"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

MARCH 2018

Monthly meeting

This month's meeting will place on **Monday 19 March** at the **Catholic Church Hall** starting at **19.00**. Dr Pieter Kotzé from SANSA will be talking on 'The Earth's magnetic field and possible changes'. See below for more details.

Membership renewal for 2018 – final reminder

The fees for 2018 are unchanged. They are as follows:

Member: R150

Member's spouse/partner/child, student: R75

Six-month membership from July – December 2017:

Member: R75 Member's spouse etc, student: R40

Payment can be made in cash (at meetings directly to the Treasurer), or via online transfer. The Standard Bank details, for the latter, are as follows:

Account name – Hermanus Astronomy Centre

Account number – 185 562 531

Branch code – 051001

If you make an online donation, please reference your name and 'subs' or 'membership', or it is not possible to attribute the payment to you.

WHAT'S UP?

The hunted hare, Lepus, can be found at the feet of upside down Orion. Although small and insignificant when compared with nearby Orion and Canis Major, it is an important part of the Greek hunter's story as the hare being chased by the dog Canis. Its roughly H-shape could be seen, with some imagination, to form a body with two ears sticking up from it in a rabbit-like manner. Its brightest star, Alpha Leporis, is named Arneb, the Arabic word for 'hare'. Despite being 51st in size of the 88 named constellations, Lepus contains a number of interesting features visible to those with telescopes. These include a small globular cluster (M79), an apparent open cluster (NGC 2017) which is not a cluster, but whose stars just happen to be in the same field of view, an intensely red variable star (R Leporis aka Hind's Crimson Star), and a couple of binaries (Gamma and Kappa Leporis). Orion's belt lies almost along the celestial equator, making it visible from all but the far north and far south of the planet. Thus, Lepus is also visible to many, but its position in relation to Orion makes it visible to only around 32°N while it is almost visible from the south pole.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The AGM took place on 19 February. The chairman's report summarised another busy year, which included several 'non-regular' events including eclipse and star gazing, a school visit to Cape Town, a Centre visit to SKA and celebration of the Centre's first decade. It also covered 'regular' events, including monthly meetings on a range of topics, continued monthly meetings of the interest groups, educational outreach to both learners and the general public, and communication via the newsletter, sky maps, website and social media. Founder members, John Saunders, is retiring from the committee. Pierre de Villiers thanked him for the huge contribution he has made to the establishment and ongoing success of the Centre, and sought volunteers to take on John's portfolios and that of membership secretary. The Treasurer then outlined the 2017 finances, confirming that the Centre's finances are healthy.

Following the meeting, two short videos were presented. The first, titled 'fantastic trip' used the powers of 10 to illustrate the scale of both the increasingly very big and increasingly very small. As the powers increased, it was clear how Earth, the solar system, the Milky Way etc became increasingly insignificant as the massive scale of the Universe was revealed. Negative values then illustrated how matter becomes increasingly small, moving from leaf to cell, to genes, to atoms and to elementary particles in the quantum world. The other video was of Eric Idle's 'Universe song', whose visual illustrated the numerically accurate values which the lyrics included on where Earth fits into our galaxy and the larger Universe.

Interest groups

Cosmology Those who attended the meeting on 5 February watched the first two episodes of the new DVD series: The Higg's boson and beyond by Dr Sean Carroll, Research Professor of physics at CalTech. These episodes were Lecture 11: 'The importance of the Higg's boson' and Lecture 2: 'Quantum field theory'.

Astro-photography There was no meeting in February.

Other activities

Educational outreach

Hawston Secondary School Astronomy Group Meetings with he new group of space cadets, twelve Grade 11 learners began at the end of January. They take place weekly during term time.

Lukhanyo Youth Club No meeting took place in February.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on **Monday 19 March** at the **Catholic Hall** starting at **19.00**. Dr Pieter Kotzé., a researcher at SANSA will be talking on 'The Earth's magnetic field and possible changes'. Dr Kotzé studied physics at both undergraduate and postgraduate levels, obtaining his doctorate in 1981. After working as a scientist at the Atomic Energy Corporation from 1981 t0 1989, moved to the Hermanus Magnetic Observatory.

He has spent extensive periods as visiting scientist at the Max Planck Institute and GeoForschungsZentrum in Germany, and the British Geological Survey in Edinburgh, He is currently the South African representative at the International Association for Geomagnetism and Aeronomy (IAGA) and a member of its Executive Committee.

His research activities are in the field of geomagnetism, in particular the time-varying characteristics of the geomagnetic field of southern Africa, as well as geomagnetic storms resulting from the solar wind's interaction with the Earth's magnetic field. In the process he uses data from ground surveys and magnetic observatories, as well as satellite observations.

