"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

NOVEMBER 2016

This month's Centre meeting
This takes place on **Monday 21 November** at the **Scout Hall** starting at t **19.00**. The scheduled presentation by Pierre de Villiers has been postponed. Instead, Stefan Lotz of SANSA will talk on the SANSA Research Group's recent visit to Marion Island.

Monthly meeting dates for 2017
Dates for your diaries are: 23 January, 20 February, 20 March, 17 April, 15 May, 19 June, 17 July, 21 August, 18 September, 16 October, 20 November and 11 December.

WHAT'S UP?

The 'SCAF' stars Four bright stars, forming an uneven curve, can be found high in the summer sky. Easiest to find, to the right of Orion, is **Sirius** (Alpha Canis Majoris), the brightest star in the night sky, and also one of the closest (8.6 light years (ly)). Moving westwards, **Canopus** (Alp[ha Carinae) is the next in the quartet. The second brightest star, it is 310 ly from Earth. Further west is **Achernar** (Alpha Eridani). Although closer to Earth than Canopus at 139 ly, it is less bright and the ninth brightest star in the sky. Its Arabic name means 'river's end', denoting its position at the southern tip of the long, meandering constellation Eridanus. Eridanus, the 6th largest of the 88 named constellations, represents a river. It runs from near Taurus on the celestial equator deep into the southern sky. The furthest west of the quartet is **Fomalhaut** (Alpha Piscis Austrini). Only 25 ly away from Earth, it is the brightest star in the small constellation Piscis Austrinus (the southern fish). Its Arabic name means 'fish's mouth' identifying its position at the mouth of the eponymous constellation.

LAST MONTH'S ACTIVITIES

Monthly centre meeting On 17 October, Jenny Morris gave a presentation titled 'Dark skies: the unseen Universe'. Johan Retief reports: "Jenny gave us an excellent talk on the darkness in our Galaxy and the Universe. She started with the Great Rift, an area of overlapping dark clouds in the Sagittarius arm of the Milky Way. Jenny showed photos of the dark dust lanes near the centre of our galaxy as well as some dark nebulae like the "Coal Sack" in the Crux constellation. She then told us about the dark denizens of the Milky Way, red dwarf stars, brown dwarf stars, black dwarf stars and stars that failed to achieve fusion in their cores and exist as loose drifting nomad planets. Jenny then ventured into the universe and discussed the unseen and unexplained dark matter and dark energy that seem to be interacting with gravity in the universe causing stars to rotate at equal speeds around the centre of the galaxy and causing galaxies to expand outward in the universe. All-in-all and excellent and thought-provoking talk that also set the scene for Halloween at the end of October!"

Interest groups

Cosmology Sixteen people (11 members, 5 visitors) attended the meeting on 3 October. They considered the main points of the second of five short books on quantum mechanics by Dr Robert Piccioni of Stanford University. The topic of 'Reality, uncertainty and Schrodonger's cat' again encouraged thoughtful questions and lively discussion.

Astro-photography There was no meeting in October.

Other activities

International Observe the Moon night Unfortuantely, cloudy conditions meant that the event scheduled for 8 October had to be cancelled.

Educational outreach

Hawston Secondary School Astronomy Group The meeting on 18 October was the first of the few which will be possible during the last term of the school year.
Lukhanyo Youth Club No meeting took place in September.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This will take place on **Monday 21 November** at the **Scout Hall** at **19.00.** The presentation on the Hubble telescope has had to be postponed until next year. Instead, Stefan Lotz of SANSA on the SANSA Research Group's recent visit to Marion Island. In the past, other SANSA staff have talked on scientific visits to distant shores south of Hermanus, notably Antarctica. These have provided fascinating insights into unusual places, and this one promises to do the same.

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. This month's meeting will take place on **7 November** at the Scout Hall. Attendees will consider Part three of Robert Picciioni's short books on quantum mechanics: 'Wave functions, superposition and virtual particles'.

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 third Monday of each month. At the **14 November** meeting, members will continue to discuss processing of their own images.

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

Stargazing No event is scheduled for November.

Hermanus Youth Robotic Telescope Interest Group Technological and communication issues continue to prevent access to the telescopes for learners.

For further information on both the MONET and Las Cumbres projects, please contact Deon Krige at deonk@telkomsa.net

FUTURE ACTIVITIES

Logistical issues at possible locations mean that no events are being planned for 2016.

