"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

FEBRUARY 2017

This month's Centre meeting
The Annual General Meeting, followed by a short presentation, will take place on **Monday 20 February** at the **Scout Hall** starting at **19.00**.

Cosmology A new DVD series "Particle Physics for Non-Physicists: a Tour of the Microcosmos' begins at the meeting on **6 February.** Details can be found below.

Membership renewal for 2017
The fees for 2017 are are as follows:

Member: R150
Member's spouse/partner/child, student: R75

Six-month membership from July – December 2017:
Member: R75 Member's spouse etc, student: R40

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

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

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

WHAT'S UP?

Partial solar eclipse In a year, 4-7 lunar and solar eclipses can occur, of which at least 2 and, at most, 5 can be solar eclipses. In 2017, there will be two. South Africans will not be able to observe the total solar eclipse which will take place in the northern hemisphere on 21 August. However, on 26 February, a partial solar eclipse will be visible over Southern Africa. Just over 50% of the solar surface will be obscured when viewed from the south-western Cape (percentages will be higher further north). First contact will be at 16.58, with maximum cover at 17.59. Further to the east, sunset will precede last contact, but observers at the in the south-west Cape will be able to observe final contact at 18.54. Solar eclipses occur only at New Moon and take place when the Sun, Moon and Earth are in direct alignment. Unlike lunar eclipses, which are visible everywhere experiencing night when the eclipse occurs, total solar eclipses cast a very narrow path across Earth's surface. This is because of the huge difference in size of the Sun and the Moon: the latter's small shadow falls on only a narrow band of Earth's surface. Partial blockage of sunlight, as will take place on the 26th is visible across a much wider area on each side of the ground track. The next total solar eclipse over South Africa will occur in 2030.

LAST MONTH'S ACTIVITIES

Monthly centre meeting On 23 January, Dr Bradley Franks from the Astrophysics, Cosmology and Gravity Centre at UCT gave a very interesting presentation titled 'SKA: a crash course'. After identifying the information which radio astronomy offers in addition to that available at optical wavelengths, he explained how the vast total collecting size of the dishes and antennae which will form the Square Kilometre Array will enable astronomers to learn more about dark matter, dark energy, galaxy evolution and even further back in time than current instruments can do.

In addition to the science, he also identified associated advantages which the precursors to SKA (KAT-7 and MeerKAT) are already offering. These include human capital development of scientists, engineers and technicians, local infrastructure developments which are informing the construction work which will continue for several years, technical innovations, particularly in computing capacity and processing, and opportunities for broader 'blue-sky' thinking and research. The massive amount of data being produced by existing dishes is already demanding innovative thinking from computer scientists and technicians, and this will continue grow significantly over time. Brad explained how this has created the notion of complex, multi-dimensional 'big data', something which has already been used by analysts during the Brexit referendum and the US election. Locally, this has led to the development of IDIA, the largely south African Inter-University Institute for Data Intensive Astronomy. The large number of questions from the floor demonstrated how interesting members and visitors found his presentation.

Interest groups

Cosmology No meeting took place in January.

Astro-photography At the meeting on 16 January, members continued to discuss processing of their own astro-images.

Other activities

Educational outreach

Hawston Secondary School Astronomy Group No meeting was held in January.
Lukhanyo Youth Club On 25 January, fifteen Grade 7 learners and two teachers joined committee members for a stargazing evening on Rotary Way. A chilly wind and some passing clouds failed to dampen the enthusiasm of the children. They shared their own knowledge of the solar system and the nature of stars, and observed constellations, planets and nebulae with the naked eye, binoculars and telescopes. In addition to being shown the Southern Cross and its Pointers, Orion and Canis Major, they observed Pleiades, the Orion nebula and the Jewel Box with the binoculars and telescopes.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting will be the AGM. It takes place on **Monday 20 January** at the **Scout Hall** starting at **19.00**. It will be followed by a short presentation by a Centre member.

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 February** at the Scout Hall. Attendees will watch the first two in the DVD series 'Particle Physics for Non-Physicists: a Tour of the Microcosmos'. It provides a very understandable, systematic and chronological explanation of all the discoveries in sub-atomic physics that eventually led to the 'Standard Model of the Atom' that physicists use today. It has great relevance in understanding many of the physical phenomena in the larger cosmos. The series will continue throughout 2017.

