FIZIKA

E-MAGAZINE OF
DEPARTMENT OF PHYSICS,
VICTORIA INSTITUTION(COLLEGE)

3rd VOLUME

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Editorial

Dear Readers,

The very first edition of the E-magazine of the Department of Physics, Victoria Institution (College), "FIZKA", was instigated in 2020-21. We are pleased to announce that we have been successfully brought the third volume of "FIZIKA" for 2022-2023 to our dear readers.

Slowly but surely our E-Magazine has been progressively improvising which shows the pure dedication of the student's of our department We have tried our best to present some eloquent, engrossing and compelling articles to our dear readers with utmost care and dedication. We hope that our articles would intrigue our readers.

Our E-Magazine is a compendium of different types of informations which are both interesting and quite knowledgeable. It comprises of different concepts like Space-time, Quantum Computing, Nuclear Fusion, Non-Newtonian Fluids, Nanotechnology, Superconductivity, Neutrino Detection, Physics in Animal Kingdom, Electro-magnetism and contribution of some of the great Indian Physicists whose Birth Centenary are being celebrated this year.

These articles written by our young writers will surely draw our readers' attention. We would like to thank all the authors for spending their valuable time in writing the articles with utmost care and dedication. We could not bring this magazine and put to light before the readers without our talented writers.

We would like to bow our heads to all our physics professors as we are highly indebted to them for their guidance and constant supervision as well as for providing necessary information regarding the articles. It is all because of their support and guidance that we are able to publish our third volume of "FIZIKA" successfully.

We would also like to express gratitude towards our respected Principal ma'am for having faith in us.

Lastly, we would like to extend our warm greetings to our readers and we wish all the readers a joyful reading experience.

Have a blissful reading!

Editors: Saptaki Chakraborty and Sumona Sarkar, VIth Sem,
Maitreyee Maiti and Prerana Saha, IVth Sem,
and Ankita Paul, IInd Sem

Our Team

Front Row: From left : Swastika, Eshita, Sayani, Chirantani
At the back: From left : Janusree, Nandini, Ahana, Solanki, Sumona and Saptaki

From left: Prerana, Maitreyee, Srijani, Dhriti, Sulagna and Madhusree

From left: Triparna, Akanksha and Ankita

Message from the Principal's Desk:

Dr. Maitreyi Ray Kanjilal,

Principal
Victoria Institution (College)

FIZIKA, the E-Magazine published by the students of Dept. of Physics emphasises the focus on the cross cutting issues in physics and its allied area. These initiatives are vibrant for the growth of young minds to motivate them towards research in both fundamental science and technology.
I would like to congratulate the team of FIZIKA and wish all the success towards its future journey. I strongly believe that this endeavor will be continued in the years to come.

Message from the Department of Physics

With great pleasure, we congratulate the Physics Honours students of Victoria Institution (College) for successfully publishing the 3rd volume of Annual E- Magazine "FIZIKA". The magazine consists of articles from varied fields ranging from classical electromagnetism to contemporary topics like quantum computing, nanomaterials, space-time, nuclear fusion, superconductivity etc. Articles on two eminent Physicists whose Birth Centenary is being celebrated this year have also been included.
All the articles are thought provoking and well written. It gives us a sense of pride as they reflect the creative potential and talents of our students. We wish to thank everyone associated with "FIZIKA" for continuously rendering their help and support throughout it's journey.

Smt. Swarnalekha Bandyopadhyay

HOD,
Dr. Gayatri Pal

Dr. Subhendu Chandra

Dr. Shinjinee Das Gupta

Ms. Kathakali Biswas

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Revisiting the Journey of Prof. Amal Kumar Raychaudhuri to the world of Physics on his Birth Centenary

Eshita Biswas, Sumona Sarkar, Swastika Mondal and Nandini Mukhopadhyay, Sem VI

The major problems with science in India, especially after the British era were- we lack in scientific temper or that scientific environment among most of us. We failed to appreciate our own scientists who contributed immensely to science. Whereas the whole world admired their contribution, most of them remain under the curtain in their own homeland. Prof. Amal Kumar Raychaudhuri (AKR) is such a name among them.

Early Days

Prof AKR was born in Barisal, now in Bangladesh on 14 September, 1923, to Surabaladevi and Suresh Chandra Raychaudhuri. His father was a school teacher in mathematics in Kolkata. He was just a child when his family migrated to Kolkata. He finished his early education in Tirthapati Institution and later completed matriculation from Hindu School, Kolkata

Why Did Prof. A.K.R. Choose Physics

Although Prof. AKR was a brilliant student of mathematics, he pursued his career in physics. He might have imbibed his love for mathematics from his father. In an interview Prof. AKR has described how he loved to solve problems from his school textbook well before the portion was taught in class. He said, 'It gave me great pleasure in solving mathematical problems, that was the insanity what it is….but I went over to physics rather than mathematics, the reason was very practical.' He said that his father told him, 'You see my fate that although I got a first class in mathematics I was not a success in practical life. So, think about studying some other subjects rather than mathematics.' and that is why he switched over physics.

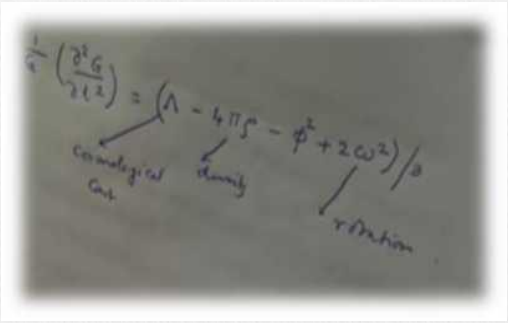
Education

Prof. AKR was brought up in Kolkata where he graduated from the Presidency College and later went on to do his M.Sc. in physics at the University of Calcutta.

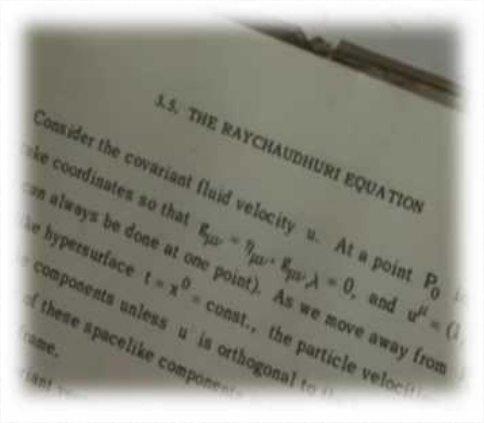
After his Masters, AKR joined the Indian Association for the Cultivation of Science (IACS) in Kolkata where he spent four years in the research in the field of X-ray crystallography. However, those four years came to nothing as Prof. AKR realized that his liking lay not in that experimental field but in theoretical physics, a subject demanding mathematical ability of a high order. In 1950 he joined the Ashutosh College, Kolkata, in a teaching position. Professor N. R. Sen built up a school of general relativity around AKR. Prof. AKR joined his group and developed a liking for astrophysics and relativity, although his interest was more from a mathematical angle. However, he soon discovered that Professor Sen did not much encourage his line of investigations in general relativity. Indeed, Prof. AKR found the attitude of Sen's group too conservative for his liking and after some time stopped going to the group meetings.

Research

Prof AKR, really began his research career as a loner. His ideas were highly original and he felt the need to have opinion of some distinguished scientist in the field and preferred to approach the legendary Satyendra Nath Bose. Bose's response appears to have been negative as he refused to discuss the work or offer advice. The area in general relativity and cosmology that Prof. AKR chose to work on, related to the formation of large-scale structure in the universe. This field had been explored by Eddington and Lemaitre in the 1930s but had not been much discussed by contemporary cosmologists of the 1950s. Today it holds center stage in cosmology.



In 1952, while Prof. AKR was doing research in the IACS, he was able to derive and publish the equation which is now named after him a few years later as the **"Raychaudhuri Equation"**, which is the key ingredient in the proofs of the Penrose-Hawking singularity theorems. The equation clearly separates and identifies the dynamical effects from various sources that control the expansion or otherwise of the universe. The Raychaudhuri equation paved the way for later research into the singularity problem. Thus, the important results of the late 1960s by Roger Penrose, Stephen Hawking and Robert Geroch gave detailed conditions that decided the outcome in various cases.

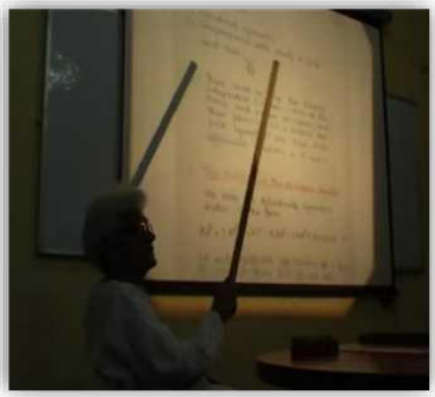

3.5. THE RAYCHAUDHURI EQUATION

Consider the covariant fluid velocity u_μ. At a point P_0 ...
...ke coordinates so that $g_{\mu\nu} = \eta_{\mu\nu}$, $g_{\mu\nu,\lambda} = 0$, and $u^\mu = (...$
...an always be done at one point). As we move away from ...
...he hypersurface $t = x^0 = \text{const.}$, the particle velo...
... components unless u is orthogonal to ...
...f these spacelike compon...
...ame.

Some years later, his 1955 paper was highly regarded by notable physicists, such as Pascual Jordan, Raychaudhuri was sufficiently emboldened to submit a doctoral dissertation and received his Doctor of Science degree at the University of Calcutta in 1959.

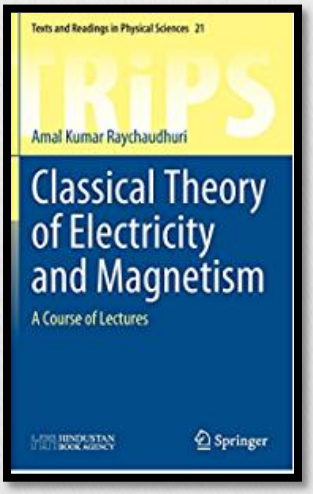
In 1961, Prof. Raychaudhuri joined the faculty of his alma mater, Presidency College then affiliated with the University of Calcutta, and remained there until his superannuation.

Prof. A.K.R. as a Teacher



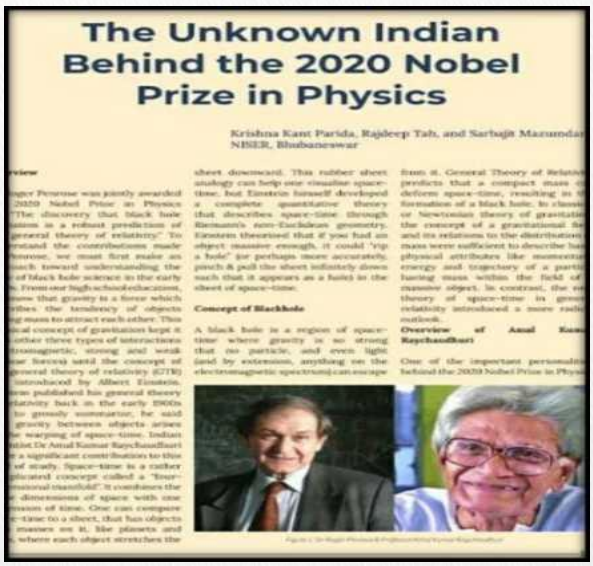
Any account of AKR would be incomplete if it did not highlight his role as a teacher. Despite his successes as a researcher in gravity theory, one can say that his impact on the large body of students was even more valuable. There are today scientists all over India and abroad, who at some time came under AKR's teaching umbrella and have felt empowered for it.

