"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

JUNE 2018

Monthly meeting
This month's meeting will place on **Monday 11 June** at the **Catholic Church Hall** starting at **19.00**. Pierre de Villiers and John Saunders, founder members of the Centre, will be reviewing the first decade of its existence in a talk on 'The story of the Hermanus Astronomy Club/Centre'.

Cederberg trip A trip to the Cederberg, including an evening at the observatory, has been arranged for the weekend of 12-14 October. See below for more details.

WHAT'S UP?

Coalsack nebula In contrast to the bright emission Tarantuala nebula described last month, the Coalsack nebula is a dark nebula, the most prominent one in the skies. A cloud if interstellar gas and dust, its matter blocks the light from behind it, making it appear dark. It is easily found with the naked eye, partly located on the outer edge of the lower left hand quadrant of the upright Southern Cross. It is about 600 light year's (ly) away, with a diameter of around 60 ly and a mass of approximately 3,500 solar masses it appears to cover the width of twelve full moons. Although very dark, the Coalsack has been found to have a weak glow created by light scattered from the incoming starlight behind it. The Coalsack and other dark nebulae, like the Horsehead within the Orion nebula (M42), are central to the ongoing life of the Milky Way and other galaxies as they are stellar nursery where new stars form. Interestingly, despite its prominence and visibility, its importance in the mythology of several southern hemisphere indigenous groups, and it mention is several science fiction books and films, the Coalsack nebula does not have a catalogue number.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the meeting held on 21 May, the celebrated amateur astronomer Andre van Staden gave an inspiring presentation on his past and ongoing work on 'An optical study of the companion star J1723-2837'. He described how his interest in pulsars (rapidly spinning neutron stars, themselves the remnants of supernova explosions) led him to closely study the interactions between just one pulsar and its companion star, from his home-based observatory in Bredasdorp. Able to study just one system for several hundred hours, much longer than professional astronomers can do, he was able to detect patterns in the resulting light curves which identified new information on such interactions. His commitment resulted in a joint publication in a leading

astrophysics journal, and ASSA awarded him a medal in recognition of his achievements As he continues his work to obtain data which could help explain the features he has already found, Andre will continue demonstrating the importance of amateur astronomers in astronomy and the valuable outcomes which can derive from such dedicated study.

Interest groups

Cosmology Those who attended the meeting on 7 May watched the next two episodes of the new DVD series: The Higgs boson and beyond by Dr Sean Carroll, Research Professor of physics at CalTech. These episodes were Lecture 7 'Colliding particles' and Lecture 8: 'Particle accelerators and detectors'.

Astro-photography Those who attended the meeting on 28 May continued work on processing their own astro-images.

Other activities

Educational outreach

Hawston Secondary School Space Cadets Meetings with the new group of space cadets continued during May.

Lukhanyo Youth Club No meeting took place in April.

Stargazing Unfortunately, cloudy weather meant that the events scheduled for 18 or 19 May had to be cancelled.

Whale Talk article An article by Jenny Morris titled 'Venus: this winter's evening star' was published in the May/June issue of the magazine.

THIS MONTH'S ACTIVITIES

Monthly centre meeting

This month's meeting, will take place on **Monday 18 June** at the **Catholic Hall** starting at **19.00**. The HAC turned 10 at the end of 2017. In recognition of this achievement and the many meetings, events and outreach activities which have taken place, two of the founder members, Pierre de Villiers and John Saunders, will present 'The history of Hermanus Astronomy Club/Centre'.

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. The next meeting will take place on **4 June** at the **Catholic Hall**, starting at **19.00**. Attendees will watch the next two episodes in the DVD series: The Higgs boson and beyond by Dr Sean Carroll, Research Professor of physics at CalTech. The content will be Lecture 9: 'The Large Hadron Collider' and Lecture 10: 'Capturing the Higgs boson'.

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 **11 June.** The topic will be image processing.

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

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

For further information, please contact Deon Krige at deonk@telkomsa.net

FUTURE ACTIVITIES

Cederberg trip A visit to the Cederberg, including an evening at the private observatory, has been arranged for the weekend of 12-14 October. Details have been e-mailed to members. For more information, or to book one of the 20 available places, please contact John Saunders at antares@hermanus.co.za

2018 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at **19.00**. Details for the first few months are:

18 June	'The story of Hermanus Astronomy Club/Centre' Presenters: Pierre de Villiers and John Saunders, Centre members
16 July	'History of the Voyager spacecraft' Presenter: Johan Retief, Centre member
20 August	Topcic: astro-photography. Presente: Pete Scully
17 September	'Gravitational waves: the new frontier in astronomy' Presenter: Dr David Buckley, SAAO, Cape Town
22 October	'Our weird and wonderful Universe' Presenter: John Saunders, Centre member
19 November	'Table Mountains: geology and astronomy' Presenter: Jenny Morris, Centre member
10 December	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Consideration of the planning application by the Council of Overstrand Municipality continues to be awaited. Hopefully, the additional information requested by staff will enable this to take place soon. In the meantime, the Friends of the Observatory pledge fund continues to be an important source of funds to cover associated costs.

