"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

AUGUST 2017

Change of meeting venue A reminder that the Scout Hall is no longer the venue for Centre meetings. From July 2017, these will take place at the neighbouring **Catholic Church Hall** (the venue for U3A meetings). The Catholic Hall is in the block on the mountain side of the Scout Hall. Parking is available to the side of the building or across the road.

This month's Centre meeting
This will take place on **Monday 21 August** at the **Catholic Hall** starting at **19.00**. The speaker is Dr Amanda Sickafoose, Astronomer and Head of Instrumentation at the SAAO in Cape Town and Honorary member of the HAC. See below for more details.

WHAT'S UP?

A low flying swan Cygnus (the swan) is one of the most prominent constellations in the northern hemisphere. At this time of year, its eponymous shape of an open-winged long-necked swan can be found low to the north. It is sometimes called the Northern Cross due to the large cross formed by the arrangement of its main stars. The 16th largest constellation, Cygnus is situated in a rich part of the Milky Way and contains a number of interesting objects including double stars, open clusters, planetary, dark and other nebulae, a strong radio source created by two colliding galaxies (Cygnus A) and an intense X-ray source (Cygnus X-1) which is believed to be a black hole whose massive gravitational field is persistently pulling in the material of a nearby supegiant star. Deneb (Alpha Cygni), its brightest star is located at the tip of the swan's tail. It is a very bright supergiant star with a luminosity 50,000 times that of the Sun. This is the reaso

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter on 17 July was Auke Slotegraaf, head of ASSA's deep sky section and editor of the South African Sky Guide. His topic of 'Deep sky observing' included both reflective and a pragmatic elements. Auke asked the audience to think about broad issues including why people want to observe the skies, to what extent observing can be objective when it involves people who will bring their own knowledge, lack of knowledge, expectations and interpretations to the activity, and to what extent observers look rather than see what they are observing. He then outlined an observer's cycle: plan – do – review – share - learn – plan and so on, before reinforcing the value of making detailed records of observations, following checklists in order to get the most out of observing, and of accessing the many available resources eg maps, catalogues, other's observation reports available on the Internet, particularly the deep-sky section of the ASSA website.

Finally, he ended his thought-provoking talk by identifying some of the projects and recorded observations which are currently needed to further develop and enrich the deep-sky knowledge base eg converting written and photographic records to digital format, building up atlases of features for which current recorded observations and mapping are limited eg the Magellanic Clouds.

Interest groups

Cosmology 14 people (all members) attended the meeting on 3 July. 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 11: 'Three quarks for Muster Mark' and Lecture 12: 'From quarks to QCD'.

Astro-photography At the meeting on 10 July, members continued to work on processing their own astro-images.

Other activities

Educational outreach

Hawston Secondary School Astronomy Group No meetings took place during the school holidays this month.

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 21 August** at the **Catholic Hall** starting at **19.00**. The speaker is Dr Amanda Sickafoose, astronomer and Head of the Instrumentation Division at the SAAO in Cape Town. She obtained her undergraduate and postgraduate degrees in the USA, including her PhD at the University of Colorado in Boulder. Based presently in Cape Town, she continues to maintain international links, particularly with MIT. She was elected an Honorary Member of the HAC particularly for the assistance she gave in the procedures involved in the naming of Asteroid Hermanus, but also for her early and ongoing support for astronomy in Hermanus. An outstanding speaker who has given several talks in previous years, Amanda will, no doubt, give another fascinating presentation on current work in which she is involved.

There is an entrance fee of R10 per person for members, R20 per person for non-members, and R10 for children, students and U3A members.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month at 19.00. This month's meeting will take place on **7 August** 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 13: 'Symmetry and conservation laws' and Lecture 14: 'Broken symmetry, shattered mirrors'.

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 **14 August**. Members will address the use of nebulosity in processing 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 images which learners can start processing with suitable software.

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

Stargazing Several committee members led a pop-up stargazing event on 18 July on Rotary way which was requested by SANSA staff for international delegates attending their Winter School. The fifteen or so delegates were all from the northern hemisphere and were particularly impressed to see 'new' features including the Southern Cross, Coalsack nebula and Omega Centauri. Although returning cloud prevented viewing beyond 21.00, they had an hour or so to also observe Jupiter and Saturn as well as southern winter constellations like Scorpius.

