"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

NOVEMBER 2017

This month's Centre meeting
This will take place on **Monday 20 November** at the **Catholic Hall** starting at **19.00**. Amoré Nel, doctoral student at SANSA will be talking on 'The mystery of the black aurora'. See below for more details.

Star-gazing this month
Star-gazing will take place on **Friday 10 November** at **Gearing's Point**, starting at **19.30**, weather permitting. If the weather is problematic, the event will move to **Saturday 11 November.** Viewing targets will include Saturn, 2 nebulae, 2 globular clusters, the Magellanic Clouds and a spiral galaxy.

WHAT'S UP?

Another celestial trio On the 20th of this month, Saturn (which is visible between Scorpius and Sagittarius all year) is joined by Mercury and the crescent Moon, forming a close threesome. It can be found after sunset low to the west. Named for the Roman god of agriculture, Saturn was one of the planets known to the ancients, its white colour easily visible to the naked eye despite being twice as far from Earth as Jupiter. However, it was not until development of the telescope that its unusual, beautiful structure began to be revealed. In 1610, Galileo noted its strange elliptical shape, but could not explain this. It was Christiaan Huygens who, in 1659, was able to identify that the bulge was created by Saturn's complex ring system. He also discovered Saturn's largest moon, Titan. It was only in 1977, with the discovery that Jupiter, Uranus and Neptune also have faint rings, that Saturn's rings ceased to be considered unique. Although it is the second largest of the planets, Saturn is also the least dense, the only one less dense than water. Although about 764 Earth's could fit into it, it contains only around 95 times the amount of material than Earth.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter on 16 October was Centre member, Jenny Morris, Johan Retief reports: 'Jenny presented a fascinating talk on the largest planet in our solar system. Jupiter, the fifth planet from our sun, 5½ times more distant from the Sun than Earth, is a gas giant planet with a mass exceeding 2.5 times the total mass of all the other planets as well as the small solar system bodies in the solar system. It formed very early during the planet forming process in the primordial nebula round the Sun and exerted a major effect on the formation of the remainder of the solar system. The planet consists mainly of hydrogen and helium in proportions similar to that of the Sun.

Structurally the planet is deemed to have a solid heavy core surrounded by liquid metallic hydrogen. It has a very low density compared to the rocky planets and has no surface as such. Mass and gravity create a situation that Jupiter is quite warm and in fact emits more heat than it receives from the Sun. Its atmosphere displays bands/zones of gas and stormy winds and is quite beautiful. A giant red spot the diameter similar to twice that of Earth exists and is the result of a massive storm similar to a cyclone.

Recent discoveries of exoplanetary systems have revealed that the order of our solar system does not correspond to the 'general' order of planetary system. Where other planetary systems have heavy 'earth-like' planets close to their parent stars, similar planets in our system do not exist. The 'grand tack hypothesis' is based on a model where Jupiter and Saturn came to orbit in resonance with one another and started sweeping inwards towards the Sun like a sailing vessel tacking against the wind. They might have pushed planet forming planetesimals into the Sun thereby denying the formation of 'super earths' in the inner orbits round the Sun. Sweeping outwards, the same two planets might have pushed outer giant planets out of the solar system.

Jenny also told us about the 69 moons of Jupiter, about the four large Galilean moons of which Ganymede is the largest and exceeds the planet Mercury in size, and about Europa, a moon with a water-ice crust and a heavy core. She also showed a beautiful slide of the rings of Jupiter which were only discovered once the space craft Voyager I passed the planet in 1979.'

Interest groups

Cosmology 12 members attended the meeting on 2 October. They watched another two episodes in the DVD series: Particle Physics for Non-Physicists: a Tour of the Microcosmos' by Prof Steven Pollock, Professor of physics at the University of Colorado at Boulder. These episodes were Lecture 17: 'Weak forces and the standard model' and Lecture 18: 'The greatest success story in physics'.

Astro-photography No meeting took place in October.

Other activities

Educational outreach

Hawston Secondary School Astronomy Group Meetings have stopped for the remainder of the year, as the learners are preparing to write Matric exams.

