Event Horizon

Volume 29, Number 4
February 2022

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Hamilton Amateur Astronomers

From The Editor

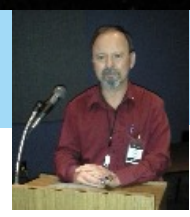
Welcome to the February 2022 Event Horizon Newsletter!

And thank you to those who contributed articles this month, and who continue to contribute fascinating content!

Clear Skies!

Bob Christmas, Editor

editor 'AT' amateurastronomy.org



Chair's Report by Bernie Venasse

Our January Zoom meeting was a great success. Dr. Paul Delaney spoke to us about occultations in a very entertaining way. Thank you, Paul. We look forward to your next visit.

Our Next Zoom meeting is scheduled for ***February 11, 2022, at 7:30pm****.*

During our February meeting, we will have a potpourri of speakers including Jo Ann Salci and John Gauvreau speaking about their love of astronomy. We will also be joined by a couple of members of the Bluewater Astronomy Group, namely Brett Tatton and John Hlynialuk.

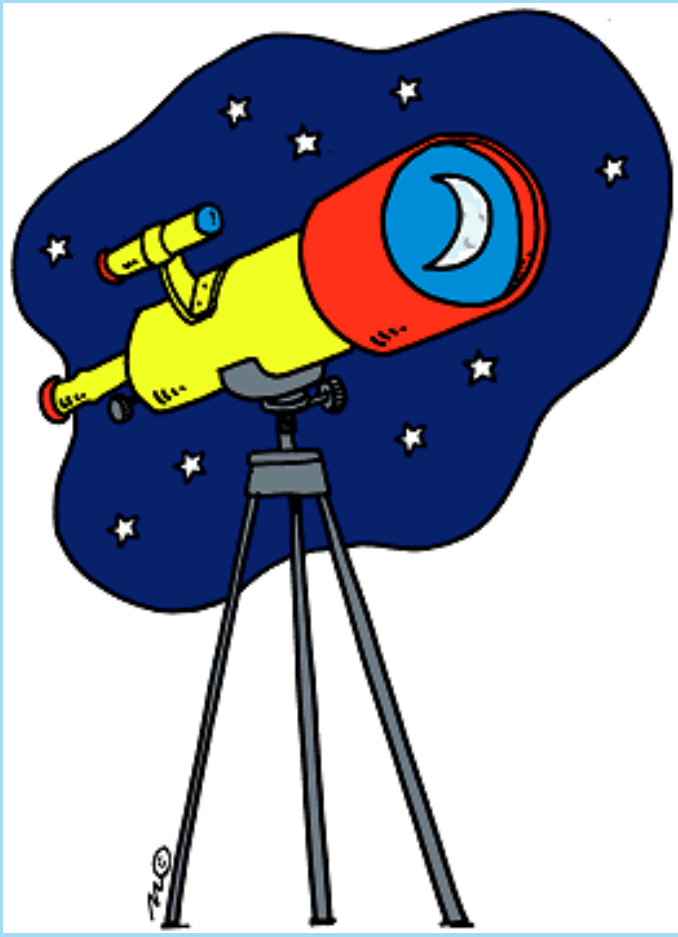
On January 18th, asteroid 7482 (2019 PC1) flew past Earth at a distance roughly equal to 5 times the distance to the Moon. Unfortunately, it was a cloudy night but I did manage to watch it pass using a remote telescope. This is a great addition to my asteroid total going toward the Astronomical League's Asteroid Observing award.

(Continued on page 2)

IN THIS ISSUE:

Chair's Report (continued)

A friendly reminder that all our meetings will be held online through the Zoom platform for the foreseeable future. If you have had any questions about joining in please feel free to get in touch and we will help you. And don't forget that you can always email zoomsupport@amateurastronomy.org, to get help joining the meeting, even once the meeting has started.



H.A.A.'s Loaner Scope Program

We at the HAA are proud of our Loaner Scope Program. It allows members who don't own a telescope to get more up close with the night sky, and it allows members to explore different types of telescopes! Paid members are welcome to borrow a telescope for one month. We have telescopes of varying expertise levels, a MallinCam, a spotter scope and various eyepieces. Please visit the HAA website for more information!

If you are interested in borrowing a telescope, please contact Melissa Whitman at

loanerscope@amateurastronomy.org.

Telescopes are loaned out on a first come basis.

HAA Helps Hamilton

While during the pandemic, the H.A.A. hasn't been able to collect donations from our members and guests for local food banks at our general meetings, the H.A.A. has always valued its relationships with food banks in the community, particularly Hamilton Food Share.

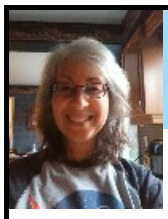
In that spirit, we encourage you to continue making donations directly to your local food banks.

Hamilton Food Share
Hunger. It's just unacceptable.

Masthead Photo: *M13, the Great Hercules Globular Cluster,* by *Peter Wolsley.*

Taken May 29, 2021 from the South Bruce Peninsula with a QHY294C camera through an 8" EdgeHD scope (+0.7 FR; 1,422mm FL) with a Moon & Skyglow filter.

Exposures: 25 x 200 seconds; 1 hour 23 minutes total, plus darks, flats and dark-flats.



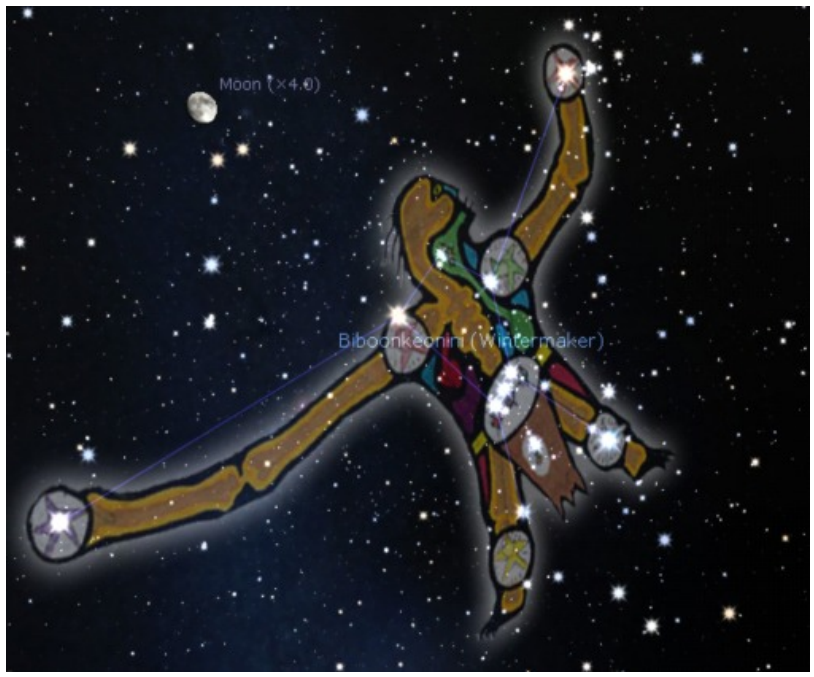
HAA Explorers by Jo Ann Salci

…A column for young astronomers - and those young at heart!

Last month we learned about Orion, "The Hunter". This month let's explore one of the animal constellations near Orion named Taurus, "The Bull". Let's explore!

Bullseye!

Taurus is another easy-to-find constellation in the winter sky. Like Orion, Taurus has been observed by many cultures over the thousands of years that humans have been looking at the night sky. Taurus is one of many animals in the sky.



Wintermaker, or Biboonikeonini

Taurus

Images generated using Stellarium

Last month we learned that the Ojibwe peoples saw Biboonikeonini, or Wintermaker, in the winter sky. Biboonikeonini's western arm extends all the way to the bright red star Aldebaran (pronounced al-DEB-a-ran). In Greek mythology, Aldebaran is the red eye of the Bull. The Greek story about Taurus talks about Zeus who fell in love with a princess. Her father was angry because she was young. So, Zeus changed himself into a white bull and because she liked animals, he would visit her. Because Taurus was beautiful and gentle, she climbed on his back and he took her to the heavens.

The three bright stars of Orion's belt point northwest to Aldebaran, which is the brightest star in the Taurus constellation. It's easy to imagine that the Bull is "seeing red".

And if you continue with the line from Orion's belt, through Aldebaran, you reach the beautiful star cluster which has many names: Messier 45, the Pleiades, "the Seven Sisters" (Greek mythology), Subaru (which means "Unite" in Japan), and Dilyehe ("Pinlike Sparkles") in Dine/Navajo. [1] The Greeks thought that the Seven Sisters rode on the back of Taurus for protection against Orion, the Hunter. Another star cluster in this constellation is the Hyades cluster, which is the group of stars in Taurus's face, below Aldebaran.

