`"The Southern Cross"

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HERMANUS ASTRONOMY CENTRE NEWSLETTER

JANUARY 2021

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 18 January,** starting at **19.00.** Access details will be circulated to members closer to the time. Dr Rosalind Skelton, SALT astronomer at the SAAO in Cape Town will be talking on 'Cosmic crowds and crashes'. See below for details.

Membership renewal for 2021

There will be no increase in fees this year.

The 2021 fees will remain at:

Member: R160

Member's spouse/partner/child, student: R80

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

Account name – Hermanus Astronomy Centre

Account number – 185 562 531

Branch code – 051001

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

2021 meeting dates For your diaries. The dates of the monthly meetings for 2021 are as follows: 18 January, 15 February(AGM), 15 March, 19 April, 17 May, 21 June, 19 July, 16 August, 20 September, 18 October and 15 November.

WHAT'S UP?

Aldebaran The inverted V-shaped Hyades open cluster, located to the left of the eponymous constellation Orion (the Hunter) is a distinctive feature in the southern summer night sky. The brightest star in the cluster (magnitude 0.9) is bright, reddish coloured Aldebaran (Alpha Tauri). Although apparently part of the open cluster, it is only a member due to its location when observed from Earth. It is 65ly away, meaning that the light which we now see when we observe the star left it 65 years ago (around 1955). the Hyades cluster itself is about the twice as far from Earth as Aldebaran is. Aldebaran is one of many stars whose name begins with the Arabic letters Al-, which means 'the' in English. Some of these star names were given by Arabs living in the Middle East long before the rise of Islam, while others are translations of ancient Greek language descriptions, many from Ptolemy's Almagest. The name Al-de-baran is Arabic for 'the foremost' or 'the leading star' because it 'leads' Pleiades, the other distinctive open cluster in the Taurus constellation. Aldebaran's reddish colour is easy to see with the naked eye. Its colour is evidence that it has burnt up its hydrogen resources and is in the early stages of dying.

LAST MONTH'S ACTIVITIES

Monthly centre meeting There was no meeting in December.

Interest groups

Cosmology At the Zoom meeting, held on 7 December, Derek Duckitt presented the next two lectures in the DVD series 'Blackholes, tides and curved spacetime: Understanding gravity presented by Prof Benjamin Schumacher of Kenyon College. The topics were: L17: 'Matter tells spacetime how to curve' and L18: 'Light in curved spacetime'.

Astro-photography There was no meeting in December.

Other activities

Educational outreach

Solar system workshop On Thursday, 19 November, Pierre de Villiers and Peter Harvey conducted a workshop at the cliff path on the Solar System for 10 learners of Lukhanyo Primary School, at the request of their science teacher, Zimkitha Buyile. Pierre reports: "Using a 300 mm diameter skymap globe as Sun model and A5 booklets depicting the relative sizes of the planets on this scale as teaching aids, Pierre demonstrated two concepts:

- Understanding the relative sizes AND distances in the Solar System with a 3D demonstration. For a Φ300 mm Sun the Earth 's relative size is 2.75mm at a distance of 32m. The learners can see the Sun model's size as well as that of the 2.75mm black dot but *saying* that size ball is *at a distance of 32m* is still a vague concept. However, getting a learner to stand 32 m away from the Sun his/her 3D image enables the eyes/brain combination to estimate the distance meaningfully. Learners at 12m, 23m, 32m and 49m illustrated the relative distances from a 300 Sun for Mercury (Φ1.05mm), Venus (Φ2.61mm), Earth (Φ2.75mm) and Mars (Φ1.46mm). By then the 3D demonstration had given the learners an understanding of the HUGE relative distances in the Solar System, which cannot be achieved from a 2D diagram.
- How empty the Solar System – and therefore space – is. On the scale of a Φ300 mm Sun all the matter in the planets, dwarf planets, asteroids, comets and Kuiper Belt & Oort cloud objects would fit into a sphere of Φ32 mm. Fortunately Pierre had a spare Neptune model of 32 mm to illustrate that the 300mm Sun and 32 mm "Neptune" represent **all** the matter in a 3D sphere of radius 8,667 km – the approximate distances to Perth, Rome or Lima!.

To re-emphasize the workshop learning, the learners were taken along the True Scale Solar System model along the Cliff Path up to Jupiter. The group was extremely participative and all enthusiastically confirmed that they could and would convey their new-found insight by repeating the 3D demonstration to their friends, parents or fellow learners. A very meaningful workshop indeed."

Peter Harvey reports: "Commencing at the scale model Sun, above Bientang's Cave, Pierre explained the distances and scales of the solar System as illustrated by the cliff path model which stretches out as far as Grotto Beach and includes Pluto, the now reclassified 'dwarf planet'. After four of the learners were sent out along the parking area to scale distances to represent the planets Mercury, Venus, Earth and Mars, they were then walked along the cliff path, visiting each model planet up to Jupiter. The learners showed their customary considerable enthusiasm for the subject."

