THE PHYSICS CLUB NEWSLETTER

NEUTRINO BREW

THE END OF THE START

And so ends the year of unwanted surprises (and also the first two months of what we hope to be the year of order but let's not go there). Those of us who have lived through both SST in ninth and tenth as well as 2020 can truly say that we can live through almost anything. This year took away a lot of opportunities from all of us, but it's also important to remember all the opportunities that it gifted us. We had more time on our hands than ever before (maybe that's why everyone's report cards look so great ._.), and we could finally devote a lot more time to things like music, art and recreation in isolation.

This year Neutrino also experimented a lot. Reading, writing, editing and formatting articles for this magazine has been a pleasure for most who participated and we can say without a doubt that this would be continued in the next session, though without our Head Editor to clean things up, it would surely be much harder. We also played around with the idea of webinars and thought of some amazing things for the next session, which hopefully will be offline. I would like to take this moment to thank everyone in the editorial board as well as everyone in Neutrino who made this year the success it has been.

In the end, each year brings with it its ups and downs; the best thing we can do to prosper is to learn how to adapt and overcome any and all obstacles that life puts in our way. I hope that despite this year’s numerous hurdles, Neutrino has taken a step, however small it may be, towards reminding people about the grandeur of the universe that lies beyond.

Yours sincerely
Shantanu Misra

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REFLECTIONS

The two years at Club Neutrino have been some of the most memorable years of my life at school. It gave me an opportunity to conduct the quiz at our annual inter school event - Cosmic 350, which really further enhanced my passion for physics and made me learn along the way. Every bit of the journey was extremely wholesome.

Adharsh S. Thirunavukkarasu
12C (Batch of 2017-18)

My journey with Club Neutrino began in Class 10. Little did I understand and realise that time, that a year later, I'd be passionate and even possessive about the club. Be it attending and even organising meetings, enthusiastically volunteering for club day events, and sitting for days in the library and lab planning our annual event - Club Neutrino gave me a platform to share my love for Physics, learn and think with other like-minded people, and even help me develop some great friendships over the years. I can say with confidence that my seniors and us, treated Neutrino like something very dear and close to us, and we are happy to see the future members being so devoted too!

All the best!

Samiha Sehgal
12B (Batch of 2018-19)

Neutrino - the Physics club has not only been an outlet for my interest in physics, it has allowed me to find renewed potential within myself. From making new friends to seeing different initiatives come to fruition, it has provided a lot more than what is expected of a 'physics club'. So it's not a surprise that Neutrino has cemented itself as a core school memory.

Anushka Sanjay
12C (Batch of 2019-20)

Club Neutrino. Well, it is more than just a club to me. I still remember that fateful day in 11th when we decided to change the name of the club from Vectors to Neutrino. Guess it stuck huh? When I first joined the club, it was very exciting! I was part of the physics club wow! And so began a crazy journey of organising fundraisers, getting badges made, organising interhouse activities and organising Cosmic 350. But what was even better were the people I met through the club, physics lovers who turned into close friends and we all still recall the days we were in the physics club with a lot of joy. Then when I became president it still seemed unreal to me how far the club had come in just one year and how lucky I was to be leading it. My one year as president of the club was an absolute delight, it had its ups and downs (much like quarks) but it taught me a lot and only invigorated my love for physics. You see, to the members of the club and to me, Neutrino was an idea, it was the love for physics in the form of a club and I am so glad that the idea has been carried forward by the future members of the club and kudos to them on all their hardwork! Keep the Neutrino fire burning!

Abhijnan Dikshit
Club President (2017 - 18)

Through collective participation, mutual agreement and cooperative brainstorming, Club Neutrino, seeks to achieve new heights and expel the common conception of "science being arduous, transcendental and complicated. The club has introduced me to great teachers and students, all of whom I'll never forget.I'm honoured to be be a part of club neutrino; it has been a great pleasure.