The **Friends of the Observatory campaign** was launched several years ago when preliminary work began on plans to construct an astronomical observatory in Hermanus. Over the years, members have been very generous, for which we are deeply grateful. It may seem logical to assume that, now money has been awarded by the National Lotteries Board, pledge monies are no longer needed. Unfortunately, that is not the case. NLC funds can only be used once the plans have been formally approved by the Municipality, something which is still awaited.

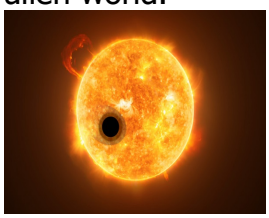
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

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

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

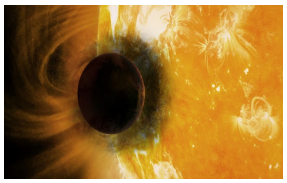
ASTRONOMY NEWS

The first detection of helium in an exoplanet's atmosphere 3 May: An international team of researchers has used a novel technique to probe the atmosphere of the exoplanet WASP-107b, resulting in the first-ever detection of helium in the air of an alien world.



Using the Hubble Space Telescope, researchers probed the exoplanet WASP-107b, located about 200 light-years way, and discovered that it has an abundance of helium steadily escaping its atmosphere. ESA/Hubble/NASA/M. Kornmesser

"Helium is the second-most common element in the universe after hydrogen. It is also one of the main constituents of the planets Jupiter and Saturn in our solar system," said Jessica Spake of the University of Exeter. "However, up until now, helium had not been detected on exoplanets - despite searches for it." The helium signal the researchers discovered was so strong that they think the planet's upper atmosphere may stretch many thousands of miles into space, making it susceptible to erosion through intense stellar winds. According to the study, this wind-induced erosion is also likely creating an extended, comet-like tail of gas around the exoplanet, which causes the planet to shed up to 4 percent of its total mass every billion years. "The helium we detected extends far out to space as a tenuous cloud surrounding the planet," said co-researcher Tom Evans of the University of Exeter. "If smaller, Earth-sized planets have similar helium clouds, this new technique offers an exciting means to study their upper atmospheres in the very near future."



WASP-107b, discovered last year, is a gas giant roughly the size of Jupiter, but is only 12% as massive, one of the lowest density planets known. It is also about eight times closer to its host star - an active K-type main-sequence star - than Mercury is to the Sun, which also makes it one of the hottest planets yet known (500 degrees Celsius). Engine House VFX

To carry out their investigation of WASP-107b, the researchers used the Wide Field Camera 3 on the Hubble Space Telescope to view infrared light passing through the planet's upper atmosphere. Then, by analysing the light's spectrum, they were able to decode the elemental composition of the planet's air, ultimately finding a great deal of helium in an excited state. The traditional method for studying exoplanetary atmospheres is to observe them in ultraviolet or optical light, which both have relatively high energies. However, this new study focused on infrared light, which has a much longer wavelength (and, therefore, lower energy) and passes directly through Earth's atmosphere. Previous ultraviolet-based searches required orbiting space observatories to investigate the chemical makeup of an exoplanet's atmosphere. By proving that infrared light can also be used, astronomers have shown that ground-based telescopes can help study the air around exoplanets, too.

"The strong signal from helium we measured demonstrates a new technique to study

upper layers of exoplanet atmosphere in a wider range of planets," says Spake. "Current methods, which use ultraviolet light, are limited to the closest exoplanets. We know there is helium in the Earth's upper atmosphere, and this new technique may help us to detect atmospheres around Earth-sized exoplanets - which is very difficult with current technology. By measuring infrared light, we can see further out into space than if we were using ultraviolet light.' Although future projects could use telescopes here on Earth to study exoplanets, the technique may be even more valuable for future space-based observatories. By: Jake Parks

WASP-96b: The cloudless exoplanet 8 May: For ome time, astronomers have suspected that hot gas giants outside of our solar system are rich in sodium - the seventh-most common element in the universe. However, this elusive element has mostly gone undetected in previous exoplanetary studies because its signatures are too weak to penetrate through cloudy atmospheres. However, now, an international team of astronomers has squashed speculation and detected the first strong sodium fingerprint radiating from a 'hot Saturn', which suggests the planet has a clear, cloud-free atmosphere.


Illustration of WASP-96b, about 980 ly away from Earth. Engine House

Using the European Southern Observatory (ESO)'s Very Large Telescope in Chile, the researchers uncovered distinct sodium signatures in the atmosphere of WASP-96b, an exoplanet located nearly 1,000 light-years from Earth. WASP-96b is about 20 percent larger than Jupiter and has roughly the same mass as Saturn, but since it is much closer to its host star than Saturn is to the Sun, its sweltering temperature drops it into the 'hot Saturn' category.