Lukhanyo Youth Club No meetings are being arranged while members are attending a series of workshops being run by SANSA staff during 2017.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting will take place on **Monday 20 November** at the **Catholic Hall** starting at **19.00**. The speaker is Amoré Nel, a doctoral student at SANSA. Her topic is 'The mystery of the black Aurora'. Amoré has a BSc in Applied Mathematics, BSc (Hons) in Astrophysics and an MSc in Space Physics. She is currently working towards her PhD in Space Physics at SANSA. She gives the following background to her presentation: 'Black auroras are regions of the sky where bright auroras are expected, but do not appear. They are observed either as small black patches or black rings that drift, mainly eastward; or as thin black arcs with specific motions and vortices.

Black auroras, whilst commonly observed at high latitudes, remain a mysterious part of our space environment whose mechanism is still unknown.

Black auroras are visible thanks to instruments like EISCAT, the world's most sophisticated incoherent scatter radar system, located in Finland, Norway and Sweden. EISCAT can study a wide range of geophysical phenomena in the ionosphere, including black auroras. For this research, the EISCAT electron energy data is combined with optical data to shed light on this mysterious auroral phenomenon.'

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 **6 November** at the **Catholic Hall**, starting at **19.00**. Attendees will watch the next 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 19: 'The Higgs particle' and Lecture 20: The solar neutrino puzzle'.

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 **13 November**. Members will continue to work on processing their own astro-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

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

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

FUTURE ACTIVITIES

The trip to SKA near Carnarvon, from 23-25 November, has been advertised to members, and is fully booked. If you wish to put your name on the waiting list, please e-mail John Saunders at antares@hermanus.co.za

2017 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at 19.00.

20 Nov	'The mystery of the black aurora' Presenter: Amoré Nel, SANSA
11 Dec	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.

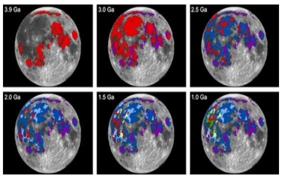
ASTRONOMY NEWS

The Moon's ancient atmosphere 6 October: The Moon has been through some rough times. Just a few hundred million years after its formation, it experienced what astronomers like to call the period of Late Heavy Bombardment. During this time - lasting from about 4.1 to 3.8 billion years ago - the Moon (and indeed, the entire inner solar system) endured endless artillery strikes from interplanetary debris. On the Moon, this triggered a series of volcanic eruptions that left its surface a hellish landscape filled with lava flows that stretched on for hundreds of miles.

In a recent study, a pair of researchers showed that between 3 and 4 billion years ago, when the primordial Moon underwent this extremely violent period of volcanic activity, it spewed out enough gas to produce a relatively thick atmosphere that persisted for about 70 million years. Although this atmosphere was extremely thick by lunar standards, it pales in comparison to that of Earth. At its densest (around 3.5 billion years ago), the Moon's atmosphere would exert a pressure of about 1 kilopascal, whereas at sea level on Earth, we experience around 100 kilopascals of pressure.

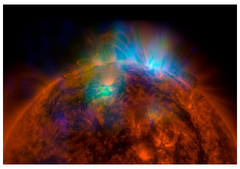
In order to calculate how much gas was present in the ancient lunar atmosphere, Debra Needham of NASA Marshall Space Flight Centre and David Kring of the Lunar and Planetary Institute (LPI) analysed ancient lava flows on the Moon's surface called maria, as well as Moon rocks collected during the Apollo 15 and 17 missions. By examining the rocks, they determined what types of gases were present, while mapping the solidified lava flows allowed them to estimate the total volume of gas that was produced.

In the Apollo rock samples, the researchers found evidence of carbon monoxide, hydrogen and oxygen (the ingredients for water), sulphur, and a number of other volatile gases. Furthermore, they used the rocks to calculate when the most intense periods of lunar volcanism occurred - about 3.8 and 3.5 billion years ago.


This time sequence of the lunar surface shows how lunar seas of basalt — a type of dark, grainy volcanic rock — changed in 500-million-year increments. Red areas show new deposits of the volcanic by-product. Debra Needham

Though the vast majority of the lunar atmosphere escaped the Moon's gravity and drifted off into space, there are some gases that could have settled into freezing, shaded craters near the lunar poles. If so, these volatile gases may be trapped in icy deposits, forming reservoirs of air and fuel that astronauts can tap into for future missions to the Moon and beyond. By: Jake Parks

FOXSI may reveal why Sun's corona is so hot 10 October: You have probably heard of solar flares before. These bright eruptions from the Sun's surface are triggered when knotted magnetic field lines within the Sun suddenly snap and reconnect, accelerating fireballs of plasma outward to distances up to 35 times the diameter of the Earth. However, have you ever heard of nanoflares?


