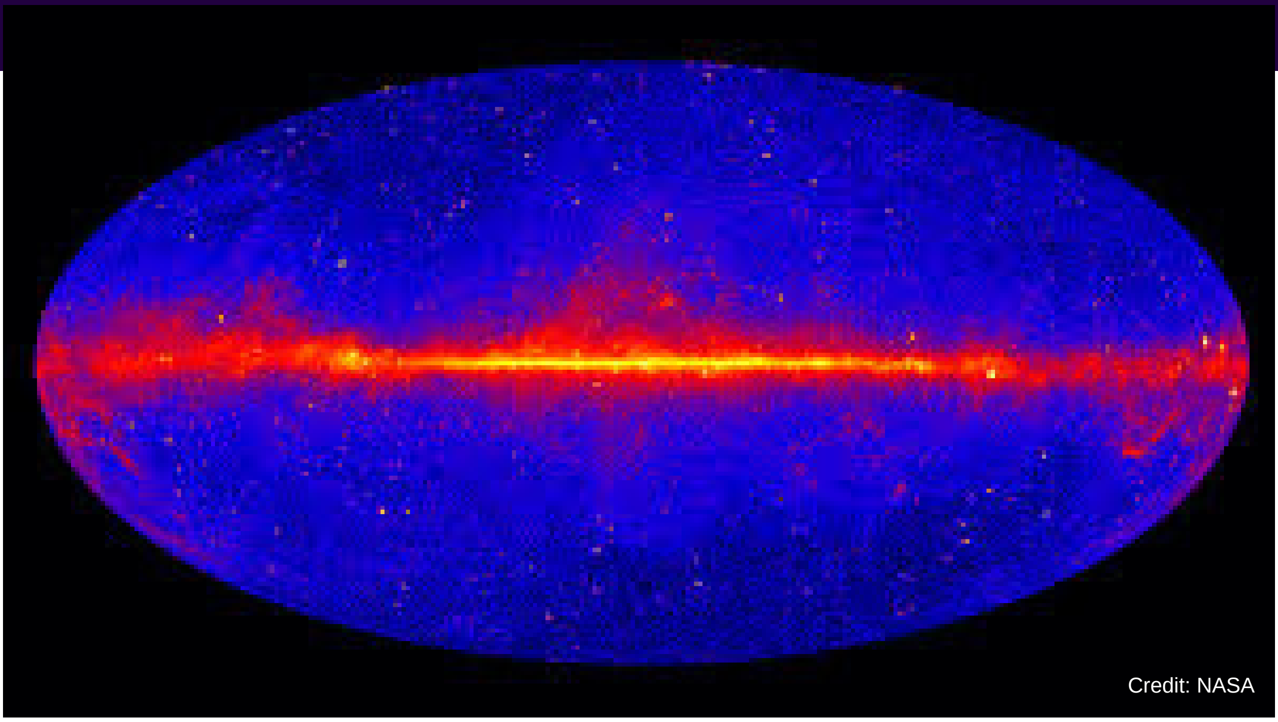
SEPTEMBER 2019 | VOL5

CENTRE FOR ASTRO-PARTICLE PHYSICS


Credit: NASA

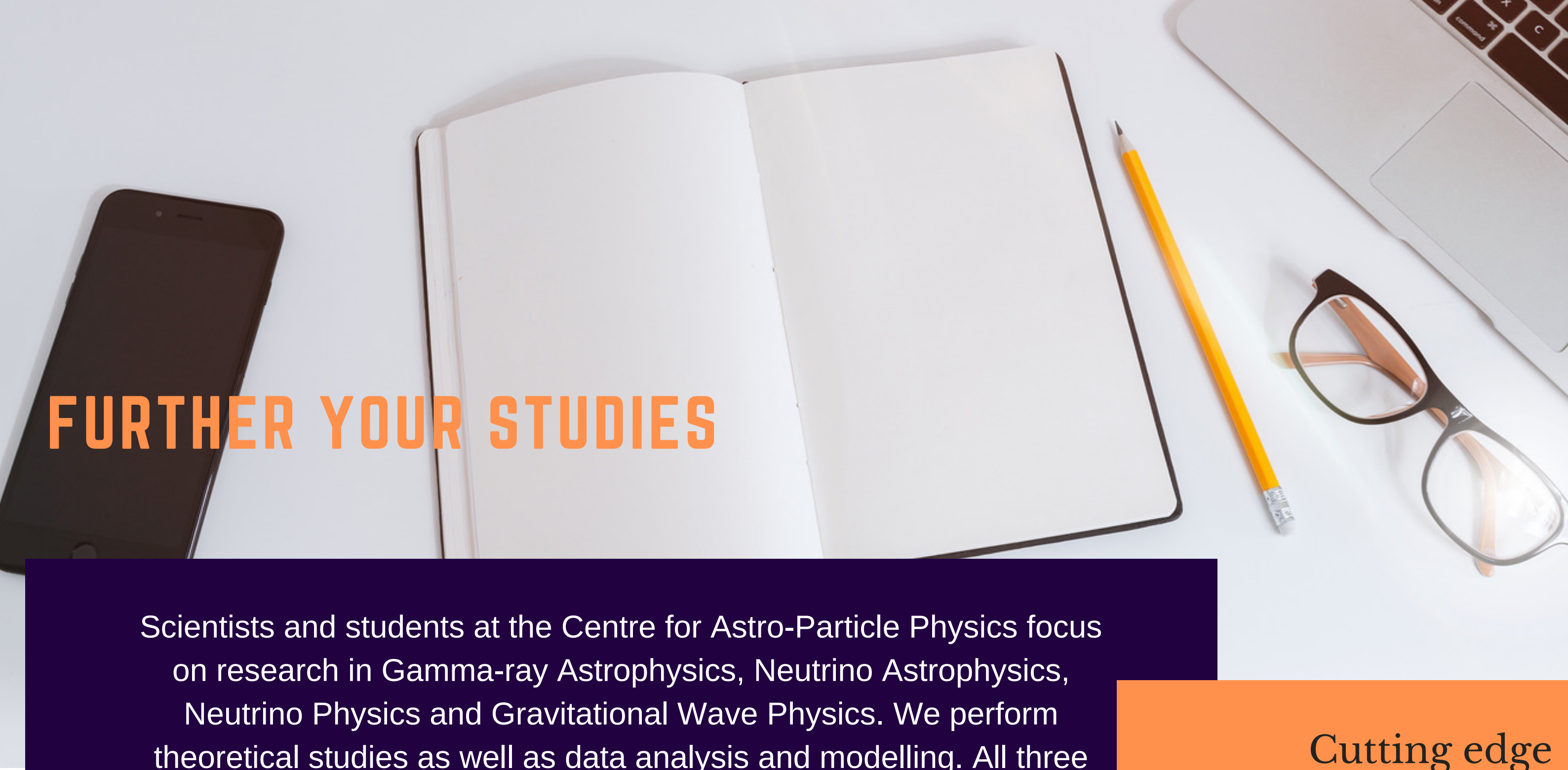
NEWSLETTER OF THE CENTRE FOR ASTRO-PARTICLE PHYSICS

UNIVERSITY OF JOHANNESBURG

FIFTH EDITION

DATE: 12-09-2019

Designed by Jessica-Sheay Verrall



FURTHER YOUR STUDIES

Scientists and students at the Centre for Astro-Particle Physics focus on research in Gamma-ray Astrophysics, Neutrino Astrophysics, Neutrino Physics and Gravitational Wave Physics. We perform theoretical studies as well as data analysis and modelling. All three experimental facilities that we are involved in, namely the Fermi Gamma-ray Space Telescope; the Cherenkov Telescope Array and the KM3NeT Neutrino Telescope, perform cutting edge research. Thus, working at CAPP can provide students and postdoctoral fellows opportunities to get involved in the science of these state of the art experiments, learn the latest techniques and interpret data collected with various instruments..

Cutting edge research by CAPP group members.

Research in Astro-Particle Physics requires strong background in Physics, Mathematics and computer programming. Although some theoretical studies are still done on papers with pencils, numerical computations and simulations on computers are the main tools to make theoretical predictions these days. Data analysis and modeling also require significant computer skills and learning specialised software.