The research team, led by Dr. Nikolay Nikolov of the University of Exeter, used the Very Large Telescope to collect detailed spectra of many hot gas giants. By collecting a planet's spectrum, researchers are able to break the light into its different wavelengths and determine the planet's chemical composition. While studying the composition of WASP-96b, they found spectral lines indicating the presence of sodium. The signs of this element, which are typically cloaked by cloudy skies, appeared in the exoplanet's spectrum as a tent-shaped silhouette, signifying the planet has a clear, cloudless atmosphere.

"We've been looking at more than twenty exoplanet transit spectra. WASP-96b is the only exoplanet that appears to be entirely cloud-free and shows such a clear sodium signature, making the planet a benchmark for characterisation," said Nikolov. "Until now, sodium was revealed either as a very narrow peak or found to be completely missing. This is because the characteristic 'tent-shaped' profile can only be produced deep in the atmosphere of the planet and cloudy atmospheres mask it. Cloudy atmospheres have been seen surrounding both extremely hot and extremely frigid exoplanets, but before WASP-96b, only hazy atmospheres were seen engulfing hot gas giants. Now that a cloudless atmosphere has been identified, researchers can compare the outlier to its cloud-rich counterparts. Studying their differences will help the research team understand why clouds favour most hot gas giants and ignore WASP-96b.

The abundance of sodium on WASP-96b undoubtedly helped to identify its clear atmosphere, but its presence could also hint at planetary conditions. The amount of sodium found is similar to amounts found in our own solar system, and on Earth, sodium regulates metabolism in humans and animals, is an abundant component of our oceans, and makes up about 2.6 percent of our crust. With comparable amounts of sodium to planets within our solar system, its conditions could be quite similar, as well. The discovery goes beyond sodium, too. The cloud-free atmosphere will enable researchers to study elements that are typically disguised by thick clouds, like carbon dioxide, carbon monoxide, and water. They plan to use NASA's Hubble Space Telescope and the upcoming James Webb Space Telescope to further study WASP-96b and its wide-open planetary features. And without pesky clouds to get in the way, who knows what else they can find.

By: Amber Jorgenson

The first carbon-rich asteroid found in the Kuiper Belt 10 May: It is believed that the solar system's gas giants caused quite a ruckus in their infancies. As they exited their tight orbits and began their outward migrations, their forceful journeys caused small, rocky bodies in the inner solar system to be ejected from their homes, with some making their way all the way out to the Kuiper Belt - a thick and extended ring of comets, asteroids, and other small objects that surrounds the outer solar system. However, due to the billions of miles that lie between Earth and the Kuiper Belt, identifying an inner solar system asteroid in our icy outskirts was far from easy. Now, an international team of astronomers has discovered Kuiper Belt Object 2004 EW95 - a carbon-rich asteroid that supports our gas giants' destructive tendencies.

Astronomers were able to determine the chemical composition of Kuiper Belt Object 2004 EW95, an asteroid 4 billion km away from Earth. ESO/M. Kornmesser

The outward migration of Jupiter, Saturn, Uranus, and Neptune is a critical element to our current solar system formation theory. Multiple models suggest that after these gas giants formed, they began rampaging away from the Sun until they hit their current orbital locations, causing carbon-rich rocky pieces in the inner solar system to scatter about. Most of these asteroids were ejected toward the Sun, where other carbon-rich objects reside, but some were sent in the opposite direction, toward the outer edge of the solar system. Since objects high in carbon are not common out in the Kuiper Belt - an icy region past Neptune - verifying their existence there could further support current formation theory.

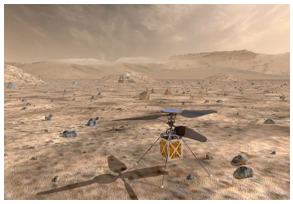
Using NASA's Hubble Space Telescope, research astronomer Wesley Fraser first spotted Kuiper Belt Object 2004 EW95 while conducting routine observations of the Kuiper Belt. The strong spectral lines radiating from this unusual asteroid caused it to stand out from its peers, which have relatively dim spectra. "The reflectance spectrum of 2004 EW95 was clearly distinct from the other observed outer Solar System objects," Tom Seccull of Queen's University Belfast. "It looked enough of a weirdo for us to take a closer look."

Since Kuiper Belt Object 2004 EW95 has a strong spectrum, its light can be broken down into different wavelengths, enabling researchers to determine its chemical composition. To identify the chemical composition of such a distant object, the team used the X-Shooter

and FORS2 spectrographs on the European Space Agency (ESO)'s Very Large Telescope. However, these powerful instruments did not change the fact that the asteroid, which stretches 300 km across, is 4 billion km away from Earth. On top of that, its carbon molecules cause it to appear dark in colour.

