

IMPEDANCE

THE OFFICIAL E- NEWSLETTER OF VIDYUT, THE PHYSICS SOCIETY

<https://www.scientificamerican.com/article/quantum-tunneling-is-not-instantaneous-physicists-show/>

Turning On a Light Beam with a Single Molecule

Read more at :

https://physics.aps.org/articles/v14/133?utm_campaign=weekly&utm_medium=email&utm_source=emailalert



Image showing that a single molecule can switch a beam of photons on or off, a potentially useful function for a quantum computer.

(SOURCE : Siarhei/stock.adobe.com)

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APPROACH

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RELATIVITY

DSKC SQUARE COVERING INSIGHTS
ON THE SUMMER RESEARCH
PROJECT

PHYSICISTS YOU SHOULD KNOW
ABOUT!

REMEMBERING PROFESSOR T.
PADMANABHAN



Credits: Getty

BLACK HOLES (THE GIANT MONSTERS) EXERT 'QUANTUM PRESSURE' ON THEIR SURROUNDINGS

By Neha Bhoria, BSc Physics Hons, 2nd year

A duo of researchers-University of Sussex's Professor Xavier Calmet and Ph.D. student Folkert Kuipers accidentally made a new discovery of static black holes exerting pressure on their surroundings thus behaving like a thermodynamic system with both thermal radiations and pressure. While trying to understand the quantum gravitational corrections to the entropy of a Schwarzschild black hole through equations (more precisely- how the entropy at the event horizon of a black hole increases over time i.e. becomes more disordered), Calmet and Kuipers were perplexed by an extra figure appearing in their equations, which they later realised that it was behaving as a pressure. Thus their discovery confirmed that quantum gravity could lead to pressure in static black holes.

The reason behind occurrence of a very small and negative pressure in their equations as per the calculations is unclear but is consistent with Hawking's prediction, although its relation with Hawking's radiation is yet to be determined.

Calmet and other physicists celebrating the discovery expressed that, though the result of their research is small but its presence opens up multiple new possibilities, extending the study of astrophysics, particle physics and quantum physics. They also hoped that when quantum field theory is incorporated into general relativity, a new description of black holes might evolve.

A BREAKTHROUGH FOR BLOOD FLOW MEASUREMENT!

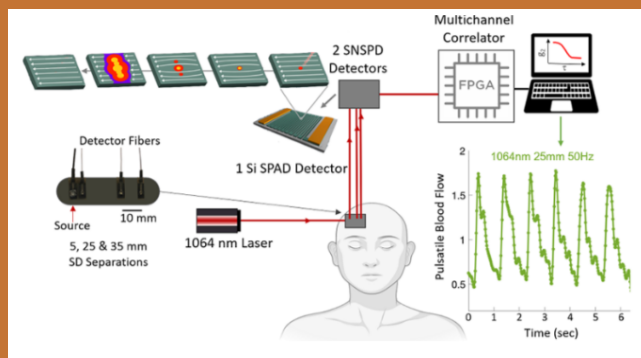


Image Credit: Ozana et al., doi 10.1117/1.NPh.8.3.035006

By Astha Asati, BSc Physics Hons, 2nd year

Recently, researchers from Massachusetts General Hospital, Harvard Medical School and MIT Lincoln labs has made a Superconducting nanowire single photon detector (SNSPD) device and it has outperformed the existing Single Photon Avalanche

Photodiodes (SPAD's) for the accurate measurement of Cerebral blood flow (which is very essential for appropriate functioning of brain). Both the Devices are based upon the diffusion correlation spectroscopy (DCS) but the low Signal to noise ratio of SPAD had posed a obstruction in accurately determining the celebral blood flow. As an alternate, SNSPD is put forward featuring a superconducting thin film which is highly sensitive to photon and adequate detection and also the high signal to noise ratio ,the chief concern for the system. The advantage of proposed system is that it not only tackled the shortcomings of conventional system but also leads to higher acquisition rates and robust estimation of Celebral blood flow.