2016 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the Scout Hall beginning at 19.00. Details for 2016 are:

12 Dec Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Progress with the project still awaits consideration of the plans by the full Council of Overstrand Municipality. 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

Deep mysteries lurk below (and even above) Mercury's surface 30 September: Mercury is the unloved planet of our Solar System, a barren rock too small and too near the Sun to be interesting. That's what we thought until we took a closer look and discovered everything about this plain little planet breaks our initial models for how it formed.

NASA / JHU Applied Physics Lab / Carnegie Inst. Washington

Mercury is a hard planet to observe. It is so close to the Sun that Earth-based telescopes are easily blinded by the star, and locked in orbital resonance that leaves us peering at the same patch of rocks over and over. Even sending spacecraft to investigate is a problem, with probes speeding up as they fall down the gravitational well towards the Sun. It took looping around Venus for Mariner 10 to slow down and redirect into Mercury flybys in the mid-1970s, and the MErcury Surface, Space ENvironment, GEochemistry, and Ranging

(MESSENGER) probe needed to make an even more elaborate dance to slip into orbit in 2011. The challenges of observing Mercury paired with its apparent simplicity to leave it frequently overlooked in favour of more dynamic planets. It is slightly larger than Earth's Moon, so scientists assumed it was another cold, dead and dull cratered world without much to offer to our understanding of the story of planetary formation.

Mercury's distinguishing characteristic is that it is unusually dense for its size, so dense that it must have a massive metallic core. The core is dramatically disproportional to those found within other terrestrial planets, over half of the planet's volume while Earth's is less than 10%. Scientists theorised that it originally formed as a larger planet similar to the Earth and Venus, and either had a major collision strip it of much of its crust (akin to the theory of how Earth gained its Moon), or that its close proximity to a younger, hotter Sun boiled the crust and vaporised lighter elements. During its flybys, Mariner 10 mapped a series of long, tall cliffs called scarps and a series of wrinkled folds. Paired with the knowledge that Mercury has an unusually large core, scientists theorised that the planet's surface crumpled as the core cooled and condensed over billions of years.

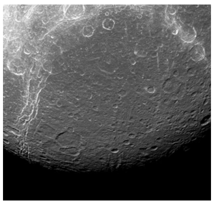
However, the more we learn, the more those glib stories unravel. Mercury has an active, modern magnetic field, the only terrestrial planet besides Earth that protects its surface from the solar wind. MESSENGER detected lingering shadows of the magnetic field in the rocks, confirming that Mercury's magnetic field has lasted billions of years. The most likely explanation is that it has a liquid core, hot metal moving fast to generate a magnetic field. This idea is reinforced by Mercury's libration, a dramatic over-rotation at the apex of its orbit possibly enabled by a liquid layer decoupling a solid inner core from the rigid surface.

The next complication to the puzzle is that the large, global scarps and wrinkles first spotted by Mariner 10 were also spotted by MESSENGER, along with much smaller version if the same structures. The scarps first identified in 1974 and 1975 are hundreds of kilometres long and several kilometres tall, enormous cliffs towering over the landscape. The latest observations supplement those with scarps a few kilometres long and only tens of meters tall, and more importantly, geologically young. The larger scarps are ancient and softened by the passage of time, but the smaller ones are crisp and fresh, likely formed within the last tens of millions of years. Thus, instead of being cold and dead, Mercury is still geologically active as its hot core cools, the planet shrinks, and the surface crumples.

Equally strange, when mapping the feology of Mercury's surface, MESSENGER found distinct regions of unique geochemistry, a mix of terrains instead of a single roughly-similar surface. The spacecraft also spotted delicate volatiles like potassium and uranium, chemicals that should have been destroyed by the enormous heat of a crust-shearing collision or the scorching heat of a crust-boiling Sun. By their very presence, these chemicals argued against either theory for Mercury's oddly-large core, leaving scientists scrambling for a new theory.

More data poured in from MESSENGER, with scientists identifying pyroclastic flows that could only be the result of explosive volcanism of lava mixed with volatile gases like water and carbon dioxide, more chemicals scientists did not expect in abundance on a planet so near the Sun. Soon afterwards, the spacecraft's radar spotted water ice lurking in the shadows of the polar craters, reminiscent to the ice hiding in polar craters of our Moon. The MESSENGER mission came to an end in 2015, the spacecraft running out of fuel and deliberately crashing into the planet. Now, scientists are left analysing and reqnqlysing the data from its 4,105 orbits to try to piece together a new explanation for how Mercury formed that pull all these pieces together. In all the mysteries lies a tantalising new possibility for investigating this deceptively-simple planet: quakes. If Mercury truly does have a hot, liquid core and is geologically active today, every time the crust moves to create a new ridge or wrinkle, a quake releases seismic waves propagating through the planet. On Earth, we detect that seismic energy with seismometers, observing the speed and distribution of the waves to map the planet's interior. Astronauts did the same thing on a smaller scale during the Apollo missions, observing moonquakes to understand what was going on below the surface. This same idea could work on Mercury, with observations of seismic waves pinning down the true size and structure of the core, and detecting if, like the Earth, it has a warm liquid outer core around a solid interior. By: Mika McKinnon

