"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

DECEMBER 2019

Monthly meeting There is no meeting in December. The committee wishes all members and their family and friends a relaxing and enjoyable festive season.

Membership renewal for 2020
There will be no increase in fees next year.

The 2020 fees remain at:
Member: R160
Member's spouse/partner/child, student: R80

New members joining after 1 October 2018 will have membership until the end of 2019.

Payment can be made in cash (at meetings 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.

2020 meeting dates For your diaries. Meeting dates will be: 20 January, 17 February, 16 March, 20 April, 18 May, 15 June, 20 July, 17 August, 21 September, 19 October and 16 November.

WHAT'S UP?

47 Tuc globular cluster The second brightest globular cluster after Omega Centauri, 47 Tuc (NGC 104) can be found in the constellation Tucana (the toucan), on the edge of the fuzzy irregular galaxy the Small Magellanic Cloud (SMC). Located towards the south at this time of year, 47 Tuc is visible through binoculars, with greater detail seen through a small telescope. At the centre is a small, bright circle of very densely grouped stars, surrounded by a noticeable halo. 47 Tuc, like other globular clusters is very distant from Earth, about 15,000 light years (ly). Observed and recorded in the early 1600s as a star it was only in the early 1750s that its true structure was revealed, by Nicolas-Louis de Lacaille while he was at the Cape. The Hubble Space Telescope was used in the 2000s to undertake a major survey of 47 Tuc's core in a search for planets. None was found, despite the statistical likelihood of a small number being present, suggesting that planets are not a

feature of globular clusters. While 47 Tuc lies within the Milky Way, however, the much more distant SMC orbits outside the galaxy. It is about 9,000 ly across and around 200,000 ly away.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter at the 18 November meeting was Centre member, Jenny Morris. Her talk was titled 'The Cassini dynasty and its Saturnian legacy'. Margaret Loesch reports: 'I liked the way the talk was introduced by going back in time from the 1600s to the 1800s - history of the observation of Saturn and its moons and rings by the four generations of the Cassini family – which no doubt impressed and amazed them even with their rudimentary telescopes - and ending with the captivating images of Saturn's beautiful rings and moons, taken in this century by the spacecraft Cassini-Huygens as it journeyed round and round the planet for thirteen years.
It was an excellent talk, informative and the stunning images of Saturn's rings were most impressive. '

Interest groups

Cosmology At the meeting on 4 November, Derek Duckitt presented the first two lectures in the DVD series 'Blackholes, tides and curved spacetime: Understanding gravity presented by Prof Benjamin Schumacher of Kenyon College. The topics were L1: 'The strangest force' and L2: 'Free fall and inertia'.

Astro-photography The 11 November meeting was cancelled.

Other activities

Educational outreach

Hawston Secondary School Space Cadets The last meeting of the year took place in October.

Lukhanyo Youth Club Construction of the analemmatic sundial at Lukhanyo is complete, Work continues on others at other Overstrand schools.

Stargazing Unfortunately, wind led to cancellation of the event planned for 28 November.

THIS MONTH'S ACTIVITIES

Monthly centre meeting These take place on the third Monday of each month a the **Catholic** Hall, starting at **19.00**. There will not be a meeting in December. The next monthly meeting will take place on 20 January.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting is on **2 December** at the **Catholic Hall**, starting at **19.00.** The next two lectures in the DVD series 'Black holes, tides and curved spacetime: Understanding gravity' presented by Prof Benjamin Schumacher of Kenyon College will be shown. The topics are L3: 'Revolution in the heavens' and L4: 'Universal gravitation'

There is an entrance fee of R10 per person for members, R25 per person for non-members, and R10 for children, students and U3A members. For further information on these meetings, or any of the group's activities, please contact Derek Duckitt at derek.duckitt@gmail.com

Astro-photography This group meets on the second Monday of each month. There is no meeting in December. The next meeting will take place on 12 January.

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

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

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

Other activities

Stargazing No event has been scheduled, yet, for December. If arranged, details will be circulated to members.

FUTURE TRIPS

No events are being planned, at present.

2019 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at **19.00**.