FUTURE ACTIVITIES

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

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.

21 Aug	Topic to be confirmed. Presenter: Dr Amanda Sickafoose, SAAO, CT
18 Sept	'Hidden features: discovering space in a reluctant Universe' Presenter: Dr Michelle Cluver, UCT
16 Oct	'Jupiter: the neighbourhood bully' Presenter: Jenny Morris, Committee member
20 Nov	TBA
11 Dec	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Additional information requested by staff at Overstrand Municipality has been submitted. Hopefully, this will enable the Council to consider the planning application within a month or two. 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.

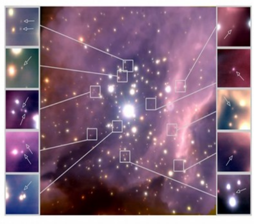
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

Brown dwarfs are as plentiful as stars 6 July: It seems that for every star that ignites, there may be a failed star. A recent study by international researchers, including scientists at York University, found that the Milky Way may be home to 100 billion brown dwarfs - which matches the projected head count of 100 billion stars in our galaxy.



Can you spot the brown dwarfs? This image of the star-forming RCW 38 shows several candidate brown dwarfs found in a recent study. Koraljka Muzic, University of Lisbon, Portugal / Aleks Scholz, University of St Andrews, UK / Rainer Schoedel, University of Granada, Spain / Vincent Geers, UKATC / Ray Jayawardhana, York University, Canada / Joana Ascenso, University of Lisbon, University of Porto, Portugal / Lucas Cieza, University Diego Portales, Santiago, Chile

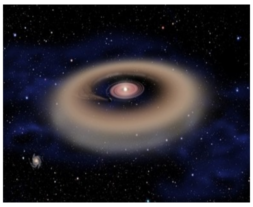
A brown dwarf is a so-called failed star because it never ignites in such a way as to fuse hydrogen into helium, which creates the hot, bright engines known as stars. Instead, brown dwarfs fuse hydrogen into heavier isotopes like deuterium, if they fuse anything at all. They typically are gaseous objects about 13 Jupiter-masses or above, and form like stars rather than planets. (Most planets start as a rocky body before gathering envelopes of gas).

The researchers performed an extensive survey of RCW 38, an ultra-dense star-forming cluster around 5,500 light-years away. Most stars that form in the region live fast, gain mass, and die young in a supernova explosion. However, within the cluster, they found the same ratio of brown dwarfs as in five other surveyed clusters going back to 2006, many without the same extreme conditions as RCW 38. In other words, there seems to be a fairly uniform distribution of brown dwarfs across the galaxy, regardless of environment. "Brown dwarfs form alongside stars in clusters, so our work suggests there are a huge number of brown dwarfs out there," said Alex Scholtz, an astronomer at University of St Andrews.

The bare minimum estimate is that there are 25 billion brown dwarfs in the galaxy.

However, brown dwarfs are hard to detect - some are frigid and emit no light at all - that number climbs higher and higher. The third-closest stellar system to us, Luhman 16, consists of two brown dwarfs. Despite being only 6.5 light-years away, the pair went undiscovered until 2013. In fact, of the 40 closest stars (loosely termed), 15 are brown dwarfs and all but one were discovered this century. By: John Wenz

Astronomers find two classes of gas giant planets 6 July: According to the NASA Exoplanet Archive, astronomers have found 3,498 confirmed exoplanets as of 19 June 2017. Of those planets, 679 have measured masses, and 281 have masses greater than 300 times that of Earth (Jupiter's mass is nearly 318 times that of Earth). As more planets circling other stars are discovered, astronomers are now hoping to use the increased statistics to understand how those planets form in the first place. Rcent work has now found evidence for at least two formation mechanisms behind the growth of giant planets in extrasolar systems.


Planets form from material in the disks around young stars, such as the one pictured in this artist's concept. New findings indicate that gas giants may form via one of two mechanisms, depending on their host star. David A. Aguilar, CfA

The work focuses on data gathered by a team at the Instituto de Astrofísica e Ciências do Espaço (IA) in Porto, Portugal. Based on information about both the exoplanets that have been discovered and the stars around which they circle, the team at IA found evidence for two types of giant planets, each with its own formation scenario. "Our team, using public exoplanet data, obtained … interesting observational evidence that giant planets such as Jupiter and its larger mass cousins, several thousand times more massive than the Earth (of which we do not have an example in the Solar System) form in different environments, and make two distinct populations," said Vardan Adibekyan of IA and Universidade do Porto.