Dione may be Saturn's third moon hiding an ocean 4 October: Saturn's moon Dione has joined the growing list of watery bodies in our solar system.



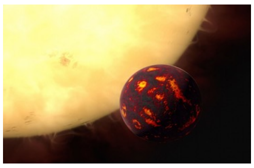
Dione reveals its past via contrasts in this view from NASA's Cassini spacecraft NASA/JPL-Caltech/Space Science Institute

Data from NASA's Cassini probe indicate that a liquid ocean some 30 km deep exists far below the icy surface of the moon. This means that its interior looks similar to two other Saturnian moons, Titan and Enceladus, both of which hide vast oceans beneath a thin crust of ice. Dione is likely different in at least one respect though: the data indicate itss ocean buried much deeper. The researchers based their analysis on gravity measurements taken by the Cassini spacecraft as it flew by Dione, tracking subtle shifts in the trajectory of the craft due to Dione's gravitational pull. Similar methods have been used before, but the data always seem to indicate that Dione had no such subterranean ocean. The new data, combined with a revised model of how the moon's crust should behave, changes that assumption.

The researchers also propose a new understanding of Enceladus. The moon's ocean and geysers have garnered a lot of attention, but i i's been assumed that Enceladus' water would be trapped deep below the surface. Based on the new model and Enceladus' libration - relatively large back-and-forth swings during its orbit - the data indicate the moon's ocean is only a few miles beneath the surface. This would also help explain the presence of those geysers.

The discovery of liquid water on yet another moon in the solar system potentially gives researchers another option in the search for life. The ocean has probably existed for most of Dione's existence, giving any potential organisms plenty of time to establish themselves. The researchers are most interested in the region where the water meets the moon's rocky core, where chemical interactions between the two could provide some of the molecules critical for life to begin. By: Nathaniel Scharping

The newest weird solar systems: lonely hot Earths 10 October: The first planets identified beyond the solar system were shockingly unlike the nine worlds long-known within it. In sorting through the new exoplanets, scientists described them in terms that compared them to Earth's neighbours, dubbing them 'hot Jupiters' or 'super-Earths'. There are also 'hot Earths', terrestrial worlds orbiting their suns in periods less than two days. Although some hot Earths have neighbours, scientists have now identified a new type of system consisting only of these molten worlds.


Artist's impression of binary star 55 Cancri. ESA/Hubble, Kornmesser

Kepler-10b is arguably the most famous hot Earth. Discovered in 2011, it was the first Earth-sized world spotted outside the solar system. However, the overheated planet has a companion, a massive giant dancing far inside what would be the orbit of Mercury in our own solar system. "We've identified a population that has an 'isolated hot Earth,' where the hot Earth is far from any companions," Jason Steffen of the University of Nevada said. Steffen and Jeffrey Coughlin, of the SETI Institute in California, analysed the most recent data from NASA's Kepler spacecraft and identified the unusual isolated systems of worlds. "A hot Earth can exist in a normal planetary system - the majority probably do," Steffen said. "This new population has a dynamically isolated hot Earth and is therefore distinct."

Thanks to their orbits, hot Earths get more than a little toasty. Kepler-10b, which circles its star more than 20 times closer than Mercury orbits the Sun, can reach temperatures as high as 1,371 degrees C. Like other hot Earths, its close orbits most likely keep them with one face perpetually pointing at their star. "If you were on the sunlit side, the surface may well be molten and slowly vaporising due to the intense radiation from the nearby star," Steffen said. "On the dark side, it's probably pretty cold since there won't be much atmosphere to circulate the heat from the day to the night side."

