"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

OCTOBER 2019

Monthly meeting This month's meeting will take place on **Monday 21 October** at the **Catholic Church Hall** starting at **19.00.** Dr Nicolas Erasmus from the SAAO in Cape Town will be talking about 'Near-Earth asteroids'. See below for more details.

Stargazing The next evening is scheduled for **Saturday 5 October** at Gearing's Point, weather permitting. See below for more details.

Visit to Cape Town You are warmly invited to join other Centre members and their partners for a day out in Cape Town on **Saturday 26 October.** See below for details. To enable meal booking, please contact Bennie Kotze on kotzebennie@telkomsa.net by **Friday 18 October** with names, numbers and a contact cell number.

WHAT'S UP?

Cartwheel globular cluster Omega Centauri and 47 Tucana are two well-known southern hemisphere globular clusters. The small constellation of Pavo (the peacock' contains another impressive one. The Cartwheel cluster (NGC 6752) is visible to the naked eye, but it best viewed through binoculars. At this time of year, Pavo can be found towards the SSW, above Triangulum Australe and west of Tucana. Named in the 16th century by the Dutch navigator-astronomers Keyser and de Houtman, Pavo was named for the peacocks which the explorers had encountered on their travels in south-east Asia. The Cartwheel cluster has a broad, dense centre surrounded by a much less dense outer area, which contains few stars. The cluster got its name from the pattern of stars radiating from the centre. Like other globular clusters it is both distant (13,000 light years away) and very old (about 13 billion years). This globular cluster is located too far south to have been observed and listed by Messier, but it is included in South African John Bennet's catalogue.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter at the 16 September meeting was Dr Pieter Kotze, Research fellow at SANSA. His fascinating talk on 'A magnetic planet in the shadow of a variable star' was a repeat of his presentation on the previous Saturday at Scopex in Johannesburg. Following an introductory overview of the prevalence of planetary magnetic fields in the solar system, Pieter outlined the characteristics and impact of Earth's magnetic field on life. Then he explained the role played by the Sun's magnetic field in its very active behaviour. Against the eleven year solar cycle, solar activity which can

potentially affect Earth include solar prominences, solar flares, coronal mass ejections and coronal holes. Although surface and atmospheric temperatures are a result of complex interactions of a number of variables, the role of solar energy is very important. Pieter used the period of the Maunder minimum, when people could skate on the River Thames, as an example of how low levels of solar activity can influence temperatures on Earth. He also outlined how the powerful solar output of the 1859 Carrington Event damaged electric systems on Earth, and the impact of such events on systems in the modern world. Finally, he talked about changes occurring in Earth's magnetic field strength and direction eg the South Atlantic Anomaly and their possible impact on human and animal life.

Interest groups

Cosmology At the meeting on 2 September, Derek Duckitt presented the first of a two-part DVD series on Loop quantum gravity''. In part 1, Carlo Rovelli talked about 'Gravity as we know it' and, in part 2, outlined 'The granular world'.

Astro-photography No meeting took place in September.

Other activities

Educational outreach

Hawston Secondary School Space Cadets Meetings continue to take place weekly.
Lukhanyo Youth Club Work continues on the construction of analemmatic sundials here and other schools in the Overstrand.

Stargazing No events took place in September.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on **Monday 21 October** in the **Catholic Hall** starting **19.00**. The guest speaker will be Dr Nicolas Erasmus from the SAAO in Cape Town. The title of his talk is 'Near-Earth asteroids'. **Biography**: 'I obtained my PhD specialising in Femtosecond Laser Physics from Stellenbosch University. After a brief post-doctorate in the Netherlands I returned to South Africa where I currently reside at the South African Astronomical Observatory as an Instrumentation Scientist. At the SAAO my research is in Solar System Science, specifically main-belt and near-Earth asteroids, while I am also involved in astronomical instrumentation development.'

Synopsis of his talk: 'Near-Earth Asteroids (NEAs) are a population of asteroids in stable orbits around the Sun that escaped from the main asteroid belt due to resonant motion with large planets like Jupiter. As of October 2019, the IAU Minor Planet Center's (MPC's) database shows that approximately 21 000 NEAs have already been discovered with over 2000 discovered so far this year. The discovery rate is continually ramping up as more sophisticated all-sky surveys are being deployed globally.

After an NEA has been discovered, NASA's Centre for Near Earth Object Studies (CNEOS) computes the orbit and determines the chance of an impact with Earth. At the moment, none of the ~21 000 NEAs in the MPC database are on a collision course with Earth within the next 200 years. However, on almost any night of the year there are a handful of known NEAs, with diameters mostly of a few meters but sometimes hundreds of meters that make close-approaches to within ten lunar distances to Earth. Because of their small size, most of these NEAs are only discovered weeks or even days before their close-approach date and very few are fully characterised before they move away from Earth and become too faint to observe.