There is an entrance fee of R10 per person for members, R20 per person for non-members, and R10 for children, students and U3A members.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month at 19.00. There is no meeting in January. The next meeting will take place on **5 March** at the **Catholic Hall**, starting at **19.00**. Attendees will watch the next two episodes in the DVD series: The Higg's boson and beyond by Dr Sean Carroll, Research Professor of physics at CalTech. The content will be Lecture 33: 'Atoms to particles ' and Lecture 4: 'the power of symmetry'.

There is an entrance fee of R10 per person for members, R20 per person for non-members, and R10 for children, students and U3A members. For further information on these meetings, or any of the group's activities, please contact Pierre Hugo at pierre@hermanus.co.za

Astro-photography This group meets on the second Monday of each month. The next meeting is on **12 March**. The topic will be image processing.

To find out more about the group's activities and the venue for particular meetings, please contact Deon Krige at astronomy.hermanus@gmail.com

Hermanus Youth Robotic Telescope Interest Group Organisers are progressing with work towards enabling learners to take and process images themselves.

For further information, please contact Deon Krige at deonk@telkomsa.net

FUTURE ACTIVITIES

No trips are being planned, at present.

2018 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at **19.00**. Details for the first few months are:

19 March	'The Earth's magnetic field and possible changes' Presenter: Dr Pieter Kotze, SANSA
16 April	'If you wish to make an apple pie from scratch, you must first invent the Universe' Presenter: Dr Sean February, CSIR
21 May	'Recent and ongoing work on pulsar light curves' Presenter: Andre van Staden
18 June	'The story of Hermanus Astronomy Club/Centre' Presenters: Pierre de Villiers and John Saunders, Centre members
16 July	'History of the Voyager spacecraft' Presenter: Johan Retief, Centre member
20 August	TBA
17 September	TBA
22 October	'Our weird and wonderful Universe' Presenter: John Saunders, Centre

	member
19 November	'Table Mountains, astronomy and some geology' Presenter: Jenny Morris, Centre member
10 December	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Consideration of the planning application by the Council of Overstrand Municipality continues to be awaited. Hopefully, the additional information requested by staff will enable this to take place soon. In the meantime, the Friends of the Observatory pledge fund continues to be an important source of funds to cover associated costs.

The **Friends of the Observatory campaign** was launched several years ago when preliminary work began on plans to construct an astronomical observatory in Hermanus. Over the years, members have been very generous, for which we are deeply grateful. It may seem logical to assume that, now money has been awarded by the National Lotteries Board, pledge monies are no longer needed. Unfortunately, that is not the case. NLC funds can only be used once the plans have been formally approved by the Municipality, something which is still awaited.

We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer, The Standard Bank details are as follows:

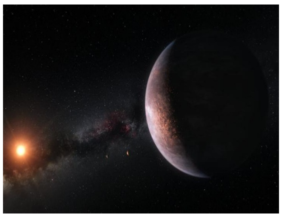
Account name – Hermanus Astronomy Centre
Account number – 185 562 531
Branch code – 051001

If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS

TRAPPIST-1 exoplanets may all be water worlds 5 February: The seven planets that make up the system orbit a dim red dwarf star much smaller and cooler than our own Sun. The planets' orbits are much tighter than in our solar system, and they are all closer to their home star than Mercury is to the Sun. Three of them are thought to be in the 'habitable zone' where liquid water could exist. The system is relatively close, only 40 light-years away, and astronomers have been probing the planets and their star with an array of telescopes to learn about how TRAPPIST-1 formed and what conditions might be like on the seven planets. The latest research provides a much better estimation of some of the planets' densities and helps narrow down the possibilities for atmospheres there. Astronomers now say that water appears to be present in significant quantities on all of the planets, in some cases up to five percent of the planet's mass.

The TRAPPIST-1 planets are so close together that their gravitational fields tug on each other as they spin around their star. By measuring the power of these tugs, and putting that data into a sophisticated computer-modelling algorithm, the researchers were able to get an idea of how dense each planet was. The picture it paints is rough, but the researchers found that the planets were not dense enough to be made of just rock and metal. Volatiles - elements and compounds with low boiling temperatures - must be present, and the best explanation is water. The amount varies, but some planets could potentially have more water than exists on Earth. Water could be liquid on the three planets within the habitable zone. On planets further from the star, a layer of ice may cover the surface, and on the second planet from the star, a thick atmosphere of water vapour is likely present.