There is an account given by one such distinguished past-student of of Presidency College, stating that he and some of his colleagues were so impressed by AKR's personality that they used to follow him from his home to college to see whatever he did. They saw AKR ride a tramcar to the College and after getting down visit the 'chana-choorwallah'. These students also started patronizing the chanachoorwallah! . AKR was accessible to them and was available to answer their doubts and queries even outside the lecture hall. In fact, in an interview he once lamented that whereas in the USA he encountered a lot of questions from students, most of his students in India seemed to take everything he said uncritically.

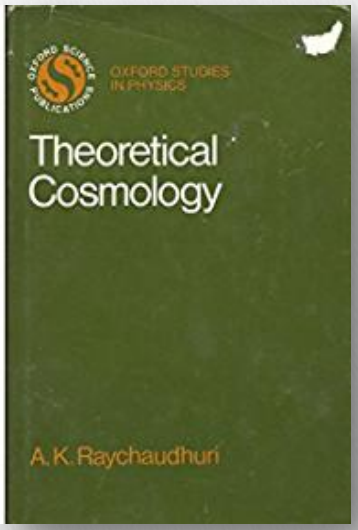


The Legacy of Prof. Amal Kumar Raychaudhuri

AKR wrote a monograph on Theoretical Cosmology which is now a must read as the introduction to the subject for aspiring researchers in this field. There one gets an account of the Raychaudhuri equation 'straight from the horse's mouth'. He also wrote college texts on classical mechanics and electromagnetism. One of his books (on dynamics) is in Bengali.


The Unknown Indian Behind the 2020 Nobel Prize in Physics

Krishna Kant Parida, Rajdeep Tah, and Sarbajit Mazumdar
NISER, Bhubaneswar



The End Note

In one of prof's interviews his wife Mrs. Namita Raychaudhuri said, 'Until and unless he got his recognition from the west, in India he was not known. When he got recognition from abroad, then he was recognized in India. I think this is the custom in our country, if foreigners praise you, then you are great'.

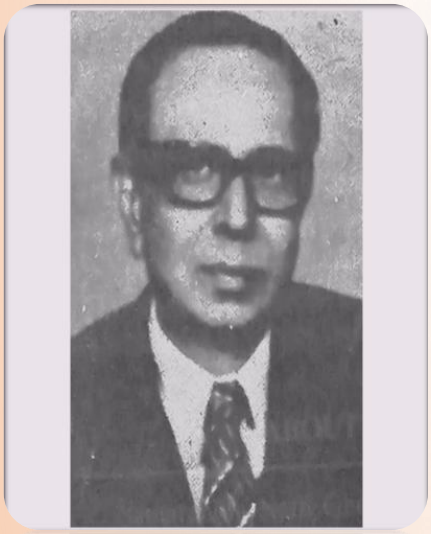
References

- **Documentary film directed by Sunil Shanbag,**
- **Biographical Memoirs by Prof . JAYANT. V. NARLIKAR, (FNA Emeritus Professor Inter-Univ Centre for Astronomy and Astrophysics)**
- **Interview of Prof. AKR by Prof. Parthasarathi Majumdar, Soumitra Sengupta and Jayanta K. Bhattacharjee. Camera: Prof. Subrata**
- **Image Source : Internet**

Contribution of Prof. S.N. Ghoshal in Physics

Ahana Dasgupta , Saptaki Chakrabarty, Sayani Das & Tanusri Santra, Sem VI

Celebration of Birth Centenary of Prof. S. N. Ghoshal



Prof. Samarendra Nath Ghoshal was born in 1923. He did M .Sc. from the University of Calcutta and Ph.D. from University of California, Berkeley , USA.
He carried out research under Prof. M.N. Saha, F.R.S. and Prof. Emilio Segre.
His fields of specialization include experimental nuclear physics and experimental mass spectroscopy.

He taught at the University of Lucknow , Saha Institute of Nuclear Physics, Presidency College, Kolkata and the University of Calcutta. He was also the Principal of Presidency college and Director of Secondary Education Government Of West Bengal.
He was an NRC Fellow at the McMaster University, Hamilton Ontario, Canada.
He visited many importance laboratories in different parts of the world and attended various international conferences.

Ghoshal's Experiment:

The Bohr hypothesis of independence was demonstrated experimentally by Prof. S. N. Ghoshal in 1950.
We now briefly discuss the basic idea underlying the experiment.
In this experiment, the same compound nucleus $^{64}Zn_{30}$ was formed in the same state of excitation by the following two processes:

$$^{60}Ni_{28} + {}^{4}He_{2} \longrightarrow {}^{64}Zn_{30}^{*}$$

$$^{63}Cu_{29} + {}^{1}H_{1} \longrightarrow {}^{64}Zn_{30}^{*}$$

In the first case, α particles with energies ranging from 10 to 40 MeV were used to measure the excitation function using ^{60}Ni as the target nucleus. In the second case, protons with energy between about 3 to 33 MeV were used for similar measurements by producing the same compound nucleus using ^{63}Cu as the target nucleus.

For producing the compound nucleus $^{64}Zn^{*}$ in the same state of excitation by the two different methods, it was found necessary, to choose the kinetic energies of the incident protons and α-particles such that

$$\mathcal{E}_{\alpha} = \mathcal{E}_{P} + 7 \text{ MeV}$$

The absorption of the proton of energy $\mathcal{E}_p$ by ^{63}Cu nucleus produces the compound nucleus $^{64}Zn^{*}$ in a state of excitation energy $E_c = \mathcal{E}_p + S_p$ where S_p is the separation energy of the proton from the nucleus ^{64}Zn in its ground state .

Similarly the absorption of the α-particle of energy Ɛα by ^{60}Ni produces the same Compound nucleus ^{64}Zn* in the same state of excitation

$$E_c = Ɛ_\alpha + S_\alpha.$$

Comparing the two expressions for E_c it is found that

$$Ɛ_\alpha = Ɛ_p + (S_p - S_\alpha)$$

That the currently accepted values of S_p and Sα give the difference $(Ɛ_\alpha - Ɛ_p)$ somewhat lower (3.7MeV) than the above estimate of 7 MeV is due to the uncertainties in the energy definitions by stacked foil method used in Ghoshal's experiment.

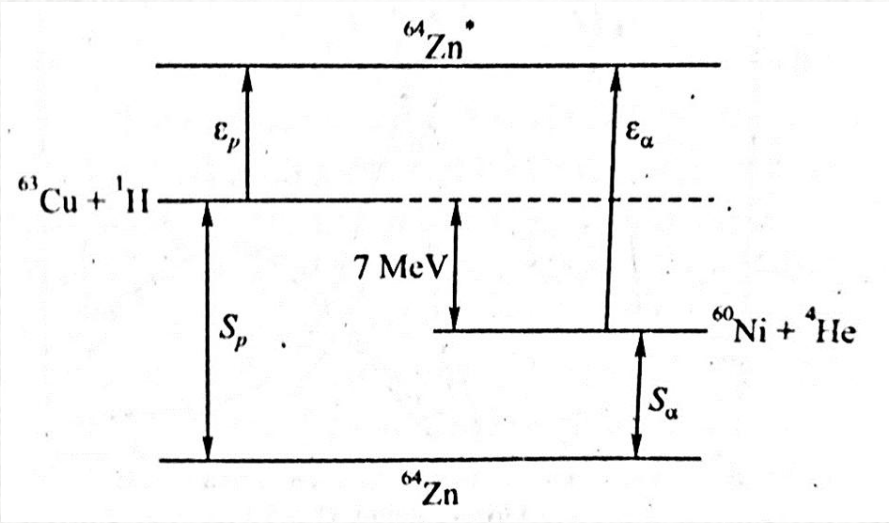
In Ghoshal's experiment , the following decay modes of 64Zn* were observed :

$^{64}Zn^* \longrightarrow {}^{63}Zn + {}^1n$

$\longrightarrow {}^{62}Zn + 2\,{}^1n$

$\longrightarrow {}^{62}Cu + {}^1n + {}^1p$

The excitation functions of the above reactions were determined as functions of the proton and α-energies for the two cases. The results are shown in the figure below:.



As is evident from the figure ,the following relationships are satisfied for all proton energies Ɛp between 3 to 33 MeV and corresponding α-energies $Ɛ_\alpha = Ɛ_p + 7$ MeV between 10 to 40 MeV:

σ(α,n):σ(α,2n):σ(α,pn):=
σ(p,n):σ(p,2n):σ(p,pn)

The reactions provide direct confirmation of the independence hypothesis under statistical assumption ,as can be seen from the following considerations.

We can write the cross section of the reaction

$X + x \longrightarrow C^* \longrightarrow Y + y$ as

$$\sigma(x,y) = \sigma_x(Ɛ_x)\eta_y$$

Where $\sigma_x(Ɛ_x)$ is the cross section for the formation of compound nucleus C* in a particular state of excitation due to the absorption of x by the nucleus X for the energy $Ɛ_x$; η_y is the total relative probability of decay of C* into Y+y irrespective of the energies of Y and y.