Shown here in X-rays, the Sun's surface bubbles with activity as solar flares burst forth, spewing fountains of plasma outward. NASA/JPL-Caltect/GSFC

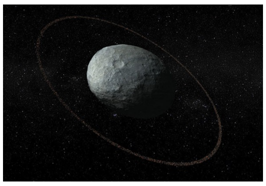
A team of researchers led by Shin-nosuke Ishikawa of the Japan Aerospace Exploration Agency (JAXA) have presented evidence that relatively small explosions called 'nanoflares' may be responsible for the mysteriously extreme temperatures found in the Sun's corona. The solar corona - the outermost layer of hazy plasma surrounding the Sun that can be viewed during a total solar eclipse - has baffled astronomers for nearly 150 years. While the Sun's surface only reaches around 5,500 K, the corona can reach staggering temperatures of several million K.

In order to make their observations, the scientists launched a rocket called the Focusing Optics X-ray Solar Imager (FOXSI) into space for 15 minutes so that seven X-ray telescopes could observe the Sun. The observations captured high-energy light from one region of the Sun that corresponded to temperatures of over 10 million K. Most interestingly, this region contained no obvious (full-size) solar flares, meaning they could not be responsible for the sweltering heat. Furthermore, if the coronal heat source were uniform and constant, as some alternative theories suggest, the plasma would not reach these tremendous temperatures.

To account for the concentrated and powerful coronal heating they did observe, the team proposed a mechanism whereby many small, intense nanoflares crop up and dissipate quickly, creating pockets of extremely hot plasma. Unfortunately, detecting these relatively faint nanoflares is exceptionally challenging and beyond our current capabilities.

The researchers hope that the next FOXSI flight, slated for August 2018, will hint at more dense, hot pockets of plasma within the Sun's corona, strengthening the case for nanoflare heating. In the meantime, the team is focused on incorporating nanoflares into coronal models, hopefully bringing theory in line with observation. By: Jake Parks

This weirdo dwarf planet has a ring around it 12 October: Long ago, something happened to Haumea. Something large smashed into the world, rendering it unable to fall back into a circular shape because of its small size. Instead, it more has the dimensions of an ellipse or grain of rice. The collision also left behind a few small moons and a trail of debris. And, it left behind a ring of material, too.


Haumea, named for the Hawaiian goddess, is not only weirdly shaped - it's also the fifth-largest object in our solar system to boast a ring. IAA-CSIC/UHU

This is not the first small solar system body discovered to have a ring. 10199 Chariklo, which is the largest of a class of objects called 'centaurs' hiding out between Saturn and Uranus, has a ring, as does fellow centaur 2060 Chiron. Both those worlds are on the smaller end of the dwarf planet spectrum. Haumea, on the other hand, is roughly six times bigger than Chariklo, making it way smaller than the Moon but now the fifth-largest object in the solar system to have a ring, after Jupiter, Saturn, Uranus, and Neptune.

The discovery was made by a Instituto de Astrofísica de Andalucía-led team as Haumea passed in front of the star URAT1 533-182543. two locations were used to observe the transit, also called an occultation. The ring is thin and about 70 km wide. This occultation also helped the team determine whether Haumea hosts an atmosphere, which it does not appear to have. The researchers speculate that rings like this could be more common in the outer solar system, which contains much of the debris of our system's formation.

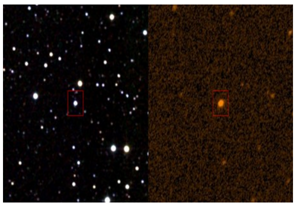
By: John Wenz

Ok, so what's really going on with Tabby's Star? 13 October: Hiding in the treasure trove of Kepler data was an exciting mystery. It was a star that dimmed so much that whatever caused it had to be 20 times the size of Jupiter. Every possible explanation under and beyond the Sun has since been thrown at the object, now known as Tabby's star (aka Boyajian's star, aka KIC 8462852). The explanations have included a fragmented planet, a swarm of comets, a slowly cannibalized hot Jupiter, or, most recently, a giant ring of dust. Oh, and aliens.

