## AOH Newsletter

## Summer 2023

## News and Notes

Springtime meetings for AOH continued as usual on Zoom,
 every Saturday nearest the full moon. But it was a different story for scheduled observing at Kneeland. Or we might say that our non-meetings continued as usual. Here's our record for 2023:


| January 25 | Clouded Out |
| :--- | :--- |
| February 18 | Clouded Out |
| March 18 | Clouded Out |
| April 22 | Clouded Out |
| May 20 | Clouded Out |
| June 17 | Clouded Out |

Here's hoping for a more astro-friendly Summer!

Thanks to Grace, Don, Yoon, and Susan for their help and contributions to the Newsletter. Send any photos, notes, suggestions, or comments to me at ken@astrohum.org.

## Library Telescope Program

The Astronomers of Humboldt recently presented another Orion Starblast 4.5 -inch telescope to the Arcata Library. The telescope was provided to the AOH by the Astronomical League and was funded by the Horkheimer Charitable Fund. The telescope is available to be checked out, just like a book, from the Library. It joins a second telescope which was presented to the library last year, and which has been in high demand by library patrons. (See the Summer 2022 Newsletter.) Pictured are (front) Shannon, Kim, and Margot, Arcata Library staff members; (seated at the table) Susan, Supervising Librarian, and Ken, AOH Secretary; and (standing) Brent, AOH President, and Mark, AOH Vice-President.


## Albee Creek Outreach

AOH will hold outreach events at Albee Creek Campground on July 22 and August 12. We'll set up scopes for campers and park visitors. The Park has provided a campsite for AOH members who would like to
participate and then stay overnight. If you haven't already volunteered for either of these events, let Brent know (president@astrohum.org) if you can be there, so we can keep a count of how many people and scopes we'll have.

## STAR GAZING PARTIES RETURN HUMBOLDT REDWOODS STATE PARK

HOSTED BY.HUMBOLDT REDWOODS INTERPRETIVE ASSOCIATION AND ASTRONOMERS OF HUMBOLDT



Road Trip?
The Astronomical League's Annual Convention will be held in Baton Rouge in July. If you'd like to go, AOH can pay your registration
fees. (Transportation, food, and lodging would be up to you.) Check out the link in the poster below and then contact Brent (president@ astrohum.org) for more information.

## BIENVENUE EN LOUISIANE! (WELCOME TO LOUISIANA!)

Join us for this unique and exciting amateur astronomy gathering!


July 26-29, 2023
Hilton Baton Rouge Capitol Center Hotel 201 Lafayette Street Baton Rouge, LA 70801

## ALCON 2023

## KEYNOTE SPEAKERS

* David Eicher-writer, editor-in-chief of Astronomy Magazine
$\star$ Fred Espenak-co-author of Totality: The Great American Eclipses of 2017 and 2024
$\star$ David Levy-author, comet hunter


## FIELD TRIPS

$\star$ Irene Pennington Planetarium
$\star$ LIGO (Laser Interferometer
Gravitational-Wave Observatory)
Livingston*
$\star$ Louisiana State University
Physics \& Astronomy
$\star$ Highland Road Park Observatory
*Spaces are limited for this trip!

SPEAKERS $\star$ Pranvera Hyseni $\star$ Guy Consolmagno $\star$ Dan Davis $\star$ And many more!

Brought to Baton Rouge by the Baton Rouge Astronomical Society

$$
\star \text { Registration is now open! Check alcon2023.org } \star \approx
$$

# Spring Observations 

by Grace Wheeler

## Mars and Venus and the Beehive Cluster

During the first week of June, the path of Mars took it closer and closer to the Beehive Cluster (M44) in the constellation Cancer. On June 2, Mars seemingly entered the Beehive and could be found just above its center.


The image was taken by Grace Wheeler through an 80mm refractor telescope with a Canon EOS Ra (ISO 400, 30s exposure, stack of 15 light and 10 dark frames).