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. The next meeting is on **13 February**. Members will continue 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 continue to work towards accessing a telescope or images which learners can start using this year.

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

FUTURE ACTIVITIES

Possible trips for 2017 are being considered. Details will be circulated to members when arrangements have been made.

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 2017 are:

20 Feb	AGM
20 Mar	'What science we have learned from space telescopes' Presenter: Pierre de Villiers, Committee chairperson
17 April	'Physics in the dark: the missing matter and energy in the Universe'. Presenter: Kate Storey-Fisher, UWC
15 May	'Asteroids, comets and dwarf planets' Presenter: Johan Retief, Centre member
19 June	'The monsters of deep space' Presenter David Groenewald, SAAO, CT
17 July	'Deep sky stargazing' Presenter: Auke Slotegraaf, psychohisotiran and editor of the Sky Guide
21 Aug	Topic to be confirmed. Presenter: Dr Amanda Sickafoose, SAAO, CT
18 Sept	TBA

16 Oct	'Jupiter: the neighbourhood bully' Presenter: Jenny Morris, Committee member
20 Nov	TBA
11 Dec	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

A decision on the planning application by the Council of Overstrand Municipality continues to be awaited. Hopefully, this will take place at their meeting this month. 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.

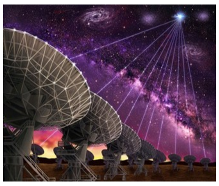
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

Fast radio bursts now a bit less mysterious 4 January: For as long as astronomers have known about Fast Radio Bursts (FRBs), they have been stumped. About a decade ago, researchers discovered in archived 2001 data an extremely fast - just a few milliseconds - burst of radio emissions. They had never seen anything like it before, and did not know where it came from or what could cause it. Finally, we are starting to get a few answers.



The dishes of the Karl G. Jansky Very Large Array depicted making the first-ever localization of a Fast Radio Burst. Danielle Futselaar [www.artsource.nl]

Astronomers announced today at the 229th meeting of the American Astronomical Society that, for the first time, they had pinpointed the origins of one of these FRBs: a small dwarf galaxy about 2.5 billion light-years away. They also found a new source of persistent, weaker radio emissions nearby. Presumably, the two are related but it is not clear.

It is big step in the study of the cosmos, but there is still got a way to go before we fully understand FRBs. The first break came in 2012, when the Arecibo Observatory in Puerto Rico detected the first-ever repeating FRB, dubbed FRB 121102 (after the date of the first detection). Before that, each one had been a single, one-off event. That alone was instructive: FRBs (or this one, at least) must not be the result of cataclysmic events, since something was still around to send the repeated signals. Even better, it meant other observatories could look in the same area to try to spot future repeat. It was "A good place to go fishing," said lead author Shami Chatterjee of Cornell.

Luckily, the universe obliged. "The FRB was extremely generous to us," said Casey Law of UC Berkeley, because the Karl G. Jansky Very Large Array (VLA) observed a total of 9 bursts in its 83 hours of observing time in 2016. This narrowed down FRB 121102's origins considerably, but still not enough. Subsequent observations from around the world, in radio and visual light spectra, found the source galaxy, in the direction of Auriga. Finally, we learned for sure FRBs (or, at least, this one) originated outside the galaxy, as had been suspected. These observations also revealed a steady source of radio emissions within 100 light-years of the FRB's precise location. The two could be results of the same process, or be otherwise related, but the answers will have to wait until more observations come in.

So, mystery solved? Not quite. We still don not know what actually causes FRBs, but at least now astronomers have some improved hypotheses. One option is a variety of exotic star, a highly magnetic kind of neutron star, which could cause just the right kind of emissions astronomers are seeing. Another possibility is a massive black hole within FRB 121102's host galaxy, which could cause the radio signals.