9 December No meeting

ASTRONOMY SELF-GUIDED EDUCATION CENTRE (ASEC)

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

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

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

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

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

ASTRONOMY NEWS\

First results: Voyager 2's recent pass into interstellar space 4 November NASA's Voyager 2 spacecraft crossed into interstellar space last November. Now, one year later, scientists have published the first results from the data Voyager 2 gathered as it passed from the Sun's sphere of influence out into interstellar space.

Voyager 2 passes into interstellar space in this artist's illustration. NASA

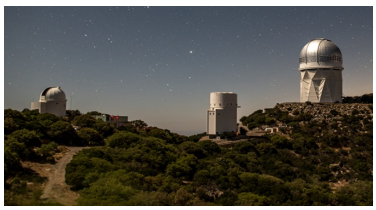
In some ways, what Voyager 2 experienced was surprisingly different from what what Voyager 1 found when it passed into interstellar space in 2012. These latest results also carry a number of other surprises for astronomers. As the Sun blows charged particles into space, it carves a bubble out of the surrounding gas and dust. Earth and the other solar system planets are nestled inside this bubble, called the heliosphere. The boundary between the heliosphere and outside space is called the heliopause. That is what the Voyager spacecraft blew past. Scientists are interested in the heliopause because it presents an opportunity to learn more about the Sun, interstellar space and the interactions between them. To understand what is happening at and near this boundary, they study the information the Voyager probes collected about magnetic fields and charged particles on either side of the heliopause

When Voyager 1 crossed the heliopause in 2012 and measured magnetic fields inside and outside the boundary, there was no significant change in the direction of the magnetic fields. That surprised scientists. Astronomers expected there may be a difference between the magnetic field direction inside the heliosphere, where magnetic fields come from the Sun, and outside of it, where magnetic fields come from exploding stars spewing their magnetic fields into surrounding material.

When Voyager 2 crossed into interstellar space, it confirmed this finding. The magnetic field outside the heliosphere looks similar to what it saw before."We continue to have surprises compared to what we had expected," veteran Voyager scientist Edward Stone of Caltech, said. Another Voyager 2 surprise is the number of particles 'leaking' out from the heliosphere into interstellar space. Even after Voyager 2 crossed the heliopause, it picked up particles coming from the Sun. Voyager 1, on the other hand, didn't see such leakage. It's still an open question why this leaking is happening. "This is a very exciting time for us," Stone said. "There's a lot to be learned by comparing Voyager 1 and Voyager 2."

By: Erica K Carlson

DESI will map millions of galaxies and reveal dark energy's history 5 November: A powerful new astronomical instrument got its first view of the sky from an Arizona mountaintop two weeks ago. Once the device officially gets to work in early 2020, it will capture the light from thousands of galaxies each night - up to 5,000 galaxies every 20 minutes, in ideal conditions. With this instrument, researchers will make a deep-space map of where galaxies lie to study dark energy throughout the history of the universe.

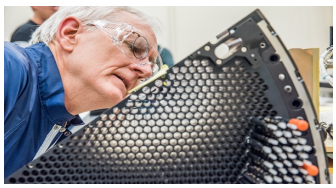

Kitt Peak National Observatory, home to the new Dark Energy Spectroscopic Instrument. NOAOAURA/NSF

Scientists installed the device, called the Dark Energy Spectroscopic Instrument (DESI), on a telescope at Kitt Peak National Observatory over a period of 18 months. On 22 October, DESI turned its gaze to the night sky to make its first test observations. Over the next few months, the DESI team will finish testing and begin its survey in earnest.

In just five years, the instrument is expected to gather light from 35 million galaxies and 2.4 million quasars, or galaxies with huge jets beaming from the supermassive black holes

in their centres. DESI will observe so many galaxies thanks to a complicated dance of machinery. Robotic 'positioners' can arrange 5,000 fibre-optic cables into pre-set locations in the instrument in just a couple of minutes. Each of the 5,000 fibres, which are about as wide as human hair, will collect light from one galaxy in the telescope's view of the sky.

