



Observations

A Monthly Publication Of The
CHESTER COUNTY ASTRONOMICAL SOCIETY

Vol. 29, No. 1 **Three-Time Winner of the Astronomical League's Mabel Sterns Award** ☼ 2006, 2009 & 2016 January 2021

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2020 Great Conjunction of Jupiter & Saturn



Image Credit: [KSPFanatic102](#). Taken with a 6" Dobsonian reflector telescope and a SV105 CMOS sensor on December 21st. Image was stacked and processed using PIPP, Registax 6, Autostakkert 3! and Adobe Photoshop. Galilean moons Ganymede and Io are left of Jupiter, and Europa right of Jupiter. Saturn's moon Titan is located top right of Saturn.

Membership Renewals Due

01/2021	Kellerman Kovacs McElwee
02/2021	Kraynik Murphy Ruggeri Tronel
03/2021	Angelini DellaPenna Fulton Sterrett Zandler Zibinski

January 2021 Dates

- 3rd** • The Quadrantid meteor shower peaks at 9:30 a.m. EST
- 6th** • Last Quarter Moon, 4:37 a.m. EST
- 10th** • Mercury, Jupiter and Saturn form a triangle after sunset
- 13th** • New Moon, 12:00 a.m. EST
- 20th** • First Quarter Moon, 4:01 p.m. EST
- 23rd** • The best viewing of Mercury for 2021 is this evening
- 28th** • Full Moon, the Full Wolf Moon or the Child Moon, 2:16 p.m. EST



Membership Dues Increase

CCAS membership dues are increasing in January 2021. They have not been increased since 2002, 18 years ago! So it is now time to put through a slight increase in our annual dues to cover our costs. All membership types will increase by \$5 except for the Student membership, which will be unchanged.

Here are the current dues and the new cost:

Type	Old Rate	New Rate
Regular	\$25	\$30
Senior	\$10	\$15
Student	\$5	\$5
Family	\$35	\$40

Winter Society Events

January 2021

12th • CCAS Monthly Meeting, ONLINE via Zoom. The meeting starts at 7:30 p.m. Eric Jensen, PhD, Professor of Astronomy and Planetary Science, Swarthmore University. His presentation is entitled “New Exoplanet Discoveries from NASA’s TESS Mission.”

14th • The von Kármán Lecture Series: [Spacecraft Origami](#). Jet Propulsion Laboratory, Pasadena, California. Live stream of free lecture presented by NASA & Caltech.

20th • Open call for articles and photographs for the February 2021 edition of [Observations](#).

26th • Deadline for newsletter submissions for the February 2021 edition of [Observations](#).

February 2021

9th • CCAS Monthly Meeting, ONLINE via Zoom. The meeting starts at 7:30 p.m. Dr. Sarah Dodson, Associate Professor of Physics and Astronomy, University of Delaware. Her presentation is entitled “Enceladus and Titan – A Dance of Two Saturnian Moons.”

14th • The von Kármán Lecture Series: [Planetary Protection](#). Jet Propulsion Laboratory, Pasadena, California. Live stream of free lecture presented by NASA & Caltech.

20th • Open call for articles and photographs for the March 2021 edition of [Observations](#).

26th • Deadline for newsletter submissions for the March 2021 edition of [Observations](#).

Minutes from the November 10, 2020, CCAS Monthly Meeting

by *Bea Mazziotti, CCAS Secretary*

- Dave Hockenberry welcomed members and guests to the November 2020 CCAS meeting. Zoom and YouTube were the platforms and 49 attended. The meeting was held on the 3rd Tuesday and at 5PM in order to accommodate our guest speaker’s location in The Netherlands.
- After a brief introduction, club Program Chair Bruce Ruggeri introduced Dr. Giovanna Tenetti. Dr. Tenetti is Head of the Astrophysics Group, UC London Department of Physics and Astronomy, and Director of the London Centre for Space Exochemistry Data. Her presentation was titled “Brave New Worlds: The Exoplanets in our Galaxy and the ESA (European Space Agency) Project Ariel Mission.” As late as 1990, the known planets were only those in our solar system. After 9 years in deep space Kepler revealed that there are billions of hidden planets, more planets than even stars—a remarkable and intriguing discovery. Ensuing space missions, including K-2, Gaia, TESS, and CHEOPS, continue to find and explore these other worlds looking for clues as to their potential habitability. To date, NASA has the number of exoplanets at 4300+ and counting. NASA estimates that half of stars similar to our sun could have rocky planets similar to our earth orbiting them.
- Dr. Tenetti is the principal investigator of Ariel, ESA’s upcoming 2028 mission to further study and characterize the chemical and thermal properties of the targeted exoplanets. She is also co-founder and co-director of Blue Skies Space, a pioneering UK company taking a private-sector approach to fund lower cost exoplanet exploration and accessibility to the data derived from these explorations. Their first mission, Twinkle, is scheduled to launch in 2023.
- After Dr. Tenetti’s presentation Don Knabb took us on a quick tour of the November 17th night sky, including the wonderful Pleiades, Andromeda galaxy and the Perseus double cluster. He also informed members that on the December solstice, 12/21/20, Jupiter and Saturn will be so close as to appear to be colliding. They will create a super bright point of light and will look like a ‘double planet’ for the first time since the Middle Ages.
- The CCAS holiday party will be on Zoom on 12/8/20 at 7 PM. Good cheer, holiday spirits and festive garb are on the agenda.

January 2021 CCAS Meeting Agenda

by *Bruce Ruggeri, CCAS Program Chair*

Our next meeting will be held on January 12, 2020, starting at 7:30 p.m. The meeting will be held ONLINE via [Zoom.us](#). Guest Speaker: Eric Jensen, PhD, Professor of Astronomy and Planetary Science, Swarthmore University – “New Exoplanet Discoveries from NASA’s TESS Mission.”

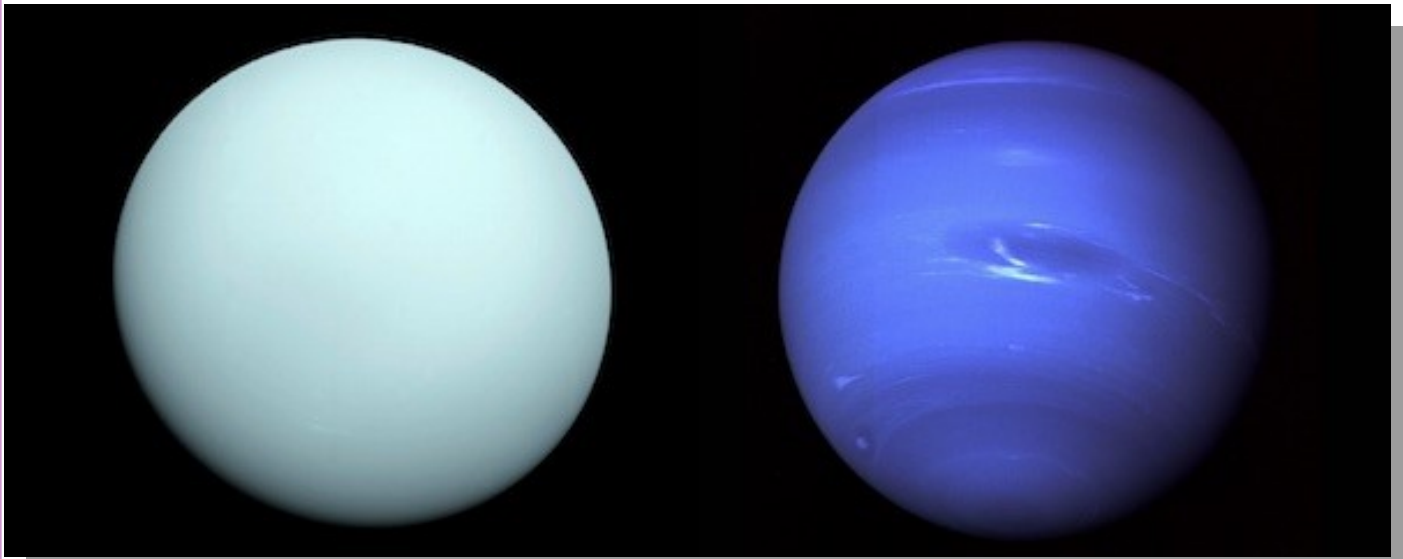
Please note that inclement weather or changes in speakers’ schedules may affect the program. In the event there is a change, CCAS members will be

notified via e-mail with as much advance notice as possible.

As for future meetings, we are looking for presenters for our 2021-2022 season and beyond. If you are interested in presenting, or know someone who would like to participate, please contact me at programs@ccas.us.

40 Years after Voyager, Scientists Push for New Missions to Uranus and Neptune

by Joel Davis, *Astronomy Magazine*



In 1781, Uranus became the first planet ever discovered using a telescope. Nearly 200 years later, Voyager 2 became the first spacecraft to visit Uranus and Neptune, in 1986 and 1989 respectively.

The Space Age blasted off when the Soviet Union launched the world's first artificial satellite in 1957. Since then, humanity has explored our cosmic backyard with vigor — and yet two planets have fallen to the planetary probe wayside.

In the 63 years since Sputnik, humanity has only visited Neptune and Uranus once — when Voyager 2 flew past Uranus in January 1986 and Neptune in August 1989 — and even that wasn't entirely pre-planned. The unmitigated success of Voyager 1 and 2 on their original mission to explore Jupiter and Saturn earned the twin spacecrafts further missions in our solar system and beyond, with Neptune and Uranus acting as the last stops on a Grand Tour of the outer solar system.

