"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

SEPTEMBER 2016

This month's Centre meeting

This takes place on **Monday 19 September** at the **Scout Hall** starting at t **19.00**. Presenter Prof Bruce Bassett, from UCT and AIMS, will be talking on '100 years of general relativity: gravitational waves, and beyond'. See further details below.

and another one...

On **Thursday 29 September**, HAC and SANSA will be co-hosting a presentation at **SANSA** starting at **19.00**. The two presenters are Prof Ted Williams, Director of the SAAO in Cape Town, who will give an overview of optical astronomy in South Africa, and Prof Mike Kosch from SANSA, who will give an overview of space science.

Stargazing

Weather permitting, the next event is scheduled for **Friday 30 September** at the **NG Kerk, Berg Street, Onrus**, starting at **19.00.** Further details, including ht observational targets, will be circulated in due course.

WHAT'S UP?

Partial lunar and solar eclipses As in 2015, two eclipses occur this month. However, although their timing is less problematic than it was last year, neither is as extensive. On the 1st, a partial solar eclipse took place between 09.40 and 11.55. The further south in Africa an observer was, the smaller coverage. During maximum magnitude, at around 10.45, from Hermanus, only a quarter of the Sun was obscured. Those in the direct pathway of the eclipse observed an annular rather than a total eclipse. An annular eclipse occurs when the Moon is close to or at its furthest distance from Earth. This means that the lunar disc appears to be smaller than normal, leaving a ring of sunlight visible around the edges. Those not in the path of totality will observe a partial eclipse. The lunar eclipse on the 16th will be a penumbral one, where the Moon passes slightly north or south of the umbra, through the less intense outer region of Earth's shadow. Even at maximum, at 20.54, only negligible dimming may be observed.

LAST MONTH'S ACTIVITIES

Monthly centre meeting On 18 August, HAC and SANSA co-hosted the talk given by Kevin Govender, Director of the International Astronomical Union's OAD, based at SAAO in Cape Town. During his talk on 'Outreach development and science, and the role of the IAU Office of Astronomy for Development', Kevin explained how the purpose of OAD is not to promote astronomy as a career, per se. Rather, its goal is to use astronomy as a means to

develop society, encouraging people to think and solve problems, and identifying what astronomical findings can mean for society, in general. Three groups form the focus of the projects funded and supported by OAD: universities and researchers, learners at school, and the general public. All the 86 current projects, managed by staff at 9 regional offices across the globe in addition to the directorate in Cape Town must have potential for their outcomes to expand to other areas and/or groups.

Kevin recognised the need for research into how well their activities meet the stated goals. Whilst acknowledging the challenges of measuring more generic societal outcomes than specific scientific ones, he outlined how OAD is working with social scientists to undertake the necessary studies. Overall, from the information Kevin presented, it can be seen that although it has only existed since 2011, the value of OAD is posited by the large amount of funding it receives for projects (±€ 100,000 annually) and its expanding partnerships with other national and international organisations.

Interest groups

Cosmology Fourteen people (13 members, 1 visitor) attended the meeting on 1 August. They viewed the final pair of episodes of the 24 part DVD series on Time, given by Prof Sean Carroll from CalTech. The topics were: Lecture 23: 'The Multiverse' and Lecture 24: 'Approaches to the arrow of time'.

Astro-photography No meeting was held in August.

Other activities

Stargazing Unfortunately, forecasts of cloud meant that the event re-scheduled from July to 5 August was also cancelled.

Planetary grouping observation Adverse weather conditions also prevented planned observation on Rotary Way on 27 August of the close positioning of Jupiter, Venus and Mercury.

Educational outreach

Hawston Secondary School Astronomy Group Johan Retief continues to hold weekly meetings with the Hawston Space Cadets.

Lukhanyo Youth Club No meeting took place in August.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This will take place on **Monday 19 September** at the **Scout Hall** at **19.00.** Prof Bruce Bassett from UCT and AIMS will be talking on '100 years of general relativity: gravitational waves, and beyond'. An applied mathematician and cosmologist with experience of studying and working at several universities across the globe, his main research interests include theoretical and observational cosmology and artificial intelligence and heuristic optimisation.