Still, the scientists cautioned, this is still just a single data source. It is still the only known repeating FRB, after all. Maybe there are multiple types of FRB, or this particular one is just an outlier. However, that's good news! "New mysteries in astronomy are somewhat rare," Sarah Burke-Spolaor of the National Radio Astronomy Observatory, so FRBs are increasingly becoming the exciting new thing. There are more hypothesised models causing FRBs than actual detected bursts, said Chatterjee, "a great situation for us to be in." By: Bill Andrews

Two stars will merge in 2022 and explode into red fury 6 January: In 2022, there will be a spectacular sky show. Two stars will merge into one, pushing out excess gas into an explosion known as a red nova. At magnitude 2, it will be as bright as Polaris in the sky, and just behind Sirius and Vega in brightness. The collision in the constellation of Cygnus will be visible for up to six months.

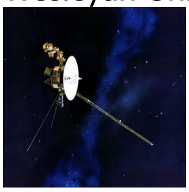

STScI

That is pretty impressive. What is more impressive: we have never been able to predict a nova before. However, Lawrence Molnar, a professor of astronomy and physics at Calvin College, was able to find a pair of oddly behaving stars giving an indication of what may happen. The objects, termed KIC 9832227, are currently contact binaries. Contact binary refers to two objects that are so close they are currently touching. The object was discovered by Kepler. The expected outcome is a merger between the two stars that will put on quite a show. Because both are low mass stars, the expected temperature is low, with Molnar terming it a 'red nova'.

So how does Molnar know what will happen? After all, as he puts it, it is "a very specific prediction that can be tested, and a big explosion." He and his team have an example to look at: V1309 Scorpii. First observed in 2008, astronomers were able to watch the light curve as the event unfolded. First, there were a few 'booms' in the sky. Then, a spectacular light show unfolded. Using precovery data, astronomers traced back the evolution from 2001 on, giving a big picture of the decade of progression of the event.

How did they know it was a merging star? "V1309 was (brightening) before the explosion," Molnar said in a press conference at the 229th meeting of the American Astronomical Society. "It isn't doing it today. That's the smoking gun of a merging star." Using Kepler data, Molnar found that KIC 9832227 fits the lightcurve of V1309 almost perfectly. All radial velocity measurements seem to indicate a contact binary, and by aligning the light curve to the period in time, he and his team came to the conclusion that the merger would complete in 2022. "We don't know if it's right or wrong, but it's the first time we can make a prediction," Molnar says. At 2nd magnitude, it'll be easy if it see if the prediction was correct. By: John Wenz

How the Voyagers and Hubble work together to map the final frontier 6 January: It is not just a cloudy day somewhere here on Earth. For Hubble, it is always a cloudy day along the paths of the Voyagers 1 and 2. Hubble cannot see the car-sized probes that far out. However, it has actively been working with the Voyager probes to measure and define interstellar space. The results are … weird. "It looks like in our local neighbourhood, there's a big blob of stuff," said Julia Zachary, an undergraduate at Wesleyan University. "That's actually a cloud of interstellar dust."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Those clouds extend out for several light-years. Voyagers 1 and 2 are headed in separate directions. When Hubble glances in the direction of each probe, it uses four total stars as guide posts. For Voyager one, those stars are Gliese 686 and Gliese 676A. For Voyager 2, that's Gliese 780 and Gliese 754. The Voyagers use their still-operational instruments to measure interactions between "outward moving solar wind and inward pressure from the interstellar medium." Optically, Hubble can characterise what the materials in the path are.

The Hubble telescope's images reveal that the clouds of dust can obscure the view of stars, dimming them in the same way a cloudy day on Earth can blot out the Sun. This is a problem for Gliese 754, the dimmest of the stars at 12th magnitude.

There are only a few years left to make these kinds of studies. The Voyagers are currently the only operational probes at or near the edge of interstellar space, but the decay of the Plutonium-238 inside each craft will reach a half-life within a decade that will dampen the ability of power output to match up with spacecraft needs. Even now, only the lowest power instruments, like the magnetometers and particle detectors, are online. After the P-238 energy is exhausted, the Voyagers will likely go dark. By: John Wenz

The Milky Way's giant black hole chews up stars and spits out planets 9 January: At the centre of every large galaxy lies a supermassive black hole that keeps the engine turning. When a star comes near these black holes, a massive fireworks show ensues - so massive that it can shred the star into 100 million Jupiter-mass puffs of hot gas that jettison away at high speeds. That is pretty massive, and it has happened in our own backyard.


