"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

FEBRUARY 2018

Monthly meeting

This Centre's Annual General Meeting will place on **Monday 19 February** at the **Catholic Church Hall** starting at **19.00**. The agenda and 2017 AGM minutes have been circulated to members.

Membership renewal for 2018

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.

Monthly meeting dates for 2018

Dates for your diaries are: 19 February, 19 March, 16 April, 21 May, 18 June, 16 July, 20 August, 17 September, 22 October, 19 November and 10 December.

WHAT'S UP?

Second brightest star Canopus (Alpha Carinae), the second brightest star in the night sky after Sirius (Alpha Canis Majoris), can be found high in the sky 'above' the False Cross (no pointers), at this time of year. With Sirius, it forms a curve which leads to the Large, then the Small, Magellanic Clouds. Canopus is a young white superigant, its brightness a result of its hot colour and its proximity to Earth, around 310 light years. The constellation Carina used to be part of the large Argo Nevis constellation, representing the Greek mythological ship in which Jason and the Argonauts travelled to retrieve the golden fleece. During the 18th century, the astronomer Nicolas Louis de la Caille divided Argo Nevis into three constellations, Carina (ship's keel), Vela (the sail) and Puppis (ship's stern). Of the three, Carina contains the most interesting features, including Canopus, nebulae and several open clusters This southern constellation is visible to only just a few degrees north of the celestial equator.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The speaker at the meeting held on 22 January was Dr Yebabel Fantaye, holder of the ARETÉ Junior Research Chair in Applied Statistical Methods, Cosmology and Big Data based at AIMS in Cape Town. His presentation was titled 'What is the size, weight and age of the Universe, and how do we measure it?' In a thought-provoking talk, Yebabel addressed these particular aspects of the Universe, against a broader background. The latter included the history of development of our understanding of the Universe and the Standard Model as it exists today, as well as the associated advances in observational and related technologies.

He noted that it is less than a century since we learned that the Universe consists of more than just the Milky Way galaxy, then outlined the ways in which scientists have expanded our knowledge of astronomy and cosmology. Although optical methods have dominated observation, instruments measuring electro-magnetic radiation in other frequencies eg X-rays, infrared and radio have and continue to add immeasurably to our understanding of the Universe and its constituents.

He then outlined the methods used to measure the distance of celestial objects, near and far eg radar, parallax, standard candles, and explained how these enabled researchers to calculate the size of the visible Universe. The Universe is probably much larger, but our ability to measure its size is limited by the speed of light and the time when the Universe began. He explained how being able to look back increasingly further in time enabled calculation of the age of the Universe, and the stages which it has passed through since the Big Bang. Regarding the weight of the Universe, Yebabel explained how we still know very little about what makes up 96% of the cosmos ie dark matter and dark energy.

Finally, he outlined how modern instrumentation and computer technology have enabled generation of increasingly massive volumes of data. In fact, so much data is being generated that, rather than just enabling testing of hypotheses, it is generating its own theory.

Interest groups

Cosmology No meeting was held in January.

Astro-photography This group met on 15 January. They continue to discuss processing of their own astro-images.

Other activities

Educational outreach
Hawston Secondary School Astronomy Group No meeting took place in January.
Lukhanyo Youth Club No meeting took place in January.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, the AGM, will take place on **Monday 19 February** at the **Catholic Hall** starting at **19.00**.

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 February** at the **Catholic Hall**, starting at **19.00**. Attendees will watch the final two episodes in the DVD series: Particle Physics for Non-Physicists: a Tour of the Microcosmos' by by Prof Steven Pollock, Professor of physics at the University of Colorado at Boulder. The content will be Lecture 23: 'Really big stuff: the origins of the Universe ' and Lecture 24: 'Looking back and looking forward'.

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 February**. 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 February	AGM
19 March	TBA
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.

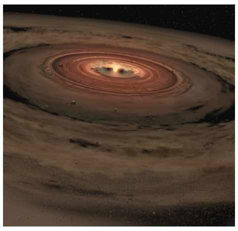
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

Did the solar system form in a bubble? 2 January: Astronomers know that our solar system formed about 5 billion years ago from material left over from previous generations of stars. However, beyond that, it gets a little murky. The prevailing theory is that a nearby supernova explosion compressed a dense cloud of gas and dust until it collapsed in on itself due to its own gravity. As the cloud condensed, it grew hotter and spun faster. Eventually, the centre of the cloud grew so hot it began fusing hydrogen into helium and became the star we call the Sun. However, according to a new study, the solar system instead might have formed inside the dense shell of an enormous bubble within a giant star.