Based on his book 'Introducing relativity', he will explain Einstein's Theory of Relativity using cartoons, including what he described as the "happiest thought of his life".Prof Bassett continues, "A century after Einstein's great breakthrough we have seen' incredible technical advances in our ability to understand the cosmos at both the largest and smallest scales (cosmology and particle physics) but very little new knowledge has been uncovered. Instead, we are faced with an almost featureless Universe with no new distinguishing features, leaving an entire generation of physicists and cosmologists scratching desperately around for signs of which direction to turn, lost in a featureless desert. Our Universe remains an enigma wrapped in a mystery and there is no expectation

that it will yield any new fundamental information in the next decade. This talk will explore this strange situation and summarise the beautiful, but very expensive experiments that have illuminated our weird Universe."

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.

Additional meeting On **Thursday 29 September**, HAC and SANSA will co-host at meeting at **SANSA**, starting at **19.00.** The co-presenters are Prof Ted Williams, Director of the SAAO in Cape Town and Prof Mike Kosch, Chief Scientist at SANSA.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month at 19.00. This month's meeting will take place on **5 September** at the Scout Hall. Attendees will participate in an in-house discussion of quantum mechanics.

There is an entrance fee of R10 per person for members, R20 per person for non-members, and R10 for children, students and U3A members. For further information on these meetings, or any of the group's activities, please contact Pierre Hugo at pierre@hermanus.co.za

Astro-photography This group meets on the third Monday of each month. The next meeting will take place on **12 September.**

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

Stargazing The next event is scheduled for **Friday 30 September** in the grounds of the **NG Kerk, Onrus** from **19.00** Further details will be circulated to members in due course.

Hermanus Youth Robotic Telescope Interest Group Technology permitting, organisers continue to plan to start working with learners during the current school term.

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

FUTURE ACTIVITIES

Logistical issues at possible locations mean that, unfortunately, no events are being planned for 2016.

2016 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the Scout Hall beginning at 19.00. Details for 2016 are:

17 Oct	'Dark skies: the unseen Universe". Presenter: Jenny Morris, Committee member
21 Nov	'Science we have learned from space telescopes'. Presenter, Pierre de Villiers, Chairman, HAC committee
12 Dec	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

Formal responses to objections to the plans received by Overstrand Municipality (OM) were submitted during August. Progress awaits consideration of the application, objections and responses by the full OM Council, in due course.. 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

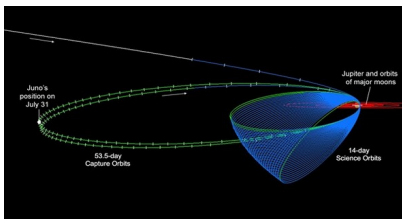
If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS

Juno is at a crossroads as it prepares to finish a capture orbit 1 August: Juno is on a long and arduous journey; having left Earth nearly five years ago, it has been a month since the spacecraft fell into orbit around Jupiter. Even after slipping into the gas giant's gravity, Juno is advancing towards a turning point.

Artist's interpretation of Juno flying above Jupiter NASA/JPL-Caltech

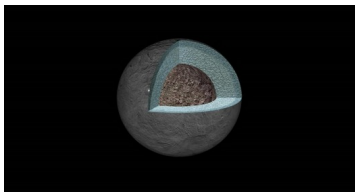
For the first time, Juno has reached its farthest point from the gas giant in its orbit, otherwise known as the 'apojove', 8.1 million km from the planet on 31 July. As the planet has a strong gravitational pull, the spacecraft will begin to fall back toward the planet for a pass to test its scientific instruments. Juno is currently in one of two long orbits prior to the science phase of its mission. Each of these two capture orbits is almost two months long and has all the science team on the edge of their seats eagerly awaiting to see if Juno works as it should. However, this wait is nothing as compared to the long wait the team had to withstand with the trip to the planet. As Juno launched on 5 August 2011, the spacecraft had to wind its way through the inner solar system to get ready for an Earth assist so the planet could fling the probe towards Jupiter.



