

# The Prairie Astronomer

November 2017 Volume 58, Issue #116

## JOVIAN TEMPEST

*This color-enhanced image of a massive, raging storm in Jupiter's northern hemisphere was captured by NASA's Juno spacecraft during its ninth close flyby of the gas giant planet. See page 8.*



**Night Sky Network**



The Newsletter of the Prairie Astronomy Club

# ***The Prairie Astronomer***

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**INSTEAD OF** our regular monthly meeting, we will present our annual “How to Buy a Telescope” program at Hyde Observatory on Saturday evening, December 9 at 7:30pm and again at 8:30pm.

**Please bring telescopes.**

## **FUTURE PROGRAMS**

December: Holiday Gathering - moved to January 2<sup>nd</sup>

January: How to Use Your Telescope

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The Prairie Astronomy Club:  
Fifty Years of Amateur Astronomy



COMPILED AND EDITED BY MARK DAHMKE

**Buy the book! The Prairie Astronomy Club: Fifty Years of Amateur Astronomy.**

Order online from [Amazon](https://www.amazon.com) or [lulu.com](https://www.lulu.com).

# EVENTS



No meeting in November. How to Buy a Telescope will be presented at Hyde on Saturday December 9.

PAC meeting  
 Tuesday January 2, 2018, 6:30pm  
 Program and location to be announced

PAC Meeting  
 Tuesday January 30, 2018, 7:30pm  
 How to Use Your Telescope

## 2018 STAR PARTY DATES



Photo by Brian Sivill

	Star Party Date	Star Party Date
January	Jan 12th	<b>Jan 19th</b>
February	Feb 9th	<b>Feb 16th</b>
March	Mar 9th	<b>Mar 16th</b>
April	Apr 6th	<b>Apr 13th</b>
May	May 4th	<b>May 11th</b>
June	Jun 8th	<b>Jun 15th</b>
July	Jul 6th	<b>Jul 13th</b>
August	Aug 3rd	<b>Aug 10th</b>
<b>NSP</b>	<b>Aug 5th -10<sup>th</sup></b>	
September	<b>Sep 7th</b>	Sep 14th
October	<b>Oct 5th</b>	Oct 12th
November	Nov 2nd	<b>Nov 9th</b>
December	Nov 30th	<b>Dec 7th</b>

Dates in **BOLD** are closest to the New Moon.



### PAC E-MAIL:

[info@prairieastronomyclub.org](mailto:info@prairieastronomyclub.org)

### PAC-LIST:

Subscribe through [GoogleGroups](#).  
 To post messages to the list, send to the address:

[pac-list@googlegroups.com](mailto:pac-list@googlegroups.com)

### ADDRESS

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### WEBSITES

- [www.prairieastronomyclub.org](http://www.prairieastronomyclub.org)
- <https://nightsky.jpl.nasa.gov>
- [www.hydeobservatory.info](http://www.hydeobservatory.info)
- [www.nebraskastarparty.org](http://www.nebraskastarparty.org)
- [www.OmahaAstro.com](http://www.OmahaAstro.com)
- [Panhandleastronomyclub.com](http://Panhandleastronomyclub.com)
- [www.universetoday.com/](http://www.universetoday.com/)
- [www.planetary.org/home/](http://www.planetary.org/home/)
- <http://www.darksky.org/>



**Night Sky Network**

## Meeting Minutes

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Minutes PAC Business Meeting  
10/24/2017

President Jim Kvasnicka called the meeting to order at 7:00 p.m.

Upcoming events and requests for help from the club were reviewed.

Club star parties are scheduled for November 10 and 17<sup>th</sup> at the observing site.

The pending closure of Holmes Park South Shore Road over Thanksgiving week would impact the regular PAC meeting on the last Tuesday of November, the 28<sup>th</sup>. That would be our annual meeting devoted to How To Buy a Telescope for the public, requiring advance publicity. We will get more

information and make a decision on what to do about that meeting.

John Reinert gave the Treasurer's report; nothing was exceptional for this time of the year.

Election of club officers was held. The nominations carried over from the previous meeting were:

President – Jim Kvasnicka  
Vice President – Brett Boller  
Treasurer – John Reinert  
Secretary – Lee Thomas  
2<sup>nd</sup> Vice President/Program Chair – Mark Dahmke removed his name from consideration, and there being no other names submitted, nomination for the office was left open.

