"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

OCTOBER 2016

This month's Centre meeting
This takes place on **Monday 17 October** at the **Scout Hall** starting at t **19.00**. Committee member, Jenny Morris, will be talking on 'Dark skies: the unseen Universe'. See further details below.

WHAT'S UP?

Planetary trio After sunset, throughout the month, another planetary trio can be observed, this time involving Venus, Saturn and Mars. Bright Venus can be found closest to the horizon, Saturn higher (in Scorpius) and red Mars highest in the sky. Logically, Venus, our closest neighbour, should be the focus of scientific interest. However, Venus has a hot, dense, poisonous atmosphere which destroys all spacecraft which enter it. In contrast, although twice the distance from Earth than Venus (78 million km v 42 million km), Mars is the focus of exploration and thoughts of future human habitation. Cold, barren Mars with its tenuous atmosphere formed almost entirely of carbon dioxide may not seem much less hostile than Venus. However, human technology is better able to manage such conditions. The numerous missions which have studied and are investigating the Martian surface and atmosphere have found surface ice (potentially providing access to water). The challenges of generating oxygen and growing the food necessary to support a human colony are being actively addressed to the extent that a manned mission to Mars is scheduled to take place within only a few decades.

LAST MONTH'S ACTIVITIES

Monthly centre meeting On 19 September, Prof Bruce Bassett of UCT and AIMS gave and excellent presentation on '100 years of general relativity: gravitational waves and beyond'. A very gifted communicator, he made often difficult and sometimes counter-intuitive concepts relating to general relativity both accessible and understandable. Having established the theoretical background of special and general relativity, he then continued to use very helpful slides and video to explain the nature and recent discovery of gravitational waves. These high-speed energy waves were predicted by Einstein's general theory, but are so weak that it has taken several decades to develop sensitive enough equipment to detect them. Bruce's interactive style prompted a number of questions from the audience, all of which he answered clearly and informatively.

Additional meeting On 29 September, HAC and SANSA co-hosted a meeting at SANSA. In his presentation 'South African Astronomical Observatory - 2016 report', Prof Ted Williams, Director of the SAAO in Cape Town reported that the new 1m telescope, with its novel wide-field view and camera, has been installed and is currently undergoing commissioning and testing. The SALT telescope is performing well, its output benefiting from routine maintenance and some new equipment. He also mentioned the recent arrival of SANSA's new facility at the site. Prof Mike Kosch, Chief Scientist at SANSA elaborated on this development in his talk 'From deep space to Antarctica and Sutherland'. Mike described how the equipment at Sutherland is enabling study of sprites, transient luminous events which erupt upwards from storm clouds. There are also plans to add an airglow imager which will enable study of atmospheric gravity waves. Finally, Mike mentioned the new scanning Doppler imager has was involved in installing at South Pole in January. Early images have already shown how auroras strongly influence wind direction, a finding which has implications for Earth's weather.

Interest groups

Cosmology Seventeen people (16 members, 1 visitor) attended the meeting on 5 September. They considered the main points of the first of five short books on quantum mechanics by Dr Robert Piccioni of Stanford University. The topic of 'Particles and waves' encouraged thoughtful questions and lively discussion.

Astro-photography At the meeting on 12 September, members discussed processing of images which they had taken.

Other activities

Partial solar eclipse Committee members arranged for telescope observation to be available on 16 September, to learners at four schools in greater Hermanus, with the public invited to join those at Curro. Unfortunately, cloudy conditions prevented observation of the event.

Stargazing On 30 September, approximately 40 Centre members and visitors enjoyed an excellent evening of stargazing. Clear, dark skies enabled them to view some of the 'Big Five of the African sky' – Milky Way, Omega Centauri, Southern Pleides, Eta Carinae – as well as Venus, Saturn and Mars, the Jewel Box, and clusters in Scorpius and Sagittarius.

Educational outreach

Hawston Secondary School Astronomy Group Weekly meetings with the Space Cadets continued during September.
Lukhanyo Youth Club No meeting took place in September.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This will take place on **Monday 17 October** at the **Scout Hall** at **19.00.** Committee member, Jenny Morris, will be talking on 'Dark skies: the unseen Universe'. The vast majority of the night sky is dark, but this is not a darkness of nothingness. Jenny will give an overview of the nature of the dark clouds which block starlight passing through them, they types and characteristics of the numerous small, cool objects which can be found with appropriate equipment, and the nature of what occupies the space between planets, stars and galaxies. Finally, she will touch on the mysterious energy believed to form almost three-quarters of the Universe, and answer the historic question of why the night sky is dark.