Two capture orbits and the many 14 day science orbits NASA/JPL

Just in time for the Fourth of July, Juno arrived at Jupiter firing its main rocket engine for 35 minutes allowing the gas giant's gravity to capture the spacecraft. Juno is now on the first of two 53.4 day-long orbits known as capture orbits. After completing the capture orbits, Juno's engine will fire once more to shorten its orbital period to only 14 days to begin the science phase of its mission. Before Juno can drop into a shorter orbital period, it must complete the first capture orbit around Jupiter on 27 August. It will be the spacecraft's closest pass to Jupiter to date at a mere 4,200 km above the tops of the clouds. During Juno's orbital insertion into Jupiter's gravity, all the science instruments were turned off the simplify the operations on the spacecraft during the important manoeuvre. However, during the close approach of the planet on 27 August, all the instruments will be powered and collecting data as a trial run. Juno's mission is to look at Jupiter's deep inner structure, its atmospheric circulation patterns, and the high-energy physics of the planet's magnetic fields. With Juno's powerful array of scientific instruments, the spacecraft will reveal clues to how the planet formed and provide insight into how our solar system evolved many billions of years ago. By: Jordan Rice

Dawn got a peek at what lies beneath Ceres' surface 3 August: Even though the interior of Ceres cannot be seen by the images that NASA's Dawn spacecraft has taken in orbit around the dwarf planet, Dawn is still a key aspect in determining Ceres' inner structure.


How the inside of Ceres may be structured NASA/JPL /UCLA/MPS/DLR

By tracking subtle changes in Dawn's motion, scientists can measure the variations in Ceres' gravity. Using this data, scientists, for the first time, have created a map of Ceres' gravity which will provide clues to Ceres' internal structure. "The new data suggest that Ceres has a weak interior, and that water and other light materials partially separated from rock during a heating phase early in its history," says Ryan Park, lead author of the study at NASA's Jet Propulsion Laboratory, in Pasadena. By using NASA's Deep Space Network (DSN), Dawn measured Ceres' gravity field by monitoring radio signals sent to Dawn and then received back on Earth. The DSN comprises many large antennas at three different locations worldwide that can communicate with interplanetary spacecraft. With these received signals, Dawn's velocity can be determined to a very small precision of 0.1 mm per second, which in turn helps the scientists calculate the gravity field on Ceres.

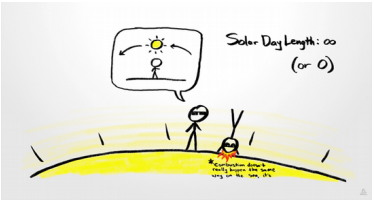
This study confirmed that Ceres possess a special quality called 'hydrostatic equilibrium' where Ceres' interior is so weak that its overall shape is determined by its rotation. The researchers compared Ceres' shape to its gravity field and found that Ceres was indeed in hydrostatic equilibrium, which often corresponds to roundness. It was because of this that Ceres was classified as a dwarf planet in the first place in 2006. The data also indicated that Ceres' interior is differentiated, which means that at different depths, its layers are

compositionally different with the most dense layer at the core. Ceres is also much less dense than other bodies in the solar system, such as the moon and asteroid Vesta (Dawn's previous target). It has been suspected that Ceres also contains low-density materials like water ice, while the study shows that these materials separated from the rocks and rose to the outer layers.

It has also been found that high-elevation areas have displaced the interior. Ceres' weak mantle can be pushed by the mass of mountains and other high topography on the outermost layer. Similar to a boat floating on the water; the amount of water displaced depends on the boat's mass. This has been observed on other planets, like Earth, but this study is the first to confirm this phenomenon. This internal structure can educate researchers on what might have happened to Ceres early on in its life. By combining this new data from Dawn and old data about the dwarf planet's surface composition, Ceres' history can be reconstructed. "We know from previous Dawn studies that there must have been interactions between water and rock inside Ceres," says Carol Raymond, a co-author of the study and Dawn's deputy principal investigator at JPL. "That, combined with the new density structure, tells us that Ceres experienced a complex thermal history."

By: Jordan Rice

How long is a day on the Sun? 8 August: The Sun is a much more complicated celestial object than the Earth or any of the other planets. Therefore, the simple question of "How long is a day on the Sun" does not possess such a straightforward answer. It depends on what one is looking for in a day to determine how long it might actually be.