By collecting specific wavelengths of light from these galaxies, DESI will let astronomers measure how quickly these objects are moving away from us because of the universe's expansion. They will also be able to measure how far the galaxies are from us, relative to each other. From the galaxies' locations in the sky and their relative distances, astronomers will make a 3-D map of where the galaxies lie in space up to 11 billion light-years away.


DESI uses a system of 5,000 fibre optic cables that can point at individual galaxies. University of California/Lawrence Berkeley National Laboratory

What does this map of galaxies have to do with dark energy? Dark energy is the mysterious force that makes the universe's expansion accelerate. By measuring how fast galaxies are moving thanks to the universe's expansion, astronomers can estimate how much dark energy there is. Thanks to DESI's ability to measure millions of distant galaxies, astronomers can measure how much dark energy there was at a given point of time in the universe's history, up to 11 billion years ago.

That's the main goal behind making such an expansive map of galaxies deep into space. DESI should be able to help determine whether the amount of dark energy in the universe stayed the same over time, as today's standard ideas of cosmology predict. Or, alternatively, if the amount of dark energy somehow changed over the universe's history. "I'm very excited to see the maps that this facility will be able to make, and to see how our theories of cosmological structure information can get challenged and extended by this enormously large dataset," said Daniel Eisenstein, a Harvard University astronomer and a member of the DESI team. By: Erica K Carlson

A rocky planet in this weird star system would have stunning skies 7 November: Over the past couple of decades, astronomers have discovered thousands of alien planets and solar systems. These worlds come in a wide variety of arrangements, many of which are quite different from what we see in our own solar system. Some have giant planets that swing through the planetary systems in stretched-out, or 'eccentric', elliptical orbits, unlike the nearly circular orbits of planets like Jupiter and Saturn. Astronomers think that many of these eccentric giant planets would act like 'wrecking balls' in their planetary systems, disturbing the orbits of other, smaller planets, but, that is not always the case.


For an observer standing on a rocky world in this star system, the oddly orbiting planet HR5183b would be up to 15 times brighter than Venus, Teo Mocnik

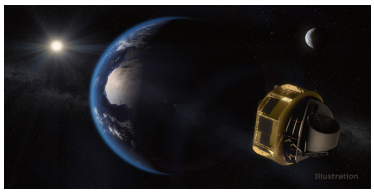
A giant exoplanet called HR 5183b, which orbits its host star in a stretched-out loop once every 75 years or so, would not disrupt the orbit of a small, rocky neighboring planet under the right conditions. Any stargazers on the hypothetical rocky planet's surface would see the giant planet grow to be 15 times brighter than Venus in Earth's sky when the giant planet swings by.

In August, a team of astronomers headed by Caltech's Sarah Blunt announced that they had discovered HR 5183b, a giant planet with a stretched-out orbit. Other eccentric giant planets found so far typically had much shorter orbits that rammed through their planetary system's habitable zones - regions where rocky planets could have liquid water on their surfaces - like wrecking balls. When Stephen Kane, an astronomer at the University of California, Riverside, heard the news, he wondered whether HR 5183b would necessarily be a 'wrecking ball' that destroyed other planets' orbits. Since this giant planet had a farther-out orbit than others found so far, he wanted to see if a small, rocky planet could survive in this system's habitable zone.

Kane teamed up with Blunt to run computer simulations of the scenario, with HR 5183b and a hypothetical rocky planet orbiting the system's star. They found that for a narrow range of orbits within the planetary system's habitable zone, a rocky planet could orbit the star without getting kicked out. This means astronomers do not necessarily have to rule out planetary systems with eccentric giant planets as possible homes to life."This shows that you can have an even greater diversity of habitable conditions than we previously thought," said Kane. Furthermore, when HR 5183b reaches its closest point to this hypothetical rocky planet about every 75 years, it would be 15 times brighter than Venus in Earth's sky. Like Halley's comet, which is clearly visible from Earth once every 75 years or so, Kane said, the sight would be a once-in-a-lifetime stargazing opportunity.