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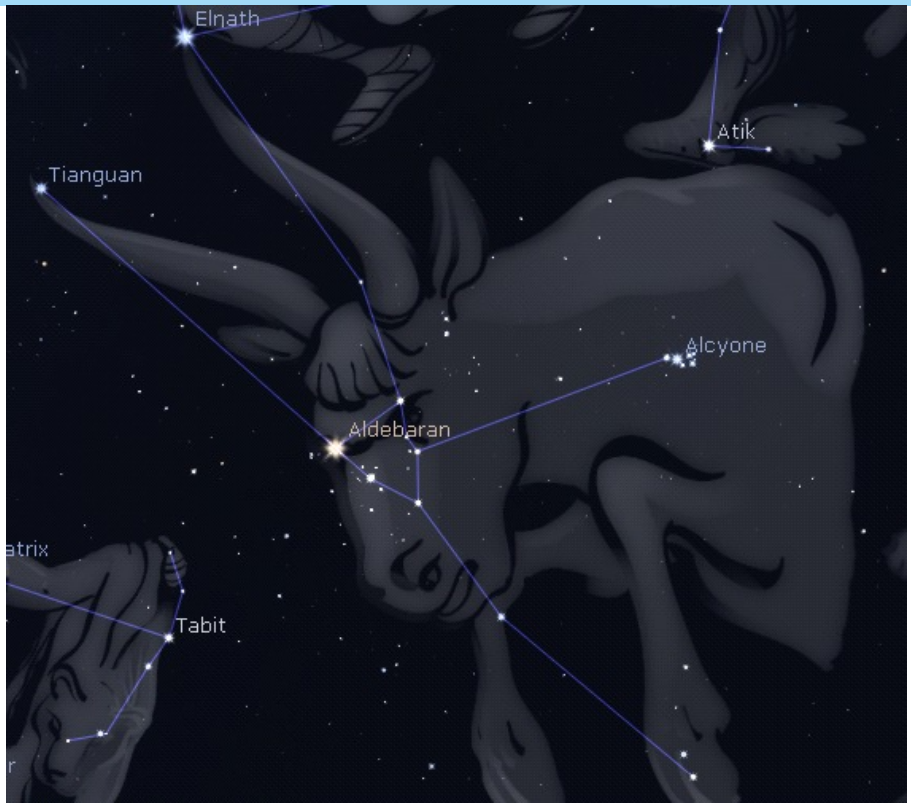

Taurus the Bull

The Pleiades Star Cluster

Images generated using Stellarium

Another interesting object in Taurus is the Crab Nebula, which is near the star Tianguan in the southern horn of Taurus. In the year 1054, a supernova occurred and we now see it as the Crab Nebula (with telescopes). Historical records suggest that it was so bright that people could see it with their eyes during the day for about a month!

Image generated using Stellarium

The Crab Nebula
Image Credit: NASA

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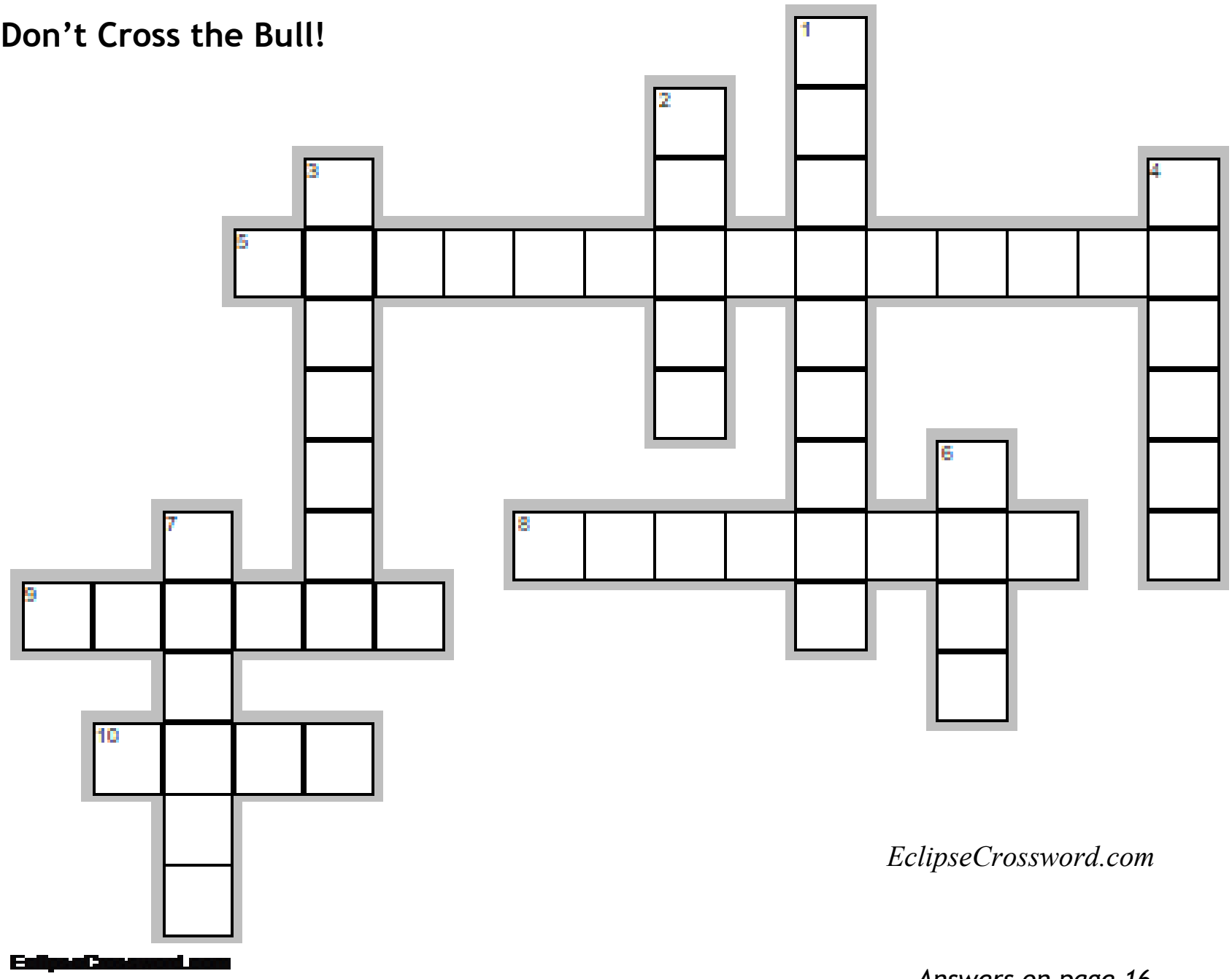
Don't Cross the Bull!



EclipseCrossword.com

Answers on page 16.

Across

5. Known in Ojibwe as the Wintermaker.
8. A star cluster in Taurus.
9. An open cluster in the face of Taurus.
10. Name of a Nebula in Taurus

Down

1. The brightest star in Taurus.
2. This constellation is near Taurus.
3. The Dine/Navajo name for the star cluster on the "back" of Taurus.
4. What season can Taurus be seen best?
6. The Greek God who changed himself into a white bull.
7. Also known as the Bull constellation.

(Continued on page 6)

HAA Explorers (continued)

Things to do until next time**:

**** Check with your parents or caregivers before checking out websites.**

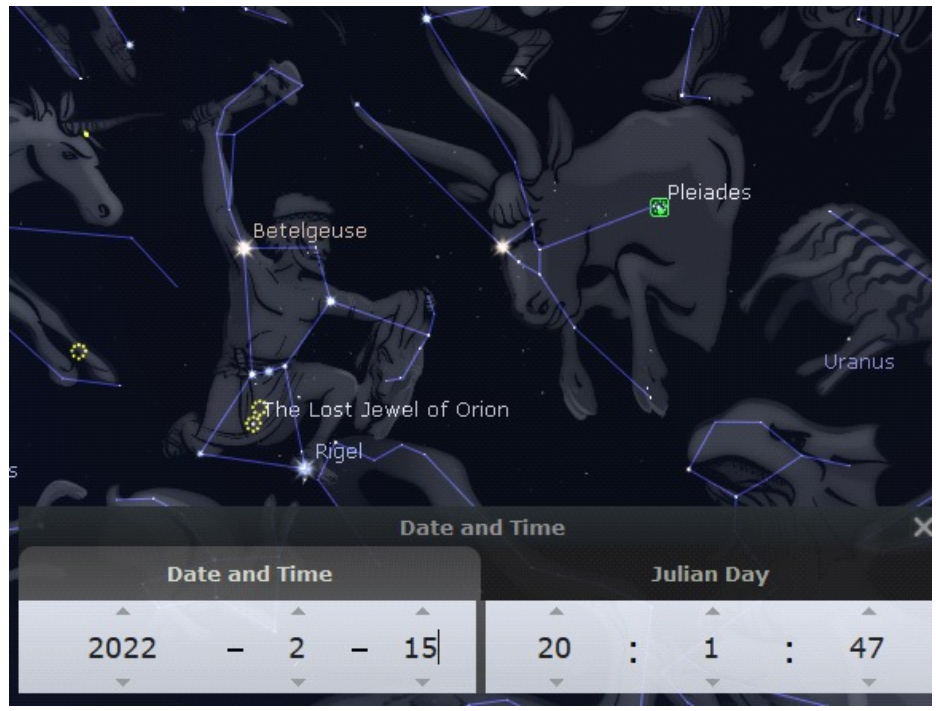
1. ***Visit:*** https://spaceplace.nasa.gov/supernova/en/ to learn more about supernovas.