In the 31 years since Voyager 2 left the Neptune system in 1989 and began its interstellar mission, more than a dozen proposals have been offered for return missions to one or both ice giants. So far, none have made it

past the proposal stage due to lack of substantial scientific interest. Effectively, the planetary research community has been giving the ice giants the cold shoulder.

But recently, exoplanet data began revealing the abundance of icy exoplanets in our galaxy “and new questions about solar system formation are bringing focus back to Uranus and Neptune,” says astronomer Candace Hansen. And it just so happens to be the perfect time to consider a return trip.

The decision to aim Voyager 2 at the ice giants was made in 1981, and took advantage of a rare planetary alignment of the outer planets. During its flyby of Jupiter, Voyager 2 received a “kick” from the planet, slingshotting it onto the right path to Uranus and eventually Neptune. A similar gravity assist from Jupiter will be possible between 2029 and 2034.

Voyager 2's flyby of the ice giants returned a wealth of new

knowledge about these frigid behemoths, succeeding beyond everyone's wildest dreams. The spacecraft discovered new rings and new moons around both planets, found wild winds on Neptune when none were expected, and revealed that Neptune's moon Triton was truly spectacular, hinting at the possibility of a subsurface ocean that could potentially support microbial life.

Hansen, a member of the Voyager imaging team during the flybys of Uranus and Neptune, recently recalled two of Voyager's many highlights: “the images of plumes or clouds (we don't know which) on Triton. And of course, seeing Neptune's Great Dark Spot for the first time.”

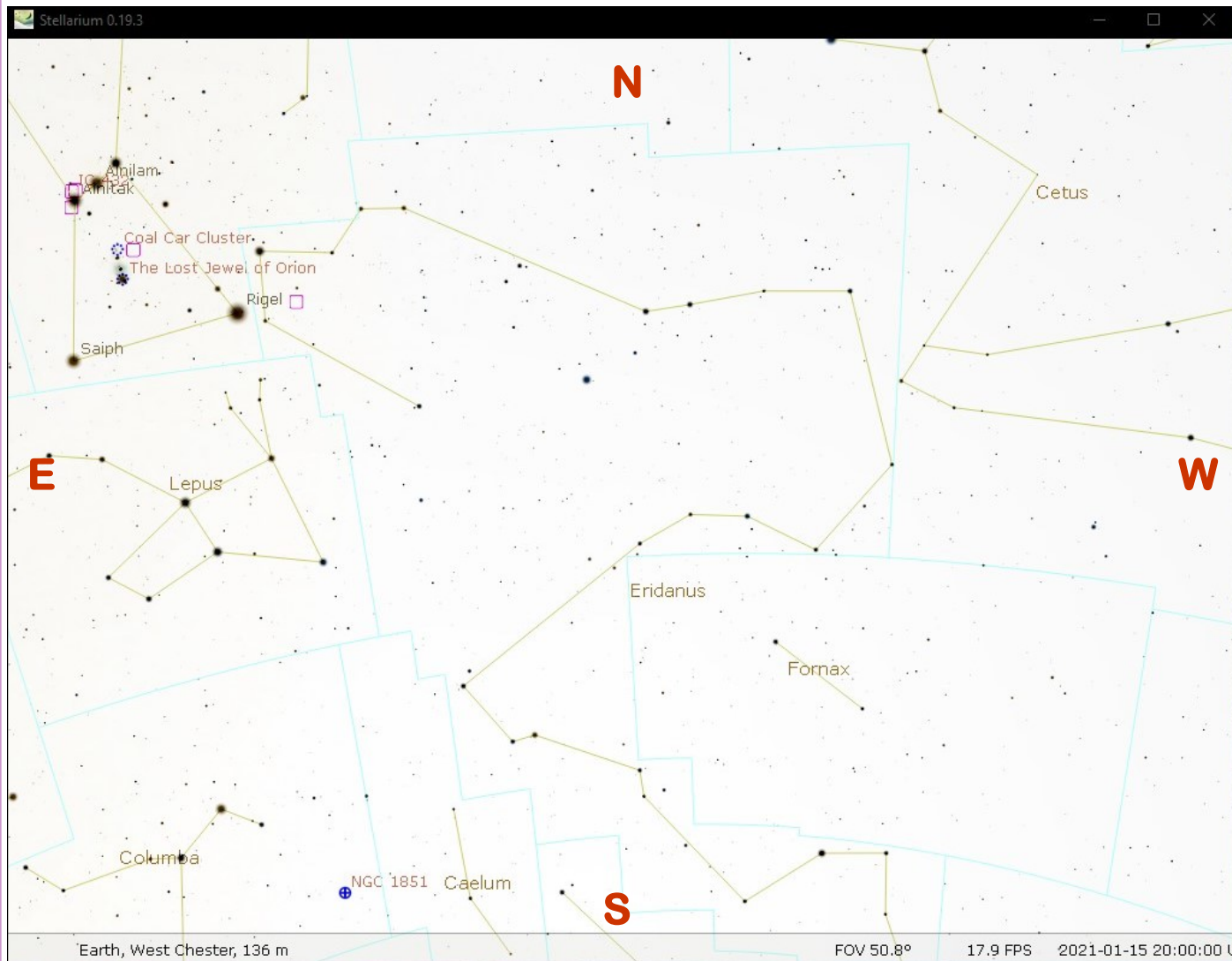
But countless questions remain, such as how the planets formed around the early Sun and the cause of their extreme axial tilts compared to the rest of the planets in the solar system. For decades, scientists have clamored for a return to these majes-

(Continued on page 6)

The Sky Over Chester County

January 15, 2021 at 8:00 p.m. ET

Note: This screen capture is taken from Stellarium, the free planetarium software available for download at www.stellarium.org.



Date	Civil Twilight Begins	Sunrise	Sunset	Civil Twilight Ends	Length of Day
01/01/2021	6:53 a.m. EST	7:24 a.m. EST	4:48 p.m. EST	5:18 p.m. EST	9h 24m 06s
01/15/2021	6:52 a.m. EST	7:22 a.m. EST	5:02 p.m. EST	5:31 p.m. EST	9h 39m 57s
01/31/2021	6:42 a.m. EST	7:11 a.m. EST	5:20 p.m. EST	5:49 p.m. EST	10h 09m 22s

Moon Phases					
Last Quarter	01/06/2021	4:37 a.m. EST	New Moon	01/13/2021	12:00 a.m. EST
First Quarter	01/20/2021	4:01 p.m. EST	Full Moon	01/28/2021	2:16 p.m. EST

January 2021 Observing Highlights

by Don Knabb, CCAS Treasurer & Observing Chair

3	The Quadrantid meteor shower peaks at 9:30 a.m.
6	Last Quarter Moon
7	The Lunar Curtis X is visible around 3 a.m.
10	Mercury, Jupiter and Saturn form a triangle after sunset
13	New Moon
20	First Quarter and the Lunar X at 2 p.m.
21	The Lunar Straight Wall is visible
23	The best viewing of Mercury for 2021 is this evening
28	Full Moon, the Full Wolf Moon or the Child Moon

The best sights this month: After the Great Conjunction last month Jupiter and Saturn are still visible low in the southwest as darkness falls and they are joined by Mercury on January 10th for Mercury's best show of 2021. The Lunar X is visible during daylight hours on January 20th around 2 p.m.

Mercury: On January 23rd we have our best opportunity to see Mercury of 2021. Look low in the southwest as the sky darkens after sunset to see this elusive planet.

Venus: Our sister planet is low in the sky shortly before sunrise.

Mars: January is the best month to see Mars during 2021 after its amazing showing in 2020. By now it is only half as large as it was at its peak last fall and has lost 90% of its brightness. But it is still a joy to look high in the sky after sunset and see that orange colored dot of light in the cold winter sky.

Jupiter: The king of the planets sets not too long after the Sun, so look for it low in the sky as darkness falls. On January 28th Jupiter passes behind the Sun and emerges into the dawn a few days later.

Saturn: The ringed planet is now leading its buddy Jupiter into the glow of the fading sunset after their historic conjunction in December. Like Jupiter, Saturn passes behind the Sun but it's a few days ahead

of Jupiter on January 23rd.

Uranus and Neptune: From about January 14 to 28 you can see Uranus in the same binocular field of view with Mars, high in the sky. They are closest on January 21st. Neptune is in the constellation Aquarius where it will be all year.

The Moon: Full Moon is on January 28. According to Native Americans, the first full Moon of January is the Full Wolf Moon. Amid the cold and deep snows of midwinter, the wolf packs howled hungrily outside Indian villages, so it was named the Full Wolf Moon. Sometimes it was also referred to as the Old Moon, or the Moon after Yule. Some called it the Full Snow Moon, but most tribes applied that name to the next full Moon. Native Canadians called this the Child Moon.