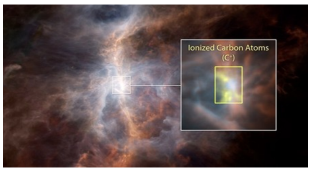
The pair examined over 3,000 planets and planet candidates to investigate differences between single and multi-planet systems. Nearly two-thirds of the worlds were the only planets spotted orbiting their stars. By searching for systems that might exist in single-only systems, the pair hoped to find insights into why so many worlds danced alone. First, though, they had to estimate how many of the one-world systems were truly single. Kepler can only spot worlds that orbit their stars along Earth's line of sight. If the planet's path around its sun is tilted in respect to our own, it could dance around the star unseen.

Other worlds could be overlooked due to their size or distant orbits. Out of the 144 hot Earths the team identified, they estimated that at least 24 of them orbit without another close planet, making them unique compared to multi-planet systems. Their finding suggests that at least 1 out of every 6 hot Earths has no nearby companion. In this case, 'nearby' means worlds with orbits "only a few times larger than the orbit of the hot Earth," Steffen said, which would translate to one or two months. "This might not sound like a distant orbit, but when it comes to planetary orbits, it is the ratio of the orbital period that matters," he said. "The equivalent in our solar system would be having Mercury and Jupiter with nothing in between."

After identifying the strange new systems, the pair turned their attention to how they could have formed. One possible source is that they are the remains of 'hot Jupiters', gas giants orbiting their star in only a few hours. "A hot Jupiter could become a hot Earth if it gets sufficiently close to the star that the star pulls the atmosphere off of the planet," Steffen said. Gas giants in the process of losing their atmosphere have already been spotted in other systems. Previously, scientists suggested that rocky worlds several times larger than our planet known as super-Earths could be the stripped worlds, but smaller cores could be hot Earths.

Hot Jupiters are a puzzle in their own right. The first hot Jupiter was spotted in 1995, but scientists still are not sure how they form. Most likely, they formed in the distant, cooler regions of their system and migrated inwards, knocking other planets out of the way before something halted their progress and they settled into a close orbit around their star. Only a handful of the hot giants have other planets in their systems. If hot Earths are the cores of hot Jupiters, then the overbaked gas giants could be twice as common as previously estimated, Steffen said. That could affect understanding of how these oddball worlds form. Another option, proposed for Kepler-10, is that the smaller terrestrial worlds began their migration before their companions formed. Ultimately, the travelling rocky world is stopped by the disk of gas and dust from which it formed. Finally, interactions between planets in a system could drive smaller rocky worlds inward. Some worlds are booted out of the system, and the hot Earth settles into orbit around its sun. By: NT Redd

Scientists find ultraviolet light may create life-essential chemicals 12 October: Scientists have found that ultraviolet light from stars is more important in creating molecules necessary for the building blocks of life than once believed. The theory used to be that hydrocarbons were created in 'shocks', or violent stellar events that cause a lot of turbulence and, with the shock waves, make atoms into ions, which are more likely to combine. Data from the European Space Agency's Herschel Space Observatory has since proved that theory wrong. Scientists at Herschel studied the components in the Orion Nebula, mapping the amount, temperature and motions for the carbon-hydrogen molecule (CH), the carbon-hydrogen positive ion (CH+) and their parent molecule: carbon ion (C+).



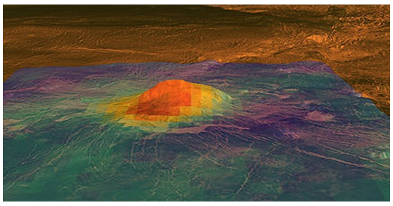
Infrared image by ESA'S HSO of the dusty side of Orion's Sword

They found that in Orion, CH+ is emitting light instead of absorbing it, which means that it is warmer than the background gas. This was surprising to scientists because the CH+

molecule is incredibly reactive and needs a high amount of energy to form, so when it interacts with the background hydrogen in the cloud it gets destroyed. This data shows that the CH+ molecules were probably created by the ultraviolet emission of young stars in the Orion Nebula. When a hydrogen molecule absorbs a photon of light it either vibrates or rotates, but when hit by an ultraviolet photon it does both.

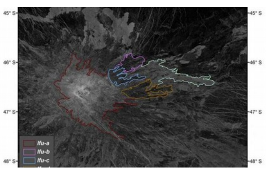
The Orion Nebula has plenty of hydrogen gas, so when ultraviolet light heats up the surrounding hydrogen molecules, it creates a perfect condition for hydrocarbons to form. When the interstellar hydrogen gets warmer, carbon ions start to react with the molecular hydrogen, creating CH+, which eventually captures an electron so that it can form the neutral CH molecule. "It's still a mystery how certain molecules get excited in the cores of galaxies," John Pearson, researcher at NASA's Jet Propulsion Laboratory and co-author of this study, said. "Our study is a clue that ultraviolet light from massive stars could be driving the excitation of molecules there, too." By: Nicole Kiefert

Venus explodes with volcanoes in the present day 18 October: Using data from the European Space Agency's Venus Express orbiter, scientists peered through the thick layer of clouds shrouding the plant to analyse the stratigraphy of lava flows discovered on Idunn Mons, a volcano in Venus' southern hemisphere. With additional radar data from NASA's Magellan mission, which visited Venus in the early 1990s, the researchers mapped the path the lava flows carved as they moved down the mountain.