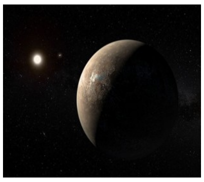
These populations are divided by planetary mass: The first population is 'lower-mass' giant planets less than four times the mass of Jupiter; the second is giant planets ranging from four to 20 Jupiter masses. The team found that the lower-mass gas giants form around metal-rich stars via a process called core-accretion, during which a rocky or icy core is formed first, which then attracts gas from the surrounding protoplanetary disk to form a gas giant. (In astronomers' parlance, any element heavier than helium is considered a metal; the Sun is considered a relatively metal-rich star).

Alternatively, higher-mass gas giants seem to form via instabilities that occur in the protoplanetary disk, without first developing a core. Instead, these instabilities cause portions of the disk to condense into giant planets. These planets are also more likely to form around more massive but metal-poor stars."The result suggests that both mechanisms may be at play, the first forming the lower mass planets, and the other one responsible for the formation of the higher mass ones," said Nuno Cardoso Santos of IA and Faculdade de Ciências da Universidade do Porto, who led the research.

The fact that more than one formation scenario exists affects the type of planets we expect to see, as well as where we expect to see them. Furthermore, determining how planets form and the environmental factors that play a role during this process will help astronomers and planetary scientists better understand how our own solar system formed. Both current and future missions, including GAIA, TESS, and JWST, will continue to provide constraints and insight on planetary formation throughout the galaxy.

By: Alison Klesman

Our nearest neighboring planet may have a sister world 7 July: Proxima Centauri b may not be alone out there.


An artist's impression of Proxima b orbiting its parent

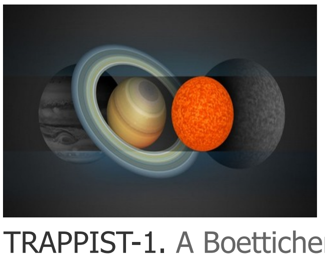
The 2016 announcement of Proxima Centauri b was a watershed moment in exoplanet research. Not only had researchers found a potentially habitable Earth-mass planet, but it was at the nearest star to Earth. This means it could be one of the easiest systems to study using future telescopes However, researchers are now looking into some promising signals suggesting there are more planets lurking in the system.

Indeed, such a companion was suggested in the initial results published in 2016, but the signal was of poor quality. "A second signal in the range of 60–500 d was also detected, but its nature is still unclear due to stellar activity and inadequate sampling," the original paper stated. The period seems to be roughly 215 days, give or take. This would be far outside the 83 day rotational period of the star, meaning it is unlikely to be caused by something in Proxima itself. Such an orbit would place it far, far outside the habitable zone. The current estimate is about 3.3 Earth-masses, making it a large rocky body - if it exists.

It may take a bit of work to draw out Proxima Centauri c from hiding - Proxima b does not pass in front of its star from our perspective, so researchers have to rely on the radial velocity method, which looks for subtle shifts in a star's spectra related to a planet tugging on its stellar home. If its found to be true, it could open the door to finding an entire solar system right next door.

By: John Wenz

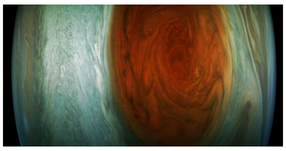
Astronomers just discovered the smallest star ever 12 July: A team of astronomers at the University of Cambridge was on the lookout for new exoplanets when they came across an exciting accidental discovery: They found the smallest star measured to this day.


This artist's rendering compares EBLM J0555-57Ab to both Jupiter and TRAPPIST-1. A Boetticher et al., 2017

This tiny new star, which is being called EBLM J0555-57Ab, is about 600 light-years from Earth, and has a comparable mass (85 Jupiter masses) to the estimated mass of TRAPPIST-1. The new star, though, has a radius about 30 percent smaller. Like TRAPPIST-1, EBLM J0555-57Ab is likely an ultra-cool M-dwarf star. The team used data from an experiment called WASP (the Wide Angle Search for Planets), which is typically used in the search for planets rather than stars, to look for new exoplanets. During their studies, they noticed a consistent dimming of EBLM J0555-57Ab's parent star, which signified an object in orbit. Through further research to measure the mass of any orbiting companions, they discovered the object they'd detected was too massive to be a planet - it was instead a tiny star.