2. ***Make*** a star finder for the month of February:
https://spaceplace.nasa.gov/review/starfinder/star_finder_feb.pdf

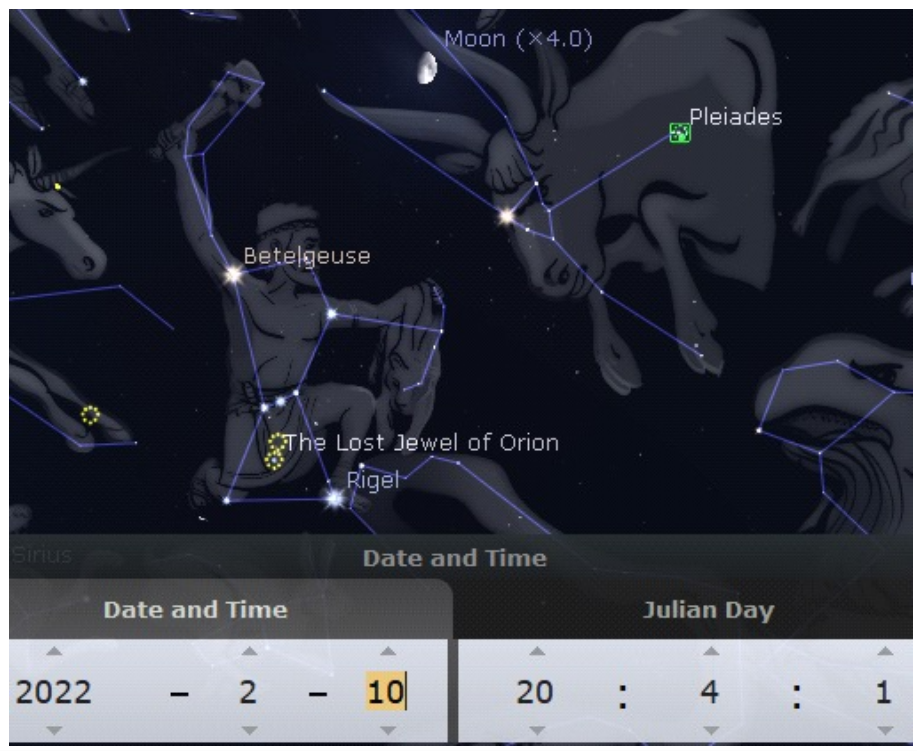
3. ***Watch this video about Nebulas:*** https://spaceplace.nasa.gov/nebula/en/.

During February, check out:

1. ***All through the month of February at about 8:00 p.m.*** facing south, you will see Taurus:



2. ***On February 10th, at about 8:00 p.m.*** the waxing gibbous Moon will form a triangle with the bright star Betelgeuse in Orion, and the bright star Aldebaran in Taurus:



Images generated using Stellarium

(Continued on page 7)

Finally:

What did Taurus like to eat? Answer: ¡ʎɐnɯo-llnB

If you have a question you would like answered in the newsletter, please send it to education@amateurastronomy.org.

Thank you to Mi for reviewing this article! 😊

Footnote:

1. Ojibwe Sky Star Map Constellation Guide: An Introduction to Ojibwe Star Knowledge. Annette S. Lee, William Wilson, Jeffrey Tibbetts, Carl Gawboy. 2014. Page 25.

References:

Astronomy for Kids. 2019.

Glow in the Dark Constellations: A Field Guide for Young Stargazers. C.E. Thomson. 1989.

Night Sky: Ultimate Explorer Field Guide. National Geographic Kids. 2016.

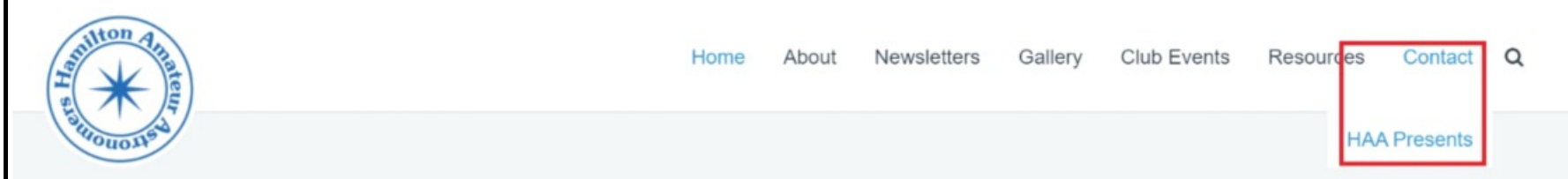
Ojibwe Sky Star Map Constellation Guide: An Introduction to Ojibwe Star Knowledge. Annette S. Lee, William Wilson, Jeffrey Tibbetts, Carl Gawboy. 2014.

Ultimate Space Atlas: National Geographic Kids..2017.

"HAA Presents"

Members of the public of any age in the GTHA can now request an in-person (once it is safe to do so) or virtual presentation from the HAA directly on our website.

Simply navigate to www.amateurastronomy.org and select "Contact" from the top menu bar and then click on "HAA Presents" (see image below). You will be presented with a request form and once all required fields are entered, click on the "Submit" button and you will see a confirmation message that your request has been successfully submitted.



Once received, our Public Education Director, Jo Ann Salci, will respond to your request within 5 business days to discuss next steps. If you have any questions, feel free to send an email to haapresents@amateurastronomy.org.

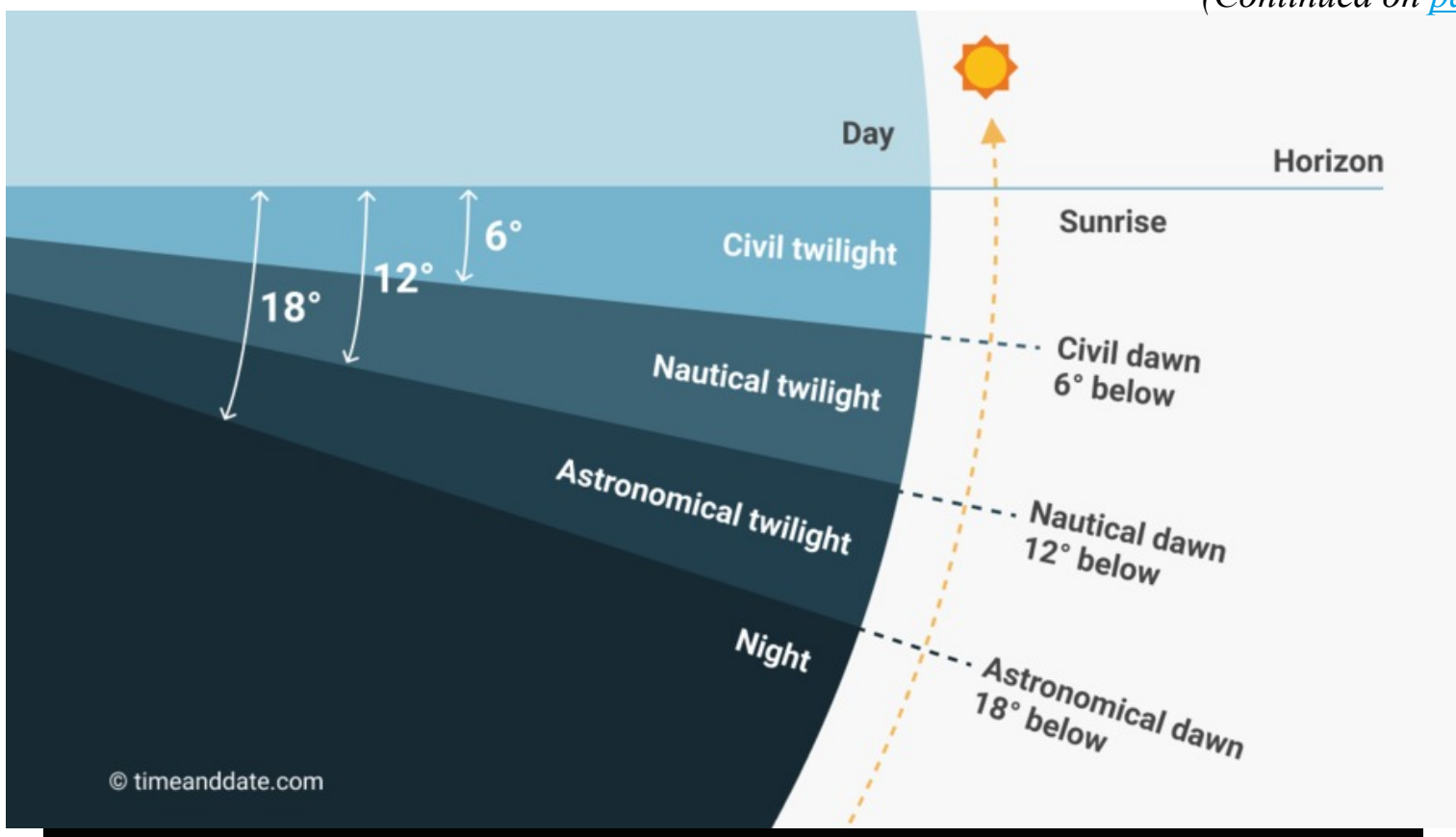
The Sky This Month for February 2022 by Matthew Mannering

The past few weeks have presented us with some wonderfully clear skies. Unfortunately, the temperatures have been brutally cold. There have been a few members out observing on these nights, but I wasn't one of them. Instead, I have been out during the days to do some bird watching along the Grand River. It was still quite cold but the apparent heat from the Sun has increased as it moves higher in the sky.

