SEPTEMBER 2020, ISSUE 2

THE NEUTRINO BREW

OFFICIAL NEWSLETTER OF THE NEUTRINO CLUB

INTRODUCTION

Dear Reader,

As the first semester comes to an end, we are heading towards the goal of studying for our final examinations. Amid the current pandemic and subsequent chaos, we understand how subjects, particularly physics, can be tough to grasp. While physics is an intricate subject that requires time and understanding, once we truly absorb the concept, it can prove to be a wondrous subject.

Through this magazine, we not only want to spark interest but also try to bridge the gap between the academic curriculum and the practical applications of physics. We hope that the magazine makes it easier for students to understand where certain concepts originated and how they developed, to reach our textbooks. Along with this, the Neutrino club is also relaunching the celebrating 'Scientia' series, to provide more in-depth reviews and webinars on the concepts discussed on our issues.

We bring to you, articles ranging from the renowned gravitational waves to GUTs and TOEs, covering topics including Newton's Bucket question and Vikram Sarabhai. This issue, along with engaging and intriguing articles, we've included a list of names of books for students interested in understanding more about the core ideas of modern and classical physics.

We sincerely hope that you enjoy reading the articles put together by the Neutrino club and again, would like to extend our heartfelt gratitude towards our readers.

Yours Sincerely
Arya Abhisri
(Editor in Chief)

Club Neutrino

TABLE OF CONTENTS

NEWTON'S QUESTION

BY ARYA ABHISRI XII A

Introduction

In the 1700s, Newton posed a question that had the scientific community questioning their previous understanding of space for the next two centuries. In his quest to understand space and its workings, he had given us the equations of gravity, but his thirst for knowledge hadn't been quenched. He posed a question about a bucket of water and a system of rocks. In this hypothetical situation, there were no celestial bodies in space, to affect the bucket in space. The two stones were to be connected by a string while the bucket was to be spun. Would the rope between the rocks tighten or remain slack?

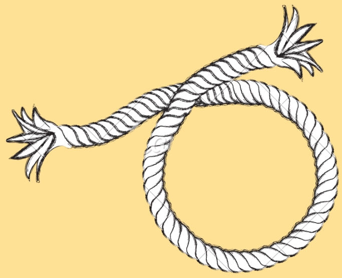
In other words, he asked whether a force would apply on the two rocks if there were no celestial bodies to take as reference. To make this idea easy to imagine, assume that instead of the original apparatus, there was an astronaut. When the bucket starts spinning, we are left to wonder the same question, will the astronaut feel the force?

This question is rooted in the idea that for us to measure velocity, we need a reference or the motion is meaningless. If we go to the implications of the velocity statement, and imagine ourselves in space, we wouldn't be able to tell if we are moving unless there was a force acting on us.

As we proceed in the article, it'll become easier for us to understand why these two statements are a problem. For now, let's keep our question in mind.

Will the rope tighten?

This article will follow up on how the scientific community took this question and how theories evolved from the classical era to its answer given at the beginning of modern physics. From Newton to Mach and finally Einstein, this question has had its fair share of popularity.



DID YOU KNOW?

We'v all heard the tale of Mr. Newton sitting under a tree contemplating life when an apple struck him on the head, simultaneously making a light bulb about gravity go off. The real story according to the man himself is that Newton was merely looking out the window when he happened to see the fruit drop. Even then, some Newton scholars think the story involving the apple was entirely made up.

Beginnings and Their Implications

Let's start with the relativity of velocity and its implications in regards to this question. Imagine that you are an astronaut in deep space with no celestial body insight, therefore no points of reference. In this situation, two inferences can be drawn, either you are moving or you are not.

Both the implications can be assumed to be true because you can't truly feel yourself moving, additionally, there's no stable object for comparison. You are an isolated being in space and there's no way for you to feel the velocity (constant velocity in and of itself implies that there is no force acting on you, so the astronaut can't feel anything).

This is where we come up with the statement about velocity being meaningless without a reference. How do we know that we are moving if we can't see or feel anything?
It is time for us to ask whether acceleration is similar.

Sir Isaac Newton

We disregarded velocity being innate because there is no 'force' acting on us; Therefore, we can't feel anything. The next question we should be asking ourselves is, whether acceleration is innate.

> Newton was grappling with the very foundation of motion and was far from ready to accept that accelerated motion such as spinning was somehow beyond the need for external comparison'
>
> -The Fabric Of Cosmos

A natural suggestion would be that we should consider the bucket as a reference itself, but this idea seems to fail from the first moment. From here on, to make the visual for the apparatus easier, we will be considering the concavity of water as a mark of centrifugal/ spinning force on the water (I know, we've changed this example multiple times, but that is to make the deductions easier to digest. All of the examples above are trying to represent the same thing: Is there a force?).