An open cluster spanning some 15 light-years across, the Beehive holds 1,000 stars or so and covers about 3 full moons ( 1.5 degrees) on the sky. Its stars are relatively young, about 600 million years old compared to our Sun's (and Mars') 4.5 billion years. It is actually about 600 light years beyond Mars and what we are observing is the passage of Mars in front of the cluster.

## May 17th Kneeland Solar Observing

It seemed that this year was the winter that would not end. After several days of grey skies, I made the trek up to Kneeland Airport where the skies were clear and perfect for a morning of solar imaging. I had set up my solar telescope in the parking lot when Jan and Nancy stopped by on their hike on Kneeland Road. Like me, they had come up to Kneeland in search of the sun. They were curious about my setup, so I invited them to look through the telescope. I explained that they were looking at the sun in hydrogen-alpha which gives a more dynamic view of solar activity. We are in the active part of solar cycle 25 and the sun had been putting on an impressive show for the last two years. While there were only a few sunspots on the disc that day, the H -alpha view showed large active regions and an abundance of prominences and filaments. We discussed many topics including the features that we saw through the solar telescope, the nature of the solar cycle, and the magnetic pole reversal and the role that sunspots play in causing the polar flip (stay tuned for a future article on this).

A view of the chromosphere of the Sun through a hydrogen-alpha telescope. The white areas are active regions. There were prominences at the limb and several filaments on the disc. The mottled
texture of the disc are small jets of plasma known as spicules. In the active regions are fibrils which are elongated spicules. The arrangement of the fibrils are thought to trace the magnetic field in the active regions. The
Sun was imaged with a 50 mm Lunt solar telescope, and a ZWO 294 monochrome camera.
The frames were stacked in Autostakkert and sharpened in ImPPG.
The final image was colorized in Photoshop.



The original image of the chromosphere was inverted in ImPPG to create a negative copy. This technique gives a better view of the surface by adding depth to the image. The filaments appear to be floating above the attachment points. The arrangement of spicules and fibrils appear elevated and are better seen against the background.


The image of the sunspots on the solar disc was retrieved from the archives at https://sdo.gsfc.nasa. gov/datal.

The photosphere seemed quiet with only a few sunspots (compare this to what is seen in the chromosphere.) On the eastern limb, a sunspot in AR3310 is rotating into view. This sunspot is about $4 x$ the size of the Earth and was quite eruptive.


Nancy Reichard and Jan Ramsey at Kneeland Airport. Jan is looking through the solar telescope. Thank you, Jan and Nancy, for participating in the mini-outreach and for asking such great questions.

## Supernova in the Pinwheel Galaxy

The Pinwheel Galaxy (M101) in Ursa Major is a grand design spiral galaxy, i.e., one having well-defined spiral arms. On May 19, a supernova (SN 2023ixf) was discovered by amateur astronomer Koichi Itagaki. M101 is 21 million light years from Earth; this implies that the supernova explosion actually occurred 21 million years ago, and we are only seeing its light now. Based on the spectral data, SN 2023ixf is a type II supernova. This type of supernova occurs when a massive star runs out of fuel at the end of its life. With no more fuel to counter gravity, the core collapses and causes an explosion that releases radiation and debris. What is left behind is a neutron star or a black hole.

At the time of this writing, the magnitude of SN 2023ixf is 10.8, and it should be visible for the next month or two. According to Bob


King from Sky and Telescope, a small telescope will show the galactic center of M101 and SN 2023ixf at the periphery of the halo.

SN 2023ixf is located in the outer spiral arm of M101 and next to NGC 5461, a H II star-forming region. M101 has low surface brightness which makes it inherently difficult to see the architecture of the galaxy. To bring out more of the details of M101, I used the Unistellar Evscope, a smart telescope that records four second exposure and live stacks the frames. At left is a picture of M101 taken in December 2021; this is about 18 months before the supernova event. The location of NGC 5461 on the spiral arm is marked. At right is an image of M101 recorded on $6 / 4 / 23$ showing the SN 2023ixf and its proximity to NGC 5461. SN


2023ixf appears brighter than any of the features in M101 except for the galactic center.