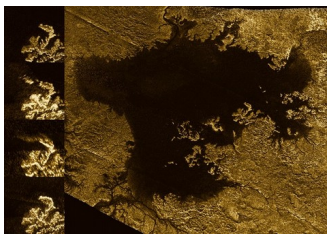
MinutePhysics

The easiest answer is that of a sidereal day, a day in which the stars are the time keepers. A star can be found at one location in the sky one night and then the time it takes to find the star in that same position the next night is a sidereal day. For Earth, that is about 23 hours and 56 minutes, or 24 hours if you round up. However, even this solution to the question depends on where one is standing on the Sun, as different parts of the Sun rotate at different speeds. At the equator, it would take approximately 24.5 Earth days while at the poles about 34 Earth days.

One can also factor in time dilation, as one day on Earth (86,400 seconds) would be one day plus some change (86,400.2 seconds) on the Sun due to the fact that the Sun is much more massive than the Earth. It is really up to you to decide what answer seems the most logical.

By: Jordan Rice

Titan's canyons are flooded with methane 10 August: Titan is a strange, strange world - a frigid moon of Saturn larger than Mercury where water is frozen rock solid and lakes of liquid methane permeate the surface. However, now there is a new weird fold in the story of Titan: it has canyons flooded with more liquid hydrocarbons.



NASA-JPL

Scientists describe 'channels' of hydrocarbons - in other words, streams of methane and other organic compounds that flow like water at low temperatures. While the canyon features were known to NASA previously, radar evidence now reveals that the features are liquid and not solid ices. The observations come from a Cassini probe encounter with Titan in May 2013. The channels flow from the giant hydrocarbon lakes into the canyons, some of which are up to 570m deep. However, the streams are typically less than a kilometre long and flow into 'ponds' at the bottom of the canyons, rather than carving giant river systems as might be found on Earth. The process is similar to what happens on Earth, but with the chemicals switched up. Canyons on Earth are typically eroded by water to create wide chasms over relatively short geologic periods. However, on Titan, water ice is the bedrock, eroded gradually by methane, ethane, and more organic compounds.

Some have hypothesised that Titan looks a lot like a smaller, colder version of early Earth and could be an ideal place for life to eventually develop. Others hypothesise that it could exist there already utilizing chemistry based on nitrogen. Even weirder, in addition to the bodies of organic compounds on the surface, there may also be a subterranean ocean as seen on other moons like Europa and Enceladus, both of which are believed to be potentially ripe for life. As the only moon with a thick atmosphere, and the only place other than Earth known to have liquid bodies on the surface, there's a lot of enthusiasm to explore Titan in the coming decade. By: John Wenz

Black holes can still shine a bright light, astronomers say 15 August: Black holes are not perfectly black. For the first time, using a model of a black hole that traps sound instead of light, scientists have seen spontaneous evidence of what comes out of them.

NASA-JPL / Caltech

These particles are so few and faint that it is not feasible to observe them for an astrophysical black hole, so Jeff Steinhauer at Technion–Israel Institute of Technology made a tabletop version of a black hole that sucks in sound instead of light. Using this, he was the first to see evidence for particles that escape a black hole, called Hawking radiation. In 2014, using the same tabletop black hole equipment, Steinhauer saw an induced form of Hawking radiation, in which something hit the black hole's event horizon to cause the Hawking radiation. However, this is the first time anyone has seen spontaneous Hawking radiation. Hawking radiation is named for Stephen Hawking, who in 1974 theorised its existence, calculating that black holes should not suck in absolutely everything. A few lucky particles should be able to escape. This is because, according to quantum theory, pairs of particles spontaneously come into being all over the universe: a particle and its antimatter counterpart. Normally, they obliterate each other, but if they

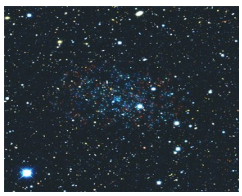
happen to pop into being in exactly the right place, one will be sucked into a black hole and the other will escape it.

Steinhauer's tabletop black hole is made of a very thin cylinder of liquid confined in the space of a laser beam. Because the liquid is flowing faster than the speed of sound, no sound waves should be able to escape, except for Hawking radiation. Here, the Hawking radiation consists of pairs of sound waves, one falling into the black hole, and the other coming out.