Hermanus Hikers stargazing On Sunday evening 13 December Pierre de Villiers and Derek Duckitt met a group of 10 Hermanus Hikers, who had just completed a 10 km hike, at the top of Rotary Drive for an introductory star-gazing session. Pierre reports: "The objective of the session was to empower the group to be able to repeat similar sessions for their friends, families of fellow hikers.
A few important concepts were fully explained:

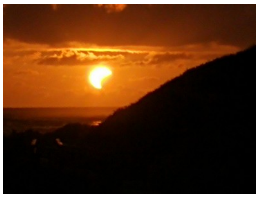
- The versatility and utility of the human eye as the most important observational aid i.t.o. its wide field of vision (120° horizontally and 60° vertically), ability to centrally observe colours under well-lit conditions, such as daylight, and peripherally view dimly lit objects in gray-scale at night or through binoculars or telescopes. The importance of dark adaption and averted vision could thus be explained and accentuated.
- As an aid to the eye-brain combination, the App SkySafari Pro was demonstrated as an unbelievably powerful and useful database of astronomical information – in your pocket or handbag and independent of the internet.
- Binocular designs (Porro Prism & Roof) were described, with specific reference to typical magnifications (7 – 10), fields of view (≈5°) and optical glass quality. BAK-4 is of higher density and better quality than BK-7 and therefore more expensive. If you look into the primary lenses of binoculars from the "reverse" side and you see a green tinge and a circular exit pupil the optical glass is BAK-4 and the design typically a Porro Prism. A reddish tinge or squared-off, non-circular exit pupils are indicative of BK-7 glass more common to Roof design binoculars.
- The importance of red light to preserve dark adaption was practically demonstrated by both Derek & Pierre always using their red headlights.
- Finally the utility of a green laser pointer was practically demonstrated by Derek & Pierre pointing out and describing the dominant summer sky constellations and asterisms with their pointers: The Hunting Scene of Taurus (the Bull) attacking Orion (the Hunter) at whose feet Lepus (the Hare) is hiding from the Large (Canis Major – Sirius) and Small (Canis Minor - Procyon) Hunting Dogs. The "summer stripe" or virtually straight SE – NW line over ≈ 75° stretching from Sirius through Orion's belt, Aldebaran (the red eye of Taurus the bull) to Pleiades was traced out.

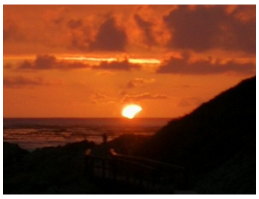
The initial binocular and telescopic observations were obviously Jupiter and Saturn, nearing their conjunction. Jupiter's Galilean Moons and Saturn's rings were a pleasant surprise to most attendees. Orion's sword and particularly M42, the Orion Nebula, was however the star of the show. Unfortunately the Southern Cross and all the interesting targets in its rich environment were too low to observe.

Although frequent scattered clouds ruled out a clear view of everything simultaneously, the session was regarded as educational and enjoyable by the attendees. They were all encouraged to visit our excellent website and specifically to read the newsletters and Skynotes, and become members."

Other activities

Partial solar eclipse Cloud cover meant that the eclipse on 14 December was not visible to many members. However, a few were fortunate to see and record it. Peter Harvey reports: "A most pleasant evening's viewing was enjoyed by 4 members (John [Saunders], Norval [Geldenhuys], Bennie [Kotze] and Peter [Harvey]) plus 3 visitors. The cloud cleared just before sunset and allowed us to witness the partial [eclipse] from an idyllic setting. Bennie and Norval were able to produce some beautiful images." Norval Geldenhuys reports: "I was with Peter and Barbara Harvey, Bennie Kotze and John Saunders at Davies's Pool. As it was very cloudy, we enjoyed some sundowners. At 19h40 (just before sunset) we saw the clouds opening up near the horizon, so we walked along the coastal path towards Jan Rabie's Pool and were able to take some nice photos."





Great conjunction Again, cloudy weather over parts of Hermanus prevented viewing, by some members, of the closest positioning of Jupiter and Saturn on 21 December. However, several members observed the ever closer and increasingly distant planets before and after the great conjunction itself. For example, Jenny Morris was privileged to have a fantastic view of them above the Atlantic Ocean on an unusually clear evening on 24 December from the road above Camps Bay in Cape Town.

Whale Talk article An article by Jenny Morris titled 'Heavenly music: Did the Sun influence the sound of violins?' Was published in the December 2020-January 2021 issue of the magazine

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting**, will take place on the evening of **Monday 18 January,** starting at **19.00**. Access details will be circulated to members. Dr Rosalind Skelton, SALT astronomer at the SAAO in Cape Town will be talking on 'Cosmic crowds and crashes'. She states: 'In this talk I'll give an overview of the current picture of galaxy formation and evolution, and discuss how galaxies are impacted by their surroundings. Galaxies are generally not good at isolating, and the consequences of not social distancing can be dire for them too - harassment, starvation, and cannibalism are just a few examples of these effects! Galaxy interactions are essential for forming and growing the population of galaxies we see today, however. I'll describe how we are investigating the role of mergers and the influence of a galaxy's location in the cosmic web in our current work at SAAO."