Eshita Mehra
Club President (2019-2020)

Being a member of Neutrino had been an aim of mine since middle school, when a particularly engaging inter-house competition led by the club introduced me to it. When I was finally able to join it- after spending two evenings trying to solve the problems in the application form- I would never have guessed how much of a cherished memory the club would become for me in the years to come. Editing its student-run journal, being part of the dedicated, close-knit team organising its flagship event Cosmic 350 and most of all spending breaks in the Physics lab planning out club work as well as "discussing" lesser known theories at random, are all experiences I miss greatly. I hope the club sets its aims high in future, and wish all its members success in their efforts.

Niharika Mukherjee
2019-20
(Editor in Chief, Neutrino Journal 2018-19)

OUMUAMUA SIGHTING

By Ayachi Singh Rathor (XI A)

Mankind is defined by its unique trait of curiosity. Our ability to observe and question laws of life has constantly given us the direction to a greater beyond.

Nevertheless, irrespective of our curious nature and creativity, the one fact that cannot be denied is that the universe is far more complex and surprising than we predict it to be. In this colossal cosmos, the mier theory of us being alone seems rather impractical and absurd.We couldn't gather all the necessary cues to state a life beyond the system's third planet. Amidst these trials and constant research was a breakthrough that led to a very varied approach, the OUMUAMUA , roughly translates from Hawaiian as "A messenger from afar arriving first".

The first known interstellar object to visit our solar system, 'Oumuamua,' was discovered by the Pan-STARRS telescope at Haleakalā Observatory, Hawaii on the 19th of October 2017 by Robert Weryk. Initial observations suggested the space rock was following a series of irregular movements. When new data showed that the object lacked some important properties of randomly explored rock, they decided it did in fact have to be an asteroid. When astronomers examined and measured the object's movements, they were stunned.

The rock had a directed motion which is being suspected as an intelligent approach of living organisms. While its elongated shape is quite surprising, and unlike objects seen in our solar system, it's big enough to confirm that "Oumuamua doesn't play by our rules." It may provide new clues into how other planetary systems formed.The rock's origin is not yet confirmed, but it is a testimony to the fact that our kind has just begun to scratch the surface of what one can think of as an eternity of knowledge.

BOLTZMANN BRAINS

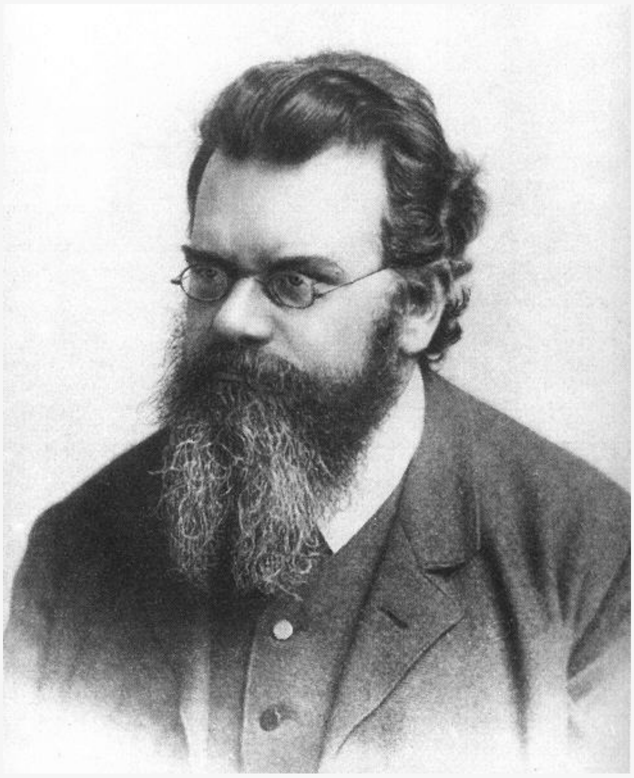
By Shantanu Misra (XI B)

Imagine a disembodied brain floating in outer space, simulating reality as we know it. Its memories of its entire life and loved ones originating from sheer randomness, by a coincidental arrangement of particles. Sounds crazy? Let me try and convince you why this might be the story of your life (statistically speaking).