First, when we let the bucket spin, there will be an initial relative motion between the bucket and water, but the water will remain flat. On the other hand, when the water also starts spinning and becomes concave, the relative velocity between them becomes zero. This implies that, with the bucket as a reference, we get the opposite of our desired result. When there's a relative velocity, the water remains flat and vice versa. These contradictions result in us disregarding the bucket as a point of reference.

Mach and His Contributions

Newton's results had not been easily accepted by the scientific community. The idea of space; an empty, meaningless void, being an entity was not an assumption that was easily digestible. How could something empty, mean anything? Never mind, an absolute being that is a reference for all forces in the universe?

Due to lack of any other explanation and considering that Newton was the leading physicist of the century, the idea was begrudgingly accepted.

There was something off about the concept of space being absolute. In the situation that Newton presented, only two things that could be the possible points of reference, in which the bucket failed.

What about situations in which there are celestial entities available for comparison? What if acceleration means nothing in space? What if it only means something in the presence of mass(contrary to a belief that we have carried through the article till now)?

These are questions that Mach dealt with. He proposed a situation in which a man was standing in space and subsequently sent into a spinning motion. What is the meaning of this motion?

Mach's suggestions sent shockwaves through the scientific community. It was a theory that was readily accepted and provoked new ideas and thoughts.

He started with the statement that in space, acceleration is meaningless. To fully absorb this statement, imagine yourself in an empty dark room and no gravity. Will you feel a tug on your limbs insinuating that you are spinning?

He further proposed the following- The amount of force that the person will experience will be directly proportionate with the number of objects that are in space.

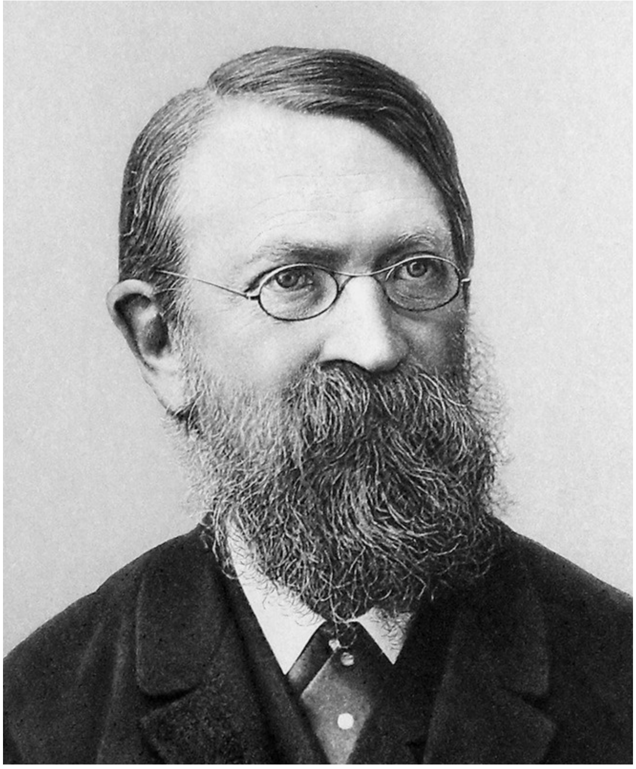
If you are swept away by this statement and feel that this theory gives us a solid working background, you are not the only one. Several scientists, including Einstein, were seduced by this theory.

Now that we have the two theories in our hands, let's go over them once.

Newton proposed that you would feel acceleration in space despite there being no reference object, while Mach proposed that acceleration is meaningless in space.

Newton said that space is an absolute being that we should use as a reference, while Mach proposed that the amount of force you experience will depend on the amount of matter in space. These theories, while persuasive, relied on no concrete evidence and left several questions unanswered.

That is until Modern Physics swept this theory and gave us an explanation that we follow to date.



Ernst Mach

Special Relativity

While this may seem like a tangent from the original train of thought, this immaculate theory will give us a working and concrete base to understand this question. For a few moments, I will have to ask you to forget what we have discussed so far to understand this theory.

Everything that has been theorized in physics has been due to questions that were left unanswered. The question for this theory was – What are the consequences of a finite speed of light, which is constant in all reference frames?

This question seemed to have no concrete answer until Einstein came into the picture. According to the previously known knowledge, theoretically, if you ran at almost the speed of light, you could scoop out a light beam and hold it in your fingers. This idea was proven otherwise.