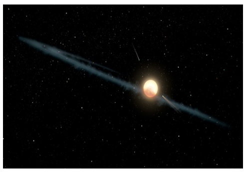

What's going on with Tabby's star? Is it destroying planets, surrounded by an alien megastructure, or something else? NASA, JPL-Caltech

The basic story of Tabby's star goes like this: Kepler caught the star dimming by as much as 20 percent in aperiodic (irregular) ways. Twenty percent dips in light are too high to be caused by a planet for a star the size of Tabby's, which is an F-type star larger than the Sun. Even something as large as Jupiter should make only about a one percent dip in light. Dr. Tabetha Boyajian, a professor at Louisiana State University, has most intensively studied the star - probably why it is named for her. In the original paper on the star, Boyajian and her co-authors put forward the idea that the dimming was likely caused by a swarm of comets or, barring that, possibly an alien megastructure. (The phrase "Dyson swarm" was most often used, referring to envisioned extraterrestrial attempts to harness a star's power from space with giant arrays).

You can guess which one people latched onto. However, the plot thickened - some astronomers suggested the star itself could be variable due to magnetic activity. So something weird is definitely going on there. "It's a mixed bag now, as astronomers are exploring all possible ideas arising from nearby solar system objects, to intrinsic stellar variability," Boyajian says. "Personally, I am in favour for a circumstellar scenario, such as a swarm of comets. But, perhaps I am biased since this is the leading idea we proposed in the discovery paper."


Tabby's star, KIC 8462852, as seen in the infrared (left) and ultraviolet (right). Infrared: IPAC/NASA; Ultraviolet: STScI (NASA)

A 'circumstellar' object simply refers to a ring of dust or ice around a star. Indeed, this is an idea recently reported by NASA researchers, who suspected that a ring of dust was responsible for the bizarre light changes. Boyajian is not fully behind the dust scenario yet, partly because dust should give off infrared excess (appear bright when observed in infrared wavelengths, even if it can't be seen in visible light), and this cloud of … something does not.


Using infrared data from two NASA telescopes, researchers have suggested a ring of dust around the star could be responsible for its strange behaviour. NASA/JPL-Caltech

So that could mean that we are not yet at the end of explanations - a new paper seems to crop up every day, most recently one suggesting a clump of something unknown in the star's habitable zone. Boyajian says of these papers, "We welcome serious, well thought out ideas from the community," but that like all things, astronomers (and the public) should often wait for peer review of the more outlandish before accepting it as the answer.

So if it is not comets and it is not dust and it is not blatantly obviously aliens, then, what is it? "Good question," Boyajian says. "My second choice is one we haven't thought of yet!"

By John Wenz

Gravitational Waves Show How Fast The Universe is Expanding 18 October: The first gravitational wave observed from a neutron star merger offers the potential for a whole raft of new discoveries. Among them is a more precise measurement of the Hubble constant, which captures how fast our universe is expanding.


This artist concept shows a cloud of debris ejected into space as two neutron stars merge. NASA Goddard Space Flight Center/CI Lab

Ever since the Big Bang, everything in the Universe has been spreading apart. It also turns out that this is happening faster and faster - the rate of expansion is increasing. We have known this for a century, but astronomers have not been able to get precise measurements of the increase in rate, due mostly to the fact that they have had to cobble together a range of data to estimate how far away things in the universe are. Gravitational wave observations offer a direct means of measuring distances in the universe. The LIGO collaboration is constantly monitoring the Universe for the subtle stretching of space-time that huge astronomical collisions can create, and measurements of the amplitude and frequency of the waves it catches hold valuable information for astronomers.

The most recent catch happened on 17 August, and the massive collision was seen for the first time with conventional telescopes as well. Multiple papers from over 4,000 researchers explore the implications of the ground-breaking find, one being that researchers finally have the data they need to better pin down the Hubble constant.

Conventional telescopes provide one piece of the puzzle by measuring redshift, or the elongation of waves of electromagnetic radiation caused when something is moving away from us. It is like the how the Doppler effect causes a siren to increase in pitch as it moves toward us, but decrease as it moves away, but for light. This shows astronomers how fast something is moving away, and it's something they've gotten very good at.

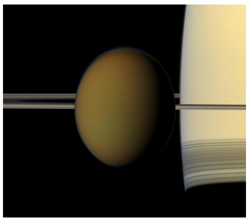
To measure expansion, though, we also need to know how far an object is away from us, which is more difficult. There is really no points of reference in the sky for astronomers to use when measuring distance, so they have had to rely on a hodgepodge of different measurements called the cosmic distance ladder. Cobbling together different observations introduces more opportunities for error, though, and the result is that astronomers got two different results for the Hubble constant based on what observations they used.