In this talk I will show results from observations characterising NEAs (and main-belt asteroids) using several telescopes located in Sutherland. I will also talk about ATLAS, an existing all-sky survey network located in Hawaii. The third telescope to join this network is due to be installed in Sutherland in 2020 which will contribute southern-sky coverage to the global effort to find all potentially dangerous NEAs.'

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting is on **Monday 7 October** at the **Catholic Hall**, starting at **19.00.** It will be the second of two meetings exploring Loop Quantum Gravity (LQG). The excellent, easily understandable layman's level course is presented, in this DVD series of short modules, by Carlo Rovelli, one of the founders of the Loop Quantum Gravity (LQG) theory, which most consider to be the next best theory superseding string theory.

Module 3: 'Loop quantum gravity' covers how general relativity and quantum theory together suggest that space itself is discrete. It covers finding the quanta of spacetime, the granular structure of space time (a spin network) and how the equations exclude a time variable. Module 4: 'Searching for white holes' considers LQG's role cam in explaining the structure of black hole interiors and singularities, and the nature of white holes.

There is an entrance fee of R10 per person for members, R25 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 Derek Duckitt at derek.duckitt@gmail.com

Astro-photography This group meets on the second Monday of each month. The next meeting will be on **Monday 14 October.**

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

Hermanus Youth Robotic Telescope Interest Group Developmental work on this will resume soon.

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

Other activities

Stargazing The next evening is scheduled for **Saturday 5 October** at Gearing's Point, weather permitting. It coincides with International Observe the Moon event, and will focus on the Moon. Details will be circulated to members closer to the time.

FUTURE TRIPS

Centre members and their partners are invited to a day out in Cape Town on **Saturday 26 October.** The programme for the interesting and varied day is as follows:

12.00	Hear the noon gun from the Lion Battery on Signal Hill
12.30	Enjoy a light lunch at the Company Garden Restaurant
14.00	Attend a show at the Iziko Planetarium
15.30	Join a guided tour of buildings and installations at the SAAO in Observatory
18.00	Enjoy supper at the neighbouring River Club
20.00	Attend the scheduled Cape Centre public presentation

You need to arrange your own transport to and from Cape Town, and between the sites.

We will send out further details, including physical locations, closer to the time.

We need to know attendance numbers in order to book at the River Club. Please contact Bennie Kotze on kotzebennie@telkomsa.net by Friday 18 October with names, numbers and a contact cell number.

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**.

21 October	'Near-Earth asteroids". Presenter: Dr Nicolas Erasmus, SAAO, Cape Town
18 November	'The Cassini family dynasty and their Saturnian legacy'. Presenter: Jenny Morris, Centre member
9 December	No meeting

ASTRONOMY SELF-GUIDED EDUCATION CENTRE (ASEC)

Work continues on planning and administrative requirements for work to begin on the proposed Astronomy Self-guided Education Centre, to be located within the existing whale-watching area at Gearing's Point.

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.

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\

Helicopter added to Mars 2020 rover 3 September: Just under a year before the launch, NASA's unnamed Mars 2020 rover is getting ready for its big mission with the new addition of the Mars Helicopter Scout. The Helicopter Scout will be the first rotorcraft to fly on another planet. Although the mission is considered high-risk, it could also come with a high reward. If the helicopter is successful, more flying craft could be used in future Mars exploration missions. On this flight, the helicopter is not carrying any scientific instruments, though it could on future missions. If anything were to happen to the helicopter on Mars, it will not affect the rest of the Mars 2020 mission.

On the way to Mars, the helicopter will be attached to the rover's belly, covered by a shield to protect it during the descent and landing. However, the rotorcraft will not be deployed and flown until a suitable area on the surface is found. Mars' atmosphere is thin,

so the extraterrestrial whirlybird needed some special modifications to achieve lift. The craft weighs less than two kilograms and its blades must spin at around 3,000 rpm, much faster than a helicopter on Earth. The craft will make several test flights of up to a few hundred meters to prove its capabilities.


The Mars 2020 rover will be equipped with a helicopter, as seen in this artist's concept, that will fly above the Red Planet's surface like no craft before it. NASA/JPL

The upcoming mission to Mars is focused around life on Mars. Not only will the Mars 2020 rover investigate the history of the planet and the possibility of past microbial life, but it will kick off preparations for crewed missions to the Red Planet. The rover is meant to explore and learn more about Mars' climate and environment, helping identify challenges future crewed missions will likely experience.

Over the past few years, the rover has been prepping for its upcoming journey to the Red Planet. Along with the addition of the helicopter, a new robotic toolkit was just recently added to the rover. With this new technology, the first samples from Mars will be collected and stored by the rover until future missions eventually bring the samples back to Earth for study. The rover will launch in July of 2020 from the Space Launch Complex at Cape Canaveral Air Force Station in Florida and is expected to reach the landing spot at the Jezero Crater on 18 February 2021. The rover is slated to be active for one Martian year, or almost 690 Earth days - though previous Mars missions have often far exceeded expectations.

