AOH Newsletter

Winter 2021

News and Notes

Meetings

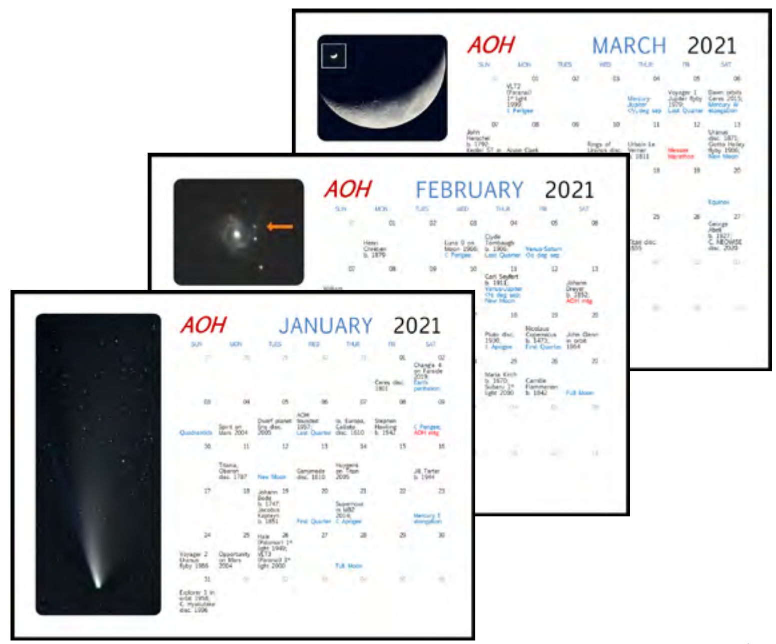
AOH has continued to hold its monthly meetings on Zoom. The November meeting was also the Annual Business Meeting. Elections were held for Board Members and Officers. Elected to the Board for 2021 were: Bernie Christen, Dan Eaton, Brent Howatt, Catrina Howatt, Mark Mueller, Grace Wheeler, Mark Wilson, Ken Yanosko, and Bob Zigler. These are all currently serving on the 2020 Board. Two other current Board members, Bea Asmundardottir and Becky Chambers, had asked to be left off the ballot because of other pressing obligations. The new Board then convened and elected Brent President, Mark W. Vice-President, Ken Secretary, and Catrina and Bob co-Treasurers. Complete minutes are at https://www.astrohum.org/members_only/minutes.php.

Dues by Mail or Online

The AOH membership year runs from January to December. This means that 2021 dues are now due. For your convenience, we now have the ability to pay dues online. Go to the membership page https://www.astrohum.org/membership.html and fill out the form. Then select one of the two options at the bottom of the page—either print the form to be mailed in with a check, or get transferred to a secure site where you can pay by Paypal, debit card, or credit card.

Calendar

The new 2021 AOH Calendar is now available for download by dues-paying AOH members from https://www.astrohum.org/members_only/calendar.php.



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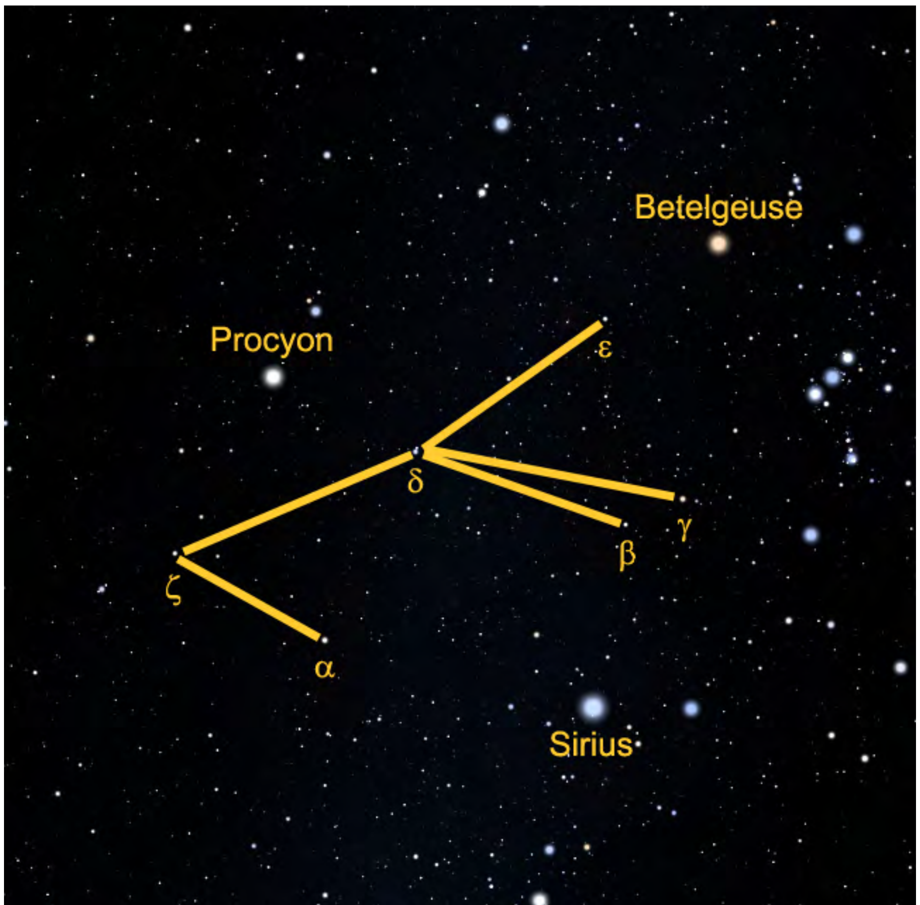
The Unicorn
by Ken Yanosko