Hawking's calculations also show that the particles should be quantum entangled with each other, and Steinhauer's experiment showed evidence that they are. He collected observations of many pairs of Hawking particles, and for each pair, the particles had exactly the same energy value, except that one was positive and the other was negative. When he graphed the correlations between the particles, "I knew it must be entangled just as soon as I saw it," he says. Steinhauer says his goal is "to learn as much as we can about real black holes," but that's not the ultimate purpose. "People are not trying to understand the black hole," he says; "they're trying to understand the laws of physics more." No one has yet reconciled our understanding of gravity with the fundamental uncertainty and randomness of quantum mechanics.

"We understand gravity on a classical level," Steinhauer says. "But we'd like to understand it more deeply, understand the randomness of gravity... In this search for the laws of quantum gravity, Hawking's radiation is considered an important first step." To this end, Steinhauer has worked on the sonic black hole model for seven years straight. "I've been working on this continually since 2009. Only this, all day, every day." To gather the data for this most recent study, he had to repeat the experiment 4,600 times, the equivalent of 6 continuous days of measurements. By: Anna Nowogrodzki

MACHOs may be out of the running as a dark matter candidate 16 August: A recently discovered ultra-faint dwarf galaxy is sending astronomers clues about the makeup of dark matter in the neighbourhood of the Milky Way. It is one more clue that a type of stellar object called massive compact halo objects (MACHOs) are probably not the dominant component of dark matter in the universe.



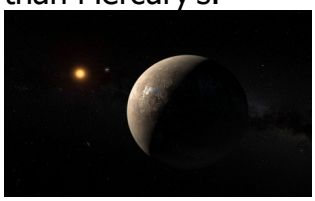
V. Belokurov, S. Koposov (IoA, Cambridge)

A star cluster in the Eridanus II ultra-faint dwarf galaxy is hinting to Timothy Brandt, a researcher at the Institute for Advanced Study at Princeton University, that dark matter cannot be made of MACHOs of more than about five times the mass of the Sun. MACHOs are any type of non-luminous, ultra-compact object that emits little radiation, such that they are not detected through normal means. It is believed that a grouping of these objects could account for the missing mass of the universe. Other work has also made it seem unlikely that MACHOs make up the bulk of dark matter in other mass ranges, so the future looks dim for MACHOs.

Eridanus II is one of nine satellite galaxies of the Milky Way discovered last year as part of the Dark Energy Survey (DES). Ultra-faint dwarf galaxies like Eridanus II were predicted by computer models but only in recent years observed. They may contain only 1,000 to 10,000 stars within a space of only 50 light-years across for the smallest of them, although the extent of their dark matter components may be much bigger. Brandt likes to use the analogy of a mixture of helium atoms and air molecules to describe the mixture of stars and potential dark matter MACHOs in Eridanus II: "If you have a mixture of helium and air, the helium atoms will move faster because they are less massive than air molecules." The two types of objects exchange kinetic energy as they bump into each other, but for the same kinetic energy, the smaller helium atoms move faster than the more massive air molecules."The same thing applies with stars and more massive MACHOs," says Brandt. "If the stars are the light objects compared to, say, 30-solar-mass black holes, the stars will tend to go faster than the MACHOs, and the visible galaxy will be puffier. Over a long period of time, the MACHO part of the galaxy (which cannot be seen) would become more compact, and the stars (which can be seen) would become more extended."

In his observations of a star cluster in the heart of Eridanus II, Brandt does not observe the expected puffiness, so he estimates that the dark matter in Eridanus II must not be MACHOs with masses of more than about five solar masses. According to measurements of the individual stars in the Eridanus II star cluster, the galaxy has had time for the stars to spread out if they were going to. The stars in most ultra-faint dwarf galaxies like Eridanus II have been around for a very long time. "In addition to being the least luminous galaxies, they're also the least chemically enriched," says Marla Geha, an astronomer who studies ultra-faint dwarf galaxies at Yale University. "That suggests that they formed very early on in the universe, before star formation really got going in creating all these various different elements." By: Allen Zeyher

Is Proxima Centauri b the most promising exoplanet yet? 24 August: A pale red dot not far from the Sun may be orbited by a pale blue dot much different than Earth. In a shocking find, on Wednesday, astronomers announced their discovery of an Earth-sized planet orbiting the nearest star, Proxima Centauri, just 4.2 light-years away. This warm world, catalogued as Proxima b, sits smack in the middle of its habitable zone - the sweetest of sweet spots - where liquid surface water could exist. However, Proxima Centauri is not like the Sun. It is a cool, low-mass star known as a red dwarf. So, the planet only qualifies as potentially habitable because it circles its Sun in an orbit tighter than Mercury's.