Artist's impression of TRAPPIST-1 System. ESO/M. Kornmesser

Atmospheres could exist on several of the other planets closer in as well, another detailing researchers' efforts to peer into those gaseous layers with the Hubble telescope. When a planet passes in front of a star, some of the light will shine through its atmosphere, if it has one. If any gases are present, they will alter the light in a predictable way, allowing astronomers to see what molecules are floating around in the atmosphere. In this case, the researchers were looking to see whether the three planets in the habitable zone, as well as one other, had the kind of thick atmospheres that typify gas giants in our own solar system. Such an atmosphere would be rich in hydrogen and cloud-free, and would make discovering liquid water on the surface less likely. After analysing the data from Hubble, they found no traces of such atmospheres, meaning the planets are likely terrestrial like Earth or Mars. An atmosphere of some sort could still exist there, of course, but it is likely not as puffy and smothering as the kind that blankets planets like Neptune.

By: Nathaniel Scharping

Did the Milky Way devour other galaxies to grow? 7 February: Galaxies like the Milky Way have several components: a disk of stars, which includes the galaxy's arms; a bar-shaped bulge in the centre, and a large, spherical outer halo of stars. While the Milky Way's stellar halo certainly is not close, its interior boundary is near enough to observe in detail and the inner portion of the halo has long been our main source for understanding the stellar halo as a whole. A recent paper outlines the first detailed observation of stars in the halo's outer region, and how their chemical compositions add credence to the theory that the Milky Way has absorbed other galaxies.


The Large and Small Magellanic Clouds, satellites of the Milky Way, are thought to be part of the galaxy growth process as they're absorbed over time. ESO/S. Brunier

Astronomers used high-resolution optical spectrometry to evaluate the chemical make-up of 28 red giant stars in the galaxy's outer halo. Spectroscopic analysis involves breaking down the light emitted by a star and sorting it by wavelength, which allows astronomers to identify its chemical compounds. A star's chemical make-up gives insight into the environment that it formed in and helps establish its origin. Based on the outer halo stars' composition, the study found that the inner halo stars may not be a good representation of the stellar halo in its entirety, as has been previously believed. "The abundance of some chemical elements in the stars in the external regions of the Milky Way halo was found to be surprisingly different from the information we had concerning the inner regions of the halo," said Instituto de Astrofísica de Canarias astrophysicist and first author of the paper, Giuseppina Battaglia.

Although the outer halo stars' chemical elements differ from those in the inner halo, their make-up is quite similar to stars found in the Large Magellanic Cloud and Sagittarius Dwarf Elliptical Galaxy - both massive dwarf galaxies orbiting the Milky Way as satellites. Because astronomers believe that satellite galaxies may be the leftover halos of larger galaxies that went into the assembly of the Milky Way, this correlation suggests that at least one massive dwarf galaxy was absorbed by the Milky Way, and that its remains are lingering in its outer halo. While this discovery is a first for the Milky Way, its premise is quite common throughout the universe. By: Amber Jorgenson

The Moon's equatorial bulge hints at Earth's early conditions 13 February: Although the Moon looks quite spherical from the ground, it is flatter at its poles and wider at its equator, a trait known as an equatorial bulge. This characteristic is common; it is usually caused by an object's rotation around its axis. However, it' ha been noted that the Moon's bulge is about 20 times larger than it should be given its rotational rate of once per month.

Researchers at the University of Colorado, Boulder created an innovative model to study the disproportionate bulge and determine the conditions needed for its formation. They found that the bulge formed over hundreds of millions of years during the Hadean time (around 4 billion years ago). However, for the bulge to form this slowly, Earth's tidal forces would have needed to be much weaker than they are today. The weak tidal forces suggest that Earth's water was less mobile ie frozen during this time period.

To reach their result, the team assessed how rapidly the Moon could have retreated from Earth, an effect likely caused by the Moon and Earth's tidal and gravitational interactions. Due to its close proximity to Earth, the early Moon was much hotter and had a higher rotational rate than it does today - optimal conditions for a heavy, prominent bulge to form. As the Moon retreated from Earth, its decreased rotation and temperature caused the bulge to gradually reduce in size. At some point, the Moon cooled enough for the bulge to solidify into a 'fossil bulge', a permanent planetary feature. Today, the Moon currently recedes from Earth by 4 centimetres each year. However, little is known about the Moon's early recession speed, making it difficult to determine when the bulge formed.