"There's a unicorn in the sky!"
"Really, where?"
"Right in the middle of the Winter Triangle."
"There's a Winter Triangle?"

* * *

Look south on a winter's evening. Betelgeuse, Sirius, and Procyon, the Alpha stars of Orion, Canis Major, and Canis Minor, form a nearly perfect equilateral triangle, commonly called the "Winter Triangle." (This triangle is part of a larger asterism called the "Winter Hexagon.") And right in the middle of the triangle are the head and forelegs of Monoceros, the Unicorn. ("Mono" means "One" and "Ceros" means "Horn" in Greek.)



Background: [Stellarium](). Foreground: KY.

Now you'd think that a mythical being with a Greek name would have its origin in some ancient fairy tale; perhaps it's the pet of some heavenly Queen or Princess. But no. Monoceros first appeared on a celestial globe produced by the Flemish cartographer Pieter Platevoet (a.k.a. Petrus Plancius) in 1613. Plancius was into unicorns. On a world map that he published in 1594, he decorated the margins with exotic animals—elephants, a giraffe, a camel—supposedly to educate his European audience about the diversity of life in the far corners of the globe. Of course, he included a unicorn. The International Astronomical Union adopted Monoceros as one of the "official" 88 constellations in 1928, thereby filling in the empty space between Orion and his dogs.

Monoceros is pretty dim. It has six stars with Bayer designations: Alpha through Zeta Monocerotis. All six are right around visual magnitude 4. A stick figure drawn using these stars suggests a horse-like animal; but since the sky already has two other horses (Equuleus and Pegasus), Plancius imagined a horn on this horse to make it different. A line of a few dim stars above Epsilon might serve as the horn, but they seem to me to go in the wrong direction. All the unicorns I've ever seen have their horns projecting forward out of the forehead, not upward from the top of the head. But imaginary beasts can have imaginary horns, I guess. Hover over the eye icon below the picture at the left to augment your imagination.

Rosette Nebula: [Slooh]() photo courtesy of Grace Wheeler

Deep-sky aficionados can find a few interesting sights in Monoceros. The Rosette Nebula, NGC 2237-8-9, is just two degrees east of Epsilon. The radiation pressure of a cluster of hot young stars sculpts and lights up the glowing gas of the rosette.

The Christmas Tree Cluster and the Cone Nebula, parts of another star-forming region, are 5 degrees NNE of the Rosette. This is another star-forming region with glowing gas; but here a dust cloud, which has been blown into an elongated shape which looks like a cone from our point of view, blocks the light from the glowing gas behind it.

Christmas Tree Cluster and Cone Nebula. This image has south up, so that the tree, which has its top at the cone and its trunk marked by the bright star at the bottom, appears right-side-up. If you're having trouble making out the tree, click here. Photo from Wikimedia.

And an open cluster lying half-way between Alpha and Beta carries the Messier designation M50. It stands out against a star-studded region of background stars in the Milky Way.

For all three of these objects, the associated star clusters are easily visible in medium-sized binoculars or small telescopes. For the Rosette and Cone, you'll need a pretty big light bucket and maybe even a time exposure and/or stacking software to see the nebulosity.

Open Cluster M50: Slooh.

So the next time you get a dark enough sky, look for the unicorn. And if you see it, be sure to make a wish!

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!