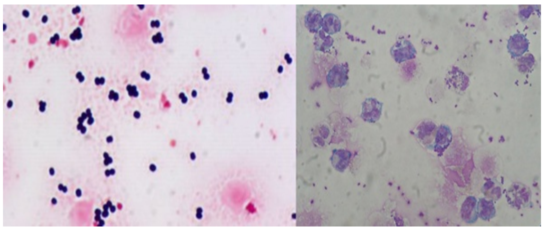
Astronomers believe that planets, asteroids, and other solar system bodies form from the disk of dust and debris around a young star. But what happens before that? NASA/JPL-Caltech

The new theory starts with an extremely massive Wolf-Rayet star. Of all the stars in the universe, these stars burn the hottest and have exceptionally strong stellar winds. As a Wolf-Rayet star sheds its outer layers – a normal end-of-life process for a giant star – its strong stellar winds plough through its loosely held cloak of material, forming densely shelled bubbles. According to the study, the solar system could have formed inside of one of these bubbles. Since such a huge amount gas and dust is trapped inside, "the shell of such a bubble is a good place to produce stars," said Nicolas Dauphas, co-author of the study and professor of geophysical sciences at the University of Chicago, The unconventional theory also addresses a long-standing mystery of the early solar system: Why did it have so much aluminium-26 and so little iron-60 when compared to the rest of the galaxy? Previous studies of meteorite samples have shown that the early solar system was ripe with the isotope aluminium-26, while other studies have shown it was deficient in the isotope iron-60. However, since supernovae explosions produce both of these isotopes, "it begs the question of why one was injected into the solar system and the other was not," said Vikram Dwarkadas, professor of astronomy and astrophysics at the University of Chicago.This is what brought the researchers to Wolf-Rayet stars, which produce lots of aluminium-26, but zero iron-60.

"The idea is that aluminium-26 flung from the Wolf-Rayet star is carried outwards on grains of dust formed around the star," said Dwarkadas. "These grains have enough momentum to punch through one side of the shell, where they are mostly destroyed – trapping the aluminium inside the shell." Over time, the bubble stops pushing outward and falls back in on itself due to gravity. This collapsing bubble is where the researcher's think our solar system could have formed. By: Jake Parks

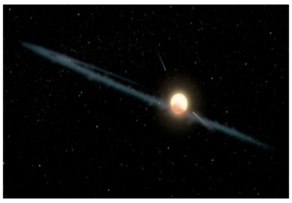
DNA of unknown microbes sequenced in space for the first time 4 January: In July 2016, while aboard the International Space Station (ISS), NASA astronaut Kate Rubins successfully sequenced mouse DNA that was delivered to her from Earth. This made Rubins the first person ever to identify an organism's DNA while working entirely in space. However, last month, NASA astronaut Peggy Whitson one-upped her.

On 18 December, NASA announced that Whitson is now officially the only person to ever take DNA samples from unknown microbes found aboard the ISS and successfully identify them while in space. The mysterious microbes, were found to be two relatively common organisms often associated with the human microbiome: Staphylococcus hominis and Staphylococcus capitis.


After collecting samples of unidentified microbes from surfaces inside the International Space Station, Whitson identified two types of common bacteria. Microbe Canvas/Paulo Henrique Orlandi Mourao

Considering that microbial samples have previously always had to be returned to Earth for analysis and identification, the ability to sequence DNA entirely in space marks a major stepping stone in the future of human spaceflight. According to the NASA statement, "The ability to identify microbes in space could aid in the ability to diagnose and treat astronaut ailments in real time, as well as [assist] in the identification of DNA-based life on other planets." By: Jake Parks

Astronomers are one step closer to unlocking the mystery of Tabby's Star 4 January: Tabby's Star — the informal name for the star KIC 8462852 — the famously and mysteriously dimming star has been the subject of extensive observations and extreme speculation, as astronomers sought to determine just why it undergoes random periods of dimming and brightening without a clear cause. Astronomers considered mechanisms for the brightness variations that ranged from transiting planets to an 'alien megastructure' encircling and harnessing power from the star. Now, following the collection of data funded by a Kickstarter campaign, the most likely explanation has been confirmed … and it is not aliens.