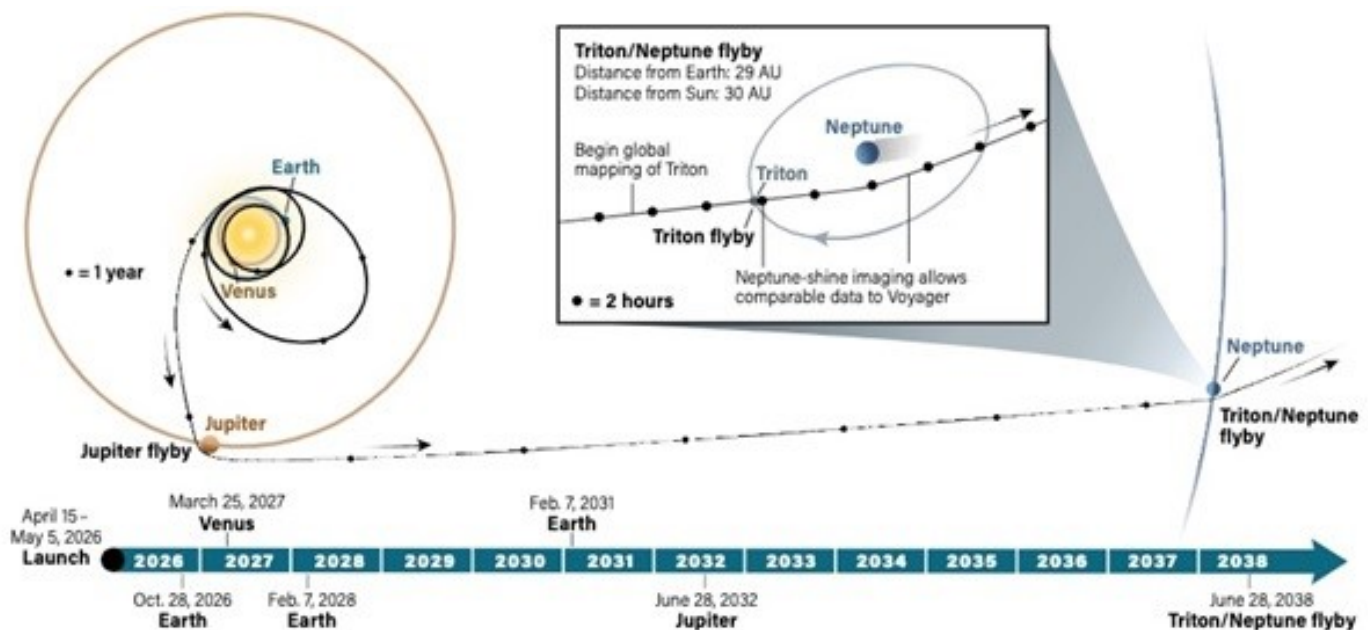
Constellations: Auriga, Taurus, Orion and Gemini are the highlights of the January skies. But the nights are so long that you can see many "summer" constellations setting early in the evening and many "spring" constellations rising if you stay up late. Dress warmly and sit in your lounge chair and see how many constellations you can record toward the Constellation Hunter club.

Messier/deep sky: During the winter months we are looking away from the center of the Milky Way, so the sky is not as full of deep sky wonders as during the summer. But, the sky is clear and there are still many beautiful objects for us to enjoy. Don't miss the trio of clusters in Auriga, and not far away is another nice cluster, M35, at the feet of the twins of Gemini. And below and behind Orion is Canis Major with the cluster M41, the Little Beehive, not far from the brightest star in the night sky, Sirius. And don't miss M42, the Great Orion Nebula. Set up your telescope and just stare at this, the brightest nebula in the sky.

Comets: There are no bright comets visible during January.

Meteor showers: The Quadrantid meteor shower peaks around 9:30 a.m. on January 3rd, so it is best viewed in the hours before dawn on that day. The Moon will interfere with this shower, but it is worth taking a look before dawn. I have seen some amazing outbursts from this shower!

Ice Giants (Cont'd)



A new mission proposal, named Trident, has been selected as one of four semifinalists for NASA's Discovery Program. The proposed trajectory of the spacecraft would take advantage of a gravitational "kick" from Jupiter to reach Neptune and its moon, Triton. Astronomy: Roen Kelly

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tic planets. And now might be the perfect time to plan a return visit, as key planetary alignments approach at the end of the decade. If we can beat the clock, an ice giant mission could help us unravel the lingering mysteries of these planets and provide new insight into their chilling beauty.

Migrating planets and screwy magnetospheres

Uranus and Neptune are called ice giants, and rightly so. The planets circle the Sun at such great distances, receiving so little external heat, that their average temperatures are hundreds of degrees below freezing.

As it turns out, ice giants are some of the most prevalent planets currently found in the universe, too. As some of the largest planets in a star system, they tend to be easier to spot when they transit their host star.

However, current models say that ice giants should be an anomaly, as the window for them to form is narrow. The solar nebula — the cloud of gas and dust left over after the formation of a star from which planets are born — needs to be almost entirely dissipated for ice giants to snatch up the available gas and ice. They also first need to have substantial cores before they can accrete any that lingering gas and ice.

Figuring out exactly how and where Neptune and Uranus formed could help scientists better understand the abundance of ice giants lurking in the universe. Computer simulations suggest that the low density of planetesimals and the weak solar gravity in the primordial outer solar system would have made it very difficult for the ice giants to form where they are today.

And perhaps they didn't. Like Jupiter and Saturn, Uranus and

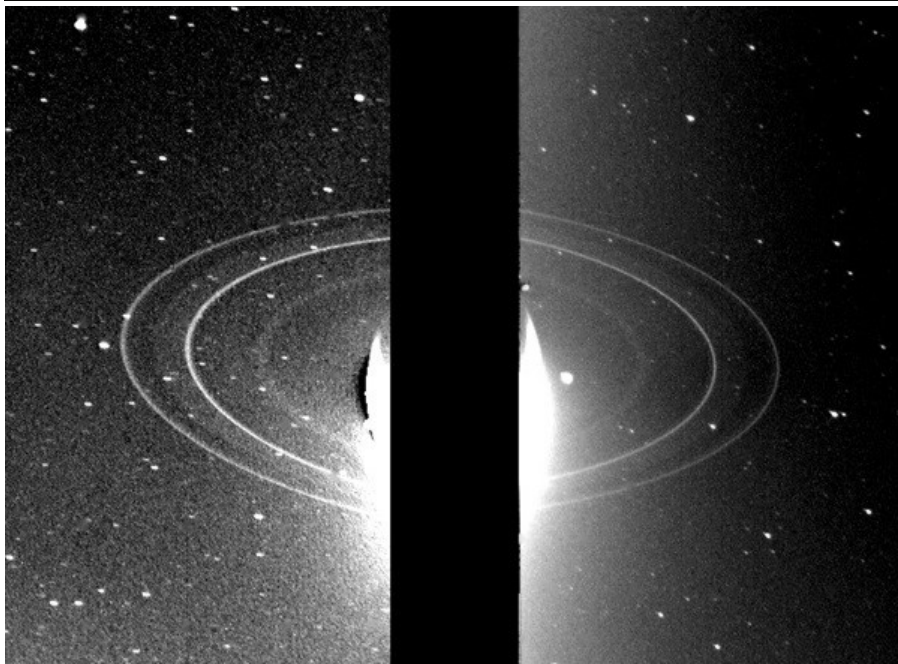
Neptune may have formed closer to the early Sun before, via gravitational processes, eventually migrating outward to their present positions. But how they formed isn't the only strange aspect about our ice giants.

Uranus rolls. Really. It's tilted at 97.8 degrees from vertical, greater than any planet except Venus (177.4 degrees). For one-quarter of its 84-year orbit, each pole on Uranus is in continuous sunlight. Current theories suggest a large planetesimal may have struck a glancing blow, flipping the planet on its side. This would also explain other mysteries, too, such as its strange magnetic field.

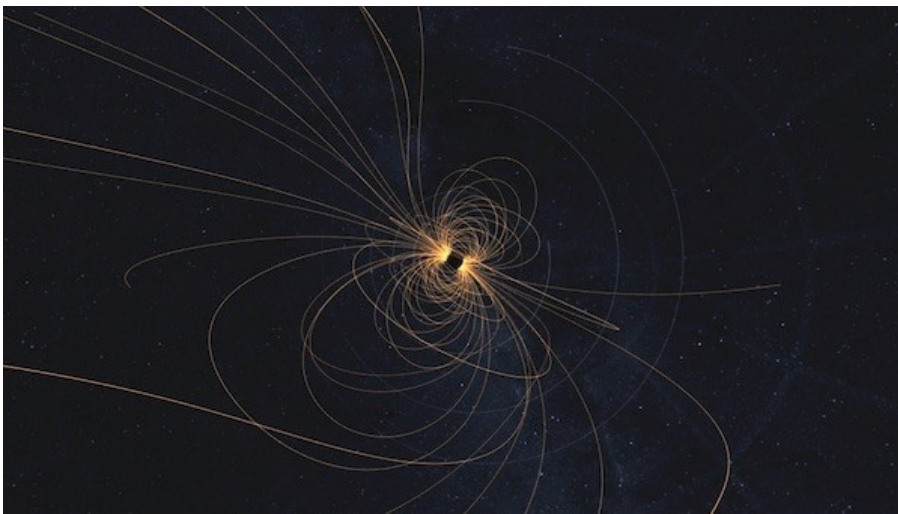
Magnetospheres are typically in line with a planet's rotation, but Uranus' is tipped at 59 degrees from the planet's rotational axis and offset from its center by one-third the planet's radius. The result is a magnetosphere

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Ice Giants (Cont'd)



At a distance of only 175,000 miles (280,000 km), Voyager 2 captured these long-exposure images of Neptune's faint rings. NASA/JPL



With a rotation axis tilted more than 90 degrees compared to its orbital plane, as well as a large magnetic axis tilt, Uranus also has a variable magnetic field (traced here in gold) and magnetosphere. NASA's Scientific Visualization Studio/JPL NAIF

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that wobbles in a complex pattern as Uranus spins on its axis.

Similarly, Neptune's magnetic field is tilted at 47 degrees from its axis and shifted away from the planet's center by more than half the planet's radius. Its magnetosphere traces a wild-looking corkscrew shape as the planet rotates.

Scientists still don't entirely understand these anomalous magnetospheres. They know that planetary magnetic fields are generated by internal dynamos, or conductive global mantle oceans. But with magnetic poles so skewed off-center, the exact cause of Uranus' and Neptune's screwy magnetospheres is, like their formation, still unknown.