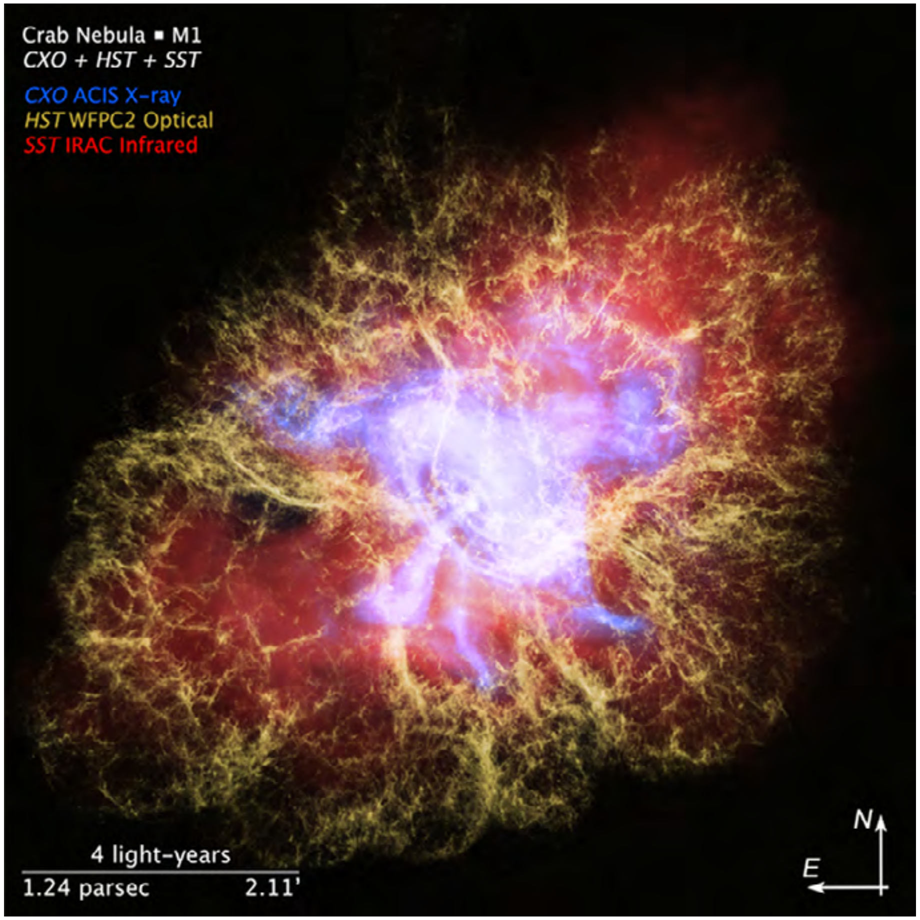
Betelgeuse and the Crab Nebula: Stellar Death and Rebirth

by David Prosper

What happens when a star dies? Stargazers are paying close attention to the red giant star Betelgeuse since it recently dimmed in brightness, causing speculation that it may soon end in a brilliant supernova. While it likely won't explode quite yet, we can preview its fate by observing the nearby Crab Nebula.

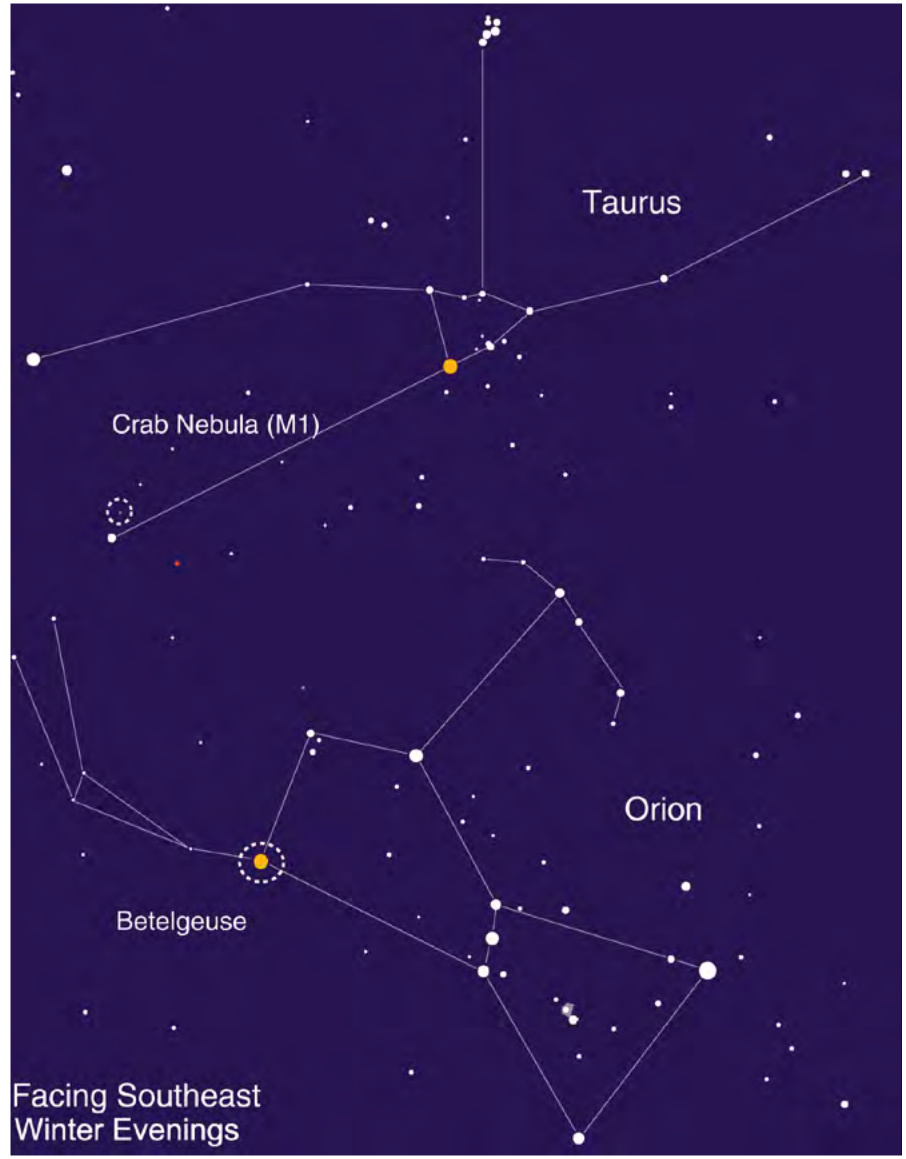
Betelgeuse, despite its recent dimming, is still easy to find as the red-hued shoulder star of Orion. A known variable star, Betelgeuse usually competes for the position of the brightest star in Orion with brilliant blue-white Rigel, but recently its brightness has faded to below that of nearby Aldebaran, in Taurus. Betelgeuse is a young star, estimated to be a few million years old, but due to its giant size it leads a fast and furious life. This massive star, known as a supergiant, exhausted the hydrogen fuel in its core and began to fuse helium instead, which caused the outer layers of the star to cool and swell dramatically in size. Betelgeuse is one of the only stars for which we have any kind of detailed surface observations due to its huge size—somewhere between the diameter of the orbits of Mars and Jupiter—and relatively close distance of about 642 light-years. Betelgeuse is also a "runaway star," with its remarkable speed possibly triggered by merging with a smaller companion star. If that is the case, Betelgeuse may actually have millions of years left! So, Betelgeuse may not explode soon after all; or it might explode tomorrow! We have much more to learn about this intriguing star.