Similarly for the reaction

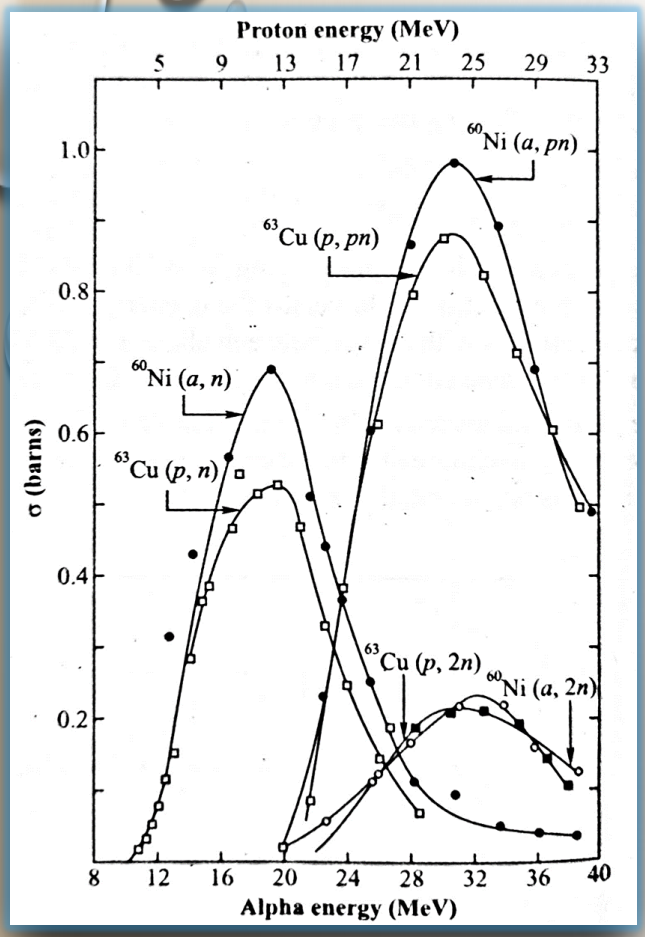
$X' + x' \longrightarrow C^* \longrightarrow Y + y$

We can write the cross section as $\sigma(x',y) = \sigma_x'(Ɛ_x')\eta_y$

We then have

$$\frac{\sigma(x,y)}{\sigma(x',y)} = \frac{\sigma_x(Ɛ_x)\eta_y}{\sigma_x'(Ɛ_x')\eta_y}$$

If the decay of C* takes place through another exit channel $C^* \longrightarrow Y' + y'$ in which two other nuclei Y′ and y′ are produced in the final state, we can write the corresponding cross sections in the two cases as



$\sigma(x,y') = \sigma_x(\mathcal{E}_x)\eta_{y'}$

$\sigma(x',y') = \sigma_{x'}(\mathcal{E}_{x'})\eta_{y'}$ ------- [1]

So taking the ratios we again get

$$\frac{\sigma(x,y')}{\sigma(x',y')} = \frac{\sigma_x(\mathcal{E}_x)\eta_{y'}}{\sigma_{x'}(\mathcal{E}_{x'})\eta_{y'}} \quad \text{------[2]}$$

comparing equations [1] and [2], we get

$$\frac{\sigma(x,y)}{\sigma(x',y)} = \frac{\sigma(x,y')}{\sigma(x',y')}$$

Which is nothing but result obtained in Ghoshal's experiment .

Achievements

- **He was a member of the National Committee of the Governance of Universities appointed by the University grant commission .**
- **He also served on Various committees of academic matter appointed by the state and the Central Governments.**
- **He was a member of the Indian physical society of which he is a past secretory and vise president .**
- **His publications include a chapter on Resolution Mass Spectroscopes in the book Mass spectroscopy edited by C.A. McDowel.**
- **He wrote a bengali book on Atomic and Nuclear Physics for Honours students published by the W.B. State Book Board.**
- **A book entitled Atomic and Nuclear physics in two volumes for graduate and postgraduate students published by S .Chand and Company Limited, of New Delhi besides numerous research papers.**

References

Nuclear physics - Dr. S.N.Ghoshal - published by S.Chand.

Image Source : Internet

Physics in Animal Kingdom

Dhriti Nath, Sem IV

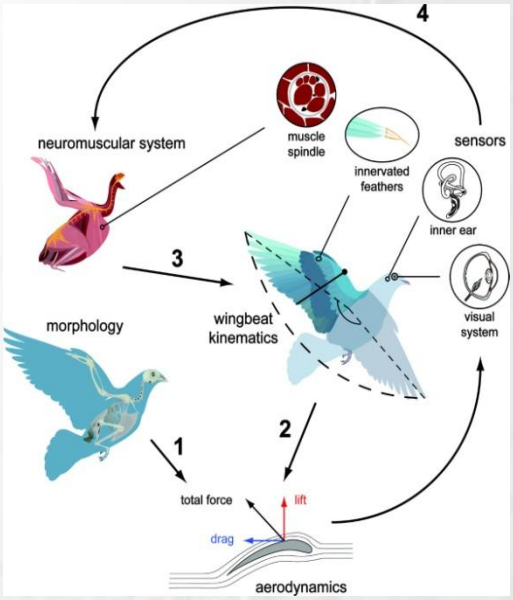
Have you ever wondered why do dogs slurp water from their drinking bowls while cats drinks by touching its tongue to the water surface and then drawing it up rapidly . How geckos walk across a ceiling and how Cats jump from high walls and still don't get hurt. The answer is Physics . From the smallest insects to the largest marine mammals, animals have evolved remarkable adaptations and strategies that utilize various principles of physics. Let's get some knowledge about how animal kingdom use physics in their lives.

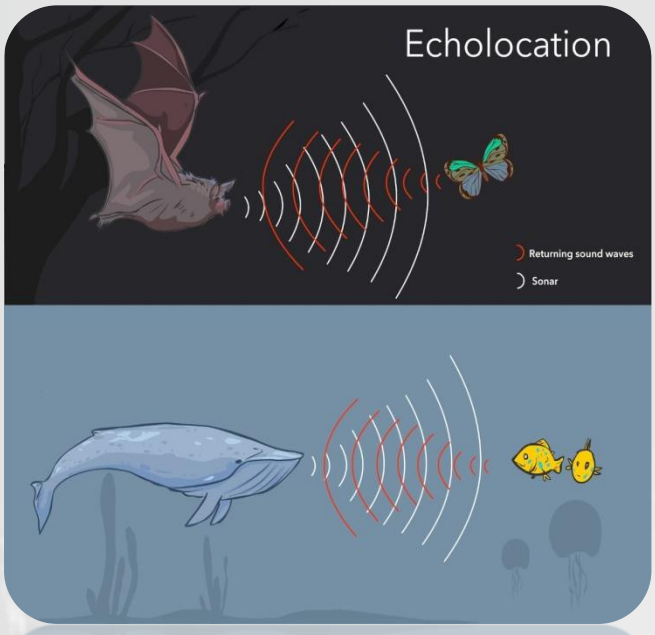
One of the fundamental aspects of animal life where physics is prominently featured is in the realm of biomechanics and locomotion. Animals have evolved unique anatomical structures and movement mechanisms that leverage physical principles to maximize efficiency. Birds, bats, and insects have perfected the art of flight by employing principles of aerodynamics. Their wings are designed to generate lift and thrust, allowing them to overcome gravity and achieve sustained flight. The shape, size, and flexibility of their wings, as well as the utilization of air currents and vortices, contribute to their ability to manoeuvre and remain airborne. Bird specially has air pockets in their body to lighten their body weight. Not only in flying there is physics, but also behind why we find it difficult to walk on sand, whereas camels being heavier than human can cross miles after miles of desert easily.

As we know that Pressure = Force/Area

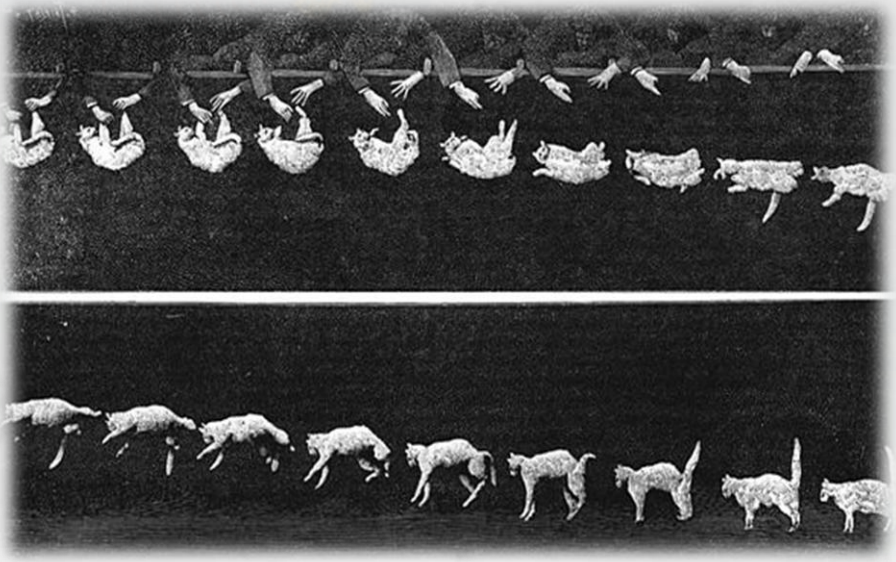
The feet of humans covers very little surface area. The entire weight of the body is concentrated on very little are, thereby, increases the pressure. Camels are heavier than humans, but they have large feet which cover more surface area. The weight is hence distributed evenly and pressure is lesser. Hence, humans sink into sand while camels do not. On the other hand Marine creatures, such as fish, dolphins, and whales, exploit fluid dynamics and hydrodynamics for efficient swimming. The streamlined body shapes, propulsive fins, and tail movements enable them to minimize drag and propel themselves through the water with minimal effort.

Animals rely on their senses to navigate and interact with their environment. Several sensory modalities involve the principles of physics to gather and interpret information .Bats and cetaceans (dolphins, whales) employ echolocation, a technique that relies on sound waves and their reflection to navigate and locate prey. By emitting high-frequency sounds and interpreting the returning echoes, these animals can construct detailed mental maps of their surroundings, enabling them to effectively navigate in darkness or murky waters. Some aquatic animals, such as sharks and rays, possess electro-receptive organs that detect and interpret electrical fields generated by other organisms. This adaptation allows them to locate prey, communicate, and navigate through the water by exploiting the principles of electromagnetism.





Maintaining an optimal body temperature is crucial for animals' physiological functions. The principles of thermodynamics and heat transfer come into play in various thermoregulation strategies. Animals can be classified as ectotherms or endotherms based on their ability to regulate body temperature. Ectothermic animals, like reptiles, rely on the environment to regulate their body heat, whereas endothermic animals, including mammals and birds, produce metabolic heat to maintain a constant internal temperature. Animals living in extreme environments have evolved remarkable adaptations to insulate themselves or dissipate heat efficiently. For instance, the insulating fur of Arctic animals like polar bears prevents heat loss, while evaporative cooling mechanisms, such as sweating and panting in mammals, help dissipate excess heat.



There are some more individual examples where fundamentals of physics is used in animal kingdom.

Geckos : Geckos possess remarkable climbing abilities due to their unique toe pads. These pads are covered in microscopic hair-like structures called setae, which take advantage of weak intermolecular forces called van der Waals forces. This adhesion allows geckos to cling to vertical surfaces and even walk on ceilings.

Elephants and Heat Dissipation: Elephants have large ears that aid in thermoregulation. The ears have numerous blood vessels near the surface, and by flapping their ears, elephants increase the airflow over the vessels, facilitating heat dissipation and helping them cool down in hot climates .