Magnificent blue marbles

Though the planet's strange magnetic fields and uncertain formation may have scientists scratching their heads, when Voyager 2 revealed the first images of the planets' atmospheres, it took our collective breath away. The valuable flyby revealed some unexpected puzzles about the atmospheres and internal mechanics of both planets.

Their cloud tops are among the coldest places in the solar system, too: -371 degrees Fahrenheit (-224 degrees Celsius) for Uranus and about -361 F (-218 C) for Neptune. Only the surface of Pluto is colder.

But despite receiving so little light from the Sun, Neptune has weather — and what weather! Wispy white clouds scoot above the planet, and in 1989, Voyager 2 clocked winds near a strange, previously unseen dark spot on Neptune, reaching 1,000 mph (1,609 km/h) — the strongest of any in the solar system. This spot, dubbed the Great Dark Spot, was a massive spinning storm the size of Earth. Since its discovery, the storm has faded, but new ones have appeared elsewhere on the planet. By studying these dark spots, scientist might find a window to Neptune's lower atmosphere.

Both ice giants have atmospheres made of mostly hydrogen and helium, with small amounts of methane. It is the methane gases, however, that give Uranus its beautiful aquamarine color, as methane absorbs red light. Neptune's color, on the other hand, is a more vivid blue. While methane contributes to that, another

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Ice Giants (Cont'd)

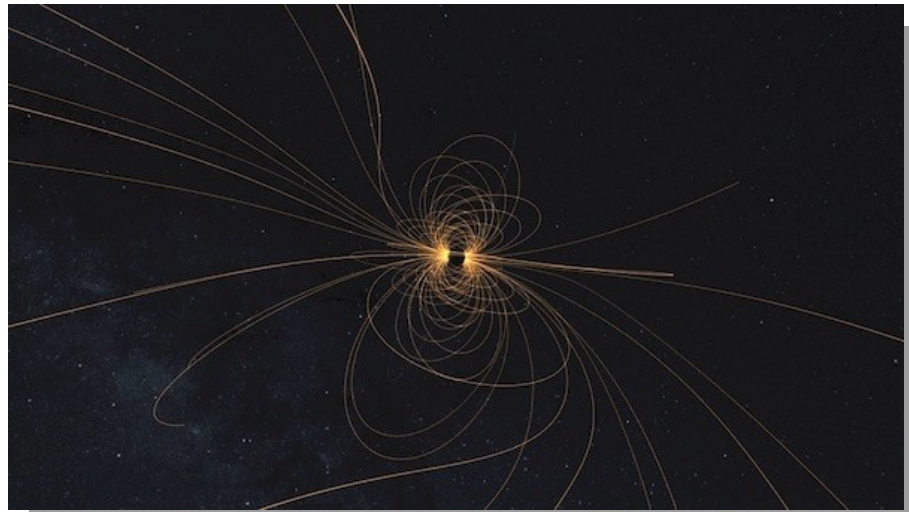
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elementary component is likely the cause of such an intense blue — but exactly which one remains uncertain.

Beneath the atmospheres of both planets, the mantles are mostly super-hot, high-pressure global oceans of water, ammonia, and methane — essentially a liquid electrical conductor. Inside their mantles, there may exist a deep layer where water is broken down into a soup of hydrogen and oxygen ions. Thousands of miles beneath their surfaces, the pressure is so great that methane splits apart and hardens its carbon compound into diamond crystals that sink to the planets' cores. Yes: It could be raining diamonds.

The solid core of both planets is made of iron, nickel, and silicates. Neptune is approximately 17 times Earth's mass and has a core weighing only 1.2 Earth masses. Uranus' core is small, only 0.55 Earth masses, while the planet's overall mass is around 14 Earth masses.

While these facts are all well known, the internal heat of both planets presents much more of a conundrum. Uranus hardly radiates any heat at all compared to other planets in the solar system. Neptune, on the other hand, despite being 10 astronomical units (AU; where 1 AU is the average distance between Earth and the Sun) beyond Uranus, radiates 2.61 times as much energy as it receives from the Sun. The explanation for this could have to do with an ancient impact from a protoplanet which expelled most of Uranus' heat. This would also explain the planet's extreme tilt.



Neptune likewise has a highly tilted rotation axis and tilted magnetic axis. As a result, Neptune has a lopsided magnetic field (traced in gold) that twists and turns in complex patterns as the planet spins. NASA's Scientific Visualization Studio/JPL NAIF

But astronomers still don't know if internal heat released by Neptune (or Uranus) varies seasonally. Another visiting spacecraft could provide more data.

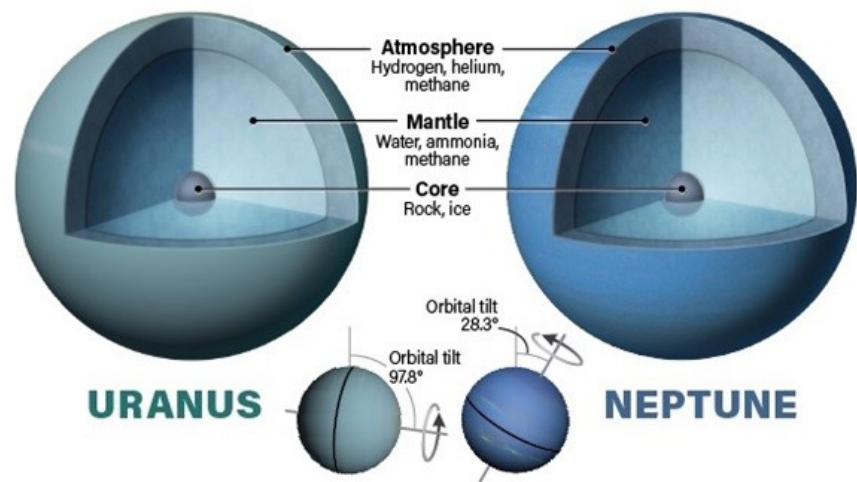
Rings: Thin, icy, and dusty

When Voyager 2 flew by Uranus and Neptune, it didn't just shine a light on the icy worlds; it gave us the first glimpses of their rings.

Like all the giant planets in our solar system, Neptune and Uranus

are each encircled by a set of rings. In 1977, James L. Elliot discovered five of Uranus' rings, the first found around a planet other than Saturn. Further observations from Earth revealed four more and, when Voyager 2 reached the planet in 1986, a 10th ring was discovered. In total, 13 known rings circle the planet, varying in both thickness and opacity.

(Continued on page 9)



Theories suggest that deep within the mantles of both Neptune and Uranus, diamonds may fall to the planets' rocky cores. Besides raining diamonds, the planets have some of the most extreme orbital tilts in the solar system, with Uranus essentially spinning on its side. Lunar and Planetary Institute

Ice Giants (Cont'd)

(Continued from page 8)

Several of Uranus' small moons appear to keep its rings constrained, acting as gravitational shepherds. Most of the rings are made of particles ranging in size from 8 inches to 66 feet (20 centimeters to 20 meters) in diameter, likely composed of water-ice mixed with radiation-produced organic matter. The rings are probably no more than 600 million years old, based on observations made by Voyager 2 of the planet's exosphere, and they may be the remains from collisions of ancient moons.

After discovering rings around Uranus, astronomers were eager to spy rings around its twin. While several claims were put forth, including the detection of

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Classic La Para by Nicholas La Para

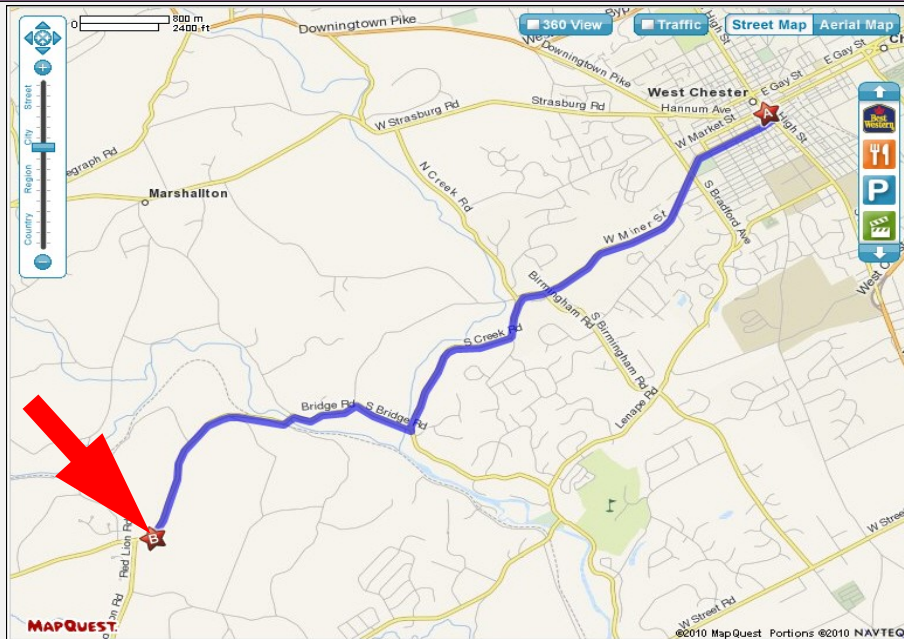
ASTRONOMY NEWS

GRAVITY REPEALED!

- * In a surprise coalition, Democrats and Republicans combined to repeal the law of gravity.
- * Republicans: "Gravity is too expensive."
- * Democrats: "This solves the problem of overweight once and for all."

LAPARA

CCAS Directions



Brandywine Red Clay Alliance

The monthly observing sessions (held February through November) are held at the Myrick Conservation Center of the Brandywine Red Clay Alliance.