CLOCKS - A THERMODYNAMIC APPROACH

By Aditi Sharma , BSc Physics Hons, 2nd year

Have you ever wondered about what a Clock is?..You might answer this- Clock measures time but for a physicist Clock is a thermal machine. Clock uses energy to tick same as engines use it to propel. Researchers discovered the relationship between the quantities with the time's arrow,

having incessant rise in the universe which could lead to autonomous quantum clocks for future quantum computers and nanorobots. You might think that how a clock is related to thermodynamics so your answer is- Clock's accuracy depends on the energy it dissipates and entropy it produces while ticking. Also Accuracy of Clock is fundamentally limited. How? - Let's consider a case of ideal clock- it will tick with perfect periodicity, dissipate an infinite amount of energy and produces infinite entropy-which is impossible.This new perspective on clocks has already provided a new way for discussions of time itself.



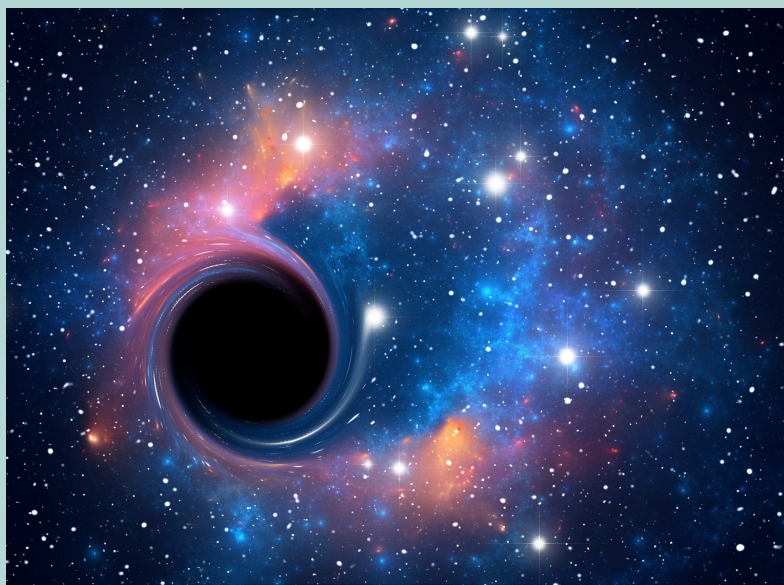
<https://images.app.goo.gl/PmURmyVsKbnPWfVx9>



STUDENTS' SQUARE

CAN HUMAN ENTER IN A BLACK HOLE AND SURVIVE THE EVENT HORIZON?

By Deepanshi Singh, BSc Physics Hons, 2nd year



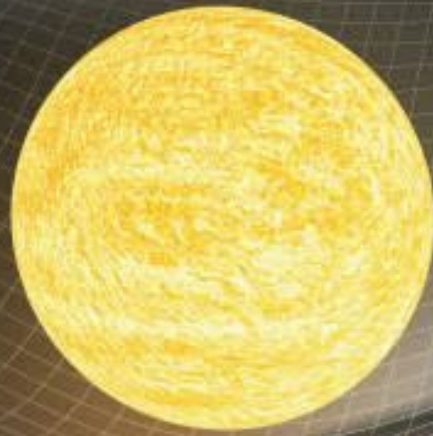
*Living in Close Proximity to a Supermassive Black Hole
Of course, there would be dangers—but it could also be entertaining!*

A human can do this only condition is that the respective black hole should be a supermassive black hole and isolated at the same time, but if a person entering the black hole does not expect to find it back in the entire universe.

Black holes are one of the enormous celestial objects in our universe. Black holes can be classified depending on their size and electrical charges, like electrons and protons in atoms. We have to understand these two types of black holes for our discussion. The first one having a mass roughly equal to the mass of the sun and is electrically neutral. The second one is supermassive black holes, which are millions to billions of times massive compared to our

sun. Moreover, we can also differentiate them based on their event horizon (a dead end) radius. If anything goes through this, be swallowed up by a black hole and disappear forever from our known universe. The force of attraction beyond this event horizon is so strong that no mechanical force can overcome it and not even the fastest and lightest thing in our universe.

