The Neutrino Journal

Club Neutrino

The Physics Club

Sanskriti School

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HOW SHOULD A CLUB BE?

With the somewhat naive expectation that some of our members will actually read this journal, I wanted to take a moment to talk about the club, this journal, and their futures.

How should a club be? I've spent 12 years in Sanskriti, and all our clubs have the common denominator of not meeting the base requirement of a club: our clubs do not in any way further our intellectual and academic interests. Nor do they offer any crevice of new exploration and discovery. In short, they do not in any way further the value of the study which has been attributed to them. This is the only requisite- make a club where people can engage with each other. A place where people can find what matters to them, and try to become brilliant at it- instead of merely adequate.

I take responsibility for our failures. Running a club is hard. Taking initiative is harder. It shouldn't have to be that way for you. People who are passionate about this study deserve a place that offers value and the promise of intellectual stimulation.

When we introduced this journal, I thought that it would encourage members to do some reading of their own. To leave school and explore beyond the bare minimum- to go an extra mile. Maybe some of you are genuinely interested in physics. The journal was meant to give you a place to display your study, to further it. And to use the skills you gain in that process as stepping stones to greater accomplishments.

Which brings us back to the Journal. I initially thought that asking (forcing?) you to write articles for a journal like this one would allow (force?) you to dive deeper into things. And also perhaps help you find something that makes you lose all track of time – something that genuinely halts the traffic in your brain and confronts you with a challenge that seems at the same time impossible and meaningful. It is possible. Most of you will eventually find something similar in your life. This was meant to accelerate the process the best way the Physics Club could, for the people who wanted to be become masters of the subject. I do not think we have accomplished that.

And that's why you're here. If any of you actually care enough to aspire to a club that platforms discussion, serious study and real thought, know that it is not impossible. But it is also up to you to accomplish that, because no one else is going to try. The upsides of learning- more skill, more nuance, more opportunities for academic showboating- far outweigh the cost. It just takes a little bit of effort and initiative every day.

I guess all I'm asking you to really do is engage- just try a little harder. Just care a little more. Pay attention and think. We have a tendency to see through most things in our line of sight. Stop. Stare. Look hard. Come to the physics club and try to learn something, or teach something. And when you've gained some knowledge, share it with your peers- at least the ones who want to know. Be a community. Get something out of this place that justifies your desire to be an engineer or a scientist. Because nothing you learn in school is enough. So at least come here and try to be a more intelligent human being. Without that effort "Neutrino-The Physics Club" will never be different/better.

That’s all I really have to say. I hope you’ll consider it.

Shreya Singh

(Vice President, 2018-2019)

Letter to the reader

Dear Reader

In the chaotic world of today where vibrant diversity and self-centred indifference have taken possession of the human being, there is a significant exodus of people from the materialistic races of the world to quieter, calmer pursuits such as those related to spirituality and relevant practices.

In effect, physics in its truest form provides a similar kind, if not a heightened sense of the same sense of peace, order and symmetry. A deeper contemplation with regard to the discipline, many figurative miles away from textbooks, academic aspirations and examinations, often seems to open out new dimensions of the mind even as one turns the pages of a book or operates an instrument of experimentation.

As Editor of this journal for the past year and a member of the club for the past three years, if there's one thing that I personally have learnt and would like to convey to anyone stepping into this field in whatever capacity, it is this: see physics not mechanically as an arduous bunch of concepts, relations and equations, but rather as a higher level of consciousness and a means to understand the complex philosophy that underlies the laws and patterns of nature. This perspective, when applied to one's learning, brings out some of the most rewarding experiences known to humans- quite like the quiet ecstasy that all great physicists in history must have had the fortune to live with as a result of their work.

The month of November brings us the opportunity to release the third issue of Club Neutrino's quarterly publication. Through this issue, we invite you to the intricacies of modern science's understanding of time travel, some of the work in the field that was awarded the Nobel Prize earlier this year, along with a glimpse at several other areas of physics that our club members feel passionate about.

Once again, we hope you shall enjoy reading this issue of our journal, and we extend our heartfelt gratitude to each and every reader.

May the passion for learning stay eternal.

Warm regards

Niharika Mukherjee

(Editor, the Neutrino Journal)

Information Paradox- Stephen Hawking's Last Paper

By Abhayraj Samir Palande

Black holes have always been a matter of great wonder. A heavenly body so powerful it doesn't even let light escape (according to Einstein's equations nothing is faster than light). So anything that comes close to the black hole, it will be immediately sucked. So have you ever wondered what happens to that thing next?

Stephen Hawking's last paper deals with this question.