"It's like observing a giant mountain of coal against the pitch-black canvas of the night sky," said Thomas Puzia, an astronomer at the Pontificia Universidad Católica de Chile. The research team was able to overcome the obstacles and identify clear signatures of carbon, iron oxides, and phyllosilicates (sheets of silicate minerals), all of which are elements commonly found in the inner solar system that had never been identified in a Kuiper Belt object. From the chemical breakdown, the researchers were able to conclude that Kuiper Belt Object 2004 EW95 was likely born in the asteroid belt between Mars and Jupiter, and made the long journey outward alongside our gas giants. "While there have been previous reports of other 'atypical' Kuiper Belt Object spectra, none were confirmed to this level of quality," said ESO astronomer Olivier Hainaut. "The discovery of a carbonaceous asteroid in the Kuiper Belt is a key verification of one of the fundamental predictions of dynamical models of the early Solar System." By: Amber Jorgenson

Mars helicopter to fly on the Red Planet 11 May: The Mars Helicopter, a small, autonomous rotorcraft, will travel with the agency's Mars 2020 rover mission, currently scheduled to launch in July 2020, to demonstrate the viability and potential of heavier-than-air vehicles on the Red Planet. "NASA has a proud history of firsts," said NASA Administrator Jim Bridenstine. "The idea of a helicopter flying the skies of another planet is thrilling. The Mars Helicopter holds much promise for our future science, discovery, and exploration missions to Mars."



NASA's Mars Helicopter, a small, autonomous rotorcraft, will travel with the agency's Mars 2020 rover, currently scheduled to launch in July 2020, to demonstrate the viability and potential of heavier-than-air vehicles on the Red Planet. NASA/JPL-Caltech

Started in August 2013 as a technology development project at NASA's Jet Propulsion Laboratory (JPL), the Mars Helicopter had to prove that big things could come in small packages. The result of the team's four years of design, testing and redesign weighs in at little under 1.8 kg. Its fuselage is about the size of a softball, and its twin, counter-rotating blades will bite into the thin Martian atmosphere at almost 3,000 rpm - about 10 times the rate of a helicopter on Earth.

"Exploring the Red Planet with NASA's Mars Helicopter exemplifies a successful marriage of science and technology innovation and is a unique opportunity to advance Mars exploration for the future," said Thomas Zurbuchen, Associate Administrator for NASA's Science Mission Directorate at the agency headquarters in Washington. "After the Wright Brothers proved 117 years ago that powered, sustained, and controlled flight was possible here on Earth, another group of American pioneers may prove the same can be done on another world."

The helicopter also contains built-in capabilities needed for operation at Mars, including solar cells to charge its lithium-ion batteries, and a heating mechanism to keep it warm through the cold Martian nights. But before the helicopter can fly at Mars it has to get there. It will do so attached to the belly pan of the Mars 2020 rover. "The altitude record for a helicopter flying here on Earth is about 40,000 feet. The atmosphere of Mars is only one percent that of Earth, so when our helicopter is on the Martian surface, it's already at the Earth equivalent of 100,000 feet up," said Mimi Aung, Mars Helicopter project manager at JPL. "To make it fly at that low atmospheric density, we had to scrutinise everything, make it as light as possible while being as strong and as powerful as it can possibly be."

Once the rover is on the planet's surface, a suitable location will be found to deploy the helicopter down from the vehicle and place it onto the ground. The rover then will be driven away from the helicopter to a safe distance from which it will relay commands. After its batteries are charged and a myriad of tests are performed, controllers on Earth will command the Mars Helicopter to take its first autonomous flight into history. "We don't have a pilot and Earth will be several light minutes away, so there is no way to joystick this mission in real time," said Aung. "Instead, we have an autonomous capability that will be able to receive and interpret commands from the ground, and then fly the mission on its own."

The full 30-day flight test campaign will include up to five flights of incrementally farther flight distances, up to a few hundred meters, and longer durations as long as 90 seconds, over a period. On its first flight, the helicopter will make a short vertical climb to 3 metres, where it will hover for about 30 seconds.

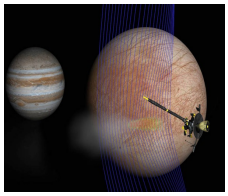
As a technology demonstration, the Mars Helicopter is considered a high-risk, high-reward project. If it does not work, the Mars 2020 mission will not be impacted. If it does work, helicopters may have a real future as low-flying scouts and aerial vehicles to access locations not reachable by ground travel. "The ability to see clearly what lies beyond the next hill is crucial for future explorers," said Zurbuchen. "We already have great views of Mars from the surface as well as from orbit. With the added dimension of a bird's-eye view from a 'marscopter,' we can only imagine what future missions will achieve."