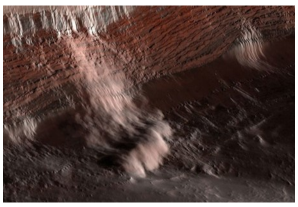

A circumstellar disk, possibly left by exocomets, is the most likely explanation for the periodic dimming of Tabby's Star. NASA/JPL-Caltech

Instead, the solution is much more mundane: "Dust is most likely the reason why the star's light appears to dim and brighten," Tabetha Boyajian, an assistant professor in physics and astronomy at Louisiana State University and the star's discoverer, said. Though the explanation of circumstellar dust seems likely, it was nonetheless elusive until the most recent data was considered. The problem is, dust should be bright at some wavelengths (infrared) and dim at others (visible), and whatever is around Tabby's Star did not show the expected infrared excess.

Catching the dips as they occurred was the key to unlocking this star's mystery. The researchers found that the dimming was much more pronounced at some wavelengths, and less intense at others. That is the opposite of what is expected from something solid: "The new data shows that different colours of light are being blocked at different intensities. Therefore, whatever is passing between us and the star is not opaque, as would be expected from a planet or alien megastructure," said Boyajian.

It is now time to narrow down the type and cause of that dust. Boyajian believes that source could be exocomets, the signature of which have been successfully spotted around other stars, but it is not the only explanation. Others believe that maybe nothing is actually blocking the star at all, and it just brightens and dims on its own — a possibility not ruled out by this new data. By: Alison Klesman

Massive, deep deposits of ice found on Mars 11 January: Despite the fact that Mars has an atmosphere just 1% as dense as Earth's, the surface of the Red Planet still has to deal with plenty of weathering and erosion. In 2008, researchers captured a full-scale avalanche on Mars as it plunged down a 2,300-foot slope into a valley. These types of geological events often expose the structures beneath the Martian surface, revealing layers of rock, dry ice, and even water ice.


The Mars Reconnaissance Orbiter captured this image of an avalanche of dusty snow. NASA/JPL-Caltech/University of Arizona

Researchers using the Mars Reconnaissance Orbiter (MRO) investigated eight such steep and eroded slopes (known as scarps) at various locations across Mars. At each of these locations, they found thick shelves of relatively pure water ice located as little as 1m below the planet's surface. Some of these massive ice deposits were found to be more than 100m thick.

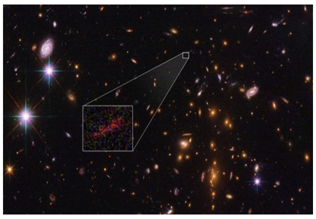
While scientists have observed water ice on the surface of the Red Planet many times before, they rarely get a chance to learn this much about its layering, thickness, purity, and prevalence. According to the research paper, "The ice exposed by the scarps likely originated as snow that transformed into massive ice sheets, now preserved beneath less than 1 to 2 [metres] of dry and ice-cemented dust or regolith near ±55° latitude".

Since the ice deposits discovered in this study were found intact along the scarps' steep, eroded slopes, the researchers believe the ice is "cohesive and strong". Furthermore, the team found that the ice appears banded, showing layered variations in its blue colour. This suggests that the massive ice deposits are composed of many distinct layers that have been squashed together over time, preserving a record of Mars' climate history. However, because there are few craters near these sites, the authors suggest the ice was formed relatively recently - in the past million years or so.

The discovery of these large reservoirs of pure water ice adds yet another piece of evidence supporting the increasingly held theory that water ice not only exists on Mars, but also is surprisingly common. Although the ice could obviously be used as a source of water for future manned missions to Mars, scientists have a long way to go before then.

By: Jake Parks

NASA images the most distant galaxy ever resolved 12 January: With the help of advanced telescopes and gravitational glasses, NASA captured an image of SPT0615-JD, the most distant galaxy ever caught on camera. This ancient galaxy was already around when the infant universe was just 500 million years old. Although we have seen other galaxies that existed during this time period, we have not been able to capture distinct images of them due to their significant distance from Earth. Galaxies this far off usually resemble indiscernible red dots, but due to gravitational lensing, researchers were able to capture a clear image of SPT0615-JD.


NASA was able to get this clear image of SPT0615-JD thanks to a phenomenon known as gravitational lensing, which magnified and stretched the galaxy. NASA/ESA/B. Salmon (STScI)

Gravitational lensing happens when the gravity of a massive foreground objects warps space into a giant cosmic lens, causing distant background objects to appear both brighter and more focused. Since SPT0615-JD was located directly behind the gravitational field of a foreground galactic cluster, researchers were able to resolve the target galaxy with much greater detail than would have otherwise been possible.