ESO

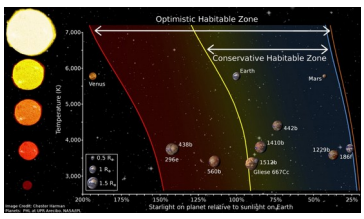
"The first hints of a possible planet were spotted back in 2013, but the detection was not convincing," says Queen Mary University of London astronomer Guillem Anglada-Escudéf, who led the discovery team. "Since then we have worked hard to get further observations off the ground." Anglada-Escudéf's group is an international team of several dozen astronomers which has collectively spent years searching for Earth's nearest neighbour.

This picture combines a view of the southern skies over the ESO 3.6-meter telescope at the La Silla Observatory in Chile with images of the stars Proxima Centauri (lower-right) and the double star Alpha Centauri AB (lower-left) from the NASA/ESA Hubble Space Telescope. Credit: Y. Beletsky (LCO)/ESO/ESA/NASA/M. Zamani)

Incredibly, the planet's ghostly signal was hidden in the data for decades. The researchers noticed a weak signal reoccurring every 11.2 days. They used this potential find to secure support from the European Southern Observatory, and then they set out on an unprecedented confirmation campaign. For months earlier this year, they kept a near-constant vigil on Proxima Centauri using ESO's 3.6-meter telescope at the La Silla Observatory in Chile. Their radial velocity technique, which detects tiny wobbles as the planet pulls on its star, provided the stunning confirmation. "You take the old data and the new data, and you combine everything together, and then the significance of the detection goes sky high - very, very significant," says Anglada-Escudéf.

The team went to great lengths to confirm Proxima b because these small suns have a history of fooling astronomers. Red dwarfs are violent stars known to erupt and create signals that look like planets. "This is such an important system. These are our next door neighbours," says Robertson, an astronomer at Pennsylvania State University. "A claim of a habitable-zone planet around Proxima is genuinely extraordinary. So you have to go to somewhat extraordinary lengths to make sure you're right, and I think that's what they were doing." He's not the only one hailing the discovery as perhaps the most exciting new world yet - and not just because it's Earth's nearest neighbour.

"I would say this is the topmost ranked exoplanet if it is confirmed," says Ravi Kopparapu of NASA's Goddard Spaceflight Center. Kopparapu is a leading expert in defining habitable zones using factors like how hot a star is and how much of its light hits the planet. These researchers, and many other exoplanet studies, rely on his calculations.



In recent years, NASA's Kepler space telescope has turned up thousands of new worlds around all sorts of stars - including small ones with planets in tight orbits, like Proxima. So experts are not surprised there is a planet next door, but they are shocked that this nearby world has a shot at hosting life. "If confirmed, this will be one of the most significant discoveries to date in the field of exoplanetary science and also for potentially habitable planets," says San Francisco State astrophysicist Stephen Kane, who chairs the Kepler

Telescope Habitable Zone working group. He points out that, "If the star closest to our Sun also has a planet in the habitable zone, then that raises the expectation that other stars will also harbour such planets."

Proxima Centauri is notable because red dwarves are the cosmos' most abundant type of star. If the Milky Way held just 100 stars — it actually has 100 billion — 75 of them would be these cool, tiny suns. A recent study used Kepler's exoplanet catalogue to predict that just 16 percent of these stars should have Earth-sized planets in their habitable zones. Based on those odds, the nearest habitable world would be 20 light years from Earth. With the discovery of Proxima b just over 4 light-years away, nature showed it still has some surprises.