Gravitational waves make all that obsolete, however, because the signal contains an intrinsic measure of distance. The amplitude of the wave lets astronomers know how far away something is, 130 million light-years in the case of this neutron star merger. Pairing that number with redshift measurements from conventional telescopes also pointed at the neutron stars gave them everything they needed. Previous measurements of universal expansion were split between either 67 or 72 kilometres per second per megaparsec. With their more precise tools, the gravitational wave astronomers landed pretty much in the middle - they say they have pinned the expansion of the universe at 70 kilometres per second per megaparsec.

The acceleration of the universe is an important variable for researchers studying things like dark matter and dark energy. Actually pinning it down is crucial in the search for those things that we can only measure indirectly. Furthermore, it is an important piece of validation for astronomers, says University of Wisconsin-Milwaukee physics professor and gravitational wave co-author Jolien Creighton. "It's completely consistent with the electromagnetic observation," he says. "It verifies that there's not something grossly wrong with our distance calibrations and electromagnetic astronomy."

There is still a bit of uncertainty in their numbers at the moment though, based on the fact that they are still not quite sure exactly how the spinning neutron stars were angled with respect to Earth. Binary mergers that face us, as opposed to appearing edge-on, yield stronger signals, so locking that down would help to reduce the margin of error in their calculations. Creighton hopes that with further analysis of the data, they can refine their predictions. By: Nathaniel Scharping

Monsoons of methane on Titan 18 October: Before 2004, we knew very little about Saturn's Mercury-sized moon, Titan, save that it had a dense, nitrogen-rich atmosphere. However, over the course of 13 years, the Cassini spacecraft completed more than 100 flybys of Titan, constantly collecting data on the mysterious moon. In 2005, Cassini even deployed its Huygens probe to the surface of the alien world, marking the first time we've landed on an outer solar system object. Thanks to the Cassini-Huygens mission, researchers learned that Titan hosts a surprisingly vast and varied landscape, speckled with lakes and seas of liquid methane and ethane, which are replenished by rains from hydrocarbon clouds.


NASA's Cassini spacecraft snapped this true colour image of Titan as it passed in front of Saturn's rings during its 13-year tour of the Saturn system. Titan's thick, nitrogen atmosphere can be seen as a blue haze shrouding the moon. NASA/JPL/Space Science Institute

Now, according to a recent study, a team of UCLA planetary scientists and geologists found that these hydrocarbon clouds are not just gently drizzling rain over the surface of the moon. Instead, they discovered that Titan experiences monsoon-like downpours capable of dumping enormous amounts of methane rain in very short periods of time. UCLA associate professor of planetary science and co-author of the study, Jonathan Mitchell, "The most intense methane storms in our climate model dump at least a foot of rain a day, which comes close to what we saw in Houston from Hurricane Harvey this summer."

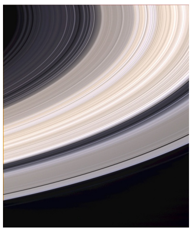
Although Titan's storms are very intense, they are also relatively rare. They occur only about once per Titan year, which is equivalent to about 30 Earth years. Even if the Titan storms are rare when compared to Earth, they are still much more frequent than scientists anticipated. "I would have thought these would be once-a-millennium events, if even that," said Mitchell, "So this is quite a surprise."

When Titan encounters one of these colossal storms, regions that are typically deserts are transformed into massive floodplains, feeding rivers that eventually spill into great lakes and seas, Mitchell explained. As the deluge flows over Titan's surface, it deposits sediment in the low lands, forming cone-shaped features called alluvial fans. The scientists found a correlation between Titan's extreme rainfall and recent detections of these alluvial fans, indicating the features were a result of severe storm flooding.

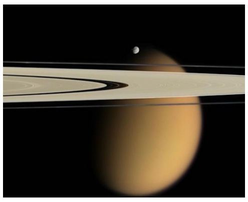
The UCLA scientists noted that most of the alluvial fans on Titan are scattered between 50 and 80 degrees latitude, generally concentrated a bit closer to the poles than the equator. This suggests that Titan's precipitation varies by region, with increased rainfall causing erosion and lake formation, while sparse rainfall causes the formation of dunes. Though precipitation was highest near the poles, where most of Titan's seas and lakes reside, the most intense rainstorms occurred near 60 degrees latitude, in the region with the highest concentration of alluvial fans. This indicates that, like on Earth, powerful storms develop when wet, cool air from higher latitudes meets with dry, warm air from lower latitudes.