By: Erica K Carlson

This spacecraft will detect if exoplanet skies are cloudy, hazy, or clear 12 November: NASA announced, last week, that it will contribute to a European Space Agency mission scheduled to launch in 2028. The spacecraft, called ARIEL (for Atmospheric Remote-sensing Infrared Exoplanet Large-survey), will be the first space mission dedicated to studying exoplanet atmospheres. During its primary mission lasting some four years, ARIEL will study the atmospheres of roughly 1,000 exoplanets. NASA's contribution, an instrument called CASE, will let astronomers tell whether these exoplanets' skies are cloudy, hazy or clear. The results will help astronomers understand how planets and their atmospheres form and change over time.



NASA is adding an instrument to the European Space Agency's ARIEL spacecraft. ESA/STFC RAL Space/UCL/Europlanet-Science Office

So far, astronomers have discovered thousands of exoplanets that pass in front of their stars from our point of view. With the right tools, they can study light from the host stars that pass through the planets' atmospheres. This can reveal information like the chemical makeup and temperatures of these atmospheres as well as what chemical reactions are taking place there. The James Webb Space Telescope, currently scheduled to launch in 2021, will be able to study exoplanet atmospheres. However,since JWST will split its time

between multiple projects, it will only focus on studying the atmospheres of a few exoplanets. ARIEL, however, will observe the skies of about 1,000 exoplanets, from rocky planets to Jupiter-like gas giants. "I'm really looking forward to the ability to place individual planets within a statistical context," says Mark Swain, an astrophysicist at NASA's Jet Propulsion Laboratory who is heading production of the CASE instrument. "That is something which you need a large survey of exoplanets to do."

CASE, which stands for Contribution to ARIEL Survey of Exoplanets, will capture wavelengths of visible and infrared light that carry evidence for clouds and hazes in planets' skies. What makes something a cloud or haze? Clouds condense out of the atmosphere, like water droplets that make clouds in Earth's sky. Hazes are molecules that often form through chemical processes when light interacts with molecules in the atmosphere. Understanding whether an exoplanet has clouds or hazes will help astronomers better interpret other information about the planet's atmosphere, like chemical makeup and temperature, and figure out what physical and chemical processes are happening.

Also, understanding chemical compositions of exoplanet atmospheres may help decide which of two leading theories for how planets form is most likely correct. One theory suggests that planets will tend to have similar fractions of heavy elements as their host stars, while another implies that the heavy element fractions could be quite different. Finally, studying the atmospheres of 1,000 planets should help astronomers find out what's typical and pick out interesting cases to delve into. "When we see a single planet, a big question is, 'Is this kind of like the others, or did something special happen here?'" Swain says. "And that's a fundamental capability that ARIEL is going to give us."

By: Erica K Carlson

SpaceX releases 60 more Starlink satellites to orbit 12 November: On 11 November, SpaceX launched a Falcon 9 rocket carrying another 60 Starlink satellites, which will eventually provide internet service worldwide. The launch from Cape Canaveral Air Force Station made history by reusing a record number of rocket parts. However, even with that feat in aerospace design, the launch was not celebrated by everyone.

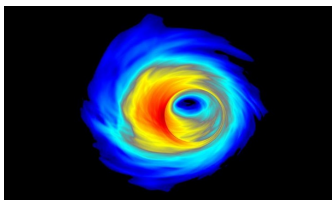

The Falcon 9 rocket taking off for the Starlink mission. Spacex Flickr

According to SpaceX's plans, Starlink will be a constellation totalling about 12,000 satellites orbiting Earth. The goal is to provide internet to the United States and Canada after just six Starlink launches. After 24 launches, the internet coverage will spread across the globe. However, with so many satellites orbiting Earth, astronomers and dark sky observers are nervous about how these satellites will affect their observations. When the first 60 satellites launched in May, many people noticed the satellites were so bright that they could be observed with the naked eye. And for professional astronomers and dedicated hobbyists, the satellites interrupted their views. At Lowell Observatory, a group of 25 Starlink satellites obstructed a photo capturing distant galaxies. Elon Musk, the founder of SpaceX, claims the satellites will be barely visible when they are in their final orbits, but many astronomers still worry the satellites could produce harmful light pollution that affects science observations.