An elevation model of Idunn Mons on Venus, with thermal emissivity data overlain on the surface. Red corresponds to warmer areas. NASA/JPL-Caltech/ESA

Astronomers first got hints that Venus was geologically active in 2010, after analysing near-infrared data from Venus Express' VIRTIS (Visible and InfraRed Thermal Imaging Spectrometer) instrument. They found multiple areas on the ground with higher levels of emissivity - an object's ability to emit infrared energ - possibly indicating the presence of magma beneath the surface. They also found evidence that the warmer rocks displayed few signs of weathering, meaning that they were brand new in terms of geological timescales.



Idunn Mons seen from above, with the five areas with lava flows outlined. Credit: NASA/JPL-Caltech/ESA/DLR)

Idunn Mons was one of the areas with warm, fresh rocks found in 2010, and researchers have found even more evidence to link the lava flows to the areas of high emissivity. Using a numerical model, they mapped out the most likely path lava would take as it flowed down the volcano. They found that this path matched up well with the areas identified as being warm, evidence that cooled lava flows sit atop geologically active areas on Venus.

“It is the first time that - combining the datasets from two different missions - we can perform a high resolution geologic mapping of a recently active volcanic structure from the surface of a planet other than Earth,” said Piero D’Incecco,

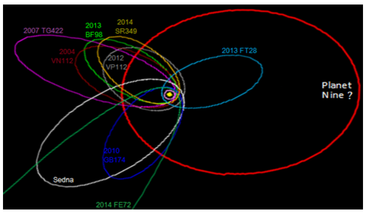
Other research solidifies evidence of ongoing geologic activity on Venus as well. Scientists in the US, France and Japan measured variations in sulphur dioxide levels in Venus’ atmosphere over time. Sulphur dioxide is associated with volcanic eruptions here on Earth, and Venus looks extremely similar to the Earth in terms of composition. Both papers noted dramatic fluctuations in atmospheric sulphur dioxide levels, sometimes on the scale of just hours. This could be the result of weird weather patterns on Venus, but another theory is that volcanic activity is injecting shots of sulphur dioxide into the atmosphere.

While the Venus Express orbiter ended its mission in 2014, another satellite, Japan’s Akatsuki, is just beginning to send back data. The craft was meant to enter orbit around five years ago, but a clogged check valve prevented it from performing a braking manoeuvre, sending it on a years-long trip around the Sun. Researchers finally regained control of the craft in December 2015, and it has begun sending back data on atmospheric conditions on Venus from its infrared, ultraviolet and visible spectrum cameras. Unlike previous missions, Akatsuki orbits Venus’ equator in the same direction as the planet’s clouds, allowing it to perform better, long-term measurements of the complex atmospheric dynamics on Venus. By: Nathaniel Scharping

Planet Nine may be responsible for tilting the Sun 19 0ctober: Earlier this year an announcement raised a tantalising possibility: a ninth planet lurking in the outer reaches of our solar system. Caltech astronomer Michael Brown and theoretical astrophysicist Konstantin Batygin found evidence for a possible 10 Earth mass planet that may be tilting long-orbiting dwarf planets on their sides and shepherding them into clusters far past the orbit of Neptune in highly eccentric orbits. In the last several months, more and more papers have been published about the possible planet and how it might prove an explanation for other strange things happening in our solar system.

At a press conference held this afternoon, another announcement was made about Planet Nine’s effects on the spin-axis tilt of our Sun. We have known for about 200 years that the Sun is tilted, but scientists have never known why. The catch here is, the Sun is not actually tilted at all. We are. To explain this oddity and what’s happening to our solar system, theoretical astrophysicist, Konstantin Batygin explained, “When planetary systems form, they form from very flat discs. The motion that everything in our entire planetary system forms in a very proto-planetary flat disc is one of the basic principles of planetary formation theory. The planetary orbits themselves are fully consistent- If you look at how inclined the planets are with respect to each other they are only inclined by no more than one degree so the planets of the solar system are remarkably flat.