No further nominees were put forth. Nominations were closed. It was established that the club bylaws required 1/3 of members to be present for a quorum; 17 were required, and 18 were present, so the quorum requirement was met. It was moved and seconded that the slate as nominated be accepted and voted by acclamation. Lacking a 2<sup>nd</sup> Vice President/Program Chair, Jim will assign the duties of that position, as needed, until the office can be filled

Business meeting adjourned at 7:25 p.m. An observing session in conjunction with a Hyde Observatory scheduled public group followed.

## Board Meeting Minutes (November 13, 2017)

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Present: Jim Kvasnicka, John Reinert, Mark Dahmke, Mike Kearns, Lee Thomas. Absent: Brett Boller.

In a discussion about the December meeting, "How To Buy A Telescope", it was decided that, given the projected work on the Holmes Park South Shore Road during Thanksgiving week, to be safe the meeting should be delayed into December, conditioned on what Lee can find out from the Parks Department about their plans. Mark suggested that we had talked about moving club meetings to a day other than Tuesday, and this might be a chance to test that idea by having "How to Buy a

Telescope" on a Saturday night when Hyde is open for regular public viewing.

We would do a brief Power Point presentation – on the questions prospective telescope buyers should be asking: Who is it for – children? Adult? Family? – What kind of telescope, What kind of mount, Where do you buy it, Where do you get help if you need it (basically adapting the page on the web site, which includes where to buy and where not to buy a scope, what to avoid) followed by the usual Hyde programs, and repeat the Power Point once or twice later in the evening as newcomers arrive at the observatory. In addition to viewing through the

observatory telescopes, club members would be encouraged to bring their own scopes that are different from the cassegrains at the observatory, and especially to bring beginner-type telescopes.

We would plan to skip the regular club business part of the meeting.

The question of a Christmas meeting was raised, contingent upon Zach Thompson's willingness to host the meeting at the planetarium. Jim will talk with Zach about a date that would work for him, not too close to the already-scheduled Hyde

Volunteer Appreciation dinner, on January 16.

Future meetings beyond the regular January “How To Use Your Telescope” were discussed. One possibility was to have a Spring meeting at Branched Oak Observatory, which a lot of members have not seen, and by that time the cement pad that the club is financing might be in place. Jim will put out a call to club members to see if anyone has a presentation they would like to make for a program. Another possible program would be some collected YouTube videos on star parties from other clubs.

There was some discussion about issuing an open invitation to the schools (LPS and other school systems around Lincoln) from the club and observatory encouraging their students to come out and look through the telescopes, and to issue that invitation especially to Ethan Van Winkle, a new Hyde board member who teaches science at Lincoln Southeast High.

Strategies for building club membership were discussed. Mike noted that outreach is limited to five or six members who actively contribute. Mark will continue to forward requests from the web site to Mike, who will encourage other members to participate because working with the public – especially working with kids – and promoting the hobby is one of the most rewarding aspects of club. It was also noted that one of the best times to pitch the club is when Hyde visitors are actually looking through the telescopes and are fascinated by what they see. It’s a perfect chance for deck leaders and volunteers to invite them to a club meeting, which they can attend free of charge and without joining.

The main points to be made in the “How to Buy a Telescope” sessions were discussed: Avoid talking about advanced amateur scopes; stick to simple designs like a refractor – something that requires little or no setup, a simple “point and look” and can be used for looking at things other than the sky; emphasizing

who the user will be because it’s different between an adult and a kid; keeping price point in mind – you can get a good beginner scope for \$200, which a prospective buyer might consider for a child but be put off by the notion of spending \$500 “for a good scope”; and avoiding getting too technical, which is off putting to someone who is just getting interested in astronomy. And push the club as the place to get help.

We need a greeter for visitors at club meetings to welcome them and get a sign in sheet, which could also establish attendance by members. Other ideas were mentioned: a swap meet, and door prizes.

Final discussion involved advertising for How To Buy a Telescope, which will employ some paid boosting on Facebook, and making Ethan Van Winkle aware of the program for possible publicity through LPS.

Submitted by: Lee Thomas



xkcd.com

## Observatory Update: PV Cephei (Gyulbudaghian's Nebula)

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*Rick Johnson*

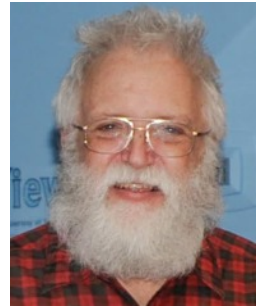
I've been monitoring the nebula around PV Cephei (Gyulbudaghian's Nebula) since 2011. Each year changes are seen but nothing nearly as dramatic as when my images are compared to the POSS I and POSS II images. In the POSS II images it is nearly invisible in red light as a streak with a bit more even fainter features but in blue it is rather similar to the brighter parts seen in all my prior images so it was very blue back in the mid 60's when those were taken. But since they could have been taken a year or

two apart this isn't saying much. In the 1950's when the POSS I plates were made the streak of red light was much stronger with little else seen. It was also seen in blue light but was much weaker so then the streak was quite red.