Aside from the ongoing controversy, the launch of the satellites itself was enough to make headlines. "Every launch is an exciting launch," said Lauren Lyons, an engineer on the Starlink team during SpaceX's livestream. "But today's launch represents some particular notable milestones for SpaceX." In what is now an era of reusable rockets, the Starlink launch saw the first reuse of a nose cone, sometimes called a payload fairing. The one used Monday had been previously used in a mission in April, which saw SpaceX's current largest rocket deliver satellite payloads into space. The launch on Monday was also the fourth launch and successful landing of a Falcon 9 booster.

The booster, which is designed to be reused up to 10 times, was caught on Monday by SpaceX's drone ship, Of Course I Still Love You, in the Atlantic Ocean. It touched down in the middle of the landing pad without missing a beat. SpaceX planned to catch the nose cone with drone ships as well, but due to rough sea conditions the company decided to retrieve the nose cone with two drone ships after it splashed down into the ocean. Many aerospace companies are looking to reuse more parts from their rockets as it reduces costs, saving millions per reusable part. SpaceX is leading the pack with many of its bigger projects. Its newest line of rockets, Starship, features reusability as a main factor in the design. By: Hailey Rose McLaughlin

Huge black holes may have cannibalistic baby black holes orbiting around them
18 November: When the LIGO collaboration first detected the spacetime ripples of a gravitational wave it came from the merger of two black holes. To date, scientists have detected at least ten pairs of black holes spiralling into and combining with each other. However,there is still an outstanding mystery about these singularities: why are some of them so big? Some have been far larger than scientists think possible for a black hole created in the aftermath of a star's death. A group of researchers has proposed a new possibility. Black holes in the accretion disk surrounding a galaxy's central supermassive black hole may gather in similar orbits. This could lead black holes to go through multiple mergers, growing larger each time. The researchers created simulations to show that this was possible.


Simulation of an accretion disk surrounding a supermassive black hole. Scott C. Noble

On 29 July 2017, gravitational wave detectors spotted the heaviest black hole merger yet, dubbed GW170729. One of the black holes in the merger was likely more than 50 times the mass of the Sun. Black holes that are created when a dying star collapses should not be this big, so astronomers think something else was probably at play. Maybe that black hole was the result of a previous merger itself. One place where a black hole might swallow multiple other singularities is in an environment that's dense with stars. Globular star clusters, for example, pack lots of stars - and the black holes they sometimes form - into a relatively tight space. There, a black hole might meet and combine with other black holes multiple times.

The new research describes another kind of environment where black holes might merge more than once. Disks of material that swirl around supermassive black holes, may

shepherd smaller black holes within them into similar tracks. As in the star clusters, there black holes might eventually converge on multiple occasions. The researchers created simulations of these orbiting black holes and found that a series of mergers would create black holes that are 50 or more solar masses, like the more massive black hole in the merger GW170729.

The mergers from black holes orbiting a supermassive black hole would probably have rotation characteristics distinct from other merger scenarios. As gravitational wave detectors spot more black hole mergers, their data might be a way to tell whether these oddly large black holes are really created this way. So far, scientists have identified 10 confirmed mergers of black hole pairs. However, there have been many more gravitational wave detections that are black hole merger candidates, which scientists are working to confirm. "Whatever questions we're asking, we're going to have a much, much better handle on answering them within a very short time period," said Imre Bartos, an astronomer at the University of Florida, Gainesville." By: Erica K Carlson

A weird, orbital dance keeps these moons of Neptune safely on track 19 November: Bobbing up and down like a carousel horse might not sound like a stable way to orbit a planet, but it works for one little moon of Neptune. The planet's innermost known satellite, Naiad, has a tilted orbit and it moves up-and-down relative to its neighbouring moon, Thalassa. The strange arrangement keeps the two moons steadily on track, despite their close orbits, without getting thrown into Neptune or into space, according to a new study. The finding also helps reveal some of the history behind Neptune's moons.