“The Sun's rotation was measured for the first time in 1850 and something that was recognised right away as that its spin axis, its north pole, is tilted with respect to the rest of the planets by 6 degrees. So even though 6 degrees isn’t much, it is a big number compared to the mutual planet-planet misalignments. So the Sun is basically an outlier within the solar system. This is a long-standing issue and one that is recognized but people don’t really talk much about it. Everything in the solar system rotates roughly on the same plane except for the most massive object, the Sun which is kind of a big deal.



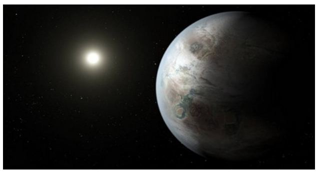
Hypothetical Planet 9, and related eTNOs WikiMedia Commons

"We asked ourselves, "what obliquity, what misalignment would Planet Nine induce in the solar system?" because it must induce some. We know that Planet Nine's orbit in inclined. As a result, when Planet Nine torques the rest of the solar system, the two sort of act as two precessing tops. Planet Nine being in its own plane induced a precession on the remainder of the solar system as if the plane of the solar system was a flat top on the surface of a table. If you imagine that the Sun and the planets were co-planar, meaning they were locked into the same plane 4 billion years ago, and allow the clock to run forward in the presence of Planet Nine, then 4 billion years later the Sun would have been apparently tilted by exactly its current obliquity, or 6 degrees. But, what's actually going on is that the Sun is staying put in its fixed reference frame and it's the planetary orbits that are being tilted by Planet Nine. So, Planet Nine has tilted the entire disk of the solar system by 6 degrees and because we live on that disc … to us it looks like the Sun is tilted, but it's actually the other way around.

"Planet Nine is only 10 Earth masses as compared to Jupiter's 300 Earth masses, but its orbit is huge. So it's an argument that is basically like an asymmetrical see-saw or a dolly. Planet Nine has a really long orbit so it can assert quite a bit of torque on the inner planets without having to apply so much force. Planet Nine has as much angular momentum as the entire solar system combined, because it's orbit is so big. All this information helps us understand planet formation because planet formation theory dictates that all things must start out co-planar, in the same plane. The fact that the Sun is tilted with respect to the rest of the solar system is almost a violation of that very fundamental principle, so understanding what's going on there is important. But, there's also a second component to why this calculation is interesting. We very quickly realised that Planet Nine must do something, it must tilt the solar system by some angle and we thought to ourselves what if this angle was really big? What if the Sun was tilted by 40 degrees in our calculations? That would actually be evidence against Planet Nine, instead we got this beautiful agreement of the theory. By: Shannon Stirone

What's the difference between Earth-mass and Earth-like? 21 October: Every time astronomers discover another exoplanet, the first thing we all want to know is "Does it look like Earth?" Finding an Earth-like exoplanet would dramatically increase our chances of finding life as we know it there, and could finally prove that we're not all alone in this big, cold universe.

However,, when we see planets described as Earth-like, we should be sceptical. With our current instruments, it is hard for us to even find that other planets are out there (although it has become easier), much less see if there are oceans and atmospheres and trees and Taco Bells. Furthermore, what does it even mean to be "Earth-like?" Does it just need to be in the habitable zone? Or does it need to have liquid water and a similar atmosphere and maybe also be undergoing catastrophic climate change to qualify as being ‘like’ Earth? The question likely won't be resolved anytime soon, because we will not be able to determine most of these things for quite a while. While some progress is being made on using the starlight that filters through a planet's atmosphere to detect what kinds of gases are there, that is about as precise as we are going to get for a while. When, and if, the Breakthrough Starshot mission ever succeeds in reaching Alpha Centauri, we may have a better idea, but even that mission is decades off. So, for now, let us put off calling planets Earth-like. Unfortunately, we really have no way of knowing exactly how alike they are to our own precious planet.


This artist's concept depicts one possible appearance of the planet Kepler-452b, the first near-Earth-size world found in the habitable zone of star similar to our Sun NASA Ames/JPL-Caltech/T. PylS

We are currently limited to just a few solid observations about planets outside of our solar system, and even those can be tough to glean. The three pieces of information we can obtain with any kind of reliability are the mass of the planet, its orbital period, and how far it orbits from its star. These may seem paltry compared with the detailed measurements we're able to return from Venus or Mars, but astronomers can still derive important information about a planet just by knowing how big and far away it is. To determine the mass of an exoplanet, astronomers usually look to the star it orbits to measure tiny back-and-forth movements caused by the planet's gravitational pull as it orbits. We should remember that mass and size are different though, and we have no real way to measure size right now - the best we can do is run an approximation based on the mass. To figure out how fast it rotates, all astronomers have to do is watch and see how often the light of the star dims when the planet passes in front of it. Combining this information with the mass of the star, we can figure out how far away the exoplanet should be, and whether that places it in the habitable zone of a star or not.

