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CENTRE FOR ASTRO-PARTICLE PHYSICS

NEWSLETTER OF THE CENTRE FOR ASTRO-PARTICLE PHYSICS

UNIVERSITY OF JOHANNESBURG

SEVENTH EDITION

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Designed by Jessica-Sheay Verrall

FURTHER YOUR STUDIES

Cutting edge research by CAPP group members.

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..

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

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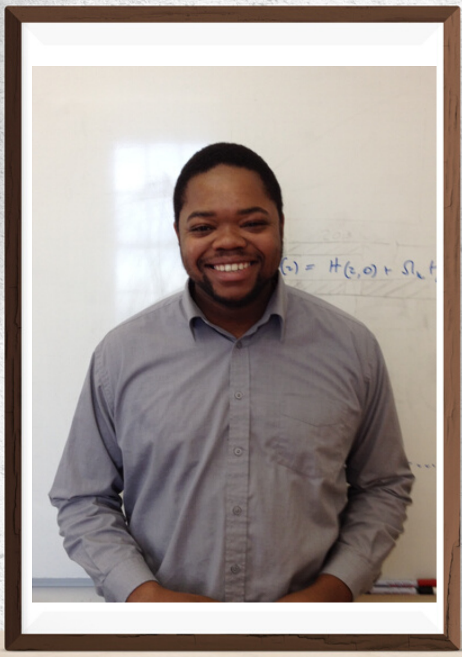


EVENTS PAGE

Physics Seminar presentations

- On the 6th of March we had Prof. Manfred Lindner (from the Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany) gave a seminar on his work, in the Physics department.

  Title: Hunting Dark Matter

  Indications for the existence of dark matter were briefly discussed and potential solutions were compared with the evidence. The different routes for the experimental detection were discussed and their strengths and weaknesses were outlined. Direct detection was covered in more detail and the latest results were shown.

- On the 11th of March we had Dr. Gopolang Mohlabeng (from the Brookhaven National laboratory, USA) give a seminar on his field of work.

  Title: Laboratory searches for Ultra heavy dark matter

  Motivated by possible new striking signals of ultra-heavy dark matter in direct detection experiments, he spoke about two theoretical scenarios of realizing such signals of super heavy dark matter. Discussed firstly was a model in which dark matter near the Planck scale is coupled to light GeV-scale messengers. This model produces multi-scattering in direct detection experiments and complimentarily, the messenger particle may be searched for in low energy accelerator experiments. Then discussed was a novel mechanism to produce such ultra-heavy particles in the early universe, thus realizing the correct relic abundance while establishing their small number density at present times.

KM3NET CHALLENGE: DRAW ME A NEUTRINO

TIME IS ALMOST UP!!

KM3NeT (Cubic Kilometre Neutrino Telescope) is a new generation water based Cherenkov neutrino detector, which is located at the bottom of Mediterranean Sea. This telescope has been distributed over three locations in the Mediterranean: one part in France, Italy and Greece coasts respectively. https://www.km3net.org/

ARCA stands for Astroparticle Research with Cosmics in the Abyss, and it will be installed at the KM3NeT-It site, about 100 kilometre off-shore the small town of Portopalo di Capo Passero on Sicily, Italy. This part of the telescope detects neutrinos in the 100 to 10^8 GeV (Giga electronvolts) energy range.
Neutrino flavor could be of three types: electron, muon and tau ones.

The University of Johannesburg (UJ) is full member of the collaboration since february 2018. The UJ group led by Professor Soebur Razzaque.

KM3NeT is having a contest for young children. The challenge: drawing the most creative, expressive, and original representation of a neutrino!

The contest ;
The KM3NeT Collaboration is organizing its first international challenge: a drawing contest. The Collaboration will provide information about what a neutrino is, its intrinsic properties, and its production in our atmosphere or in the vastness of our Universe. This information will help the participants to get to know the neutrino, its role in astrophysics and particle physics, and the work of our Collaboration to detect it.

With this project, we aim at: creating awareness of particle physics and astronomy to a young community that may become interested in science in the future, engaging and informing the families and teachers, introducing research and science in schools using an original approach, creating/reinforcing the link between the participating universities and research agencies with the schools and the public, promoting the science carried out by KM3NeT around the World.

There are great National and International Prizes to be won.

In short:
Who?
Everyone! There are different groups of participants:
- Group 'muon neutrino': secondary school
- Group 'tau neutrino': adults

When?
The drawings should be submitted by end of March 2020 and the winners will be announced in April 2020.

How?
Any format and technique is allowed as long as the project can be submitted as a PDF, PNG,or JPEG file on the contest website. The drawings can also be sent by mail to the hosting labs.