The crescent of Neptune and Triton, captured by Voyager 2 on August 25, 1989, as the spacecraft was fleeing from the planet toward interstellar space. NASA-JPL

The arrangement of the two moons' orbits is an example of what scientists call an orbital resonance. Repeating patterns in their orbits apply a regular set of gravitational forces to the two moons. In this case, the repeating forces keep the moons in their orbits, but resonances can be disruptive as well. Astronomers have found many examples of orbital resonances in the solar system. Pluto and Neptune are in a resonance in which Pluto orbits the Sun twice for every three times that Neptune does. This resonance keeps the two objects' orbits stable. Within the asteroid belt, there are gaps without asteroids where resonance patterns from Jupiter's orbit disrupt the path of large groups of space rocks.

However, the newly discovered resonance of Naiad and Thalassa is not like anything scientists have seen in the solar system so far. Naiad and Thalassa are two small moons, each about 100 km or so in size, with orbits nestled close together. Thalassa circles Neptune in about 7.5 hours, while Naiad laps it from the inside, taking just 7 hours per orbit. Naiad's orbit is tilted by almost 5 degrees relative to Thalassa's orbit and Neptune's equator. This makes the little moon weave up and down in a wave motion that keeps it farther from Thalassa even as it passes by. Though it looks bizarre, the arrangement reinforces the moons' orbits and keeps them stable despite being so near each other.

The researchers are already investigating how this orbital arrangement came to be. Scientists think that a group of Neptune's moons - including these two - formed out of debris from a collision. Moons formed from the same disk of debris should have orbits that are in the same plane, not tilted. That implies that an orbital resonance with some other moon must have bumped Naiad into this titled orbit, said Marina Brozović, a physicist at NASA's Jet Propulsion Laboratory. "You can read the history, the dynamical history, by just carefully looking at their orbits," Brozović said. "And you can get to what they've been through in the past." By: Erica K Carlson

Astronomers look inside meteorites and find the sugars needed for life 22 November: Scientists keep finding important molecules for life in meteorites. Now, they can add another one to the list: ribose. It is a type of sugar that plays a vital role in the genetic code of life. A team of researchers led by Yoshihiro Furukawa of Tohoku University in Japan recently analysed meteorite samples and found ribose and other 'bioessential' sugars for the first time. The finding offers even more evidence that some of the chemistry necessary for life as we know it can happen naturally outside of Earth.

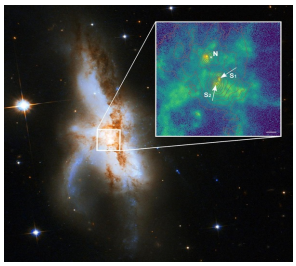
Scientists want to understand how life arose on Earth. To do that, they must first unravel how organic molecules form and interact in environments without living things. Geologic activity has erased records of much of the chemistry that happened pre-life on Earth. However, meteorites - pieces of primitive solar system rocks that have fallen to Earth - preserve chemical records of what the solar system was like in our planet's early days. "We rely on meteorites to tell this story," said Daniel Glavin, an astrobiologist at NASA's Goddard Space Flight Center "They're basically frozen time capsules."

Scientists studying meteorites have already found molecules like amino acids and nucleobases, which are necessary for life. However, they had never seen ribose. This sugar makes up the 'backbone' of RNA, a type of molecule responsible for carrying genetic messages in our cells. Furukawa's team employed careful techniques to ensure they wouldn't destroy the sugars in their attempts to find them, and were able to uncover ribose and other sugars.

Scientists found some of the same sugars needed to make RNA in this Murchison meteorite.Yoshihiro Furukawa

Simply finding these molecules needed for life does not necessarily mean that space rocks were responsible for bringing them to Earth. It at least shows that there are natural, geologic ways for these organic molecules to form in lifeless environments like on asteroids and the early Earth. Figuring out how these molecules could have come together to form the more complex structures necessary for life - like DNA and RNA - is a lingering challenge. However, Glavin said finding these essential molecules in meteorites makes him think that finding life outside of Earth might be just a little more likely. "Every time we find a new building block in a meteorite, it gives me new hope." By: Erica K Carlson

Three supermassive black holes found lurking in one galaxy 22 November: Catching two supermassive black holes sharing close quarters isn't that unusual. But spotting three jockeying for position is quite bizarre. In fact, astronomers rarely witness such a triplet. But now, according to a new study, astronomers have discovered a single galaxy that is home to three supermassive black holes: NGC 6240.