According to Seulgi Moon, UCLA assistant professor of geomorphology, the findings show that intense methane downpours can significantly alter Titan's icy surface, a principle that likely also applies to Mars (which sports its own large alluvial fans), as well as other planetary bodies. By studying how rainfall influences planetary surfaces, researchers hope to better understand how certain weather patterns can alter a planet's overall climate, and even its habitability. And, though modelling methane monsoons may not be directly applicable to Earth's own climate, the more we understand about eccentric weather, the more equipped we are to address climate change here on Earth. By: John Wenz

Saturn's rings take seven siblings to stay in place 20 October: New data from the Cassini spacecraft suggests that Saturn's outermost 'main' A ring is held in place by seven moons, rather than the single originally suspected shepherd, Janus. The small moons Pan, Atlas, Prometheus, Pandora, and Epimetheus play important roles, but Mimas, a larger Enceladus-sized world, does a lot of heavy lifting in the rings as well.


The neat "grooves" in Saturn's A ring are actually density waves caused by the seven moons that keep it in place. Cassini Imaging Team, SSI, JPL, ESA, NASA

The moons' combined influence keeps the A ring fairly compact. Without them, the ring particles would naturally spread out at that distance from the planet, causing the ring to disappear. Instead, the moons provide gravitational "confinement" to keep the ring in place. As they orbit, the moons maintain resonances (in which one moon completes X number of orbits, while another completes Y) that ensure the A-ring keeps up appearances, which some NASA researchers have compared to the grooves on a vinyl record. In reality, the grooves are actually density waves caused by the moons, as their resonances carve out these neatly delineated features.

 Pan, Atlas, Prometheus, Pandora, Epimetheus, Mimas, and Janus are responsible for maintaining Saturn's A ring. NASA/JPL/David Seal

This is just one discovery in the thousands more that will come from the recently ended Cassini craft's data. Cassini crashed into Saturn on September 15, but spent its final months swinging through the rings of the sixth planet, getting unprecedented close-ups of the clumpy matter and icy particles that may be the remains of larger moons that got too close to the planet. As new details emerge, researchers may grow closer to understanding how the rings interact with each other and the planet as well. By: John Wenz

Space changes how genes are expressed 26 October: Siblings compete; it is pretty much a ubiquitous fact of life. So when astronaut Scott Kelly returned to Earth in March 2016 after nearly a year in space, it must have really irked his identical twin brother, former astronaut Mark Kelly, that Scott was temporarily two inches taller. However, Scott's height was not all that changed during his time in space.

 Former astronaut Mark Kelly (left) attempts to keep a straight face while posing with his identical twin brother, astronaut Scott Kelly (right). As part of NASA's Twins Study, Scott spent nearly a year in space, while Mark stayed here on Earth. This gave researchers a chance to study the health effects of long-term spaceflights. NASA

According to preliminary results from NASA's Twins Study, Scott's year in space also drastically increased his rate of DNA methylation, the process responsible for turning genes on and off. By regulating gene expression, methylation is believed to play a major role in the development in many diseases, ranging from cancer to cardiovascular disease.

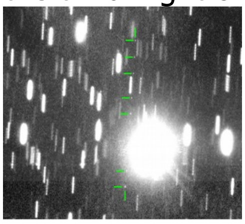
"Some of the most exciting things that we've seen from looking at gene expression in space is that we really see an explosion, like fireworks taking off, as soon as the human body gets into space," said Chris Mason, principal investigator of the Twins Study. "With this study, we've seen thousands and thousands of genes change how they are turned on and turned off. This happens as soon as an astronaut gets into space, and some of the activity persists temporarily upon return to Earth."

As part of the study, Scott spent a year in zero gravity working on the International Space Station. In the meantime, his brother Mark went about his daily life on Earth as an author, political activist, and aerospace consultant. Taking advantage of the Kellys' identical genetics, the Twins Study monitored subtle genomic changes that were elicited by each brother's environment - namely Earth and space- helping researchers investigate the long-term effects of extended spaceflights.