Researchers have long been using gravitational lensing to seek out galaxies that are not detectable with standard telescopes or observatories. But, "no other candidate galaxy has been found at such a great distance that also gives you the spatial information that this arc image does," said Brett Salmon, a post-doctoral researcher at the Space Telescope Science Institute "By analysing the effects of gravitational lensing on the image of this galaxy, we can determine its actual size and shape."

Salmon's preliminary analysis, made with Hubble and Spitzer's data, estimates that the image captured the galaxy as it was 13.3 billion years ago, about half a billion years after the Big Bang It also suggests that SPT0615-JD has a maximum weight of 3 billion solar masses, roughly 1/100th the mass of the Milky Way, and is no more than 2,500 light-years across. The Milky Way is 100,000 light-years across. Statistics like this make it an archetypal example of other young galaxies that formed soon after the Big Bang.

By: Amber Jorgenson

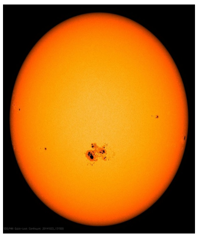
Future spacecraft can use pulsars to navigate completely autonomously 15 January: Although it is possible for space missions to communicate data with Earth, the process is anything but fast. Voyager 1, for example, takes about 19 hours to send a signal back to Earth, and that lag only increases as the spacecraft gets further away. For truly long-term, deep space missions, the significant amount of time it takes to send a signal is not going to cut it. The spacecraft will need to adjust its own trajectory without relying on ground navigation. That is where pulsars come in.

NASA engineers have shown that fully autonomous space navigation is possible through the use of X-rays, a discovery that could overhaul our approach to deep space travel. The X-ray guidance system was successfully tested during the Station Explorer for X-ray Timing and Navigation Technology (SEXTANT) experiment. Using pulsars timed down to the millisecond, the test craft relied on X-rays to pinpoint the location of a space object moving at thousands of miles per hour.

Though the Global Positioning System (GPS) can track objects located on Earth or in low-Earth orbit, GPS navigation is not an option for long-distance spacecraft because its Earth-orbiting satellite network quickly loses the signal once the craft travels away from Earth. In order to autonomously track deep space vehicles, researchers needed to find a strong signal that is capable of propagating many light-years. For this, the researchers turned to pulsars - the rapidly rotating cores of neutron stars - because they are available virtually everywhere (especially in deep space), and emit strong X-ray signals.

By: Amber Jorgenson

Counting starspots 17 January: Small dark regions on the Sun have helped solar scientists learn more about our closest star for centuries. However, while picking out sunspots is reasonably easy on the Sun, identifying them on Sun-like stars lying light-years away can be a challenge. Now, astronomers have used an orbiting planet to probe starspots on its star, revealing once again that our Sun is not anything special.



The Sun often sports sunspots, which are darker, relatively cooler areas associated with our star's magnetic field. NASA/SDO

"The distribution of the spots on the Sun is an outward expression of what's going on within the Sun, making visible the magnetic fields that are anchored deep below the surface," Brett Morris, a fifth-year PhD candidate at the University of Washington, said. Morris worked with a team of astronomers that used observations made by NASA's Kepler spacecraft to measure spots on the distant star HAT-P-11. By measuring the location and activity of the starspots, they found that the star acted much like the Sun.

Kepler hunts for planets by measuring dips in the brightness of the stars they orbit. As planets pass between the telescope and their sun, the light drops ever so slightly. At the same time, the planets can help reveal sunspots because more light shines when the planet covers a bright part of the star than when it covers the dark starspot regions. "The apparent dips in brightness which famously indicate the planet's presence can also be used to measure the presence of brightness variations on the stellar surface," Morris said.

This is not the first time astronomers have measured spots on faraway stars. Other methods can study large-scale magnetic activity or resolve the surface of a few large stars themselves. However, according to Morris, smaller, cooler and older stars are all more difficult to observe. "S HAT-P-11, a middle-aged star with 80 percent the mass of the Sun, would ordinarily be a difficult target for activity studies if it weren't for its planet," he said. By using a planet, researchers were able to target smaller spots than they would otherwise have been able to see. It also helps that its planet circles the poles of its star, rather than the equator. Kepler was able to view the Neptune-sized world as it crossed several different latitudes on the star, revealing activity across the surface rather than a single band of rotation and highlighting where the starspots were most plentiful. Over four year of observations, the researchers found the starspots clustered much like those of our Sun. By: Nola Taylor Redd

The Hypatia stone's composition leaves researchers questioning where and how it formed 18 January: It is common for researchers to conduct a mineral analysis on a suspected meteorite, to determine what it is and where it came from. The process is usually done with ease. However, that simplicity was challenged when researchers came across a peculiar pebble in southwest Egypt, with a mineral makeup unlike any other planetary object.