The strange galaxy NGC 6240 is an ultra-rare example of a galaxy harboring three supermassive black holes near its core. The white bar at bottom right of this image represents a distance of 1,000 light-years. P. Weilbacher (AIP), NASA, ESA, the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration, and A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University)

An international team of astronomers identified three supermassive black holes lurking near the centre of galaxy NGC 6240, which has been visibly disturbed by the gravitational effects of a triple merger. NGC 6240 is relatively close - only about 300 million light-years away - and astronomers previously assumed its odd shape was the result of a run-of-the-mill merger between two galaxies. These two galaxies, they thought, slammed together while moving at hundreds of miles per second, and they are still in the process of melding together. Therefore, the researchers expected to find two supermassive black holes hiding near the centre of the cosmic collision.

Instead, when they peered into NGC 6240's core using 3D-mapping techniques, the team unexpectedly found three supermassive black holes, each weighing more than 90 million Suns. (For comparison, the supermassive black hole at the centre of the Milky Way Sagittarius A* weighs about 4 million solar masses). Furthermore, NGC 6240's three behemoth black holes are all crammed into a region less than 3,000 light-years across, which is less than one percent the size of the galaxy in which they reside. "Up until now, such a concentration of three supermassive black holes had never been discovered in the universe," said Peter Weilbacher of the Leibniz Institute for Astrophysics Potsdam. Although astronomers have previously found three separate galaxies and their associated black holes on a collision course before, this is the first time they have witnessed a trifecta of supermassive black holes crammed into such a small space.

The finding is not only a strange, exciting, and unprecedented discovery, but it also shows how multiple galaxies can come together simultaneously to build the universe's biggest galaxies. That is a process that has mystified astronomers, who see galaxies today that are too huge to have been built up by slower, two-galaxy mergers, even despite the universe's almost 14-billion-year age. "If, however, simultaneous merging processes of several galaxies took place, then the largest galaxies with their central supermassive black holes were able to evolve much faster," Weilbacher said. "Our observations provide the first indication of this scenario." By: Alison Klesman

Earth might have recently destroyed one of its own minimoons 26 November: The Moon is probably not Earth's only natural satellite right now. Our planet's gravity

regularly captures small space rocks and pulls them into orbit. Astronomers estimate that there's probably a 1-yard-wide 'minimoon' orbiting Earth at any given time. Now, a team of researchers in Australia think they actually spotted one burning up in Earth's atmosphere in 2016 as a particularly bright meteor, or fireball. It' i only the second fireball that scientists suspect came from a minimoon.


Meteors are both common and beautiful. But bright fireballs, like the one illustrated here, are much more rare. Vadim Sadovski/Shutterstock, with elements from NASA

Astronomers have not had much more luck finding minimoons in orbit, either. So far, scientists have just spotted one while it was still circling Earth. Starting in 2006, a tiny asteroid called 2006 RH120 stuck around for about 11 months before leaving the Earth-moon system. However, researchers expect they will find more of these temporary moons in the coming years. The upcoming Large Synoptic Survey Telescope (LSST) will create regular maps of the night sky, turning up faint and transient events in its surveys.

Though rare, minimoons are so appealing to researchers because they are the closest space rocks to Earth. "Minimoons are really awesome because they are the most accessible object to get to from Earth in the solar system," Shober said. This means it will take less energy or fuel to reach these objects than it would for other space rocks —- whether for sample return missions, tests of asteroid redirection technologies or resource mining.

Australia's Desert Fireball Network is a group of automated cameras that constantly watches the skies for fireballs and captures their flight paths on camera. Researchers use this information to calculate the objects' trajectories and see where a meteorite might have hit the ground. They can also use the data to estimate the fireball's path before entering Earth's atmosphere, as researchers did. However.it's still far from easy to find minimoon fireballs. "It is an extremely rare event that only the largest fireball networks in the world would have a chance of observing," said Patrick Shober, a planetary scientist at Curtin University in Australia. Of the fireballs their network has observed, this is the only one suspected to have come from an object that was in orbit. I's also only the second probable minimoon fireball ever spotted. The first was detected by a similar fireball-monitoring network in Europe in January 2014. By: Erica K Carlson

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

DID YOU KNOW?