The Crab Nebula (M1) is relatively close to Betelgeuse in the sky, in the nearby constellation of Taurus. Its ghostly, spidery gas clouds result from a massive explosion; a supernova observed by astronomers in 1054! A backyard telescope allows you to see some details, but only



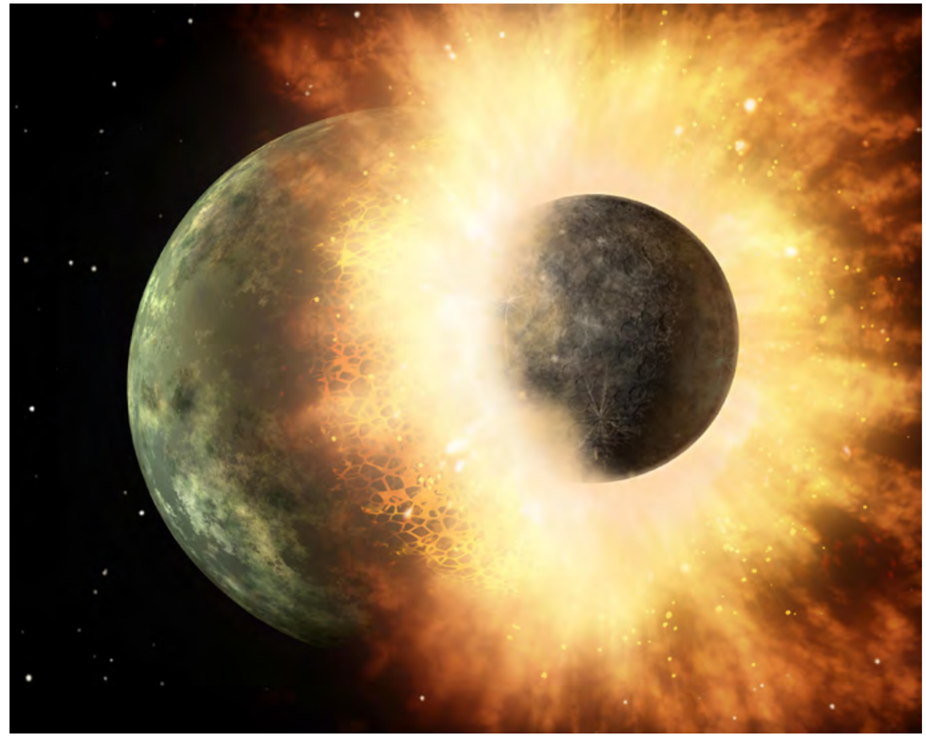
This image of the Crab Nebula combines X-ray observations from Chandra, optical observations from Hubble, and infrared observations from Spitzer to reveal intricate detail. Notice how the violent energy radiates out from the rapidly spinning neutron star in the center of the nebula (also known as a pulsar) and heats up the surrounding gas. More about this incredible "pulsar wind nebula" can be found at bit.ly/Crab3D.
Credit: NASA, ESA, F. Summers, J. Olmsted, L. Hustak, J. DePasquale and G. Bacon (STScI), N. Wolk (CfA), and R. Hurt (Caltech/IPAC)

advanced telescopes reveal the rapidly spinning neutron star found in its center: the last stellar remnant from that cataclysmic event. These gas clouds were created during the giant star's violent demise and expand ever outward to enrich the universe with heavy elements like silicon, iron, and nickel. These element-rich clouds are like a cosmic fertilizer, making rocky planets like our own Earth possible. Supernovae also send out powerful shock waves that help trigger star formation. In fact, if it wasn't for a long-ago supernova, our solar system—along with all of us—wouldn't exist! You can learn much more about the Crab Nebula and its neutron star in a new video from NASA's Universe of Learning, created from observations by the Great Observatories of Hubble, Chandra, and Spitzer: bit.ly/CrabNebulaVisual .