Students who would like to pursue postgraduate studies in Astro-Particle Physics should choose Physics and Mathematics for their BSc degree. The BSc Honours programme at the Department of Physics offer a wide range of advanced courses, including Astrophysics courses, that can prepare students for future MSc and PhD research in Astro-Particle Physics. Honours students also get a taste of research by doing a project that helps them to prepare for MSc and PhD studies.

A limited number of top-up bursaries are available for Honours, MSc and PhD students from the CAPP. Interested students should contact Ms Jessica-Sheay Verrall (capp@uj.ac.za) with their academic transcripts.

FOLLOW US

We now have a Facebook and Instagram page. Please help us grow by following us and sharing the news.

WEBSITE

You can view our website to see events, the latest news, images, and info regarding the research of our group members as they happen and when they happen.
www.uj.ac.za/capp

INSTAGRAM

You can follow us on Instagram @ ujcapp.

FACEBOOK

Centre for Astro-Particle Physics

EMAIL

You can also contact us at capp@uj.ac.za

LINKEDIN

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FOR MORE INFORMATION

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EVENTS PAGE

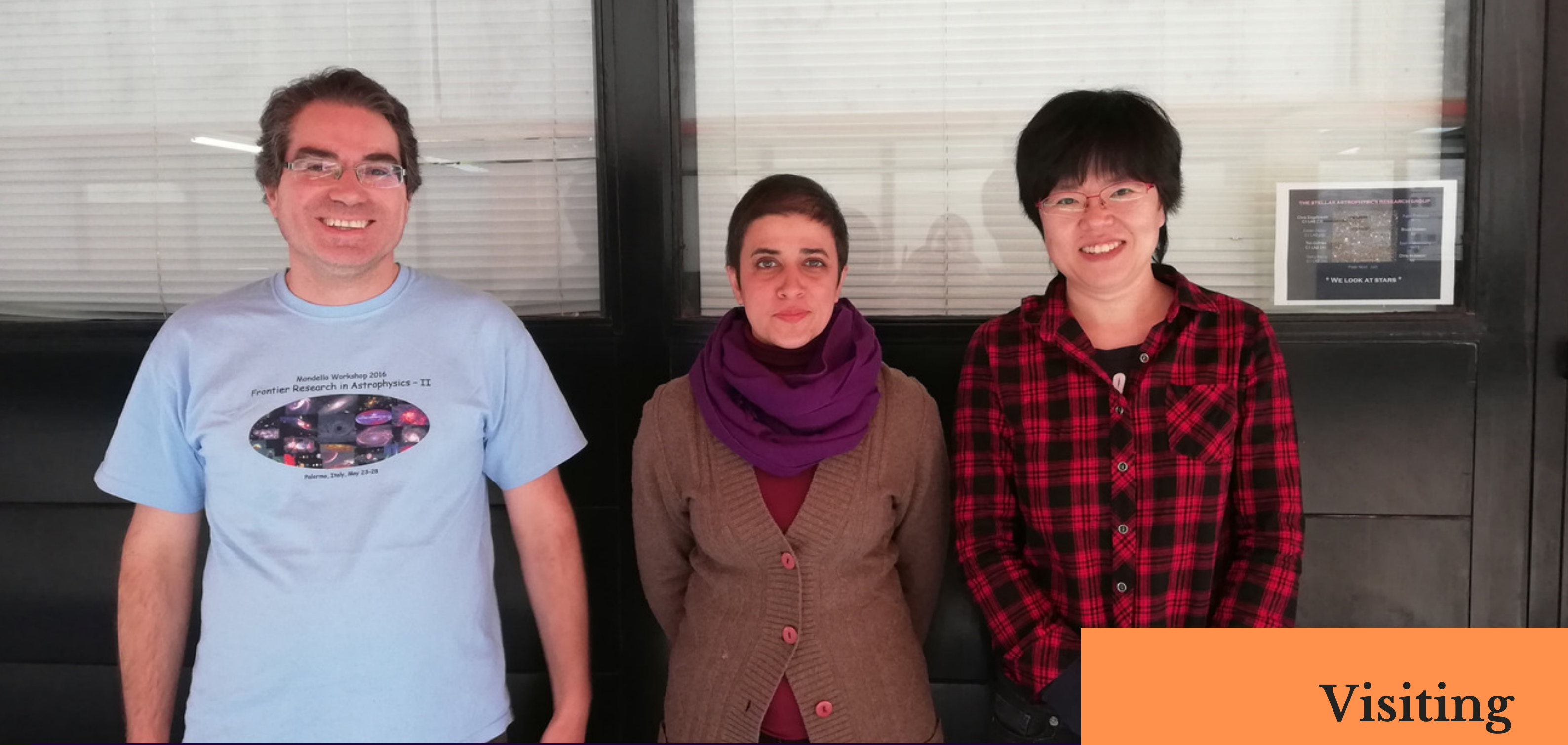
Outreach activities

UJ PHYSICS DEPARTMENT-OPEN DAY

On the 2nd of August 2019, our Master's student Lutendo Nyadzani gave a presentation to some of the third year physics students, about the Centre for Astro-Particle Physics. He also spoke about research done at CAPP and the Centre's collaborations. Pamphlets for the Centre were included in the students' goodie bags.

NATIONAL SCIENCE WEEK

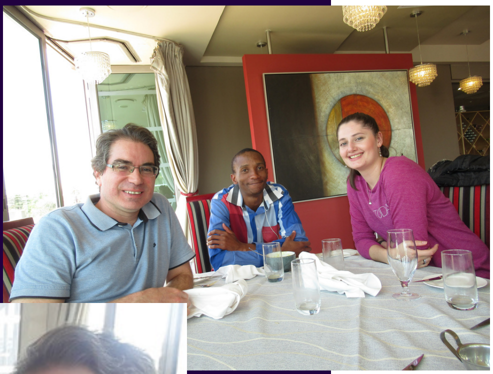