By: Amber Jorgenson

Just how big is the Andromeda galaxy? 14 February: Both the Milky Way and the Andromeda galaxy (M31) are giant spiral galaxies in our local universe. And in about 4 billion years, the Milky Way and Andromeda will collide in a gravitational sumo match that will ultimately bind them forever. Because astronomers previously thought that Andromeda was up to three times as massive as the Milky Way, they expected that our galaxy would be easily overpowered and absorbed into our larger neighbour. However, new research suggests we have overestimated our opponent. A team of Australian astronomers has found that Andromeda is not actually the heavyweight we once thought it was. Instead, they found that our nearest galactic neighbour is more or less the same size as the Milky Way - some 800 billion times the mass of the Sun.

To determine the size of the Andromeda galaxy, the team used a technique that calculates the speed required for a quick-moving star to escape the gravitational pull of its host galaxy. This required speed needed for ejection is known as an object's escape velocity.

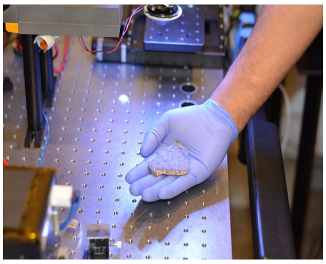
“When a rocket is launched into space, it is thrown out with a speed of 11 km per second to overcome the Earth’s gravitational pull,” said Prajwal Kafle, an astrophysicist from the University of Western Australia branch of the International Centre for Radio Astronomy Research. “Our home galaxy, the Milky Way, is over a trillion times heavier than our tiny planet Earth, so to escape its gravitational pull, we have to launch with a speed of 550 km per second. We used this technique to tie down the mass of Andromeda.”


Image of the Andromeda galaxy, captured by NASA’s Galaxy Evolution Explorer, showing the ultraviolet side of our familiar galactic neighbour. NASA/JPL-Caltech

This is not the first time a galaxy’s weight has been recalculated based on analysing the escape velocities of objects within it. In 2014, Kafle used a similar technique to revise down the mass of the Milky Way, showing that our galaxy has much less dark matter - a mysterious form of matter that has gravity but does not interact with light - than previously thought. Much like the 2014 study showed for the Milky Way, today’s paper suggests that previous research has overestimated the amount of dark matter present in the Andromeda galaxy. “By examining the orbits of high-speed stars, we discovered that [Andromeda] has far less dark matter than previously thought,” said Kafle, “and only a third of that uncovered in previous observations.”

Although revising down Andromeda’s overall mass may seem like it should help the Milky Way out during the galaxies’ eventual collision, the researchers say that new simulations are first needed to determine exactly what will happen when the galaxies meet. But no matter what happens in 4 billion years, Kafle says today’s new finding “completely transforms our understanding of the local group.” By: Jake Parkes

NASA is taking a piece of Mars back home 15 February: A joyous homecoming awaits a piece of Mars that lost its way. The slice of a Martian meteorite, named Sayh al Uhaymir 008 (SaU008), will head back home on NASA’s Mars 2020 mission and function as a calibration target for the rover’s high-precision laser instrument, called the Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals (SHERLOC).


The SaU008 meteorite was found in Oman in 1999 and has the chemical components needed to serve as a calibration target for Mars 2020’s SHERLOC instrument. NASA/JPL-Caltech

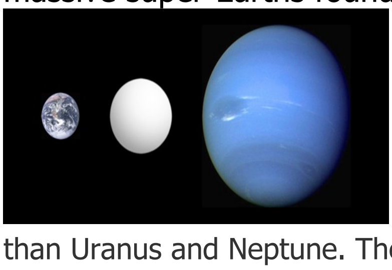
The mission, currently being constructed in Pasadena, California, at NASA’s Jet Propulsion Laboratory (JPL), will use SHERLOC to study and collect samples of Mars’ surface to be brought to Earth by a later mission. The instrument is capable of detecting rock elements as fine as a strand of hair, but to ensure this level of precision, a calibration target is required. "We're studying things on such a fine scale that slight misalignments, caused by changes in temperature or even the rover settling into sand, can require us to correct our aim," said JPL's Luther Beegle, SHERLOC's principle investigator. "By studying how the instrument sees a fixed target, we can understand how it will see a piece of the Martian surface."

Calibration targets are chosen based on what the on-board instrument is testing, with metal, glass, and rock having served as targets for past NASA missions. For SHERLOC, the target needs to contain both the texture and the chemical components the instrument is designed to detect to ensure it is working properly. Given the chemical make-up needed for the job, researchers saw an opportunity to reunite a meteorite with its homeland.

To help select SHERLOC'S target, JPL called upon NASA's Johnson Space Center in Houston and the Natural History Museum of London. The Meteoritical Society has only confirmed about 200 Martian meteorites, and the Mars 2020 team had to make sure they chose one solid enough to withstand the mission's launch and landing. Researchers cut off small fragments of multiple meteorites to see if they would crumble, and eventually settled on the sturdy SaU008 meteorite, which was found in Oman in 1999. SaU008 will go down as the first Martian meteorite to return home to the Red Planet's surface; NASA's Mars Global Surveyor also contained a meteorite, which remains in orbit today.