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 **3 October** at the Scout Hall. Attendees will consider Part two of Robert Picciioni's short books on quantum mechanics.

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. There is no meeting in October.

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 October.

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:

21 Nov	'Science we have learned from space telescopes'. Presenter: Pierre de Villiers, Chairman, HAC committee
12 Dec	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Progress with the project continues to await 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

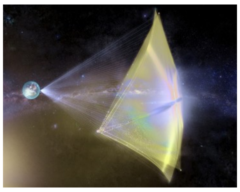
Account number – 185 562 531
Branch code – 051001

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

ASTRONOMY NEWS

How can we get to Proxima Centauri b? 1 September: There's an exoplanet as close to us as one can get. So how will we get there? Sometimes it takes a while for the meaning of a new scientific discovery to really sink in. In the case of the planet Proxima Centauri b, announced last week, it may take decades or even centuries to fully grasp the importance of what we have found. You see, this is not just any planet: It is similar to Earth in mass, and it orbits its star in the 'habitable zone', where temperatures could potentially allow the existence of Earthlike bodies of liquid water. Proxima Centauri is not just any star, either: it is the very nearest one after the Sun, and it is a small red orb whose feeble light makes it relatively easy to study the planet close beside it.
The science at stake here is enormous. Proxima Centauri b will surely become the archetype for understanding more distant Earth-size, and possibly Earth-like, planets all across our galaxy. The effort needed to study it will be enormous, too, however. At present the planet cannot even be glimpsed directly through the mightiest telescopes on Earth. Nevertheless, the race is on–a thrilling but maddeningly slow-motion race to bring Proxima Centauri into view, to figure out if it could (or does) support life, even to visit it with an interstellar probe.

That last goal is the most ambitious; some might call it the most absurd. However, the discovery of Proxima Centauri b comes at a propitious time, just as a group of physicists and engineers have been thinking very realistically about how to send a space probe to another star, and to do it within a single human lifetime. The resulting Breakthrough Starshot concept would use an array of extremely high-power lasers to shoot a beam at a huge, extremely thin reflective sail. Energy from the beam would accelerate the sail (and a miniature probe attached to it) to 1/5 the speed of light, more than 1,000 times faster than anything humans have yet achieved.


Breakthrough Starshot concept would use a giant Earth-based laser array to accelerate a space sail to a significant fraction of the speed of light. (Breakthrough Initiatives)

This proposal envisions technology beyond what is available today, but there are no science-fiction elements in it. No warp drive, no wormholes. It is a straight extrapolation from things we know and do right now, just executed on a vastly greater scale - which is broadly similar to where the idea of going to the moon was around 1950. In other words, we don't know how to build a Starshot yet, but at least we know where to start. If we invested seriously in the project—on the order of $20 billion total, more than the Large Hadron Collider but far less than the International Space Station - and got started right away, researchers guesstimate that we could have the technology ready in three decades. I'll be more conservative and add another two decades to allow for all the full suite of components: In addition to the phased laser array you need the energy-collecting sails, the probes themselves, and a ‘mothership’ to carry them into orbit before interstellar launch.

The Breakthrough Starshot announcement suggests a target velocity of 0.2c (a fifth the speed of lilght). I’ll again be conservative - within this frame of crazy optimism, that is - and say that what is really possible is closer to 0.05c, or 5 percent the speed of light. That is still roughly 10,000 miles per second, a hugely ambitious goal. At that speed, sending probes to Proxima Centauri b would take approximately 85 years.

To make the Starshot work, you want to start with very small payloads, no larger than an iPhone and possibly a good deal smaller; the lighter the payload, the easier it is to accelerate to ultra-high velocity. A low-mass payload will necessarily have limited capabilities, probably a camera, a couple types of spectrometers, particle & magnetism detectors, and a laser communication system. When that probe reaches its destination, it will still be moving at 10,000 miles per second and will have no way to slow down. Your trip through the most interesting part of the Proxima Centauri system will happen very quickly, in a matter of hours, and you will have no way to steer toward planet b or any other specific targets.