The Hypatia stone, discovered by geologist Aly Barakat in 1996, contains a combination of chemicals and minerals that stumps researchers trying to figure out its origin. Dr Mario Di Martino/INAF Osservatorio Astrofisico di Torino

Unlike most meteorites, which have chemical compositions similar to Earth and the other rocky planets, this one had elements in the wrong proportions, or in forms not usually seen in the inner solar system. It raises the question: Is our idea of how the solar system formed and how the elements were originally scattered throughout it the right one?

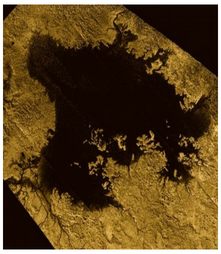
The curious case started in 2013 when a team of researchers at the University of Johannesburg revealed that an Egyptian stone, discovered in 1996, was definitely extraterrestrial. In 2015, a separate group of researchers conducted a nuclear probe and noble gas analysis, determining that the Hypatia stone (named after the famous Western woman astronomer and mathematician, Hypatia of Alexandria) did not come from any recognised comets or meteorites.

Hypatia has a mineral composition unlike that of any known meteorite. A chondritic meteorite's chemical composition, for example, is similar to Earth's, with high amounts of silicon and low amounts of carbon. (Chondritic meteorites are common, making up about 86 percent of known meteorites). Hypatia's composition, however, is just the opposite, with unusually high amounts carbon and low amounts of silicon. Hypatia's abnormal composition implies that it is made up of material that existed prior to the formation of the Sun and the planets in our solar system. But then, based on its composition, the question of how and where the iron, nickel, and phosphorus within Hypatia were formed arises.

It is believed that the solar nebula, a massive cloud of dust and gas, produced the Sun and the planets in our solar system. Planet formation likely began with concentration of the nebula's solar dust, which has long been believed to be homogeneous (the same throughout). However, Hypatia casts doubt on the homogeneous theory. There are no silicate minerals in Hypatia's matrix, in contrast to chondritic meteorites (and planets like the Earth, Mars and Venus), where silicates are dominant. Then there are the exotic mineral inclusions. If Hypatia itself is not pre-solar, both features indicate that the solar nebula wasn't the same kind of dust everywhere - which starts tugging at the generally accepted view of the formation of our solar system.

Despite the shroud of mystery that hangs over Hypatia's existence, we do know that it formed in an environment with temperatures colder than that of liquid nitrogen, which is about -196° Celsius. We also know that it came from an area beyond the asteroid belt, which produces the majority of our meteorites, and the Kuiper Belt, where most of our comets come from. However, very little is known about the chemical compositions of deeper space objects. By: Amber Jorgenson

Cassini uncovers a 'sea level' on Titan, similar to Earth 23 January: Before Cassini completed its historic 13-year mission in September 2017, it sent back data that uncovered a striking similarity between Earth and Titan, one of Saturn's 53 moons. Researchers used the mission's radar instrument data to create of a topographical map of Titan, and found that its seas share an average elevation level, similar to Earth's 'sea level'.


NASA's Cassini mission captured a false-color image of Ligeia Mare, Titan's second largest known body of liquid. The dark imagery represents the liquid hydrocarbons that make up Titan's seas and lakes. NASA/JPL-Caltech/ASI/Cornell

Earth and Titan are the only objects in our solar system known to have liquids on their surface, but the type of fluid that encompasses each object differs. While much of Earth's surface is covered in water, Titan's seas and lakes are made up of hydrocarbons, which lie over 'bedrock' of water ice covered by a layer of solid organic material.

Cornell University researchers in Ithaca, New York, suggests that Titan's three seas maintain continuous elevation with respect to Titan's gravitational pull. "We're measuring the elevation of a liquid surface on another body 10 astronomical units away from the Sun to an accuracy of roughly 40 centimetres. Because we have such amazing accuracy we were able to see that between two seas the elevation varied smoothly about 11 meters, relative to the centre of mass of Titan, consistent with the expected change in the gravitational potential," said Alex Hayes. These results suggest that Titan's liquid is communicating beneath its surface, either by travelling through underground rock - like an aquifer on Earth - or via channels connecting them.