To get to the Myrick Conservation Center from West Chester, go south on High Street in West Chester past the Courthouse. At the next traffic light, turn right on Miner Street, which is also PA Rt. 842. Follow Rt. 842 for about 6 miles. To get to the observing site at the BRC property, turn left off Route 842 into the parking lot by the office: look for the signs to the office along Route 842. From that parking lot, go left through the gate and drive up the farm lane about 800 feet to the top of the hill. The observing area is on the right.

If you arrive after dark, *please turn off your headlights and just use parking lights* as you come up the hill (so you don't ruin other observers' night vision).

Brandywine Red Clay Alliance

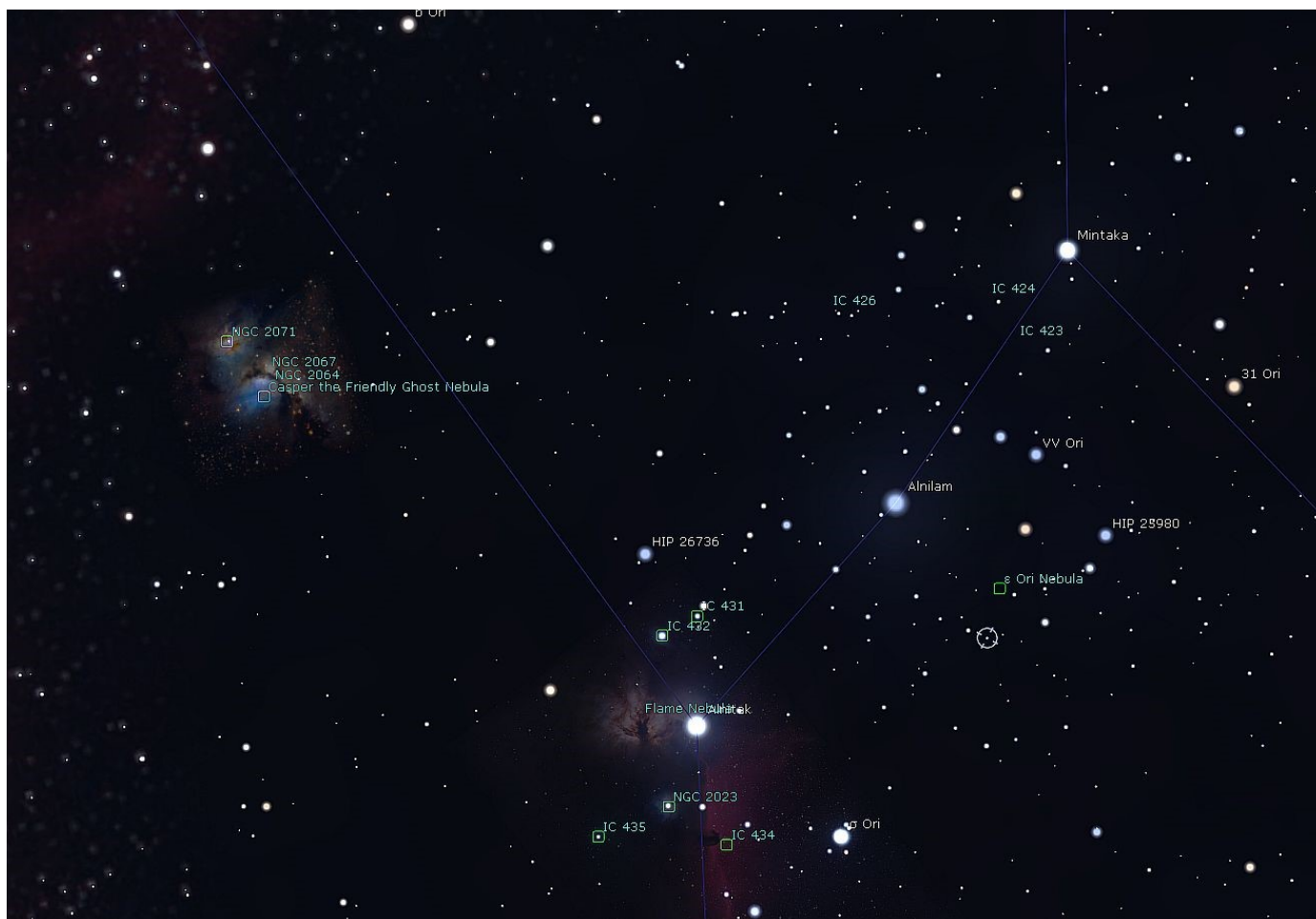
1760 Unionville Wawaset Rd
West Chester, PA 19382
(610) 793-1090

<http://brandywinewatershed.org/>

BRC was founded in 1945 and is committed to promoting and protecting the natural resources of the Brandywine Valley through educational programs and demonstrations for all ages.

Through the Eyepiece: Casper the Friendly Ghost Nebula, M78, a reflection nebula in Orion

by Don Knabb, CCAS Treasurer & Observing Chair



Star chart made using Stellarium, the free planetarium software

During the winter months it seems that my eyes and telescope or binoculars are drawn to Orion as if it were an optical magnet. The large size and distinctive shape of Orion just begs for close examination. I've spent a great deal of time staring into M42, the Great Orion Nebula and I always look at Collinder 70, which is the three belt stars of Orion and the 80+ stars that surround them, including the chain of stars that make a distinct "S" shape between the center and right stars of the hunter's belt.

My next target is M78, the brightest diffuse reflection nebula in the sky. M78 is part of the

large cloud of gas and dust that is centered on M42. As a reflection nebula, M78 is a cloud of interstellar dust which shines in the reflected and scattered light of bright blue stars within the cloud.

M78 is easy to find on a dark night using binoculars or a telescope. As you can see in the sky map of Orion's belt below, just scan up at a 90-degree angle to the belt. M78 is about a thumb's width away from Alnilam, the eastern (left in the map) star of the three bright stars that make up Orion's belt. But you won't see this object with your naked eyes.

Visually, M78 resembles a faint comet. It is just visible in binoculars under good conditions, as a very dim patch. Small telescopes show it to be remarkably bright and you will see the two stars within the nebula as can be seen in Dave Hockenberry's photo below.

When telescope size increases, brighter areas are revealed as stars and the visible nebula size itself increases. For larger telescopes, be sure to look for adjoining nebula NGC 2071 to the northeast, NGC 2067 in the northwest and very faint NGC 2064 located southwest. M78

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Eyepiece (Cont'd)



Photo credit: David Hockenberry, astrophotographer

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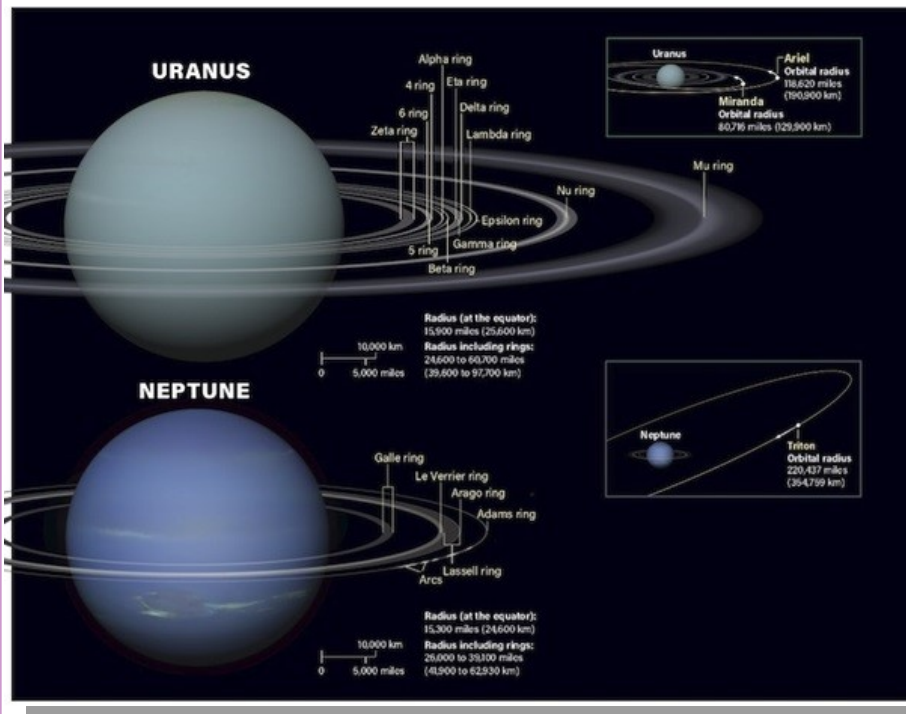
doesn't hold up well to moonlight conditions.

So add M78 to your list of targets for cold but clear winter nights. With Orion's belt as a guide to find it you will not get too cold while seeking this faint fuzzy of the winter night sky!

Information credits:

- http://en.wikipedia.org/wiki/Messier_78
- <http://www.seds.org/messier/m/m078.html>
- <http://www.universetoday.com/39296/messier-78/>

Ice Giants (Cont'd)



Uranus is host to 13 known rings and 27 moons. Miranda and Ariel are notable due to their unusual surfaces. Neptune has just five rings and 14 moons, the most famous of which is Triton. This distant moon circles Neptune in a retrograde orbit, or counter to the planet's spin. Astronomy: Roen Kelly

The planet's five rings — Galle, Le Verrier, Lassell, Arago, and Adams — are named after astronomers who made important discoveries regarding the planet: Johann Gottfried Galle, Urbain Jean Joseph Le Verrier, and John Couch Adams all independently discovered the planet in 1846 using mathematics, making it the first planet found with calculations. François Arago suggested Le Verrier investigate the anomalies in Uranus' motion, which hinted at Neptune's existence, while William Lassell discovered Triton.