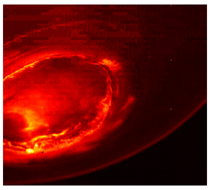
However, there is a huge upside to the Starshot concept. Almost all of the cost goes into the laser system that launches your probe. The probe itself would be a tiny, solid-state device attached to a thin sail. If the probes were mass produced, the cost per launch might be just a few hundred thousand dollars. The Breakthrough Starshot team therefore envisions launching not one, but a swarm of thousands. Some of those probes would fail at launch; some would fail along the way; some would miss Proxima Centauri, or not pass close enough to interesting targets to get a good look. But it doesn’t matter; a 99 percent failure rate would still be a tremendous success. If you launch 1,000 probes, you need only a dozen to survive in order to achieve one of the most amazing missions of exploration in human history.

If you tally my numbers, I envision the first probes reaching Proxima Centauri in about 135 years (and then you have to allow another 4.3 years for their signal to get back home). It is a very long wait time to make sense of a new discovery, and that assumes both a sustained, focused effort and the successful resolution of a vast number of technical challenges.

Fortunately, this race passes a lot of milestones that are much closer and easier to reach. Even in its early stages, laser-sail technology would be useful for high-speed exploration through the solar system, or for deflecting and manoeuvring asteroids. More to the point, there is a whole other race to Proxima Centauri–one that does not require high-power lasers and interstellar travel, one that is underway right now.   By: Corey S Powell

Juno gets the first-ever view of Jupiter's North Pole 2 September: On 27 August, NASA’s Juno spacecraft, with all its instruments blazing, swooped within 4,000km of the Jovian surface and beamed back the first-ever images of its north pole. It was the first of 36 planned flybys planned for the mission, so there is plenty more where this came from. Still, even from the first 6-megabyte download, Jupiter’s revealing why it is unlike any other planet in our solar system.

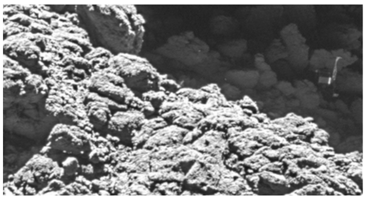
Jupiter is easily recognized by its giant, red, stormy spot, and its distinct latitudinal bands. However, at its north pole, things are different. The clouds are pale blue in colour, and those signature bands or zone belts are nowhere to be found. Despite its cooler colour, the north pole is still a stormy place, with high-altitude clouds that cast shadows on features below. And to the south, NASA captured infrared images of the southern pole, illuminating its aurora — another first-ever.


An infrared glimpse at Jupiter's south pole. (NASA/JPL-Caltech/SwRI/MSSS)

Jupiter's north pole is a weird place. For a decade now, researchers have kept their instruments trained on a pulsating X-ray aurora constantly hovering over the pole. It seems grow brighter and dimmer every 45 minutes or so, and when its blasted with solar storms it grows larger - sometimes the size of Earth - and more intense.

And apart from Jupiter's pale blue pole, Juno also tuned in to Jovian radio. The planet's sporadic radio emissions were first noticed in 1955, when Bernard Burke and Kenneth Franklin picked up the signal from the Mills Cross radio telescope in Australia. Jupiter's radio emissions can actually be heard from Earth on frequencies ranging from about 10 to 25 Mhz Juno's Radio/Plasma Wave Experiment recorded radio emissions from the planet's aurora, and we've never listened to the planet from this close of a vantage point. NASA scientists shifted the radio waves into audio frequencies, and produced a recording that really helps ua grasp the vast, haunting emptiness of space. By: Carl Engelking

Philae's final resting place has been found 6 September: After not knowing the exact location of the Philae lander for almost two years, the cameras on the European Space Agency's Rosetta orbiter picked up images on Friday of Philae tucked into a crack on Comet 67-P/Churyumov-Gerasimenko.


