from the black hole sweeping over the surface that's being projected towards us at speeds of 20 million miles per hour (three percent the speed of light)," said Maksym. "We really are still getting our heads around the event. You shred the star and then it's got this material that's making its way into the black hole. And so you've got models where you think you know what is going on, and then you've got what you actually see. This is an exciting place for scientists to be: right at the interface of the known and the unknown."

The results were reported during a press conference on Jan. 12 at the 241st meeting of the American Astronomical Society in Seattle, Washington.

The Hubble Space Telescope is a project of international cooperation between NASA and ESA. NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Maryland, conducts Hubble and Webb science operations. STScI is operated for NASA by the Association of Universities for Research in Astronomy, in Washington, D.C. ✲

One of the best star projectors in 2023

By Jamie Carter

SPACE.COM, JANUARY 14, 2023

One of the sleekest-looking and most powerful star projectors around, the satin black Sega Toys Homestar Flux, although compact, comes with a high price — and ambition to match. More of a home, scientific planetarium than a simple star projector, we found the Homestar Flux's multilevel glass lenses produce realistic-looking night skies from the comfort of your own home and are plenty bright enough, even for rooms that aren't 100% dark. After adjusting the focus to suit on your projection surface, you'll see 60,000 stars — many more than its competitors.

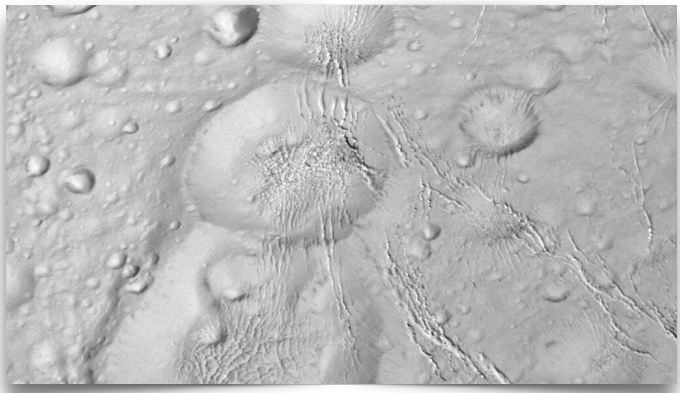
This globe-shaped product excels with the sheer number of distinct stars it projects, and it has some tempting science-based upgrade options. The Homestar Flux comes with two discs, the Northern Hemisphere and the Northern Hemisphere Constellations. One shows a starry sky with 60,000 stars while the other contains constellation labels to aid with learning. A further 17 Sega-branded disks are available to be purchased separately for around $18 a piece, and it's also compatible with Homestar Original disks. Like many other star projectors, there's a 'shooting star' function, although in our Sega Homestar Flux review we explained how we'd like this

to be at random intervals, or in a different place each time so it isn't as predictable. It has an automatic switch-off after 15, 30 or 60 minutes function.

Go to Astrial, Sega Toys' official online shop and you can choose from 30 more disks. Simulation of the aurora borealis and the aurora australis are perhaps the highlights. There's also a disk that shows the planets of the solar system, yet there are others that really impress, including some that display galaxies, nebulas, and various NASA-based imagery. For example, the North America nebula as taken by NASA's Spitzer Space Telescope and the weird seven-star system called Jabbah (officially called Nu Scorpii and IC 4592) as imaged by NASA's WISE mission. You can also buy disks that simulate fireworks, 'night jellyfish' and a hot-air balloon festival. ✳

Enceladus is blanketed in a thick layer of snow

The fluff suggests the moon's famous plume was once more active than it is today.



This chain of craters on Enceladus looks like a Saturnian snowman, but it's actually made from snow draining into fissures underneath.

By Lisa Grossman

SCIENCENEWS, JANUARY 13, 2023

Saturn's moon Enceladus is shrouded in a thick layer of snow. In some places, the downy stuff is 700 meters deep, new research suggests.