The rover will conduct geological assessments of its landing site on Mars, determine the habitability of the environment, search for signs of ancient Martian life, and assess natural resources and hazards for future human explorers. Scientists will use the instruments aboard the rover to identify and collect samples of rock and soil, encase them in sealed tubes, and leave them on the planet's surface for potential return to Earth on a future Mars mission. By: NASA/JPL

Old data reveal new evidence of Europa plumes 14 May: Scientists re-examining data from an old mission bring new insights to the tantalising question of whether Jupiter's moon Europa has the ingredients to support life. The data provide independent evidence that the moon's subsurface liquid water reservoir may be venting plumes of water vapour above its icy shell.

Data collected by NASA's Galileo spacecraft in 1997 were put through new and advanced computer models to untangle a mystery -- a brief, localised bend in the magnetic field -- that had gone unexplained until now. Previous ultraviolet images from NASA's Hubble

Space Telescope in 2012 suggested the presence of plumes, but this new analysis used data collected much closer to the source and is considered strong, corroborating support for plumes.


Artist's illustration of Jupiter and Europa (in the foreground) with the Galileo spacecraft after its pass through a plume erupting from Europa's surface. A new computer simulation indicates how the magnetic field interacted with a plume. The magnetic field lines (depicted in blue) show how the plume interacts with the ambient flow of Jovian plasma. The red colours on the lines show more dense areas of plasma. NASA/JPL-Caltech/Univ. of Michigan

The research was led by Xianzhe Jia, a space physicist at the University of Michigan in Ann Arbor. "The data were there, but we needed sophisticated modeling to make sense of the observation," Jia said. Jia's team was inspired to dive back into the Galileo data by Melissa McGrath of the SETI Institute in Mountain View, California when she delivered a presentation to team scientists, highlighting other Hubble observations of Europa. "One of the locations she mentioned rang a bell. Galileo actually did a flyby of that location, and it was the closest one we ever had. We realised we had to go back," Jia said. "We needed to see whether there was anything in the data that could tell us whether or not there was a plume."

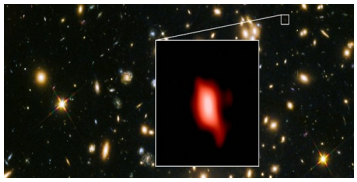
At the time of the 1997 flyby, about 200 km above Europa's surface, the Galileo team did not suspect the spacecraft might be grazing a plume erupting from the icy moon. Now, Jia and his team believe, its path was fortuitous. When they examined the information gathered during that flyby 21 years ago, sure enough, high-resolution magnetometer data showed something strange. Drawing on what scientists learned from exploring plumes on Saturn's moon Enceladus - that material in plumes becomes ionised and leaves a characteristic blip in the magnetic field - they knew what to look for. And there it was on Europa – a brief, localised bend in the magnetic field that had never been explained.

Galileo carried a powerful Plasma Wave Spectrometer (PWS) to measure plasma waves caused by charged particles in gases around Europa's atmosphere. Jia's team pulled that data as well, and it also appeared to back the theory of a plume. However, numbers alone could not paint the whole picture. Jia layered the magnetometry and plasma wave signatures into new 3D modelling developed by his team at the University of Michigan, which simulated the interactions of plasma with solar system bodies. The final ingredient was the data from Hubble that suggested dimensions of potential plumes.

The result that emerged, with a simulated plume, was a match to the magnetic field and plasma signatures the team pulled from the Galileo data. "There now seem to be too many lines of evidence to dismiss plumes at Europa," said Robert Pappalardo, Europa Clipper project scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. "This result makes the plumes seem to be much more real and, for me, is a tipping point. These are no longer uncertain blips on a faraway image."
The findings are good news for the Europa Clipper mission, which may launch as early as June 2022. From its orbit of Jupiter, Europa Clipper will sail close by the moon in rapid, low-altitude flybys. If plumes are indeed spewing vapour from Europa's ocean or

subsurface lakes, Europa Clipper could sample the frozen liquid and dust particles. The mission team is gearing up now to look at potential orbital paths, and the new research will play into those discussions. "If plumes exist, and we can directly sample what's coming from the interior of Europa, then we can more easily get at whether Europa has the ingredients for life," Pappalardo said. "That's what the mission is after. That's the big picture." By: NASA/JPL

The first stars formed when the universe was less than 2% its current age 16 May: An international team of astronomers used this impressive ALMA array to observe an extremely distant galaxy called MACS1149-JD1. Within the galaxy, the team was surprised to discover faint signals of ionized oxygen that were emitted almost 13.3 billion years ago (or 500 million years after the Big Bang).



With the help of the Atacama large Millimeter/submillimeter Array, astronomers have detected the earliest signs of oxygen (red) distributed in the galaxy MACS1149-JD1. ALMA (ESO/NAOJ/NRAO), NASA/ESA Hubble Space Telescope, W. Zheng (JHU), M. Postman (STScI), the CLASH Team, Hashimoto et al.