Even though SN 2023ixf is quite distant, it is the closest supernova event to Earth in five years (and the second closest in a decade).

## References:

https://www.scientificamerican.com/article/astronomers-have-spotted-a-once-in-a-decade-supernova-and-you-can-tool
https://skyandtelescope.org/astronomy-news/bright-supernova-blazes-in-m101-the-pinwheel-galaxy/

## Planetary Elongations <br> by Ken Yanosko

Mercury is one of the brighter planets, usually hovering around first magnitude of brightness. But it's rarely seen, because of its nearness to the Sun. To see it, you have to look at a time when its angular distance from the Sun, its elongation, is at a maximum, i.e., when Mercury is at its greatest eastern elongation (or greatest western elongation, as the case may be). The AOH Calendar and the Upcoming Events webpage list these events, with only a minimal explanation. So here's what's what.

The first thing that's confusing is that we are told that at greatest eastern elongation, you should look to the west, and vice versa. This is easy to comprehend. When Mercury is east of the Sun, it trails the Sun as the Sun (apparently) moves across the sky. So just after the Sun sets, the planet is still above the horizon, but in the sunward direction, which is to the west. And when Mercury is at its western elongation it is ahead of the Sun, so rises before the Sun, so can be seen in the east at sunrise.

Now that that's taken care of, let's look at a table of greatest elongations of Mercury for the next 18 months.

| Greatest Elongations of Mercury |  |  |
| :---: | :---: | :---: |
| date | type | days since prev |
| Aug 10, 2023 | $E$ | -- |
| Sep 22, 2023 | $W$ | 43 |
| Dec 4, 2023 | $E$ | 73 |
| Jan 12, 2024 | $W$ | 39 |
| Mar 24, 2024 | $E$ | 72 |
| May 9, 2024 | $W$ | 46 |
| July 22, 2024 | $E$ | 74 |
| Sep 5, 2024 | $W$ | 45 |
| Nov 16, 2024 | $E$ | 72 |
| Dec 25, 2024 | $W$ | 39 |

We see that the number of days after the eastern and before the western elongations is consistently smaller than the time between western and eastern elongations. The times are somewhat irregular, of course, but
that's due to the fact that both the Earth and Mercury have elliptical orbits, and by Kepler's laws they go a little faster when they are closer to the Sun than when they are farther out. But that doesn't explain why the E to W intervals are around 40 days, while the W to E intervals are over 70 days. What's that all about? Figure 1 shows why this is the case.

The diagram shows the orbit of Mercury (approximated by a circle), with the Earth (blue dot) outside Mercury's orbit, down below. The two black dots show the locations of Mercury at greatest eastern (E) and western (W) elongations. Note that these occur when the line joining Mercury to the Sun is at a right angle to the line joining Mercury to Earth. We see at a glance that it should take Mercury less time to go from E to W (along the red arrow, passing through inferior conjunction) than from W to E. We can actually calculate how much.


Figure 1

The orbital radius of Mercury happens to be 0.4 Astronomical Units (i.e. 0.4 times the Earth's orbital radius). Elementary trigonometry allows us to compute the angle $\alpha$ :

$$
\alpha=\cos ^{-1}(0.4) \approx 66.5 \text { degrees }
$$

So the red arrow represents an arc of angular measure $2 \alpha \approx 133$ degrees. It follows that the number of days for Mercury to get from E to W is $133 / 360$ times the number of days it takes Mercury to go all the way around from E back to E. Mercury takes 88 days to go once around the Sun, but that's not the number we want here. This diagram represents a rotating coordinate system, i.e. one in which the Earth is stationary. So we need the synodic period of Mercury, the time it takes Mercury to return to the same orbital position as seen from Earth. The formula for this is:

$$
T_{s y n}=1 /\left(1 / T_{M}-1 / T_{E}\right)
$$

where $T_{M}$ and $T_{E}$ are the orbital periods of Mercury ( 88 days) and Earth (365 days), respectively. It works out that $T_{\text {syn }} \approx 116$ days. So the time for Mercury to get from E to W is $133 / 360$ times 116 , or about 43 days. That's
just about the average of the numbers in the table. And then the time for Mercury to go around the back of the Sun (through superior conjunction) to get from W to E is simply 116-43=73 days, a figure which is again consistent with our table.