I was in for a surprise when the first frame for 2017 came in. It had changed drastically with the streak portion seen in three of the POSS images being the main feature though the eastern half of the triangular part of the nebula was visible it no longer

reached PV Cephei itself with much of the western side very faint. PV Cephei itself is much fainter than in any of my prior images.

Also, the dark nebula seems to have changed being less bright with weaker color. The lower right part of the cloud is LDN 1155C. The portion nearer PV



Cephi may be [YDM97] CO 8. I'm not all that great at identifying these dark nebulae.

Above Gyulbudaghian's Nebula is a separate short streak. It is unrelated as it is HH 415 due to a jet from a protostar at its south end. Though the star likely formed from the same molecular cloud that fills much of the field. Gyulbudaghian's Nebula is just a part of it lit by PV Cephi. It likely changes due to dark clouds right around PV Cephi which itself is a young stellar object and thus a variable star.

An interesting paper suggests that PV Cephi formed in the NGC 7023 star cluster and was

ejected about 100,000 years ago and entered the molecular cloud in which we now see it about 35,000 years ago.

<http://iopscience.iop.org/article/10.1086/383139>

Besides this year's image, I've included comparison images, processed as similarly as possible for me, going back to 2011 showing how it has changed. Note the "streak" remains rather constant while the rest seems to change significantly. The star and its nebula are thought to be about 1600 light-years away. As the name indicates it is in Cepheus near the western edge. Not far from the Iris Nebula.

I'm running this one out of order. While I've been processing mid September images I decided to process this October image out of order. Thanks to nothing but clouds since then I don't know if it has reverted to its look for the last 6 years.

While several have made "movies" of Hubble's Variable Nebula changing in just a couple days I find no such movie for this nebula. Its changes seem greater than of Hubble's Variable Nebula. Someone with more consistent skies than I have needs to undertake this task.



*See next page for November, 2015 to October 2017 images*



November 8, 2015

December 23, 2016

October 13, 2017

## Cover Photo - Jovian Tempest

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*This color-enhanced image of a massive, raging storm in Jupiter's northern hemisphere was captured by NASA's Juno spacecraft during its ninth close flyby of the gas giant planet.*

*The image was taken on Oct. 24, 2017 at 10:32 a.m. PDT (1:32 p.m. EDT). At the time the image was taken, the spacecraft was about 6,281 miles (10,108 kilometers) from the tops of the clouds of Jupiter at a latitude of 41.84 degrees. The spatial scale in this image is 4.2 miles/pixel (6.7 kilometers/pixel).*

*The storm is rotating counter-clockwise with a wide range of cloud altitudes. The darker clouds are expected to be deeper in the atmosphere than the brightest clouds. Within some of the bright "arms" of this storm, smaller clouds and banks of clouds can be seen, some of which are casting shadows to the right side of this picture (sunlight is coming from the left). The bright clouds and their shadows range from approximately 4 to 8 miles (7 to 12 kilometers) in both widths and lengths. These appear similar to the small clouds in other bright regions Juno has detected and are expected to be updrafts of ammonia ice crystals possibly mixed with water ice.*

*Citizen scientists Gerald Eichstädt and Seán Doran processed this image using data from the JunoCam imager.*



# December Observing: What to View

Jim Kvasnicka

This is a partial list of objects visible for the upcoming month.

## Planets

**Saturn:** Not visible in December.

**Neptune:** Magnitude 7.9 in Aquarius.

**Uranus:** Magnitude 5.7 in Pisces.

**Mars:** Rises about 3-4 hours before the Sun.

**Jupiter:** Appears about two hours after Mars at magnitude -1.8 with a disk 33" wide.

**Venus:** Rises just 45 minutes before the Sun.

**Mercury:** Goes through inferior conjunction and is visible again around December 20<sup>th</sup>.

## Meteor Showers

**Geminids:** Peaks the nights of December 13-14 with an average zenithal hourly rate (ZHR) of 120. Meteors will be visible from December 4-16.