"We've found one right next door," says Kopparapu. "It's in the middle of the habitable zone and Earth-size. It has all the things that we can dream of -except we don't know if it has an atmosphere." However, even with an atmosphere, Proxima b could still be barren. The planet's close-in orbit means it's tidally locked like the moon is to Earth. Proxima b's day-side forever faces its sun, and the same constellations seen from Earth shine perpetually on the planet's night-side. "It's possible the daytime side of the planet would be roiling hot and the night-time side would be freezing cold," says Robertson.

However, even if Proxima b does have a scorched and frozen side, there's still a chance for Goldilocks perfect conditions in between those two regions, where the planet would be bathed in permanent twilight. "It might be like being in Alaska, where you only see the sun peeking out of the sky perpetually," says Robertson. "That would be the only place that it would be temperate enough to stand there." That's only the start of the caveats for this terrestrial world. Proxima Centauri is also 100 times more active than the Sun, bombarding the planet with ultraviolet and x-ray radiation. The star is about the same age as our own, and if those eruptions were too strong while the planet was forming, it could have wiped away any water.

"Whether there is water or not we do not know," says research team member Ansgar Reiners of the German Universität Göttingen. "That entirely depends on the formation, on the history of the planet, and this will be subject to further studies." Thankfully, Proxima is perfectly placed for follow-ups. There can be no exoplanets closer. Furthermore, the next potential find is already showing itself. There's a periodic signal that hints a second planet - Proxima c - could be lurking in the data. But they'll need many more nights at the telescope to be certain it's not just the machinations of a violent star. By: Eric Betz

Astronomers find a galaxy that's mostly dark matter 25 August: The hazy oval is not glare on your screen; it is an entire galaxy. Dragonfly 44 weighs about the same as the Milky Way, except it's 99.99% dark matter and has less than a hundredth the number of stars. Dark matter is stuff that cannot interact with the electromagnetic force (how we mostly experience the world) so we cannot see or touch it. Scientists can observe its gravitational effects, though, which keep Dragonfly 44's paltry collection of visible stars from flying apart. There iss around five times as much dark matter as regular matter in the Universe, and even the Milky Way is around 90% dark matter.


An image of Dragonfly 99, a faint galaxy dominated by dark matter. Pieter van Dokkum, Roberto Abraham, Gemini Observatory/AURA

Astronomers found Dragonfly 44 with the Keck Observatory and the Gemini North telescope on Mauna Kea, Hawaii. The team measured Dragonfly 44's mass by observing its stars' velocities as they zoomed around the galaxy. Scientist Pieter van Dokkum from Yale University pointed out that a galaxy like this one would allow astronomers to better study a huge mass of dark matter with far fewer stars to block the view, or lack thereof.

By: Ryan F Mandelbaum

Russian SETI researchers are pursuing a promising signal 29 August: It may not be aliens, but something weird was picked up by Russian radio astronomers, who are now digging for answers. It could be nothing. In the kinds of circles that search for transmissions from alien civilizations, it always is. Nonetheless, Russian researchers in the Search for Extraterrestrial Intelligence (SETI) have something intriguing they are pursuing.


This 2013 photo shows the RATAN-600 observatory, where a recent microwave transmission has SETI researchers excited. Wikimedia Commons / ратан 600

This needs to be considered cautiously. SETI efforts worldwide have had plenty of promising signals. None of them has been confirmed to come from extraterrestrial civilizations. Several have turned out to be from terrestrial sources, and early on, two high profile "What ifs?" lead to the discovery of pulsars and quasars rather than alien megastructures or technologically advanced societies. Still, there is enough substance to this message that researchers working from the RATAN-600 observatory in Russia are investigating what might have caused it. They have pinpointed a likely star, HD 164595, which is located in the Hercules constellation known to have one planet, a Neptune-sized world in a 40 day orbit. Given that HD 164595 is a Sun-type star, that planet would be too hot for life, but there may be other undiscovered planets in the solar system.