As it turned out, the incomplete arcs previously detected were the densest parts of the Adams ring. The rings themselves have more dust-sized grains than Uranus', such that much of the system resembles

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 incomplete arcs, it wasn't until

Voyager 2 reached Neptune that definitive rings were discovered.

NASA Night Sky Notes: Check Your Sky's Quality with Orion!

by David Prosper

This article is distributed by the NASA Night Sky Network, a coalition of hundreds of astronomy clubs across the US dedicated to astronomy outreach.

Visit nightsky.jpl.nasa.gov to find local clubs, events, stargazing info and more.

Have you ever wondered how many stars you can see at night? From a perfect dark sky location, free from any light pollution, a person with excellent vision may observe a few thousand stars in the sky at one time! Sadly, most people don't enjoy pristine dark skies – and knowing your sky's brightness will help you navigate the night sky.

The brightness of planets and stars is measured in terms of apparent magnitude, or how bright they appear from Earth. Most visible stars range in brightness from 1st to 6th magnitude, with the lower number being brighter. A star at magnitude 1 appears 100 times brighter than a star at

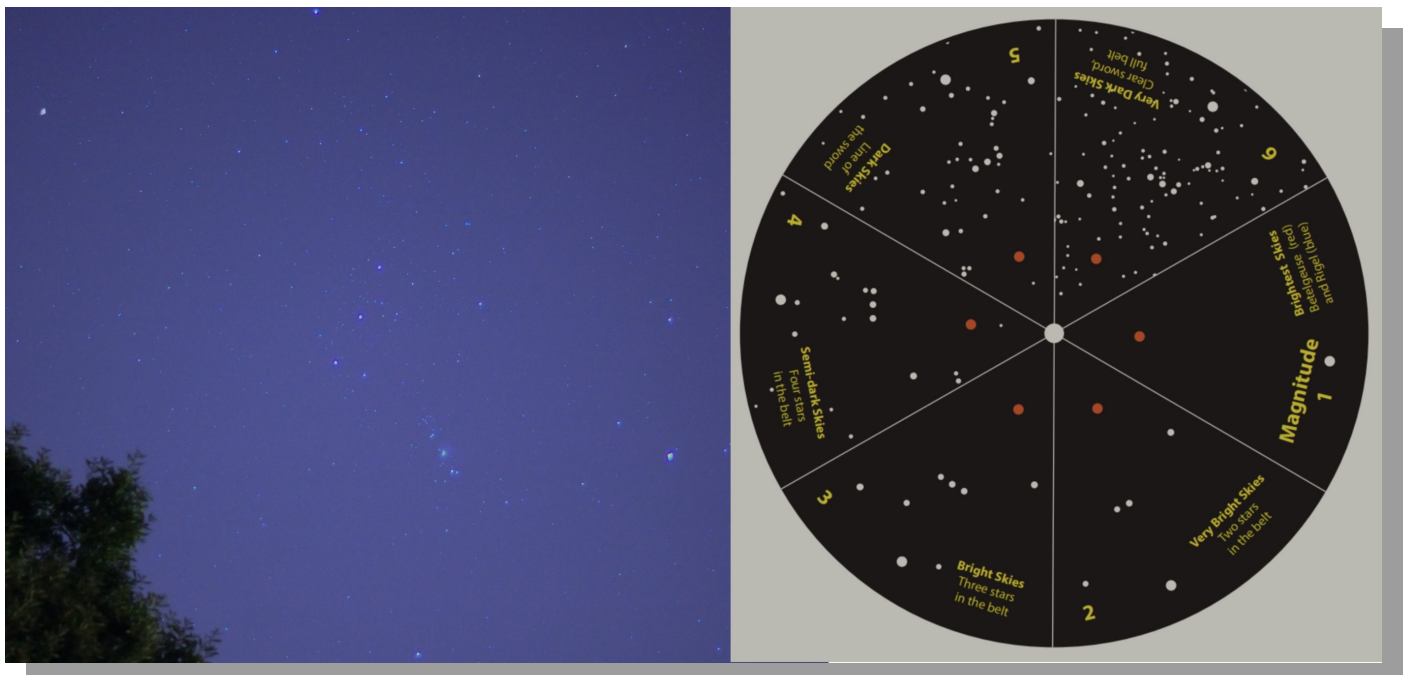


magnitude 6. A few stars and planets shine even brighter than first magnitude, like brilliant Sirius at -1.46 magnitude, or Venus, which can shine brighter than -4 magnitude! Very bright planets and stars can still be seen from bright cities with lots of light pollution. Given perfect skies, an observer may be able to see stars as dim as 6.5 magnitude, but such fantastic conditions are very rare; in much of the world, human-made light

pollution drastically limits what people can see at night.

Your sky's limiting magnitude is, simply enough, the measure of the dimmest stars you can see when looking straight up. So, if the dimmest star you can see from your backyard is magnitude 5, then your limiting magnitude is 5. Easy, right? But why would you want to know your limiting magnitude? It can help you plan your observing! For example, if you have a bright sky and your limiting magnitude is at 3, watching a meteor shower or looking for dimmer stars and objects may be a wasted effort. But if your sky is dark and the limit is 5, you should be able to see meteors and the Milky Way. Knowing this figure can help you measure light pollution in your area and determine if it's getting better or worse over

(Continued on page 13)



The Dark Sky Wheel, showing the constellation Orion at six different limiting magnitudes (right), and a photo of Orion (left). What is the limiting magnitude of the photo? For most observing locations, the Orion side works best on evenings from January-March, and the Scorpius side from June-August.

Ice Giants (Cont'd)

(Continued from page 11)

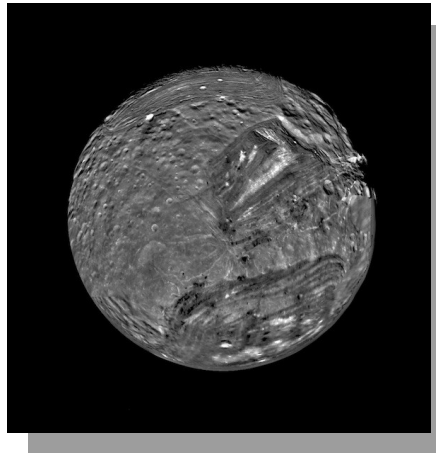
the faint rings of Jupiter. To even see the rings clearly, light from Neptune must be blocked.

The lone flyby of the planets revealed rings previously unseen; a future mission could uncover even more about the fine structural detail of the ice giants' ring systems and help pin down their age.

Moons small and large

The planets aren't just surrounded by rings; over a dozen moons circle both Neptune and Uranus, and one moon may just give scientists reason to return to the ice giants.

Uranus' 27 moons include a generous sampling of mystery and marvel. For example, the surface of Miranda, a moon over



Miranda is the innermost of Uranus' spherical moons and has one of the most extreme topographies of any object in the solar system. The only close-up images of Miranda are from the Voyager 2 flyby of Uranus in January 1986. NASA/JPL/USGS

seven times smaller than our Moon, looks like a cosmic patchwork quilt and includes a gorge 12 times deeper than the Grand Canyon. Meanwhile, Ariel may have the youngest surface of Uranus' moons, possibly redone by recent low-impact

collisions. Ariel is over twice the size of Miranda.

Neptune, on the other hand, has 14 known moons. The two outermost, Neso and Psamathe, are incredible because of their miniscule size. Neso is a mere 37 miles (60 km) in diameter, 60 times smaller than the Moon. Psamathe is even tinier with a diameter of 25 miles (40 km). While not the smallest moons in the solar system (that position is currently held by Mars' moon Deimos, which is just 7.6 miles [12.4 km] in diameter), Neso orbits the furthest from its host planet, at a little over 30 million miles (49 million km). It takes little Neso a whopping 27 years to make a single orbit around Neptune. Psamathe, on the other hand, orbits just shy of 30 million miles (48 million km) from the ice giant.

Neptune's largest moon, Triton, is the planet's standout satellite. The moon is bigger than Pluto and the only one of the solar system's large moons with a retrograde orbit, meaning it circles Neptune in the opposite direction from the planet's spin. Voyager 2 discovered that Triton is scattered with relatively young surface features, hosts active geysers, and even shows hints of a subsurface ocean. Scientists suspect that Triton is a captured Kuiper Belt object due to its strange orbit and surface, although an alternative method of capture during the early solar system when planets passed each other near enough to steal moons has been recently suggested.

Triton has one of the more

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Night Sky Notes (Cont'd)

(Continued from page 12)

time. And regardless of location, be it backyard, balcony, or dark sky park, light pollution is a concern to all stargazers!

How do you figure out the limiting magnitude in your area? While you can use smartphone apps or dedicated devices like a Sky Quality Meter, you can also use your own eyes and charts of bright constellations! The Night Sky Network offers a free printable Dark Sky Wheel, featuring the stars of Orion on one side and Scorpius on the other, here: bit.ly/darkskywheel. Each wheel contains six "wedges" showing the stars of the constellation, limited from 1-6 magnitude. Find the wedge containing the faintest stars you can see from

your area; you now know your limiting magnitude! For maximum accuracy, use the wheel when the constellation is high in the sky well after sunset. Compare the difference when the Moon is at full phase, versus new. Before you start, let your eyes adjust for twenty minutes to ensure your night vision is at its best. A red light can help preserve your night vision while comparing stars in the printout.

Did you have fun? Contribute to science with monthly observing programs from Globe at Night's [website \(globeatnight.org\)](http://www.globeatnight.org), and check out the latest NASA's science on the stars you can - and can't - see, at nasa.gov.