How the moon formed – new research

by Christian Schroeder



How the Earth got its moon is a long debated question. The giant impact theory – which states that the Moon formed from a collision between the early Earth and a rocky body called Theia – has become the front runner among the explanations. But the details around how this happened are blurry and there are many observations that scientists are still struggling to explain.

Now a new study, published in Nature Geoscience, has shed light on what actually happened by solving one of the biggest mysteries surrounding the crash – why the Moon ended up being nearly identical to Earth, rather than Theia, assuming she existed.

According to the giant impact theory, Theia was a body roughly the size of Mars or smaller – half the diameter of Earth. It smashed into the developing Earth 4.5 billion years ago. This collision produced enough heat to create magma oceans and ejected a lot of debris into orbit around the Earth, which subsequently coalesced into the Moon.

The theory explains the way and the speed which the Earth and Moon spin around each other. They are tidally locked, which means that the Moon always shows the same side towards Earth as it spins around it. This is why it was such an achievement when the Chinese landed their Chang'e 4 spacecraft on the far side of the Moon in 2019 – direct communications with that side are never possible from Earth.

The Moon and the Earth are nearly identical in composition. The differences are that the Moon has less iron and less of the lighter elements such a hydrogen, which are needed to produce water. The giant impact theory explains why. The heavy element iron would have been retained on Earth. And the heat produced during the impact and the ejection into space would have boiled the lighter elements off while the rest of the material of Earth and Theia would have mixed.

Computer models have reproduced the events that led to the formation of the Moon. The models that best fit all of the observations suggest that the Moon should be composed by approximately 80% from the material originating from Theia. So why is the Moon instead suspiciously similar to Earth?

One explanation is that Theia and the early Earth must have had an identical composition to start with. That seems unlikely because every documented planetary body in our solar system has their own unique composition, with slight differences reflecting the distance from the sun where a body formed.

Another explanation is that the mixing of the two bodies was much more thorough than anticipated, leaving a less clear signature of Theia in the Moon. But that is also unlikely, as it would require a much larger impact than the one that actually took place.

The new study resolves this dilemma by showing that the Earth and the Moon aren't as similar as previously thought. The researchers looked with very high precision at the distribution of isotopes of the element oxygen in rocks returned from the Moon by the Apollo astronauts. In chemistry, any element's atomic nucleus is made up of particles known as protons and neutrons; isotopes of an element have the same number of protons in the nucleus as the regular version, but different numbers of neutrons. In this case, oxygen's isotope, O-18, which has eight protons and ten neutrons, is slightly heavier than the much more common than O-16, with its eight protons and eight neutrons.

The study shows that there is a small difference between the Earth and the Moon in their oxygen isotope composition – their profiles aren't identical after all. What is more, the difference increases when you look at rocks from the Moon's mantle, which is a layer below the surface or crust – having more lighter oxygen isotopes than the Earth. This is important. The crust is where mixed debris would have ended up, whereas the deep interior would have more bits of Theia.

So Theia and Earth weren't identical, and the Moon and the Earth aren't identical either. But the results also teach us a bit more about Theia itself.

Because of gravity, one may expect slightly more of the heavier isotopes closer to the Sun. Compared to Earth, Theia must have had more of the lighter oxygen isotopes, which suggests that it would have formed further away from the Sun than the Earth.

With the results from this study the giant impact theory has crossed another hurdle in explaining the formation of our Moon, and we have learned a little more about Theia itself on the way.

Christian Schroeder is a Senior Lecturer in Environmental Science and Planetary Exploration at the University of Stirling in Scotland.

There's a nice video of a simulation of two planettary bodies colliding at https://youtu.be/mQAdYWcA7ig .

2020 Nobel Prize in physics awarded for work on black holes – an astrophysicist explains the trailblazing discoveries

by Gaurav Khanna

Black holes are perhaps the most mysterious objects in nature. They warp space and time in extreme ways and contain a mathematical impossibility, a singularity – an infinitely hot and dense object within. But if black holes exist and are truly black, how exactly would we ever be able to make an observation?

On October 6, 2020 the Nobel Committee announced that the 2020 Nobel Prize in physics will be awarded to three scientists – Sir

Roger Penrose, Reinhard Genzel, and Andrea Ghez – who helped discover the answers to such profound questions. Andrea Ghez is only the fourth woman to win the Nobel Prize in physics.