This artist's rendering shows planet-mass objects formed from star fragments that were shredding by the galaxy's supermassive black hole. Mark A. Garlick/CfA

At the centre of the Milky Way lies Sagittarius A* (Sgr A*), a supermassive black hole. Stellar tidal disruption events likely happen every few million years. Rather than swallowing the star completely, Sgr A* rips the star apart. The end result is pretty brutal: 100 million Jupiter-size swarms of gas: 'celestial spitballs'.

"What will make them distinguishable from normal planets is how fast they're moving," Eden Girma, a sophomore at Harvard University who worked on the project, said in a press conference Friday at the 229th meeting of the American Astronomical Society. Girma's work focused on how close one such object might have come to our solar system. Simulations suggest that most of them are tossed out of the galaxy entirely, while a few may have stayed bound to Sgr A*. However, anywhere from 1,000 to 10,000 of these objects are spewed back into the galaxy at large. According to her simulations, though, the closest to encounter Earth might have been 700 light years away.

Finding such objects might be difficult, Girma says, because "by the time they reach us, they'll be extremely cold." This also might make it more difficult to characterise them. Though they will be Jupiter-mass, they will not have formed by the typical mechanism of planets, where layers of gas accumulate over time. Instead, the timescale of formation could be measured in years instead of millions of years. They would be abundant in hydrogen and helium thanks to their stellar origins. Although the gas may be gravitationally bound, it may not have the density typically expected of a planet.

Even if such a planet(-ish) is found through a microlensing event, it might be hard to distinguish them from planets that formed through traditional mechanisms and were ejected out of their solar system. For now, what we know is that there may be stragglers in the spaces between stars, remnants of a violent incident moving swiftly away from their place of origin. By: John Wenz

The Moon is much older than everyone thought 12 January: The Moon has been a constant in the sky, but do we know just how old it actually is? A team of researchers at UCLA wondered that exact thing and conducted a study to find an exact age and found the Moon is as much as 140 million years older than we've previously known. This moves the potential age back to 4.51 billion years old.

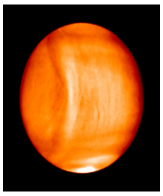
The team studied zircons, or minerals from the Moon, brought back from the Apollo 14 mission in 1971. In 2016, a UCLA research team reported that the collision between the Earth and planetary embryo Theia was a violent, head-on collision that resulted in the creation of the Moon.

Mélanie Barboni, a research geochemist in UCLA's Department of Earth, Planetary and Space Sciences and lead author on this study, said that looking for the age of the Moon has been difficult because "whatever was there before the giant impact has been erased." To find some answers, Barboni studied eight zircons in a lab at Princeton using a mass spectrometer. "Zircons are nature's best clocks," Kevin McKeegan, a UCLA professor of geochemistry and cosmochemistry, and a co-author of the study said. "They are the best mineral in preserving geological history and revealing where they originated."

The Moon was initially covered in a magma ocean after the collision between Earth and Theia, which later cooled and became the Moon's mantle and crust. To see when that happened, Barboni studied the uranium zircon and how it had decayed to lead. To figure out when the magma itself formed, she studied the lutetium zircons and how it decayed to hafnium. "Mélanie was very clever in figuring out the moon's real age dates back to its pre-history before it solidified, not to its solidification," said Edward Young, a UCLA professor of geochemistry and cosmochemistry and a co-author of the study. The team is still studying the zircons to find more information about the early ages of the Moon.

By: Nicole Kiefert

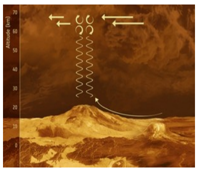
Bulge in Venus' atmosphere likely caused by gravity waves 16 January: A massive, bow-shaped wave was spotted for the first time in the highest regions of Venus' atmosphere, perplexing astronomers.


The massive bow wave is visible in the upper atmosphere of Venus in this infrared image ©Planet-C

The structure was captured by the Japan Aerospace Exploration Agency (JAXA) in some of the first images returned by their Akatsuki orbiter following a troubled orbital insertion in late 2015. Using both infrared and UV imaging, researchers spotted the prominent feature in the planet's upper atmosphere, where winds whip by in excess of 200 miles per hour. Any features spotted in the atmosphere should get carried along by the fierce winds, but this curved wave remained planted firmly in place, lasting for at least four days.