ESA

Philae was attached to Rosetta during its 10-year journey through space to catch up to the comet and was released to touch down in November 2014, making it the first spacecraft to land on a comet. It sent data to Earth for three days before its battery died, causing Philae to go into hibernation. When the comet came closer to the sun, though, it helped charge it enough to communicate with Rosetta briefly in 2015. Thanks to radio signals between Rosetta and Philae, the general area of where Philae landed was known, but it had bounced after its initial touchdown and the exact location couldn't be found until now. Rosetta was 2.7km from the comet's surface when it captured the images that show Philae's body and two of its three legs. The data recovered from Philae has already immensely helped scientists to understand the nature of comets and the role they play in universe. By: Nicole Kiefert

After a successful launch, OSIRIS-REx is headed for an asteroid encounter 9 September: Blasting out of Earth's orbit on 8 September, NASA's OSIRIS-REx mission began its two-year journey to sample an asteroid. It will be seven long years before the spacecraft returns home, dropping its bounty into the Utah desert. En route, it will map an asteroid in depth and help scientists better understand the secrets of the early universe.

The vehicle entered an almost-perfect orbit, making a handful of minor corrections to ensure it remained on course. Following its separation, the spacecraft was "immediately able to start receiving some telemetry back from the vehicle," Rick Kuhns, the OSIRIS-REx program manager for Lockheed Martin, told the press. In the time between launch and the evening conference two hours later, the propulsion system was initialised, the solar arrays were deployed, and the spacecraft turned in multiple directions to ensure everything functioned properly. Within 40 minutes of separation, OSIRIS-REx communicated with the Canberra Deep Space Ground Communication in Australia.

OSIRIS-REx will travel through space for two years to reach the asteroid Bennu, and another two years mapping its surface in search of the best site to retrieve a sample from. Once it has scooped up material from the asteroid's outer layer, it will spend another two years travelling back home, hurling its sample to Earth when it arrives. By: N Taylor Redd

The moon may be obliterated pieces of Earth reformed 13 September: New evidence shows that the once-planet Theia may have been destroyed in the early impact that formed the Moon.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Our moon has a violent past that just got a little more fearsome. Planetary formation is not for the weak of heart. Building a planet from countless grains of dust and tendrils of gas is a violent process of colliding, coalescing, and melting into bigger and bigger rocks. Earth was a decently-sized world when it took one final hit: a Mars-sized object smashed into our home planet. We used to think this object, Theia, struck a glancing blow and was captured into Earth orbit as our new moon. With this theory of a relatively low-energy impact, Theia peeled off a chunk of the Earth as molten debris and vaporized a bit more with the energy of impact. The material coated the new moon in a mantle of terrestrial geological material around an alien core, geologically similar yet distinctly separate.

However, that story does not hold up under the cold light of geochemical analysis. The Apollo astronauts brought back a precious cargo of 842 pounds of rock, pebbles, and dust from the moon. Scientists painstakingly analyse these samples to build a picture of our nearest neighbour. During recent reanalysis with high-precision instruments, researchers found a curious quirk. Lunar rocks are almost, but not quite, like those on Earth. They are too similar to be formed from completely different parent-rocks, and must share a common past. Yet lunar rocks have a slight over-abundance of a particular chemical isotope, potassium-38, so their pasts cannot be identical.

Researchers Kun Wang and Stein B. Jacobsen developed a new origin story for the moon to explain this potassium riddle. Instead of a glancing blow, what if Theia hit the Earth straight on? In this theory, the higher-energy impact disintegrates Theia completely, and strips Earth of its outer layers of crust and mantle. The debris melts into a planetary stew, the implacable power of angular momentum drawing it out into a dense, hot disk. Earth's brief ring is more reminiscent of Venusian hellscapes than Saturn's delicate structures. It is hot enough to vaporise rock and rain lead, with atmospheric pressures more than ten times higher than we find at sea level. In this stew, the biggest fragments of coalesce into moonlets, growing into a moon. The lightest potassium elements disproportionately condense out on the young moon, leaving the heavier elements to rain down on Earth.

By: Mika McKinnon

Can the moon make an earthquake worse? 14 September: When an earthquake occurs, it represents the release of years, sometimes decades or centuries, of pent-up stress. Somewhere along the fault line, a section of rock can take the strain no longer and gives way, allowing a tectonic plate to jerk into motion in a series of spasmodic shudders. The factors that determine when, where and why earthquakes happen are numerous, and we are still a long way from figuring out how to reliably predict them. However, one of the many small stresses leading up to an earthquake may be extraterrestrial.