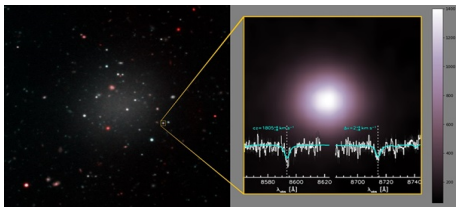
With an ideal launch window spanning from July 2020 to August 2020, NASA is far from the only space agency with plans for a Martian mission. The European Spaces Agency (ESA) is preparing to send their rover, named the Rosalind Franklin, to the Red Planet as well. Along with NASA and ESA, China and the United Arab Emirates are likewise looking to launch missions to Mars next summer By: Hailey Rose McLaughlin

Astronomers cannot agree on galaxies without dark matter 6 September: Some 60 million light-years from Earth, not too far from our local galactic neighbourhood, a strange little galaxy is causing a cosmic stir. This little island universe holds far fewer stars than your average galaxy. However, it is not the lack of stars that is surprising astronomers. The galaxy, nicknamed DF2, also seems to lack any significant amount of dark matter.

Because DF2 would be the very first known galaxy without the mysterious substance, the news of its discovery in 2018 quickly spread throughout the astronomical community. If confirmed, a galaxy without dark matter would throw a wrench into our understanding of how galaxies form and evolve. Every galaxy we know of so far has a sizeable chunk of the invisible matter, so finding one without it would mean one of two things: Either DF2 never had any dark matter to begin with, or it somehow managed to shed its dark matter during the course of its life. DF2 is a member of a unique class of galaxies called ultra-diffuse galaxies (UDGs). Although UDGs can grow as large as the Milky Way - some 100,000 light-years across — these hazy spectres contain hundreds to thousands of times fewer stars

than our own galaxy. This makes them essentially see-through, which means they're difficult for astronomers to observe in detail.

To probe the properties of DF2, researchers led by Peter van Dokkum of Yale University identified 10 globular clusters (large, spherical groups of old stars) within DF2 and measured how quickly they appear to orbit around it. To their surprise, they discovered the globular clusters are moving at a snail's pace compared to what we see in other galaxies that are chock-full of dark matter. This led them to conclude that DF2 contains, at most, a miniscule amount of dark matter. After all, if it had more, the clusters would be moving much faster.


To determine how quickly the globular clusters were rotating around DF2, the researchers analysed the absorption lines of spectra taken with the Keck Observatory. Gemini Observatory/NSF/AURA/W.M. Keck Observatory/Jen Miller/Joy Pollard

Not everyone agrees with van Dokkum's conclusion. "Something that caught my attention very early on was the fact that the galaxy was not only anomalous for not having dark matter, but also for having an extraordinarily bright population of globular clusters," says Ignacio Trujillo of the Instituto de Astrofisca de Canarias, who led the main study rebuking the distance to DF2. "I remember thinking: 'Two anomalies at the same time really looks odd.'" This led Trujillo to consider whether DF2 is really as distant as van Dokkum's team thinks. If DF2 were some 64 million light-years away, like van Dokkum suspects, then the galaxy would be a strong candidate for the first example of a galaxy without dark matter. Trujillo says that if DF2 is closer, the galaxy's observed properties would more or less fall in line with what's expected from your run-of-the-mill, dark-matter-dominated galaxy.

To test their theory, Trujillo and his team set off to determine their own distance estimates to DF2 using five different methods - all with varying degrees of trustworthiness. Two of the methods relied on analysing the brightnesses and sizes of DF2's globular clusters. According to the short-distance camp, if DF2 is a bit closer than initially thought, then the galaxy's globular clusters would no longer be weirdly big and bright. They also compared DF2's properties to a similar galaxy, called DD044, which has a more reliable distance estimate, as well as recalculated DF2's distance using the same method as the original team. Finally, Trujillo's team analyzed the Tip of the Red Giant Branch (TRGB) in DF2's colour-magnitude diagram (CMD), which plots the temperatures and luminosities of stars within a galaxy. Because the brightest red giant stars all shine with the same true brightness when observed in infrared, the only thing that should greatly impact how bright they appear to us is their distance."This is by far the most accurate way of measuring the distance to the galaxy if the data have good quality," Trujillo says. Based on all five methods, Trujillo and his team estimate DF2 is probably only about 42 million light-years away, rather than the original estimate of 64 million ly.