The wave extends for more than 10,000 km, stretching nearly from pole to pole. It is marked by the presence of slightly warmer air in the upper portion of the planet's thick atmosphere, some 40 miles above the surface. While small aberrations are common in the upper atmosphere, such a large feature, to say nothing of one that refuses to move, is highly uncommon. Venus' atmosphere is in a state of super-rotation, meaning it moves much faster than the planet does. Venus rotates very slowly on its axis, completing just one rotation every 243 Earth days - longer than it takes the planet to go around the Sun. On Earth, winds move only 10 to 20 percent the speed of the planet at most, but on Venus they far outpace the planet's stately spin.

The researchers believe that the enormous structure might be caused by so-called 'gravity waves' in Venus' atmosphere. Gravity waves (which are entirely different from gravitational waves), are upheavals in a planet's atmosphere caused by winds colliding with features on the surface. In the case of Venus, mountainous features on the surface may be forcing winds into the upper atmosphere, where they slow down enough to create a lasting bow wave. Indeed, the atmospheric bulge is located above Aphrodite Terra, a continent-sized region of highlands.


An illustration of how gravity waves likely form on Venus. Surface winds are pushed upwards by topological features such as mountains into the upper atmosphere where they "break" like waves on a shore, slowing down high-altitude winds. ESA

The bow wave was only spotted for four days near the beginning of Akatsuki's mission. When researchers looked again a month later, it had disappeared. Scientists have observed the presence of gravity waves in the upper atmosphere of Venus before - the European Space Agency's Venus Express orbiter found the telltale cloud shapes over the smaller Ishtar Terra region in 2014 - but those gravity waves were not nearly as large as the planet-spanning feature found by JAXA.

Our understanding of gravity waves is currently based on models of Earth's atmosphere. On Venus, where the air is composed mainly of carbon dioxide and the atmospheric pressure is almost 100 times greater than that on Earth, the atmospheric dynamics are likely different. The waves could give astronomers another way to discern the terrain hidden beneath Venus' thick layer of opaque clouds. By: Nathaniel Scharping

What dark gunk on Enceladus' surface reveals about the ocean below 24 January: Plumes spouting from Saturn's moon Enceladus provide a tantalising glimpse of the ocean beneath, a potentially habitable region where life might have evolved. Light and dark swaths of the moon reveal information about the material as it falls to the surface. By studying the discolourations on the crust, scientists hope to learn more about watery realm underneath.


A global mosaic of Saturn's moon Enceladus produced by Cassini. The blue regions are where plume particles fall back to the surface. The yellow regions receive very little plume fallout, and so are dominated by material from Saturn's E-rings. NASA/JPL-Caltech/Space Science Institute/Lunar and Planetary Institute

While the most massive particles fall directly back onto the surface, lighter ones leave the moon entirely, creating Saturn's thin E-ring. Radiation converts the material from its original pristine form into something else, a darker, chunkier material that eventually falls back onto Enceladus as the moon ploughs through it. "It's clear that the E-ring grains are a different colour in the visible [spectrum] than the plume grain regions," says Amanda Hendrix, of the Planetary Science Institute in Colorado. By studying the different grains with Cassini's Ultraviolet Imaging Spectrograph (UVIS), Hendrix hopes to narrow down the ingredients coming from the plumes. She presented her research in Octoberat the annual Division for Planetary Sciences meeting in Pasadena, California.

Enceladus was considered a dead icy world until NASA's Cassini mission arrived. In 2006, it spotted a fountain of material erupting from the moon's southern pole. Later observations by the spacecraft revealed that an ocean, rather than a localized lake, existed beneath the surface of the moon. Cassini had no plans for analysing particles erupting from a planet, but that did not stop its engineers from re purposing an existing instrument for the task. Since it spotted the plumes, the spacecraft has made multiple dives through the spouts, concluding its final trip in October 2015. Still, the revised instrument could only go so far in analysing the organic material.