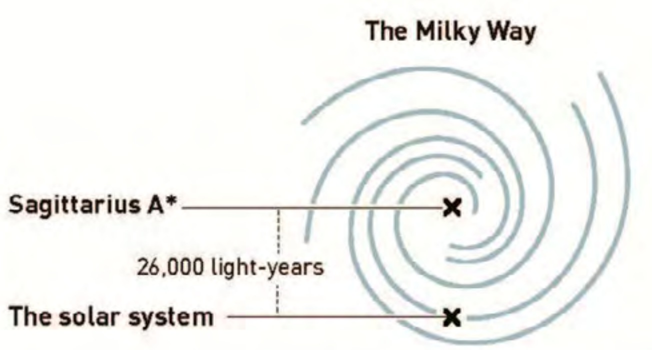
Roger Penrose is a theoretical physicist who works on black holes, and his work has influenced not just me but my entire generation through his series of popular books that are loaded with his exquisite hand-drawn illustrations of deep physical concepts.

As a graduate student in the 1990s at Penn State, where Penrose holds a visiting position, I had many opportunities to interact with him. For many years I was intimidated by this giant in my field, only stealing glimpses of him working in his office, sketching strange-looking scientific drawings on his blackboard. Later, when I finally got the courage to speak with him, I quickly realized that he is among the most approachable people around.

Dying stars form black holes

Sir Roger Penrose won half the prize for his seminal work in 1965 which proved, using a series of mathematical arguments, that under very general conditions, collapsing matter would trigger the formation of a black hole.

This rigorous result opened up the possibility that the astrophysical process of gravitational collapse, which occurs when a star runs out of its nuclear fuel, would lead to the formation of black holes in nature. He was also able to show that at the heart of a black hole must lie a physical singularity – an object with infinite density, where the laws of physics simply break down. At the singularity, our very conceptions of space, time and matter fall apart and resolving this issue is perhaps the biggest open problem in theoretical physics today.



The Milky Way, our galaxy, seen from above. It is shaped like a flat disc about 100,000 light-years across. Its spiral arms are made of gas and dust and a few hundred billion stars. One of these stars is our Sun.

©Johan Jarnestad/The Royal Swedish Academy of Sciences

Penrose invented new mathematical concepts and techniques while developing this proof. Those equations that Penrose derived in 1965 have been used by physicists studying black holes ever since. In fact, just a few years later, Stephen Hawking, alongside Penrose, used the same mathematical tools to prove that the Big Bang cosmological model – our current best model for how the entire universe came into existence – had a singularity at the very initial moment. These are results from the celebrated Penrose-Hawking Singularity Theorem.

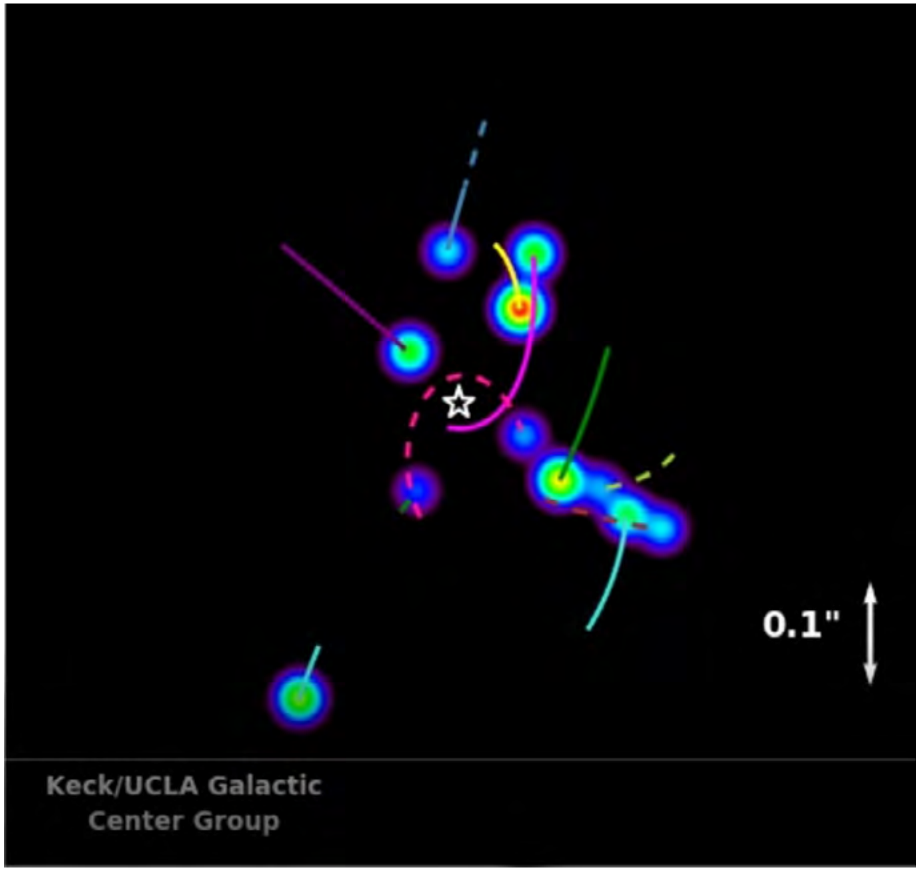
Andrea Ghez

The fact that mathematics demonstrated that astrophysical black holes may exactly exist in nature is exactly what has energized the quest to search for them using astronomical techniques. Indeed, since Penrose's work in the 1960s, numerous black holes have been identified.