Astronomical catalogues Part 14: Palomar Observatory Sky Survey – a leap forward for observational astronomy

In the 1940s, the National Geographic Society funded a major new survey of the night sky. The first of almost 2,000 14 inch square photographic plates were exposed at the Palomar Observatory in California in 1948. The *Palomar Observatory Sky Survey* (POSS) took ten years to complete. Each region of sky was filmed twice, once with red sensitive

plates, the second with blue sensitive plates, allowing colour recording of objects. The survey included objects down to 22nd magnitude (about a million times fainter than the limit of human vision). The collection of 1,872 photographic negatives was published soon afterwards as the *NGS-POSS* catalogue. Another 100 red-sensitive plates were added in the 1965 *Whiteoak Extension.*

Innumerable astronomical objects were discovered by astronomers studying the original POSS photographs and several astronomical catalogues are derivatives of the POSS catalogue. Four examples are outlined below.

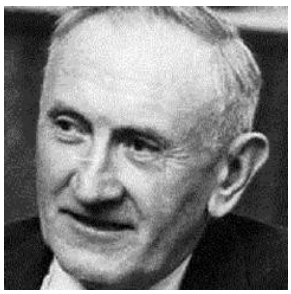
Sharpless Catalogue

While the POSS survey was still underway, American astronomer Stewart Sharpless (1926 – 2013) used the existing plates to compile a catalogue of Hll regions in the milky Way. These regions are emission nebulae, luminous clouds of gas and dust. The 1953 list included 142 regions. The final updated list of 313 regions was published in 1959. It also includes some planetary nebulae and supernova remnants in addition to Hll regions. The so-called 'Sharpless objects' are listed with the prefix Sh.

Abell Catalogue

The American astronomer George Abell (1927 – 1983) studied the POSS photographs to identify galaxy clusters. In 1958, he published the *Abell Catalogue* of 2,712 rich clusters of galaxies. For a cluster to be included, it had to meet certain criteria. These included containing over 50 galaxies and having a dense concentration. Clusters were classified as regular ® or irregular (I) in appearance, ranked in increasing richness from 1-5 and increasing distance from 1-6. So-called 'Abel clusters' refer to galaxy clusters listed in the catalogue.

Zwicky Catalogue



Fritz Zwicky (1898 – 1974) was Swiss-born, but emigrated to the US in 1958. He made many important contributions to theoretical and observational astronomy, particularly regarding the characteristics of supernovae and galaxies. He played a central role in construction of the Palomar Observatory, which began in the 1930s.

During his long career, detailed study of POSS photographic plates resulted in him observing 120 supernovae. He also undertook a long term study of galaxies and galaxy clusters, listing his findings in the *Catalogue of galaxies and clusters of galaxies* (CGCG). Published between 1961 and 1968, its 6 volumes contain 19,418 galaxies and 9,134 galaxy clusters. Inclusion criteria were similar to those set earlier for the *Abell Catalogue.* Items are listed as Zwicky plus their catalogue number eg Zwicky 32. In the catalogue, Zwicky introduced the system of classifying galaxy clusters as compact, medium compact and open which still in use.

Palomar list of globular clusters

In addition to individual named catalogues, a list of globular clusters was also compiled from the POSS photographic plates during the 1950s. The 15 so-called 'Palomar clusters' are some of the faintest of the 158 known globular clusters in the Milky Way. They were discovered by some of the most famous astronomers in America, at that time, including Edwin Hubble, Walter Baade, Fritz Zwicky and George Abell. The list was compiled by

Abell. Initially containing 13 objects, the final two were added later. Identification of these very faint deep sky objects is testament to the great sensitivity of the survey. All but two had never been seen before. They are identified by the prefix Pal.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.astronomy-mall.com, www.deep-sky.co.uk, www.en.wikipedia.org, www.skyandtelescope.com

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