Speaker's biography Dr Rosalind Skelton is based at the South African Astronomical Observatory (SAAO), where she is a support astronomer for the Southern African Large Telescope (SALT) with a research focus on galaxy formation and evolution. She completed her PhD on galaxy mergers at the Max Planck Institute for Astronomy (University of Heidelberg) in 2010 and then took up a postdoctoral research position at Yale University. She returned to South Africa in 2013 for a Professional Development Programme postdoctoral fellowship at the SAAO, and became a member of the SALT team in 2016. She has close links with the University of Cape Town, where she enjoys lecturing for the National Astrophysics and Space Science Programme and mentoring students at all levels. Her group investigates galaxy formation processes and interactions in different environments, from the formation of low surface brightness galaxies to the most massive galaxies and large-scale structures in the universe.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. There is no meeting in January.

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 normally meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next meeting will take place in February.

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

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

Other activities

Stargazing While no events will take place during the coronavirus pandemic, members are encouraged to submit their own images for circulation to the membership. Please e-mail them to petermh@hermanus.co.za

FUTURE TRIPS

No outings are being planned, at present.

2021 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented via Zoom. The dates for this year are as follows: 18 January, 15 February (AGM), 15 March, 19 April, 17 May, 21 June, 19 July, 16 August, 20 September, 18 October and 15 November.

Speakers for 2021 include Dr Rosalind Skelton (January), Dr Kechil Kirkham (March), Dr Vanessa McBride (April), Clyde Foster (May), Case Rijsdijk (September), Pieter Kotzé (October). The remaining presenters are Centre members: Pierre de Villiers, Johan Retief and Jenny Morris. Details will be circulated closer to the time, each month.

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\

Chang'e 5: Chinese spacecraft lands on Moon, prepares to collect lunar samples

2 December: 1 December was a momentous day for the Chinese National Space Administration (CNSA). On this day, the long-awaited Chang'e 5 mission, which launched from the Wenchang Satellite Launch Centre little more than week ago, touched down on the Moon. The goal of the Chang'e 5 mission is to return at least (2 kilograms of lunar samples to the Earth via a fully robotic spacecraft. The last time Moon rocks were brought back to Earth was 44 years ago, when the Soviet Luna 24 probe returned six ounces of material for detailed analysis. Chang'e 5 is the latest step in China's so called 'Lunar Exploration Program'. While most Chinese missions do not get much attention from Western media outlets, Chang'e 5 marks a major step forward for CNSA, and the world is finally taking notice.

Both the mission profile of Chang'e 5 and the spacecraft itself are extremely complex, and the parallels to NASA's Apollo missions are evident. The spacecraft consists of four primary components: a service module, a lander, an ascent stage, and the Earth return module. The entire craft was carried to space aboard China's heavy-lifting Long March 5 rocket on November 23. To get to the Moon, it then performed several burn manoeuvres, followed by braking burns that allowed it to enter orbit some 200 kilometres above the lunar surface. After dropping to an altitude of some 15 km, the lander and ascent module detached from the rest of the craft to make a self-guided, safe lunar landing. According to CNSA officials, the craft touched down near Mons Rümker, a mountain in the Ocean of Storms. The lander, which in some ways resembles an Apollo lunar module, quickly deployed its solar panels to begin generating electricity. This will power the lander's array of instruments, which include ground-penetrating radar, spectrometers, and a drill capable of collecting samples as far as 2 m below the lunar surface.


Chang'e 5 lifts off aboard a Long March 5 rocket. CNSA

After these samples are collected, they will be transferred to the ascent module. The ascent module will separate from the lander via springs before firing its own rocket motor. CNSA chose this approach to minimize the risk of damaging the lander itself. Once in orbit, the ascent module will unfold and deploy its own solar panels before rendezvousing with the orbiting service module, which holds the Earth return module. The ascent module will then dock with the service module, where the lunar samples will be transferred to the return module. With the samples set for their return trip, the ascent module will then be jettisoned from the area. After several more lunar orbits, the service module (still paired to the Earth return module) will fire its rocket engine, beginning its journey back to Earth.

Upon entering Earth orbit, the return module will separate from the service module and begin its descent to the surface. The Earth return module will follow a curved trajectory that skips it through the atmosphere to slow down before deploying a parachute system. Finally, it plans to float down and 'softly' land in Mongolia. If all goes well - and that is a tall order - CNSA will accomplish an impressive technological feat that has not been pulled off by any nation for more than four decades. Chang'e 5 is just the latest in a series of ambitious lunar missions by CNSA, each of which has incrementally built on the lessons learned from its predecessors. By: Doug Adler

Are strange space signals in Antarctica evidence of a parallel universe? 8 December: Last spring, a report from the world's largest neutrino telescope - a sprawling grid of detectors woven into Antarctica's ice - coincided with a blaze of hyperbolic headlines. They teased the possibility of an anti-universe where, from our point of view, time runs backward and the Big Bang represents an end, not a beginning. While it is too soon to start searching for our reverse-aging, other-handed doppelgängers, physicists are still wrestling with strange signals coming in from space that, to date, have defied easy explanation.