Detailed rules can be found on: http://wos.ba.infn.it

Contact for the national contest:
Jessica-Sheay Verrall
capp@uj.ac.za

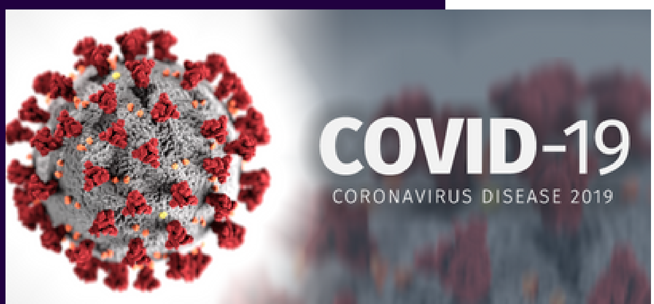
POSTPONED

COVID-19 OUTBREAK IN SOUTH AFRICA

Due to the COVID-19 (otherwise known as the Coronavirus) outbreak in South Africa we unfortunately have no choice but to postpone the Fermi Symposium.

The new dates have been set as 21-26 June. We are closely monitoring the COVID-19 development, however. Any further change will be communicated as soon as possible.

Postponement of the 9th International Fermi Symposium



The latest news and discoveries

NEWS

Detection of the biggest explosion in the history of the universe

ScienceDaily. 2020. Astronomers Detect Biggest Explosion In The History Of The Universe. [online] Available at: <https://www.sciencedaily.com/releases/2020/02/200227114459.htm> [Accessed 18 March 2020].

The mystery of matter

ScienceDaily. 2020. Why Is There Any Matter In The Universe At All? New Study Sheds Light: Scientists One Step Closer To Understanding The Mystery Of Matter In The Universe. [online] Available at: <https://www.sciencedaily.com/releases/2020/02/200228142022.htm> [Accessed 18 March 2020].

The dying breaths of Betelgeuse

ScienceDaily. 2020. Betelgeuse: A Massive Star's Dying Breaths: Physicists At UC Santa Barbara Model The Supernovae That Result From Pulsating Supergiants Like Betelgeuse. [online] Available at: <https://www.sciencedaily.com/releases/2020/02/200228142009.htm> [Accessed 18 March 2020].

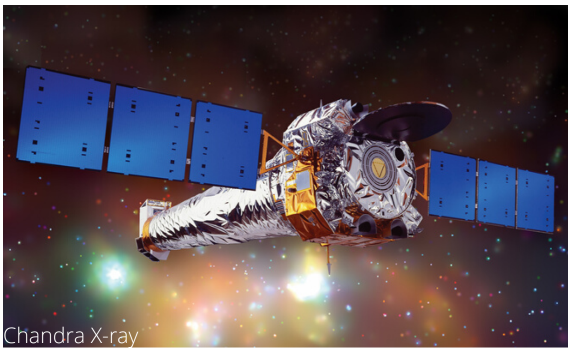
Detection of the biggest explosion in the history of the universe

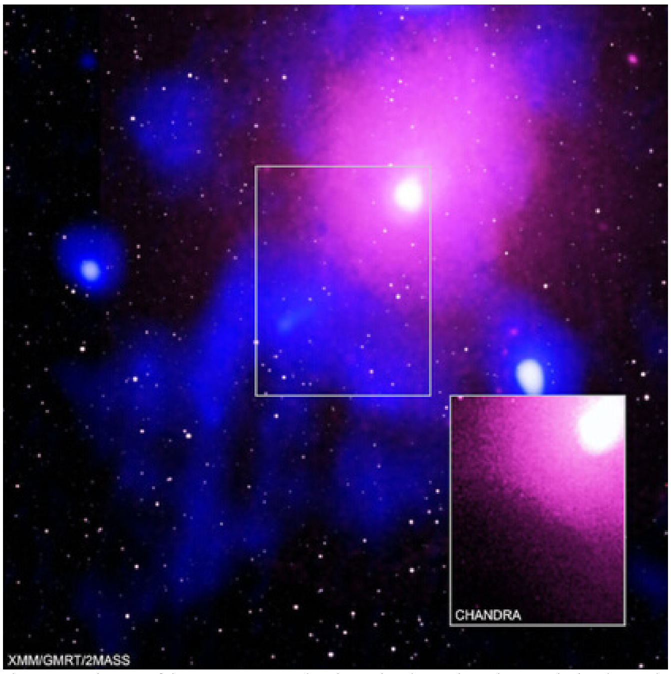
A blast came from a supermassive black hole at the centre of a galaxy called the Ophiuchus galaxy cluster, which is roughly 390 million light-years from Earth. It seems that the explosion took place very slowly over the period of hundreds of millions of years.

It was such a powerful explosion that it punched a cavity in the cluster plasma (the super-hot gas surrounding the black hole). It is estimated that 15 Milky Way galaxies could fit into the crater this eruption punched in the hot gas.