Cats and the Righting Reflex: **Cats have a remarkable ability to reorient their bodies in mid-air if they fall. This is due to their flexible spine and the "righting reflex." Cats can twist their bodies and spread their legs out to increase air resistance, which helps them to land on their feet, minimizing the impact of the fall.**

Spiders and Elasticity: **Spiders use the property of elasticity to launch themselves through the air and catch prey in their webs. They store potential energy by stretching their silk, which acts as a natural spring. When a spider releases the silk, the stored energy propels it forward, allowing It to reach nearby objects or capture insects.**

Chameleons and Colour Changing: **Chameleons are known for their ability to change the colour of their skin. They achieve this through a combination of pigments in their skin cells and specialized layers of cells called iridophores. By manipulating the arrangement of these cells, chameleons can alter the wavelengths of light that are reflected, allowing them to display various colours for camouflage, communication, and thermoregulation.**

Bees and Hexagonal Honeycombs: **Bees construct their honeycombs using hexagonal cells. Hexagons are the most efficient shape for maximizing storage space while minimizing the amount of wax needed. The angles and sides of the hexagons distribute forces evenly, providing structural stability to the honeycomb.**

Physics plays a fundamental role in shaping the lives of animals, enabling them to navigate their environments, communicate, and secure their survival. By harnessing the principles of biomechanics, hydrodynamics, and sensory perception, animals have developed remarkable adaptations. From the efficient flight of birds to the precision of leaping frogs, these adaptations showcase nature's ingenious use of physics. Exploring the ways in which animals utilize physics not only deepens our understanding of their behavior but also provides inspiration for human technological advancements. By observing and studying the physics of animal life, we uncover nature's lessons and unlock a treasure trove of knowledge that can inform and inspire human innovation

References

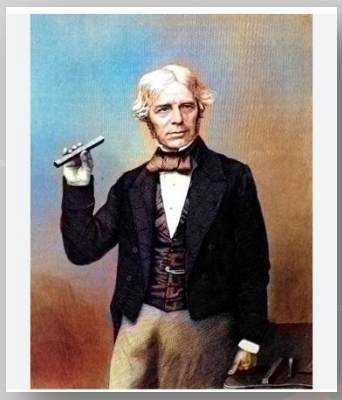
Google , Quora, Wikipedia
Image Source : Internet

Electromagnetism : A Brief Review

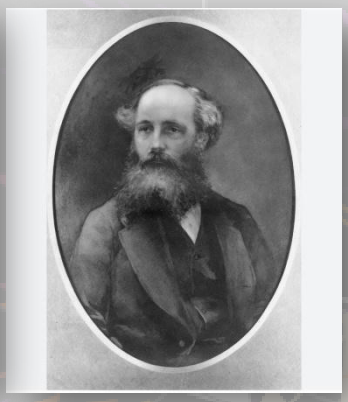
Madhusree Mukherjee, Sem IV

Electromagnetism is a branch of physics that deals with the electromagnetic force which is the dominant force in the interactions of atoms and molecules. And because of which we can see.

Pioneers



Michael Faraday

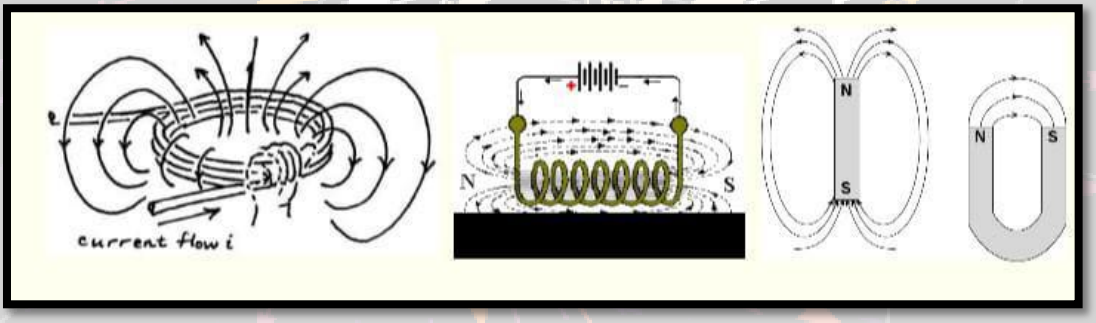


James clerk Maxwell

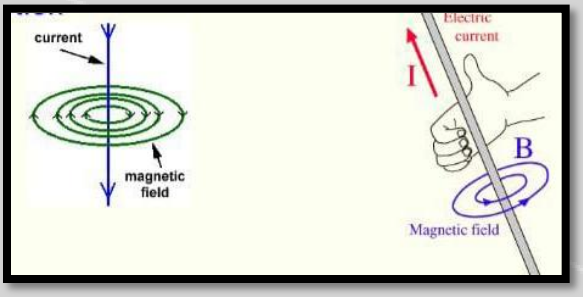
Magnetic fields from electricity:

Magnetic field produces from electricity when the electric charge is moving but if the electric charge is at rest then the magnetic field is not produced.

Electromagnetism: Electricity and magnetism are two different facets of electromagnetism - a moving electric charge produce magnetic fields and changing magnetic fields move electric charges. This connection was first elucidated by Michael Faraday. Maxwell saw electricity and magnetism as frame – dependent facts of the unified electromagnetic force.



Electromagnets: Electromagnets are made of coils of copper wire with electricity passing through them. These coils can be of two kinds. One is the DC electromagnetic coils and other is the AC (AF/RF) coils.
DC electromagnetic coils are used in electro-magnets operating under steady current, solenoids and AC electromagnetic coils are used in transformer, MRI machine etc.

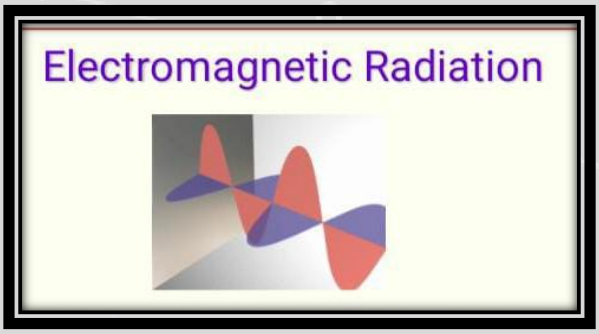


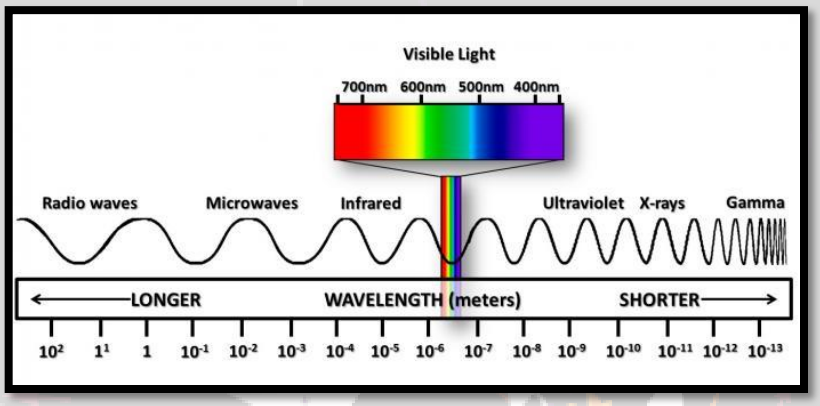
Induced Current and Magnetic Induction:

An induced current is produced by a changing magnetic field. Example is a generator.

Temporary occurrence of magnetism in a magnetic material when it is in the vicinity of a magnet is known as the Magnetic Induction. Mutual induction and Self induction are the two types of it.

An electromagnetic field is a classical field produced by moving electric charges. It is a combination of invisible electric and magnetic fields of force. EM wave can be used to treat many medical problems like nervous disorders, diabetes, spinal cord injuries, ulcers, asthma etc.





Uses of different components of the Electromagnetic Spectrum:

1) **Radio and television waves: Radio waves are electromagnetic waves having longest wavelengths and lowest frequencies and it is used in radio and television broadcasts .**

2) **Infrared Rays: It is a part of the electromagnetic spectrum and facilitates infrared cameras, night vision devices etc.**

3) **Visible light : It is the electromagnetic radiation visible to human eye, mainly used in fiber optic communication, photography, electronic devices etc.**

4) **Ultraviolet light: This form of electromagnetic radiation has shorter wavelength than that of visible light. It is used to treat variety of skin conditions, mood disorders and neonatal jaundice.**

5) **X-Rays: It is a form of electromagnetic radiation and it has high energy and uses to generate images of bones and structures inside the body.**

6) **Gamma Rays: They are highly energetic electromagnetic waves having small wavelengths and uses to sterilize food and to sterilize medical equipments. Gamma rays plays an important role in nuclear physics.**

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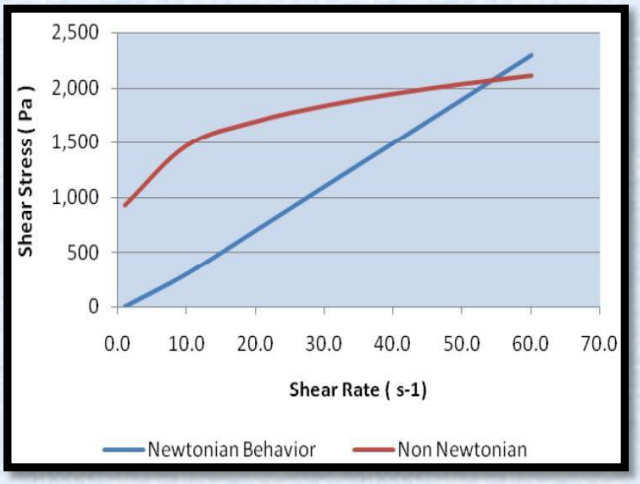
Image Source : Internet

Introduction to Non-Newtonian Fluids

Maitreyee Maiti ,Sem-IV

It has been recognized over more than five decades that a lot of fluids of industrial importance, do not comply with the Newtonian postulate of the linear relationship between shear stress and the shear strain rate. These fluids are known as Non-Newtonian fluids and they follow varying degree of Non-Newtonian flow behaviour. The Non-Newtonian fluid behaviour plays an important role both in nature and in technology.

Apparent viscosity changes with the applied stress or forces in case of a non-Newtonian fluid and the correlation between the shear stress and the rate of strain is non-linear. For these types of fluids the constant of proportionality, viscosity, may change with time. The following graph shows a comparison of Newtonian and Non-Newtonian Fluid behavior.



Non-Newtonian fluid has been classified into two main categories: Inelastic and Viscoelastic Non-Newtonian Fluid.

The first category can be again subdivided into (i) time independent and (ii) time dependent Non-Newtonian Fluid.

(i) Time independent Non-Newtonian fluid

In the Time-independent fluids properties such as viscosity is independent of time.

Subcategories of Time independent Non-Newtonian fluid are:

(a) Pseudoplastic: Pseudoplastic fluids or shear-thinning fluids often exhibit an apparent viscosity of the fluid that decreases with stress. It is the amount of stress that matters rather than the duration.

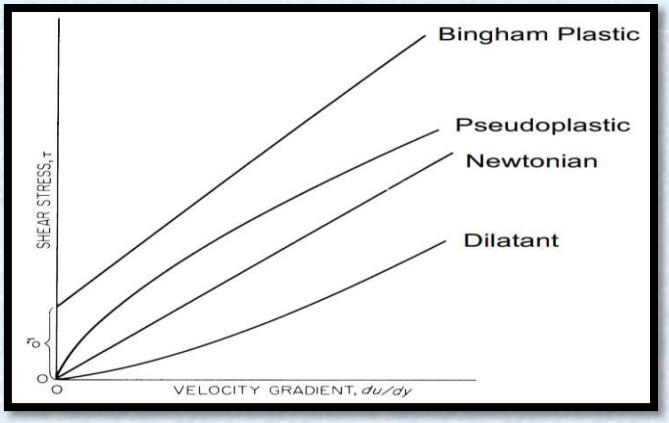
Examples :Polymer solutions, polymer melts and blood are the pseudoplastic fluids.