A team of Japanese researchers says it has found a statistical correlation between periods of excessive tidal forces and large earthquakes. The tides, of course, are a consequence of the moon's gravitational tug. As it orbits the Earth, the moon pulls a small bulge of water with it, sloshing the oceans back and forth. Just as the oceans move with the moon, so too does the land. The Earth's crust actually moves by about a foot every day due to the motion of the moon, a so-called 'and tide'. The subtle flexing of the Earth's crust could be another factor in determining when the critical points along fault lines give way. As the moon tugs on the rock, it could provide that final nudge that sets a cascading series of larger slips into motion, creating an earthquake.

The researchers say that several major earthquakes in recent history happened during full or new moons, when the sun, Earth and moon line up, and tidal stress is at its highest. In addition, the ratio of large earthquakes to smaller temblors appears to increase during that time. Interestingly, however, there appears to be no correlation between tides and smaller earthquakes - the relationship only holds for the largest rumbles. In all, nine of the 12 biggest quakes on record happened near new or full moons, a number that appears to exceed chance. This included the 2004 Indonesian earthquake and ensuing tidal wave, and the 2011 earthquake in Japan that caused the Fukushima nuclear disaster.

The idea that the moon's gravitational tug may kickstart earthquakes is not new. The researchers cite papers going back to the 19th century that examined the link between lunar cycles and earthquakes. More recently, a paper from researchers at the U.S. Geological Survey found that a specific kind of deep earthquake at the San Andreas fault was more likely to occur when tidal forces were increased during the two-week fortnightly tide cycle. Scientists have never been able to find any conclusive evidence of a link, however. Both papers stop far short of saying the Moon is causing earthquakes, though. Instead, it seems that the tidal forces the moon exerts may cause what could have been a small quake to grow much larger. The mechanism by which this happens is still unclear, however. Tidal forces are just one of many, many factors all working together to push, pull and twist the Earth's crust, all of which combine to occasionally produce a quake.

Somewhere along that chain of events, the moon could provide the extra nudge needed to set the earth in motion. Knowing that the movements of the moon affect how earthquakes happen potentially gives us a better idea of when and where they'll strike.

By: Nathaniel Scharping

Cosmic microwaves show reionisation happened later than thought 15 September: New analysis of data taken by the European Space Agency's (ESA) Planck spacecraft of the cosmic microwave background (CMB) has revealed that the 'epoch of reionisation' occurred much later than previously thought.


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The universe was initially ionized just after the Big Bang, explains Jan Tauber, Planck project scientist at ESA. The latest data show that reionization occurred about 700 million years after the Big Bang; the previous estimate was 450 million years. After 380,000 years, the universe had expanded and cooled enough for electrons and protons to stick together in electrically neutral hydrogen atoms. At that point, photons were free to travel, because they were no longer scattering off of ions. Those freed photons are what we now see as the CMB.

From detailed observations of the CMB, astronomers have known that at some point, the universe became reionised, but when it happened has been a subject of hot debate. The reionised universe is not opaque enough to block the CMB photons from travelling, but it is enough to polarise them to some degree. Istvan Szapudi of the Institute for Astronomy at the University of Hawaii at Manoa likens looking through the reionized universe to looking toward a mountain on a misty morning. Szapudi studies the CMB, but was not involved in Tauber's work.

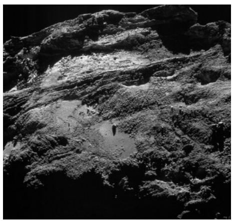
The CMB bears the polarisation imprint of the ionization history of the universe from the epoch of reionisation to today. "The CMB photons scatter off free electrons, and therefore when the CMB travels through an ionized medium, it is slightly attenuated," says Tauber. "By measuring this attenuation (which we call the 'opacity') we can estimate the 'distance' travelled through the medium, which in turn tells us when the medium was ionized. We can determine the opacity with a precision of 10-20 percent, depending on what assumptions you make." "The highly sensitive measurements from [Planck's High-Frequency Instrument (HFI)] have clearly demonstrated that reionization was a very quick process, starting fairly late in cosmic history and having half-reionised the universe by the time it was about 700 million years old," says Jean-Loup Puget from Institut d'Astrophysique Spatiale in Orsay, France, principal investigator of the HFI.