On the 3rd of August 2019, Ms. Jessica-Sheay Verrall gave a presentation at the Soweto Science Centre for National Science Week. Ms. Verrall spoke about the Centre, research done at the Centre, CAPPs collaborations as well as informed the students what marks they need to get into physics and the opportunities CAPP has to offer them. The presentation was given to 2x grade 10 groups and 2x grade 11 groups. Pamphlets for the Centre were also handed out to students.



Visiting researchers

GROUP LUNCH-2019

On the 14th of August 2019, CAPP went out for a group lunch in order to commemorate our visiting researchers. From left: **Dr. Richard Britto,** Prof. Saeeda Sajjad, and Prof. Lili Yang, . Their contribution to the Centre is greatly appreciated.



PROF. LILI YANG

Seminar by our Senior Visiting Research Associate

On the 16th of August 2019, CAPP's Senior Visiting Research Associate Prof. Lili Yang, from Sun Yat-Sen University, Zhuhai, China, gave a seminar in the Physics department.
Title: "Indirect Dark Matter Searches with the Cherenkov Telescope Array"
Abstract: The Cherenkov Telescope Array (CTA) is the next generation Imaging Air Cherenkov Telescope planned for the next decade and beyond.

It will probe the sky in the 20 GeV to 300 TeV energy range with excellent energy and angular resolutions and up to an order of magnitude improvement in sensitivity as compared to currently operating instruments, as VERITAS, H.E.S.S. and MAGIC. CTA will address a wide range of fundamental questions in and beyond astrophysics, with covering the major aspects of cosmic particle acceleration, exploring the extreme universe and probing frontiers in physics.

Especially for dark matter searches, it is expected to probe heavier dark matter with unprecedented sensitivity, reaching the thermal annihilation cross-section at TeV regime.

The talk will first introduce and report the recent status of the project, summarize the planned dark matter search strategies with CTA, focusing on the signal from the Galactic center, and update the current collaboration effort to study the impact of diffuse astrophysical backgrounds and systematic uncertainties on the searches.