But, when A comes back from the race, A complains that they could never approach the light beam since the light beam always seemed to travel away from them at the light speed.The discrepancy between their accounts gives us a seemingly impossible problem to solve. Here, Einstein gave us a revelation.

He had broken the assumption that space was absolute. To justify the problem and the solution, Einstein gave a theory in which both space and time are relative and fluid, not absolute. He said, in life, we not only travel through space but also time. In addition to this, the sum of our speeds in time and space is equal to the speed of light.

In the late 1800s, several experiments were conducted, in regards to the speed of light. The result drawn from this was, the fact that no matter how fast we run behind a light beam, the relative speed difference between us and the light beam will be equal to the speed of light; in other words, the light beam will always move away from us at light speed, no matter how hard we chase after it.

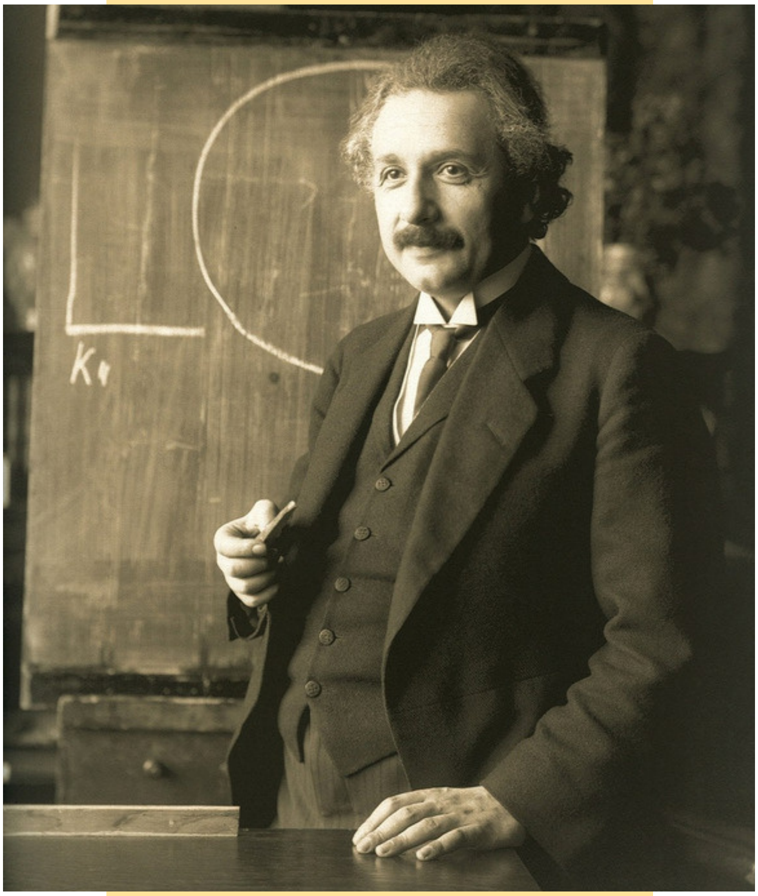
Let us play out a situation which explains what this means exactly. There are two people, A and B, that are on a playing field. Person B holds the stopwatch to time a race between A and light.
The race starts and A races after the light beam at half of the light speed. When B measures their velocities from an outside perspective, they say that A travels at half of the light speed.

To put this into perspective, assume that we have a limited amount of fuel to burn or use. Generally, we use most of this fuel in travelling through time. But when we try to increase our speed in space, we use the fuel being utilized by travel in time and reutilize it to speeding through space. Therefore, decreasing our velocity through time.
In conclusion, when we travel faster in space, we move slower in time(this is why time is considered the fourth dimension. When we move northeast, our velocity is divided between North and East, similarly, velocity also divides between space and time).

Apply this to the situation of persons A and B. For B, who is stationary and observing the motion, time moves at a normal rate, as he observes A and light race. But, for A, during the race, time moves slower than that of B. In A's perspective, it seems that light is still speeding away at full speed, but in reality, A's watch will be moving slower. Therefore, time is moving slower for him and that helps light speed away.

What we can derive from this theory, is that space is not a constant, like Newton had previously thought.

Combined travel between space and time is constant, therefore, space-time is a constant entity, not space itself.



Einstein smirking over student's pain

The Bucket, According to Special Relativity

While the relativity of space and time is revolutionary, we have to remember that not everything in Relativity is relative. Space-time provides us with a steady backdrop that we can use as a reference for acceleration.