A black hole is created when a star which has a mass 1.4 times or more than the mass of our sun runs out of 'fuel'. Every star runs out of energy at the end of its lifespan, but the final form which it will take be it a black hole or a neutron star solely depends on its mass.

A particle will only get attracted towards to a black hole when it passes beyond its event horizon. It's just like an instance wherein you are near a cliff. If you go beyond the cliff, you will plunge downwards (i.e. towards the black hole) where there is no point of returning back due to the heavenly body's humongous gravitational force.

Many theories have suggested that if you enter a black hole you'll turn into spaghetti or end up in a place characterised by different space and time.

Hawking theorized that due to entropy (meaning the various ways in which an atom(s) can be placed in a system) of a black hole, whatever goes beyond the event horizon will be consumed and the entropy of the black hole changes. This change in entropy is recorded by the photons that are just at the event horizon (the ones hanging on the cliff). When a black hole evaporates(yes , they evaporate.- bigger the black hole, quicker it goes away), information of entropy is released- as a result it spits out everything.

String theory

By Satvik Shankar

The String Theory takes us much before even the Big Bang is supposed to have started. It says that we don't live in a universe- rather, we live in a multi-verse. All this starts from the Einstein FieldEquations (EFE) or The Theory of Relativity.

Albert Einstein concluded that the faster you move through space, the slower you move through time.This gives us a relation between speed and time-

SPEED IS INVERSELY PROPORTIONAL TO TIME.

The string theory states that each and every particle is made up of strings even at the atomic and molecular level. Even light, for instance, is made up of strings. For explaining the string theory however, I first need to explain the basics of the theory of relativity.

The theory of relativity: This is also known as the special theory of relativity, determining that the laws of physics are the same for all non-accelerating observers. This is shown by the observation that the speed of light within vacuum is the same irrespective of the speed at which an observer travels.

The string theory:String theory assumes that we live in a multiverse with at least 10 dimensions. It is based on a cosmological theory on the existence of cosmic strings.String theory was first studied in the late 1960s as a theory of the strong nuclear force, before being abandoned in favour of quantum chromodynamics.

It later developed into the superstring theory, which proposes a connection called super symmetry between bosons and the class of particles called fermions. Another issue is that the theory is thought to describe an enormous landscape of possible universes, and this has complicated efforts to develop theories of particle physics based on string theory. String theory describes how strings propagate through space and interact with each other. One of the main developments of the past several decades in string theory was the discovery of certain dualities, mathematical transformations that identify one physical theory with another.

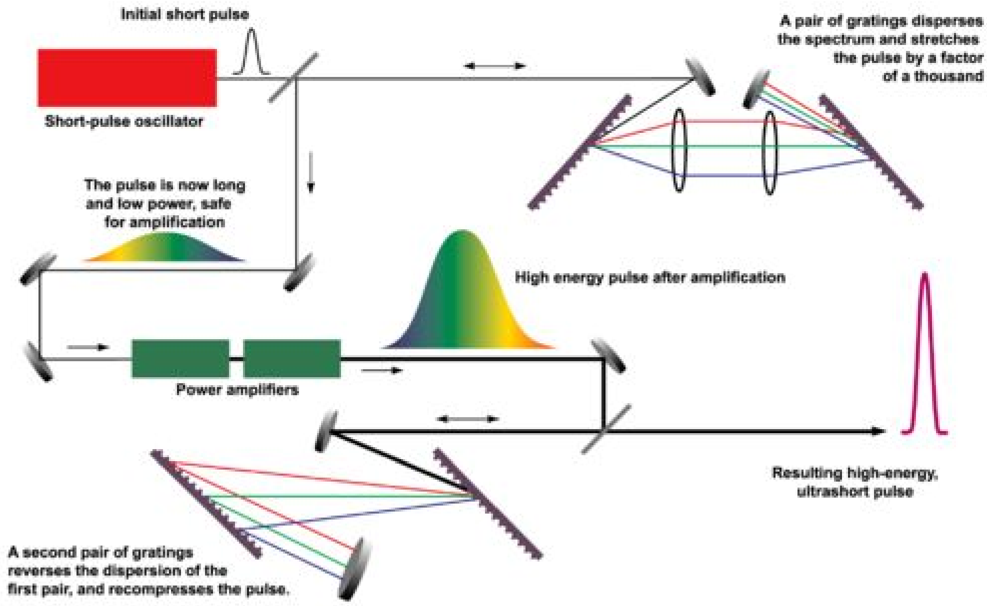
Extra dimension: In spite of the fact that the universe in well described by a four-dimensional space-time, there are several reasons why physicists consider theories in other dimension. In bosonic string theory, space-time is 26 dimensional, where as in super string theory it is 10 dimensional.