The radial distance of the event horizon of any black hole depends on its masses and is the crucial point to the survival of the person who falls into it. A black hole with a mass about solar mass, have an event horizon of radius just below 2 miles. While the supermassive black holes like we have at the centre of our galaxy, the Milky Way, are nearly 4 million times more massive than the solar mass, it has an event horizon of radii approx. 7.3 million miles. So, if someone falls into a stellar black hole, instead of falling into a supermassive black hole, they will get too close to the centre of the black hole before passing the event horizon. This indicates that due to the proximity to the centre of the black hole, the force changes by the factor of 1,000 billion times. If a person free fall in it like its feet towards it, thus the gravitational tug on his feet will be exponentially more than the pull on his head. Then the person would experience spaghettification and most likely would not be able to survive being stretched into a long, thin noodles shape. Now, if a person jumping into a supermassive black hole would enter the event horizon much remote from the central source of gravitational pull, which means that the difference in the gravitational tug between head and toe is negligible. Thus, the person would easily survive through the event horizon without being stretched into a long, thin noodle and will painlessly float over the black hole's horizon. Most of the black holes that we discover till now in the universe are surrounded by very hot disks of matter, mainly consist of gases and dust and other objects such as stars and planets. These disks are known as accretion disks and are very hot and violent. They are certainly not friendly and would make the trip too dangerous. So, to get in safely, all you need to do is find a supermassive black hole that is lonely and is not surround by material like gas or stars. But remember that beyond this event horizon nothing escapes attraction. The fallen man would not be able to convey any information about his discoveries and lost for the rest of the time beyond the horizon. But they would enjoy exploration and adventure as long as they survived ... Maybe ...



Credit: vchal/Shutterstock

IN SERIES PART 1

TALKS ON RELATIVITY- PILOT

-By Mahak Poonia , BSc Physics Hons, 2nd Year

The theory of Relativity has arguably been one of the most researched, thought about and fascinating fields in all of science, since centuries. But for the general public, Relativity became a thing of importance only after Dr. Einstein took it forward, giving us seemingly unrealistic but (experimentally) true interpretations of space, time and, in a way, life itself. However, intense work had been done in this field for a long time by the likes of Galileo, Newton, Huygens, Ernst Mach and Lorentz. There are questions about inertial frames, non inertial frames, relativity, nature of time and space, of distance and measurement which have baffled the best of minds, giving us immense volumes of work which help us understand what they thought and relate it to what we now know. Some questions still remain. It's as if nature were playing with us, giving us hints and clues and baffling phenomena along the way, but never fully revealing her secrets. So what is so special about relativity? What does it tell us about our world and our existence? In this monthly series, we will explore, and learn and question, everything. Passages and definitions written ages ago will be explored, meanings will be prodded, and the minds of some of the most prominent experimentalists, theorists, philosophers and critics will be looked into. Are you ready?



DSKC SQUARE

-By Eswari Lekhya

BSc Physical Science with Computer Science, 3rd year

I have had the great opportunity to experience a flavor of research once again through the DS Kothari Summer Research internship conducted by our college in 2021. Earlier I had been a part of 2020 DSKC project on ZnO-GO nanoparticles.

This year under the DSKC 2021 session, I chose to go with my field of interest i.e. Blackholes and Relativity under the guidance of Dr Sunita Singh. After obtaining the basic tools and prerequisites needed for our projects, we had kick started our work on our chosen topic – “Inside the Horizon of a Blackhole.” The paper starts with recollecting the known laws and fundamentals and the importance to study Blackholes.

Then we had a quick review of Christoffel tensors, Riemann curvature tensors, Bianchi identity and Einstein's field equation, all as a part of generalizing the special theory of relativity. Some of the mathematical tools are further used to analyze and study the geometric properties of blackhole and interpret other behaviors.