With a surmountable amount of evidence, this theory is irrefutable and provides concrete evidence. It answers all questions that can arise while questioning the universe and its nature.

Therefore, space-time becomes a reference in the original question.

So, will the rope tighten?

Yes, it will.

GRAVITATIONAL WAVES

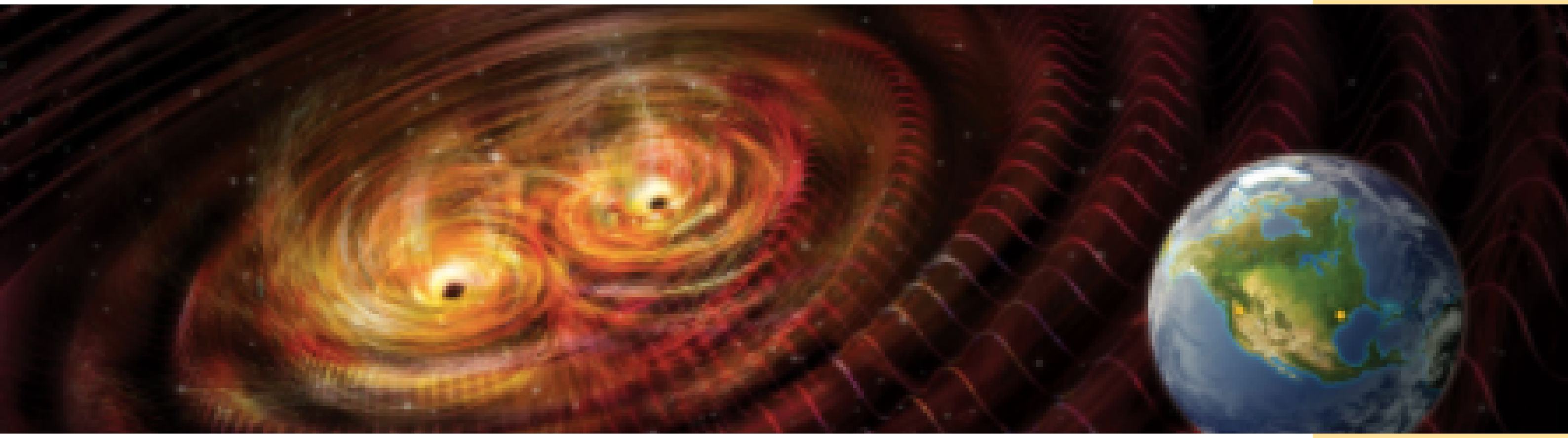
BY AMISHI CHAUHAN IX B

A gravitational wave is an invisible (yet incredibly fast) ripple in space. We've known about gravitational waves for a long time. More than 100 years ago, a great scientist named Albert Einstein came up with many ideas about gravity and space. So what do gravitational waves mean?

Gravitational waves are 'ripples' in space-time caused by some of the most violent and energetic processes in the Universe.

Gravitational waves transport energy as gravitational radiation, a form of radiant energy similar to electromagnetic radiation. Newton's law of universal gravitation does not predict their existence, since that law was formulated with the assumption that physical interactions propagate instantaneously (at infinite speed) – showing one of the ways in which Newtonian mechanics fail to explain phenomena associated with relativity.

Gravitational-wave astronomy is a branch of observational astronomy that uses gravitational waves to collect observational data about sources of detectable gravitational waves such as colliding pairs of black holes and neutron stars.



Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity. Gravitational waves are disturbances in the curvature of spacetime, generated by accelerated masses, that propagate as waves outward from their source at the speed of light. They were proposed by Henri Poincaré in 1905 and subsequently predicted in 1916 by Albert Einstein.

In 1993, Russell A. Hulse and Joseph Hooton Taylor Jr. received the Nobel Prize in Physics for the discovery and observation of the Hulse–Taylor binary pulsar, which offered the first indirect evidence of the existence of gravitational waves. The discovery of gravitational waves was a very important event in the history of physics as gravitational waves can be used to observe systems that are invisible (or almost impossible to detect) to measure by any other means.

Even we can create these waves. Every massive object that accelerates produces gravitational waves. This includes humans, cars, airplanes etc., but the masses and accelerations of objects on Earth are far too small to make gravitational waves big enough to detect with our instruments. So what are the techniques to detect these waves and the answer to this question was the LIGO.