Van Dokkum is not convinced by this competing distance determination. Last year, his team published yet another paper in response. Their result: DF2 is about 61 million light-years away, which would mean DF2 still has a negligible amount of dark matter. The debate did not stop there. After this academic back-and-forth, van Dokkum and his team

uncovered yet another galaxy, DF4, that also seems to be lacking dark matter. By measuring how DF4's light is distributed across the galaxy, van Dokkum determined DF4's distance is similar to DF2's - about 65 million light-years. Trujillo and his team have since published their own analysis of DF4's distance using the TRGB method. In it, they conclude DF4 is just 44 million light-years away, which would make DF4's globular clusters more similar to those found in the Milky Way. "All in all," they conclude, "the proposition that both [DF2] and [DF4] are 'missing dark matter' is still far from being placed on sure footing."

Although the answer to whether the galaxies have dark matter or not is still up in the air, the discourse between the two teams serves as real-world glimpse of the scientific process in action."The broader point is that these are fascinating galaxies, and all aspects of our findings should certainly be questioned and scrutinized," van Dokkum says. There may be a definitive answer on the horizon. Recently, van Dukkum's team secured a chunk of observing time with the Hubble Space Telescope. They expect the new observations to help them pin down DF4's distance to within about 5 percent. So for now, both van Dokkum's and Trujillo's teams are simply waiting to dive deep into the new data. When they do, we may finally learn whether galaxies without dark matter can actually exist, or whether some galaxies just happen to be very good at hiding the already stealthy substance. By: Jake Parks

India still trying to contact its lost Moon lander 9 September: The Indian Space Research Organization (ISRO) is not giving up hope for its lost lunar lander just yet. The space agency will keep trying to establish contact with the Virkam lander for 14 days, according to the Times of India.

Virkam lander being hoisted and readied, prior to its launch. ISRO

On 6 September, the spacecraft was scheduled to have a soft landing in the Moon's south pole region. However, as it neared the one-mile marker above the surface, communication cut out with mission control in India. The lander has not been heard from since, and engineers suspect Virkam hit the surface much harder than anticipated. Chandrayaan-2 was intended to be a multi-part mission, and a follow-up to India's first lunar mission, Chandrayaan-1. In this latest attempt to study the Moon, India was focused on the south pole region, launching orbiter, the Virkam lander, and a rover named Pragyan on 22 July.

Early in the landing sequence last week, everything in the control room seemed to be going as planned. However, as the lander approached the surface, expressions of tense frustration and confusion broke out on the faces in the room. The phrase, "the data is being analyzed," was said over and over, but the outcome seemed bleak. Over the weekend, ISRO announced that the orbiter had caught sight of the lander. The photos have not yet been released, but according to ISRO's chief, Kailasavadivoo Sivan, the lander has been seen near the targeted landing site and apparently in one piece. The extent of the damage to the lander and the rover inside are not yet known. As part of the Chandrayaan-2 operation, the orbiter will continue to study the south pole region of the

Moon. In a statement from ISRO, officials said the lunar orbiter will now be operational for seven years. The rove was only set to last for a couple weeks. However, it would provide new information on the Moon's scarcely-explored south pole region.

By: Hailey Rose McLaughlin

Giant bubbles spotted rushing out from Milky Way's centre 11 September: The Milky Way is blowing bubbles. Two giant radio bubbles, extending out from the galaxy for over 1,400 light years, were just discovered in X-ray data. Astronomers think the bubbles started forming a few million years ago due to some type of cataclysmic event near the galaxy's central supermassive black hole.

The bubbles' location also closely matches the range of over 100 narrow, magnetized filaments of radio emissions that stretch for tens of light years in length. First discovered 35 years ago, these filaments' origins have remained a mystery, but the bubbles' discovery may now provide an answer. "The filaments have been a mystery for a long time," said Ian Heywood, astronomer at the University of Oxford and lead author on the new discovery. He says their results hint that the event that created the bubbles could have also produced high-energy charged particles that created the filaments.

The symmetry of the bubbles billowing above and below the galaxy suggests they were formed by an extremely energetic explosion near the supermassive black hole at the centre of the Milky Way. The most likely explanation is a flare up in the black hole's activity as it gobbled up extra nearby material and burped out other particles and radiation. The bubbles could also have been created by an extreme burst in star formation that sent a shock wave across the galactic center. Or possibly, it was a combination of both events.