We moved further to study “The Schwarzschild Metric”- a solution of Einsteins equation which describes spacetime under the influence of a massive, non-rotating, spherically symmetric object i.e Blackhole . Another way to understand the geometry of a spacetime is by studying light cones. Further we specified about Event Horizons (The boundary separating the Blackhole from the rest of the spacetime) and killing horizons.

Then we come talk of ,The Blackhole Singularity, which is a one dimensional point with infinite mass at the centre of the blackhole infinitely small space, where density and gravity become infinite and space-time curves infinitely, and where the laws of physics breakdown.

Moving ahead we studied the spacetime curvature just outside the horizon of a blackhole. And later also had learnt the behavior of matter, space and time that ends up being inside a blackhole.

Finally we had concluded our study by stating the possible behavior inside a blackhole that has been theoretically analyzed so far and are curious to know the real practicality.

PHYSICISTS YOU SHOULD KNOW ABOUT!



Remembering Professor T. Padmanabhan

(10 March, 1957- 17 September, 2021)

By Gauri Patti, BSc Physics Hons, 2nd year

A legacy in itself Professor T. Padmanabhan was a distinguished professor at IUCAA, Pune. He worked on the area of theoretical physics for which in a Stanford study of 2020 ranked him at the 24th position in the whole world. His very first research paper was published on general relativity while he was still an undergraduate (at the age of 20) at Kerala University. Apart from being a Padma Shri (2007), he had been a gold medalist in his BSc and MSc (Kerala University), Kerala Shashtra Puraskaram (2021), M.P Birla memorial award (2019), and the list goes on and on. He had over 300 publications in international journals of repute. The area of his research focused on mainly theoretical physics wherein gravity played a major role such as concepts of Gravitation, Quantum Gravity and structure formation in the Universe. Apart from these, he has contributed extensively through authoring over 100 popular science articles which are published in international and national journals and has also authored over 13 books. The most popular of these include "Story of Physics" which is a cosmic strip published from September 1984 to December 1986. This has also been translated into many regional languages of India. He also authored two series of 24 installment articles under the journal Resonance namely 'Snippets in Physics' (2008-09) and 'Dawn of Science' (2010-12). He had also been a visiting faculty at CalTech, Princeton University, Pennsylvania State University and Pauli Center for Theoretical Physics (Zurich).

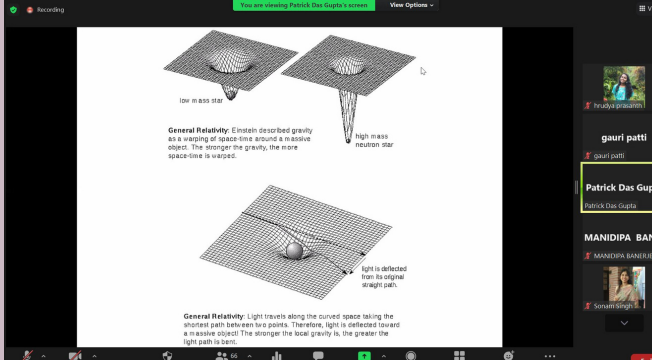
In Discussion and recommendation- Resonance (April 2008) Snippets in Physics- "4. Schwarzschild Metric at a Discounted Price"

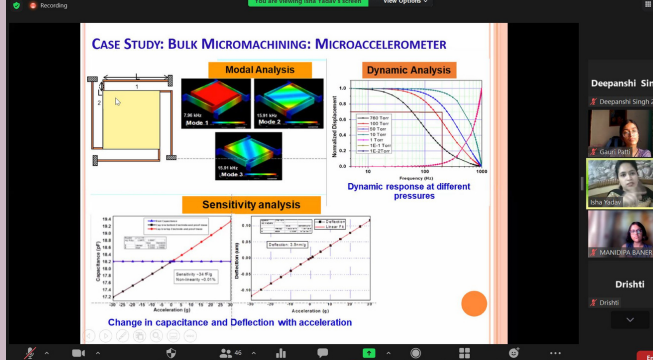
The article published in April 2008 volume features a beautiful yet intriguing derivation of the well known Schwarzschild metric using the principles of Special Theory of Relativity. The results which we can infer from the metric by using the principles of special relativity have also been discussed.