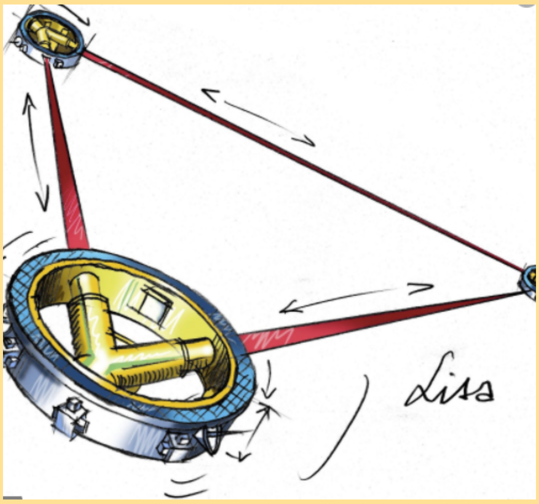
LIGO

LIGO stands for "Laser Interferometer Gravitational-wave Observatory". It is the world's largest gravitational wave observatory and a marvel of precision engineering. LIGO is so precise that it's even sensitive to nearby moving trucks and earthquakes. At its most sensitive state, LIGO can be able to detect a change in distance between its mirrors 1/10,000th the width of a proton! This is equivalent to measuring the distance to the second nearest star to the Earth (some 4.2 light years away) to an accuracy smaller than the width of a human hair. To reduce noise in the data, the desert of Eastern Washington, and the forests of Louisiana were chosen as the locations of the two LIGO detectors. India's first LIGO detector is to come up in Hingoli, Maharashtra. It will be the third such detector in the world and the first outside the United States.

LIGO announced the first-ever observations of gravitational waves in 2016 and has now made a total of 50 gravitational wave detections (as of 2019). LIGO made the find in collaboration with the Virgo gravitational wave observatory (the Virgo is a large interferometer located in Italy).

The observation was made five months earlier, on 14 September 2015, using the Advanced LIGO detectors. The gravitational waves originated from the merging of a binary black hole system. After the initial announcement the LIGO instruments detected two more confirmed, and one potential, gravitational wave events.

The future of gravitational wave astronomy is bright, with plans of an interferometer in space, named LISA (Laser Interferometer Space Antenna) which will remove noise from the data and allow us to listen to the tunes of gravitational waves from distant supernovae and maybe even the Big Bang itself.



GUTS AND TOES

BY RANAV SETHI X E

The crowning achievement of physics and what would be the greatest scientific achievement of all time - the Theory of Everything (TOE) has been long sought after. Tis theory would be able to explain the deepest and most philosophical questions ever asked. Not only would it resolve the question of time, but would also explain what our universe really is and how it came to be. Another exciting prospect it holds is the discovery of the multiverse; something which can help us understand the laws of physics magnitudes better.

Now let's try to explain what this theory really is, however we must first explain what a Grand Unified Theory (GUT) is.
Keep in mind the four fundamental forces of the universe: the strong force, the weak force, the electromagnetic force and the gravitational force.

To start off their quest, physicists thought of a particle as an excitation in a field that permeates the entire universe (like the electron can be thought of as an excitation in the electron field). Known as the Quantum Field Theory, it successfully explained and predicted several phenomena, and is also responsible for great advancements in technology (like maglev trains). This accurately defined three of the four forces of nature (excluding gravity).

A Maglev Train

DID YOU KNOW?

Einstein began to search for a unifying theory in the 1920s, a quest on which he never gave up, right up to his death in 1955

The unification of these three forces (the electromagnetic, weak and strong forces) into one single force is what we call the Grand Unification Theory. None have been tested, however several promising theories do exist. It is this potential incorporation of gravity along with the other three forces which we are after - which we call the Theory of Everything.

Yet another problem was - that the three remaining forces already had particles which carried them (the W and Z bosons for the weak force, the photon for the electromagnetic force, and the gluon for the strong force), but there was no particle for gravity, and when a hypothetical particle (named the graviton) was created, it simply didn't work and the mathematics just broke down and spat out infinities.

Thinking of force carriers as points simply did not work. It is important to remember here, that gravity is an effect caused by the warping of spacetime and is incredibly different from other forces.

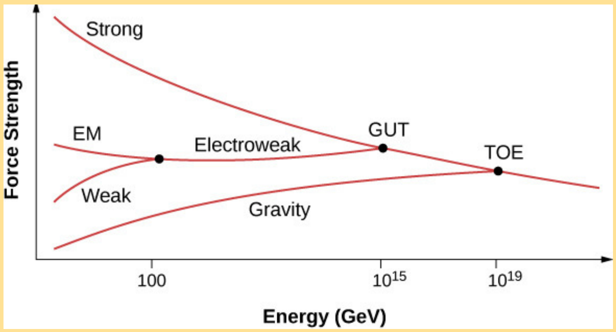
And so, physicists got desperate and did what they do best: think. And so, String Theory was born. This famous theory explained elementary particles as vibrations of a string. Similar to how a guitar's strings will produce different notes when strung - different vibrations of the string would give you different particles. However, it came with its own strings attached.