Though EBLM J0555-57Ab is incredibly small, it still has enough mass for hydrogen fusion, which powers the Sun and making it Earth's energy source. Just barely bigger than Saturn, the star has a gravitational pull 300 times stronger than Earth's. If the star were much smaller (about 83 Jupiter masses), there would not be enough pressure in its centre for the process to occur, and it would instead have formed as a brown dwarf, rather than a true star. By: Nicole Kiefert

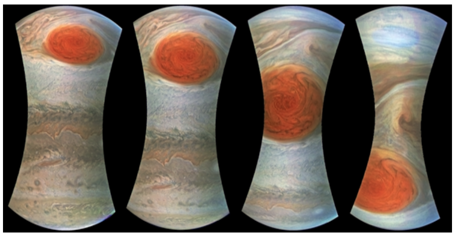
Juno gets up close and personal with Jupiter's Great Red Spot 14 July: Jupiter's Great Red Spot is one of its most iconic features. The giant storm, which has been raging in the atmosphere of the gas giant for at least hundreds of years, is larger than Earth and can be seen easily even with an amateur telescope. However, despite its size and prominence, the Great Red Spot is a mystery that continues to intrigue planetary scientists. Now, NASA's Juno probe has returned the best ever images of the Great Red Spot, following its most recent close flyby of our solar system's largest planet on 10 July.



Jupiter's Great Red Spot pops in this enhanced-color image, taken by the Juno spacecraft during its seventh close Jupiter flyby on 10 July 2017. NASA/JPL-Caltech/SwRI/MSSS/Gerald Eichstadt

The pictures the probe returned are stunning. As it passed over the Great Red Spot at a height of 9,000 km, Juno's imaging camera, JunoCam, snapped several apple core-shaped photos of the feature in optical light. However, pretty pictures were not Juno's only goal; all of the spacecraft's eight additional instruments recorded data during the flyby as well. Those instruments include a magnetometer, a radio and plasma wave sensor, a microwave radiometer, and an ultraviolet spectrograph. By combining the multi-wavelength data from these state-of-the-art instruments, scientists can create a more complete model of the storm than ever before.

"These highly-anticipated images of Jupiter's Great Red Spot are the 'perfect storm' of art and science. With data from Voyager, Galileo, New Horizons, Hubble and now Juno, we have a better understanding of the composition and evolution of this iconic feature," said Jim Green, NASA's director of planetary science.

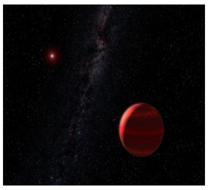
 The close-up images JunoCam takes are shaped roughly like an apple core because the craft swings so close to the planet during perijove, affecting the illuminated area the camera can capture. NASA-JPL/SwRI/MSSS/Ted Stryk

The Great Red Spot has been seen continuously since at least 1830, though it may have developed earlier. In recent decades, it has been shrinking in size; in April of this year, it measured 16,350 km across, or about 1.3 Earth diameters. Its winds have been clocked at 640 km/h, though its centre is calm, like the eye of an earthly hurricane. Recent experiments suggest that the storm's red colour is caused by a reaction in Jupiter's upper atmosphere when energetic ultraviolet photons in sunlight hit ammonia and acetylene gas.

"For hundreds of years scientists have been observing, wondering and theorising about Jupiter's Great Red Spot. Now we have the best pictures ever of this iconic storm," said Scott Bolton, Juno principal investigator from the Southwest Research Institute in San Antonio. Although he added that it will take time to sort through and analyse the influx of new data, the details Juno is returning are vital to understanding the storm's dynamics, both past and present.