Black holes play yo-yo with stars

The remaining half of the prize was shared between astronomers Reinhard Genzel and Andrea Ghez, who each lead a team that discovered the presence of a supermassive black hole, 4 million times more massive than the Sun, at the center of our Milky Way galaxy.

Genzel is an astrophysicist at the Max Planck Institute for Extraterrestrial Physics, Germany and the University of California, Berkeley. Ghez is an astronomer at the University of California, Los Angeles. Genzhel and Ghez used the world's largest telescopes (Keck Observatory and the Very Large Telescope) and studied the movement of stars in a region called Sagittarius A* at the center of our galaxy. They



Movement of stars around Sagittarius A. For an animation go to https://youtu.be/tMax0KgyZZU.*

both independently discovered that an extremely massive – 4 million times more massive than our Sun – invisible object is pulling on these stars, making them move in very unusual ways. This is considered the most convincing evidence of a black hole at the center of our galaxy.

This 2020 Nobel Prize, which follows on the heels of the 2017 Nobel Prize for the discovery of gravitational waves from black holes, and other recent stunning discoveries in the field – such as the the 2019 image of a black hole horizon by the Event Horizon Telescope – serve as great recognition and inspiration for all humankind, especially for those of us in the relativity and gravitation community who follow in the footsteps of Albert Einstein himself.

Gaurav Khanna is a Professor of Physics at UMass Dartmouth.

Parker Solar Probe: Humanity's First Visit to a Star

National Aeronautics and Space Administration

NASA's historic Parker Solar Probe mission is revolutionizing our understanding of the Sun, where changing conditions can propagate out into the solar system, affecting Earth and other worlds. Parker Solar Probe travels through the Sun's atmosphere, closer to the surface than any spacecraft before it, facing brutal heat and radiation conditions to provide humanity with the closest-ever observations of a star.

Journey to the Sun

In order to unlock the mysteries of the Sun's atmosphere, Parker Solar Probe uses Venus' gravity during seven flybys over nearly seven years to gradually bring its orbit closer to the Sun. The spacecraft will fly through the Sun's atmosphere as close as 3.8 million miles to our star's surface, well within the orbit of Mercury and more than seven times closer than any spacecraft has come before. (Earth's average distance to the Sun is 93 million miles.)

Flying into the outermost part of the Sun's atmosphere, known as the corona, for the first time, Parker Solar Probe employs a combination of in situ measurements and imaging to revolutionize our understanding of the corona and expand our knowledge of the origin and evolution of the solar wind. It also makes critical contributions to our ability to forecast changes in Earth's space environment that affect life and technology on Earth.

Extreme Exploration

Parker Solar Probe performs its scientific investigations in a hazardous region of intense heat and solar radiation. The spacecraft will fly close enough to the Sun to watch the solar wind speed up from subsonic to supersonic, and it will fly though the birthplace of the highest-energy solar particles.

To perform these unprecedented investigations, the spacecraft and instruments are protected from the Sun's heat by a 4.5-inch-thick (11.43 cm) carbon-composite shield, which needs to withstand temperatures outside the spacecraft that reach nearly 2,500 F (1,377 C).

The Science of the Sun

The primary science goals for the mission are to trace how energy and heat move through the solar corona and to explore what accelerates the solar wind as well as solar energetic particles. Scientists have sought these answers for more than 60 years, but the investigation requires sending a probe right through the 2,500 degrees Fahrenheit heat of the corona. Today, this is finally possible with cutting-edge thermal engineering advances that protect the mission on its dangerous journey. Parker Solar Probe carries four instrument suites designed to study magnetic fields, plasma and energetic particles, and image the solar wind.

Teaming for Success

Parker Solar Probe is part of NASA's Living With a Star program to explore aspects of the Sun-Earth system that directly affect life and society. The Living With a Star flight program is managed by the agency's Goddard Space Flight Center in Greenbelt, Maryland, for NASA's Science Mission Directorate in Washington. The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, manages the mission for NASA. APL is designed, built, and operates the spacecraft.

Why do we study the Sun and the solar wind?

To perform these unprecedented investigations, the spacecraft and instruments are protected from the Sun's heat by a 4.5-inch-thick (11.43 cm) carbon-composite shield, which needs to withstand The Sun is the only star we can study up close. By studying this star we live with, we learn more about stars throughout the universe.