By the way, for any birders out there, the Eagles Have Landed at their aerie down-stream of Wilke's Dam in Brantford. They have been doing maintenance on the nest for the last week or so, getting ready for the arrival of one or two Eaglets.

One of the astronomical sights of the season, *Zodiacal light*, is an interesting but seldom seen apparition that makes its presence known as a wedge of faint light along the plane of the ecliptic at a steep angle to the horizon. Therefore, the best months to see it are in the evenings of February and March and in the mornings of September and October. Look for the Zodiacal light due west in the hour after the end of astronomical twilight in winter and due east in the hour before the start of astronomical twilight in the fall. The intersection of twilight and night occurs when the Sun is 18° below the horizon.

(Continued on page 9)



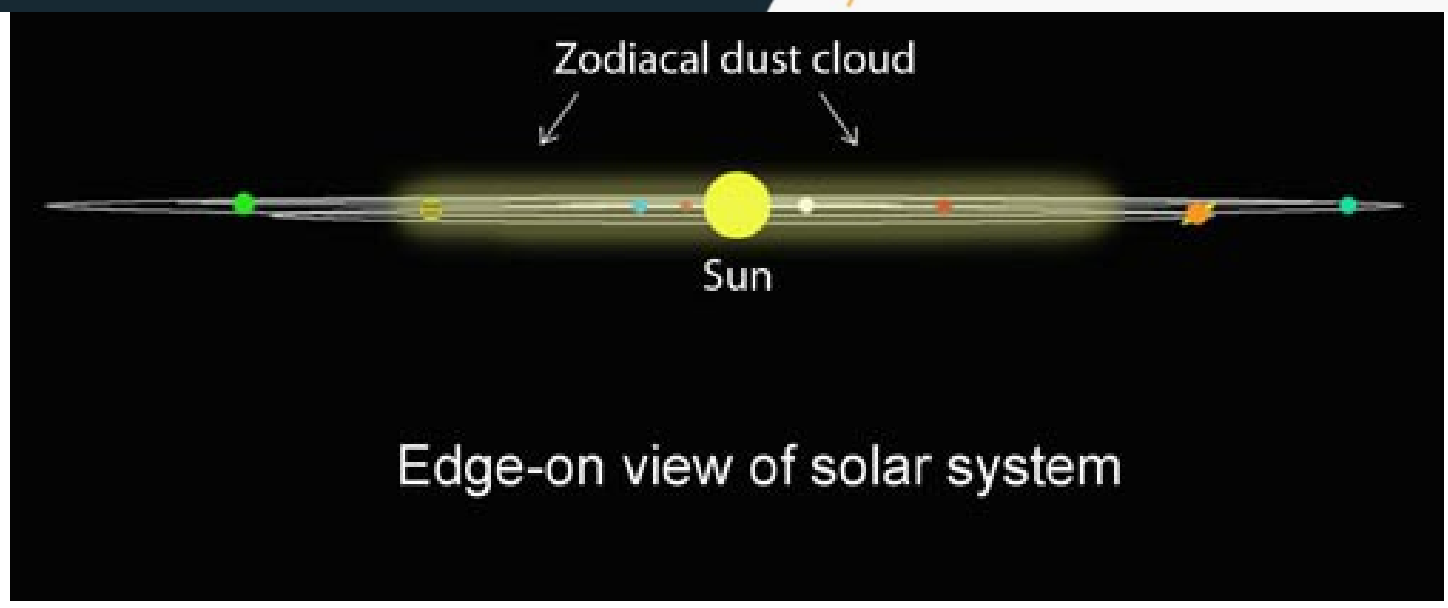


Image Credit: Sky and Telescope

The Sky This Month for February 2022 (continued)

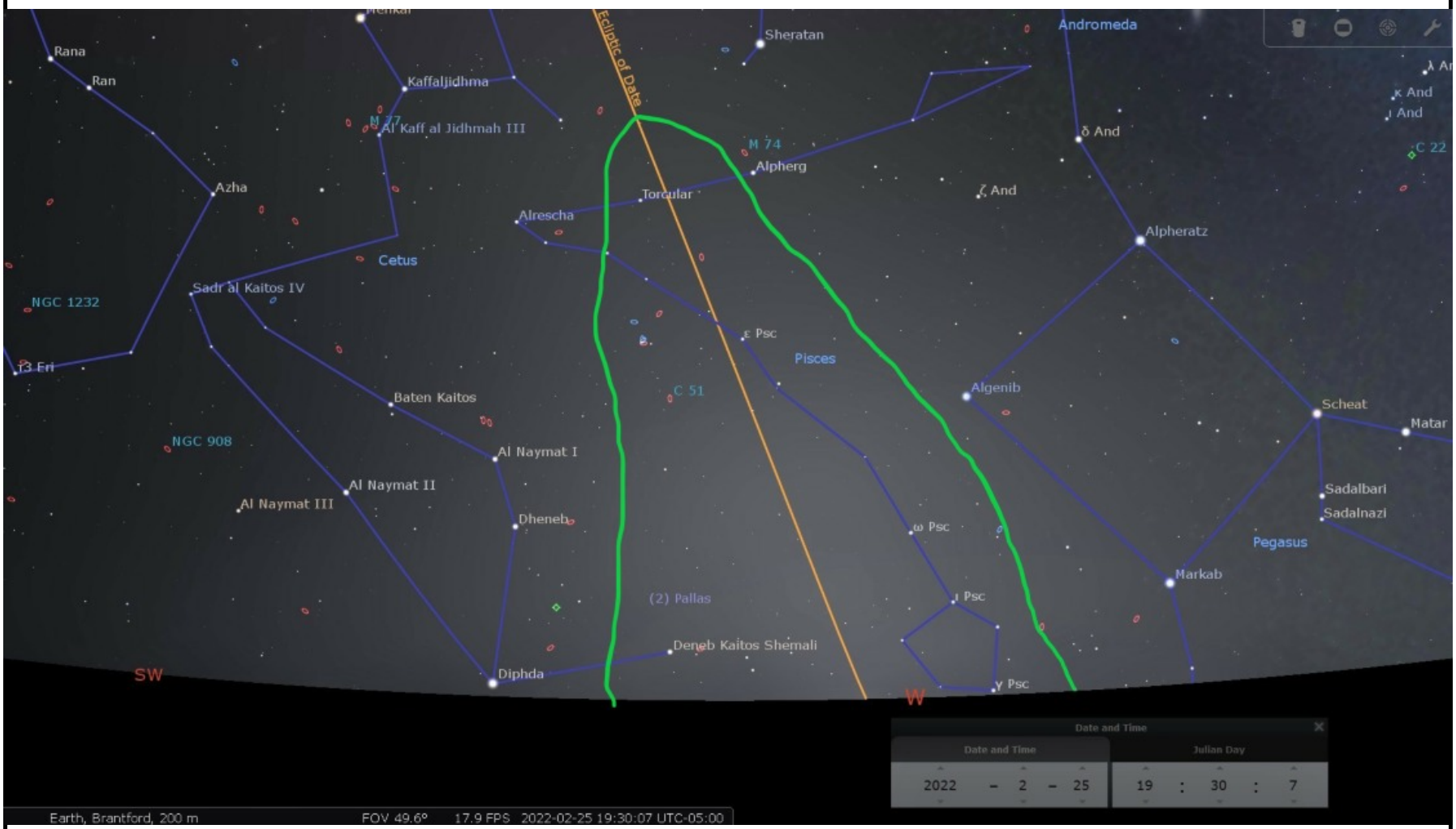
Zodiacal light is the faint light reflected off millions of particles of comet and asteroid dust. The dust orbits the Sun in the same plane as the planets and extends outward from about three million kilometres from the Sun to well beyond the orbit of Mars. It is the largest visible entity in the solar system. If it is visible to the naked eye, it can be captured in a photo using just a basic camera and tripod.