(b) Dilatant: Dilatants often referred as shear-thickening fluids, exhibit viscosity increase with increasing in the powerful stress.

Examples : Cornstarch in water, gum solution, aqueous suspensions of titanium dioxide, wet sand, starch suspensions are treated as dilatants fluids.

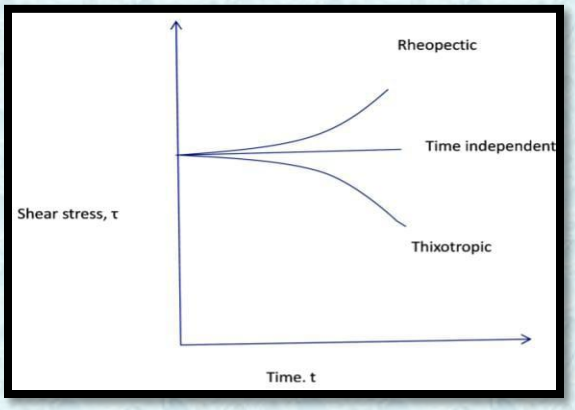
(c) Bingham : It is a viscous fluid that possesses a yield stress which must be exceeded before the fluid will flow and then show a linear shear stress versus shear rate relationship.

Examples: Molten liquid crystalline polymers, foams, paint, toothpaste.



(ii)Time-Dependent Non-Newtonian Fluids

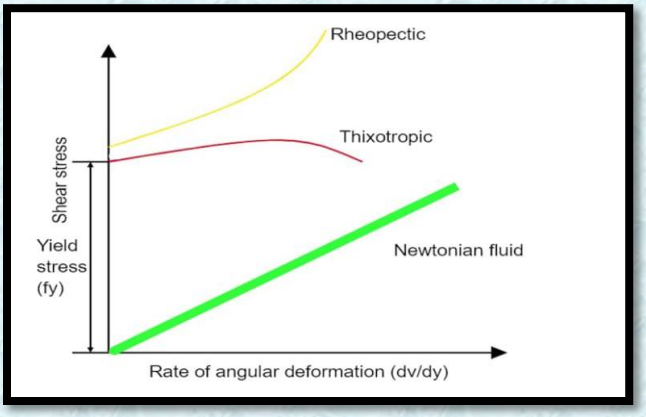
In these types of fluids apparent viscosity depends on the time of applied shear along with strain rate. Such types of liquids are regarded as complex Non-Newtonian fluid.



Subcategories are:

(a) Thixotropic fluid: The Greek word 'thixis' which means shaking and 'trepo' means changing. Viscosity of this fluid decreases as stress over time increases. It exibits a reversible decrease in shear stress with time at a constant rate of shear and fixed temperature. Such types of fluid acquire the property of flow due to low viscosity. They take time to return to their original states.

Examples: Thixotropic fluids are gelatine, crude oil, cream, drilling muds and pectin gels.



b)Rheopectic fluid: It is a rare property of some time-dependent Non-Newtonian fluids for which viscosity increase with time.These fluids exhibits a reversible decrease in stress with time at the constant rate of shear and constant temperature. When this fluid is shakened for a long time it gets hardened. As long as the viscosity is increased, the fluid undergous continous shearing force upto a limit.. Sometimes the rheopectic behavior of fluid may be considered as time-dependent dilatant behavior.

Examples: gypsum pastes ,printer inks and some clay suspensions.

Viscoelastic Non-Newtonian Fluid

These types of fluids exhibits Non-Newtonian behavior with some additional properties of elasticity. These fluids exhibit process properties which lie in -between those of viscous liquids and elastic solids. It has certain amount of strain energy stored in them which on deformation tries to come back to its original shape but with partial elastic recovery. It also exhibits mild elastic drag-reducing behavior, i.e. it reduces tremendous energy losses due to surface friction in heating systems.

Examples: Polymer melts and solutions.

Non-Newtonian fluids are utilized in the development of several different products as brakes, body armors, protective equipment, pipelines, and printer inks. The technologies utilizing strange rheological behaviors of non-Newtonian fluids are still in progress and are expected to provide surprising products and applications we can benefit from in our everyday life.

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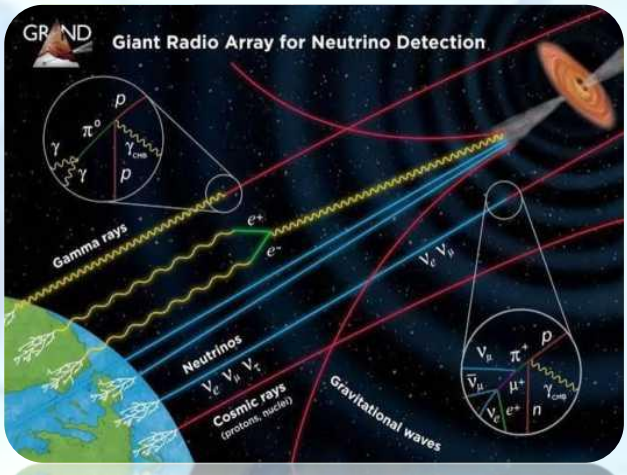
Neutrino Detection : A Path To Future

Prerana Saha, Sem IV

Neutrinos are subatomic particles which belong to the family of elementary particles known as leptons. It is neutral and it has a very negligible amount of mass. Neutrinos are described as "the most mysterious" subatomic particles . It is one of the smallest , lightest particles in the universe. There are three types of neutrinos: i)the electron neutrino , ii)the muon neutrino, iii)the tau neutrino. Neutrinos are produced in various processes, such as nuclear reactions, radioactive decay, and high-energy particle interactions. They interact very weakly with matter, which makes them challenging to detect. They can pass through vast amounts of material , including the Earth , without being significantly affected.

❑ Neutrino Detection :

There are several important reasons why scientists are interested in detecting neutrinos: Neutrinos are one of the fundamental particles in the Standard Model of particle physics. Studying neutrinos can help us better understand the fundamental building blocks of the universe and the underlying laws of physics. It also play a crucial role in understanding the matter-antimatter asymmetry in the universe. Investigating the properties of neutrinos, such as their masses and oscillation behavior, can provide insights into this asymmetry. Neutrinos are produced in various astrophysical phenomena, such as supernovae, black holes, and the Sun. Detecting neutrinos from these cosmic sources can provide valuable information about the physics of these events and the nature of the universe. Neutrinos have been proposed as a possible candidate for dark matter, which is the mysterious substance believed to make up a significant portion of the universe's mass. Detecting and studying neutrinos can help determine their contribution to the total mass of the universe and their role in the formation and evolution of cosmic structures



It could help us identify other forces in the universe that we have not yet been able to detect or understand. They can teach us about the core of the densest stars and they could one day lead to the discovery of new astrophysical objects. It has great importance across multiple scientific disciplines, ranging from particle physics to geophysics and Earth sciences.

In brief, if we can understand the neutrinos, we will be able to answer some of the most important questions in physics.

▪ Types of Neutrino Detector :

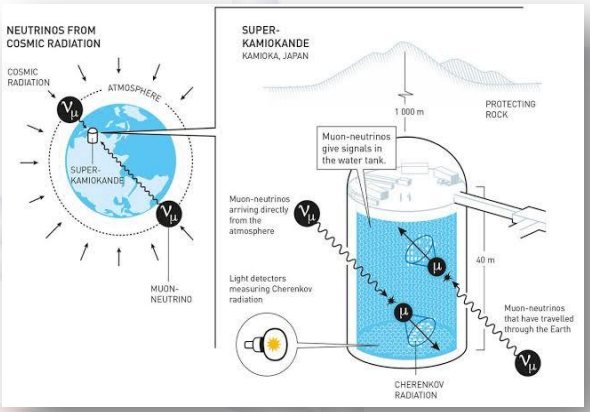
- **Scintillation Detector use scintillating material to detect the light produced when neutrinos interact with electrons or nuclei in the material.**
- **Cherenkov Detector detects the Cherenkov radiation produced when a neutrino passes through a medium faster than the speed of light in that medium and Water Cherenkov Detector uses a large volume of water as the detection medium and detects the Cherenkov radiation produced when a neutrino passes through the water.**
- **Tracking Detector tracks the path of charged particles produced when a neutrino interacts with matter in the detector.**
- **Bubble Chamber Detector uses as a superheated liquid to detect bubbles formed by the energy released when a neutrino interacts with atoms in the liquid.**

Neutrino detectors can range in size and complexity, Some large-scale facilities like Super-Kamiokande, Ice Cube Neutrino Observatory.

❖ Super-Kamiokande

Super Kamiokande is a neutrino observatory which is located under Mount Ikeno, Japan. It is located3,300 ft underground in the Mozumi Mine in Hida's Kamioka area. It is a Cherenkov detector which is used to study neutrinos from different sources including the Sun, Supernovae, and the atmosphere and it is also used to search for proton decay. In 1998, Super-Kamiokande found first evidence of neutrino oscillation from the observation of muon neutrinos changed into tau-neutrinos. It consists of a cylindrical stainless steel tank, 50,000 ton of purified water and 11,000 of 20-inch Photomultiplier Tubes (PMTs), these PMTs detect faint flashes of light produced when neutrinos interact with water. The fiducial volume of the this detector is 22.5 kton.

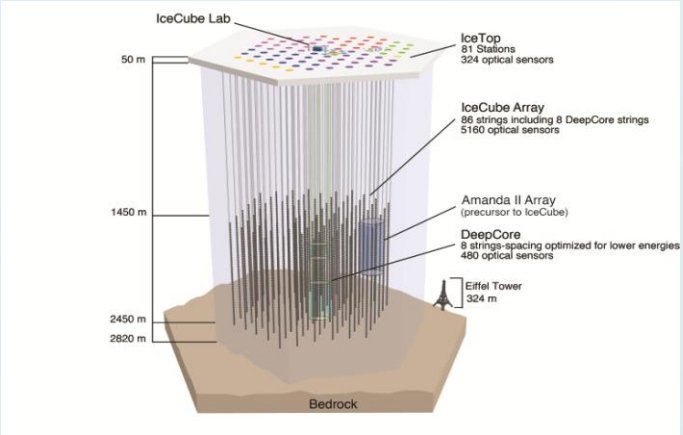
It was built so deep into the ground in order to shield the device from cosmic rays and other particles which can adversely affect observation.



When a neutrino interacts with a water molecule in the tank, it produces charged particles, such as electrons or muons. Surrounding the water tank are approximately 13,000 photomultiplier tubes (PMTs) that are sensitive to faint light signals. The PMTs capture the Cherenkov light and convert it into an electrical signal, and the signal is then amplified and timing, intensity, and spatial distribution of the detected light signals, scientists can reconstruct the properties of the incoming neutrino, such as its energy, direction, and interaction type. The Super Kamiokande experiment has yielded significant findings and discoveries which helps scientists gain insights into fundamental particle physics, astrophysics, and the nature of the universe.