The 10 July flyby was Juno's seventh close approach to the planet; in total, it will orbit Jupiter 37 times, with the closest pass bringing the spacecraft within about 3,400 km of the cloud tops. At mission's end in 2018, Juno will plunge into the planet's atmosphere, just like the Cassini mission currently orbiting Saturn. By: Nicole Kiefert

The hunt is on for planets around some of our closest neighboring stars 18 July: The Pale Red Dot team is coasting off the success of their discovery last year of a planet in the Proxima Centauri system by casting its net even wider as the Red Dots campaign

 CHRX 73 B is a 12-Jupiter-mass planet circling a red dwarf star like the stars under investigation by the Red Dots campaign. NASA, ESA and G. Bacon (STScI)

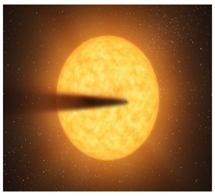
Whereas Pale Red Dot focused just on Proxima Centauri, Red Dots is looking toward Barnard's Star and Ross 154 as well. These three stars will be held up to intense scrutiny by the team in the hunt for planets — or in the case of Proxima, additional planets. Barnard's Star has been a popular target since the 1963 announcement by Swarthmore College professor Peter van de Kamp of a Jupiter-mass planet around it. His observations ended up discredited, as the telescope he used at Sproul Observatory had a flaw that caused some stars to appear to 'wobble' when they were doing no such thing.

"We are inviting anyone willing to collaborate to observe the stars' brightnesses and to join our campaign," Mikko Tuomi, a European Southern Observatory astronomer and Red Dots scientist, said. "We have already 1,700 brightness observations of Ross 154 from 5 different observers and as many as 2,500 brightness observations of Barnard's star from as many as 9 observers (Barnard's star is on the northern sky, so more accessible for US and European observers) using as many independent telescopes helping us in studying the variability of these stars in detail."

One of the observatories participating isn't an optical telescope at all. It's the radio telescope at the Arecibo Observatory in Puerto Rico. "Planets can be detected in the radio spectrum because they disturb known radio emissions of the star (eg pulsars) or emit their own radio emissions," Abel Mendez, director of the Planetary Habitability Laboratory at Arecibo, says. Mendez says that no planets have been found by radio telescopes beyond a handful of pulsar planets, but the team is hopeful. "Big short-periods planets in elliptical orbits around red dwarf stars are probably easier to detect since they might produce more interactions with the star (eg tides) to alter their flare patterns or frequencies," he says.

The Red Dots team is logging its progress on its website. All three stars are less than 10 light-years away, so detecting planets around them could make our corner of the universe seem a little less lonely. By: John Wenz

'Alien megastructure' star may be a sign of a dying world 19 July: In 2015, reports of an unusual signal observed around a distant star spurred suggestions of the presence of an alien megastructure. However, new research suggests that the bizarre discovery could instead be the sign of a destroyed world.



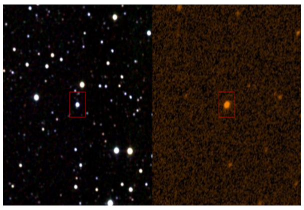
This artist's concept depicts a larger-than-Mercury-sized planet disintegrating as its surface is melted and then evaporated away by its star. NASA/JPL-Caltech

While most planets orbit their stars from a safe distance, some see their suns up close and personal. Orbiting far closer than Mercury, these worlds experience extreme temperatures that cause their atmospheres to expand. If the planet is too small, with too little gravity to hold on to the growing atmosphere, it can wind up losing it. A handful of worlds has been spotted with the remnants of their atmospheres trailing along behind them. "Disintegrating planets can reveal extremely important compositional information, which is the primary reason we are interested in them," said Jake Hanson, a doctoral student at Arizona State University, studying how exoplanets lose their atmospheres.

When scientists see an atmosphere flowing behind its planet, it is unlikely to be the one the world was born with. That atmosphere was likely lost soon after the planet began its close residence to its star. Instead, Hanson said, the molten surface of a disintegrating planet most likely resupplied the atmosphere, as gases escaped from the overheated landscape. "Depending how much of the planet has already evaporated, we could be looking deep into the remnants of a giant planet or near the original surface of a rocky planet - or near the core of a rocky planet, for that matter," he said.

Even the best instruments can only peer at the upper layers of the atmosphere surrounding a world beyond the solar system. However, these melting worlds may provide the first look at what's going on deeper down, at the surface. To help understand what's happening on these worlds, Hanson first modelled how an exoplanet may look if it was steadily losing its atmosphere at a consistent rate. He found that it was difficult to drain an atmosphere from a planet by the same degree over time. It is more likely that atmospheres on these worlds build up in large quantities, then suddenly blow off in massive chunks. "The rock is vaporised into an atmosphere and then, BAM! Bulk ejection," Hanson said. "Then reboot and restart."