There are a few limiting factors when trying to see the faint glow of the Zodiacal light. The Moon mustn't be in the sky, and you must be away from light pollution. For any given time (let's say 7:30pm), the Moon is above the horizon 14 or 15 days out of every 29-day Lunar cycle. That leaves two weeks per Lunar cycle when the Moon won't interfere with Zodiacal light. In other words, the Zodiacal light is present in the sky every evening in February and March; we just can't see it half of the time due to Lunar light pollution.

For the months of February and March this year the Zodiacal light should be visible from a dark Moonless location on the following dates.

- February 18th to March 4th around 8pm.
- March 20th to April 1st around 9pm.

In the following screen shot from Stellarium, I added a green line to show the visual extent of the Zodiacal light.



The Planets

Mercury may be visible very low in the east just before sunrise in the second week of February.
Venus will be prominent in the morning eastern sky all month and Mars will approach Venus by mid-month.
Jupiter should be visible for most of the month low in the west during evening twilight. It will be lost in the glare of the setting Sun by month end and will be in line with the Sun (conjunction) on March 5th.
Saturn will begin to emerge from the glare of the rising Sun by the end of the month.
Uranus and the Moon will meet on the evening of February 7th with a separation of less than 2°.
Neptune is lost in the evening twilight for the month coming to conjunction on March 13th.

What's Up in Awards? February-March 2022 by Bernie Venasse

Contents:

What's Up in Awards?

The Hamilton Amateur Astronomers Observing Programs are designed to provide direction for amateur astronomer's observations and to reward their accomplishments. A certificate is awarded when the goals of the observing program are met. The HAA offer various certificates based upon achieving specific observing goals. There is no time limit for completing the required observing but good record keeping is required. Each observer must perform all the requirements of each Observing Program themselves. However, observers are able to receive help from (an)other observer(s) as they learn to find and identify different objects. Each observer will then need to locate and observe the object on their own to meet the goals of the program. Observing logs will be submitted to and examined by the HAA Observing Programs Project Coordinator to confirm all observations before a certificate is granted.

This column tells you which objects are visible this next month for the HAA Observing Programs and other sights of interest.

HAA Rising Star Observing Award

February
Constellations: Gemini, Canis Major
Stars: Pollux, Sirius
Double stars: Castor, Aludra (eta Canis Majoris)
Object Pairs: NGC 2437, NGC 2438
Messier objects: M35, M42

March
Constellations: Ursa Major
Stars: Regulus
Double stars: Tau Cancri
Object Pairs: M81/M82
Messier objects: M35, M42, M45

Pathways Observing Program

Observable this season: January, February, March
Group D,
Winter Constellations: Find, observe, sketch: *Taurus, Orion, Gemini.*
Stars: Find, observe, sketch: *Capella, Sirius, Betelguese.*
Asterisms: Find, observe, sketch: *Head of the Whale, Winter Triangle, Winter Hexagon.*
Planet: Any one planet that is remaining in the list.

HAA Messier Objects Observing Award

February Messier targets

M1 The Crab nebula is a supernova remnant in Taurus. It is a hazy patch in small telescopes, large scopes can resolve some detail. It is difficult but possible to see in binoculars.

M45 The Pleiades are a large open cluster in Taurus. Easy to resolve six stars naked eye. Binoculars provide the best view. Large telescopes can show some nebulosity. *(Continued on page 11)*

What's Up in Awards? February-March 2022 (continued)

M35, M37, M36, M38 A series of open clusters in the winter milky way. M35 is in Gemini, the others are in Auriga. All can be seen naked eye as faint fuzzy stars, binoculars reveal fuzzy patches, low power telescopes can resolve these rich clusters.

M42, M43 M42 is the great Orion Nebula. It can be seen as small fuzzy patch naked-eye. Binoculars show some detail, and the view is superb in most any scope. M43 is a small region of nebulosity next to M42, and probably requires the use of a telescope to view. Use low to moderate powers for the best view of this pair.

M78 A small reflection nebula in Orion, a tough binocular object. Best viewed in a telescope at moderate powers.

M79 One of the smallest and dimmest globular clusters in the catalog. A tough binocular object in Lepus, best viewed in a telescope at moderate powers.

March Messier targets

M41 This cluster in Canis Major is visible as a hazy patch to the naked eye just below Sirius. M41 appears fairly loose in telescopes at low power.

M93 This is a small fuzzy patch of light in Puppis. Use low power to examine this cluster and the surrounding richness in a telescope. Medium power provides a nice view of the cluster itself.

M47 A bright cluster in Puppis, easily visible as a hazy patch to the naked eye. Telescopes show a fairly loose cluster with stars of wide variety of magnitudes.

M46 This cluster is right next to M47 and is also visible to the naked eye. In telescopes at low powers this cluster evenly fills the eyepiece. While you are here go to medium or high power and look for the planetary nebula NGC 2438. It will appear as a faint uneven ring, with a blue/green color.

M50 An open cluster in Monoceros. Like M93, the richness of the surrounding field is the only difficulty in finding this object. This is a fairly tight cluster at low power in a telescope.

M48 M48 appears as a large fuzzy patch in binoculars, partially resolvable. Use low to medium power in your telescope for a spectacular view.

M67 In the southeast portion of Cancer is another open cluster, barely visible as a fuzzy patch to the naked eye. Use low power to resolve this large, rich cluster in a telescope.

M44 Known as the Praesepe or Beehive Cluster, this open cluster is easily visible to the naked eye as a large, fuzzy patch wider than the moon. Binoculars or wide field, low power telescopes provide the best views of M44.

M81, M82 Both galaxies will fit into the same low power telescope field. M81 will appear as a large oval gray patch of light. M82 is a pencil like streak of light next to and perpendicular to the long axis of M81.

(Continued on page 12)

What's Up in Awards? February-March 2022 (continued)

The Planets… February 2022 via (BBC) Sky at Night Magazine

Mercury: Dim morning object, not well placed. Best seen just before mid-month.

Venus: Bright morning planet, rising over two hours before sunrise. Near Mars at end of February.

Mars: Brightening morning object, near Venus towards the end of February.

Jupiter: Bright evening planet, rapidly lost to the twilight during the month.

Saturn: Saturn lines up with the Sun in the sky on 4 Feb and is unlikely to be seen this month.

Uranus: Mag. +5.8 Uranus loses altitude during February but remains a viable target.

Neptune: The evening twilight catches up with Neptune this month, the planet is lost from view.

The Planets… March 2022 via (BBC) Sky at Night Magazine

Mercury: Morning planet, poorly placed throughout the month.

Venus: Bright morning planet, 50% phase around 20 March. Near Mars and Saturn at end of March.

Mars: Morning object, slowly brightening. Sits close to Saturn and Venus at end of month.

Jupiter: Solar conjunction on 5 March; thereafter Jupiter not visible for the rest of the month.

Saturn: Poorly positioned morning planet. Near Venus and Mars at end of March. Crescent Moon nearby on 28 March.

Uranus: Best at the start of March. Currently in southern Aries, lost by end of the month.

Neptune: Neptune in conjunction with the Sun on 13 March and not visible this month.

Meteor Showers via American Meteor Society

There are no major meteor showers taking place in February or March.

Lyrids

Period of activity: April 15th, 2022 to April 29th, 2022
Peak Night: Apr 21-22, 2022

The Lyrids are a medium strength shower that usually produces good rates for three nights centered on the maximum. These meteors also usually lack persistent trains but can produce fireballs. These meteors are best seen from the northern hemisphere where the radiant is high in the sky at dawn. Activity from this shower can be seen from the southern hemisphere, but at a lower rate.

Shower details - Radiant: 18:04 +34° - ***ZHR:*** 18 - ***Velocity:*** 30 miles/sec (medium - 48.4km/sec) - ***Parent Object:*** C/1861 G1 (Thatcher)
Next Peak - The Lyrids will next peak on the Apr 21-22, 2022 night. On this night, the moon will be 67% full.