SHERLOC will use fluorescence and Raman spectroscopies to scan Mars' surface for specific chemical compounds, a first-of-its-kind study of the Red Planet. The laser will shine ultraviolet light over the Martian surface, causing specific carbon-based chemicals to illuminate. SHERLOC will also snap photos of the rocks and record the chemicals it picks up. Researchers will use the data to see if Mars' chemical components hint at signs of past microbial life. In addition to searching for previous life, the rover will help determine safety conditions for future astronauts. Mars 2020 will bring spacesuit fabric, a helmet visor, and gloves to see how they hold up under Mars' weather conditions. By Amber Jorgenson

A super-Earth in Pisces may be one of the most massive ever discovered 19 February: Three planets, all slightly larger than Earth in diameter, orbit a star called GJ 9827, about 100 light-years away in the constellation Pisces the Fish. A study of the planet trio found that, although they are all similar in size to our home planet, one of the most massive super-Earths found to date lies among them.



Super-Earths have masses that are larger than Earth but smaller than Uranus and Neptune. The image compares the size of Earth (left), a super-Earth (middle), and Neptune (right). Wikimedia/Aldaron

NASA's Kepler/K2 mission, which seeks out transiting exoplanets, discovered the triplets, named GJ 9827b, c, and d. According to Kepler's overall findings, super-Earth-sized planets (which have masses larger than Earth but smaller than Uranus and Neptune) are the most common in the Milky Way Galaxy. However, no planets of this size exist within our solar system. A group of researchers, led by Johanna Teske of the Carnegie Institution for Science, set out to determine why by learning more about the environment in which these planets formed.

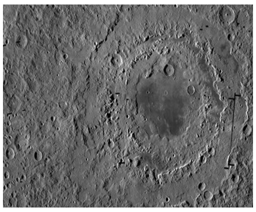
The first step to understanding their formation is to determine their compositions. Are they rocky, like Earth, or do they have smaller cores surrounded by large, gaseous envelopes, like the ice giant Neptune? To find out, the researchers needed to establish their bulk densities by measuring their masses and radii. However, "usually, if a transiting planet is detected, it takes months if not a year or more to gather enough observations to measure its mass," Teske explained. Fortunately, Carnegie scientists had already been observing GJ 9827 with their Planet Finding Spectrograph (PFS) on the Magellan II Telescope in Chile, and had the data on hand. "Because GJ 9827 is a bright star, we happened to have it in the catalog of stars that Carnegie astronomers been monitoring for planets since 2010. This was unique to PFS," Teske said.

The researchers used PFS's data to compare the planets' radii to that of Earth, and found that planet b is 1.64 times larger, planet c is 1.29 times larger, and planet d is 2.08 times larger. Based on this, they were able to test a trend observed among exoplanets: If a planet's radius is more than 1.7 times that of Earth, it tends to be an ice giant, and if it's smaller, it tends to be rocky. Researchers have suggested that a process called photoevaporation could be the root cause of this trend. Photoevaporation rids a planet of its envelope of volatiles (elements with low boiling points, like hydrogen, carbon dioxide, and water), leaving behind a rocky core and a smaller radius. However, more research is needed to corroborate this theory - and their unique range of sizes throws GJ 9827's planets into a unique zone for comparison.

When evaluating the planets' mass, PFS found that planet b weighs about eight times as much as Earth, placing it among the densest and most massive super-Earths ever found. It' is believed that the planet is about 50 percent lead, which would help explain its hefty mass. Although researchers are not as confident with the other planets' measurements, they estimate that planets c and d have masses two and a half and four times that of Earth, respectively. Planet d's radius-to-mass ratio suggests that it has a prominent volatile envelope, as expected, but planet c's ratio leaves researchers uncertain. Although additional research is needed to definitely determine their compositions, the three super-Earths will serve as tools for astronomers looking to understand the formation and evolution of planets similar in size to our own. By: Amber Jorgenson

The wibbly wobbly Moon 26 February: Earth's Moon strikes a dignified pose in the sky, its stately figure casting a regal glow on the planet below. However, the Moon was not always so august. In its past, it may have wobbled like a top, tumbling haphazardly after massive collisions sent it spinning. New research probes how large objects smashing into its surface could have affected Earth's largest satellite.