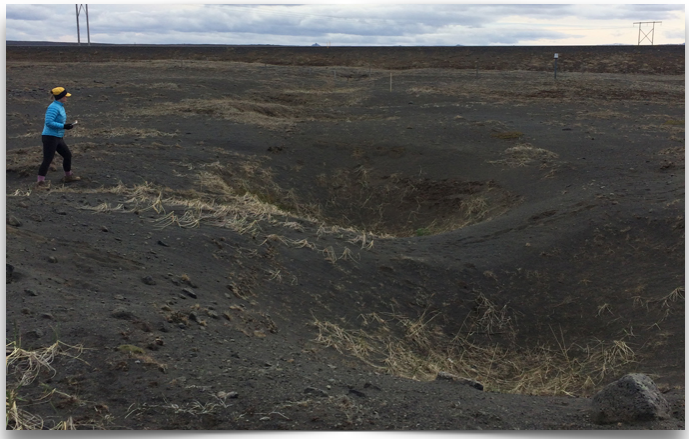
"It's like Buffalo, but worse," says planetary scientist Emily Martin, referring to the famously snowy city in New York. The snow depth suggests that Enceladus' dramatic plume may have been more active in the past, Martin and colleagues report in the Mar. 1 *Icarus*.

Planetary scientists have been fascinated by Enceladus' geysers, made up of water vapor and other ingredients, since the Cassini spacecraft spotted them in 2005 (*SN: 12/16/22*). The spray probably comes from a salty ocean beneath an icy shell.

Some of that water goes to form one of Saturn's rings (*SN: 5/2/06*). But most of it falls back onto the moon's surface as snow, Martin says. Understanding the properties of that snow — its thickness and how dense and compact it is — could help reveal Enceladus' history, and lay groundwork for future missions to this moon.

"If you're going to land a robot there, you need to understand what it's going to be landing into," says Martin, of the National Air and Space Museum in Washington, D.C.

To figure out how thick Enceladus' snow is, Martin and colleagues looked to Earth — specifically, Iceland. The island country hosts geological features called pit chains, which are lines of pockmarks in the ground formed when loose rubble such as rocks, ice or snow drains into a crack underneath (*SN: 10/23/18*). Similar features show up all over the solar system, including Enceladus.



Pit chain craters in Iceland, like those shown here, helped planetary scientist Emily Martin and colleagues verify that they could measure the depth of craters on Enceladus. Martin took this image during a field excursion.

Previous work suggested a way to use geometry and the angle at which sunlight hits the surface to measure the depth of the pits. That measurement can then reveal the depth of the material the pits sit in. A few weeks of fieldwork in Iceland in 2017 and 2018

convinced Martin and her colleagues that the same technique would work on Enceladus.

Using images from Cassini, Martin and colleagues found that the snow's thickness varies across Enceladus' surface. It is hundreds of meters deep in most places and 700 meters deep at its thickest.

It's hard to imagine how all that snow got there, though, Martin says. If the plume's spray was always what it is today, it would take 4.5 billion years — the entire age of the solar system — to deposit that much snow on the surface. Even then, the snow would have to be especially fluffy.

It seems unlikely that the plume switched on the moment the moon formed and never changed, Martin says. And even if it did, later layers of snow would have compressed the earlier ones, compacting the whole layer and making it much less deep than it is today.

"It makes me think we don't have 4.5 billion years to do this," Martin says. Instead, the plume might have been much more active in the past. "We need to do it in a much shorter timeframe. You need to crank up the volume on the plume."

The technique was clever, says planetary scientist Shannon MacKenzie of the Johns Hopkins University Applied Physics Laboratory in Laurel, Md. Without rovers or astronauts on the ground, there's no way to scoop up the snow and see how far down it goes. "Instead, the authors are very cleverly using geology to be their rovers, to be their shovels."

MacKenzie was not involved in the new work, but she led a mission concept study for an orbiter and lander that could one day visit Enceladus. One of the major questions in that study was where a lander could safely touch down. "Key to those discussions was, what do we expect the surface to be?" she says. The new paper could help "identify the places that are too fluffy to land in." ⁕

Billions of celestial objects revealed in gargantuan survey of the Milky Way

Sciencedaily, January 18, 2023

The Milky Way Galaxy contains hundreds of billions of stars, glimmering star-forming regions, and towering dark clouds of dust and gas. Imaging and cataloging these objects for study is a herculean task, but a newly released astronomical dataset known as the second data release of the Dark Energy Camera Plane Survey (DECaPS2) reveals a staggering number of these objects in unprecedented detail. The DECaPS2 survey, which took two years to complete and produced more than 10 terabytes of data from 21,400 individual exposures, identified approximately 3.32 billion objects -- arguably the largest such catalog compiled to date. Astronomers and the public can explore the dataset here.