The previous estimate of 450 million years was based on data gathered by the Wilkinson

Microwave Anisotropy Probe (WMAP), which was more accurate than the Cosmic Background Explorer before it. However, Planck has better resolution than WMAP and carried a Low-Frequency Instrument sensitive to three frequency bands in the range 30-70 gigahertz and the HFI, which is sensitive to six frequency bands from 100-857 GHz.

What does all this mean? Tauber and his colleagues in ESA's Planck Collaboration believe pushing back the epoch of reionisation shows that the first generation of stars in the universe were the only sources needed to account for reionisation. Four hundred and fifty million years post Big Bang, the universe did not have enough stars emitting ultraviolet (UV) light to reionise the cosmos, so astronomers were forced to postulate the existence of other, exotic ionizing forces. The new estimate places reionisation at a time when there were enough stars to accomplish the task. The first stars in the universe would have been excellent ionisers. They were most likely very large — from 300 solar masses up to as much as 1,000 solar masses — and very hot, with surface temperatures as high as 100,000 kelvin. Their light would have been mainly UV and would have been very effective at ionizing the neutral hydrogen and helium gas around them. By: Allen Zeyher

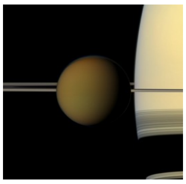
Rosetta's camera captured images of the comet 21 September: ESA has released a series of vivid images taken by its Rosetta probe of Comet 67P/Churyumov-Gerasimenko to the public. Rosetta is will be ending its mission on 30 September with a controlled crash onto the comet. It will join Philae, the probe's lander, rediscovered earlier this month.


The image taken from the NAVCAM on 11 Sept. . ESA/Rosetta/NAVCAM)

Rosetta was 8.8km away from the comet when it took the first of the images on 31 August. The image shows steep slopes in the Hathor region, an area on the comet that consists of a 900 meter cliff with marked lines, streaks, and small terraces. The smoother terrains of Hapi, a region on the comet's neck, is also visible in the image.

By: Nicole Kiefert

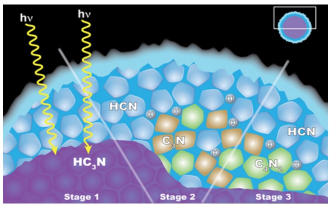
The strange chemistry that creates 'impossible' clouds on Titan 22 September: Strange chemistry may explain a seemingly impossible cloud in Titan's upper atmosphere.


NASA/JPL-Caltech/Space Science Institute

Scientists looking through Cassini's 2010 data recently noticed something strange in an infrared snapshot of Titan's stratosphere: a wide, thin, colourless cloud, about 20km thick, high in the atmosphere above the moon's north pole. The cloud was composed of frozen crystals of a compound called dicyanoacetylene, (C4N2), which everything we know about Titan suggests should not be there in any notable quantity.

Titan's atmosphere is rich with complex organic chemistry, but this cloud was a rare sight. "The dicyanoacetylene clouds are sparsely populated relative to many other organic compounds in the stratosphere that condense to form clouds, such as ethane, acetylene, cyanoacetylene, and hydrogen cyanide," said Carrie Anderson of NASA's Goddard Space Flight Research Center, co-investigator on Cassini's Composite Infrared Spectrometer (CIRS) instrument Mostly, that's because there's just not enough dicyanoacetylene vapour in Titan's stratosphere to condense into ice particles and form a cloud. CIRS detected dicyanoacetylene vapour only about 1% dense enough to condense an icy cloud like the one CIRS observed in 2010. It looked like Cassini had sent home a picture of something utterly impossible.

This was not the first time something seemingly impossible had appeared in Titan's northern skies, though. Voyager 1's spectrometer saw a similar dicyanoacetylene cloud on its 1980 flyby during Titan's northern spring. Researchers were puzzled at the time, but concluded that the cloud was proof that dicyanoacetylene vapour had to be present in Titan's stratosphere, and they just could not see it. Voyager 1's instruments, scientists decided, just were not sensitive enough to the right wavelengths of light to see the vapour. Then, in 2010, again during Saturn's northern spring, Cassini sent home a snapshot of a similar cloud. CIRS was sensitive enough to confirm that there was not enough vapour to have produced it. Anderson and her colleagues spotted it during a recent analysis of the April 2010 data. The mystery was back.