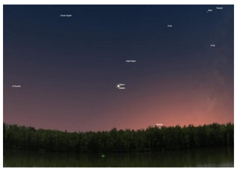

The balloon-based Antarctic Impulsive Transient Antenna (ANITA) floats over Antarctica. The University Of Hawai'i

The signals were flagged by a NASA-funded collection of horn radio antennas held aloft over Antarctica by a giant balloon. The device, called the Antarctic Impulsive Transient Antenna (ANITA), picks up radio signals produced when high-energy particles coming from deep space encounter our atmosphere. Some waves skim the Earth before they hit ANITA, and others bounce off the ice. ANITA can tell the difference. During its first float in 2006 and again in 2014, the device picked up anomalous signals that resembled the kind that skim the Earth - but strangely, they seemed to be coming from the surface. "That means they had to pass through a huge chunk of the Earth," says physicist Stephanie Wissel of Penn State, who works on the ANITA experiment.

At the heart of this mystery are neutrinos: ghostly, high-energy particles that can stream through almost any material unscathed but can produce the telltale radio pulses that ANITA catches. To further investigate the unusual signals, physicists turned to IceCube, a neutrino telescope made up of long strings of detectors buried near the South Pole. A neutrino passing through the ice may produce other particles that emit tiny flashes of light that IceCube's sensors can detect. Scientists reasoned that ANITA's anomalies should also have produced signals in IceCube, and those signals could reveal the deep-space source of the particles. However, after eight years' worth of data was searched, the mystery remained: The exhaustive analysis turned up no matches. "If the ANITA signal was astrophysical, then we should be able to detect it in IceCube - and we did not," says physicist Justin Vandenbroucke of the University of Wisconsin-Madison, who works on the neutrino observatory.

The new findings mean scientists have to continue looking for less obvious explanations. Some have proposed that the anomalies arose from radio waves bouncing through caverns or buried lakes in the ice. Other theorists proposed more exotic ideas, such as that the heavy, high-energy particles in line with ANITA's data may describe one candidate for dark matter - the mysterious stuff that's believed to make up 85 percent of the matter in the universe but has never been detected. Still others hypothesize that the exotic particles fit an existing theoretical model of a parallel universe - one that is symmetric to ours, but populated with antimatter and running backward. Wissel and her colleagues are preparing a more sensitive upgrade to ANITA that, they hope, will find more of these strange signals. As an experimentalist, she says she is beholden to data, but appreciates the ideas about where the signals originated. New questions and tests can then confirm or refute theories about these deep-space particles and how the universe began. "They're trying to do with our data exactly what we want people to do with our data," says Wissel. "We want ANITA to push observations of ultra-high energy neutrinos into a new regime. We think that there is interesting new physics to be done." By: Stephen Ornes

The 'Christmas Star' appears again: Jupiter and Saturn align in the 'great conjunction' 21 December: Jupiter and Saturn will line up on 21 December, so close together that they will appear as one bright shining star. Many are referring to it as the "Christmas Star". It is the closest the two planets have appeared together in about 800 years, and will not occur again until 2080. This conjunction of Jupiter and Saturn may have an even closer tie to the Biblical story of the birth of Jesus Christ than its occurrence so close to Christmas this year. As noted by Johannes Kepler in the 17th century, a similar conjunction occurred in 7 BCE and could be the astronomical origin of the Star of Bethlehem that guided the wise men. However, there are notable differences between the two events, and the full story has several interesting ties to the history of astronomy, starting with the origins of the word 'planet', which comes from the Greek word meaning 'wanderer'. The planets have always been recognisable to astronomers, not only because they are relatively bright points of light among the stars, but because of their unique wandering nature. This posed a problem to ancient astronomers, which lasted more than 2,000 years and was only resolved during the Scientific Revolution.

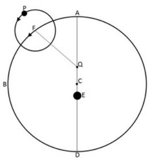


A graphic made from a simulation program, showing a view of the 2020 great conjunction through the naked eye just after sunset on 21 December. NASA

As the Earth spins on its axis every 24 hours, the Sun, moon, stars and planets all appear to move across our sky, rising in the East and setting in the West. However, because the planets orbit the Sun, all travelling in counter-clockwise directions when viewed from above the North Pole, to us on Earth, the Sun and planets all appear to move with respect to the background stars. As Earth moves around the Sun, the Sun in turn appears to move slowly to the East, by about a degree each day as it travels through the Zodiac constellations. Mercury and Venus move from one side of the Sun to the other as they circle it, and the outer planets of the solar system - Mars, Jupiter and Saturn are visible to the naked eye - appear to move East through the stars as they orbit the Sun.

However, a peculiar thing happens to the positions of the outer planets when the Earth passes between them and the Sun: They appear to briefly reverse direction, and travel West, against the background stars. This apparent retrograde motion is caused by a parallax shift that occurs for the same reason your thumb hops back and forth if you hold it fixed in front of your face and wink first with one eye, then the other; it is an optical illusion caused by a shift in our perspective.