❖ Ice Cube Neutrino Observatory

The Ice Cube Neutrino Observatory is a neutrino observatory constructed at the Amundsen-Scott South Pole Station which is located in Antarctica. It is designed to detect neutrinos, elusive subatomic particles that have very little interaction with matter. The construction of Ice Cube began in 2005 and was completed in 2010.



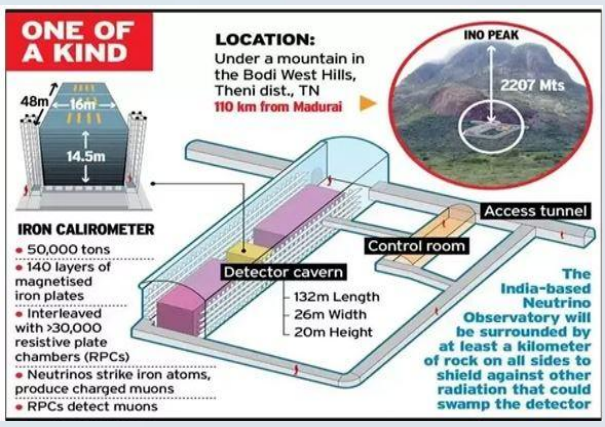
It consists of a cubic kilometer of ice, extending down to a depth of about 2.5 kilometers. Within this volume, a total of 5,160 digital optical modules (DOMs) are deployed, which house the light sensors. When a high-energy neutrino interacts with a water molecule in the ice, it produces a secondary particle called a muon. The muon emits a cone of blue light known as Cherenkov radiation. Each DOM contains a photomultiplier tube (PMT) that can detect and amplify the faint light signals. When the Cherenkov radiation emitted by the muon passes through the ice, some of it reaches the DOMs. The PMTs inside the DOMs detect these faint flashes of light and convert them into electrical signals. The electrical signals from the PMTs are collected and transmitted to the surface using a network of cables. The signals are then processed, digitized, and sent to the data acquisition system, where they are recorded and analyzed. By analyzing the timing, intensity, and pattern of the light signals scientists can reconstruct the path and energy of the neutrino interaction. This information helps determine the direction and properties of the incoming neutrino. In 2017,

Ice Cube identified the first astrophysical source of neutrinos, a blazar named TXS 0506+056, located 4 billion light-years away. By using the transparent ice of the Antarctic as a detection medium,

Ice Cube allows scientists to capture and study neutrinos, shedding light on the most energetic and elusive processes occurring in the universe.

❖ India-based Neutrino Observatory (INO) :

It is a particle physics research project under construction to primarily study atmospheric neutrinos in a 3,900 ft deep cave under INO Peak. The location of this observatory would be in the Bodi hills region of the Theni district which is located in Tamil Nadu. INO is an underground project and it will comprise a complex of caverns. The main experiment proposed at INO is the Iron-Calorimeter Detector (ICAL). ICAL will be a 50000 ton magnetized iron calorimeter and it is also 130 m long, 26 m wide, and 30 m high. The primary goals of the ICAL are 1) Unambiguous determination of neutrino oscillation parameters using atmospheric neutrinos. 2)Study of matter effects through identification of electric charge. 3) Study of charge-conjugation and charge parity violation in the leptonic sector. 4) Study of Kolar events, possible identification of very-high energy neutrinos. As the project falls exactly on the hill slopes of this part of the Western Ghats, which align within it the Mathikettan-Periyar tiger corridor (a significant tiger corridor), Tamil Nadu has conveyed to the Supreme Court that it does not want India-based Neutrino Observatory to be set up in a sensitive ecological zone in the Western Ghats.



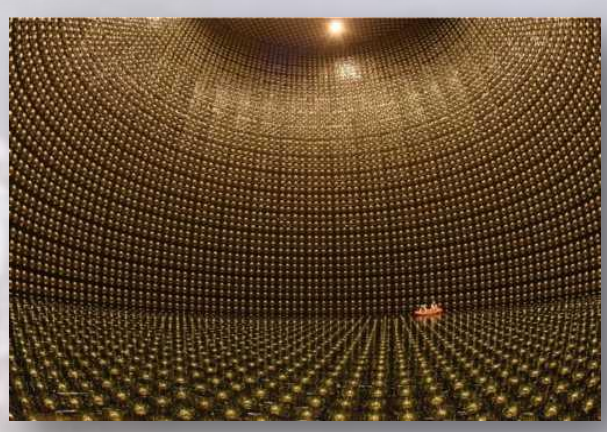
Some underwater neutrino telescopes :

- **ANTARES (2006 onwards)**
- **KM3NeT (future telescope; under development since 2013**
- **NESTOR Project (under construction since 1998)**

Some underground neutrino observatories:

- **Baksan Neutrino Observatory, Russia.**
- **Gran Sasso National Laboratories (LNGS), Italy.**
- **Underground Neutrino Observatory, Mont Blanc, France**

One notable future project in neutrino detection is the Deep Underground Neutrino Experiment (DUNE). DUNE is an international collaboration aiming to build a massive neutrino detector located deep underground at the Sanford Underground Research Facility in South Dakota, USA. The primary goals of the DUNE experiment include studying neutrino oscillations, determining the neutrino mass hierarchy, and searching for proton decay, among other research objectives.



The field of neutrino detection has made significant advancements in recent years, leading to groundbreaking discoveries and advancing our understanding of neutrino physics, astrophysics, and the fundamental nature of the universe. Neutrino detectors play a crucial role in unraveling the mysteries of these elusive particles and their interactions, providing valuable insights into the workings of the cosmos.

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Image Source : Internet

Glimpses of Nanotechnology

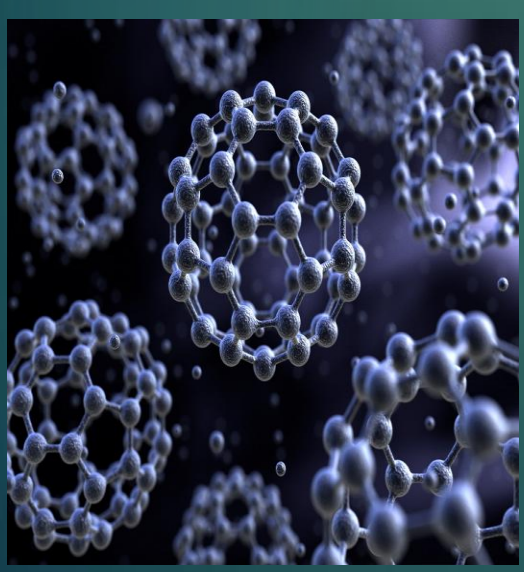
Srijani Banerjee, Sem IV

Nanotechnology is the technology to manipulate and control a substance at the nanometer (nm) level (1 nm = one billionth of a meter). The nanometer level is the level of atoms and molecules. It creates new materials and devices with fascinating functions making the best use of the special properties of nano-sized substances. For example, today people need devices able to store information at high densities and high speeds, using little energy. One way of realizing this is to make each component very small. This can be achieved by using nanotechnology which can process components and systems with nanometer level precision.

Moreover, when the size of the matter is at the level of several molecules or atoms, certain physical properties change significantly like widening of band gap, change of colour of the same material.

The rapid development of nanotechnology research in recent years is closely related to the advances made in nanometrology. For example, in the first half of the 1980s, the IBM group invented the scanning tunneling micro-scope, which enabled researchers to observe and manipulate a substance at the level of individual atoms and molecules. This opened the way for creating various nano-structures.

The two basic methods of synthesizing the structure of matter at the nanometer level are the top-down and bottom-up methods. In the top-down approach, larger masses are finely processed, as in lithography, with light or electron beams. Whereas in the bottom-up approach, structures are created by assembling atoms and molecules.



Nanometrology covers a broad range of measurements addressing chemical and structural characterization, electronic, thermal, and mechanical properties, fabrication and monitoring of nanodevices, as well as theoretical modeling of properties of nanomaterials

The bare-bones nanometrology programs focus on the evaluation of the purity and the uniformity of the dispersion of typical nanomaterials.

There are many different views of about what is included in nanotechnology. In general, however, most scientists agree that three things are most important:

1.Small size, measure of 100s of nanometer or less.

2.Unique property because of the small size.

3.Control the structure and composition on nm scale in order to control its properties.

The Science Behind:
Quantum size Effect

The term ‘quantum confinement’ is mainly deals with energy of confined electrons (electrons or electron-hole). The energy levels of electrons will not remain continuous as in the case of bulk materials when it suffer confinement. Such kinds of effects appear when the dimensions of the potential /device is of the order of the de Broglie wavelength of electrons and resulting in discrete levels of energy. This effect is defined as the quantum confinement. Nano-crystals that suffer 3 dimensional confinement are of called quantum dots (QDs). Furthermore, quantum dots affect different properties of the nanomaterials such as electrical, optical as well as mechanical behavior. Depending on the size of the nanomaterial, confined electrons have higher energy than the electrons in bulk materials. Semiconductor quantum dots are also known as semiconductor nanocrystals or nanoparticles. A semiconductor nanocrystal (SNC) or quantum dot (QD) is a semiconductor whose excitons are confined in all three spatial dimension. As a result, they have properties that are between bulk semiconductors and of discrete molecules. Quantum Size effects are observed in nanocrystals measuring few nm.

The quantum confinement effect in low dimensional semiconductor systems was described about 25 years ago. The bulk crystalline structure is preserved in a nanocrystal. However, due to quantum confinement, nanocrystals have molecule-like diiscrete electronic states which exhibit strong in size dependent properties. In the last decade, comprehensive investigations were made to explore size dependent properties of semiconductors with emphasis on optical properties, including absorption and luminescence.

As the no of confined dimension increases, an increasing trend into the energy gap was observed between the highest occupied molecular orbitals (HOMO) and the lowest unoccupied molecular orbitals (LUMO). For a bulk semiconductor, the filled and empty state form separated continuums i.e., the valence and conduction bands. However, for Quantum Dot (Q-size) regime region energy levels were within the empty and filled states remain discrete and the band gap energy levels were higher between the HOMO and the LUMO than that of the bulk materials .

This size dependent widening of band gap alters the optical properties of the nanomaterials greatly.

Multidisciplinary Nature of Nano-Science and Nano-Technology

MEDICINE:

Nanomedicine is a relatively new field of science and technology. It looks sometimes ill defined and interpretations of that term may vary, especially between Europe and the United States. By interacting with biological molecules, therefore at nanoscale, nanotechnology opens up a vast field of research and application. Interactions between artificial molecular assemblies or nanodevices and biomolecules can be understood both in the extracellular medium and inside the human cells. Operating at nanoscale allow to exploit physical properties different from those observed at microscale such as the volume/surface ratio. The investigated diagnostic applications can be considered for in vitro as well as for in vivo diagnosis.