Much of the math involving the string theory worked out in 10 dimensions, something that could never fit in our 4 (three spatial, one temporal) dimensional world.

The concept failed to be explained in never fit in our 4 (three spatial, one temporal) dimensional world

Scientists tried to remove the additional six dimensions from the final computations - but they did so to no avail.

However, this does not mean that it has no use - it can tell us a lot of phenomena that may eventually lead us to the Theory of Everything, not to mention that the mathematics involved in it is completely correct.



The energies at which different forces unite

Several upcoming candidates have also proposed their versions of the theory - with some concerning the removal of concepts such as time from the calculations, but the Theory of Everything still continues to elude us.

We may still not know the true nature of reality, and much about our universe - but it's the passion with which we chase the answers, which defines our species and will ultimately help us succeed.

SERENDIPITY IN SCIENCE - NOT SO RARE

BY VANI TYAGI X F

If I asked you to name the greatest inventor of all times, you would probably say something like Nikola Tesla, Archimedes, Thomas Edison, maybe even Leonardo da Vinci. Now, had I inquired about the same to Mark Twain (an extremely famous American humorist, journalist, lecturer and novelist), he would have replied, “Accident”. How could ‘accident’ ever relate to Physics you might think. Nothing can even come close to the precision with which Physics enables you to understand the world, it is based on accuracy and careful analysis. In contrast, accidents seem irregular and odd, don’t they? Nevertheless, some of the most profound discoveries in Physics have been made by pure serendipity.

Let’s start with something that can make the invisible visible, shall we? It was the year 1895, when physicist Wilhelm Conrad Röntgen became the first person to observe X-rays, a significant scientific achievement. This discovery occurred accidentally in his lab in Wurzburg, Germany where he was testing whether cathode rays could pass through glass or not. It was then that he noticed a glow coming from a nearby chemically coated screen. The rays that caused this glow were dubbed X-rays by him due to their unknown nature (like X-men!).

Now, an X-ray or X-radiation is a penetrating form of high energy electromagnetic radiation. They act similar to light rays, but at wavelengths approximately 1000 times shorter (from 10 picometres to 10 nanometres). Röntgen, through a series of experiments, learned that X-rays penetrate human flesh, but not higher-density substances such as bone and lead. Thus, it was possible to photograph various human bones.

This was termed a medical miracle and X-rays soon became an important diagnostic tool in medicine as it allowed doctors to see inside the human body without surgery for the first time ever. They were initially used in 1897 on a military field to find broken bones and bullets inside the body. It all sounded pretty good, so it was used extensively, but unlike the benefits, the harmful effects of being exposed to radiation (burns, skin cancer and various other skin diseases) for prolonged periods of time were not realised until a long time after.

Wilhelm Conrad Röntgen

Wilhelm Röontgen remained modest and never patented his discovery even after receiving various awards and the first Nobel Prize in Physics (in 1901).This technology has today benefitted millions. It is widely used in medicine, airport scanners and material analysis.

Now that we have covered making the invisible visible, let us move on to an inexplicable yet persisting ‘hum’. It was on the 20th of May, 1964 that American radio astronomers Robert Wilson and Arno Penzias discovered the cosmic microwave background (CMB). The cosmic microwave background refers to radiation from an early stage of the universe.

It is a faint glow of light that fills the universe, falling on Earth from all directions with a uniform intensity. CMB began saturating this universe almost 380,000 years after its creation.

In the beginning, they could make neither head nor tail of it and considered it to be of least significance. It wasn’t until after they had exhausted every possible explanation for the sound’s origin did they understand that they had stumbled upon something big.

And it was indeed big. No, it was huge! They had just discovered the thermal echo of the universe’s explosive birth! This put the Big Bang Theory which suggested that the cosmos had grown from a single point 13.8 billion years ago on solid ground at a time where it had another theory as its competitor - the Steady State Theory. It opposed the Big Bang Theory and stated that the universe had always existed and was expanding due to the hydrogen that was continuously produced.

The two radio astronomers won the 1978 Nobel Prize in Physics for their work, sharing the award with Soviet scientist Pyotr Kapitsa (best known for his work in low-temperature physics).