## Messier List

**M2:** Class II globular cluster in Aquarius.

**M15:** Class IV globular cluster in Pegasus.

**M29:** Open cluster in Cygnus.

**M31:** The Andromeda Galaxy.

**M32:** Companion galaxy to M31.

**M39:** Open cluster in Cygnus.

**M110:** Companion galaxy to M31.

**Last Month:** M27, M30, M56, M57, M71, M72, M73

**Next Month:** M33, M34, M52, M74, M76, M77, M103

## NGC and other Deep Sky Objects

**NGC 578:** Galaxy in Cetus.

**NGC 672 / IC 1727:** Two galaxies in Triangulum separated by 8'.

**NGC 779:** Edge on galaxy in Cetus.

**NGC 869 / NGC 884:** The Double Cluster in Perseus.

## Double Star Program List

**Eta Cassiopeiae:** Yellow primary with a rose colored secondary.

**Sigma Cassiopeiae:**

Yellow and light blue stars.

**Theta Aurigae:** Bright white and pale blue pair.

**1 Camelopardalis:** White and pale blue stars.

**32 Camelopardalis:** Equal white pair.

**Gamma Ceti:** White

primary with a pale yellow secondary.

**Chi Tauri:** White and pale blue pair.

**118 Tauri:** White primary with a yellow secondary.



## Challenge Object

**Arp 318 Galaxy Group:** Group of four galaxies in Cetus that include NGC 833, NGC 835, NGC 838, and NGC 839. The four make a curved line E-S.

# Focus on Constellations: Cetus

Jim Kvasnicka

## Cetus

Cetus the Sea Monster or Whale is the fourth largest constellation covering 1,231 square degrees of the sky. It contains the star Omicron Ceti, names Mira “The Wonderful”, prototype of the red giant long-period variables. Cetus is well off the Milky Way in a rather blank part of the sky. It contains no open clusters or diffuse nebulae, and has a number of galaxies. Cetus is best seen in the month of December.

## Showpiece Objects

**Galaxies:** M77, NGC 157, NGC 247, NGC 578, NGC 1087

**Planetary Nebulae:** NGC 246

## Mythology

In Greek mythology, Cetus is the Sea Monster of the Andromeda myth, turned to stone when Perseus exposed to its sight the severed head of the snake haired Medusa. Anyone who looked upon the Medusa was turned to stone.