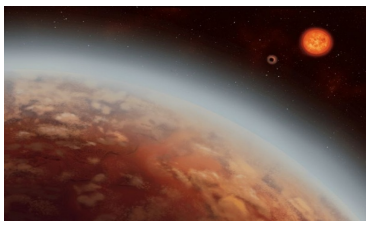
The discovery used the MeerKAT telescope, a radio telescope with 64 antennas, at the South African Radio Astronomy Observatory (SARAO) in South Africa. Astronomers there were taking some of the first science images with the new telescope, looking at the radio emissions of the central galactic region, when they made the surprising discovery. "These enormous bubbles have until now been hidden by the glare of extremely bright radio emission from the centre of the galaxy," said Fernando Camilo of SARAO in Cape Town,

The astronomers were specifically looking at a type of radio emission called synchrotron radiation. This type or radiation is created when relativistic electrons - those travelling at nearly the speed of light - encounter strong magnetic fields, which imparts a particular signature on the light. Astronomers often use this type of radiation to pinpoint highly energetic regions in space. The new discovery is not the first giant bubble seen escaping from the Milky Way. In 2010, astronomers discovered two similar giant bubbles of gamma ray radiation blossoming above and below the galaxy, extending a combined length of 50,000 light-years. Now known as the Fermi bubbles, the origin of these balloons of radiation is still unexplained, but likely linked to the galaxy's central supermassive black hole. The astronomers on this latest research think that the new radio bubbles they've discovered may have been caused by a smaller but similar event. "These fascinating radio bubbles provide a new window into understanding recent activity at the galactic centre," Andrew Fox, astronomer at the Space Telescope Science Institute, in Baltimore, Maryland, who was not involved with the new research, said. "Other observations taken across the electromagnetic spectrum have revealed evidence for a burst of activity several million

years ago, and these new observations provide another clue. Taken together, the results show that the Milky Way blows bubbles on different scales."

By connecting the origin location of the bubbles to the central black hole region of the galaxy, astronomers are starting to learn more about the processes in this dynamic region. It may also help them learn about events unfolding in other galaxies. Evidence for giant gamma ray bubbles, like the Fermi bubbles, have also been seen outside the Milky Way in its nearest neighbour, the Andromeda galaxy. By: Mara Johnson-Groh

Water found in habitable super-Earth's atmosphere for first time 11 September: Astronomers have finally uncovered water vapour in the atmosphere of a super-Earth exoplanet orbiting within the habitable zone of its star. The find means that liquid water could also exist on the rocky world's surface, potentially even forming a global ocean.


Exoplanet K2-18 b orbits a red dwarf star and has an extended atmosphere containing at least some water vapour, as seen in this artist's concept. Alex Boersma

The discovery, made with NASA's Hubble Space Telescope, serves as the first detection of water vapour in the atmosphere of such a planet. Because the planet, dubbed K2-18 b, likely sports a temperature similar to Earth, the newfound water vapour makes the world one of the most promising candidates for follow-up studies with next-generation space telescopes. "This is the only planet right now that we know outside the solar system that has the correct temperature to support water, it has an atmosphere, and it has water in it, making this planet the best candidate for habitability that we know right now," lead author Angelos Tsiaras, an astronomer at University College London said.

Planet K2-18 b sits some 110 light-years away in the constellation Leo, and it orbits a rather small red dwarf star that is roughly one-third the mass of our own Sun. Red dwarfs are infamous for being active stars that emit powerful flares, but the researchers point out that this particular star appears to be surprisingly docile. This bodes well for the water-bearing planet, as its 33-day orbit brings it about twice as close to its star as Mercury is to the Sun. "Given that the star is much cooler than the Sun, in the end, the planet is receiving similar radiation to the Earth," said Tsiaras. "And based on calculations, the temperature of the planet is also similar to the temperature of the Earth."

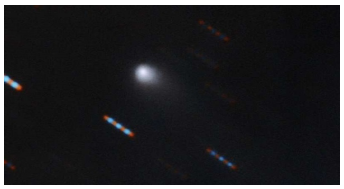
Specifically, the research suggests K2-18 b has a temperature between about –73 °C and 47°C. For reference, temperatures on Earth can span from below –84°C in regions like Antarctica to above 49 °C in regions like Africa, Australia, and the Southwestern United States. Although K2-18 b flaunts some of the most Earth-like features observed in an exoplanet so far - water, habitable temperatures, and a rocky surface - the researchers point out the world is still far from Earth-like. First off, K2-18 b is roughly twice the diameter of Earth, which makes it about eight times as massive. This puts K2-18 b near the upper limit of what we call a super-Earth - which typically refers to planets between about one and 10 Earth masses. It is the density of K2-18 b is what really cements it as a rocky planet. With a density about twice that of Neptune, K2-18 b has a composition most similar to Mars or the Moon. So, because the planet is believed to have a solid surface,

and it is known to have an extended atmosphere with at least some water vapour, researchers say it is feasible that K2-18 b could actually be a water world with a global ocean covering its entire surface.

However, they cannot say for sure. The uncertainty is because Hubble cannot probe the atmospheres of distant exoplanets in great detail. For instance, thanks to a sophisticated algorithm, the researchers were able to tease out the undeniable signal of water vapour in the atmosphere of K2-18 b, but they could not tell exactly how much water vapour is really there. So, they took the conservative approach and gave a broad-range estimate for the abundance of water - somewhere between 0.01 percent and 50 percent. In order to pin down exactly how much water is really on K2-18 b, the researchers say we will have to wait for the next generation of advanced space telescopes to come online. Specifically, NASA's James Webb Space Telescoope, scheduled for launch in 2021, and the European Space Agency's Atmospheric Remot-sensing Infrared Exoplanet Large survey (ARIEL) telescope, planned for launch in the late 2020s, are perfectly suited for the challenge.