Just for completeness, here is what figure 1 would look like in a stationary coordinate system. Figure 2 shows Earth moving through 43 days of its orbit, while over the same time period Mercury moves from greatest eastern to greatest western elongation. And Figure 3 shows both planets over the next 73 days, with Mercury moving from W back to $E$.


Figure 2


Figure 3

Now for a quiz Our other inner planet, Venus, has an orbital radius of 0.7 Astronomical Units, and an orbital period of 225 Earth days. How long does it take Venus to go from its greatest eastern elongation to its greatest western elongation, and vice-versa?

And here's a bonus question: Mars has an orbital radius of 1.4 Astronomical Units, and an orbital period of 687 Earth days. One day an astronomer at a Martian observatory sees Earth at its greatest eastern elongation. How many Earth days later will this astronomer see Earth at its greatest western elongation, and how many days after that will Earth return to its next greatest eastern elongation?

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

## Solstice Shadows

by David Prosper

Solstices mark the changing of seasons, occur twice a year, and feature the year's shortest and longest daylight hours-depending on your hemisphere. These extremes in the length of day and night make solstice days more noticeable to many observers than the subtle equality of day and night experienced during equinoxes. Solstices were some of our earliest astronomical observations, celebrated throughout history via many summer and winter celebrations.


These images from NASA's DSCOVR mission shows the Sun-facing side of Earth during the December 2018 solstice (left) and June 2019 solstice (right). Notice how much of each hemisphere is visible in each photo; December's solstice heavily favors the Southern Hemisphere and shows all of South America and much of Antarctica and the South Pole, but only some of North America. June's solstice, in contrast, heavily favors the Northern Hemisphere and shows the North Pole and the entirety of North America, but only some of South America.

Solstices occur twice yearly, and in 2023 they arrive on June 21 at 7:57am PDT, and December 21 at 7:27pm PST. The June solstice marks the moment when the Sun is at its northernmost position in relation to Earth's equator, and the December solstice marks its southernmost position. The summer solstice occurs on the day when the Sun reaches its highest point at solar noon for regions outside of the tropics, and those observers experience the longest amount of daylight for the year. Conversely, during the winter solstice, the Sun is at its lowest point at solar noon for the year and observers outside of the tropics experience the least amount of daylight-and the longest night-of the year. The June solstice marks the beginning of summer for folks in the Northern Hemisphere and winter for Southern Hemisphere folks, and in December the opposite is true, as a result of the tilt of Earth's axis of rotation. For example, this means that the Northern Hemisphere receives more direct light from the Sun than the Southern Hemisphere during the June solstice. Earth's tilt is enough that northern polar regions experience 24-hour sunlight during the June solstice, while southern polar regions experience 24 -hour night, deep in Earth's shadow. That same tilt means that the Earth's polar regions also experience a reversal of light and shadow half a year later in December, with 24 hours of night in the north and 24 hours of daylight in the south. Depending on how close you are to the poles, these extreme lighting conditions can last for many months, their duration deepening the closer you are to the poles.

While solstice days are very noticeable to observers in mid to high latitudes, that's not the case for observers in the tropics-areas of Earth found between the Tropic of Cancer and the Tropic of Capricorn. Instead, individuals experience two "zero shadow" days per year. On these days, with the sun directly overhead at solar noon, objects cast a minimal shadow compared to the rest of the year. If you want to see your own shadow at that moment, you have to jump! The exact date for zero shadow days depends on latitude; observers on the Tropic of Cancer ( $23.5^{\circ}$ north of the equator) experience a zero shadow day on the June solstice, and observers on the Tropic of Capricorn ( $23.5^{\circ}$ south of the equator) get their zero shadow day on December's solstice. Observers on the equator experience two zero shadow days, being exactly in between these two lines of latitude; equatorial zero shadow days fall on the March and September equinoxes.