## Number of Objects Magnitude 12.0 and Brighter

**Galaxies:** 43

**Globular Clusters:** 0

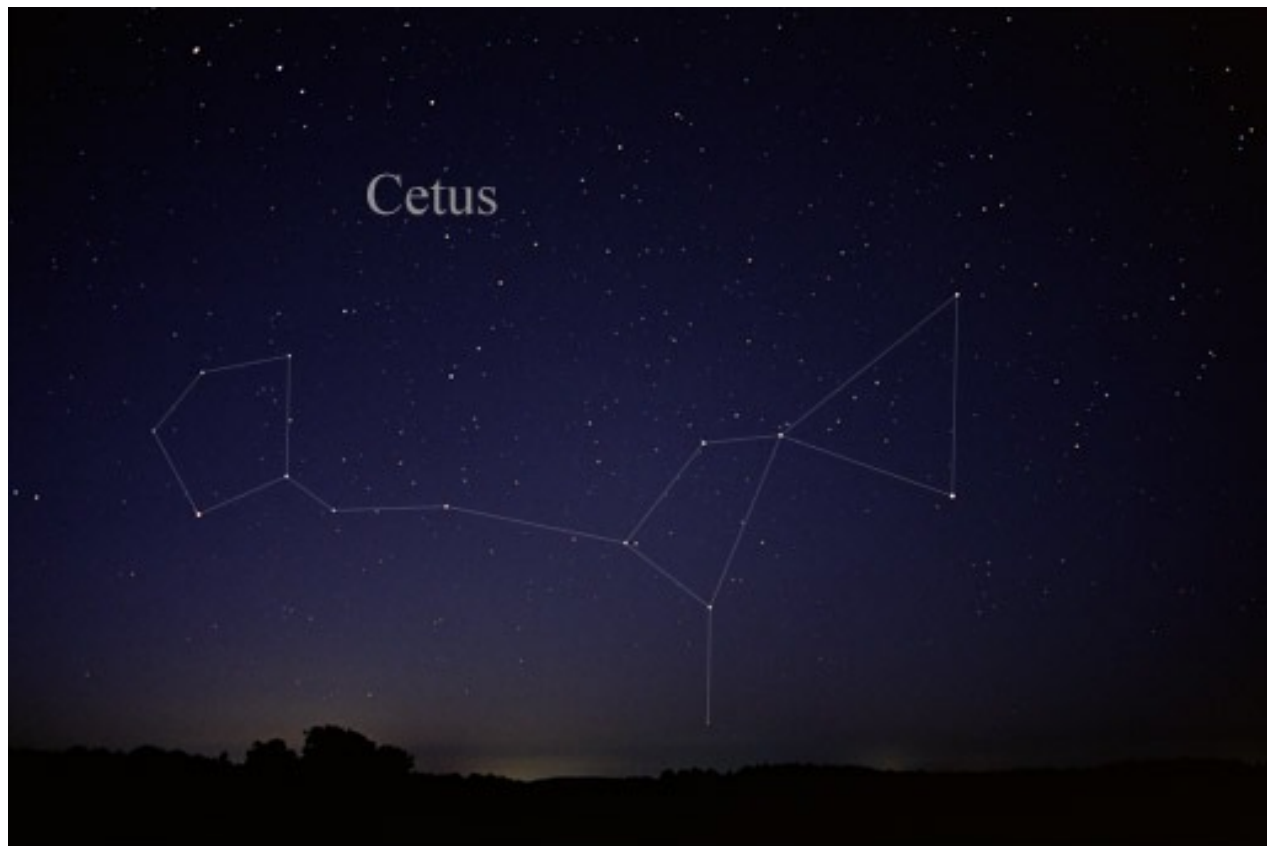
**Open Clusters:** 0

**Planetary Nebulae:** 1

**Dark Nebulae:** 0

**Bright Nebulae:** 0

**SNREM:** 0



*Photo credit: Till Credner - Own work: AlltheSky.com*

# Howling Homestead Star Party

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Saturday, October 28, 2017

We probably had about 30 to 40 people who looked through the three scopes we had operating (Jim Kvasnicka, John Lammers, and myself), and although it was cold, people were still enthusiastic about views of the moon, Saturn, several double stars, and a few open clusters. – Dave Knisely



# Astrophotography

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Above: Moonrise at Mauna Lani, Hawaii, by Mark Dahmke.

November 4, 2017,  
8:21pm.

Panasonic Lumix GX8,  
handheld, 1.3 seconds  
f/2.8 ISO 800 12mm  
(24mm equivalent).  
Perseus is in the upper  
left.

Right: twilight sky,  
taken at Mauna Lani  
Bay. Sagittarius is on  
the left.



# From the Archives: November, 1987

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Observing Chairman's Report  
by Dave Knisely

The next scheduled star party is on the night of December 18th at the Atlas observing site. December skies offer the best in nebulae and open star clusters. Start out your observing in Cassiopeia with the diffuse nebula NGC 281, located about one and a half degrees east of Alpha. It should just be visible in a six inch rich-field telescope as a large hazy area with a few stars involved. An eight inch with Lumicon's UHC or OIII filter will make the area look like M16 with much dark and light detail being visible. Just north-west of the faint star 34 Cassiopeiae is the rich and bright star cluster NGC 457. It is a beautiful group of both bright and faint stars that looks like a bird in flight when viewed in almost any telescope.

In Auriga are several spectacular open star clusters that are good targets for moderate apertures. M38 is a moderate sized rich group of stars located about one and one half degrees south and a bit east of Sigma. Those with six inch or larger apertures may also see the small tight cluster NGC 1907 just to the south of M38. It is very rich and reminds me of the companion to M35, NGC 2158, except that this cluster is brighter. About a degree and an half east of 16 Aurigae is the moderate sized open cluster NGC 1893. It is a "Y" shaped group of about 20 stars with some faint nebulosity involved. My ten inch only showed a hint of the nebula until I used the OIII filter. It then became rather obvious and showed some dark detail. Two degrees north-east of this object is the bright cluster M36. It is visible in binoculars but is not as rich

in stars as M38 is. Probably the richest star cluster in Auriga is M37, located just under four degrees east and a bit north of Chi. This object is also visible in binoculars but takes at least a 60mm refractor to show many stars. It is spectacular in a six inch and reminds me of M11.