Conferencing

HIGH ENERGY ASTROPHYSICS OF SOUTHERN AFRICA 2019 CONFERENCE

From the 27th- 30th of August 2019, some members from CAPP and others from the UJ Physics Department participated in the HEASA Conference in Namibia. Below are the speakers and the title of their talks given at the conference

Mfuphi Ntshatsha: Effects of the gamma-ray absorption in the broad line region and secondary cascade emission on blazar spectra.

Nomthendeleko Motha: Modelling of synchrotron emission from galaxies and extragalactic radio background.

Oscar Teixeira: Time-scale of Ergosphere Depletion Around a Kerr Black Hole Due to Energy and Angular Momentum Extraction by the Blandford-Znajek Process.

Prof. Harmut Winkler: New insights from early spectra of the bright Nova Vela 1999.

Lutendo Nyadzani: Coalescence rate of NS-WD systems.

Daymore Makope: The optical and x-ray properties of a sample of Seyfert galaxies that have undergone significant spectral change.

Bynish Paul: Analysis of Optical Fe II emission in connection with the X-ray properties of a selected sample of AGN of I Zw 1 type objects

Jessica-Sheay Verrall: Reaching out to our youth.

Prof. Soebur Razzaque: Light to intermediate mass nuclei model for ultrahigh-energy cosmic rays.

The latest news and discoveries

NEWS

Fermi shows images of the moon glowing brighter than our Sun

ScienceDaily. (2019). Moon glows brighter than sun in images from NASA's Fermi. [online] Available at: https://www.sciencedaily.com/releases/2019/08/190815120656.htm [Accessed 10 Sep. 2019].

A "glitch" in neutron stars could provide astronomers a brief insight into these mysterious objects.

ScienceDaily. (2019). Glitch in neutron star reveals its hidden secrets. [online] Available at: https://www.sciencedaily.com/releases/2019/08/190812130823.htm [Accessed 16 Aug. 2019].

Could a Black Hole at the Center of our Galaxy unravel Einstein's theory of General Relativity

ScienceDaily. (2019). Einstein's general relativity theory is questioned but still stands for now: Detailed analysis of the star's orbit near supermassive black hole gives a look into how gravity behaves. [online] Available at: https://www.sciencedaily.com/releases/2019/07/190725150408.htm [Accessed 16 Aug. 2019].

Fermi shows images of the moon glowing brighter than our Sun

Fermi's Larger Area Telescope (LAT) had detected a prominent glow centered on the Moon's position in the sky. In previous studies the Moon's gamma-ray glow has been analyzed as a way of better understanding another type of fast moving particles called cosmic rays. For clarity, cosmic rays are mostly protons accelerated by some of the most energetic phenomena in the universe, for example, the blast waves of exploding stars and jets produced when matter falls into black holes. These particles are electrically charged and are strongly affected by a magnetic field. The Moon, however, does not have a magnetic field and therefore, even low-energy cosmic rays can reach the surface.