The Atacama Large Millimeter/submillimeter Array (ALMA), located in the high-and-dry Atacama Desert of northern Chile, is a radio telescope made up of 66 high-precision antennas that operate in perfect harmony. When ALMA's antennas (which range from 7 to 12 metres in diameter) are configured in different ways, the array is capable of zooming in on some of the most distant cosmic objects in the universe, as well as capturing images that are clearer than those produced by the Hubble Space Telescope.

This discovery is not only the most distant detection of oxygen ever made by any telescope, but more importantly, the discovery of the ancient oxygen serves as clear evidence that stars began forming just 250 million years after the Big Bang, when the universe was less than 2 percent its current age. Before the first stars kicked on, the universe was a relatively boring place, consisting primarily of radiation leftover from the Big Bang, as well as hydrogen, helium, and a trace amount of lithium. However, many of the heavier elements we take for granted today (such as carbon and oxygen) did not exist before the first stars. This is because stars are the burning crucibles that convert hydrogen and helium into larger elements, so without stars, there is no oxygen. "I was thrilled to see the signal of the distant oxygen in the ALMA data," said Takuya Hashimoto, a researcher at Osaka Sangyo University and the National Astronomical Observatory of Japan. "This detection pushes back the frontiers of the observable universe."

One of the most burning questions on astronomers' minds is: When did the first galaxies emerge from total darkness? This period, commonly referred to as 'cosmic dawn', is of particular interest because it marked the transition from a hot, dense, and nearly homogeneous universe to the universe we are more familiar with today - one filled with stars, planets, nebulae, and people. "Determining when cosmic dawn occurred is akin to the Holy Grail of cosmology and galaxy formation," said co-author Richard Ellis, an astronomer at University College London. "With these new observations of MACS1149-

JD1, we are getting closer to directly witnessing the birth of starlight! Since we are all made of processed stellar material, this is really finding our own origins." By: Jake Parks

Second Gaia release results so far 18 May: At noon on 25 April, much to the delight of astronomers from around the world, the European Space Agency released one of the largest datasets ever compiled in the history of astronomy. The second release of data from the Gaia satellite – which precisely measured the positions, motions, colours, and luminosities of over a billion Milky Way stars – provided astronomers with a treasure trove of information just waiting to be explored. And within less than a month, many researchers have already found some gems.

Among the most intriguing results stemming from the recently released Gaia data are: the discovery of a supernova-propelled white dwarf zipping through the Milky Way at a steady clip of 5 million miles per hour; a 12-billion-year-old supermassive black hole that is devouring mass faster than any other black hole ever found; and nearly 14,000 white dwarfs, some of which likely formed through mergers, all located within a few hundred light-years of Earth.

A team of researchers presented measurements for three of the fastest known stars in the Milky Way, each of which is likely a previous white dwarf companion to a star that exploded as a Type Ia supernova. Thanks to Gaia's incredible ability to track the motions of stars, the researchers were able to rewind the tape on these hypervelocity white dwarfs, all of which travel faster than 3.5 million km per hour. When they traced back the motions of the white dwarfs, they even found that one originated from a faint, old supernova remnant, bolstering its case as a hypervelocity runaway from a binary system that was subjected to a supernova blast.

Though many of the Gaia results are focused on stars near or within the Milky Way, some researchers saw Gaia's incredible ability to track the motions of cosmic objects as an opportunity to study distant and bright targets far beyond our local universe. Sstronomers from the Australian National University (ANU) have announced the discovery of the fastest-growing black hole ever found. The supermassive black hole, estimated to have the mass of about 20 billion Suns, is growing by around one percent every million years, which means it's devouring a Sun's worth of matter every two days.

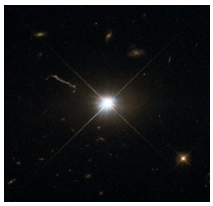
"If we had this monster sitting at the centre of our Milky Way galaxy, it would appear 10 times brighter than a Full Moon," said Christian Wolf, an astronomer at ANU. "It would appear as an incredibly bright pin-point star that would almost wash out all of the stars in the sky." Fortunately, based on the redshift in the black hole's light, the researchers estimate we are seeing the black hole as it appeared 12 billion years ago, so there's no chance of the Sun winding up on its menu.

Moving back closer to home, an international team of researchers combed through the Gaia data to identify 13,928 white dwarfs in our nearby stellar neighbourhood, exponentially increasing the number of known white dwarfs located within 100 parsecs (326 light-years) of Earth. Within the data, the researchers were surprised to find a lot more massive white dwarfs than they expected, indicating that many of the nearly 14,000 white dwarfs formed in binary systems through mergers. The study of white dwarfs, which are the remaining stellar cores of exhausted stars originally less than eight solar masses, is vital to understanding the life cycle of stars in general. Furthermore, since merging white

dwarfs can produce one of the most violent events in the universe – type 1a supernovae - understanding their merger rates and distribution is necessary for many areas of astronomical study.