Many beginners with small refractors try and fail to see M1, the Crab Nebula. This object can be found about a degree north-west of Zeta Tauri and is fairly difficult, although I have seen it in a 60mm refractor at about 25x as a dim fuzzy "L" shaped patch. Larger instruments brighten the nebula but add little detail to it. Under excellent conditions, eight or ten inch apertures will show some irregularities in the edges and some variations in brightness in the nebula. I have seen traces of the filaments of gas using the Lumicon filters and a ten or twelve inch telescope, but for the most part, this object is somewhat disappointing.

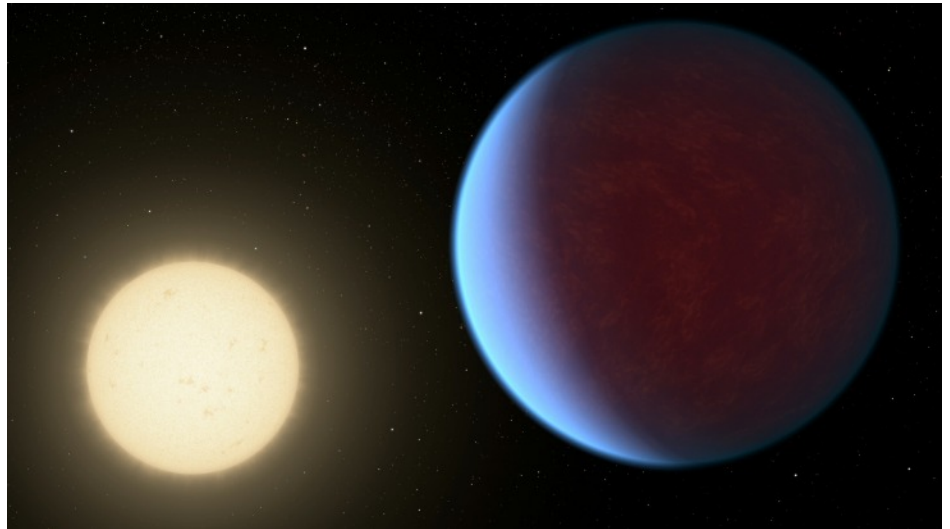
After you have had a nice long look at the Great Orion Nebula, those of you with large telescopes may want to try the challenging nebula NGC 2174-5, located in Orion's club less than a degree north-west of the faint star 68 Orionis. It is in a rich area of the milky way and is involved in a star cluster but is very faint. If you use Lumicon's OIII filter, the nebulosity stands out well as a large and detailed circular area of light. I found it to be a real winner in my ten inch with the filter and you probably will too!

## Lava or Not, Exoplanet 55 Cancri e Likely to have Atmosphere

Twice as big as Earth, the super-Earth 55 Cancri e was thought to have lava flows on its surface. The planet is so close to its star, the same side of the planet always faces the star, such that the planet has permanent day and night sides. Based on a 2016 study using data from NASA's Spitzer Space Telescope, scientists speculated that lava would flow freely in lakes on the starlit side and become hardened on the face of perpetual darkness. The lava on the dayside would reflect radiation from the star, contributing to the overall observed temperature of the planet.

Now, a deeper analysis of the same Spitzer data finds this planet likely has an atmosphere whose ingredients could be similar to those of Earth's atmosphere, but thicker. Lava lakes directly exposed to space without an atmosphere would create local hot spots of high temperatures, so they are not the best explanation for the Spitzer observations, scientists said.

"If there is lava on this planet, it would need to cover the entire surface," said Renyu Hu, astronomer at NASA's Jet Propulsion Laboratory, Pasadena, California, and co-author of a study published in *The Astronomical Journal*. "But the lava would be hidden from our view by the thick atmosphere."



*The super-Earth exoplanet 55 Cancri e, depicted with its star in this artist's concept, likely has an atmosphere thicker than Earth's but with ingredients that could be similar to those of Earth's atmosphere.*

Using an improved model of how energy would flow throughout the planet and radiate back into space, researchers find that the night side of the planet is not as cool as previously thought. The "cold" side is still quite toasty by Earthly standards, with an average of 2,400 to 2,600 degrees Fahrenheit (1,300 to 1,400 Celsius), and the hot side averages 4,200 degrees Fahrenheit (2,300 Celsius). The difference between the hot and cold sides would need to be more extreme if there were no atmosphere.

"Scientists have been debating whether this planet has an atmosphere like Earth and Venus, or just a rocky core and no atmosphere, like Mercury. The case for an atmosphere is now stronger than ever," Hu said.

Researchers say the atmosphere of this mysterious planet could contain nitrogen, water and even oxygen -- molecules found in our atmosphere, too -- but with much higher temperatures throughout. The density of the planet is also similar to Earth, suggesting that it, too, is rocky. The intense heat from the host star would be far too great to support life, however, and could not maintain liquid water.