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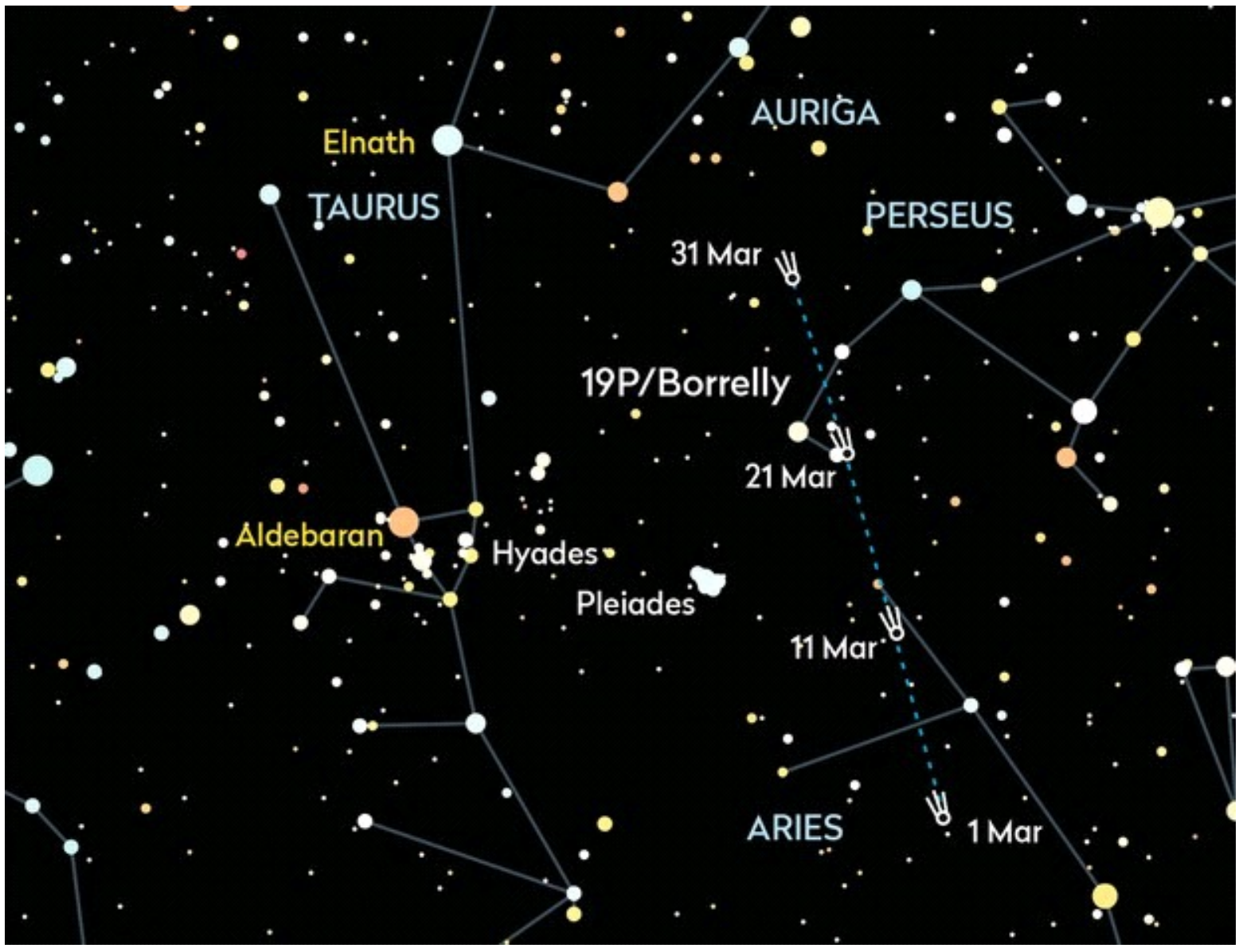
What's Up in Awards? February-March 2022 (continued)

Comet Borrelly

Comet 19P/Borrelly is a viable target for small telescopes in March 2022, shining brighter than 10th magnitude.



Path of Comet 19P/Borrelly during March 2022.
Credit: Pete Lawrence

Observing Award Recipients

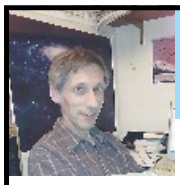
We would like to give recognition and congratulations to any member who completes an award program regardless of the sponsoring organization. Congratulations to the following:

HAA
Rising Star Awards
001 Jean Jefferson
002 Kevin Salwach
003 Jo Ann Salci (Nov 2021)

RASC
Swapna Shrivastrava
Explore the Moon
Explore the Universe
Jo Ann Salci
Exploring Exoplanets (on-line course)

Astronomical League
Bernie Venasse
Binocular Double Star Observing Program 143
Binocular Variable Star Observing Program 051
Binocular Solar System Observing Award 183-B
Sketching Observing Program 052

Please feel free to contact me with any questions or comments at eclipse@amateurastronomy.org
— Bernie



Confirmation of the First Exo-Moon by Doug Currie

Introduction

I would like to share in this article, what I think, and some others think, will be the beginning of a new class of many celestial objects. What do other members think about other astronomical objects in other stellar systems. One long hypothesized class of objects, but with an example of such only recently confirmed are exo-moons. Exo-moons are moons or satellites of planets around other stars or moons or exo-planets that are sometimes also called extra-solar planets. The first confirmed exo-moon, according to one of the primary databases of extra-solar objects, called The Extra-solar Encyclopedia at link http://exoplanet.eu is *Kepler 1708 b i*.

Parent Star Kepler 1708 and Parent Planet Kepler 1708b of New Confirmed Exomoon Kepler 1708 b i

According to The Extrasolar Encyclopedia, Kepler 1708 is a star that is around 5,500 light years, or more specifically 1,667 parsecs, from Earth with a mass of 1.088 solar masses and a size of 1.117 solar radii. It is probably a spectral G type star like our sun. The parent star is of apparent magnitude 16.0 and is in the constellation Cygnus. The co-ordinates of this stellar system are Right Ascension (RA) 19 hours, 47 minutes, 19 seconds and Declination (Dec.) +43 degrees, 37 minutes and 29 seconds. These co-ordinates place the Kepler 1708 system fairly close on the sky to the fairly bright star Delta Cygni. The planet, around which the new confirmed exo-moon orbits, is called Kepler 1708 b. It has a mass of 4.6 Jupiter masses, according to the Extra-solar Encyclopedia, and a radius of 0.8886 Jupiter radii so it would have a substantially greater density (and gravity) than our Jupiter. The planet, Kepler 1708 b, is located probably in the outer part of the habitable zone of its parent star, Kepler 1708. This location of Kepler 1708 b in or near the star's habitable zone is because the star is somewhat more massive and larger than our sun and the planet is only a little farther than Mars is from our sun with Mars at or near the outer part of the habitable zone around our star the sun or Sol. In particular, Kepler 1708 b is located at an average distance of 1.64 astronomical units (AU or Earth-sun distances of about 93 million miles). The planet Kepler 1708 b has a year of about 737 Earth days and its orbit has an eccentricity or "ovalness" of 0.4 which is quite eccentric. This high eccentricity would give Kepler 1708 b more variation in the distance from its parent star in percentage terms than either Mercury or Pluto have from our sun with both of them have eccentricities of over 0.2. If there are any other more terrestrial moons around this planet they might not be habitable becomes of the extremes of temperature they would likely have because of the large variation in how much radiation they would get from the parent star.

Newly Confirmed Exomoon Kepler 1708 b i

Concerning the now confirmed moon around the planet Kepler 1708 b, which is the first fully confirmed exo-moon with designation Kepler 1708 b i, I will give some data about again from Extrasolar Encyclopedia. This moon is MASSIVE!!! It has a mass of 0.116 Jupiter masses, that is approximately the mass between that of Uranus at 15 Earth masses or Neptune at 17 Earth masses and Saturn at about 75 Earth masses in our solar system, or to put it another way this newly discovered exo-moon has a mass of about 36 Earth masses. Kepler 1708 b i is also HUGE, especially for a moon, in terms of size as well as mass. It has a radius of 0.2329 Jupiter radii or about 2.56 Earth diameters or about 20,000 miles or 32,000 kilometres. The diameter of Jupiter is about 143,000 kilometres or about 89,000 miles. By comparison, in our solar system Saturn has a diameter of about 120,000 kilometres or about 75,000 miles, Uranus has a diameter of 51,120 kilometers or 31,950 miles and Neptune has a diameter of 49,532 kilometers or 30,958 miles. This works out to a density of about 0.457 times that of Earth which is about 5.5 grams/cubic centimeter or about 2.51 grams/cubic centimeter or 2.51 g/cc for the newly confirmed exomoon Kepler 1708 b i.

(Continued on page 15)

Confirmation of the First Exo-Moon (continued)

Kepler 1708 b i Exomoon Discoverer and Leading Exomoon Researcher David Kipping

The astronomer that can be credited with the discovery of this new confirmed exomoon is David Kipping. He is an Assistant Professor in the Astronomy Department at Columbia University in New York City. He is best known for his research in exomoons and according to a statement he made in a previous Cool Worlds Lab episode, quite credibly, he is the principle author of about half the research papers on exomoons. He also leads the Cool Worlds Lab at Columbia University and their web site at www.coolworldslab.com. He is also the primary speaker on a regular podcast that is also available on Youtube called Cool Worlds Lab. It is mostly about extra-solar planets and sometimes about exo-moons, especially research he is involved in. Cool Worlds Lab also covers some other aspects of astronomy and space exploration. Professor Kipping is from somewhere in the British Isles as can be noted by his British accent. He is the Principal Investigator (PI) of The Hunt for Exomoons with Kepler (HEK) project. He also several years ago was the main astronomer who discovered the earlier candidate although not yet confirmed exomoon Kepler 1625 b i. According to his biography sketch on the Columbia University website his other research interests include: "the study and characterization of transiting exoplanets, the development of novel detection and characterization techniques, exoplanet atmospheres, Bayesian inference, population statistics and understanding stellar hosts." The title of the recent Cool Worlds Lab by David Kipping about the discovery of the now confirmed exomoon Kepler 1708 b I is: "We Discovered a New Exomoon Candidate! A Survey of 70 Cool Gas Giants and at Youtube has link watch?v=Blej3YvveCl with date of posting probably in January 2022. One of the older Cool Worlds Lab episodes about the earlier exomoon candidate discovered by astronomer David Kipping has the title: "EXOMOON SPECIAL, The Nature of our Exomoon Candidate that was posted on Youtube on October 3, 2018 and has Youtube link designation *watch?v=vlcc2MdYaik*.