The unusual signal could provide a way to detect worlds too small to be spotted with current instruments, he said. The four disintegrating worlds known to date are small, estimated to have diameters within the size of Earth and the Moon, while their massive comet-like tails suggest they are losing roughly an Earth-mass of atmosphere every billion years.


KIC 8462852, also known as Tabby's star, continues to baffle astronomers with its strange behavior. Could its periodic dimming and brightening be caused by a disintegrating planet? Infrared: IPAC/NASA, Ultraviolet: STScI (NASA); Atlas Image courtesy of 2MASS/Umass/IPAC-Caltech/NASA/NSF.

The sudden shedding of an atmosphere could be one explanation for Tabby's star, the unusual star whose bizarre signal led some to suggest the presence of an alien megastructure. In 2015, researchers reported unusual changes in the light around KIC 8462852, also referred to as Tabby's star or Boyajian's star. Since its discovery, scientists have proposed a myriad of possible causes, ranging from comet swarms to Dyson spheres. The buildup and bulk ejection of the atmosphere would create a strange signal, "which is why it's worth considering in the context of Tabby's star," Hanson said.

Still, he cautioned that this is a rough explanation rather than a precise one, and one he plans to crunch the numbers on in the near future. A huge atmospheric tail would be necessary to block the light from Tabby's star, making Hanson suspect the explanation is 'unlikely', though it remains a possibility. Regardless, disintegrating worlds remain one of the best ways of peering down to a planet's surface, even if the surface has already left the planet. While researchers can use the size and mass to calculate a planet's density, that provides only an average. However, as the atmosphere trails behind, it provides greater insight into the world it came from. NASA's upcoming James Webb Space Telescope, scheduled to launch at the end of 2018, will allow scientists to glimpse the minerals in trailing atmospheres, which would provide insights about the surface. "This would give us an unprecedented look at exoplanet surface information," Hanson said

By: Nola Taylor Redd

Is the Moon's mantle wet? 24 July: While there are plenty of features dubbed ';seas' on the Moon, none of them ever contained watery depths. For decades, scientists believed this was also true of our satellite's interior - based on our theories of the Moon's formation, its mantle should contain little water. However, a new study indicates that the Moon's mantle may be more water-rich than was thought.

Ralph Milliken, an associate professor in Brown's Department of Earth, Environmental and

Planetary Sciences, and Shuai Li, a recent Brown graduate now working as a postdoctoral researcher at the University of Hawaii began seeking a way to more accurately measure the water content of the Moon after studies performed in 2008 and 2011 found traces of water in lunar samples returned to Earth on the Apollo 15 and 17 missions. Based on the amount of water in the samples, which was comparable to the water content of basalts on Earth, planetary scientists calculated that parts of the Moon's mantle could contain similar amounts of water - much more than previously thought.

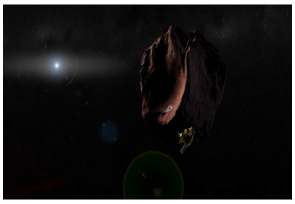
However, because we have such limited samples of lunar rock from only a few landing sites, it was unknown whether the Apollo mission samples were unique. "The key question is whether those Apollo samples represent the bulk conditions of the lunar interior or instead represent unusual or perhaps anomalous water-rich regions within an otherwise 'dry' mantle," said Milliken. Thus, the team turned to orbital data taken with the Moon Minerology Mapper, an instrument on the Indian Space Research Organisation's Chandrayaan-1 lunar orbiter, to deconstruct reflected sunlight from the Moon's surface. Specifically, they looked at large-scale volcanic deposits called pyroclastic deposits, which brought material from deeper within the Moon to its surface. These deposits were not sampled by the Apollo astronauts. By studying the reflected light from these areas, the team aimed to determine the makeup of the material and look for water.

However, there was a snag - the wavelengths at which water can be detected are also the wavelengths affected by heating as sunlight strikes the Moon. "So, in order to say with any confidence that water is present, we first need to account for and remove the thermally emitted component," Milliken explained. That required the pair to understand and model this heating. To accomplish this task, Milliken and Li used the existing Apollo samples in combination with additional data on the heating experienced by the Moon's surface to remove this component from the Chandrayaan-1 readings.