Link for the pedagogical article- <https://www.ias.ac.in/article/fulltext/reso/013/04/0312-0318>
es.

EVENTS HELD IN SEPTEMBER

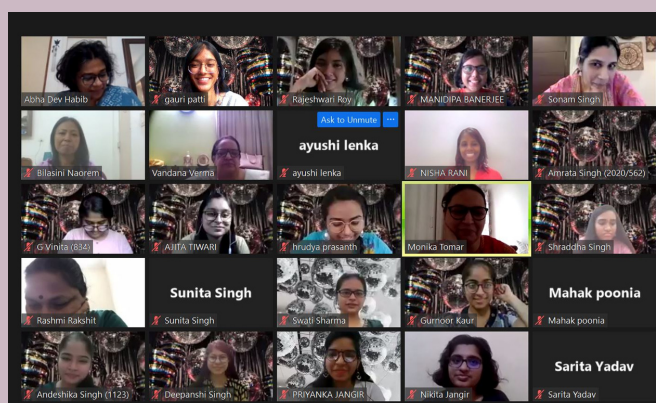

VIDYUT, THE PHYSICS SOCIETY
 MIRANDA HOUSE, UNIVERSITY OF DELHI
Presents
LIVE WEBINAR
On
**STEPPING STONES TO EINSTEIN'S
GENERAL RELATIVITY**
 by **DR. PATRICK DAS GUPTA**
 Professor,
 Department of Physics and Astrophysics,
 University of Delhi
6th September, 2021
11:30 am Onwards
 For more details Contact:
 Gauri: 8580443128
 Hrudya: 9188268473
 Register through the form provided below!
 @vidyut.mirandahouse | vidyut.physics@mirandahouse.ac.in


 The screenshot shows a presentation slide titled "General Relativity". It features three diagrams: a "low mass star" with a flat spacetime grid, a "high mass neutron star" with a curved grid, and a diagram showing light rays being deflected by a massive object. Text on the slide explains that Einstein described gravity as a warping of spacetime and that light travels along the shortest path between two points, which is curved in the presence of gravity.


 The screenshot shows a presentation slide titled "CASE STUDY: BULK MICROMACHINING: MICROACCELEROMETER". It includes four sub-sections: "Modal Analysis" with 3D stress plots, "Dynamic Analysis" with a graph of normalized displacement vs. frequency, "Sensitivity analysis" with a graph of capacitance vs. acceleration, and "Change in capacitance and Deflection with acceleration" with a graph of deflection vs. acceleration.


VIDYUT, THE PHYSICS SOCIETY
 MIRANDA HOUSE, UNIVERSITY OF DELHI
Presents
LIVE WEBINAR
On
MEMS DEVICES: DESIGNS & FABRICATION
 by **DR. ISHA YADAV**
 Scientist E,
 SOLID STATE PHYSICS LABORATORY, DRDO
25th September, 2021
3:00 Pm Onwards
 For more details Contact:
 Gauri: 8580443128
 Hrudya: 9188268473
 Register through the form provided below!
 @vidyut.mirandahouse | vidyut.physics@mirandahouse.ac.in

Teacher's Day Celebration
(September 5, 2021)



STEPPING STONES TO GENERAL RELATIVITY

BY PROFESSOR PATRICK DAS GUPTA

A report by Neha Bhorla, BSc Physics Hons, 2nd year

Dr. Patrick Das Gupta started the session with an imaginary comical scene:
“A 26 year old patent clerk (Sir Albert Einstein) entered hearing an old poem of Newtyard Galiling

O space is SPACE and time is TIME ,
Never the twain shall mix.

He quipped:

Oh yeah! Their mix is no longer a jinx,
For, I have a Minkowskian quick fix!”