I would finally say that this can eventually lead to what we all think of today as time travel and teleportation.

Chirped Pulse Amplification

By Avyukt Sachdeva

Two researchers with ties with the University of Rochester, New York, have won the 2018 Nobel Prize in physics for their ground-breaking work with lasers. Donna Strickland and Gérard Mourou have developed a technique called chirped pulse amplification, which makes it possible to generate high-intensity, ultra-short optical pulses.



How it happens

Mourou and Strickland demonstrated what has been described as a stunning advance in laser power, with a table-top terawatt laser. At the time, the peak power of laser pulses was limited because of the serious damage the pulses caused to the material used to amplify them. The technique that Strickland and Mourou developed takes a short laser pulse, stretches it, amplifies it and squeezes it together again.

Applications

The development of chirped pulse amplification by Gérard and Donna has created numerous new applications in science and industry and has catalyzed research around the world in high peak power lasers. The research that led to the Nobel Prize was conducted at the Laboratory for Laser Energetics and highlights the quality and innovation that has long characterized the University's contributions to optics and laser science. The breakthrough made it possible to create very precise laser systems.

The applications of the technology include Lasik eye surgery, semi-conductor manufacturing, and solid state hard drives.

General Relativity vs Quantum Mechanics

By Shreya Singh

What if the universe were entirely empty except for two astronauts? One of them is spinning, the other is stationary. The spinning one feels dizzy, doing cartwheels in space. But which one of the two is spinning? From either astronaut's perspective, the other is the one spinning.

Originally credited to Einstein, this thought experiment has fuelled the emergence of two broader schools of physics: General relativity and Quantum Mechanics, which have long been thought to be incompatible and fundamentally different. Physicists typically separate Quantum Mechanics and General Relativity because the two usually operate on vastly different scales. Quantum mechanics, for instance, was unknown to science for so long because it normally becomes important only on the scales of atoms. Relativity, on the other hand, tends to be important in strong gravitational fields. Time, for instance, gets slowed near the surface of the earth compared to far away; light gets bent around clusters of galaxies. These effects can be *largely* ignored unless you're talking about the surfaces of neutron stars and the like. In other words, General Relativity typically operates on large scales, from stars all the way on up to the entire universe. General relativity is what's known as a classical field theory, which describes the universe as a continuous distribution of numbers – exact numbers, if you had the tools precise enough to measure them – that can tell you all about the curvature of space-time everywhere and every when. The curvature, in turn, is described completely and exactly by the distribution and motion of mass and energy. As John Wheeler famously put it: Mass tells space-time how to curve, and space-time tells mass how to move.

But quantum theories are totally different. In quantum theories, particles interact by sending particles between them. Electricity, for instance, sends photons between charged particles, the strong force uses gluons, and the weak force uses the W and Z bosons.

An example of this is the famous "double-slit experiment." The experiment involves shooting a beam of electrons (or photons, or any other particles) through a screen with two small slits etched out. Because of quantum uncertainty, there is no way to figure out which slit a particular electron travels through: An electron literally travels through both slits at once. While this theory is hard to reconcile with what we know about everyday physics, in the context of gravity, it gets even stranger. If the electron goes through one slit, it presumably creates a very slightly different gravitational field than if it goes through the other. It gets even stranger when you realize that according to

Wheeler's delayed choice experiment it's possible to set up the experiment so that *after* you've already run the experiment, you can retroactively observe the system and force the electron to travel through one slit or another (though you can't choose which). Put another way, the world of gravity is supposed to be entirely deterministic, but quantum mechanics is anything but.

But while Physicists don't yet have a theory of quantum gravity, they do have some idea of what a successful theory must be like. For instance, there needs to be a graviton, and because gravity seems to be able to extend over all space, the graviton (like the photon) needs to be massless. Massive mediators (like the W and Z bosons) can only operate over a very short range.

Surprisingly enough, it turns out that there is a unique relationship between classical and quantum theories. For instance, electromagnetism is generated by electric charges and currents. The sources are described mathematically by a vector, and it turns out that vectors produce spin-1 mediator particles. It turns out that mediators with odd spin produce forces in which like particles repel. And indeed, two electrons will repel one another.

General relativity, on the other hand, is known as a "tensor theory" because there are all sorts of sources related to the pressure and flow and density of an energy distribution. The quantum versions of tensor theories have spin-2 mediator particles. So whatever else, the graviton will be spin-2. And, even spin mediators *attract* like particles.

In the battle between General relativity and Quantum mechanics, physicists tend to award more credibility to the quantum side. That Quantum Mechanics is more fundamental than relativity is has been the prevailing view ever since the

1920s, when Einstein tried and repeatedly failed to find flaws in the counterintuitive predictions of quantum theory.