While the Ancient Greeks had considered this explanation of the retrograde motions of planets, they mainly preferred an alternate, Earth-centred model in which the planets move around a fixed Earth on small circular orbits, the centres of which went around larger, Earth-centred circles. Thus, as the planets orbited an empty point in space while that point went around the Earth, the planets would occasionally stop and move backwards in their motion against the background stars. Astronomers mainly described the solar system in this Earth-centred way until Nicolaus Copernicus proposed a Sun-centred theory in 1543. Copernicus's theory did not do any better job of describing planetary motion than the Earth-centred models did, but the idea gained traction. The German 17th-century astronomer Johannes Kepler eventually found the key to describing planetary motion in a Sun-centred system. Rather than orbiting the Sun in circles, Kepler found the planets moved in ellipses, a distinction that allowed him to precisely predict their observed positions.



The Earth-centred model of planetary motions could explain why other planets sometimes appeared to be moving backwards. Nicolaus Copernicus proposed a Sun-centred theory in 1543. (Muhammad/Wikimedia), CC BY-SA

A conjunction is said to happen when two astronomical objects pass each other due to their movement along the direction of the stars' daily rotation. Since solar system objects do not all move within precisely the same plane, conjunctions can sometimes happen with a wide separation. Since Jupiter orbits the Sun every 11.9 years while Saturn's orbit takes 29.5 years, it happens that a conjunction of Jupiter and Saturn - called a 'great conjunction' due to its rarity - occurs roughly every 20 years. Most great conjunctions are not particularly notable. However, occasionally, like this year, Jupiter and Saturn cross paths so close to each other that they can be barely distinguishable to the naked eye. Or sometimes the two planets cross paths when they are opposite the Sun, so their apparent retrograde motion results in a triple conjunction, as was the case in 7 BCE.

In 1604, while he was working in Prague, Kepler observed the tight arrangement of the three planets – Mars, Saturn and Jupiter – and a bright new star, a supernova, that would slowly fade over the course of a year. This occurrence inspired him to consider a similar set of events that might have led the wise men to Bethlehem in time for Jesus Christ's birth. Knowing that Herod the Great had died in 4 BCE, he placed the birth of Christ before that date. Using his knowledge of planetary motion, he found that Jupiter and Saturn underwent a triple conjunction in 7 BCE, that conjunctions of Mars with each planet in 6 BCE were shortly followed by conjunctions of the planets with the Sun. Kepler suggested that these solar conjunctions aligned with the conception of Christ and that the wise men arrived the following year to witness Christ's birth beneath the Star of Bethlehem.

On 21 December of this year, Jupiter and Saturn will be only one-tenth of a degree apart, well within the field of any telescope's view. As we watch this year's event, it is worth keeping in mind the historical significance previous conjunctions have had. Kepler's fascination with planetary motion led, only a handful of years later, to his discovery that planets follow elliptical paths around the Sun. Kepler's discovery would, before the end of that century, inspure Newton's work on his most important contribution, the great Philosophiae Naturalis Principia Mathematica, where he laid down his ideas on the law of gravity, and which forever changed the world of science.

Without fear of exaggeration, it is possible to link the wandering motion of the planets - never more clearly on display than when we can simultaneously see Saturn's rings and the

Galilean moons of Jupiter through a telescope - with the discovery that Earth is a planet within a solar system in which motions are dominated by a universal gravitation that acts between all massive bodies. By: Daryl Janzen

Physicists prove the existence of two-dimensional particles called 'anyons' 22 December: After decades of exploration in nature’s smallest domains, physicists have finally found evidence that anyons exist. First predicted by theorists in the early 1980s, these particle-like objects only arise in realms confined to two dimensions, and then only under certain circumstances - like at temperatures near absolute zero and in the presence of a strong magnetic field.


Shutterstock

Physicists are excited about anyons not only because their discovery confirms decades of theoretical work, but also for practical reasons. For example: anyons are at the heart of an effort by Microsoft to build a working quantum computer. This year brought two solid confirmations of the quasiparticles. The first arrived in April, in a paper featured on the cover of Science, from a group of researchers at the École Normale Supérieure in Paris. Using an approach proposed four years ago, physicists sent an electron gas through a teeny-tiny particle collider to tease out weird behaviours - especially fractional electric charges - that only arise if anyons are around. The second confirmation came in July, when a group at Purdue University in Indiana used an experimental setup on an etched chip that screened out interactions that might obscure the anyon behaviour.

MIT physicist Frank Wilczek, who predicted and named anyons in the early 1980s, credits the first paper as the discovery but says the second lets the quasiparticles shine. “It’s gorgeous work that makes the field blossom,” he says. Anyons are not like ordinary elementary particles; scientists will never be able to isolate one from the system where it forms. They are quasiparticles, which means they have measurable properties like a particle - such as a location, maybe even a mass - but they are only observable as a result of the collective behaviour of other, conventional particles. (Think of the intricate geometric shapes made by group behaviour in nature, such as flocks of birds flying in formation or schools of fish swimming as one.) The known universe contains only two varieties of elementary particles. One is the family of fermions, which includes electrons, as well as protons, neutrons, and the quarks that form them. Fermions keep to themselves: No two can exist in the same quantum state at the same time. If these particles did not have this property, all matter could simply collapse to a single point. It is because of fermions that solid matter exists.

The rest of the particles in the universe are bosons, a group that includes particles like photons (the messengers of light and radiation) and gluons (which ‘glue’ quarks together). Unlike fermions, two or more bosons can exist in the same state at the same time. They tend to clump together. It’s because of this clumping that we have lasers, which are streams of photons all occupying the same quantum state.