To learn more about the interior of Enceladus, Hendrix is studying the material on its crust. By examining differences in how the material is changed by its time in space, she hopes to better understand its original condition. "All of those E-ring grains coat the surface of Enceladus," Hendrix says. While a lot of it escapes into space, the majority of them fall back onto the surface. "You wind up with these visible colour variations."

Previous models of the plumes suggested that while some of the material that immediately crashes back to the surface can coat the northern hemisphere and equatorial regions, most of it lands around the south pole. The discolouration supports that idea as it reveals lighter, unprocessed material dense around the southern pole and thinning out farther north. In a 3-colour images, the plume fallout appears bluish, while material from the E-rings are yellower, Hendrix says. This helps scientists to identify the different sources. While in space, radiation processes the particles, making them chunkier as the smooth profile of the fine ice grains becomes rougher.

Most of the material falling back to the surface is salt-rich, Hendrix says, a contrast to the salt-free E-ring. That is because the salts are too massive to break free from the moon's gravity and join the ring. Hendrix and her colleagues also identified differences in the organic content, most likely due to the amount of processing that occurs in space. "It may be that the plume fallout zones contain just as much organic material but it hasn't been processed as much, because it hasn't spent as much time in the E-ring," she said.

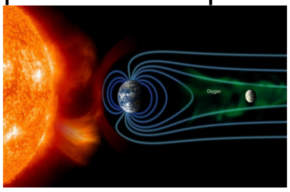
Enceladus is not the only moon that captures in-falling material. The splotchy reddish moon Tethys lacks the geysers of its sibling satellite, but still winds up covered as it interacts with the ring. Because it is tidally locked, with one face permanently turned toward Saturn (as all of Saturn's moons are), one side captures the brunt of the material while the other side remains relatively bare.

The material that lands on its surface looks different from the particles falling on Enceladus, where the returning particles are soon covered by plume material. Because Tethys lacks plumes, radiation continues processing the icy material that falls to the surface into something else. "They're almost like tholins," Hendrix says. Tholin is something of a catch-all term for the material created when simple organics undergo radiation. Tholins are suspected to cause the reddish spot on Pluto's moon, Charon, and are thought to exist on other moons like Saturn's Titan. "It's probably not proper tholins, but some complex organics," Hendrix says. While tholins are gunky, the particles on Tethys are probably icier than their Charon counterparts.

By probing the mysteries of the plume material on multiple moons, Hendrix and her colleagues hope to understand more about the potentially habitable ocean beneath the surface of Enceladus. By: Nola Taylor Redd

'Earth wind' bathes the Moon with oxygen 30 January: A new study from Japanese researchers reveals that for the past 2.4 billion years, the Moon has been bathed in a

stream of oxygen particles stripped from the Earth's atmosphere. By combining measurements taken with the lunar orbiter Kaguya and studies of lunar rocks, researchers prove that Earth contributes its own unique whiff of elements to the Moon's surface. The findings adds substantial proof to the theory that solar winds can carry particles of terrestrial origins all the way to the lunar surface.
The Earth is constantly bombarded by a current of charged particles emanating from the Sun, called a solar wind, which is responsible for auroras. Earth's magnetic field provides a bubble of protection from these charged particles as they are diverted around the planet. When Earth passes between the Sun and the Moon, the Moon is briefly protected from the solar wind. During this time, particles ripped from the upper layers of the Earth's atmosphere can land on the moon, planted in the topmost layer of lunar soil. Over the course of millions of years, these particles would come to represent a timeline of the planet's atmosphere that researchers might be able to read.



An illustration of Earth's magnetic field and the plasma sheet created by the solar wind that extends far behind us. Osaka Univ./NASA

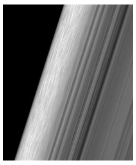
Previous studies of lunar rocks have found trace amounts of nitrogen, oxygen and noble gases with isotopic compositions that match those found on Earth. However, it was not clear if they came from Earth. To prove solar wind-assisted deposition was responsible, the researchers used instruments aboard Kaguya to identify particles that passed by during that brief window when the moon hides behind Earth, shielded from the solar wind. The oxygen ions passing through at that time looked completely different than the ones that came from the sun, and, because the Earth was right in the way, this indicated that they came from us.