ENERGY:

Nanotechnology is used to develop more efficient solar cells, which can convert sunlight into electricity more effectively. Nanoscale materials andNanostructure science and technology is a wide area of research which involves various disciplines of science and technology. It has greatly contributed to the worldwide growth over the years. Nanotechnology is used to develop better batteries such as lithium-ion battery with improve energy-density.,charge and discharged efficiency.The ability to create devices creates many door for the debelopment of new ways to capture store,and transfer energy. These newly highlighted properties have the ability for great impacts in electrical, electronics, medicine, and other fields.

FABRIC:

The design, characterization, production and application of structures, devices and systems by controlling shape and size of building blocks at the nanometer scale. The study of control of matter on an atomic and molecular scale involves engineering on a small scale to create smaller, cheaper, lighter, and faster devices that can do more things with less raw materials. A nanofiber is a continuous fiber which has a diameter in the range of billionths of a meter. The smallest Nano fibers made today are between 1.5 and 1.75 nanometers. Three types of nanotechnology in textiles can be distinguished: 1) Nanotechnology in fibers and yarns 2) Nanotechnology in coatings 3) E-textile.

TECHNOLOGY:

Recent versions of commercially available software, and even freeware and shareware, can perform surprisingly accurate simulations. On the other hand, the micronizatiom of solid particle,surface area increases generally in reverse preposition of the particle size.Nano-materials are used to manufacture structures in coal, silicon, inorganic materials, metals and semiconductors that do not work with humidity. It is based on biological systems present in an aqueous environment — including genetic material, membranes, enzymes and other cellular components .

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Image Source : Internet

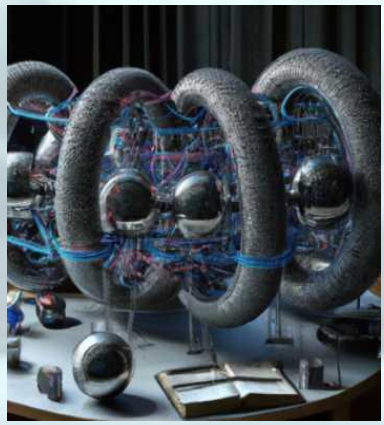
The Quantum Leap: Unveiling the Extraordinary World of Superconductivity

Sulagna Dey, Sem IV

In the realm of physics, few phenomena capture the imagination quite like superconductivity. It is a captivating field that defies conventional understanding and promises a future of incredible scientific advancements. Superconductivity is a state of matter where electrical resistance vanishes, allowing for the unimpeded flow of electric current. This astonishing property opens up a myriad of possibilities for efficient energy transmission, powerful magnets, and revolutionary technologies. In this article, we delve into the intriguing world of superconductivity and explore its profound impact on science and technology.

Unveiling the Basics of Superconductivity :

Superconductivity was first discovered in 1911 by Heike Kamerlingh Onnes, a Dutch physicist. He observed that certain materials, when cooled to extremely low temperatures, displayed a complete absence of electrical resistance. This groundbreaking finding shook the foundations of classical physics and paved the way for a new era of research.



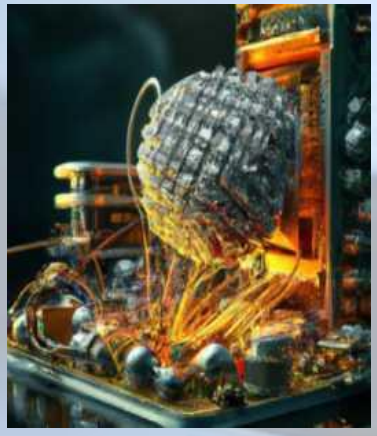
Superconductivity is a quantum mechanical phenomenon that occurs when certain materials exhibit zero electrical resistance below a specific temperature, known as the critical temperature (Tc). At temperatures above Tc, these materials behave like ordinary conductors, but as they cool below this threshold, they undergo a remarkable transformation.

The cornerstone of superconductivity lies in the formation of Cooper pairs. In conventional superconductors, electrons typically experience resistance due to scattering caused by lattice vibrations (phonons). However, at extremely low temperatures, electrons overcome this resistance by forming pairs, now called Cooper pairs, through an interaction mediated by lattice vibrations. These Cooper pairs are characterized by their ability to move through the material without scattering, resulting in zero electrical resistance.

The Advantages of Superconductivity :

The implications of superconductivity are profound and far-reaching. Here are some of the key advantages offered by this extraordinary phenomenon:

1. **Zero Resistance: The most notable property of superconductors is their ability to conduct electricity without any loss of energy due to resistance.**



This characteristic opens up possibilities for ultra-efficient electrical power transmission over long distances, reducing energy wastage and increasing overall efficiency.

2. **Magnetic Levitation: Superconducting materials exhibit a remarkable property called the Meissner effect. When a superconductor is subjected to a magnetic field, it expels the magnetic field lines from its interior, effectively creating a magnetic shield. This phenomenon allows for magnetic levitation, as demonstrated by high-speed trains such as the Maglev, which "float" above their tracks using superconducting magnets.**

3. **Strong Magnetic Fields: Superconducting magnets can generate immensely powerful magnetic fields, far beyond what conventional magnets can achieve. These magnets find applications in various fields, including medical imaging (MRI machines), particle accelerators, and fusion research.**

4. **Faster Computers and Data Storage: Superconductivity enables the development of superconducting quantum interference devices (SQUIDs), which are incredibly sensitive to magnetic fields. This technology holds great promise for advancing fields such as quantum computing and data storage, where high-speed and low-energy operations are essential.**

Challenges and the Quest for Higher Temperatures :

While superconductivity has already revolutionized various fields, there are still significant challenges to overcome. One of the primary challenges is raising the critical temperature (Tc) at which superconductivity occurs. Most conventional superconductors require extremely low temperatures near absolute zero (-273.15°C or 0 Kelvin) to achieve zero resistance.

Efforts are underway to discover and develop higher-temperature superconductors that exhibit the remarkable properties of superconductivity at more practical temperatures, such as liquid nitrogen temperatures (-196°C). This would significantly enhance the feasibility and accessibility of superconducting technologies.

Scientists are exploring different types of superconducting materials, including cuprates, iron-based compounds, and topological materials, in their quest for higher-temperature superconductivity. The mechanisms driving superconductivity in these materials are still not fully understood, but ongoing research is shedding light on the underlying physics and offering new possibilities for technological breakthroughs.

Conclusion :

Superconductivity stands as one of the most intriguing phenomena in physics, unlocking a vast array of applications and possibilities. From revolutionizing power transmission to enabling advanced medical diagnostics and quantum computing, the impact of superconductivity spans multiple domains. While challenges remain, ongoing research and electrical exploration are propelling us toward higher-temperature superconductors, further expanding the frontiers of this remarkable field. As our understanding deepens, we are poised to witness even more awe inspiring advancements in the realm of superconductivity, revolutionizing the way we harness and manipulate energy

----------The end----------

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Image Source : Internet

SPACETIME: The Sea of Enigmatic Mysteries

Akanksha Roy, Sem II

Spacetime in simple words is the union of space and time. The concept of spacetime involves a model that expands beyond the dimension that we are aware of. A hundred years ago, Albert Einstein started a scientific revolution which requires us to let go of our common sense ideas about what space and time are.

Instead of thinking of our universe as a 3-Dimensional place, that just changes over time, we should think of reality as a 4-Dimensional place called Space-time. Our observations of time are directly coupled to watching something move in space. We get questions in our mind: 'What is the difference between a day, but the rising in setting of the sun', or 'an hour but the motion of a hand on a clock?' The 3-Dimensions of Space are linked with one dimension of time making a 4-Dimensional Space time continuum. Motion through space is connected to motion through time. We move through space time not space or time. As soon as one has motion through space, some of the intrinsic movement through space time is taken up by the motion as one moves faster through space, one moves slower through time. Scientists call this 'Time Dilation'. Now there is a force that messes up with time. We call that force "Gravity".

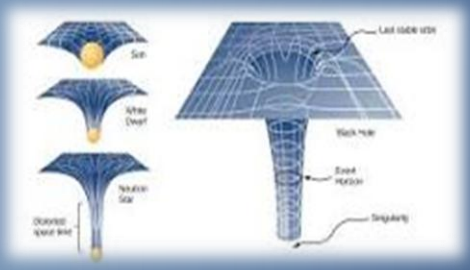
Gravity is a bending of space time itself. Space time is like a rubber sheet; massive objects like planets and stars stretch it, thus bending space and passages of time. As we get closer to something with a lot of gravity, time and space are stretched and that really does mean that time goes more slowly.

This even happens on earth. Here time runs more slowly, close to the ground.

In simple words, if we live high up in an apartment, our clock would tick slightly more quick than people living at the bottom of the apartment building. We would feel the Earth's gravity slightly different than the people residing on top would feel. These time differences are just tiny fractions of a second, but there is a place in the universe where powerful gravitational forces slow time dramatically – a black hole. A black hole is a region of space where the space is so curved that even light cannot escape. A black hole in many ways is a more into gravity, the slower time goes. If one enters a strong gravitational field like near a black hole, and then the person comes back, he/she will have experienced less time than someone who just stayed behind on Earth. But it would not feel different to the person; the clock would always tick at the rate as expected. He / She would not even notice their presence in a gravitational field, until they came back and compared their clocks to the people who left behind. In this way, travelling close to a black hole and then coming back allows one to accelerate their passage through time compared to people who stayed behind. So it seems we are jumping in time; and we are really are time travelling that way.

The closer we get to a black hole, we approach to the CENTRAL SINGULARITY which is a true discontinuity; a causal break in the fabric of space time itself. The laws of Physics do not work at or beyond this point. If singularity is a break in Space Time, could it let us jump through Time?
What happens on the inside of a supermassive black hole is all very much in the realm of very advanced theoretical physics.

In fact, the singularity, at the center of a super massive black hole, it may be possible to even go through it. There are many interpretations of what it could potentially mean parallel universes or time travel. It could be that Space and Time, are far more chaotic. Different points in space and time, connect to each other in every direction. So at the very heart of a black hole, we indeed may be able to access any point in space or time in the universe. We are yet to confirm if the singularity is a portal through time. What we do know is that, crossing a black hole's event horizon is a one-way trip. The way that scientists currently understand time travel in a real sense is through either travelling very quickly or through a gravitational field. All of these things would bring a person into the future, but not into the past.



Stars and Planets curve space and time. Black holes bend it infinitely, but strange theoretical objects called wormholes could punch right through space time connecting two different points in time with a tunnel. If the fabric of space time is imagined as a giant rubber sheet, and a person wants to reach from one point to another, the wormhole would provide a bridge between the two points, making them next to each other.
According to some theories, related to general relativity, that allows for a concept of wormholes, if one entered it and somehow survived, travelling through it, one would exit the wormhole at a time, before the person actually entered it.