NASA/JPL-Caltech/GSFC

The cloud could not have condensed from dicyanoacetylene vapor cooling and sinking over Titan's north pole, but it had to form somehow. Anderson and her team proposed a different idea. Instead of condensing from a mass of vapor, the dicyanoacetylene ice crystals are the product of a chemical reaction between ice crystals from two other compounds, triggered by ultraviolet (UV) rays. About 150km above Titan's surface, cyanoacetylene (HC3N) vapour condenses into icy particles. As those particles sink another few kilometres through the stratosphere, they pick up a coating of hydrogen cyanide (HCN) ice particles. When UV rays strike the particles, they pierce that hydrogen cyanide shell and cause a chemical reaction inside. Dicyanoacetylene ice is a product of that reaction, along with hydrogen.

Cassini did not keep an eye on Titan's northern latitudes long enough to watch the cloud disperse, but Anderson said, "Once formed, the ice particles will slowly precipitate downward in solid form, but it wouldn't look like rain or snow. The cloud is very tenuous, and it's in the stratosphere – high above the troposphere, which is the layer where rain clouds form." It is similar to a process that happens high in the stratosphere above Earth's poles. As water ice particles condense from the water vapour in Earth's atmosphere, chlorine compounds attach to the ice crystals. UV light triggers a reaction between the chlorine compounds and the water, which produces nitric acid trihydrate (HNO3) and chlorine. The chlorine is part of the process that depletes ozone over the poles.

These dicyanoacetylene clouds are rare, and they seem to be a seasonal phenomenon. "We think these stratospheric clouds form as polar winter gives way to early spring – when temperatures are quite cold but there's enough sunlight, and other conditions also are right," said Anderson. According to CIRS data, the chemistry of Titan's stratosphere does seem to cycle with the seasons. Late in the northern winter, cyanoacetylene is fairly abundant, but almost no dicyanoacetylene shows up in spectral readings. By early spring, though, the two compounds have switched places, with cyanoacetylene becoming scarce as dicyanoacetylene becomes more common. And that, say to Anderson and her colleagues, supports the idea that cyanoacetylene is being destroyed in chemical reactions that produce dicyanoacetylene as winter gives way to spring. By: K.N. Smith

Hubble finds more evidence of plumes on Europa 26 September: Hubble has not found aliens on Europa, but it may have found new evidence that plumes of salt water from the moon's globe-spanning salty ocean can escape through cracks in its icy shell.

Using its Space Telescope Imaging Spectrograph (STIS) instrument, Hubble captured far-ultraviolet images of what could be geysers of water from beneath the surface, erupting in Europa's southern hemisphere. If the features in those images are really geysers, that could be very good news for future missions to Europa, providing an easier source of samples from Europa's subsurface ocean and making it easier to search for signs of life beneath the ice.

Space Science Telescope Institute astronomer William Sparks and his colleagues borrowed a method from exoplanet research and applied it to a potentially habitable world much closer to home (in relative space terms, anyway; Europa is about 625 million kilometres away). When an exoplanet passes in front of its star, astronomers can look at the very edge of the visible part of the planet, called the limb, to see what wavelengths of light from the star get absorbed by the thin band of the exoplanet's atmosphere. Because different chemicals absorb light at different wavelengths, that can yield clues about what alien atmospheres are made of.

In early 2014, Hubble looked for features along Europa's limb that might absorb the sunlight reflected by Jupiter. Hydrogen and oxygen both absorb light in the ultraviolet wavelengths, so Sparks and his colleagues looked at Europa in the far ultraviolet. Hubble sent home ten images of Europa's silhouetted surface, and features that might be geysers appeared in three of them.

"Anything that absorbs [light] will appear in our image. We presume it to be water vapour or ice particles because that's what Europa's made of and those molecules do absorb at the wavelengths we observed at, which is why we chose those wavelengths," said Sparks during a press conference earlier today.

This is the second piece of evidence for geysers on Europa, following a 2012 Hubble observation of hydrogen and oxygen in potential plumes coming from the same areas of the planet's southern latitudes. Because Europa is tidally locked with massive Jupiter, it always shows the same face to Earth, much like our own Moon. The Galileo mission, launched in 1989 and which arrived at Jupiter in 1995, did a single scan for plumes erupting from Europa, but came up empty. If the plumes are really there, says Sparks, they won't exactly be the Europan version of Old Faithful; they're most likely intermittent.