Anyons do not fit into either group. What makes anyons especially exciting for physicists is they exhibit something analogous to particle memory. If a fermion orbits another fermion, its quantum state remains unchanged. The same goes for a boson. Anyons are different. If one moves around another, their collective quantum state shifts. It might require three or even five or more revolutions before the anyons return to their original state. This slight shift in the wave acts like a kind of memory of the trip. This property makes them appealing objects for quantum computers, which depend on quantum states that are notoriously fragile and prone to errors. Anyons suggest a more robust way to store data. Wilczek points out that anyons represent a whole 'kingdom' containing many varieties with exotic behaviours that can be explored and harnessed in the future. He began thinking about them about 40 years ago in graduate school, when he became frustrated with proofs that only established the existence of two kinds of particles. He envisioned something else, and when asked about their other properties or where to find these strange in-betweeners, half-jokingly said, "anything goes" giving rise to the name. Looking forward, he sees anyons as a tool for finding exotic states of matter that, for now, remain wild ideas in physicists' theories. By: Stephen Ornes

Here is what we know about the signal from Proxima Centauri 28 December: An enigmatic radio signal from the direction of Proxima Centauri, the Sun's nearest stellar neighbour, has set the internet ablaze with rumour and speculation. It could turn out to be the real deal - a calling card from another civilization. More likely, it is much ado about nothing. The discovery was leaked to the British newspaper The Guardian, which reported the story on 18 December. Researchers subsequently granted interviews to Scientific American and National Geographic. Since then, however, the discovery team has remained tight-lipped about the signal, but the information revealed to date is intriguing.


Proxima Centauri, our Sun's nearest stellar neighbor, . ESA/Hubble & NASA

The 64-metre Parkes radio telescope in Australia picked up the faint signal in April and May 2019 while observing Proxima Centauri, a red dwarf 4.25 light-years from Earth. Notably, this feeble star has at least two planets, one of which is a super-Earth with at least 1.17 Earth masses that orbits in the star's habitable zone - the region around a star where a planet with the right conditions could host liquid water on its surface. Astronomers were using Parkes to catch radio emission from powerful flares shooting off the star. However, the $100 million Breakthrough Listen project, the world's most advanced SETI endeavour, was piggybacking on the observations to simultaneously search for alien signals. In late October 2020, Breakthrough Listen intern Shane Smith, an undergraduate at Hillsdale College, found a narrowband transmission at a frequency of 982.002 megahertz - in a portion of the radio spectrum rarely used by human-made transmitters - buried in the data.

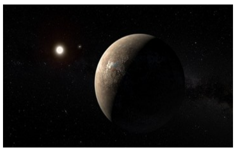
Although the press reports are a bit unclear on exactly how and when Parkes detected the signal, it apparently showed up during five 30-minute periods over several days, all while the telescope was pointing directly at Proxima. Notably, when the telescope was turned away from the star, the signal vanished. Ultimately, the signal's origin appears tightly constrained within a 16'-wide circle - roughly half the size of the Full Moon - around Proxima Centauri on the sky. Breakthrough Listen employs software filters that reject the cacophony of signals originating from Earth or Earth-orbiting satellites to isolate those coming from deep space. This transmission was unlike anything the project has previously encountered. Researcher Andrew Siemion said, "It has some particular properties that caused it to pass many of our checks, and we cannot yet explain it."


Astronomers using the Parkes radio telescope in Australia have detected a signal of unknown origin coming from around Proxima Centauri. Robert Naeye

The team has dubbed the signal BLC-1, for Breakthrough Listen Candidate-1. They are emphasising the word 'candidate'. Pete Worden, executive director of Breakthrough Listen's parent organization, Breakthrough Initiatives, said that the signal is 99.9 percent likely to be human radio interference. On 19 December, he tweeted: "At this point we have some interesting signals we believe are interference but as of yet have not been able to track down the source." Based on the information that has been made public, the signal was concentrated into an extremely narrow range of frequencies - the hallmark of an artificial signal and distinctly unlike all known natural radio sources. The transmission was apparently monotone, meaning it was not modulated in a manner that conveys more complex information.

Over the course of the observations, it increased in frequency - essentially rising in pitch - by an unspecified amount, suggesting a source moving toward the telescope. "It could be from the orbital motion of a planet, or from a free-floating transmitter, or from a transmitter on a moon," Penn State University astronomer Jason Wright wrote on his blog. However, he quickly added, "The most likely explanation is probably that it is a source on the surface of the earth whose frequency is, for whatever reason, very slowly changing." Astronomers think the fact that the signal is very close to an integer MHz value strongly suggests a human origin, Wright also wrote. After all, why would aliens transmit signals that match such a specific value of a human-derived unit of measurement?