The composition of Earth's oxygen is unique because it is the result of biological processes that have no known correlates anywhere else in the universe. If the lunar oxygen molecules could have come from nowhere else, we should be able to use them to dig into the moon and peer back through the history of the Earth's atmosphere - all the way to the time oxygen first appeared some 2.4 billion years ago. This could potentially give us insights into the progress of biological life as it evolved and spread across the planet.

Still to come are further experiments into the composition of lunar soil to tease out exactly which elements come from Earth. Because the moon floats in our protective wake for five days out of every orbit, the contributions from Earth's atmosphere are likely to be overshadowed by the particles emanating from the sun. If we can successfully differentiate the terrestrial and solar, scientists may be rewarded with a glimpse back into the atmosphere of an Earth very different from the one we inhabit today.

By: Nathaniel Scharping

Cassini's final days begin with the most detailed images of Saturn's rings to date 30 January: Saturn's ring system is unique among all the planets in our solar system. Ever since entering orbit around Saturn on 1 July 2004, the Cassini spacecraft has sent back stunning images of the gas giant, its moons, and, of course, its rings. Even as the mission nears its end on 15 September 2017, itis still showing us never-before-seen details of the rings and the icy particles that comprise them.

 NASA/JPL-Caltech/Space Science Institute

In preparation for the Grand Finale portion of its mission, the Cassini spacecraft has begun performing a series of 'ring grazes' which are taking it closer and closer to the subject of its study. Now, the Cassini team has released the most detailed images of the outer parts of Saturn's main rings to date.

Although Cassini actually approached the rings more closely as it entered orbit in 2004, the images it took at that time were not as detailed as the ones it is returning now. That is due to several factors, including the lighting of the rings and the speed of the spacecraft at the time. While previous close-up images of the rings used short exposures and only imaged the rings while backlit, Cassini is now providing backlit and sunlit pictures, and will continue to send more such photos back to Earth as it passes by these structures every week in the coming months. Cassini's most recent images feature the highest level of detail achieved yet, resolving structures that are just 550 metres across - that's roughly the size of some of Earth's tallest buildings. The Burj Khalifa in Dubai (currently the world's tallest building) is 828 metres) tall.

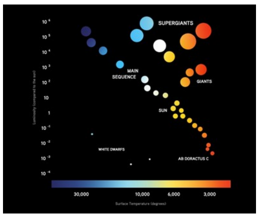
Cassini Imaging Team Lead Carolyn Porco, currently at the Space Science Institute in Boulder, Colorado, was responsible for planning the initial ring images that have remained the best available for over a decade. Now, she says, "I am taken aback by how vastly improved are the details in this new collection." Cassini scientist Matthew Tiscareno of the SETI Institute in Mountain View, California, planned these newest images. He adds, "These close views represent the opening of an entirely new window onto Saturn's rings, and over the next few months we look forward to even more exciting data as we train our cameras on other parts of the rings closer to the planet."

Saturn's ring system is not only unique, but amazingly complex as well. The rings are made up of icy particles that range in size from dust grains to mountain-sized boulders measuring miles across, and their behaviour is intricately intertwined with many of Saturn's moons. In fact, many structures within in the rings, including ripples and clumps, are due to interactions with moonlets either shepherding the rings as they orbit alongside them, or orbiting embedded within the rings themselves. And when Cassini begins the 22 orbits that will constitute its final phase in late April, astronomers anticipate surprises to come as the spacecraft sends back ever-more-stunning views of this unique, beautiful, and intriguing ring system. By: Alison Klesman

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

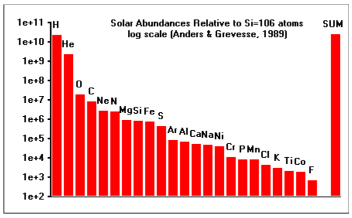
DID YOU KNOW?