Once the heating was removed, the team found evidence for water in almost every volcanic deposit they studied, including sites located near where Apollo 15 and 17 touched down. "The distribution of these water-rich deposits is the key thing," Milliken said of their finding. "They're spread across the surface, which tells us that the water found in the Apollo samples isn't a one-off. Lunar pyroclastics seem to be universally water-rich, which suggests the same may be true of the mantle."

If that is true, it may require us to tweak our theory of the Moon's formation. Previously, the Moon was not thought to contain a significant amount of water because the collision that created it should have been hot enough to destroy the hydrogen required to form water as the debris condensed into our satellite. However, the new finding does not discredit this theory. "The growing evidence for water inside the Moon suggests that water did somehow survive, or that it was brought in shortly after the impact by asteroids or comets before the Moon had completely solidified," said Li. "The exact origin of water in the lunar interior is still a big question." By: Alision Klesman

New Horizons' next target: spotted 25 July: NASA's New Horizons spacecraft changed our view of the outer solar system forever when it flew by Pluto in 2015. Now, it is on its way to the next destination: a Kuiper Belt object (KBO) known only as 2014 MU69. Although the spacecraft will not reach its target until New Year's Day in 2019, NASA is already looking ahead to learn as much about 2014 MU69 as possible, thanks to a convenient temporary alignment that recently allowed the object to pass in front of a background star.


What will New Horizons see when it reaches the Kuiper Belt object 2014 MU69? This artist's concept imagines one possible scenario. Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute (JHUAPL/SwRI)

The passage, called an occultation, occurs when objects 'line up' in the sky as viewed from Earth. When an object, such as an asteroid, planet, dwarf planet, or KBO, passes in front of a distant star, astronomers can watch the way the starlight dims and returns to gain information about the object passing in front of it. This information can include size, shape, and even whether the object possesses rings, moons, or an atmosphere.

The recent occultation was visible from the Southern Hemisphere; the New Horizons team used 24 mobile telescopes in Argentina to view the event, which lasted only about two seconds. This effort, which thus far has yielded five successful occultation detections, is vital to the characterisation of 2014 MU69 before New Horizons arrives. That is because this tiny, distant object is poorly understood; currently, it is believed to span about 22-40 km in diameter, but little else is known about its shape and composition - thus far.

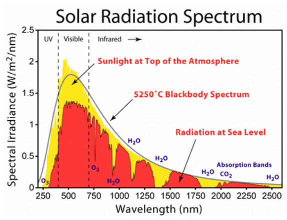
Now, armed with the data from this occultation and two additional recent occultations (3 June and 10 July), the New Horizons team will get to work to better understand the spacecraft's next stop. "This effort, spanning six months, three spacecraft, 24 portable ground-based telescopes, and NASA's SOFIA airborne observatory was the most challenging stellar occultation in the history of astronomy, but we did it!" said Alan Stern, the New Horizons mission principal investigator. "We spied the shape and size of 2014 MU69 for the first time, a Kuiper Belt scientific treasure we will explore just over 17 months from now. Thanks to this success we can now plan the upcoming flyby with much more confidence."

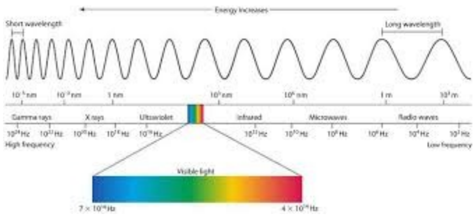
Currently, New Horizons is 38 astronomical units (AU = 6 billion km) from Earth and just over 4 AU (600 million km) from 2014 MU69 (which sits more than 6.5 billion km from our planet. It is zipping along at nearly 14 km/s. At its current location, it takes light - and radio signals - a little over 5 hours and 15 minutes to travel one way between Earth from the spacecraft, and vice versa. The spacecraft is currently in the midst of a 157-day 'hibernation', which began in April. By: Alision Klesman

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

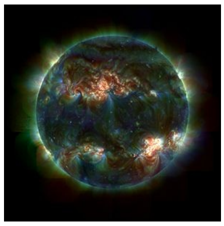
DID YOU KNOW?