Earlier Exomoon Candidate Kepler 1625 b i's Parent Star and Planet Kepler 1625 and Kepler 1625 b

The previous exomoon candidate Kepler 1625 b i is similar to the more recent now confirmed candidate Kepler 1708 b I but not identical. The parent star of this exomoon is Kepler 1625. It and its stellar system are at a distance of 1,213 parsecs or 3,954 light years from Earth and our solar system. Kepler 1625 and its system are located at Right Ascension (RA) 19 hours, 41 minutes and 43 seconds and Declination (Dec.) +39 degrees, 53 minutes and 12 seconds. This is also in the constellation Cygnus and the closest marked object, in the Astronomy magazine Atlas of the Stars, is the deep sky object NGC 6819. Unlike the parent star of the other exomoon candidate Kepler 1708 that is slightly larger and more massive than our sun, the parent star of the exomoon candidate Kepler 1625 is slightly less massive and slightly smaller than our sun at about 0.96 solar masses and 0.94 solar radii. The mass of the parent planet of Kepler 1625 b, the parent planet of the other and earlier exomoon candidate Kepler 1625 b i, is 11.6 Jupiter masses which is about 3,600 Earth masses that is significantly heavier than the now confirmed, newer exomoon candidate Kepler 1708 b I at 4.6 Jupiter masses or about 1,400 Earth masses. The radius of the parent planet of the Kepler 1625 system exomoon is 0.541 Jupiter radii. This leads to a diameter of about 77,363 kilometres or 48,149 miles. The exomoon's parent planet in this system has a year of about 287 days. With the parent star Kepler 1625 being a little smaller and less massive than our sun, the star is probably a little fainter. This could work out that the Kepler 1625 planet, Kepler 1625 b, and its moon Kepler 1625 b i, are just inside the inner edge of the habitable zone of their parent star Kepler 1625. (The semi-major axis or close to average distance of the planet from the parent star Kepler 1625 and the eccentricity in the orbit of Kepler 1625 b around its parent star are not known or at least aren't published yet in The Extrasolar Encyclopedia.

Earlier Exomoon Candidate Exomoon Kepler 1625 b i

The discovery of Kepler 1625 b i was in 2017 by David Kipping and his colleague Alex Teachey using the transit method. This exomoon has a mass of 19.1 Earth masses or 0.06 Jupiter masses. This mass is just

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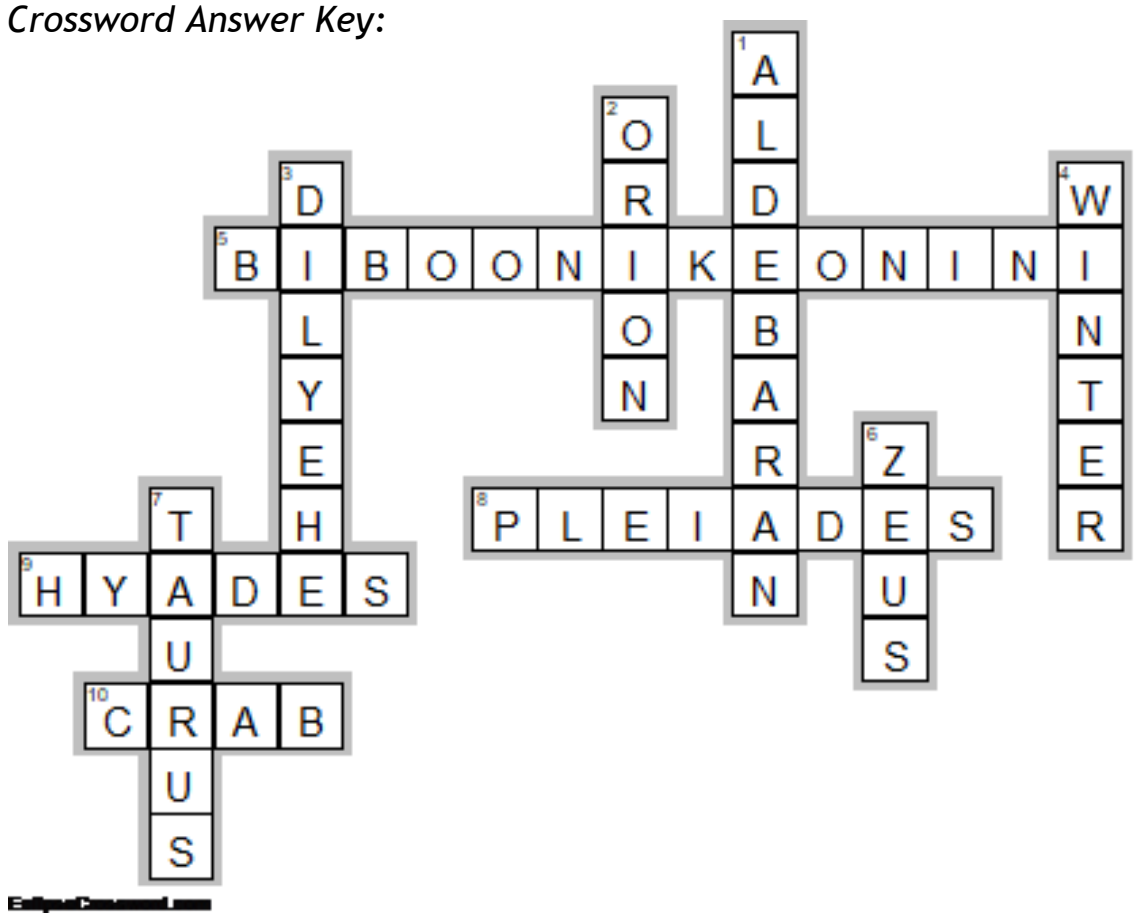
Confirmation of the First Exo-Moon (continued)

larger than the 15 Earth masses of our solar system's planet Uranus and of 17 Earth masses of Neptune in our solar system. This mass of the earlier exomoon candidate Kepler 1625 b I is significantly less than that of the newer confirmed exomoon candidate Kepler 1708 b i at about 36 Earth masses. The radius of the exomoon candidate Kepler 1625 b i is very extensive at 0.437 Jupiter radii or 4.8 Earth radii. This leads to a diameter or about 62,000 kilometers or about 39,000 miles. This is a much larger size than the newer confirmed exomoon Kepler 1708 b i with a diameter of about 32,000 kilometres or 20,000 miles. The density of Kepler 1625 b i, according to the Wikipedia article about it, is 0.954 grams/cubic centimeters or a little less than the density of water that is by definition 1 gram per cubic centimeter. This density for the previously discovered exomoon candidate Kepler 1625 b i is much less than the density of the more recently discovered and confirmed exomoon candidate Kepler 1708 b i with a density of 2.51 grams/cubic centimeter. These differences indicate that, if this data and these calculations are correct, Kepler 1708 b i must have much more heavier materials such as rocks or even metals in its bulk composition than Kepler 1625 b i.

Conclusion About Hunt for and Discoveries of Exomoons

In view of all this data and comparison of these first two candidate exomoons, also in comparison with Earth and the gas or ice giants in our solar system, it seems that there is or will be found to be much variety in other of the largest exomoons. These different properties could include their size, density, parent planets, and distance and heat from their parent stars. This could lead to other differences in the properties of such super exomoons. What will be especially interesting to me and probably at least some other people is what other types of exomoons will be discovered when astronomers get better or more sensitive equipment or analysis computer or other tools. I think what will be especially interesting about exomoons is what range of sizes and other properties they will have. In particular it will be very intriguing how common Earth size exomoons will prove to be especially potentially habitable ones. Hopefully we will be able to find out in the relatively near future more information about exomoons and their stellar systems will provide a whole new window on the universe, cosmos or heavens and the things in it.