The Sun Part 11: **Stellar spectral classification 2**



Herzsprung-Russell diagram

Cecilia Payne Gaposchkin



Sun element abundance

The fact that the Harvard system indicated a star's surface (photospheric) temperature was not fully understood until after its initial development. However, by 1914, when the Hertzsprung-Russell (H-R) diagram was formulated, this was generally suspected to be true, although it was only confirmed in the late 1920s. Because the sequence developed by Cannon pre-dates understanding of it being a temperature sequence, placement of a spectrum into a given sub-type eg B3, A7, depends largely on subjective estimates of the strengths of absorption features in stellar spectra. As a result, these sub-types are not evenly divided into sort of mathematically representable intervals.

The H-R diagram is a graph on which a measure of the brightness of stars is plotted against a measure of their temperature. It shows how the luminosities and surface temperature of stars are linked. It was independently devised by the American astronomer Henry Norris Russell and the Danish astronomer Ejnar Hertzsprung. In 1905, Hertzsprung showed that a stars luminosity was related to spectral line width, a characteristic enabling calculation of its distance and, in 1906, plotted the first version of the H-R diagram. However, his work remained largely unknown, and, in 1910, Russell independently developed the diagram in a slightly different form. During this process, he found that red stars fall into two groups, giants and dwarfs. Unaware that Hertzsprung had done the same in 1906, in 1913, Russell further developed the diagram which, a year later, became known as Hertzsprung-Russell diagram. In 1928, Russell established the composition of the Sun's atmosphere from its spectrum.

The H-R diagram provides more than just information about a stars temperature and luminosity. From its position on the diagram, it is also possible to estimate its mass and stage of evolution. Most stars, including the Sun, lie in the main sequence ie they shine by converting hydrogen to helium in their core. The main-sequence is the diagonal strip on the diagram which runs from the top left to the bottom right. A stars position on this strip depends on its mass, with the most massive at upper left and the least massive at the lower right. Other areas on the diagram are populated by stars not burning hydrogen in their core, but which may be burning it in a thin surrounding shell. The giant branch is the most prominent of these areas, consisting of stars which have exhausted the hydrogen fuel in their cores. Other features are the supergiants (luminosities 300-100,000 times that of the Sun) and white dwarfs (dying stars with luminosities typically 10,000 times the Sun).

The Sun, an average star, lies about half-way along the main-sequence. Whatever its mass, a star on the main-sequence is termed 'dwarf' and belongs to luminosity class V. Most stars are of this type, their masses ranging from 0.1-100 solar masses. The term 'dwarf' is used because stars in the main-sequence are smaller than those of the same mass which have evolved into giants. However, so-called white, black and brown dwarfs are not dwarfs in the sense of being main-sequence stars. Stars spend most of their lives on the main-sequence, remaining at roughly constant temperature and luminosity. The time they spend on main-sequence depends on their mass. For very massive stars, it lasts only a few million years, for least massive, potentially longer than the age of the Universe.

In the late 1920's, Russell suggested that all stars contain a high prop of hydrogen. However unknown to most, the same conclusion had originally reached, in 1925, by Cecilia Payne Gaposchkin, another of Pickering's computers. During work she undertook during the previous two years, she demonstrated that the O-M spectral sequence in the Harvard classification is actually a sequence of temperatures. The temperature scale she developed for the various types of stars based on the strengths of their spectral lines enabled her to accurately relate spectral classes to actual stellar temperatures. She showed that the great variation in stellar absorption lines was a consequence of differing amounts of ionisation at different temperatures, not to differing amounts of elements, as was currently assumed. Her findings allowed her to correctly conclude that silicon, carbon and common metals seen in the Sun's spectrum existed in about the same amounts as on Earth, but that hydrogen and helium were vastly more abundant in stars. Her research established that hydrogen is, by, far the largest constituent of stars. However, her findings were only published some time later.

Over time, the details of existing classes in the M-K system have been refined and additional classes have been added following newly discovered types of stars, but the system of stellar classification which has evolved since the 1860s has proved to be a sound one. It also has a role in the search for exoplanets, particularly those which may be habitable. The range of stars predicted to be able to support life is limited by several factors. In the main-sequence, stars more massive than 1.5 times that of the Sun ie types O, B or A age too quickly for advanced life to develop. Dwarfs of less than half the Sun's mass (class M) are likely to tidally lock planets within their habitable zone, reducing the likelihood that life can develop.

Sources – Wikipedia, Dictionary, www.missionscience.nasa.org

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

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