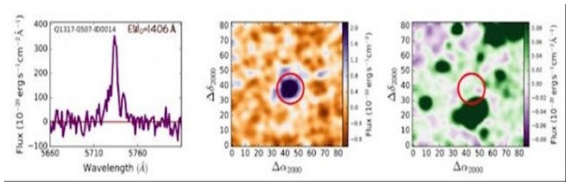
Although this second release of Gaia data is already serving as a galactic goldmine for astronomers, the best may be yet to come. In late 2020, Gaia will be releasing its third set of data, which will contain even more precise measurements for a plethora of galactic targets, as well as data tracing the orbital motions of numerous solar system objects. For the next few years, astronomers will continue mining the current release, and in that time, they are sure to make countless more fascinating discoveries. By: Jake Parks

Shedding light on dark galaxies 23 May: An undeniably important phase in a galaxy's life is when it starts to birth hot new stars and illuminate the night sky. For decades, researchers have struggled to figure out exactly how these stars are born from the gas that lingers between galaxies, known as the intergalactic medium. It has been theorised that there is an early stage in galaxy formation where hot gas accumulates substantially, but stars have not yet started forming. This has been referred to as a 'dark phase', and just like its name, its lack of starlight makes it near impossible to observe. Recently, a group of researchers has identified six 'dark galaxy' candidates, which could close a crucial evolutionary gap in galaxy formation.



Quasars, like 3C 273, are 'flashlights' to find dark galaxy candidates. ESA/ NASA

Led by Raffaella Anna Marino and Sebastiano Cantalupo of ETH Zurich's Department of Physics, researchers searched for these dark galaxies using one of the universe's natural flashlights – quasars. Known as the brightest objects in the universe, quasars emit extraordinary amounts of ultraviolet light. This intense energy causes nearby hydrogen atoms to emit fluorescent light, known as the Lyman-alpha line. Since hydrogen is a key component in galaxy formation, it is believed to be present in all stages of galactic evolution, including the dark phase. So, if a dark galaxy is in close proximity to a bright quasar, incident UV light will cause the otherwise hidden object's hydrogen to give off visible, fluorescent light.



Details of one of the dark galaxy candidates. It features its spectral information (left), gas emissions (middle), and stars (right), with the dark galaxy itself enclosed in the red circle. R. A. Marino / MUSE

Using quasars to search for dark galaxies is not a new technique, but finding them at such far distances was impossible in the past. However, with the help of the Multi Unit Spectroscopic Explorer (MUSE) instrument, attached to the European Space Observatory (ESO)'s Very Large Telescope (VLT), the research team was able to survey a region of distant quasars - one that had previously been too far away to see. The team identified

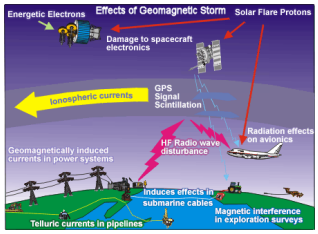
200 objects emitting Lyman-alpha lines. From this, they pinpointed six hydrogen-rich regions that did not appear to be forming stars in a typical galactic fashion. They followed up on their leads by dedicating 10 hours of in-depth observation to each candidate, which included collecting their full spectral information. After analysing the data, they concluded that the six regions were solid dark galaxy candidates.

Instruments like MUSE could revolutionise how we search for distant celestial objects. In the past, researchers could only image a narrow band of frequencies, each requiring specially designed filters, within a small region of sky. MUSE functions as a high-powered spectrograph that collects visible wavelengths and also employs a wide field of view, allowing researchers to scour large regions without any filters. By: Amber Jorgenson

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

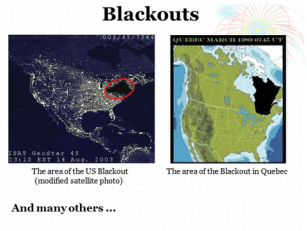
DID YOU KNOW?

The Sun Part 27: **Geomagnetic storms**



GMS effects


GMS – transformer burnout



1989 GMS – blackout areas

A geomagnetic storm (GMS) is a major disturbance of Earth's magnetic field that occurs 36-48 hours following violent activity on the Sun eg solar flares, coronal mass ejections (CME). The frequency of GMSs rises and falls with the 11-year sunspot cycle. CME driven storms are more common during solar maximum. They last an average of 2-3 days.

The Prussian geographer Alexander von Humboldt was possibly the first to record a GMS, when, while recording bearings on a magnetic compass in Berlin in December 1806, he noticed erratic readings during a bright auroral event. The 1859 Carrington event was the largest recorded GMS, so far. A massive CME had been launched from the Sun, reaching Earth in 18 hours (usually 3-4 days). Ice cores show evidence of similar high intensity events once per 500 years, on average.