This unprecedented collection was captured by the Dark Energy Camera (DECam) instrument on the Víctor M. Blanco 4-meter Telescope at Cerro Tololo Inter-American Observatory (CTIO), a Program of NSF's NOIRLab. CTIO is a constellation of international astronomical telescopes perched atop Cerro Tololo in Chile at an altitude of 2200 meters (7200 feet). CTIO's lofty vantage point gives astronomers an unrivaled view of the southern celestial hemisphere, which allowed DECam to capture the southern Galactic plane in such detail.

DECaPS2 is a survey of the plane of the Milky Way as seen from the southern sky taken at optical and near-infrared wavelengths. The first trove of data from DECaPS was released in 2017, and with the addition of the new data release, the survey now covers 6.5% of the night sky and spans a staggering 130 degrees in length. While it might sound modest, this equates to 13,000 times the angular area of the full Moon.

The DECaPS2 dataset is available to the entire scientific community and is hosted by NOIRLab's Astro Data Lab, which is part of the Community Science and Data Center. Interactive access to the imaging with panning/zooming inside of a web-browser is available from the Legacy Survey Viewer, the World Wide Telescope and Aladin.

Most of the stars and dust in the Milky Way are located in its disk -- the bright band stretching across

this image -- in which the spiral arms lie. While this profusion of stars and dust makes for beautiful images, it also makes the Galactic plane challenging to observe. The dark tendrils of dust seen threading through this image absorb starlight and blot out fainter stars entirely, and the light from diffuse nebulae interferes with any attempts to measure the brightness of individual objects. Another challenge arises from the sheer number of stars, which can overlap in the image and make it difficult to disentangle individual stars from their neighbors.

Despite the challenges, astronomers delved into the Galactic plane to gain a better understanding of our Milky Way. By observing at near-infrared wavelengths, they were able to peer past much of the light-absorbing dust. The researchers also used an innovative data-processing approach, which allowed them to better predict the background behind each star. This helped to mitigate the effects of nebulae and crowded star fields on such large astronomical images, ensuring that the final catalog of processed data is more accurate.

"One of the main reasons for the success of DECaPS2 is that we simply pointed at a region with an extraordinarily high density of stars and were careful about identifying sources that appear nearly on top of each other," said Andrew Saydjari, a graduate student at Harvard University, researcher at the Center for Astrophysics | Harvard & Smithsonian and lead author of the paper. "Doing so allowed us to produce the largest such catalog ever from a single camera, in terms of the number of objects observed."

"When combined with images from Pan-STARRS 1, DECaPS2 completes a 360-degree panoramic view of the Milky Way's disk and additionally reaches much fainter stars," said Edward Schlafly, a researcher at the AURA-managed Space Telescope Science Institute and a co-author of the paper describing DECaPS2 published in the Astrophysical Journal Supplement. "With this new survey, we can map the three-dimensional structure of the Milky Way's stars and dust in unprecedented detail."

"Since my work on the Sloan Digital Sky Survey two decades ago, I have been looking for a way to make better measurements on top of complex backgrounds," said Douglas Finkbeiner, a professor at the Center for Astrophysics, co-author of the paper, and principal investigator behind the project. "This work has achieved that and more!"

"This is quite a technical feat. Imagine a group photo of over three billion people and every single individual is recognizable!" says Debra Fischer, division director of Astronomical Sciences at NSF. "Astronomers will be poring over this detailed portrait of more than three billion stars in the Milky Way for decades to come. This is a fantastic example of what partnerships across federal agencies can achieve."

DECam was originally built to carry out the Dark Energy Survey, which was conducted by the Department of Energy and the US National Science Foundation between 2013 and 2019. ✲

POLAR STRATOSPHERIC CLOUDS

spaceweather.com, January 25, 2023

Arctic skies are filling with color today--but it's not the aurora borealis. A rare outbreak of polar stratospheric clouds (PSCs) is underway. Jónína Óskarsdóttir photographed the display from Fáskrúðsfjörður, Iceland:

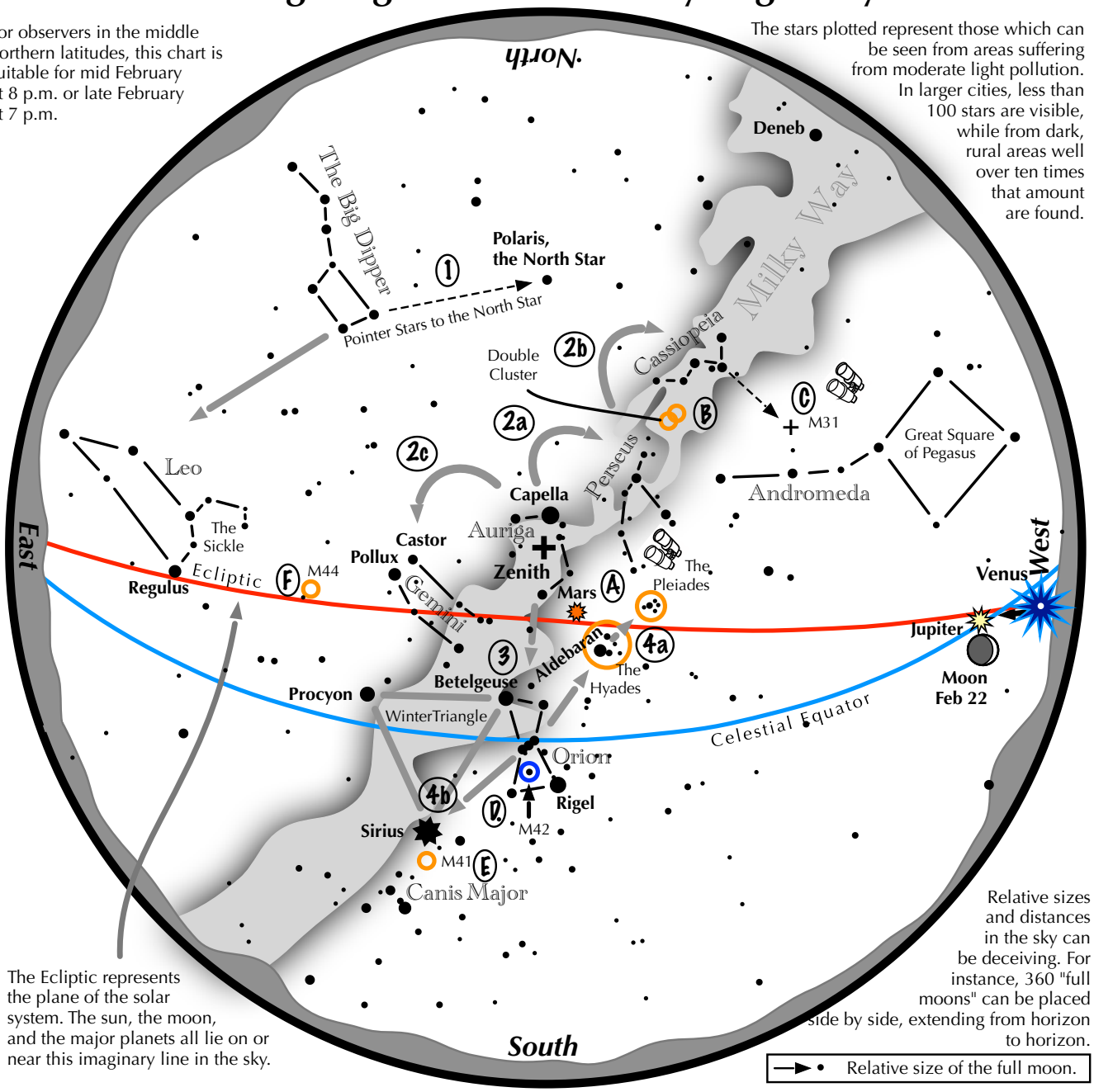
"We have been seeing these clouds for a couple of days," reports Óskarsdóttir. "In this picture, Mt. Jökultindur is silhouetted by a sky-full of nacreous color."

Polar stratospheric clouds are rare. Earth's stratosphere is very dry and normally it has no clouds at all. PSCs form when the temperature in the Arctic stratosphere drops to a staggeringly-low -85 C. Then, and only then, can widely-spaced water molecules begin to coalesce into tiny ice crystals. High-altitude sunlight shining through the crystals creates intense iridescent colors often likened to auroras. ✲

Navigating the mid February Night Sky

For observers in the middle northern latitudes, this chart is suitable for mid February at 8 p.m. or late February at 7 p.m.

The stars plotted represent those which can be seen from areas suffering from moderate light pollution. In larger cities, less than 100 stars are visible, while from dark, rural areas well over ten times that amount are found.



The Ecliptic represents the plane of the solar system. The sun, the moon, and the major planets all lie on or near this imaginary line in the sky.

Relative sizes and distances in the sky can be deceiving. For instance, 360 "full moons" can be placed side by side, extending from horizon to horizon.

Relative size of the full moon.