Page 5 Crossword Answer Key:



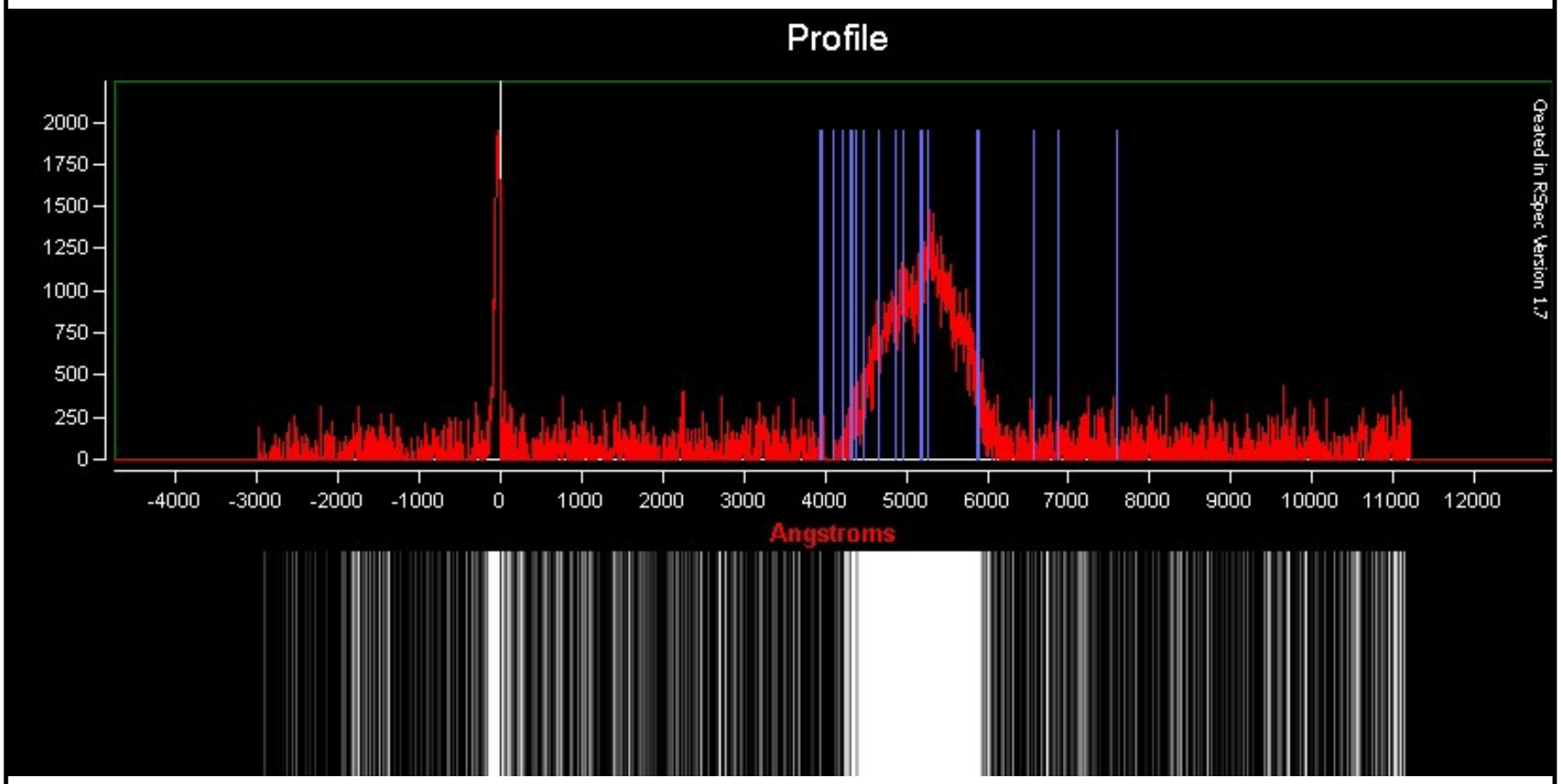
Universal Complexity by Mike Jefferson

It is said that the universe is finite and unbounded, which seems like a complex contradiction in terms. The spectrum below of the Sun's light, reflected off the surface and atmosphere of Mars, would seem to illustrate that concept.

It is a line profile, G2V picture which I took a few years ago under one of our clearer skies. G2V means a main sequence dwarf (ie. the Sun). Heavily contrasted, it portrays a huge amount of complex detail revealed by a camera and simple spectroscope. The white rectangle is over contrasted and is the area where most of the visible light is located. To the left of 3,900 Angstroms and to the right of about 7,600 Angstroms is, for the most part, invisible to us. Here, it registers basically as noise. The spike at 0 Angstroms is referred to as the 0-order spectrum, or an image of Mars itself. The black and white lines at the bottom of the image are a pseudo-spectrum drawn from the information in the upper line profile. They are the way spectra used to look when done in the days of film photography. Colour can be added to the line profile but serves no purpose other than for aesthetics.

Playing with these pictures is a lot of fun and they betray much information. The blue lines are taken from several libraries of element lines; one of which is 'the ladder of Balmer' hydrogen lines and the second is from the Fraunhofer solar spectrum, pasted together on the same image. The bumps and depressions in the profile and the black and white lines beneath show the absorption and emission of photons at specific wavelengths. These govern the capture or escape of electrons to specific orbitals around the nuclei of atoms and ions.

Yes, complex! Very! To go further, this atomic activity can be illustrated with Grotrian diagrams which show the various steps of these transitions. Beyond hydrogen and helium, it gets very confusing. However, it means that we will never run out of frontiers to explore, despite the Webb Telescope's attempts to peer back to the earliest stages of the universe.



The Sun's G2V Spectrum, as reflected off Mars.
Credit: Mike Jefferson / generated with RSpec Version 1.7

NASA Night Sky Notes

This article is distributed by NASA Night Sky Network.

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach.

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

Hang Out with the Twins of Gemini

David Prosper

The night skies of February are filled with beautiful star patterns, and so this month we take a closer look at another famous constellation, now rising high in the east after sunset: Gemini, the Twins!

If you're observing Orion, as discussed in last month's article, then Gemini is easy to find: just look above Orion's "head" to find Gemini's "feet." Or, make a line from brilliant blue-white Rigel in the foot of Orion, through its distinct "Belt," and then on through orange Betelgeuse. Keep going and you will end up in between the bright stars Castor and Pollux, the "heads" of the Gemini Twins. While not actually related – these stars aren't bound to each other, and are almost a magnitude apart in brightness – they do pair up nicely when compared to their surrounding stars. Take note: more than one stargazer has confused Gemini with its next-door neighbor constellation, Auriga. The stars of Auriga rise before Gemini's, and its brightest star, Capella, doesn't pair up as strikingly with its second most brilliant star as Castor and Pollux do. Star-hop to Gemini from Orion using the trick above if you aren't sure which constellation you're looking at.

Pollux is the brighter of Gemini's two "head" stars - imagine it has the head of the "left twin" - and located about 34 light-years away from our Solar System. Pollux even possesses a planet, Pollux b, over twice the mass of Jupiter. Castor - the head of the "right twin" - by contrast, lies about 51 light-years distant and is slightly dimmer. While no planets have been detected, there is still plenty of company as Castor is actually a six-star system! There are several great deep-sky objects to observe as well. You may be able to spot one with your unaided eyes, if you have dark skies and sharp eyes: M35, a large open cluster near the "right foot" of Gemini, about 3,870 light-years away. It's almost the size of a full Moon in our skies! Optical aid like binoculars or a telescope reveals the cluster's brilliant member stars. Once you spot M35, look around to see if you can spot another open cluster, NGC 2158, much smaller and more distant than M35 at 9,000 light-years away. Another notable object is NGC 2392, a planetary nebula created from the remains of a dying star, located about 6,500 light-years distant. You'll want to use a telescope to find this intriguing faint fuzzy, located near the "left hip" star Wasat.

Gemini's stars are referenced quite often in cultures around the world, and even in the history of space exploration. NASA's famed Gemini program took its name from these stars, as do the appropriately named

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twin Gemini North and South Observatories in Hawaii and Chile. You can discover more about Gemini's namesakes along with the latest observations of its stars and related celestial objects at nasa.gov.

Castor and Pollux are Gemini's most prominent stars, and often referred to as the "heads" of the eponymous twins from Greek myth. In Chinese astronomy, these stars make up two separate patterns: the Vermillion Bird of the South and the White Tiger of the North. What do you see? The Night Sky Network's "Legends in the Sky" activity includes downloadable "Create Your Own Constellation" handouts so you can draw your own star stories: bit.ly/legendsinthesky

Image created with assistance from Stellarium.

Montage of Gemini North, located on Mauna Kea in Hawaii, and Gemini South, located on Cerro Pachón in Chile. These "twin" telescopes work together as the Gemini Observatory to observe the entire sky.

Image Credit: NOIRLab Source: https://www.gemini.edu/gallery/media/gemini-northsouth-montage

UPCOMING EVENTS

February 11, 2022 - 7:30 pm — Virtual Online H.A.A. Meeting. Our speakers will be the HAA's own *Jo Ann Salci* and *John Gauvreau*, as well as the Bluewater Astronomy Group's *Brett Tatton* and *John Hlynialuk*.

Due to the COVID-19 Coronavirus pandemic, the meeting will be conducted on the platform Zoom. Be on the lookout for an invitation e-mail with a meeting link. You may download the Zoom app for various platforms from Zoom's Download Center.

We hope to return to in-person meetings very soon!

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All active HAA members have the privilege of access to an exclusive HAA members only dark sky location.

Be on the lookout for e-mails with dark sky observing details. Space is limited.

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