On the off chance that BLC-1 turns out to be the real deal, it would raise the question of whether humanity should send a reply - something within our current means. Our message could potentially stimulate a response in less than a decade, starting an interstellar dialogue well within the lifetimes of most people alive today. That is an incredibly exciting prospect. However, this possibility also raises concerning questions about our conversation partners: Who are they? What are their motives? Do they pose a threat? Technologically advanced beings at Proxima Centauri could reach Earth in a few decades if they can traverse interstellar space at an appreciable fraction of the speed of light. After all, Breakthrough Initiatives is planning just such a venture with its Starshot project, which plans to use a powerful laser to accelerate about a thousand ultra-lightweight, centimetre-sized craft attached to light sails. Such craft can theoretically attain 15 to 20 percent the speed of light, meaning they could reach the Proxima system in 20 to 30 years. "I find it difficult to believe that a technological civilization on Proxima Centauri would not know about life on Earth," says astrobiologist Jacob Haqq-Misra of the Blue Marble Space Institute of Science. "The only way they would not know is if they are almost exactly at our present-day level of technology, so that we are discovering them the same time they are discovering us. This is generally unlikely, because even a thousand-year difference between our two civilizations - a short time in astronomy - would lead to drastic differences in our detection capabilities."

 This artist's concept shows the rocky super-Earth Proxima b, which orbits in Proxima Centauri's habitable zone. ESO/M. Kornmesser

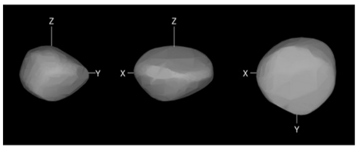
The Breakthrough Listen team is now working on two scientific papers that will report more details on BLC-1. They are also undoubtedly trying to identify all possible sources of terrestrial interference, as well as determine whether the signal repeats by observing again with Parkes and other radio telescopes, or combing through archival data. At least for now, BLC-1 is the most tantalizing SETI signal since Ohio State University's Big Ear radio telescope picked up the powerful "Wow" signal on 15 August 1977. That 72-second narrowband transmission emanated from the direction of Sagittarius. The signal has never repeated, but it also remains unexplained. If BLC-1 is simply - as is most likely - human interference, then it is no big deal, perhaps just a bit of an embarrassment to whomever leaked the story to The Guardian. However, if BLC-1 is a bona fide extraterrestrial signal, it could change the course of world history. An alien radio transmitter just 4.25 light-years from Earth would be a game changer. No doubt this is why the discovery team has gone silent and is working hard to get its analysis right. Even if BLC-1 turns out to be human radio interference, detailed analysis will help SETI researchers refine their search parameters to make later searches more efficient. "Ultimately, I think we'll be able to convince ourselves that [BLC-1] is interference. But the end result will certainly be that it will make our experiments more powerful in the future," Siemion said.   By: Robert Naeye

Citizen astronomers map near-Earth asteroid 29 December: In the battle to defend the planet from hazardous asteroids, amateur astronomers have taken on a new role - for the first time, helping to map a near-Earth asteroid (NEA), revealing its shape. The effort came as a collaboration between researchers at the SETI Institute and 26 citizen observers from seven countries who observed the 2 kilometre -wide asteroid 1999 AP10. All of the observers were using an eVscope - a new 'smart' telescope model produced by the startup Unistellar.

 The Unistellar eVscope is pictured here at Meteor Crater in this press kit photo. SETI Institute, Unistellar

Amateur astronomers have always been on the front lines of planetary defence as discoverers of asteroids and comets. Their observations and submissions to organizations like the Minor Planet Cetnre are invaluable in tracking objects that could one day collide with Earth. However, this is the first time that amateur observers have teamed with researchers to generate a detailed model of the shape of an asteroid. They used a technique called light curve inversion, which analyses how an object changes brightness as it tumbles and rotates through space, reflecting sunlight differently at every angle. Using the 81 sets of observations that eVscope users collected over October and November - plus some archival data from 2009 - the researchers were able to reverse engineer the asteroid's physical shape. Previously, astronomers had determined the shapes of only 68 other near-Earth asteroids, mostly using powerful planetary radar facilities to do so.

The results are also a milestone for the eVscope, which began as a Kiskstarter campaign in 2017. The initial campaign was so successful it spawned the company Unistellar, which has now shipped about 3,000 eVscopes to users. The eVscope's main claim to fame is that instead of an optical eyepiece, it has a built-in CMOS sensor and can stack images on the fly. Users can view the results on a paired smartphone or peer into the telescope's electronic "eyepiece," which projects an image from an OLED screen, similar to electronic viewfinders commonly found on mirrorless cameras. Another key feature is that users can participate in observing campaigns developed through a partnership between Unistellar and scientists from the SETI Institute.



Observations from citizen astronomers resulted in this model of the near-Earth asteroid 1999 AP10. Josef Hanuš, Charles University & Franck Marchis, SETI Institute

Franck Marchis of the SETI Institute ways hat the ability to tap into a network of thousands of identical eVscopes is a "game-changer" because results from standardised equipment can be combined more consistently. "You know that the telescopes react with the same sensitivity, the same quantum efficiency, the same profile of different colors," he says. "That means we can clearly identify if there is an issue coming from the seeing, from the sky quality, or from the wind." Plus, instead of relying only on advanced amateurs who know how to calibrate their equipment and process their data, the science team can program the eVscope to do it automatically, allowing anyone to participate.