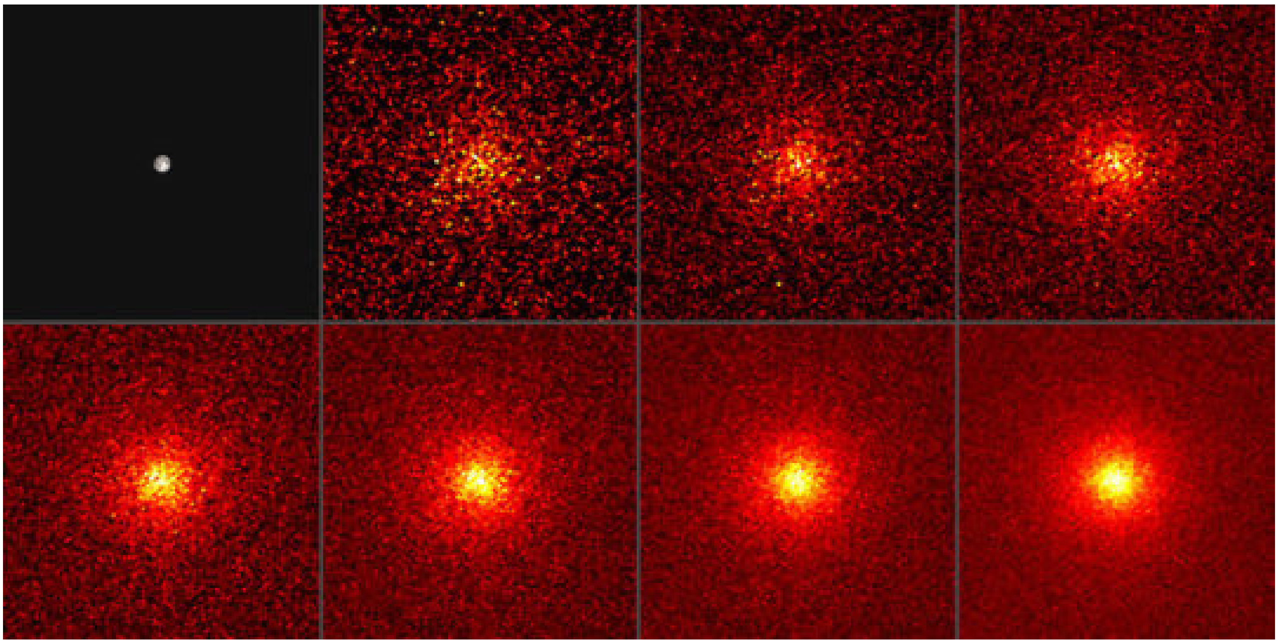
When these cosmic rays reach the surface of the Moon, they interact with the powdery surface of the Moon, called the regolith, to produce gamma-ray emission. The Moon does absorb most of these gamma rays, but some of them escape.
As seen in the images for this article, there is a steady improving view of the Moon's gamma-ray glow from NASA's Fermi Gamma-Ray Space Telescope.

Each 5-by-5-degree image is centered on the Moon and shows gamma rays with energies above 31 million electron volts, or tens of millions of times that of visible light. At these energies, the Moon appears brighter than the Sun. The brighter the colours, the greater the number of Gamma Rays. The view was improved over a time period of 10.7 years of imaging. Even though the Moon's gamma-ray glow is impressive, the Sun does technically shine brighter in gamma rays with energies higher than 1 billion volts. The cosmic rays with lower energies do not reach the Sun due to its powerful magnetic field screening them out, however, the much more energetic cosmic rays can penetrate this magnetic field and strike the Sun's denser atmosphere, producing gamma rays that can reach Fermi.

Even though the gamma-ray Moon doesn't show a monthly cycle of phases, its brightness does change over time. Data obtained from Fermi LAT show that the Moon's brightness varies by about 20% over the Sun's 11-year activity cycle. These variations in the intensity of the Sun's magnetic field during the cycle change shows the rate of cosmic rays reaching the Moon, altering the production of gamma rays.

This study is a reminder that astronauts on the Moon will require protection from the same cosmic rays that produce this high-energy gamma radiation, seen as NASA sets its sights on sending humans to the Moon by 2024 through the Artemis program, with the eventual goal of sending astronauts to Mars. Understanding these various aspects of the lunar environment as well as other environments can take on a whole new importance when it comes to space exploration.

UJ is a full member institute of the Fermi mission.



Credit: NASA/DOE/Fermi LAT Collaboration

A "glitch" in neutron stars could provide astronomers a brief insight into these mysterious objects.

It has been known that Neutron stars are the most dense objects in the Universe and they also rotate very fast and regularly, however, recently it has been studied that only 5% of neutron stars start to spin faster. The cause of this increase in spin is due to portions of the inside of the star moving outwards. This is known as a “glitch”.

A team from Monash University studied the Vela Pulsar, a neutron star in the southern sky, that is 1000 light years away. The Vela pulsar is famous because it glitches” once every three years. Reanalyzing data from observations of the Vela glitch in 2016 showed that during the glitch the star actually started spinning even faster, before it relaxed down to a final state.

This gave scientists a glimpse into the interior of the star, revealing that the inside of the star has three different components. The first and second being a soup of superfluid neutrons in the inner layer of the crust, which moves outwards first and hits the rigid outer crust of the star causing it to spin up. Third a soup of superfluid that moves in the core which catches up to the first, causing the spin of the star to slow back down.