Ice Giants (Cont'd)

(Continued from page 13)

substantial atmospheres of the solar system moons, but it is still significantly thinner than Earth's. Consisting of nitrogen, methane, and carbon monoxide, this atmosphere likely originated from volcanic activity. Besides Earth, Triton is only one of three solar system bodies known to currently be volcanically active. Evidence of ongoing geological activity points to the possibility of a subsurface ocean. As such, Triton was identified as one of the highest priority candidate ocean worlds for future missions by the NASA Outer Planets Assessment Group Roadmaps to Ocean World (ROW) group in the recent "NASA Roadmap to Ocean Worlds" report, which summarizes their findings. ROW provides a framework to guide the future of ocean world exploration over the next several decades.

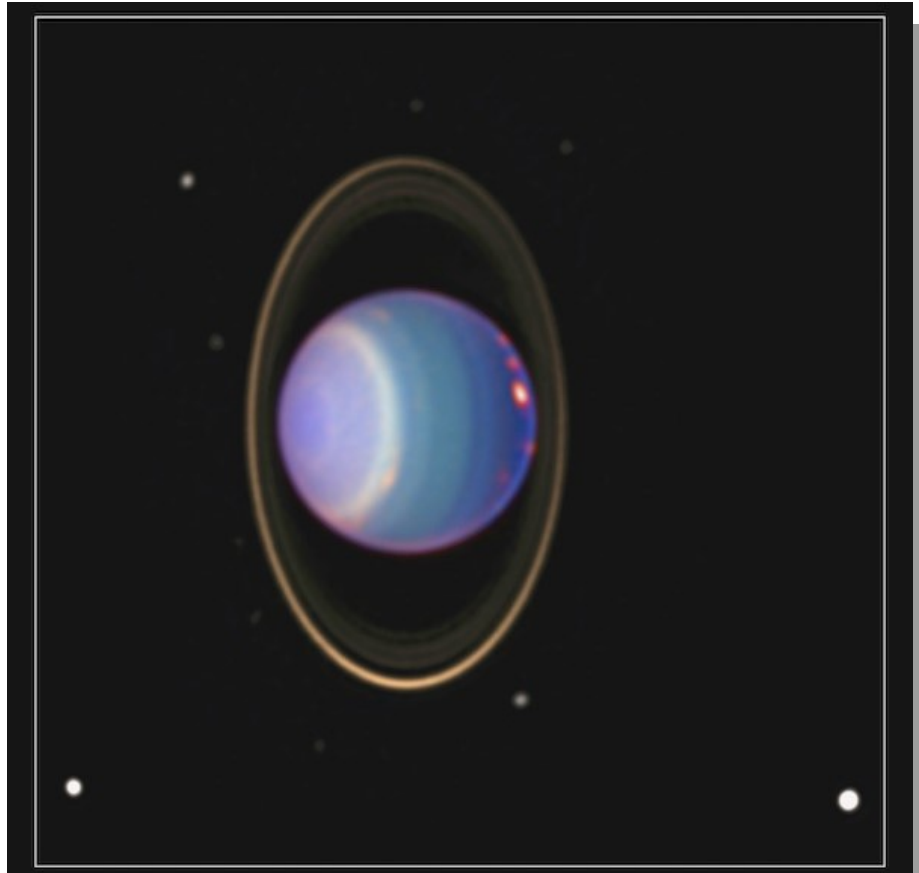
Triton earning this high priority may just be what it takes to get us back to the outer solar system so we can explore the ice giants once more.

Trident: A mission to Triton

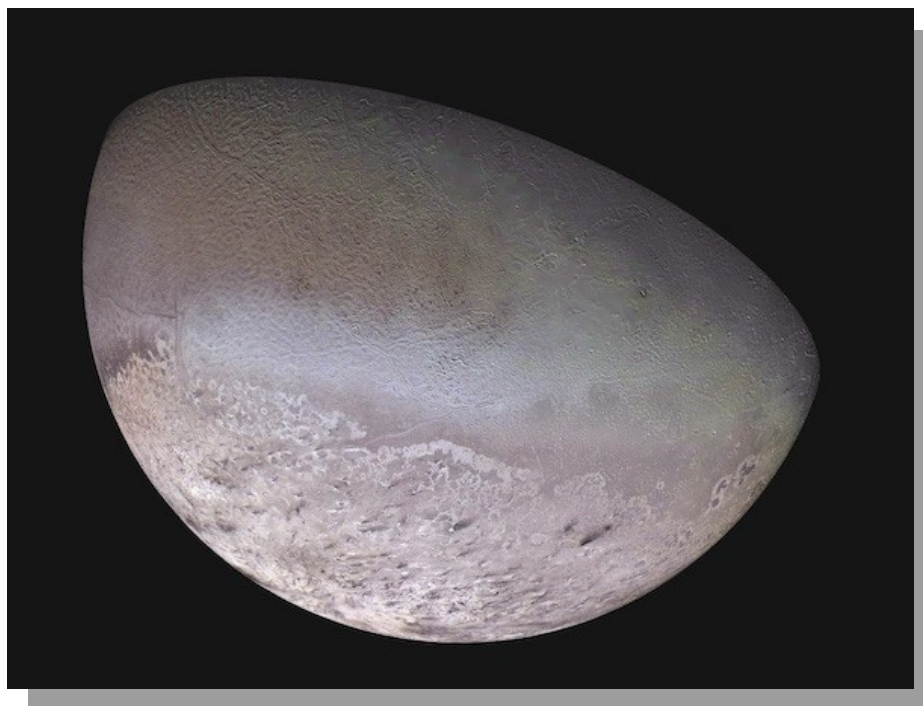
Under NASA's Discovery Program, a new mission to the ice giants may be within reach. Started in 1992, the program provides scientists a chance to imagine innovative, low-cost ways to unlock the mysteries of the solar system.

In August 2017, a Discovery proposal period began and a small group at JPL convened a two-day brainstorming session. The group produced the Trident proposal — a flyby mission to Triton. "The whole process went

(Continued on page 15)

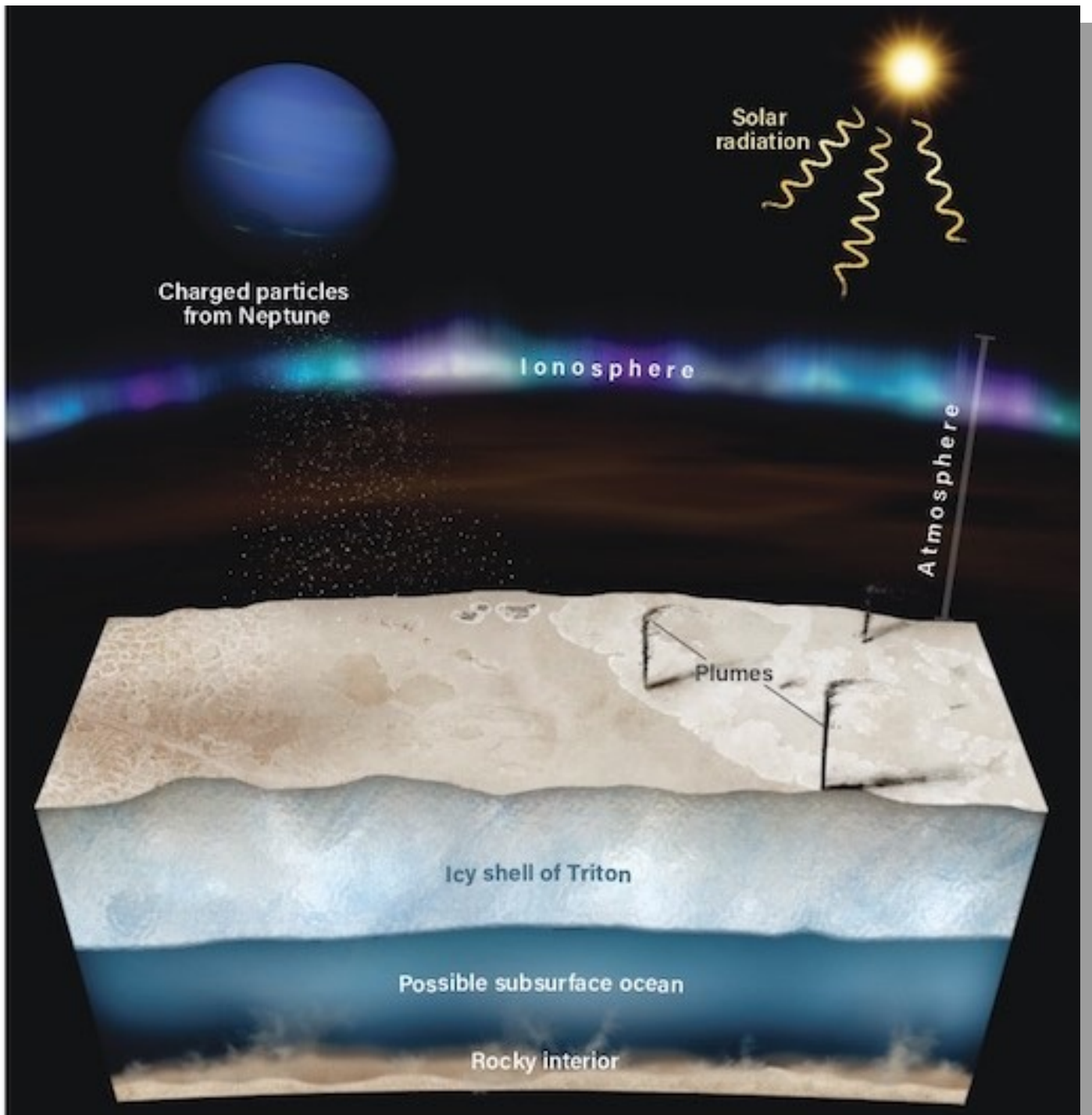


This Hubble Space Telescope image showcases the four major rings surrounding Uranus, along with ten of its known satellites. NASA/JPL/STSCI



Triton has the coldest known surface in the solar system and is the only known satellite with a surface made of mostly nitrogen ice. This global color mosaic of the moon, taken by Voyager 2, indicates that it has a vast southern polar cap believed to contain methane, which was stained pink by sunlight. NASA/JPL/USGS

Ice Giants (Cont'd)



Fittingly named after the son of Poseidon, Triton may be hiding an ocean world beneath its icy crust. The moon is also one of only four bodies in the solar system to be volcanically active. NASA/JPL-Caltech

(Continued from page 14)

from concept to a real project remarkably quickly,” recalls co-author Karl Mitchell.