Hu developed a method of studying exoplanet atmospheres and surfaces, and had previously only applied it to sizzling, giant gaseous planets called hot Jupiters. Isabel Angelo, first author of the study and a senior at the University of California, Berkeley, worked on the study as part of her

internship at JPL and adapted Hu's model to 55 Cancri e.

In a seminar, she heard about 55 Cancri e as a potentially carbon-rich planet, so high in temperature and pressure that its interior could contain a large amount of diamond.

"It's an exoplanet whose nature is pretty contested, which I thought was exciting," Angelo said.

Spitzer observed 55 Cancri e between June 15 and July 15, 2013, using a camera specially designed for viewing infrared light, which is invisible to human eyes. Infrared light is an indicator of heat energy. By comparing changes in

brightness Spitzer observed to the energy flow models, researchers realized an atmosphere with volatile materials could best explain the temperatures.

There are many open questions about 55 Cancri e, especially: Why has the atmosphere not been stripped away from the planet, given the perilous radiation environment of the star?

"Understanding this planet will help us address larger questions about the evolution of rocky planets," Hu said.

NASA's Jet Propulsion Laboratory, Pasadena, California, manages the Spitzer

Space Telescope mission for NASA's Science Mission Directorate, Washington. Science operations are conducted at the Spitzer Science Center at Caltech in Pasadena. Spacecraft operations are based at Lockheed Martin Space Systems Company, Littleton, Colorado. Data are archived at the Infrared Science Archive housed at IPAC at Caltech. Caltech manages JPL for NASA. For more information about Spitzer, visit:

<http://spitzer.caltech.edu>

<https://www.nasa.gov/spitzer>

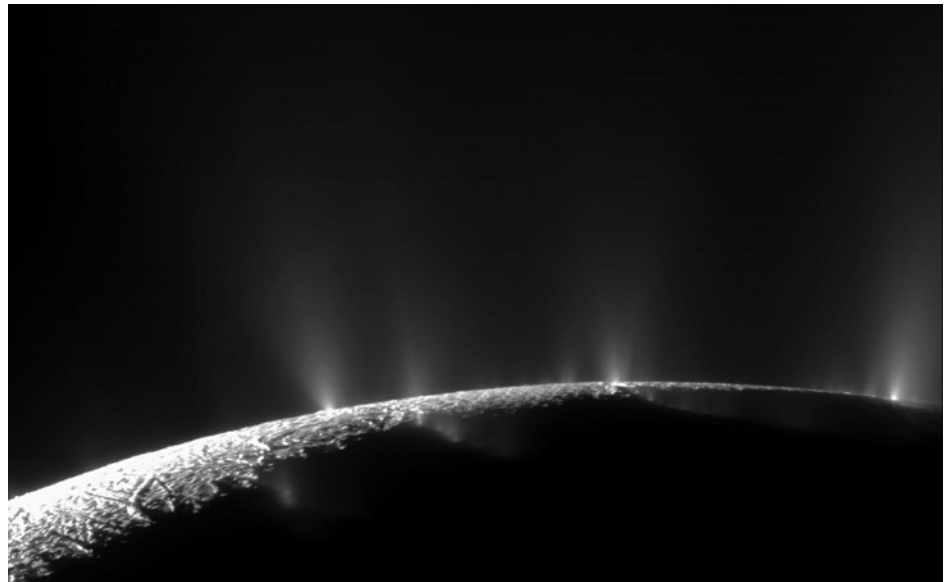
## Powering Saturn's Active Ocean Moon

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Heat from friction could power hydrothermal activity on Saturn's moon Enceladus for billions of years if the moon has a highly porous core, according to a new modeling study by European and U.S. researchers working on NASA's Cassini mission.

The study, published today in the journal *Nature Astronomy*, helps resolve a question scientists have grappled with for a decade: Where does the energy to power the extraordinary geologic activity on Enceladus come from?

Cassini found that Enceladus sprays towering, geyser-like jets of water vapor and icy particles, including simple organics, from warm fractures near its south pole. Additional investigation revealed the moon has a global ocean beneath its icy crust, from



*A recent study has provided new insights into how the warm interior of Saturn's geologically active moon Enceladus could be sustained for billions of years. Credit: NASA/JPL-Caltech/Space Science Institute*

which the jets are venting into space. Multiple lines of evidence from Cassini indicate that hydrothermal activity -- hot water interacting chemically with rock

-- is taking place on the seafloor.