Marchis hopes to compare their model of 1999 AP10 with forthcoming results from the Goldstone Solar System Radar, which also observed the asteroid this fall. But already the campaign has demonstrated the eVscope's potential for including amateur astronomers in scientific research, he says. Other researchers agree. "I think this is a great public engagement project that can provide useful and helpful data for asteroid research, including planetary defence," says Anne Virkki, who heads the planetary radar team at Arecibo Observatory. Arecibo's 305 metre radio telescope was the world's most powerful planetary radar before it collapsed following a series of cable failures this fall. Its loss was a big blow to planetary defence efforts - NASA funded the observatory to observe near-Earth objects, mapping their shapes and surfaces. Although comparing the eVscope to a planetary radar like Arecibo is "a bit of an apples-and oranges comparison," says Virkki, "more data is always a plus, and having the public engaged in participating and helping is even a bigger plus."

The crowdsourced light curve approach has limitations. Unlike planetary radars such as Arecibo, the eVscope network struggles to detect depressions on an asteroid's surface (eg mpact craters). That is because the maths behind the light curve inversion approach assumes the object is entirely convex, with no low-lying regions. Arecibo could also observe more objects, obtaining high-resolution images of 20 to 30 NEAs per year, according to Virkki. Marchis hopes that the eVscope network will map one or two NEAs annually. But still, he says, the eVscope network represents an alternative approach that can help "fill up the gap left by Arecibo." "Arecibo was a great telescope, but still one that was built in the 1960s, when we were building these gigantic facilities to learn about the cosmos used by a few people," he adds. "We're reaching a moment where we can democratize astronomy and make it accessible to a lot of people." By: Mark Zastrow

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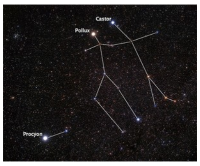
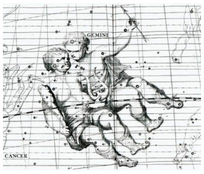
DID YOU KNOW?

Zodiac constellations 11: Gemini



The name of the 30th largest constellation is the Latin word for 'twins'. Both Uranus (William Herschel, 1781) and Pluto (Clyde Tombaugh, 1930) were discovered in Gemini. It is Identified by its two brightest stars – Castor and Pollux, which mark the heads of the twins. They can be found to the east of the stars of Orion's belt. From the southern hemisphere, the star closer to the horizon is Castor, with Pollux above it.



Gemini is one of the original constellations In Babylonian astronomy, the 'great twins', were regarded as minor gods. In Greek mythology, Castor and Pollux were the children of Leda, Pollux the son of Zeus by seduction and Castor the son of Tyndareus. King of Sparta and Leda's husband. Both were Argonauts, When mortal Castor died, Pollux begged Zeus to make his brother immortal. He did so by uniting them in the heavens. The twins are also mythologically linked with St Elmo's fire in their role as protectors of sailors.

The Sun passes through Gemini from late–June to late-July. The constellation contains over 80 stars visible with small equipment. Several of these stars are known to have exoplanets. There are few deep sky objects present, as the sky area of Gemini is directed away from the Milky Way.

Notable features include:

- Alpha Geminorum (Castor): a blue-white star with magnitude mag 1.6. 53 ly away, it is actually a multiple star system consisting of two blue-white binaries with 470 yr orbital period, plus a pale red dwarf companion. Each star is a spectroscopic binary ie Castor is a 6-star system. Johann Bayer inaccurately labelled it alpha in 1603).
- Beta Geminorum (Pollux): the brighter twin is an orange giant with magnitude mag 1.2. It is also closer than Castor, 34 ly away
- M35: an open cluster lying at the feet of the twins. Discovered in 1745 by Swiss astronomer de Cheseaux, it is large and elongated. The 200 stars are arranged in chains 2,800 ly away. It is visible to the naked eye only if the skies very clear and is best viewed through binoculars.

- Eskimo nebula (NGC 2392): a planetary nebula 3,000 ly away. It eponymous name derives from the fringe of gas surrounding the central star, making it appear Eskimo-like through large telescopes It is also known as the Clown Face Nebula.
- Geminid meteor shower: this radiates from a point near Castor, in middle weeks of December, peaking in mid-month. It is one of three most active annual meteor showers. The meteors are slow and often bright They are produced by debris in a common orbit with asteroid Phaethon. Its apparent asteroidal origin is usual, differing from the cometary sources of most meteors. This may account for the longer duration in flight and dearth of persistent trains.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary or astronomy Oxford, OUP, Ridpath, I (Ed) 2006 Astronomy London, Dorling Kinderslety, en.wikipedia.org

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

COMMITTEE MEMBERS

Pierre de Villiers	(Chairperson, GPAED)	028 314 0830
Laura Norris	(Treasurer)	028 316 4453
Peter Harvey	(Secretary, Sky notes)	028 316 3486
Jenny Morris	(Vice-chair, events co-ordinator, newsletter)	071 350 5560
Mick Fynn	(Educational outreach)	028 313 1361
Derek Duckitt	(Cosmology group co-ordinator, website editor)	082 414 4024
Deon Krige	(Astro-photography, youth robotics project)	028 314 1045

Non-committee members with roles:

Johan Retief	(Membership)	028 315 1132