The proposed Trident mission will pass within 310 miles (500

km) of the giant moon, close enough to move through its atmosphere. Trident plans to map Triton, characterize its active processes, and determine whether the moon has a magnetic field

— which would strengthen the argument that the moon is hiding an ocean beneath its surface. To accomplish these tasks, Trident will need a host of instru-

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CCAS Directions

West Chester University Campus

The monthly meetings (September through May) are held in Room 112 in Merion Science Center (formerly the Boucher Building), attached to the Schmucker Science Center. The Schmucker Science Center is located at the corner of S. Church St & W. Rosedale Ave. Parking is generally available across Rosedale in the Sykes Student Union parking lot (Lot K).



Ice Giants (Cont'd)

(Continued from page 15)

ments, including a magnetometer, both a narrow-angle and wide-angle camera, and a plasma spectrometer.

In February, NASA selected the Trident proposal as one of four Discovery-class semifinalists. The team will visit NASA in February or March 2021 for an intensive review before the agency makes their final selection of which missions will fly.

Hopefully Trident is one of them, as it's time to return to the majestic ice giants and take the next steps in unraveling the mysteries of these enigmatic goliaths.

CCAS Membership Information and Society Financials

Treasurer's Report by Don Knabb

Dec. 2020 Financial Summary

Beginning Balance	\$1,118
Deposits	\$145
Disbursements	-\$282
Ending Balance	\$981

New Member Welcome!

Welcome new CCAS members Matt Reynolds from Springfield, PA, and the Joe Orso family from Glen Mills, PA. We're glad you decided to join us under the stars! Clear skies to you!

Membership Renewals

You can renew your CCAS membership by writing a check payable to "Chester County Astronomical Society" and sending it to our Treasurer:

Don Knabb
988 Meadowview Lane
West Chester PA 19382

The current dues amounts are listed in the *CCAS Information Directory*. Consult the table of contents for the directory's page number in this month's edition of the newsletter.

Join the Fight for Dark Skies!



You can help fight light pollution, conserve energy, and save the night sky for everyone to use and enjoy. Join the nonprofit International Dark-Sky Association (IDA) today. Individual memberships start at \$30.00 for one year. Send to:

International Dark-Sky Association
 3225 North First Avenue
 Tucson, AZ 85719
 Phone: 520-293-3198
 Fax: 520-293-3192
 E-mail: ida@darksky.org

For more information, including links to helpful information sheets, visit the IDA web site at:

<http://www.darksky.org>

Dark-Sky Website for PA



The Pennsylvania Outdoor Lighting Council has lots of good information on safe, efficient outdoor security lights at their web site:

<http://www.POLCouncil.org>

Find out about Lyme Disease!

Anyone who spends much time outdoors, whether you're stargazing, or gardening, or whatever, needs to know about Lyme Disease and how to prevent it. You can learn about it at:

<http://www.LymePA.org>

Take the time to learn about this health threat and how to protect yourself and your family. It is truly "time well spent"!

Good Outdoor Lighting Websites

One of the biggest problems we face in trying to reduce light pollution from poorly designed light fixtures is easy access to good ones. When you convince someone, a neighbor or even yourself, to replace bad fixtures, where do you go for good lighting fixtures? Check out these sites and pass this information on to others. Help reclaim the stars! And save energy at the same time!



Light pollution from poor quality outdoor lighting wastes billions of dollars and vast quantities of valuable natural resources annually. It also robs us of our heritage of star-filled skies. Starry Night Lights is committed to fighting light pollution. The company offers the widest selection of ordinance compliant, night sky friendly and neighbor friendly outdoor lighting for your home or business. Starry Night Lights is located in Park City, Utah.

Phone: 877-604-7377
 Fax: 877-313-2889

<http://www.starrynightlights.com>



Lighthouse Outdoor Lighting is a dedicated lifetime corporate member of the [International Dark-Sky Association](#). Lighthouse's products are designed to reduce or eliminate the negative effects outdoor lighting can have while still providing the light you need at night.

Phone: 484-291-1084

<https://www.lighthouse-lights.com/landscape-lighting-design/pa-west-chester/>

Local Astronomy-Related Stores

Listing retail sites in this newsletter does not imply endorsement of any kind by our organization. This information is provided only as a service to our members and the general public.



Skies Unlimited is a retailer of telescopes, binoculars, eyepieces and telescope accessories from Meade, Celestron, Televue, Orion, Stellarvue, Takahashi, Vixen, Losmandy and more.

Skies Unlimited
Suburbia Shopping Center
 52 Glocker Way
 Pottstown, PA 19465

Phone: 610-327-3500 or 888-947-2673
 Fax: 610-327-3553

<http://www.skiesunlimited.net>



Located in Manayunk, Spectrum Scientifics educates and entertains customers with an array of telescopes, microscopes, binoculars, science toys, magnets, labware, scales, science instruments, chemistry sets, and much more.

4403 Main Street
Philadelphia, PA 19127

Phone: 215-667-8309
 Fax: 215-965-1524

Hours:
 Tuesday thru Saturday: 10AM to 6PM
 Sunday and Monday: 11AM to 5PM

<http://www.spectrum-scientifics.com>

CCAS Information Directory

CCAS Lending Telescopes

Contact Don Knabb to make arrangements to borrow one of the Society's lending telescopes. CCAS members can borrow a lending telescope for a month at a time; longer if no one else wants to borrow it after you. Don's phone number is 610-436-5702.

CCAS Lending Library

Contact our Librarian, Barb Knabb, to make arrangements to borrow one of the books in the CCAS lending library. Copies of the catalog are available at CCAS meetings, and on the CCAS website. Barb's phone number is 610-436-5702.

Contributing to *Observations*

Contributions of articles relating to astronomy and space exploration are always welcome. If you have a computer, and an Internet connection, you can attach the file to an e-mail message and send it to: newsletter@ccas.us

Or mail the contribution, typed or handwritten, to:

Dr. John C. Hepler
21103 Striper Run
Rock Hall, MD 21661

CCAS Newsletters via E-mail

You can receive the monthly newsletter (in full color!) via e-mail. All you need is a PC or Mac with an Internet e-mail connection. To get more information about how this works, send an e-mail request to Dr. John Hepler, the newsletter editor, at: newsletter@ccas.us.

CCAS Website

Dr. John Hepler is the Society's Webmaster. You can check out our Website at:

<http://www.ccas.us>

Dr. Hepler welcomes any additions to the site by Society members. The contributions can be of any astronomy subject or object, or can be related to space exploration. The only requirement is that it is your own work—no copyrighted material! Give your contributions to Dr. Hepler at (410) 639-4329 or e-mail to webmaster@ccas.us

CCAS Purpose

The Chester County Astronomical Society was formed in September 1993, with the cooperation of West Chester University, as a non-profit organization dedicated to the education and enjoyment of astronomy for the general public. The Society holds meetings (with speakers) and observing sessions once a month. Anyone who is interested in astronomy or would like to learn about astronomy is welcome to attend meetings and become a member of the Society. The Society also provides telescopes and expertise for "nights out" for school, scout, and other civic groups.

CCAS Executive Committee

For further information on membership or society activities you may call:

President: Dave Hockenberry
610-558-4248

Vice President: Pete Kellerman
610-873-0162

ALCor, Observing, & Treasurer: Don Knabb
610-436-5702

Secretary: Beatrice Mazziotta
610-933-2128

Librarian: Barb Knabb
610-436-5702

Program: Bruce Ruggeri
484-883-5092

Education: Don Knabb
610-436-5702

Dennis O'Leary
610-701-8042

Webmaster & Newsletter: John Hepler
410-639-4329

Public Relations: Ann Miller
610-558-4248



CCAS Membership Information

The 2021 membership rates are as follows:

REGULAR MEMBER.....\$30/year
SENIOR MEMBER.....\$15/year
STUDENT MEMBER.....\$ 5/year
JUNIOR MEMBER.....\$ 5/year
FAMILY MEMBER.....\$40/year

Membership Renewals

Check the Membership Renewals on the front of each issue of *Observations* to see if it is time to renew. If you need to renew, you can mail your check, made out to "Chester County Astronomical Society," to:

Don Knabb
988 Meadowview Lane
West Chester PA 19382-2178

Phone: 610-436-5702
e-mail: treasurer@ccas.us

Sky & Telescope Magazine

The club membership subscription cost for *Sky and Telescope* magazine has increased to **\$43.95**. This is still a good saving from the regular rate of **\$54.95**.

There is no need to go through the CCAS treasurer for subscriptions or renewals. Just go to the Sky and Telescope website and select "Magazine", then under the FAQs you can subscribe at the club rate.

<https://skyandtelescope.org/subscribe/>

If you have **any** questions call Don Knabb at 610-436-5702.

Astronomy Magazine Group Rates

Subscriptions to this excellent periodical are available through the CCAS at a reduced price of **\$34.00** which is much less than the individual subscription price of **\$42.95** (or \$60.00 for two years).

There is no need to go through the CCAS treasurer for subscriptions or renewals. Just call customer service at 877-246-4835 and request the club rate for your new subscription or renewal.