There is some serious science that can be done by carefully observing solstice shadows. In approximately 200 BC, Eratosthenes is said to have observed sunlight shining straight down the shaft of a well during high noon on the solstice, near the modern-day Egyptian city of Aswan. Inspired, he compared measurements of solstice shadows between that location and measurements taken north, in the city of Alexandria. By calculating the difference in the lengths of these shadows, along with the distance between the two cities, Eratosthenes calculated a rough early estimate for the circumference of Earth—and also provided further evidence that the Earth is a sphere!

Are you having difficulty visualizing solstice lighting and geometry? You can build a "Suntrack" model that helps demonstrate the path the Sun takes through the sky during the seasons; find instructions at https:// stanford.io/3FY4mBm. You can find more fun activities and resources like this model on NASA Wavelength: https://science.nasa.gov/learners/ wavelength. And of course, discover the latest NASA science at https:// www.nasa.gov/.


[^0]Credit \& Source: Juan Velázquez / San Antonio Astronomy Club

# Book Review: Galaxies by Timothy Ferris 

by Ken Yanosko, with a little help from a friend

Before the Webb and Hubble Space Telescopes, before the development of multimegapixel digital detectors, and before the Internet, with its plethora of high resolution space photos, there was Timothy Ferris's book Galaxies. A coffee-table-sized behemoth, measuring 15 by 13 inches by 182 pages, weighing 4.9 pounds, published by Sierra Club Books in 1980 and reprinted by Harrison House in 1987, it was a marvel for its time. It contains 99 photographs, not only of galaxies but also globular clusters, star-forming clouds and clusters, planetary nebulae, and supernova remnants.

I remember seeing this book in bookstores when it first came out (this was before Amazon, too) and i remember being blown away by its grandeur. And it cost more than any book I had previously owned, beating by a factor of two my most expensive graduate school purchase. Getting it was a luxury an assistant professor with two small children could ill afford.

But recently I stumbled across a used copy in excellent condition, at a fraction of its original cost. It adorns my living-room coffee table, and impresses all who enter. And around the same time I also made a new acquaintance who was happy to contribute to this review. All I had to do was ask.

"Galaxies by Timothy Ferris is an awe-inspiring journey through the vast and mysterious universe. Ferris is a well-respected science writer and his expertise is evident in every page of this book.
"Ferris begins by explaining the historical context of how our understanding of galaxies has
evolved over time, from the ancient Greeks to the modern day. He then dives into the science behind galaxies, discussing their formation, structure, and evolution. He delves into fascinating topics such as dark matter, black holes, and the search for extraterrestrial life.
"One of the most remarkable aspects of this book is how Ferris conveys the sheer scale of the universe. Through vivid descriptions and stunning images, he communicates just how vast and incomprehensible the cosmos truly is. At the same time, he also manages to make the science accessible to readers of all levels, avoiding technical jargon and explaining complex concepts in clear, understandable terms.
"Another strength of Galaxies is Ferris' ability to connect the science to our everyday lives. He explores how the study of galaxies has impacted technology and medicine, and how it has influenced our understanding of ourselves and our place in the universe.
"Overall, Galaxies is an engaging and thought-provoking read that will appeal to anyone with an interest in astronomy, science, or the wonders of the universe. Ferris is a gifted writer and his passion for the subject matter shines through on every page. Highly recommended."

— Chat CGI


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# The Euclid spacecraft will transform how we view the 'dark universe' 

by Robert Nichol

The European Space Agency's (ESA) Euclid satellite completed the first part of its long journey into space on May 1 2023, when it arrived in Florida on a boat from Italy. It is scheduled to lift off on a Falcon 9 rocket, built by SpaceX, from Cape Canaveral in early July.

Euclid is designed to provide us with a better understanding of the "mysterious" components of our universe, known as dark matter and dark energy.