To survive a passage, through the wormholes, one literally needs to essentially hold open the throat of the wormhole. There is only one way to do that, to keep the wormhole open, require negative energies. However, it is not known whether the negative energies could really be made or not. The closest thing known about the dark energy is that, they are supposedly accelerating the expansion of the universe. Dark energy pushes the universe apart, but is not exotic enough to hold open a wormhole. It doesn't have negative energy.

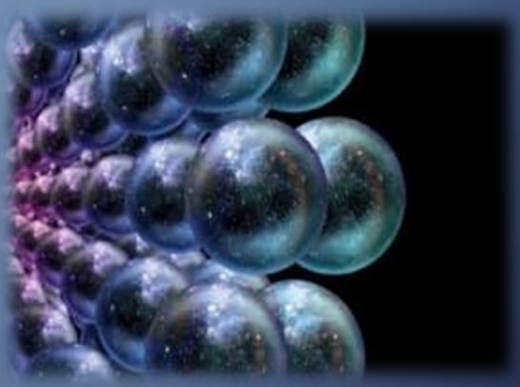
Time itself may be something that can be bent or/ and stretched, there may even be different versions of time; so in some respects, time travel may be every bit as real and every bit as strange as our wildest science fiction, "fantasies".

By investigating time travel, scientists are unraveling mysteries of our universe, but one question remains unanswered, 'why does time seem to run only in one direction? How is it then that we remember our past but don't know the future?' This seemingly obvious question turns out to have its explanation in origin of our universe shockingly.

The passage of time is not set in stone; time can be bent, slowed and even frozen. But our experience of time seems fixed; time only flows in one direction. There is no difference between up, down. Left or right, forward or backward, but there's still a difference between yesterday and tomorrow. This arrow of time, that seems to flow only in the forward direction, appears to be linked to the chaos and disorder we see in our day to day lives. Across the universe, entropy always increases just like across the universe, time flows from past to future. Everything in the universe is gradually becoming more and more disordered.

13.8 billion years ago, spacetime expanded from a tiny point. In the blink of an eye, the universe was born. This marked the first moment of time, the big bang.

The idea of multiple universes or time travelling is quite difficult to explain. Maybe if there are infinite number of universes, there might exist other version of ourselves. Time travel is definitely more science fiction than science fact, but thinking about time travel and trying to understand why it might not be possible is really interesting and can teach us a lot about the nature of our universe.



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Quantum Computing And Physics: Newfound Best Friends?

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What is Quantum Computing? Why is it the need of the hour?

The first instinct of a scientist or an engineer when struck at a difficult problem is to tend to a supercomputer which is basically a giant classical computer with hundreds and thousands of CPU and GPU cores to find a solution for it. But at times, there arises problems of higher complexities involving multiple variables interacting in complicated ways, say for example- if we were to study about the modelling of an individual atom, it becomes a much-complicated problem because of all the electrons interacting with each other at sub-atomic level, which even a supercomputer can't precisely solve.

Now, 'Congratulations!' is what strikes my head every time I come across the fact that, what felt like a dream just about a while ago, is the reality of the moment! Quantum Computing is the name of that successful technology which is known to utilize the laws of quantum mechanics (which is basically a fundamental theory to describe the physical properties of nature at the scale of atoms and sub-atomic particles) to find solutions for problems which is supposedly too complex for classical computers to solve.

How do Quantum Computers Work?

While classical computers use bits to operate, Quantum computers operate on Qubits (the basic unit of information in Quantum Computing and counterpart to the bit in classical computing) to process intricate quantum algorithms.

Quantum Computers are mainly built using super fluids and superconductors as it requires an operational temperature of about a hundredth of a degree above absolute zero. Microwave photons are used to fire qubits such that we can acquire control over their behaviour and read out individual units of quantum information. Quantum information is then hold into a state of superposition, representing all possible configuration of qubits, creating a complex, multifaceted computational spaces to operate on. On entanglement (A quantum mechanical effect that correlates the behaviour of two separate things) of two qubits, changes made on one directly impacts the other.

Usage of Quantum Computing in the field of Science:

- **Astrophysics:** Modern day science says that the evolution of this universe could be studied better using quantum computers as it can be used to stimulate the behaviour of the stars and galaxies better.

- **Particle Physics:** Quantum Computers can aid us in having a better understanding of the fundamental forces of nature as it can be used to stimulate the behaviour of subatomic particles.

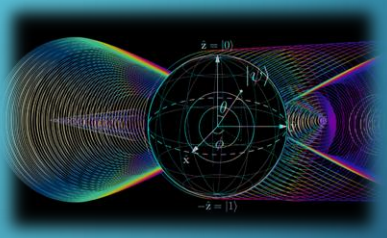
- **Nuclear Physics:** Quantum Computers can be proven effective in developing new nuclear technologies which could be cleaner and safer to use, by stimulating the behaviour of nuclear reactions.

- **Material Science:** By stimulating the behaviour of materials at the atomic level, Quantum computers can help us in fabricating materials with unprecedented properties such that they are more efficient at emerging storing, more resistant to corrosion, can selfheal quicker and faster, etc.

Nonetheless to say, Quantum computers can also evidently serve greater purposes by its means of competency in the field of AI, machine learning, computational chemistry, drug design and development, cybersecurity and cryptography, logistics optimisation, weather forecasting, etc.

The Future of Quantum Computing in the field of Physics:

Undoubtedly, with the advent of the idea of integrating quantum computing with physics and its much-awaited development, scientists are going to enjoy much liberty in exploring different fields of sciences which they didn't have access to until today. Perhaps, on a day in future, cosmology could become a cakewalk for us with all the technology we aspire to build!



Conclusion:

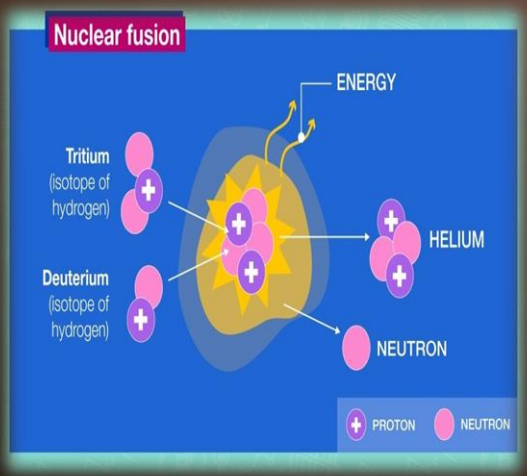
Indeed, we can conclude that advancement in technology has always been in favour for exploration undertaken by scientists around the world. Perhaps to what classical computers said a no to, quantum computers can answer them all! Therefore, to answer if Quantum computers and Physics are best friends, my friends, definitely they are! The potential of Quantum computing in the field of physics or just to say in the field of science, is just undeniable!

Information Source: Wikipedia, IBM, Caltech, etc.
Picture Source: Internet

Nuclear Fusion-From Atomic level to Stars

Triparna Debnath, Sem II

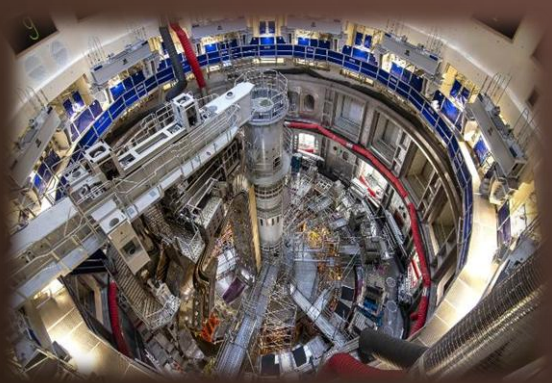
Isn't it interesting that everyday we enjoy the effects of nuclear fusion probably without even realizing it! Now the question arises,what is Nuclear fusion? The answer goes straight that Nuclear fusion is the process in which two lighter nuclei merge to form a single heavy nucleus. A very high value of temperature(like 100 million degerees of temperature) is required to initiate the process to overcome the Coulombic repulsion between the two nuclei and the fusion results in release of a huge amount of energy because the mass of the resulting nucleus is less than the mass of the two original nuclei; the leftover mass becomes energy. Everything in this universe is made up of atoms. Inside atoms there's a nucleus, positively charged protons and negatively charged electrons. Amazingly, it's the fusion of these smaller than microscopic atoms that powers our sun and provides both heat and light.



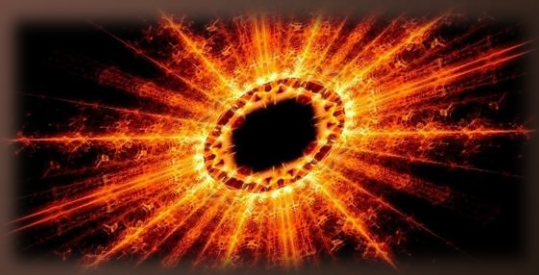
In 1920, Arthur Eddington suggested that Hydrogen-Helium fusion could be the primary source of stellar energy. An important fusion process is the stellar nucleothysis that powers stars, including the sun. In the 20th century, it was recognized that the energy released from nuclear fusion reactions accounts for the longevity of stellar heat and light. The study of nuclear fusion dates to the late 1940's and early 1950's when the United States, United Kingdom and Soviet Union began to yield a better understanding of Nuclear fusion and investigators embarked on the ways of exploiting the nuclear process for harnessing nuclear energy; the future of energy resource. Some Nuclear projects have been developed by some countries singly as well as jointly (i.e., in collaboration with other countries) .

In 2005, India became a member of the ITER (International Thermonuclear Experimental Reactor) project; till date India has delivered the projects with cryostats, cooling water systems etc. Fusion power has been seen as an important part of India's long-term energy supply. India has its own nuclear fusion reactor named SST-1 (Steady State Tokamak-1) which is a plasma confinement experimental device situated at the Institute For Plasma Research (IPR), India. The SST-1 project was commissioned in 2013; the project was chaired by Indian plasma physicists Prof. Y.C Saxena, Dr. Chenna Reddy and headed by Dr. Subrata Pradhan.

China also has its own nuclear fusion reactor CFETR (China Fusion Engineering Test Reactor) which has promised to produce a massive quantity of energy (which may be nearly equal to solar energy as said by China) when it will be finished around 2035, with a peak power output of up to 2 gigawatts. Till date, ITER is the biggest nuclear fusion project based on magnetic confinement fusion that uses magnetic fields to contain the fusion fuel in plasma form.



Although nuclear fusion reactors been built and some under construction, till date it is almost impossible to achieve such high temperature like that in sun's core for initiating fusion reaction; sun's core is at extremely high temperature due to which fusion reactions are continuously going on at sun's surface which is providing heat and light to all the planets in the solar system. The initial experiments and machinery required to built fusion reactors are costly so there are not many fusion reactors in countries across the globe leaving few like India, China, USA, UK etc. Moreover, it is technically difficult to build fusion reactors with such materials which are extremely heat resistive to resist such high temperature in the fusion reactors. Nuclear power especially nuclear fusion is a source of unlimited power supply (renewable energy source) unlike fossil fuels (non-renewable energy source) e.g coal but more research and brainpower is needed to build cost effective reactors to sustain fusion reaction and harness the energy from it.



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