Over the last year, NASA has released a number of fascinating preliminary results from some of the 10 research projects that make up the Twins Study. For example, researchers in one study were surprised to find that Scott's telomeres - the protective caps that shield the ends of DNA strands - were longer than Mark's. And previous research has shown that longer telomeres are associated with fewer age-related problems. "This study represents one of the most comprehensive views of human biology," Mason said. "It really sets the bedrock for understanding molecular risks for space travel as well as ways to potentially protect and fix those genetic changes."

Although Scott has now returned to his pre-spaceflight height, there is no doubt that drifting through space has caused many more unseen changes to his body. By studying Scott's changes and comparing them to Mark's, researchers hope to learn as much as possible about how long-duration spaceflights can affect the human body — a necessary step for a manned mission to Mars. NASA is expected to publish final results for the Twins Study in 2018. By: Jake Parks

Our close call with an 'alien probe' 27 October: In 1991, Jim Scotti, senior research specialist at the Lunar and Planetary Lab at the University of Arizona, was working on the Spacewatch Project's second survey campaign. The project was looking specifically for small objects in the solar system. On 6 November, Scotti saw a 10- to 20-meter object move across the night sky in a way that seemed to indicate it was near Earth. The next night, it was gone, but there was a different nearby object behaving exactly the same. On the third night of observing, neither object was there.


1991 VG (marked with green lines) tumbled through the sky in November 1991. Defying explanation at the time, some astronomers thought it could be an alien probe. OlivierHainaut on Wikipedia

Scotti was confused. A fourth observation finally found one of the objects and revealed what was going on: they were the same object moving in circles across the night sky, indicating an orbit around the Sun nearly identical to Earth's. "(It) would be moving across the sky, but it would be moving in little loops," Scotti says. "It wouldn't be moving in just a straight line because it's relatively close to the Earth."

The spin of the object was way too fast. The sort of rotation rate he witnessed would rip an asteroid apart, according to the model of small asteroids at the time, which described them as loosely-bound "rubble piles." Scotti thought he might instead be working with a spaceship - but a human-built one. By tracking the orbit, he inferred that the last time it passed by Earth was around 1974. Suspicions turned toward early Apollo missions or the ascent stage of the Helios probe, but the Apollo missions were too early, and Scotti and his collaborators later found out that Helios' rocket had been intentionally turned around and placed in a high-Earth orbit, eliminating it as a candidate.

Duncan Steel, an astronomer focused on small solar system bodies, proposed "very tentatively" that it could be an alien probe, saying that in the absence of other explanations, it represented a "candidate for consideration." Robert Freitas and Frank Valdes looked for objects behaving just like this in the 1980s as part of the Search for Extraterrestrial Artifacts, which applied scientific rigor to a science-fiction idea: that a spaceship could be hiding in groups of asteroids near Earth and in the main belt. "We reasoned that unless the probes were intended to hide from detection it would be possible to actually look," Valdes, a scientist at the National Optical Astronomy Observatory, says.

He adds that the best way to find an alien probe would be to conduct an asteroid-like hunt for them. "This is the same process used for finding asteroids, including potential impacting asteroids," Valdes says. "The main difference is that these would not whiz by but remain in a stable nearby orbit." Based on its orbit, the object christened 1991 VG was expected to re-encounter Earth earlier this year. And indeed it did, but, in that 26-year interim, our understanding of asteroids and meteors improved, as did the sample population of small asteroids like 1991 VG. It turns out, most 10- to 20-meter asteroids tumble like that without falling apart. "What [Steel] was suggesting was that we knew how many objects in the 10- to 20-meter size range were out there and we didn't," Scotti says.

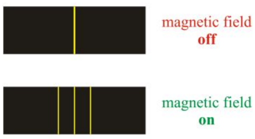
Rocket bodies are hollow, and as such, can be pushed around by radiation from the Sun. Their orbits would likely move and shift over time. Hpwever, 1991 VG was exactly where Scotti and his collaborators predicted on its return in May 2017. As it tumbled through, the intervening years had taught us that this was not an alien probe or a human spaceship: it was just another rock in our neighborhood dropping by for a visit.   By: John Wenz

EDITOR'S NOTE: This week, another NEO discovered at the University of Arizona was revealed as a companion to Earth rather than a piece of space junk. (469219) 2016 HO3 exhibited much of the strange behaviour of 1991 VG and is now known to be a 'quasi-satellite' of Earth that behaves in a similar orbit, though it officially orbits the Sun with a little input from Earth.