The Sun Part 17: **Sunlight 1**





Electromagnetic spectrum



False colour X-ray solar image

Sunlight is the electromagnetic radiation given off by Sun, particularly infrared, visible and ultraviolet light. On Earth, when not blocked by cloud, it is experienced as sunshine, a combination of bright light and radiant heat, and is essential to almost all life on Earth. It takes about 8.3 minutes to reach Earth from the solar surface. However, a photon's journey through the Sun itself takes much longer. If it is produced at the Sun's centre and changes direction every time it encounters a charged particle, it would take 10,000-170,000 years to reach the solar surface.

The total amount of energy received on Earth from the Sun depends on distance to the Sun and, thus, on time of year. In January, at perigee, it is about 3.3% higher than average and, in June, at apogee, about 3.3% lower. At the top of Earth's atmosphere, sunlight is composed of about 50% infrared, 40% visible and 10% ultraviolet light. It is about 30% more intense, there than on Earth's surface. In terms of energy, sunlight at Earth's surface is around 52-55% infrared. 42-43% visible, and 3-5% ultraviolet. The important difference in ultraviolet percentage is a consequence of absorption of 70% of damaging short-wave ultraviolet by the atmosphere.

The Sun emits radiation across most of the electromagnetic spectrum during normal energy emission including X-ray, ultraviolet, visible, infrared, microwave and radio waves. The exception is very high energy gamma rays. These are produced as a result of nuclear fusion, but are converted by internal absorption and thermalisation to lower energy photons before reaching the solar surface and emitted into space. The Sun does emit some gamma rays, during active events like solar flares, but the amount is tiny. The Moon produces more gamma rays (from cosmic rays striking heavy elements in the Moon) than the Sun does.

In addition to electromagnetic radiation, solar nuclear fusion also produces neutrinos. These tiny, almost massless, particles interact very weakly with surrounding matter and, unlike photons, escape quickly from the core without colliding with the overlying material. Their passage through the Sun takes only 2 seconds.

Gamma ray radiation Solar gamma rays scatter off electrons from the core to the photosphere, collisions with solar material making them less energetic. Their speed is not affected, but the energy loss is marked by wavelength changes. As they make their arduous journey to the surface, these rays are continuously absorbed by the solar plasma and re-emitted at lower frequencies. By the time they reach space they have shifted to shifted frequency to ultraviolet, visible and infrared and are not gamma rays any more.

X-ray radiation In the solar system, the Moon is the main source of X-ray emissions, although most of this brightness arises from reflected solar X-rays. X-rays are absorbed by Earth's atmosphere, so detection needs to take place at high altitudes using balloons, sounding rockets and satellites. X-ray emission was expected from celestial objects with very hot gases at temperatures from about 1–100s of millions K. It was in the 1940s that, during a V-2 rocket flight, X-rays were first observed emanating from the Sun. Solar x-ray emission was later confirmed by the Yohkoh satellite in 1991.

The Sun's X-ray emission is about a million times less than its visible radiation. While some X-ray radiation is emitted during solar flares, the solar corona is the main source of solar X-rays. This is explained by the fact that coronal temperature averages 1-3 million K, with hottest regions having temperatures of 8-20 million K, temperatures high enough to produce X-ray radiation. However, an explanation for the source of such high temperatures, when the temperature of the photosphere (surface) is only around 5,500 K and insufficient to achieve such temperatures via direct heat conduction, has yet to be found. Two possible answers to the so-called coronal heating problem have been proposed, both associated with turbulent motion in the convection zone below the photosphere. However, the ability of either high temperature waves travelling outwards and dissipating into the corona and/or heat produced during magnetic activity emitting heat in solar flares and coronal mass ejections to heat the corona to such high temperatures remains uncertain.

Aside from this problem, it is known that, while cycles in solar activity only slightly alter the amount of visible light emitted (about 0.1%), they can change levels of X-ray and ultraviolet emissions by a hundred-fold. Solar flares can dramatically alter levels of both X-ray and ultraviolet emission from the Sun over the course of a just a few minutes.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org, www.quora.com, www.windows2universe.org, www.universetoday.com, www.solar.physics.montatn.edu, www.missionscience.nasa.gov

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