The explosion was only discovered when scientists looked at the galaxy cluster with radio telescopes. The radio data fit with the X-rays perfectly. There are four telescopes which were used during the discovery: NASA's Chandra X-ray Observatory, ESA's XMM-Newton, the Murchison Widefield Array (MWA) in Western Australia and the Giant Metrewave Radio Telescope (GMRT) in India.

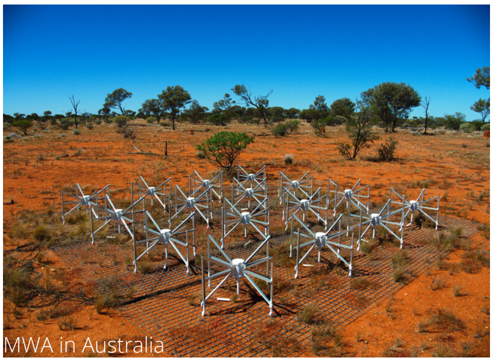
Some of these telescopes are still only in the first phase of detection, when there were only 2048 antennas pointed towards the sky. Soon there are going to be observations with 4096 antennas, which could be ten times more sensitive. This will allow for scientists to hopefully make many more exciting discoveries.

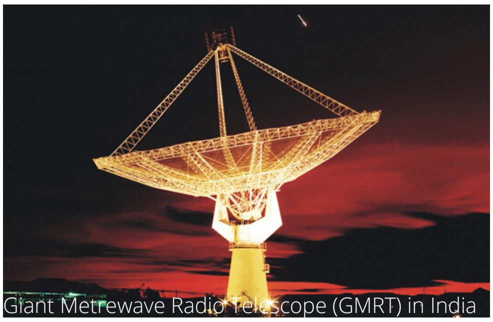

Chandra X-ray

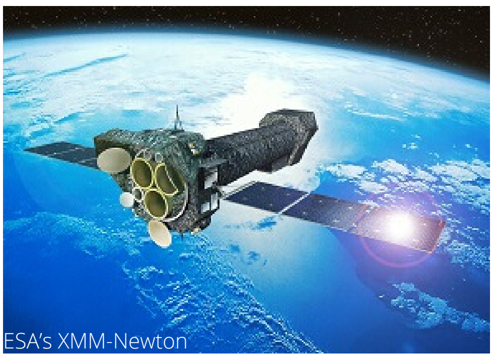


This extremely powerful eruption occurred in the Ophiuchus galaxy cluster, which is located about 390 million light-years from Earth. Galaxy clusters are the largest structures in the Universe held together by gravity, containing thousands of individual galaxies, dark matter, and hot gas.

The four telescopes


MWA in Australia


Giant Metrewave Radio Telescope (GMRT) in India


ESA's XMM-Newton

The mystery of matter

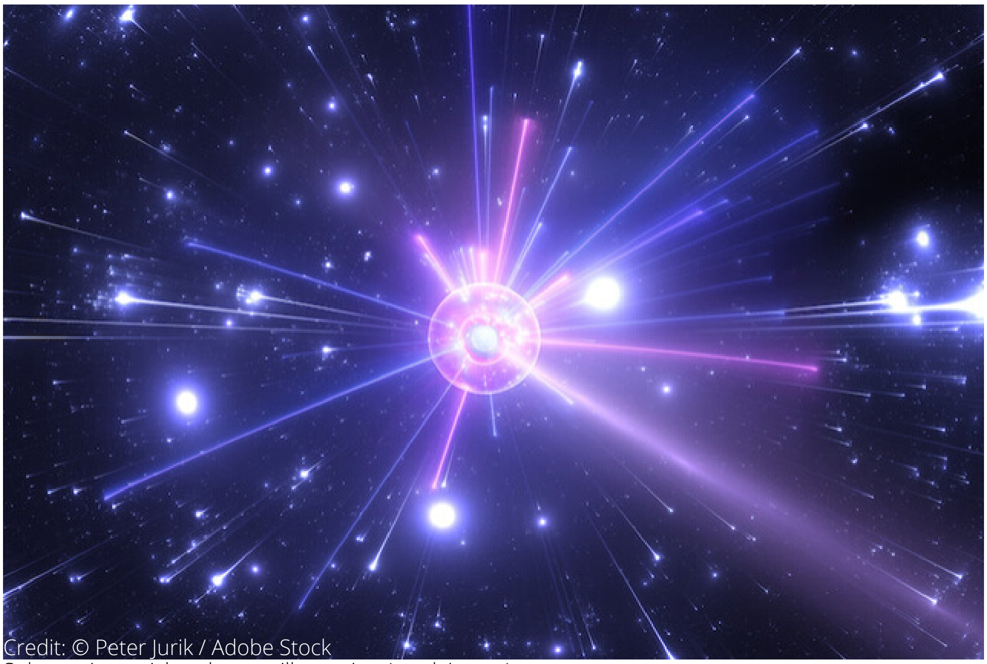
A team of scientists were looking into whether or not the neutron acts like an "electric compass". It is believed that neutrons are slightly asymmetrical in shape, where they will have a slightly positive side and a slightly negative side, such as that of an electric dipole moment (EDM). This is what the team were trying to figure out to be true or not.