Being in the habitable zone, the small ring around a star where temperatures could allow liquid water to exist, is one of the biggest tests we can do right now for astronomers to determine if a planet could support life or not. If a planet lives outside of that thin ring, the chances of finding life there are pretty much zero. While the habitable zone of a star may be the first hurdle for a planet to overcome on the path to being like Earth, it is far from the last. Just because liquid water could exist there, does not mean it actually does. The planet could be full of toxic minerals too, or a complete wasteland. Its core, the internal dynamo that powers our radiation-deflecting magnetic field here on Earth, could be dead, or it could have lost its atmosphere. It could be blasted by waves of powerful radiation from its star, or it could have been assaulted by asteroids. Thus, there are many reasons why a potentially exciting exoplanet could be uninhabited, and our methods of observation aren't refined enough to explore most of those reasons. Calling an exoplanet 'Earth-like' is a little too much of a stretch at this point. By: Nathaniel Scharping

New NASA Images Confirm Schiaparelli's Demise 27 October: The tragic fate of the European Space Agency's lander has been confirmed. An image, taken on 25 October by NASA's Mars Reconnaissance Orbiter reveals a series of impact crates strewn about the expected landing zone of the craft, with no sign of the lander itself. The craft's back shell and parachute appear at the bottom of the image, while the heat shield rests in what appears to be several fragments at top right. A dark crater at the upper left is the only evidence of the craft's landing.

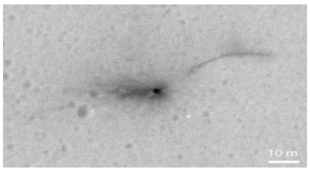


Image of Schiaparelli's landing site. The dark streaks are consistent with an impact crater. NASA/JPL-Caltech/Univ. of Arizona

The lander was supposed to make a soft landing on the Martian surface on 19 October, using a combination of a heat shield, parachute and rocket thrusters to slow its descent. A probable softward error caused the craft to malfunction, jettisoning its parachute too early and firing its thrusters for only three seconds. The result was a free fall from over a mile above the planet, and a landing at around 180 miles per hour - far from a soft landing.

Schiaparelli was still able to return valuable data for the first few minutes of its flight, and the experiment should hopefully provide valuable insights for future missions as well. ESA's Trace Gas Orbiter, which arrived at Mars along with Schiaparelli, is currently functioning as expected. By: Nathaniel Scharping

New Horizons sends back last of Pluto data 29 October: The last bit of data from NASA's New Horizons Pluto mission has arrived on Earth.


Composite enhanced colour images of Pluto (right) and Charon (left), taken by NASA's New Horizons spacecraft on 14 July 2015. NASA/JHUAPL/SwRI

The flyby that recorded the data took place in July 2015, lasted about 12 hours, and gathered about 16 gigabytes of data. It only had one pass at its target and gathered 100 times more data on its close approach to Pluto and its moons than it could have sent home before moving on. Because there was so much data, it took a year and a half to send back all of it because it only sent back between one and four kilobytes per second. The last of the 50-plus megabytes of data on the Pluto system data came into the John Hopkins University Physics Laboratory in Laurel, Maryland early on 25 October .

Scientists are still sorting through the data to learn more about Pluto and all five of its moons. "There's a great deal of work ahead for us to understand the 400-plus observations that have all been sent to Earth," Alan Stern, New Horizons principal investigator from Southwest Research Institute in Boulder, Colorado, said. "And that's exactly what we're going to do – after all, who knows when the next data from a spacecraft visiting Pluto will be sent?" New Horizons will depart in January 2019 for its next mission: an icy body called 2014MU69, a Kuiper Belt object about a billion miles past Pluto. By: Nicole Kiefert

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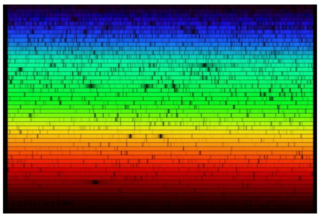
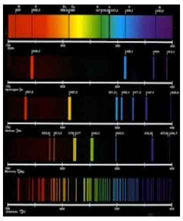
DID YOU KNOW?