"Every little impact can change the spin of the Moon. The question really is, how big of an impact do you need to do something geologically meaningful?" says James Tuttle-Keane, a researcher at the California Institute of Technology. Tuttle-Keane is working on modelling the Moon's behaviour after the more massive impacts to determine how the collisions that created the largest impact basins would have sent the Moon spinning. "Your run-of-the-mill asteroid impacts will change the Moon's spin by an imperceptible amount .... The impacts that form basins, craters with diameters over a few hundred kilometres, on the other hand, can really mess with the Moon," he says.

 The Moon's Orientale basin is a the remnant of a past impact. It stretches 580 miles (930 kilometers) across and formed about 3.8 billion years ago. NASA/GSFC/Arizona State University

Rocks and objects travelling through space carry a little bit of angular momentum with them. When they slam into something else, such as the Moon, they pass that angular momentum on, imparting a slight spin. Previous studies have modelled how these objects affect the Moon. Rocks slamming into the Moon have a more noticeable effect than changing the satellite's spin. They create impact craters that carve the surface of the Moon, sending material flying upward and outward, only to settle back down. Each impact affects how mass is distributed throughout the Moon, and that mass distribution then affects how the Moon spins. When a large object carves out an enormous impact basin, the shifting mass can affect the overall lunar rotation.

"The formation of these larger impact basins can drive large wobbles of more than 10 degrees, and even unlock the Moon from synchronous rotation [the effect that keeps one side permanently pointed towards Earth]," Tuttle-Keane says. Carving out these basins can stir up the Moon's inner core and magnetic field, as well, he says.

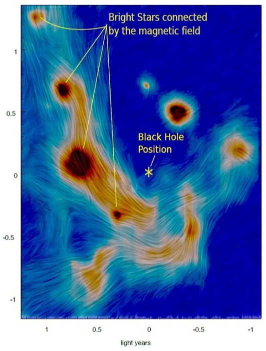
Tuttle-Keane used measurements taken by a variety of missions and spacecraft to determine how to best model the impact basins today. These include the Apollo Lunar Laser Ranging (LLR) project, and NASA's Gravity Recovery and Interior Laboratory (GRAIL) and Lunar Reconnaissance Orbiter (LRO) satellites. Since most of the basins he is concerned with are about 4 billion years old, and have changed over time, he then used numerical models to figure out what the basins were like when they first formed. "Between the information we have about the present-day Moon from GRAIL, LRO, [and] LLR, and inferences about the early Moon from numerical models of impact basin formation, we can start to piece together how the Moon's spin has evolved," Tuttle-Keane says.

The results reveal that the Moon has nt been so staid and stately throughout its life. "The tumbling that happens right after basin formation can be quite extreme," Tuttle-Keane said. Sometimes the Moon completely unlocks from the Earth, or tumbles significantly. He referred to it as "the wibbly wobbly Moon." Eventually the Moon re-asserts itself into the calm body we know today, as the chaotic motion slows over time. If a single face of the Moon was locked towards Earth before the impact, tides remove the extra energy and the Moon eventually presents only a single side towards our planet once more.

"If you could see the formation of a large impact basin, you'd be in for quite a show," Tuttle-Keane says. "You would see a flash of light, material splattered into space and across the surface of the Moon, and a red-hot impact melt where the basin formed." "If you watched from Earth in the years afterwards, you'd see the Moon wobbling in the sky," he adds. It would continue to tilt crazily for hundreds or thousands of years, but would eventually calm back down.

By: Nola Taylor Redd

The core of the Milky Way unveiled in clearest infrared image yet 27 February: At the centre of nearly every galaxy resides a gargantuan black hole. For the Milky Way, the supermassive black hole - dubbed Sagittarius A* - is so massive that its gravity flings stars around at speeds of up to 30 million km per hour. In order to accelerate stars to these breakneck speeds, astronomers estimate that Sagittarius A* must be about 4 million times more massive than the Sun. With such a monstrous and intriguing object located in the centre of our galaxy, you would think that astronomers know a great deal about it. However, thanks to the fact that the Milky Way is full of light-blocking gas and dust, many questions still remain about the structure and behaviour of Sagittarius A*.



New high-resolution map showing the magnetic field lines embedded in gas and dust around the supermassive black hole (Sagittarius A*) residing in the core of the Milky Way. Red areas show regions where warm dust particles and stars are emitting lots of infrared radiation (heat), while dark blue areas show cooler regions that lack pronounced warm and dusty filaments. E. Lopez-Rodriguez/NASA Ames/University of Texas at San Antonio

Astronomers recently shed some light on this black hole by producing a new high-resolution map that traces the magnetic field lines present within gas and dust swirling around Sagittarius A*. The team created the map, the first of its kind, by observing polarised infrared light that is emitted by warm, magnetically aligned dust grains.