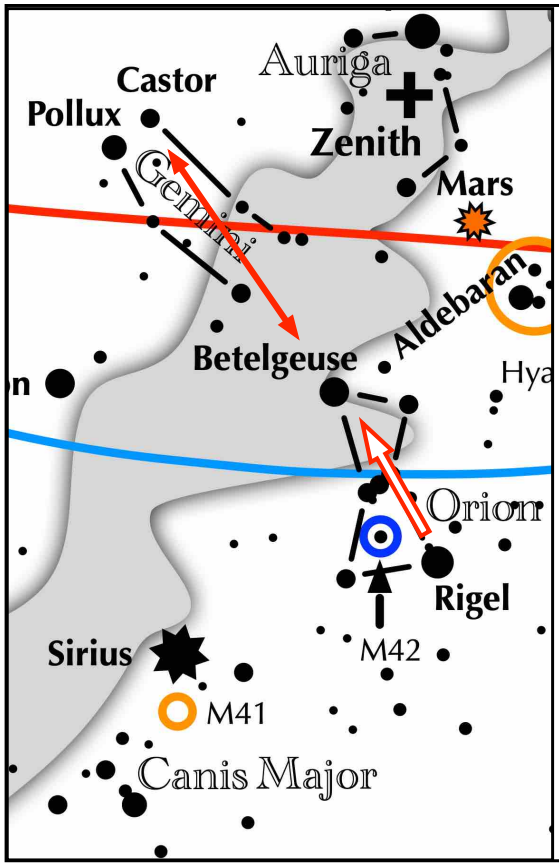
Navigating the February night sky: Simply start with what you know or with what you can easily find.

1. Above the northeast horizon rises the Big Dipper. Draw a line from its two end bowl stars upwards to the North Star.
2. Face south. Overhead twinkles the bright star Capella in Auriga. Jump northwestward along the Milky Way first to Perseus, then to the "W" of Cassiopeia. Next jump southeastward from Capella to the twin stars of Castor and Pollux in Gemini.
3. Directly south of Capella stands the constellation of Orion with its three Belt stars, its bright red star Betelgeuse, and its bright blue-white star Rigel.
4. Use Orion's three Belt stars to point northwest to the red star Aldebaran and the Hyades star cluster, then to the Pleiades star cluster. Travel southeast from the Belt stars to the brightest star in the night sky, Sirius, a member of the Winter Triangle.

Binocular Highlights

A: Examine the stars of two naked eye star clusters, the Pleiades and the Hyades.
B: Between the "W" of Cassiopeia and Perseus lies the Double Cluster.
C: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval.
D: M42 in Orion is a star forming nebula. **E:** Look south of Sirius for the star cluster M41. **F:** M44, a star cluster barely visible to the naked eye, lies southeast of Pollux.

Astronomical League *www.astroleague.org/outreach; duplication is allowed and encouraged for all free distribution.*



Other Suns: Castor

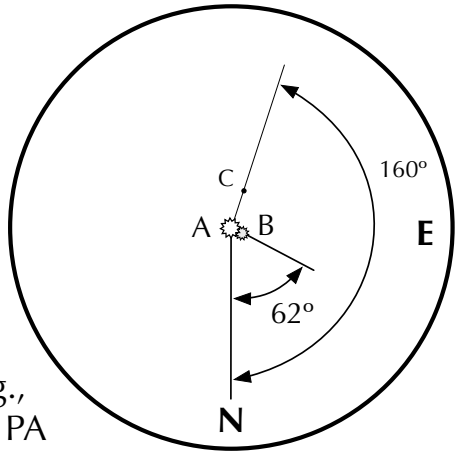
How to find Castor on a February evening

Look south toward Orion. Extend a line northeastward from Rigel through Betelgeuse and continue 1-1/2 times that length. It ends at Castor.

Suggested magnification: >60x
Suggested aperture: >3 inches

Castor
A-B separation: 6 sec
A magnitude: 1.9
B magnitude: 3.0
Position Angle: 62°
A color: white
B color: white

C component: 9.2 mag.,
A-C sep: 71 sec., 160° PA



About Astronomy Associates

The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the last Sunday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. These meetings and the public observing sessions that follow are scheduled at the Baker Wetlands Discovery Center, south of Lawrence. All events and meetings are free and open to the public. Periodic star parties are scheduled as well.

Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Sundays when events are scheduled.

Copies of the Celestial Mechanic can also be found on the web at newsletter.
Annual Dues for the club are: $12 for regular members; $6 for students Membership forms can be accessed at the club website form.