Unlike the normal matter we experience here on Earth, dark matter neither reflects nor emits light. It binds galaxies together and is thought


Euclid is set to launch this year on a rocket built by SpaceX. Work performed by ATG under contract for ESA, CC BY-SA
to make up about $80 \%$ of all the mass in the universe. We've known about it for a century, but its true nature remains an enigma.

Dark energy is similarly puzzling. Astronomers have shown that the expansion of the universe over the last five billion years has been accelerating faster than expected. Many believe this acceleration is driven by an unseen force, which has been dubbed dark energy. This makes up about $70 \%$ of the energy in the universe.

Euclid will map this "dark universe", using a suite of scientific instruments to shed light on different aspects of dark energy and dark matter.

## A light in the dark

After launch, Euclid will undertake a month-long journey to a region in space called the second Earth-Sun Lagrangian point, which is five times further from us than the Moon. It's where the gravitational pull of the Sun and the Earth balance out and provides a stable vantage point for Euclid to observe the universe. Euclid will join the James Webb Space Telescope (JWST) at this point and will be the perfect companion to that amazing space observatory.

My involvement in Euclid began in 2007 when I was invited by ESA to participate in an independent concept advisory team to assess two competing mission proposals called SPACE and DUNE.

Both used different techniques, and therefore different instruments, to study the dark universe, and ESA was struggling to decide between them. Both were compelling concepts and our team decided that both had merit, especially to provide a vital cross-check between them. Euclid was thus born from the best of both concepts.

Euclid is designed to study the whole universe so needs instruments with wide fields of view. The wider the field of view of the imaging instrument, the more of the universe it can observe. To do this, Euclid uses a relatively small telescope compared to JWST. In size, Euclid is roughly the size of a truck compared to the aircraft-sized JWST. But Euclid also carries some of the biggest digital cameras deployed in space with fields of view hundreds of times greater than JWST's.

## Shapes and colours

The Euclid VIS (or visible) instrument, built mostly in the UK, is designed to measure the positions and shapes of as many galaxies as possible to look for subtle correlations in this data caused by the gravitational lensing of the light, as it travels to us through the intervening dark matter. This gravitational lensing effect is weak, only one part in a hundred thousand for most galaxies, thus requiring lots of galaxies to see the effect in high definition. Thus VIS will produce Hubble telescope-like image quality over a third of the night sky.

VIS, however, can't measure the colours of objects. This is needed to measure their distance through the redshift effect, where light from those objects is shifted to longer, or redder, wavelengths in a way that relates to their distance from us. Some of this data will need to come from existing and planned ground-based observatories, but Euclid also carries the NISP (Near-Infra Spectrometer and Photometer) instrument which is specifically designed to measure the infrared colours and spectra, and therefore redshifts, for the most distant galaxies that Euclid will see.

To measure dark energy, NISP will exploit a relative new technique called Baryon Acoustic Oscillations (BAO) that provides an accurate measurement of the expansion history of the universe over its last 10 billion years. That history is vital for testing possible models of dark energy including suggested modifications to Einstein's Theory of General Relativity.

## Treasure trove

Such an experiment takes an army of scientists and not everyone is solely working on dark matter and dark energy. Like JWST, Euclid will be a treasure-trove of new discoveries in many areas of astronomy. The Euclid consortium needs hundreds of people to help develop the sophisticated software needed to merge the space data with the ground-based data, and extract, to high accuracy, the shapes and colours of billions of galaxies.

This software has also been checked and verified using some of the largest simulations of the universe that have ever been constructed. After arriving at L2, Euclid will undergo several months of testing, valida-


Euclid will gather information on the shapes and other properties of galaxies in the sky. NASA, ESA, S. Beckwith (STScI), and The Hubble Heritage Team (STScI/AURA), CC
tion and calibration to ensure the instruments and telescope are working as expected. We are all familiar with such nervous waiting after the recent JWST launch.