This so called “overshoot” has been theorized a few times in literature, however, this is the first time it has been identified in observations. It is not known why this glitch occurs and it is the first time it has ever been seen, but it has given scientists insight into the study of these neutron stars.

Credit: © dani3315 / Adobe Stock

Could a Black Hole at the Center of our Galaxy unravel Einstein's theory of General Relativity

Einstein noticed that in certain situations, Newtonian laws of gravity didn’t seem to hold, hence Einstein Developed his own theory of gravity well known as general relativity. One of the fascinating predictions of this theory is the existence of black holes. Black holes are massive and dense objects in the universe. Black holes have such high density that nothing can escape their gravitational pull, not even light, and can’t be observed directly.

Even though black holes can’t be observed directly due to their strong gravitational pull, this strong gravitational pull allows astronomers to indirectly observe black holes by studying objects moving near them. A supermassive black hole, with a mass of about four million times that of the Sun resides at the center of our galaxy, the Milky Way.

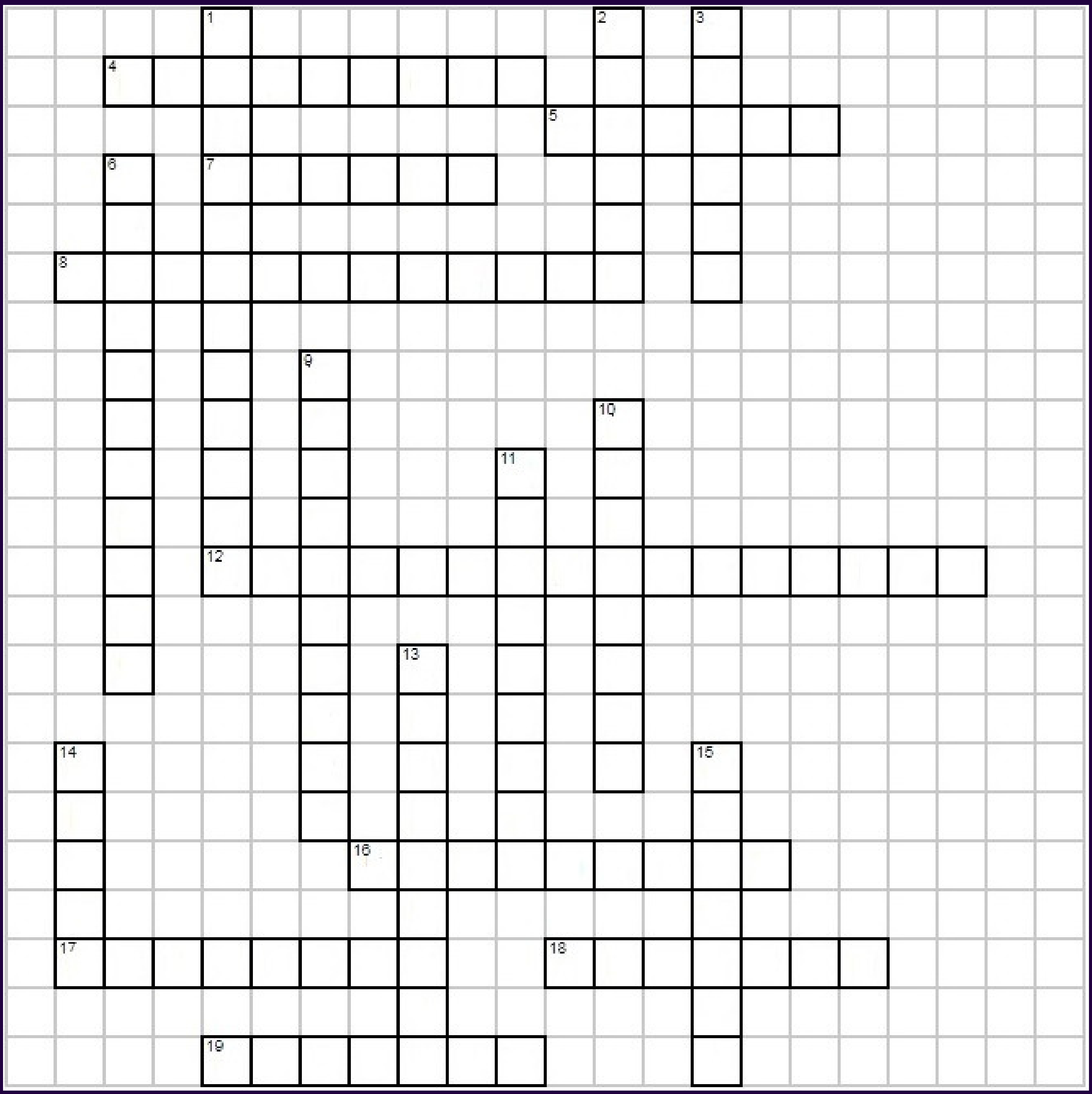
A team lead by Andrea Ghez, has studied the motion of stars around this supermassive black hole at the center of our galaxy. One of the stars they studied is a star named S0-2, this star takes 16 years to complete one full orbit around the central supermassive black hole. This star is moving at an incredible speed of about 26 million km/h.