By: Jake Parks

Early results hint newfound interstellar comet is 'very red' 16 September: Astronomers are keen to learn more about the newest visitor to our solar system, comet C/2019 Q4. While it has not yet been officially confirmed, they are largely convinced the object originated outside our solar system. "I will say there is no debate at this point," said Quanzhi Ye, astronomer at the University of Maryland. "The orbit is clearly interstellar."



The Gemini Observatory: first-ever colour image of the interstellar comet and its faint tail. Composite image by Travis Rector. Gemini Observatory/NSF/AURA

On 11 September, the Minor Planet Centre, a division of the International Astronomical Union charged with cataloguing the orbits of minor planets, asteroids and comets, issued a circular announcing the discovery and initial observations of the comet. In the days since, astronomers worldwide have turned their telescopes to gather as much information as possible about the interstellar visitor, which is only the second known, after the discovery of the asteroid 'Oumuamua in 2017.

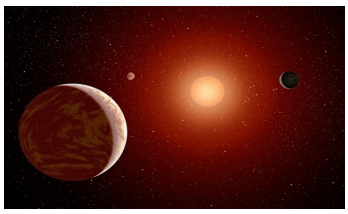
C/2019 Q4, initially named Gb00234, was first seen by amateur Ukrainian astronomer Gennady Borisov on 30 August. Borisov was looking close to the Sun, an area most surveys don't cover due to its poor visibility. Because of that proximity to the Sun in the sky, the object remains hard to see, but astronomers have already clearly resolved its tail, identifying it as a comet. Early calculations confirm a hyperbolic orbit, meaning the object is not bound to the solar system. Those same observations suggest the hyperbolic excess velocity - a measure of how fast the comet is travelling is between 30 to 40 kilometres an hour, which is a strong sign of its interstellar nature. "All the observations are taken close to the Sun and in those cases the uncertainties [in the orbit calculations] can be a little large, so we're waiting for the object to be a little farther away from the Sun in the sky to confirm [the orbit]," said Davide Farnocchia, an astronomer at NASA's Jet Propulsion Laboratory who has been involved in analysing some of the initial images of the comet. "It will probably take days or weeks before we're fully confident."

Once observations definitively confirm the hyperbolic orbit and interstellar origin, the Minor Planet Centre is expected to publish an announcement. The comet is the 48th to be discovered and reported by the Minor Planet Centre this year, but if confirmed, it would be the first interstellar comet ever discovered. The comet will likely be renamed with the prefix 2I/ according to standard nomenclature. Some astronomers have proposed the comet be named 2I/Borisov after its discoverer. The official name for the first interstellar object, 1I/'Oumuamua or 1I/2017 U17, comes from the Hawaiian word meaning scout and was chosen to depict the object as a messenger sent to us from afar.

In the meantime, astronomers are rushing to put together proposals to use major telescopes to observe the comet in greater detail in the weeks to come, hoping to measure things like its composition, size and rotation. From preliminary observations astronomers suspect the nucleus of the comet is somewhere between one mile to 16 km in diameter, and it looks like other known comets. "From the very early results, it's similar to comets in our solar system," said Mike Kelley, astronomer at the University of Maryland who is already analysng initial data. "It has a similar colour, a very red colour, which is already an interesting result."

The comet is slightly brighter than the average comet, but it is not visible to the naked eye. However, at around 18th magnitude, the comet is visible when imaged with a camera attached to mid-sized telescope, and given it is much brighter than its interstellar predecessor, it will likely become a target of interest for amateurs as well as professional astronomers. "With the [telescopes] that advanced amateurs tend to have, if they know where to look, you will be able to image it with the right camera," Ye said. Since the comet is still inbound, it will provide astronomers and amateurs plenty of time to observe it further. 'Oumuamua was seen on its way out of the solar system and within a few weeks was already to faint to be seen by even the Hubble Space Telescope. The new comet will reach closest approach to the Sun around 7 December and likely remain visible for an entire year. "Hopefully, observing this one and the previous interstellar object 'Oumuamua, and more to come, will help us understand not only how our comets and asteroids compare to other solar systems' comets and asteroids, but also about this journey that they do to the galaxy," Kelley said. By: Mara Johnson-Groh

Weirdly giant planet found around tiny star defies expectations 26 September: Astronomers have discovered a gigantic planet orbiting a puny star some 30 light-years away. And according to current theories, the planet should not exist. Dubbed GJ 3512 b, the gas giant is at least half the mass of Jupite, but it orbits a red dwarf star that's just one-tenth the mass of our Sun. "Around such stars there should only be planets the size of the Earth or somewhat more massive Super-Earths," said Christoph Mordasini of the University of Bern. "GJ 3512 b, however, is … at least one order of magnitude more massive than the planets predicted by theoretical models for such small stars."