The signal was first detected in May 2015 at the 2.7 cm band, which is around 11 Ghz in the super-high frequency band. That places whatever the signal was in the microwave band. As Lee Berger at Ars Technica points out, there is no known astrophysical source at these wavelengths. There is some chatter that if (BIG if) this is of non-natural origin, it could be slightly to moderately more advanced than our own. "... if it came from an isotropic beacon, it would be of a power possible only for a Kardashev Type II civilization," Paul Gilster at Centauri Dreams writes. "If it were a narrow beam signal focused on our Solar System, it would be of a power available to a Kardashev Type I civilization." In the Kardashev scaled, Type I civilizations are those somewhat like our own, technology-wise, able to utilise radio signals to reach out and make contact. Type II are more

technologically advanced civilisations, the type brought up when talking about "alien megastructures" like some people have theorised may be around Tabby's Star.

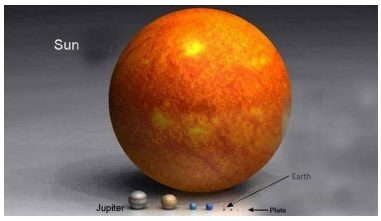
There are other natural reasons that may have caused this. Gilster points to both potential 'noise' contamination from other sources could have played a role, as well as a microlensing event which could have boosted the signal from something natural in the background. More telescope time is needed to figure it out and get to the bottom of it. Researchers could then see if it repeats (a much-needed element of SETI research, in order to gather as much data as possible), if there are other unexplored natural scenarios that could have created it, or any other scenario that might be possible. After that, it can be said for sure whether or not it is aliens. However, for now, go with the words "promising," and hope for the best but prepare for it to be bupkis. By: John Wenz

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

DID YOU KNOW?

The Sun Part 6 **Sun – size and mass**

'The Sun plus some debris'. This description of the solar system accurately recognises the physical dominance of the Sun. Although just a medium-sized star among hundreds of billions of stars in the Milky Way galaxy, the Sun is, by far, the largest object in the solar system.



Sun-planets size comparison

An almost perfect sphere, the equatorial and polar diameters of this gaseous object differ by only approximately 10 km.

Solar size vital statistics
Diameter 1,392 km (109x Earth's diameter)
Mean radius 696,000 km
Circumference Around 4,366,813,km
Total volume 1.4 x 1027 m^3 (about 1.3 million Earth's could fit inside the Sun).

Solar mass vital statistics
The Sun contains 99.8% of the total mass of the solar system.

Because Earth follows an elliptical orbit around Sun, the solar mass can be computed from the equation for the orbital period of a small body orbiting a central mass. Based on the length of the year, the equation includes the Earth-Sun distance (AU) and the gravitational constant. Early calculations, however, were inherently inaccurate as this calculation of solar mass was used before either the AU or G, the gravitational constant, had themselves been precisely calculated.

Isaac Newton was the first to estimate the solar mass. In his *Principia* (1684) he estimated that the ratio of Earth's mass to that of the Sun was about 1/28,700. Later, he realised that the calculation was based on a faulty value for the solar parallax which he had used to calculate AU. In the 3rd edition of Principia, he corrected the estimated ratio to

1/169,282. Although more accurate, solar parallax was only correctly calculated a century late after transits of Venus in 1761 and 1769. The current value for solar parallax is even smaller: 1/332,960.

The modern calculation of solar mass identifies a value of 1.989 x 1,030 kg (about 333,000 times Earth's mass or 1,048 times Jupiter's mass).
Solar mass is used as a standard unit to indicate the masses of other stars, as well as clusters, nebulae and galaxies.

The mass of the Sun has decreased since the time the star was formed. This due to two processes acting in almost equal amounts:

- the Sun's core hydrogen is converted into helium by nuclear fusion. The primary reaction process (proton-proton chain) converts some mass into energy in form of gamma ray photons, most of which eventually radiates away from the Sun.
- High-energy protons and electrons in the solar atmosphere are ejected directly into outer space as the solar wind.

The original mass of the Sun when it reached the main sequence (when it began to shine by converting hydrogen to helium) is uncertain. The early Sun had much higher mass-loss rates than at present, so it might have lost anywhere from 1-7% of its initial mass over the course of its main sequence lifetime, so far. The Sun does gain a very small mass through asteroid and comet impacts, but these cannot offset the mass lost to radiation and ejection.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary of astronomy 2nd ed rev, Astronomy (Dorling Kindersley – Eyewitness companions, www.en.wikipedia.org, www.space.com,

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

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