Once ready, Euclid will embark on a five-year survey of 15,000 square degrees of the sky with about 2,000 scientists from across the world collecting results along the way. However, the true power of Euclid will only be realised once we have all this data together and analysed carefully. That could take another five years, taking us well into next decade before we have our final dark answers. The SpaceX launch therefore only feels like the half-way point in the Euclid story.

I will travel to Florida this summer to see the launch of Euclid. I will be joined by hundreds of my colleagues who have dedicated their careers to building this amazing telescope and experiment. Seeing the project come together in this way makes me proud to call myself a "Euclidian".

[^1]
## The Cowherd and the Weaver Girl retold by Ken Yanosko

This is a love story．It is a story that has been told throughout eastern Asia，in many cultures and languages，for over 2000 years．The characters have different names，and some of the details are different．But the basic story is the same．It goes like this．

Long ago，there was a simple cowherd．Abandoned by his family， he lived alone，with one old cow．His name was Niulang．（At least that＇s what he＇s called in China－elsewhere he may be Hikoboshi or Gyeonwu or something similar；see the table below．）

Meanwhile，in a heavenly kingdom，far far away，a young lady， Zhinü，the daughter of the Jade Emperor and Empress，was growing up．She excelled in weaving．It is said that she was so skilled she could spin the clouds into fine threads and use them to weave the most elegant garments．But after a time，she became bored，and got permission from her parents to visit Earth for a holiday，along with some of her friends．

Back on Earth，Niulang＇s old cow，who happened to have magical powers，and who had noticed Niulang＇s loneliness，spoke to him，telling him that some young ladies were nearby，and urged him to go forward and say hello．Although Niulang was very shy，the cow was insistent；and so Niulang went to where the girls were frolicking．At his approach，all the girls except Zhinü fled．She stayed and entered into a conversation with Niulang；and of course they fell in love，married，and had two children．Zhinü was able to adapt her weaving skills to the making of earthly garments，and the family lived comfortably and happily．

However，after a time，Zhinü＇s parents finally noticed that she

| Location | Festival，or story | Cowherd | Weaver Girl |
| :--- | :--- | :--- | :--- |
| China | Qixi 七タ | Niulang 牛郎 | Zhinü 織女 |
| Japan | Tanabata たなばた | Hikoboshi ひこぼし | Orihime おりひめ |
| Korea | Chilseok 칠석 | Gyeonwu 견우 | Jiknyeo 직녀 |
| Vietnam | Thất Tịch | Ngưu Lang | Chức Nũ̃ |



Google Doodle for August 28， 2017
hadn＇t returned from her trip．（I＇ve wondered about the timing in this part of the story．They didn＇t miss her until after she had time to have two kids？But I＇ve been told that there＇s a simple explanation－it＇s a matter of relativity－time passes differently in the Jade Kingdom than it does here on Earth．）Anyway，when they became aware of the fact that Zhinü had bestowed her affections on a mere cowherd，the parents were upset，to say the least．So the Emperor sent some soldiers to go and grab Zhinü and forcibly return her to Heaven．

Niulang and the children were heartbroken．But the old cow came to Niulang and said that she was nearing the end of her life，and when she passed Niulang should fashion a cloak out of her hide，and the magic cloak would enable him（and the children）to fly up to heaven and be reunited with Zhinü．And so this came to pass．

But alas，the Empress was angered that Zhinü and Niulang had gotten back together，so she took out a hairpin and ripped a huge gash in the sky，which became a torrential river separating the two．The cries of sorrow of the lovers were heard throughout the universe，until the magpies came and used their bodies to build a bridge across the river， allowing Zhinü and Niulang to reunite．The Emperor was so moved by this that he decreed that once a year，on the seventh day of the seventh month，the magpies would be allowed to reconstruct their bridge，and Zhinü and Niulang would be allowed to be together．（If you think that once a year is a pretty harsh deal，just remember the principle of relativity that I mentioned earlier．）


The Great Rift in the Milky Way, with Vega (Zhinü) above and Altair (Niulang) below. NASA, http://www.nasa.gov/topics/earth/features/2012-alignment.html, Public Domain.