Thereby, introducing the idea of Galilean coordinates and inertial frames of reference i.e. ‘ a frame in which the objects are either at rest or move with constant velocity in the absence of any real force acting on them’. He also described emergence of Minkowskian Space-time with the help of interesting graphics. To gain the attention of the audience, he began with Einstein’s Special Theory of Relativity describing how speed of light is an invariant quantity and that space and time merge together into a four dimensional world. He then highlighted on Lorentz transformations including length contraction, time dilation and the famous expression $E=mc^2$ given by Einstein. Using the famous painting “The Persistence of Memory” of Salvador Dali, he described how in relativity space and time are not rigid, they get deformed. With this he highlighted the fact that “Without TIME we cannot even THINK or IMAGINE about anything, be it our existence or the world we perceive or the notion of TIME itself. Thereafter, he laid emphasis on salient features of ‘General Theory of Relativity’ and its consequences, Gravitational Lensing, Bending of Light, Waves emerging from several binary compact objects. The participants found the webinar very informative and showed their active participation with a number of questions asked during the session which included concepts of electromagnetic radiations, different geometries, entangled state, etc. The feedback link was posted during the webinar in the chat box and collected from all the participants.

MEMS DEVICES: DESIGNS AND FABRICATION

BY DR. ISHA YADAV

A report by Susmitha, BSc Physics Hons, 2nd year

Dr. Isha Yadav started the session with the inquisitive question “What are MEMS?” and there by explaining about different types of MEMS sensors, and their various processes, criteria to be categorized as MEMS device like one of the components used should have a mechanical functionality and about the importance of miniaturization with different instances leading to multifunctionality of devices. She made the webinar more intriguing by introducing about the one of the lectures of RICHARD FEYMAN with a statement “There is a Plenty of Room at the Bottom...” also explaining silicon is more preferred than germanium because of various reasons like Germanium crystals being destroyed at high temperature, a native silicon oxide being formed on layer of silicon which acts as a good dielectric which in turn being an essential property of transistor, silicon having a same young modulus as steel, tensile strength, melting point of silicon being high, the ability to be integrated into electronics on same substrate being the significant property. And explained different Physical and chemical MEMS

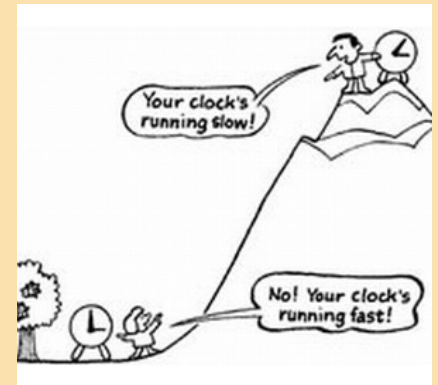
processes like Sputtering, Etching (and its types), Photolithography, Lift off... in very detail using a very simple language and examples that can be deciphered easily.

Subsequently, discussed about the MEMS Design and Scaling laws (since they need to be miniaturized) by illustrating an elementary examples like resistors and capacitors, MEMS structures like cantilever, torsion bars, diaphragm and the way design structures can be calculated in online simulator “Coventorware software” by electro mechanical simulation, significance of mesh and later proceeded to different techniques of Fabrications like Bulk Micro Machining, Surface Machining, LIGA different case studies of Fabrications.

The session was very interactive with active participation of audience with different queries related to process of MEMS, applications of MEMS in space, software used in simulation. The feedback link was posted during the webinar in the chat box and was filled by the participants.

Because of time dilation, clocks at higher altitudes run faster than those at lower altitude .

<http://www.leapsecond.com/great2016a/>



The Diamond Planet

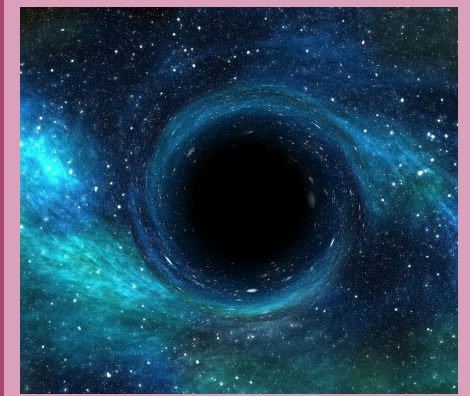


The exoplanet 55 Cancri E is called the 'Diamond Star' as it is covered with graphite and diamond .