The newly discovered planet, named GJ 3512 b, is half the mass of Jupiter. Researchers think its tiny red dwarf host not only likely harbors an additional massive planet, but also ejected another in the past. NASA/JPL-Caltech

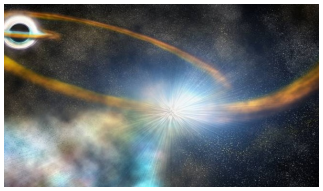
Scientists thought that gas giants like Jupiter always started their lives by developing heavy, solid cores before quickly accumulating thick, gassy atmospheres. That's what current models predict. However, because of this new planet's unusual heft compared to its host star, the new research suggests that is not always the case. The discovery is important because red dwarfs are thought to be the most common stars in the universe, accounting for roughly 75 percent of all stars. Typically, red dwarfs only have a few petite planets. This is because small stars should not have enough extra material left over from their formation to build large planets. The planets found around red dwarfs typically range from about the mass of Earth to roughly the mass of Neptune. But they almost never approach the mass of Jupiter, like GJ 3512 b does. (For reference, Jupiter is about 300 times the mass of Earth and 20 times the mass of Neptune.)

Because GJ 3512 b is such a big fish in a little pond, the researchers say its host star should not have had enough material to form the gas giant in the first place - at least according to current models. So, simply the existence of GJ 3512 b is making researchers reconsider whether gas giant planets reall must start their lives as nascent embryos of heavy particles before gobbling up copious amounts of gas (a process called core accretion). "One way out would be a very massive disk that has the necessary building blocks in sufficient quantity," said planet-formation expert Hubert Klahr from the Max Planck Institute for Astronomy (MPIA).

The basic idea is that if the star GJ 3512 initially started its life surrounded by a particularly massive disk of both gas and dust, the gravity of the disk itself would be strong enough to trigger instabilities within it. Some regions of the disk would then directly collapse, ultimately forming large planets without undergoing the typical two-stage growth process. This is called the gravitational disk collapse model, and so far, it has been largely ignored when it comes to planets around red dwarfs. The major issue with this scenario is that researchers have not yet found examples of such oversized disks around young red dwarf stars. However, according to the study, the gravitational collapse scenario is the most logical way a planet as large as GJ 3512 b could have formed around a star so small.

The case for gravitational collapse is made even more compelling by the fact that the astronomers also found evidence for a second large planet much farther out in the system - as well as hints that a third massive planet might have been ejected from the system long ago. "With GJ 3512 b, we now have an extraordinary candidate for a planet that could have emerged from the instability of a disk around a star with very little mass," said Klahr. "This find prompts us to review our models." By: Jake Parks

Astronomers just watched a black hole shred a star 26 September: A NASA spacecraft built to find alien planets just spotted a star getting shredded by a black hole. Scientists used NASA's Transiting Exoplanet Survey Satellite (TESS) to capture the unfortunate sun getting torn apart in unprecedented detail after it passed too close to a supermassive black hole in a galaxy some 375 million light-years away.



Artist's illustration of a black hole ripping a star into a thinstream of gas
Illustration by Robin Dienel/Courtesy Carnegie Institution for Science

When a black hole destroys a star, scientists call it a Tidal Disruption Event, or TDE, and this was among the most detailed such events ever seen. Astronomers hope the find will offer new insights into the exotic processes involved. Back in January, an international network of telescopes dubbed the All-Sky Automated Survey for Supernovae (ASAS-SN) picked up the first signs that something was brewing in a distant galaxy. A telescope in South Africa caught the first glimpse of an object growing brighter.

Carnegie Institution for Science astronomer Tom Holoien was working at the Las Campanas Observatory in Chile that night when he saw the alert. He trained the observatory's two ASAS-SN telescopes on the galaxy's central black hole and notified other instruments around the world so they could do the same. The timing let astronomers collect key observations of the chemical composition and speed of the material thrown out by the destroyed star. Thanks to some good fortune, NASA's TESS spacecraft was also already monitoring that exact same patch of sky as the event played out. That let astronomers see closer to the black hole during the process than they'd even been able to see before. The observations also confirmed that they were indeed seeing a star ripped apart by a black hole.

"TESS data let us see exactly when this destructive event, named ASASSN-19bt, started to get brighter, which we've never been able to do before," Holoien said. Because TESS had already been studying the area for some time, scientists were able to reconstruct what happened in the weeks leading up to the star's death. The results offer up some surprises. Astronomers used to think all tidal disruption events would look very similar.