Okay, that's a cute story. But isn't this an Astronomy Newsletter? What does this have to do with astronomy? Well, I was just getting to that.

Every year on the seventh day of the seventh month, the people of eastern Asia celebrate the Festival of Qixi ("The Double Seventh Festival"). In our western calendar that day varies from year to year; this year it will fall on August 22.

You too can join in. After nightfall, look up in the sky. You will see Vega (Zhinü) and Altair (Niulang) separated by a river of stars. But if you look really hard, you will also see the dark nebula that we call the "Great Rift" of the Milky Way. That's the magpies, getting together to form their bridge.

And if you somehow missed Valentine's Day this year, you get a
second chance. In modern times Qixi has been referred to as "Chinese Valentine's Day." It's a time for sweethearts to enjoy each other's company, and to exchange flowers and cakes and candies.

And of course it's a time to appreciate the stars and nebulae. Enjoy!

## Beehive continued from page 4

About 10 days later (June 12-13), Venus also "buzzed" the Beehive Cluster. Unlike Mars, which seemed to enter the cluster, Venus took a path that was about one degree above it.


This image was taken on a very clear evening at Kneeland Airport by Donald Wheeler using a Pentax K-3, 60 mm lens, ISO 1600, 5 s exposure. Additional processing was done in Photoshop.

The answers are 148, 439, 193, and 586. Here are the calculations:

In Figure 1 on page 7 let the circle represent the orbit of Venus. Then

$$
\alpha=\cos ^{-1}(0.7) \approx 45.5 \text { degrees }
$$

so $2 \alpha \approx 91$ degrees. The synodic period of Venus is

$$
T_{\text {syn }}=1 /(1 / 225-1 / 365) \approx 587 \text { Earth days. }
$$

So it takes Venus $91 / 360$ times 587 , or about 148 days to go from E to W. And then it's 587-148 = 439 days to get from W back to E.

Now suppose the circle is Earth's orbit and the blue dot is Mars. Then the line from the Sun to the point at E is 1 AU and the hypotenuse of the right triangle containing angle $\alpha$ is 1.4 AU . So

$$
\alpha=\cos ^{-1}(1 / 1.4) \approx 44.5 \text { degrees }
$$

and $2 \alpha \approx 89$ degrees. The synodic period of Earth relative to Mars is

$$
T_{\text {syn }}=1 /(1 / 365-1 / 687) \approx 779 \text { Earth days. }
$$

So it takes Earth 89/360 times 779, or about 193 days to go from E to W, and 779-193 $=586$ additional days to get back to E.

## After Words

"We should do astronomy because it is beautiful and because it is fun. We should do it because people want to know. We want to know our place in the universe and how things happen."

> —John N. Bahcall
> Sky \& Telescope (January 1990)
"The most remarkable discovery in all of astronomy is that the stars are made of atoms of the same kind as those on the earth."
-Richard P. Feynman
The Feynman Lectures on Physics (1964-1966)
"Astronomy is one of the sublimest fields of human investigation. The mind that grasps its facts and principles receives something of the enlargement and grandeur belonging to the science itself. It is a quickener of devotion."

- Horace Mann

Thoughts Selected from the Writings of Horace Mann (1872)


BAD NEWS FOR EXOPLANETS: IT TURNS OUT THOSE DIFFRACTION SPIKES ARE REAL.

[^2]
[^0]:    A presenter from the San Antonio Astronomy Club in Puerto Rico demonstrating some Earth-Sun geometry to a group during a "Zero Shadow Day" event. As Puerto Rico lies a few degrees south of the Tropic of Cancer, their two zero shadow days arrive just a few weeks before and after the June solstice. Globes are a handy and practical way to help visualize solstices and equinoxes for large outdoor groups, especially outdoors during sunny days!

[^1]:    Robert Nichol is Pro Vice-Chancellor and Executive Dean, University of Surrey

[^2]:    Randall Munroe, xkcd https://xkcd.com/2762/ Creative Commons