Holmdel Horn Antenna

The Horn Antenna was built in 1959 as part of NASA's Project Echo. Rather than using powered satellites for communication, as is done today, Project Echo involved placing 30- to 40-meter spherical balloons in orbit and bouncing microwave signals off them.

This may seem like a really long period of time on the human timescale but, is actually like a blink of the eye as compared to the age of the Universe, which is a whopping 13.8 billion years old!

Bell Labs' Holmdel Horn Antenna in New Jersey was originally constructed in 1959 to support Project Echo and NASA’s passive communication satellites. However, it picked up an odd buzzing sound that came from all parts of the sky at all times. This puzzled Wilson and Penzais who did their best to remove all possible sources of interference including the pigeons in the area as they pooped on the radio antenna.

And it was indeed big. No, it was huge! They had just discovered the thermal echo of the universe’s explosive birth! This put the Big Bang Theory which suggested that the cosmos had grown from a single point 13.8 billion years ago on solid ground at a time where it had another theory as its competitor - the Steady State Theory. It opposed the Big Bang Theory and stated that the universe had always existed and was expanding due to the hydrogen that was continuously produced.

VIKRAM SARABHAI

BY ANANYA SINHA XII D

"He who can listen to music in the midst of noise can achieve great things"

Aptly quoted by Vikram Sarabhai, the founder of the Indian National Committee for Space Research which was later renamed the Indian Space Research Organisation (ISRO). Vikram Ambalal Sarabhai was born on the 12th of August, 1919 in Ahmedabad, India. He belonged to a family of industrialists who were known for the social work that they did for the underprivileged fraction of the society.

Vikram Sarabhai was an Indian physicist and also an industrialist who ignited the spark for research in space, inspiring innumerable and helped develop nuclear power in India.
He attended Gujarat College in Ahmedabad, but later shifted to the University of Cambridge, England, where he took his tripos in natural sciences in 1940. He was forced to return to India owing to the Second World War, where he undertook research in cosmic rays under the Doctoral guidance of physicist Sir Chandrasekhara Venkata Raman at the Indian Institute of Science, Bangalore (now Bengaluru).

Sarabhai returned to Cambridge to pursue a doctorate in 1945. At Cambridge in 1947, he wrote a thesis: 'Cosmic Ray Investigations in Tropical Latitudes,'. On his return, after the independence of India, understanding the need of the hour, Vikram Sarabhai solicited a charitable trust for the research work in the field of Science. This was the genesis of the Physical Research Laboratory in Ahmedabad which is an extraordinary institute for research in space and science.

Dr Sarabhai had a wide spectrum of interests that were remarkable. It ranged from his intense involvement in scientific research to his active interest in industry, business and development issues. He set up the Operations Research Group, the first market research organisation in the country. He had founded in 1947, an association for the research in textiles in Ahmedabad which came to be known as Ahmedabad Textile Industry's Research Association. He looked after its affairs until 1956. He felt the need for professional management education in India and therefore was instrumental in setting up the Indian Institute of Management in Ahmedabad (IIM) with Kasturbhai Lalbhai in 1962.

Vikram Sarabhai

He had founded in 1947, an association for the research in textiles in Ahmedabad which came to be known as Ahmedabad Textile Industry's Research Association. He looked after its affairs until 1956. He felt the need for professional management education in India and therefore was instrumental in setting up the Indian Institute of Management in Ahmedabad (IIM) with Kasturbhai Lalbhai in 1962.

Vikram Sarabhai was unstoppable until he persuaded the government of India to set up the Indian Space Research Organization. This was soon after the launch of Sputnik, the Russian satellite. He, at the young age of twenty-eight proved to the government that India could be in the league of nations stepping on the moon and advancing their scientific database and research work.

After establishing ISRO, Sarabhai set up the Thumba Equatorial Rocket Launching Station in southern India aided in his ordeal by another world-famous physicist Homi Jehangir Bhabha. Sarabhai was appointed chairman of the Atomic Energy Commission of India after the unforeseen daunting death of Homi Bhabha in 1966.

Sarabhai carried forward Bhabha's work in the field of nuclear research. He established and developed India's nuclear power plants. He can be credited to have laid the foundations for the indigenous development of defence nuclear technology.

Sarabhai initiated programs for the education of people residing in remote villages through satellite communication. This called for the development of satellite-based remote sensing of natural resources. He was determined to apply all aspects of science and technology for the amelioration of the people. Vikram Sarabhai was also the vice-president of the fourth UN Peace Conference held in 1971 where the topic of concern taken up was 'Peaceful Uses of Atomic Energy.'

DID YOU KNOW?