The Sun Part 8: **Spectroscopy 2**



Sun's absorption spectrum



Sun's emission spectrum

Bunsen and Kirchhoff

Fraunhofer lines are absorption lines, dark areas which occur when the energy from a radiative source is absorbed by the material or object. Absorption lines result when an electron moves to a higher energy level and needs an input of energy to do so. They are formed by cooler gas in the Sun's photosphere (outer layer) that absorbs radiation emitted by hotter gases below. Each line is a unique signature of the element or molecule that forms it, enabling the chemical composition of the star to be determined.

In contrast, emission lines are bright lines in particular wavelengths in a spectrum, given out by emitted hot or excited atoms. Emission lines result are formed when an electron drops from a higher to a lower energy level, with associated release of energy. They are the means by which scientists can determine the temperature, pressure and chemical composition of the emitting gas. They can appear on their own, or superimposed on an absorption spectrum eg from the hot gases round a star. Whether absorption or emission lines are observed depends on the type of material and its temperature relative to another emission source.

In the 1850s, the Swedish physicist and astronomer Anders Ångström, while using the fact that the simplest method of exciting a sample is to heat it to a high temperature, discovered the phenomenon of discrete emission lines. He also noted that the dark Fraunhofer lines in the solar spectrum had the appearance of a reversed emission spectrum ie they were absorption lines. In 1861, he began intensive study of the solar spectrum. A year later, combined photographic and spectrographic study of the Sun's emission spectrum led to him proving the presence of hydrogen in the Sun, among other elements.

These hydrogen lines were later named Balmer lines after the Swiss mathematician Johann Balmer who, in 1885, identified that the four visible hydrogen lines were part of a series that could be expressed in terms of integers. In 1868, Ångström published an atlas of solar spectrum and measurements which contained the wavelengths of over 1,000 spectral lines.

Advances in spectral analysis in chemistry were essential prerequisites to improved understanding of astronomical spectroscopy, including explanations for the phenomena behind the dark lines. Two of the scientists central to this were The German chemist Robert Bunsen and the German physicist Gustav Kirchhoff. In 1859, they started working together on emission spectra. Using advanced techniques, including a prototype spectroscope, they established the principles of spectral analysis while discovering several new elements during their study of the spectra of heated materials. This work established the direct link between chemical elements and their unique spectra.

Independently of Ångström, they identified that Fraunhofer lines indicated that light from the photosphere was being absorbed by at those wavelengths by the Sun's atmosphere. They also realised that one of the Fraunhofer lines was produced by sodium in the solar atmosphere, and that, therefore, other Fraunhofer lines revealed other elements present in the Sun. Kirchhoff also independently developed three laws relating to spectroscopy. These are:

- An incandescent solid, liquid or gas under high pressure emits a continuous spectrum
- A hot gas under low pressure emits a 'bright line' or emission line spectrum
- A continuous spectrum source viewed through a cool, low-density gas produces an absorption line spectrum

The work of Bunsen and Kirchhoff on the Sun's spectrum formed the foundation of astronomical spectroscopy and kick-started the work done by the English astronomer William Huggins and others. In the 1860s, William and Margaret Huggins used spectroscopy to determine that stars are composed of the same elements as those found on Earth. Their spectral analysis of celestial objects also enabled them to distinguish between features like nebulae and galaxies. They achieved this by identifying that nebulae eg Orion nebula had the pure emission spectra characteristic of gas, while others eg Andromoeda galaxy had the spectral characteristics of stars. In 1864, they were the first take take a spectrum of a planetary nebula, the Cat's Eye Nebula.

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

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

COMMITTEE MEMBERS

Pierre de Villiers (Chairperson, observatory, youth club)	028 313 0109
Laura Norris (Treasurer)	028 316 4453
Peter Harvey (Secretary, monthly sky maps)	028 316 3486
Jenny Morris (Vice-chairperson, newsletter)	071 350 5560
Karin de Bruin (Observing)	028 316 2080
Derek Duckitt (Website editor)	082 414 4024
Bennie Kotze (Outreach co-ordinator)	128 316 3666
Deon Krige (Youth robotics project, astro-photography)	028 314 1045
John Saunders (Guest speakers and events)	tibouchina286@gmail.com

Non-committee members with roles:

Pierre Hugo (Cosmology interest group)	028 312 1639
Johan Retief (Hawston School Youth Club)	028 315 1132