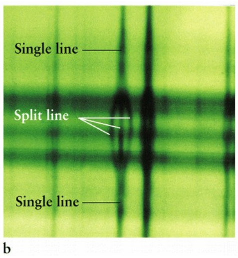
Source of these and further astronomy news items: www.astronomy.com/news

DID YOU KNOW?

The Sun Part 20: **Solar magnetic field 2 – Zeeman effect**



The Zeeman effect



The effect in a solar spectral line


Pieter Zeeman

This is a means of measuring a magnetic field from a distance, one that is particularly useful in astronomy where such measurements for stars have to be made indirectly. Use of the Zeeman effect is particularly important in relation to the Sun's magnetic field because of the central role played by the solar magnetic field in solar activity eg solar flares, coronal mass ejections, which can, potentially, pose a serious hazard to many aspects of human life.

The Zeeman effect is the splitting of a spectral line into several components due to the presence of a static magnetic field. Normally, atoms in a star's atmosphere will absorb a certain frequency of energy in the electromagnetic spectrum. However, when the atoms are within a magnetic field, these lines become split into multiple, closely spaced lines. For example, under normal conditions, an atomic spectral line of 400nm would be single. However, in a strong magnetic field, because of the Zeeman effect, the line would be split to yield a more energetic line and a less energetic line, in addition to the original line. The distance between the splits is a function of the magnetic field, so this effect can be used to measure the magnetic fields of the Sun and other stars. The energy also becomes polarised, with an orientation depending on the orientation of the magnetic field. Thus, strength and direction of a star's magnetic field can be determined by study of Zeeman effect lines.

The effect is named after the Dutch physicist Pieter Zeeman. While a doctoral student, he worked as assistant to theoretical physicist Hendrik Lorentz. (Lorentz is famous for the Lorentz transformation, a set of equations relating position and time of an event a seen by one observer to the time and position of the same event seen by a second observer who is moving at a constant velocity relative to the first – equations fundamental to the precepts of Einstein's later theory special relativity). In 1896, Zeeman disobeyed the orders of his thesis superior and used laboratory equipment to measure the splitting of spectral lines by a strong magnetic field. He was fired, but vindicated later, as he had discovered what is known as the Zeeman effect.

Lorentz heard about Zeeman's observations and explained them in relation to the laws of classical physics and his theory of electromagnetism. Zeeman's discovery confirmed Lorentz's prediction about the polarisation of light emitted in the presence of a magnetic field. It made clear that the oscillating particles that, according to Lorentz, were the source of light emission, were negatively charged, and a thousandfold lighter than the hydrogen atom (these particles were later shown to be electrons, but these had not been discovered yet).

Because of his discovery, Zeeman was reinstated and appointed a lecturer in physics in 1897, continuing to study the Zeeman effect and magneto-optics during his career. In 1902, he won the Nobel prize in physics for his discovery of the Zeeman effect jointly with his mentor Lorentz.

Quantum physics was also needed to fully explain the Zeeman effect. According to quantum theory, all spectral lines arise from transitions of electrons between different allowed energy levels within the atom, the frequency of the spectral line being proportional to the energy difference between the initial and final levels. Because of its intrinsic spin, the electron has a magnetic field associated with it. When an external magnetic field is applied, the electron's magnetic field may assume only certain alignments. Slight differences in energy are associated with these different orientations, so that what was once a single energy level becomes three or more.

Practical applications based on the Zeeman effect include spectral analysis and measurement of magnetic field strength. Since the separation of the components of the spectral line is proportional to the field strength, the Zeeman effect is particularly useful where the magnetic field cannot be measured by more direct methods eg in astronomy.

There is a theory that the magnetic sense of birds which assumes that a protein in the retina is changed due to the Zeeman effect, enabling them to 'see' Earth's magnetic field lines.

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

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)	028 314 0830
Laura Norris (Treasurer)	028 316 4453
Peter Harvey (Secretary, monthly sky maps)	028 316 3486
Jenny Morris (Vice-chairperson, newsletter)	071 350 5560
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)	028 316 2302
Non-committee members with roles:	
Pierre Hugo (Cosmology interest group)	028 312 1639
Johan Retief (Hawston School Youth Club)	028 315 1132