From a seasoned perspective however, the real issue is not general relativity versus quantum field theory, but classical dynamics versus quantum dynamics. Relativity, despite its perceived strangeness, is classical in how it regards cause and effect; quantum mechanics most definitely is not. Einstein was optimistic that some deeper discoveries would uncover a classical, deterministic reality hiding beneath quantum mechanics, but no such order has yet been found. The demonstrated reality of spooky action at a distance argues that such order does not exist. The reconciliation exists not between quantum mechanics and general relativity, but fundamentally, between idea and perception.

Time travel

By Vidhi Sagar

The answer is yes. We all travel in time. For example, during the last year I moved forward one year and so have you. But the real question is, can we travel in time faster or slower than this?

The answer again is surprisingly yes. But unlike in movies or fiction, it is the concept of movement between certain points in time analogous to movement between different points in space by an object or a person. According to Albert

Einstein's theory of 'special relativity', space and time are really the aspects of the same thing-- space-time.

There's a speed limit of 300,000 kilometres per second for anything that travels through space-time,and light travels the speed limit through empty space.

Special Relativity also says that a surprising thing happens when you move through space-time, especially when your speed relative to other objects is close to the speed of light. Time goes slower for you than for the people you left behind. You won't notice this effect until you return to those stationary people.

So if you were 15 years old when you left Earth in a spacecraft traveling at about 99.5% of the speed of light (which is much faster than we can achieve now), and celebrated only five birthdays during your space voyage. When you get home at the age of 20, you would find that all your classmates were 65 years old, retired, and enjoying their grandchildren! Because time passed more slowly for you, you will have experienced only five years of life, while your classmates will have experienced a full 50 years.

Therefore, traveling forwards in time is easy but there’s only one problem for anyone wishing to get a glimpse of the future – getting back. It would mean travelling faster than light – and that’s not possible.

Some scientists believe that traveling back in time (past) is theoretically impossible.

Physicist Albert Einstein showed that time is an illusion; it is relative — it can vary for different observers depending on their speed through space. To Einstein, time is the "fourth dimension." Space is described as a three-dimensional arena, which provides a traveller with coordinates — such as length, width and height —showing location. Time provides another coordinate — direction — although conventionally, it only moves forward.

Hence we don't really understand the science behind travelling in past, but if wormholes and the theories related to them are possible, then maybe… Maybe.

From the lab: Physics News

By

Shriya Mishra

1-The conversion of neutrons and other baryons to a quark gluon plasma in blue supergiant stars could lead to supernovae explosions, concludes David Blashcke of the University of Wroclaw and an international team of astrophysicists, who have calculated that such events could be observed via the distinct neutrino signals they emit.

At the end of their lives, blue supergiant stars, which can be over 50 times the mass of sun, may collapse to form remnants partly compromising a sea of free quarks and gluons. These events, which would emit to powerful neutrino pulses in rapid successions, could help to explain how such stars can undergo supernova, when some conventional models suggest that they should just form black holes.

2-The halo of the Milky Way mainly comprises of remnants of pre-formed structure of stars that merged into our galaxy 10 billion years ago, researchers in France and Netherlands have concluded. The researchers studied new data from ESA's Gaia space observatory, alongside spectral information from the Sloan digital sky survey, and they concluded that the stars from the object, which they have termed Gaia- Enceladus, are chemically and kinematically distinct from other stars that formed from dusts and gas in our galaxy.

3- A thought experiment proposed more than 50 years ago by Richard Feynman has finally been realised by physicists in the us and China. Feynman's ratchet is a microscopic heat engine that converts thermal fluctuations into work when connected to two heat sources at different temperatures.

Although the device has a very low efficiency , it's creators believe it can be used in a number of applications, such as providing a better understanding of molecular motors that drive living cells.

4- Neutrino fluxed generated by nuclear reactions inside the sun have been measured more precisely than ever before using a detector housed under the Gran Sasso mountain in central Italy, the Borexino collaboration has captured neutrinos from four different reactions involved in the reaction of helium 4 from hydrogen.

5-Hawaii's Supreme Court has ruled that construction of the protest hit thirty metre telescope can begin.

The TMT will be one of the world's largest ground based telescope with a 30 m primary mirror that is made up of 492 hexagonal segments. The structure that will house the telescope will be 66m wide and 56m tall.

6- A physicist demonstrated how to describe the shape of a symmetrical wormhole- a black hole that can theoretically be a kind of portal between any two points in space and time- based on its wave spectrum. The RUND institute of Gravitation and Cosmology showed that the shape and mass of a wormhole can be calculated based on the red shift value and the range of gravitational waves in high frequencies.