<https://exoplanets.nasa.gov/exoplanet-catalog/7005/55-cancri-e/>

Vacuum is not an empty space . It's filled with clouds of virtual particles (matter with its antimatter) which exist and fade away instantaneously.

<https://www.insidescience.org/news/study-about-nothing>



Time is not just the fourth dimension , it's an illusion!

<https://www.nature.com/articles/d41586-018-04558-7>

IMAGES OF MONTH



<https://www.nasa.gov/jpl/nustar/BI509-pia17566>



'Lynds Dark Nebula 1251' image

<https://apod.nasa.gov/apod/ap210920.html>



'The Red Square Nebula' image

<https://apod.nasa.gov/apod/ap210926.html>



'Rubin's Galaxy' image

<https://apod.nasa.gov/apod/ap210918.html>



'Perseid Outburst at Westmeath Lookout' image

<https://apod.nasa.gov/apod/ap210924.html>

PHY-EMES

Me trying to pay attention in my
8:30 lecture*



ME STUDYING PHYSICS*
MY BRAIN*



Difference between freshers and
seniors



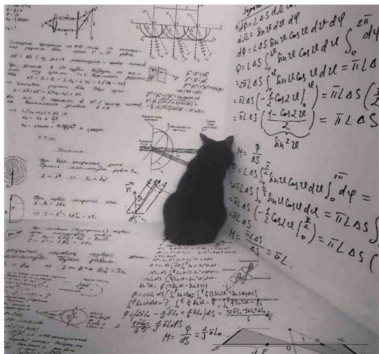
Exams



It's OBE



Meanwhile, inside the box,
Schrödinger's cat plans its
revenge.



Source: Twitter*

Fermions



Bosons



FOR MORE INFO:-

Black Holes (The Giant Monsters) Exert 'Quantum Pressure' On Their Surroundings

- Websites- Sciencealert.com, cosmosmagazine.com, sci-news.com
- The times of India article and The team's paper published in the journal Physical Review D.

Superconduction based nanowire single photon detectors

- <https://spie.org/news/superconducting-nanowire-single-photon-detectors-next-big-thing-in-blood-flow-measurement>
- <https://physicsworld.com/a/superconducting-nanowire-detectors-accurately-estimate-blood-flow-in-the-brain/>

Clocks - A Thermodynamic Approach

- <https://www.quantamagazine.org/the-new-science-of-clocks-prompts-questions-about-the-nature-of-time-20210831/>

STEPPING STONES TO GENERAL RELATIVITY BY PROFESSOR PATRICK DAS GUPTA

- <https://tinyurl.com/GRwebinarecording>

Can human enter in a Black Hole and survive the Event Horizon?

- [HTTPS://ASTRONOMY.COM/NEWS/2021/02/COULD-A-HUMAN-ENTER-A-BLACK-HOLE-TO-](https://astronomy.com/news/2021/02/could-a-human-enter-a-black-hole-to-)

Interesting Facts :

- <https://www.dailymail.co.uk/sciencetech/article-1314656/Scientists-prove-time-really-does-pass-quicker-higher-altitude.html>
- <https://www.space.com/37654-exoplanet-55-cancer-facts.html>
- https://en.wikipedia.org/wiki/Outer_space
- <https://www.npr.org/2013/05/17/184775924/re>
- <https://ysjournal.com/the-4th-dimension/setting-the-theory-of-time>

Remembering Professor T. Padmanabhan

- <https://www.iucaa.in/~paddy/>

MEMS devices: designs and fabrication by dr. isha yadav

- <https://tinyurl.com/MEMSwebinarecording>

DEPARTMENT OF PHYSICS | MIRANDA HOUSE



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CLICK HERE

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