The plumes could become targets for a planned Europa flyby mission, tentatively slated for launch in the 2020s, which will carry a spectroscopic instruments from infrared to far ultraviolet, as well as instruments to measure the composition of samples - such as material from watery plumes. Thermal imaging will also allow the Europa flyby spacecraft to look for hotspots (or at least relatively warm spots) in the ice where plumes might erupt. It is possible that the mission could fly a pass, or several, through Europa's plumes, much as the Cassini spacecraft flew through the jets of water erupting from the south pole of Saturn's moon Enceladus. Mission planners are still planning potential trajectories, and they are interested in narrowing down which of the possible plumes might be the best target. It's unlikely that life will be found in those plumes, but the flyby mission could look for signs of organic chemistry that might provide a strong clue. "Even if there is a small amount of biomass in the plumes as they start out from the ocean, by the time they get into space and the radiation environment of Europa at cryogenic temperatures, it's not going to survive," said Sparks. "We'd have to be looking for the remains of something that was once protected in the ice or under the ice."   By: K.N. Smith

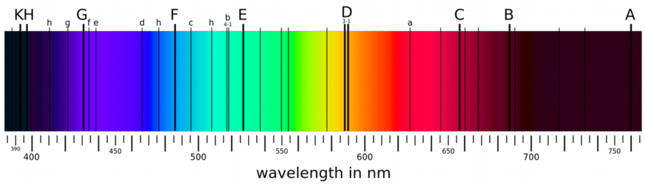
Source of these and further astronomy news items: www.astronomy.com/news

DID YOU KNOW?

The Sun Part 7: **Spectroscopy 1**

Isaac Newton

Joseph von Fraunhofer



Fraunhofer lines

Spectroscopy studies the interaction between matter and electromagnetic radiation. It is central to the study of astronomical objects, as information about them can only be obtained indirectly. The ability to determine the characteristics and composition of different types of celestial objects eg stars, nebulae, galaxies etc as well as details like their temperature, pressure, density, and mass is possible only because of the nature of electromagnetic radiation and light.

The achievements of astronomical spectroscopy were made possible because of the work and insight of a relatively small number of pioneering scientists. Although he was not the first to study and report on light emitted by the Sun, Isaac Newton is often regarded as the father of spectroscopy. In 1666, during his optic experiments, he discovered that a prism breaks white light into different colours and that different colours were refracted at different angles. He concluded that colour is a property intrinsic to visible light and applied the term 'spectrum' to describe the rainbow of colours that combine to form white light.

The discipline of spectroscopy, thus, originated in study of light dispersed, according to wavelength, by a prism. Later, the concept expanded to comprise any interaction with radiative energy as a function of wavelength or frequency. A number of devices have been developed to produce and study spectra. These include, spectrometers, spectral analysers, spectrophotometers and spectrographs.

The development of astronomical spectroscopy was inextricably linked with advances in chemistry. Once it was realised that atoms and molecules have unique spectra, spectroscopy became central to the advancement of chemistry, particularly in the race to identify chemical elements. It was a chemist, British scientist William Wollaston who, in 1802, was the first to note the appearance of several dark features in the Sun's spectrum.

However, the father of spectroscopy as an astronomical tool is widely accepted to be Joseph von Fraunhofer. In 1814, the highly skilled German optician and scientist built the first spectrometer in order to measure the dispersive power of lenses, using a yellow flame as the light source. Importantly, he replaced a prism with a diffraction grating, a device which greatly improved spectral resolution. He then independently rediscovered the Sun's spectral lines when he compared the flame spectrum with a solar spectrum produced by a prism. Von Fraunhofer began systematic study and careful measurement of the wavelengths of black lines in the solar spectrum, eventually mapping over 570 of what are known as Fraunhofer lines. He designated the principal features with letters A to K, and weaker lines with lower case letters. Modern sunlight observation have detect many thousands of lines.

A spectral line is a dark or bright line in an otherwise uniform and continuous spectrum. They arise when electrons move between two energy levels in an atom and reflect the emission or absorption of this energy at particular frequencies, depending on the nature of the atoms. The atoms of different atoms (elements) and molecules produce unique spectral lines, enabling identification of which are present in an object. They can be observed across the electromagnetic spectrum, from gamma to radio waves. Lines can broaden or shift depending on both sub-atomic and larger scale effects.

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

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