"But it turns out that astronomers just needed the ability to make more detailed observations of them," said Ohio State researcher and study co-author Patrick Vallely. "We have so much more to learn about how they work." That's been a challenge in the past. In galaxies like our Milky Way, a tidal disruption event like this one only happens about once every 10,000 to 100,000 years, researchers say. They are rare because it is actually not easy for a star to find itself so close to a black hole. To get chewed up, the star must pass by the black hole at a distance about as close as our Earth is to the sun. "Imagine that you are standing on top of a skyscraper downtown, and you drop a marble off the top, and you are trying to get it to go down a hole in a manhole cover," Ohio State astronomer Chris Kochanek said. "It's harder than that." That makes these events much harder to spot than something like a supernova, which a galaxy may see every century or so. Just 40 tidal disruption events have ever been discovered before. "We were very lucky with this event in that the patch of the sky where TESS is continuously observing is small, and in that this happened to be one of the brightest TDEs we've seen," Vallely said. By: Erik Betz

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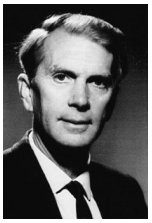
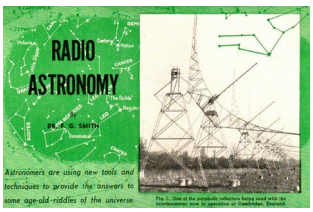
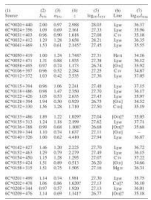
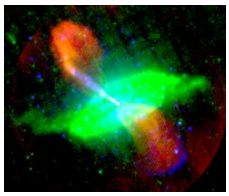
DID YOU KNOW?

Astronomical catalogues Part 12: The Cambridge catalogue – pioneering radio astronomy catalogue which helped decide the origin of the Universe









Martin Ryle Early Cambridge interferometer Sample of 6C data Modern radio galaxy image

As the field of astronomy grew, it became increasingly divided into specialities, and catalogues reflected these specialisations. Although it had been born in the 1930s, radio astronomy came into its own after World War ll, when people trained and experienced in radar turned their eyes towards the skies. One of the pioneers was the radio astronomer Martin Ryle (1918 – 1984).

He and others established Cambridge as a leading centre for radio astronomy after 1945. Frustrated by the limited accuracy of current radio telescopes compared with optical instruments, he became the driving force in the creation and refinement of interferometry and, later, aperture synthesis. These techniques combine the signals from several telescopes to improve their overall accuracy. These advances enabled him and his colleagues to commence a series of large scale surveys of radio sources, in 1948. The data found called for compilation of a catalogue of radio sources.

They published what the *First Cambridge Catalogue of Radio Sources* (1C), in 1950. It listed about 50 sources, based on interferometry observations. Later, many of these were found to be artefacts rather than real radio sources, reflecting the limitations of early instrumentation. Claims made by Ryall about the location of these sources embroiled him in the topical debate of the steady-state versus the Big Bang theories. Determined to prove the latter, he worked to prove that the radio galaxies which had been found were very distant objects. Such findings would support the assertion of a universe which had evolved over a long time period. Their findings were published in several new editions of the *Cambridge Catalogue.*

In 1955, the *Second Cambridge Catalogue of Radio Sources* (2C) was published. Several of the 1,936 sources were, later, also found to be artefacts, but the percentage of these was falling as the technology improved. It was the detail in the *Third Cambridge Catalogue of Radio Sources* (3C) which began to undermine the steady-state theory. Published in 1859, it was a much more reliable source of northern radio sources, the wavelength used helping to significantly reduce the confusion of earlier lists caused by artefacts. It listed 470 sources, in right ascension order. References to this catalogue use the prefix 3C followed by the entry number eg 3C 273. The positions listed were accurate enough to stimulate an intensive search for optical counterparts. This eventually confirmed every source listed. It also confirmed that radio galaxies are clustered far away, proof that the steady-state theory was wrong.

For many years, 3C and its early 1960s extensions were considered the definitive listing of brighter radio sources in the northern hemisphere. A further 6 versions of the *Cambridge Catalogue* have been published, including data from ever more accurate radio telescopes. 4C was published in 2 parts, in 1965 and 1967. Data was based on use of the recently developed system of aperture synthesis. From 1975 to 1985, 5C was published in several parts. It included sources fainter than any previously catalogued radio sources. The ever-growing number of radio sources detected meant that 6C was published in 6 parts, between 1985 and 1993. The latest version, 9C, was published in 2003. The *Cambridge Catalogue* has provided an invaluable source of generic information which has enabled the undertaking of other astronomical work.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, Graham-Smith, F (2013) Unseen cosmos: the universe in radio Oxford, Oxford University Press, en.wikipedia.org

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

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