The lander on India's moon mission Chandrayaan-2, which was to land near the South Pole of the moon on September 20, 2019, was named Vikram in his honour.

30th of December, 1971, was a dark day for the world when one of her most admired and remarkable scientists was lost. Dr Vikram Sarabhai died at Halcyon Castle, Kovalam in Kerala post a cardiac arrest. This is said to have happened when he was visiting Thiruvananthapuram to lay the foundation stone in Thumba Equatorial Rocket Launching Station.

Vikram Sarabhai was instrumental not only for development in science but also for innovation in business. Dr Sarabhai's exceptional contributions in space research gave him recognition as the Father of the Indian space program. He was the creator and innovator of a number of institutions in varied fields including but not limited to space, nuclear energy, arts, education and management. Dr Sarabhai set up a project for the fabrication of an Indian Satellite. This plan was executed and using a Russian Cosmodrome, the first Indian satellite, Aryabhata, his brainchild was put in orbit in 1975. It was largely Dr Sarabhai's efforts that the television was introduced in India. His steady communication with NASA formed the backbone for the establishment of the Satellite Instructional Television Experiment in 1975. This was followed by the coming in of cable television in India.

The perspicacious Vikram Sarabhai was awarded two of India's highest honours, the Padma Bhushan (1966) and the Padma Vibhushan (awarded posthumously in 1972).

BOOK RECOMMENDATIONS

THE NEUTRINO EDITORIAL BOARD

TECHNICAL

HC Verma
For classes 9- 12, comprehensive with emphsis on IIT

University Physics Textbooks
By Hugh D. Young, Highly recommended for 11th and 12th graders

The Feynman Lectures
Great for everyone, more effective for 11th and 12th graders (Volumes 1,2,3)

Philosophy of Physical Science
By Arthur Eddington

What is Life?
By Erwin Schrödinger

POPULAR SCIENCE

A Brief History of Time
By Stephan Hawking, Must read for all physics enthusiasts

Brief Answers to the Big Questions
By Stephan Hawking, Must read for all physics enthusiasts

In Search of Schrodinger's Cat
By John Gribbin

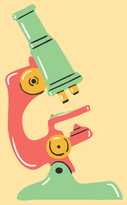
The Elegant Universe
By Brian Greene, covers string theory and related physics

Astrophysics for People in a Hurry
By Neil deGrasse Tyson

IN BETWEEN

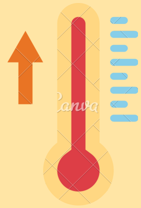
The Theoretical Minimum Series
By Leonard Susskind, Volumes 1,2,3

QED: The Strange Theory of Light and Matter
By Richard Feynman



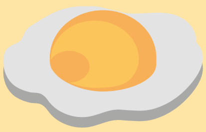
PAUSE AND PONDER

Q1 Is there a maximum possible temperature?



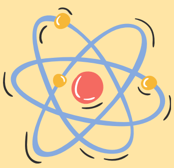
Q2 What if we combine DNA storage with machine learning? Will these computers be alive?

Q3 When you heat an egg why does it become solid and not gas?



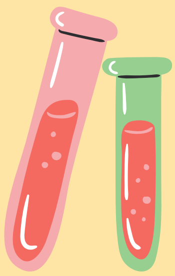
Q4 What makes some particles unstable and other stable?

Q5 How will you make a black body emit radiation of high intensity of just one colour?



Q6 Are electrons identical in mass, size, shape etc? If so why?

Q7 Why do atoms constantly vibrate?



CREDITS

Editorial Team

Arya Abhisri (Editor in Chief) XII A

Ananya Sinha XII D

Avyukt Sachdeva XII A

Krishh Chaturvedi XI B

Shivang Verma (Technical Incharge) XI D

President *Kartikeya Tomar XII D*

Vice President *Shantanu Misra XI B*

Teachers in Charge

Ripple ma'am

Shampa ma'am

Nidhi ma'am

Vrinda ma'am

The articles in this magazine were primarily written by the members of the physics club, however you (yes, you!) can also have your articles published. ***You don't need to be a member of the physics club in order to submit articles, nor do you have to be in senior school****. Articles can be about various topics like: recent discoveries and inventions, experimental physics, black holes, scientists, light, electronics, or anything under the sun that's related to physics. Just be sure to send your articles to:* ***neutrinoeditorial@gmail.com.*** *We look forward to reading your articles.*

Contact Us At

Gmail : neutrinoeditorial@gmail.com

Arya   9953986061

Ananya   7042307779

Avyukt   9818112820

Krishh   9873233906

Shivang   8527476464