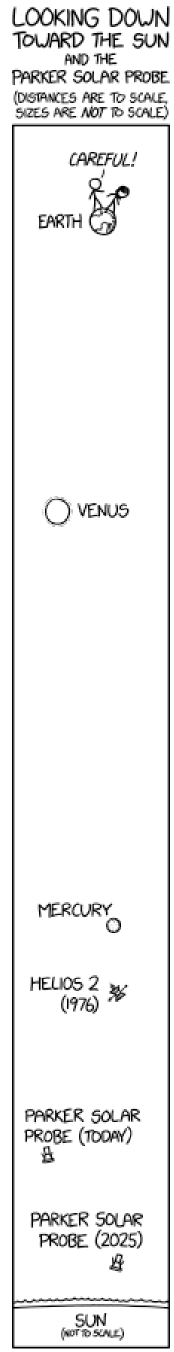
- The Sun is a source of light and heat for life on Earth. The more we know about it, the more we can understand how life on Earth developed.
- The Sun also affects Earth in less familiar ways. It is the source of the solar wind; a flow of ionized gases from the Sun that streams past Earth at speeds of more than 500 km per second (a million miles per hour).
- Disturbances in the solar wind shake Earth's magnetic field and pump energy into the radiation belts, part of a set of changes in near-Earth space known as space weather.
- Space weather can change the orbits of satellites, shorten their lifetimes, or interfere with onboard electronics. The more we learn about what causes space weather – and how to predict it – the more we can protect the satellites we depend on.
- The solar wind also fills up much of the solar system, dominating the space environment far past Earth. As we send spacecraft and astronauts further and further from home, we must understand this space environment just as early seafarers needed to understand the ocean.

Launch: Aug. 12, 2018
Launch Site: Cape Canaveral Air Force Station, Florida
Launch Vehicle: Delta IV-Heavy with Upper Stage

At closest approach, Parker Solar Probe hurtles around the Sun at approximately 430,000 mph (700,000 kph). That's fast enough to get from Philadelphia to Washington, D.C., in one second.

At closest approach to the Sun, the front of Parker Solar Probe's solar shield faces temperatures approaching 2,500 F (1,377 C). The spacecraft's payload will be near room temperature.

On the final three orbits, Parker Solar Probe flies to within 3.8 million miles of the Sun's surface — more than seven times closer than the current record-holder for a close solar pass, the Helios 2 spacecraft, which came within 27 million miles in 1976, and about a tenth as close as Mercury, which is, on average, about 36 million miles from the Sun.



https://xkcd.com/2262/ *Creative Commons*

https://www.nasa.gov/content/goddard/parker-solar-probe-humanity-s-first-visit-to-a-star
NASA Page Editor: Rob Garner
NASA Official: Brian Dunbar

International Observe the Moon Night

On September 26, 2020, and for a week thereafter, people around the world participated in International Observe the Moon Night. AOH sponsored an activity where individuals observed, sketched, or photographed the Moon and submitted a report. We had participants from three states and four countries. Next year's event will he on October 16, 2021; stay tuned.

Participants: Humboldt County: Mark Wilson, Kevin Kellogg, Grace Wheeler, Brent Howatt, Ken Yanosko, Susan Frances, Rick Gustafson; Morro Bay, California: Susie Christian; Washington: James and Riley Aldrich; Virginia: Jim Williams; Panama: Alberto and Arlette Moreno; Scotland: Caitlin Castelvecchi; India: Arpit Jha, Shlok Shah, Upasana Budakoti, Anshpreet Kaur, Aryan Singh, Anureet Dhaliwal, Yash Shroff.

The Golden Handle

Once every lunation, about four days before the moon is full, the peaks of the Jura Mountains are bathed in sunlight, while the Bay of Rainbows below is still in darkness. The effect, as seen from Earth, gives the appearance of a handle affixed to the lighted area of the Moon. See the details in the Winter, 2020 Newsletter. Here is a list of dates and times in 2021 when the Golden Handle is visible from Humboldt County.

Golden Handle Apparitions for 2021

date	time of appearance	time of disappearance
Sat Jan 23	13:10 *	20:30
Mon Feb 22	01:30	04:00 **
Tue Mar 23	16:00	02:00
Thu Apr 22	03:45	04:20 **
Fri May 21	15:10 *	00:00
Sat Jun 19	20:45	02:40 **
Mon Jul 19	16:30 *	19:30
Tue Aug 17	20:30	01:50 **
Fri Oct 15	21:15	03:10 **
Sun Nov 14	15:10 *	21:15
Tue Dec 14	03:00	03:15 **
	* at moonrise	** at moonset

The Jura Mountains at sunrise, March 4, 2020. Grace Wheeler.

Virtual Meetings

For the foreseeable future, AOH will continue to invite individuals to observe on their own on the Saturdays nearest the new moon. These next few Saturdays will be December 12, January 16, February 13, and March 13 (Messier weekend). We will also continue to get together on Zoom on the Saturdays nearest the full moon. These are December 26, January 30, February 27, and March 27. AOH members should look for the Zoom invitations in their email a few days before these scheduled sessions. Stay safe, everyone, and Happy 2021!

Thanks

To Grace, Susie, and Susan, for contributing and proofreading.

Ken *ken@astrohum.org*

Heavenly Bodies
by Susie Christian