To create the detailed map, which spans about one light-year on each side of Sagittarius A*, the researchers used the CanariCam infrared camera on the Gran Telescopio Canarias (GTC), located on the island of La Palma, Spain. Because infrared light passes straight through the visual-light-blocking dust located between Earth and the Milky Way's core, astronomers were able to view the area around Sagittarius A* much more clearly than would have been possible with other types of telescopes. Furthermore, since CanariCam combines infrared imaging with a device that preferentially filters polarized light associated with magnetic fields, the team was able to trace the magnetic field lines around Sagittarius A* in unprecedented detail.

"Big telescopes like GTC, and instruments like CanariCam deliver real results," said Pat Roche, a professor of astrophysics at The University of Oxford. "We're now able to watch material race around a black hole 25,000 light-years away, and for the first time see magnetic fields there in detail."

These new observations not only make for a wonderful image - the clearest infrared image of our galactic core to date - but also provide astronomers with vital information regarding the relationship between luminous stars and the filaments of gas and dust that stretch between them. One prominent feature in the map shows that dusty filaments connect some of the brightest stars in the centre of the Milky Way despite incredibly strong stellar winds. The researchers believe that these filaments remain in place because they are bound by magnetic fields that permeate through the dust.

Based on map, the researchers also think that a smaller magnetic field exists near the core of the Milky Way, and that the field gets stretched out as intervening filaments are pulled apart by gravity. They point out that the filaments, which are several light-years long, seem to pool below (on the map) Sagittarius A*. The team believes that this likely marks a location where streams of gas and dust orbiting the black hole converge. By: Jake Parkes

Water on the Moon might actually be locked in place and widespread 27 February: Although Earth is known for its expansive oceans, lakes, and rivers, it may not be the only body in the neighbourhood with sprawling water molecules. Researchers found that the Moon's water is not restricted to certain landscapes or regions, but is rather dispersed broadly over its surface. The total amount of water and its accessibility are unknown, but if the stars align, future missions could potentially use it as drinking water, convert it to oxygen for breathing, or use it as rocket fuel by converting it to oxygen and hydrogen.


Understanding the Moon's water could help trace back its origin and, if accessible, could serve as a resource for future missions. NASA's Goddard Space Flight Centre

"We find that it doesn't matter what time of day or which latitude we look at, the signal indicating water always seems to be present," said Joshua Bandfield, senior research scientist at the Space Science Institute in Boulder, Colorado. "The presence of water doesn't appear to depend on the composition of the surface, and the water sticks around."

Previous studies found that the Moon's polar latitudes appear more water-rich than other regions, and that the amount of water in a given region depended on the lunar day (29.5 Earth days). These results make researchers wonder if water molecules travel to the Moon's north and south poles and end up in 'cold traps' within craters - areas so cold that water vapour inside them freezes and is unable to escape for significant periods of time, possibly billions of years. However, this theory has been brought into question based on the methods used to obtain the results. Most studies of water on the Moon use remote-sensing instruments to measure the amount of sunlight reflecting off of the Moon's surface. These instruments look for spectral lines associated with water at wavelengths of about three micrometers, which falls into the infrared portion of the spectrum, rather than visible light. The problem is that the Moon is capable of producing its own infrared radiation if its surface gets hot enough, making it difficult to tell which radiation comes from heat and which is produced by water.

The new study set out to differentiate the sources of radiation by using data from NASA's Lunar Reconnaissance Orbiter's Diviner instrument to create an in-depth model of the Moon's temperatures. They took data that had been previously collected by the Moon Mineralogy Mapper, a visible and infrared spectrometer on the Chandrayaan-1 orbiter, and applied it to the model. Their model suggests that water on the lunar surface is rather motionless and does not favour one type of landscape over another, which implies that its primary form might actually be hydroxyl (OH). OH is a similar compound to H2O and is composed of a hydrogen atom and an oxygen atom. OH has a tendency to latch onto or fuse with other molecules, meaning that it does not move around much and that we would have to extract it from minerals to use it.