This "electric compass" is thought to be an important piece of the puzzle in the mystery of why there is more matter than antimatter in the Universe. Measuring this "electric compass" may help scientists get closer to the truth about why matter remains. Upon experiments the team of physicists found that the neutron has a slightly smaller EDM than predicted in theory. This means that the current theories cannot be correct, so scientists either have to alter the theories or they have to find a new theory.

It has also been a question why there is so much more matter than antimatter in our Universe, apparently the answer lies in the structural symmetry that should appear in fundamental particles like neutrons. Moving forward we know that the EDM is smaller than theory predicted, this understanding helps scientists rule out theories about why there is matter left over- because the theories governing the two things are linked.

The researchers' latest results supported and enhanced those of their predecessors: a new international standard has been set. The instruments used have not been able to measure the EDM's because the EDM's were too small. New, more precise measurements are being constructed at PSI Collaboration (Paul Scherrer Institiut) and their next series of measurements will be measured by 2021.

These studies will retain its huge and ongoing impact in the field of particle physics.



Credit: © Peter Jurik / Adobe Stock
Subatomic particles abstract illustration (stock image)

The dying breaths of Betelgeuse

Betelgeuse, the red supergiant, is nearing the end of its life. Its brightness has recently dipped to the lowest point in the last 100 years. Betelgeuse may go supernova, and when a star over 10 times the mass of the Sun dies, it goes out in spectacular fashion, exploding in a dazzling display that could even be visible in daylight. Betelgeuse is found in the Orion constellation. Even though it might meet its end in the next million years, scientists believe that its dimming is due to the star pulsating. This phenomenon is relatively common among red giants. Researchers have already made predictions about the brightness of the supernova that would result when a pulsating star like Betelgeuse explodes.

How it works:
When a star the size of Betelgeuse runs out of material to fuse in its center, it loses the outward pressure that kept it from collapsing under its own immense weight. This resultant core collapse occurs in under half a second. As the iron core collapses the atoms disassociate into electrons and protons. These combine to form neutrons, and in the process release high-energy particles called neutrinos. The numbers and energies of the neutrinos produced in the core collapse are so immense that even though a tiny fraction collides with the stellar material, it's generally more than enough to launch a shock wave capable of exploding the star. This resulting explosion smacks into the star's outer layers with stupefying energy, creating a burst that can briefly outshine an entire galaxy.

The explosion will remain bright for about 100 days, since the radiation can escape once the ionized hydrogen recombines with lost electrons to become neutral again. This proceeds from the outside, inwards. The fact that Betelgeuse pulsates makes it very difficult for scientists to predict how it will explode.

If only we could live to see such a supernova!

Available at: <https://www.spaceexploration92.com/wp-content/uploads/2020/01/IMG_20190527_163844-1024x543.jpg> [Accessed 18 March 2020].
Illustration of what Betelgeuse is thought to look like when it reaches the end of its lifespan. It will result in a stunning display of light which may even be see during the daylight on Earth

ASTROPHYSICS THEMED WORD SEARCH

Have a go at our new astrophysics themed word search.

Astrophysics word search

W	T	M	I	R	S	G	N	A	B	G	I	B	T	A
Y	R	O	E	H	T	L	O	K	T	I	M	R	E	F
N	N	T	T	H	A	R	I	O	S	H	K	M	C	M
T	Z	B	H	G	R	A	T	V	R	M	J	H	W	A
S	F	S	N	O	I	T	A	L	U	C	L	A	C	S
I	Q	T	P	O	E	C	S	E	B	Z	M	Z	Z	T
T	K	Q	T	M	N	E	L	G	Y	U	U	K	Q	R
N	N	R	I	S	T	F	U	D	A	V	I	N	Q	O
E	K	Q	B	V	R	I	P	E	R	N	S	S	J	P
I	D	O	R	H	O	L	L	L	A	I	O	C	C	H
C	R	X	O	T	P	D	Q	W	M	L	P	I	Z	Y
S	R	R	O	R	Y	J	N	O	M	Y	M	E	Z	S
B	Z	S	Q	A	U	P	U	N	A	U	Y	N	H	I
G	K	Z	R	E	H	N	S	K	G	P	S	C	A	C
K	P	P	H	Y	S	I	C	S	X	P	E	E	L	S

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