Ghez and her team using data collected over a period of 24 years from the W.M. Keck Observatory in Hawaii were able to confirm that the motion of this star around the supermassive at the Milky Way central black hole is well described by Einstein's theory of general relativity.

Despite SO-2's motion being consistent with Einstein’s relativity, deeper probing questions about black holes seem to allude that a more general theory of gravity than Einstein’s is required. One flaw of Einstein’s theory of general relativity is that, even though it predicts the existence of black holes, it cannot give a complete description of what a black hole is. “Einstein’s is right, at least for now,” said Ghez.

ASTROPHYSICS CROSSWORD PUZZLE

Have a go at our new astrophysics themed crossword puzzle. Answers will be given on the last page our of newsletter.



Across:

4. A region of spacetime exhibiting gravitational acceleration so strong that nothing—not matter nor light—can escape from it (5, 4)
5. What is a gravitationally bound system of stars, stellar remnants, interstellar gas, dust, and dark matter? (6)
7. A giant cloud of dust and gas in space thrown out by the explosion of a dying star (6)
8. A cluster of galaxies which themselves occur as clusters is called a ....? (5, 7)
12. The phenomenon of the interaction of electric fields and magnetic fields (16)
16. A very young star that is still gathering mass from its parent molecular cloud (9)
17. What is a fermion that interacts only via the weak subatomic force and gravity? (8)
18. Fifth planet from the Sun (7)
19. The cosmological model used to explain the beginning of the universe (3, 4)

Down:

1. A continuous and distinctive band of stars that appears on plots of stellar color versus brightness (4, 8)
2. An active galactic nucleus (AGN) with a relativistic jet directed very nearly towards Earth (6)
3. An extremely luminous active galactic nucleus (AGN), in which a supermassive black hole is surrounded by a gaseous accretion disk (6)
6. A celestial object of very small radius and very high density, composed predominantly of closely packed neutrons (7, 4)
9. A stellar core remnant composed mostly of electron-degenerate matter (5, 5)
10. Astronomers estimate the distance of nearby objects in space by using a method called ....? (8)
11. A planet outside the Solar System is called a ....? (9)
13. The brilliant explosion of a dying supergiant star (9)
14. A prominent constellation located on the celestial equator and visible throughout the world (5)
15. A force of attraction between any two objects in the universe (7)

Some images from HEASA Conference in Namibia










Crosswordhobbyist.com. (2019). Crossword Puzzle Maker | Make Your Own Crossword Puzzle. [online] Available at: https://crosswordhobbyist.com/create_crossword/659887 [Accessed 16 Aug. 2019].

Solutions for crossword puzzle

Across:

4. BLACKHOLE
5. GALAXY
7. NEBULA
8. SUPERCLUSTER
12. ELECTROMAGNETISM
16. PROTOSTAR
17. NEUTRINO
18. JUPITER
19. BIGBANG

Down:

1. MAINSEQUENCE
2. BLAZAR
3. QUASAR
6. NEUTRONSTAR
9. WHITEDWARF
10. PARALLAX
11. EXOPLANET
13. SUPERNOVA
14. ORION
15. GRAVITY