Despite the information gained in the study, where the Moon's OH and/or H2O came from remains a mystery. While it is widely believed that it formed when hydrogen from solar wind came in contact with oxygen housed in Moon rocks, the researchers are not disregarding the possibility that it has been there all along, and is just now being released from the minerals that locked it in during the Moon's formation. By: Amber Jorgenson

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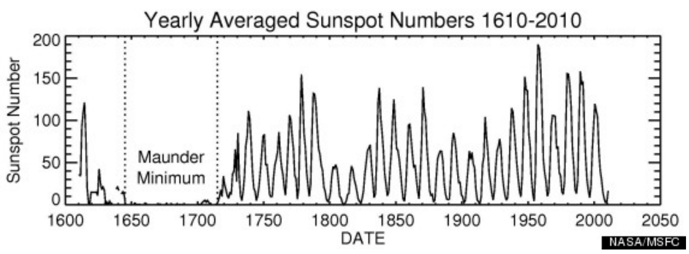
DID YOU KNOW?

The Sun Part 24: **Maunder Minimum**



Maunder Minimum

Frozen River Thames

This well-known event in solar cycle history was the period, from around 1645–1715, when sunspots became very rare, as noted by solar observers at that time, and aurorae were virtually absent. The term was introduced in a paper by John Eddy in 1976.

Edward Maunder (1851–1928) was an English solar astronomer. In 1873, he became a spectroscopic assistant at the Royal Observatory, Greenwich. For 40 years, as part of his job, he photographed, counted and measured solar sunspots on every possible day. This enabled him, and his assistant wife, Annie, to identify several patterns in sunspot activity. However, it was his concurrent study of the history of astronomy which led to discovery of the period of very low sunspot activity which now bears his name.

While studying historical records to seek additional evidence of latitude variation in sunspot positions, the Maunders noted that German astronomer Gustav Sporer (1822-1895) had noticed an almost complete absence of sunspots during those 70 years. For 28 years (1672-1699) Sporer had noted that fewer than 50 sunspots were observed (40,000-50,000 is more typical).

Lack of data on sunspot activity during that period was not the explanation for this finding eg Cassini had led a systematic programme of solar observations in Paris which included that period. Maunder's research, published in 1894 and 1922, revealed the existence of what is now called the Maunder Minimum. Maunder agreed with Sporer's conclusion that there had been a real decline in solar activity then. Later, findings of increased carbon-14 content in tree rings from that period confirmed this (cosmic rays that produce increases in carbon-14 reach Earth in greater numbers when solar activity is low). Historical records of what was called the Little Ice Age which occurred during the same time period also supported the existence of the Maunder Minimum.

However, more detailed investigations have revealed that the reality of the presence of a causal relationship between solar activity and cold temperatures on Earth is not as straightforward as Maunder, Sporer and others accepted. One concern is that fact that the Maunder Minimum and the so-called Litle Ice Age are often regarded as referring to the same event. However, the Maunder Minimum coincided only with the middle part of the Little Ice Age, which began about 50 years earlier and continued for several decades afterwards. In a longstanding, ongoing debate, some have argued that the Little Ice Age and Maunder Minimum were the result of a terrestrial cause, a consequence of volcanic activity on Earth.

Furthermore, the terms Little Ice Age and Maunder Minimum have also been argued to be misleading, as they suggest global events. This was not the case. The Little Ice Age refers only to unusual cold experienced in Central Europe and North America. Even then, in the UK, during the periods of very cold temperatures, some years in the Maunder Minimum were some of the warmest on record until then. Also, summer temperatures during the Minimum years were not very different from the average. Review of historic records has further shown that auroral activity was not reduced during the Minimum.

Modern solar observations have also identified that solar ultraviolet output varies more during the solar cycle than was previously thought. This implies that, although what is known as the Maunder Minimum was a period of reduced solar activity, it was more an example of what happens at the extreme ends of the normal variation range than an exception. In fact, studies suggest that the Sun currently spends up to a quarter of its time in minima. Eighteen periods of sunspot minima during the last 8,000 years have been identified. Some were marked enough to also earn them names eg Sporer Minimum (1450-1550), Dalton Minimum (1790-1820, but they are not the rare events which the historical perception of the Maunder Minimum has suggested.

Despite these confounding factors, sunspot observation records and carbon-14 and beryllium-10 tree ring and ice sheet analysis do confirm notably lower solar activity during the Maunder Minimum. This period is an important time in the study of sunspot activity, but explanations are not as simple as historically suggested. Although a 1% decrease in solar output could cause such effects on Earth as occurred during the Maunder Minimum eg freezing of the River Thames, a direct association between reduced sunspot numbers and lower temperatures on Earth has not been proven.

The explanation may even be Earth-based. For example, in addition to the possible volcanic activity, changes in jet stream behaviour have also been proposed as an explanation. This has been found to affect winter temperatures in different areas of the Northern hemisphere ie colder winters in North America and central and northern Europe and milder winters in southern europe, Canada and Greenland.(as occurred during the Little Ice Age and Maunder Minimum).

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev,
www.en.wikipedia.org,

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