One of those lines was the detection of tiny rock grains

inferred to be the product of hydrothermal chemistry taking place at temperatures of at least 194 degrees Fahrenheit (90 degrees Celsius). The amount of energy required to produce these temperatures is more than scientists think could be provided by decay of radioactive elements in the interior.

"Where Enceladus gets the sustained power to remain active has always been a bit of a 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," said the study's lead author, Gaël Choblet from the University of Nantes in France.

Choblet and co-authors found that a loose, rocky core with 20 to 30 percent empty space would do the trick. Their simulations show that as Enceladus orbits Saturn, rocks in the porous core flex and rub together, generating heat. The loose interior also allows water from the ocean to percolate deep down, where it heats up, then rises, interacting chemically with the rocks. The models show this activity should be at a maximum at the moon's poles. Plumes of the warm, mineral-laden water gush from the seafloor and travel upward, thinning the moon's ice shell from beneath to only half a mile to 3 miles (1 to 5 kilometers) at the south pole. (The average global thickness of the ice is thought to be about 12 to 16 miles, or 20 to 25 kilometers.) And this same water is then expelled into space through fractures in the ice.

The study is the first to explain several key characteristics of Enceladus observed by Cassini: the global ocean, internal heating, thinner ice at the south pole, and hydrothermal activity. It doesn't explain why the north and south poles are so different though. Unlike the tortured, geologically fresh landscape of the south, Enceladus' northern extremes are heavily cratered and ancient. The authors note that if the ice shell was slightly thinner in the south to begin with, it would lead to runaway heating there over time.

The researchers estimate that, over time (between 25 and 250 million years), the entire volume of Enceladus' ocean passes through the moon's core. This is estimated to be an amount of water equal to two percent of the volume of Earth's oceans.

Flexing of Enceladus' icy crust due to the tidal pull of Saturn had previously been considered as a heat source, but models showed this would not produce enough sustained power. The ocean in Enceladus would have frozen within 30 million years. Although past studies modeled how tidal friction could generate heat in the moon's core, they made simpler assumptions or simulated the moon in only two dimensions. The new study ramped up the complexity of the model and simulated Enceladus in 3-D.

Although the Cassini science team had suspected for years that a porous core might play an important role in the mystery of Enceladus' warm interior, this study brings together several more recent lines of evidence in a very elegant way, according to

NASA's Cassini Project Scientist Linda Spilker at the agency's Jet Propulsion Laboratory in Pasadena, California. "This powerful research makes use of newer details -- namely that the ocean is global and has hydrothermal activity -- that we just didn't have until the past couple of years. It's an insight that the mission needed time to build, one discovery upon another," she said.

Launched in 1997, the Cassini spacecraft orbited Saturn from 2004 to 2017. Cassini made numerous dramatic discoveries, including the surprising activity on Enceladus and liquid methane seas on Saturn's largest moon, Titan. Cassini ended its journey with a dramatic plunge into Saturn's atmosphere on Sept. 15, 2017, returning unique science data until it lost contact with Earth.

The Cassini-Huygens mission is a cooperative project of NASA, ESA (European Space Agency) and the Italian Space Agency. NASA's Jet Propulsion Laboratory, a division of Caltech in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington. JPL designed, developed and assembled the Cassini orbiter.

More information about Cassini:

<https://www.nasa.gov/cassini>

<https://saturn.jpl.nasa.gov>



## CLUB MEMBERSHIP INFO

REGULAR MEMBER - \$30.00 per year. Includes club newsletter, and 1 vote at club meetings, plus all other standard club privileges.

FAMILY MEMBER - \$35.00 per year. Same as regular member except gets 2 votes at club meetings.

STUDENT MEMBER - \$10.00 per year with volunteer requirement.

If you renew your membership prior to your annual renewal date, you will receive a 10% discount.

Club members are also eligible for special subscription discounts on Sky & Telescope Magazine.

## CLUB TELESCOPES

*To check out one of the club telescopes, please contact a club officer. Scopes can be checked out at a regular club meeting and kept for one month. Checkout can be extended for another month if there are no other requests for the telescope, but you must notify a club officer in advance.*

100mm Orion refractor: David Pennington  
10 inch Meade Dobsonian: Lee Taylor  
13 inch Truss Dobsonian: Available

## CLUB APPAREL



Order club apparel from [cafepress.com](http://cafepress.com):



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## CLUB OFFICERS

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