In addition to measuring the moon's sea level, the team also studied the elevation of Titan's lakes, which often sit hundreds of metres above sea level, another similarity between Titan and Earth. They found that, within a localised area, dry lakes always sit at higher elevations, while lakes at lower elevations are filled. "We don't see any empty lakes that are below the local filled lakes because, if they did go below that level, they would be filled themselves. This suggests that there's flow in the subsurface and that they are communicating with each other," said Hayes. "It's also telling us that there is liquid hydrocarbon stored on the subsurface of Titan." By: Alison Klesman

Opportunity will celebrate its 14th year on Mars 24 January: Opportunity, one of the two Mars Exploration Rovers launched in 2003, landed successfully on the Red Planet on 25 January 2004. Its original mission parameters planned for 90 Martian days (called sols) of operation during the mild summer on the Meridiani Planum near the planet's equator. As of 16 January 2018, Opportunity has been operational for 4,970 sols and driven 45.09km on the Martian surface. On 25 January 2018, Opportunity turns 14 - in Earth years. In Mars years (which last about 687 Earth days, or 669 sols), she turns 7.4.
By: Alison Klesman

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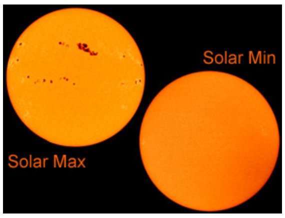
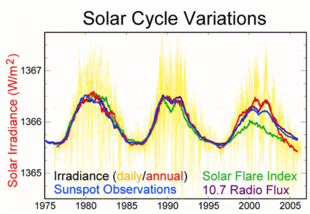
DID YOU KNOW?

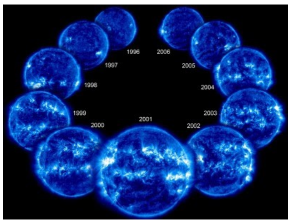
The Sun Part 23: **Solar cycle 2**



Sunspot cycle



11 year solar cycle


Solar cycle in ultraviolet

Related solar phenomena Various phenomena follow the solar cycle, including sunspots and coronal mass ejections (CME). As stated in Part 1, it is the number of sunspots which identifies the stages of the solar cycle. Sunspot positions also vary across the cycle. As each cycle begins, sunspots appear at mid-latitudes and then closer to the equator until solar maximum. They are almost never seen lower than 5° or higher than 40° North or South.

There is a direct relationship between the solar cycle and solar luminosity. The photosphere radiates more actively when there are large sunspot numbers eg during maximum, although the presence of large groups can decrease luminosity for several days as they rotate across Earth's view. Solar irradiance output can increase by about 0.07% during maximum.

The numbers of eruptions of solar flares and CMEs are also higher during solar maximum than minimum. Large CMEs occur, on average, a few times a day at maximum but down to one every few days at minimum. The size of these events, however, does not depend on the phase of the solar cycle; large flares can occur near solar minimum.

While magnetic field changes are concentrated at sunspots, the whole Sun undergoes changes during the solar cycle, albeit of small magnitude.

Other solar cycles Cyclical solar activity with much longer periods have been proposed eg 210 year Suess cycle, 2,300 year Hallstatt cycle, an unnamed 6,000 year cycle. Carbon-14 analysis has also identified cycles of 105, 131, 232, 395, 504, 805 and 2,241 years, possibly matching cycles derived from other sources. However, understanding of longer cycles is limited.

Effects of solar cycle Understanding of the cycle is important because of the known effects of some of its features on human life and activities. For example, the radiation flux of high energy protons produced by CMEs can damage electronics and solar cells in satellites, pose health risks to astronauts in space, interfere with aircraft and other long distance radio communications, and cause widespread power outages.

A number of possible adverse effects on other factors have also been proposed. The amount of UVB reaching Earth varies by up to 400% over the solar cycle due to variations in the protective ozone layer. During solar minimum, the decrease in ultraviolet radiation from the Sun leads to fall in ozone concentration. This allows increased UVB to reach Earth's surface, with associated increased risks to human health.

Changes in ionisation affecting aerosol abundance, which serves as the condensation nucleus for cloud formation, could encourage formation of cloud types likely to produce less precipitation. Links with regional weather patterns have also been hypothesised, with some research support. Also, both long and short term variations in solar activity have also been hypothesised to affect global climate, but quantification has proved very challenging eg trying to correlate solar activity with global temperatures.

Despite the value of predicting solar activity and the wealth of historical records, even advanced scientific efforts have, so far, proved to be highly inaccurate.

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

For more information on the Hermanus Astronomy Centre and its activities, visit our website at www.hermanusastronomy.co.za

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