It is the solar wind which carries the ejected solar magnetic field and associated highly energised particles towards Earth. Increased wind pressure initially compresses the magnetosphere before transferring its increased energy into it. Both interactions increase plasma movement through the magnetosphere, driven by increased electric fields inside the magnetosphere and an increase in electric current in the magnetosphere and ionosphere. During a GMS, part of the ionosphere becomes unstable, it fragments and may even disappear, with challenges for organic safety and electrical functions on Earth.

GMSs are defined by changes in the Dst (disturbance storm time) index, which estimates globally averaged changes of the horizontal component of Earth's magnetic field at the magnetic equator, based on measurements from a few magnetometer stations.
The Dst is computed once an hour and reported in near real time. GMSs occur in phases. Normally, during the initial phase, also known as storm sudden commencement, there is a sudden increase in Dst value. However, not all GMSs have an initial phase and not all sudden increases in Dst value are followed by a GMS. The main phase is characterised by

a decrease in Dst value and usually lasts 2-8 hours. Finally, during the recovery phase, the Dst recovers to the normal quiet time values. This phase may last from 8 hours to 7 days. A GMS is classified as moderate, intense or super-storm, depending on Dst values.

GMSs can have many and widespread effects. Space weather phenomena associated with GMS include solar energetic particle events, geomagnetically induced currents, ionospheric disturbances that cause radio and radar scintillation, disruption of navigation by magnetic compass, and auroral displays at much lower latitudes than normal.

Hazards to humans include radiation poisoning in astronauts caused by the very high energy particles. This can cause chromosomal damage, cancer and other health problems, or immediate death if doses are large enough. Solar energetic particle (proton) events can also produce elevated radiation in aircraft at high altitudes. The risks are small, but need to be monitored. Fauna is also at risk, and some birds' navigational abilities have been found to be degraded. GMSs may also affect other migratory animals which demonstrate magneto-sensitive behaviour eg whales, dolphins.

Electrical and electronic systems are particularly vulnerable. GMSs can damage satellites, power grids and radio communications, and cause electrical blackouts. Ionospheric storms can affect radio communications at all latitudes. TV and commercial radio are little affected, but short-wave ship-tp-shore broadcasts and amateur radio frequently are easily disrupted. Some military detection and early warning systems which bounce signals off the ionoosphere are also affected by extreme solar activity. GMSs can also mask or distort the magnetic signatures of submarines as one input of their location detection. Long haul telephone lines and non-fibre optic undersea cables are also vulnerable while communication satellite damage can disrupt non-terrestrial telephone, TV, radio and internet links. Navigation systems which incl GPS are also susceptible.

Satellite hardware damage can result from GMS. Increasing solar ultraviolet emissions which heat the upper atmosphere cause it to expand. The resulting rising of heated air increases drag on satellites, causing them to slow and change orbit slightly. Within satellites, the more advanced and compact spacecraft and satellite components used currently have increased their sensitivity to more energetic solar particles. Microchip damage is possible, which can change software commands on satellite based computers. Differential charging can result from a satellite passing through the highly energised environment associated with an increase in number and energy of electrons and ions, discharge possibly damaging components

On Earth, mains electricity grids are susceptible to damage when geomagnetically induced currents are produced in long transmission lines eg in US, China, SA, and Australia, especially modern ones with high-voltage and low resistance. Transformers are particularly at risk. Pipelines can also be affected by geomagnetically induced currents, affecting eg flow meters and corrosion estimates

GMS prediction and warning systems are becoming increasing important to enable action to be taken, where possible, to avoid or minimise these effects. Magnetometers monitor the auroral zones and equatorial regions, while radar is used to probe the auroral ionosphere. Instruments on spacecraft include magnetometers, electric sensors to measure electric field strengths, radio sounders which bounce radio waves of varying frequencies off the ionosphere, their return times allowing determination of electric density profiles, particle detectors including Geiger counters, scintillation counters, and electron multipliers.

Recent notable GMS events occurred in 1989 (when power outages in SE Canada affected millions of people), 2000 and 2003.

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

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

COMMITTEE MEMBERS

Pierre de Villiers (Chairperson, AECA)	028 314 0830
Laura Norris (Treasurer)	028 316 4453
Peter Harvey (Secretary, sky notes)	028 316 3486
Jenny Morris (Vice-chairperson, newsletter)	071 350 5560
Derek Duckitt (Website editor)	082 414 4024
Bennie Kotze (Outreach co-ordinator, youth clubs)	028 316 3666
Deon Krige (Youth robotics project, astro-photography)	028 314 1045

Non-committee members with roles:

Pierre Hugo (Cosmology interest group)	028 312 1639
Johan Retief (Membership, Hawston School Youth Club)	028 315 1132
John Saunders (Events co-ordinator)	028 316 2302