But before that, let's talk about Boltzmann. Ludwig Boltzmann revolutionised physics with many groundbreaking ideas, his most excellent gift to science being the Kinetic Theory of Gases. Boltzmann showed that thinking of gasses as amalgamations of particles in constant random motion could explain the three laws of Thermodynamics. Boltzmann figured out why the entropy of a closed system (like the universe!) must always increase. Entropy can be thought of as the number of configurations of possible states that the constituents of a system that arrange themselves in. It's just a measure of the "specialness" of the different attributes of a system's particles. The more special the attributes, the lower the entropy. Khanacdemy has some brilliant videos to build a strong intuition on the intricacies of entropy.

For example, take our the air molecules in the lower part of Earth's atmosphere. Air molecules are moving randomly and after an infinite amount of time, they pass through all possible arrangements that they could have.

If I were to plonk you in this atmosphere and ask you to distinguish between the different arrangements of the air molecules, you'd have a pretty hard time. This is an example of a high entropy situation, and it characterises almost all of the arrangements that you'll see in the atmosphere. BUT since the air molecules are in random motion, it's totally possible (but stupidly improbable) that they will all simultaneously do something weird, like moving in the same straight line or forming neat big concentric circles.



Ludwig Boltzmann

Boltzmann said that entropy of a closed system increases because the system is more probable to take on arrangements of particles that are unordered simply due to the fact they are more abundant. It's all statistical. Please note that this only applies to our macroscopic world, microscopic dips in entropy happen all the time, but it's the bigger picture that we're concerned with.
Now, on to Boltzmann Brains.

Imagine an infinitely large universe, forever in thermal equilibrium. Given infinite time, all sorts of dips in entropy will happen. Particles would form stars, galaxies, black holes or maybe something especially weird like amino acids, all of these situations extremely improbable. But can you think of something that's more improbable?

How about this: all the particles in the infinitely large universe end up in exactly the same location. Sound familiar? Well it should, I've just described the big bang!

According to Boltzmann, systems are always most probable to progress towards a state of higher entropy, and whenever a dip in entropy occurs, the smaller the dip the more probable it is. So what sounds more probable, collapsing a whole universe's worth of particles to a single position, or just collapsing a galaxy's worth of particles to a single position? Collapsing a galaxy's worth of particles to a single position or just collapsing a planet's worth of particles? Collapsing a planet's worth of particles, or have a swath of particles converse directly into a single human brain in the right right arrangement to have an illusion of memory and sensation that mimics our current experience? That would be a Boltzmann brains. In a universe dominated by structure that results from entropy fluctuations, a vast majority of conscious being (like you, and I guess me too) would Boltzmann brains.

It's the logical conclusion if we suppose that the Big Bang resulted from an Entropy Fluctuation. AH HA, but there's the catch. IF the universe resulted from an entropy fluctuation. There is no evidence to back this up (to be fair, none against it either), further more, the conclusion is unfplseiable, and therefore sits comfortably in the realm of philosophy, not science.

There have been many arguments against us being Boltzmann Brains, but this I'm afraid is for you to explore. Think about the many reasons why this hypothesis may be wrong and try and convince yourself. Proving what we know to be false, as you know, is the best way get closer to the truth.

PHYSICS AND ECONOMICS: IS THERE A NODAL CORRELATION? (CONTINUED)

By Raghav Sarangi (XII B) & Ishaan Kanudia (XII F)

Physics: The Science of Understanding

The objective of this paper is to use Coulomb's Electrostatic equations to confer a value upon the tendency of populations to migrate from any given region to another. Migration is a phenomenon that is prevalent in an unbalanced world. It is defined by the International Organisation for Migration (I.O.M.) as "The movement of persons away from their place of usual residence, either across an international border or within a State". For any migrant, the desire to relocate can be to achieve any, or all, of the following outcomes:

- To attain a higher standard of living by moving to a region that has more economic opportunities such as a better education system, higher availability of jobs, etc.
- To escape a politically unfriendly environment
- To find an alternate source of income for a temporary duration (seasonal migration) such as the movement of those involved in the rural agricultural sector in winters.
- The classical models that attempt to pattern migration are generally as follows:

$$V = R - C$$

Where:
V: net present value of the migration potential
R: total benefits expected to be obtained
C: current total value of the costs that may occur

In this sense, the regions that such migrants gravitate towards are called Economic Attractors while those that push them away may be called Economic Repellers. These can be related to the concept of gravitational or electromagnetic fields in Physics, which essentially distort the region in which they exist so as to exert a corresponding force on any interacting body.

For our discussion, an electric field is more appropriate than a gravitational one since it can occur in two different states, positive or negative, similar to the contrast between regions that "push" inhabitants and regions that "pull" migrants. Coulomb's Law for the force between two charges is given by:

$$F = K\frac{qw}{r^2}$$

Where:
F: represents the electric force exerted by any particular region
q and w: the interacting electric charges such that, for our frame of reference, q is the source charge and w is the test charge
r: the distance between the two charges
K: proportionality constant that depends on the properties of the environment between the two charges and quantises the electrical permittivity of the force's transmission through the medium.

The magnitude of the electric field, E , is defined as the force experienced by a unit charge at a particular point in the field. In other words, it is an inherent property of the effect created due to the presence of our “source charge”. Mathematically,

$$E = \frac{F}{w} = K\frac{q}{r^2}$$

The permittivity constant K, to some degree, specifies the “type” of migration occurring. The economic distance between the two regions (which includes factors such as the cost of relocation, assimilation in the foreign region of any ethnicity and the physical journey required) is measured by the variable r. As can be seen, r is inversely proportional to E . From the relation given above, it is evident that

$$F = wE$$

where w represents a given migrant population and thus completes our analogy in the form of a test charge. Additionally, those subjected to these forces i.e. the individual migrants can be acted upon by more than one “migratory forces”, which may be attractive or repulsive, analogous to the Principle of Superposition in the field of Vector Physics.

Modelling migratory trends using Coulomb’s Law is an ingenious method of using observed occurrences in the field of Natural Sciences and applying it to seemingly unpredictable human behaviour. The key to making such a model work is to determine which parameters have the greatest effect on such practices, and using them in the aforementioned equations with appropriate weightage (Gheorghiu and Spânulescu 2011).

Macro-Realism vs Micro-Idealism and the Theory of Everything

In the years following the Great Depression, the study of Economics was split into two, Macroeconomics and Microeconomics. John Maynard Keynes’ contribution in pioneering the former shaped it to be a sphere that deals with the complex interactions of aggregate variables that influence how a colossal entity (usually a nation) operates, along with large-scale policies and their overall effect on an economy. It often involves international interplay since foreign markets have deep effects on domestic ones through various channels of trade and investment. Since any Macroeconomic study is governed by several factors (ranging from the socio-political status of a country to taxes, geo-political tensions and the inventory of industrial resources), whose ramifications are often unforeseen, it requires an empirical analysis. It is difficult to clearly map out the individual relationships between each element that constitutes a particular economic scenario. Macroeconomics plays a foundational role in our understanding of the national and global economies, be it in forecasting business cycles or determining fiscal policy measures.

Microeconomics, on the other hand, is relatively more intuitive. It is often called “idealistic” since it considers very small units of the economy, such as a household or a discrete consumer. These are then placed in tightly-constructed environments to determine their responses to varying climates, such as an increase/decrease in the supply of a particular commodity.

In fact, Adam Smith's concept of such units and their"selfish" desire to pursue those actions which maximise their own well-being guides supply and demand, and forms the basis for most of this sphere. It is easier to model than its counterpart, and has been grounded in Mathematics to an extent, thereby nurturing far less contention in its theories as compared to Macroeconomics.

The study of smaller units in the economy is used not only to understand the larger landscape, but also develop concepts such as Game Theory that help a firm understand its interaction with its competitors.

While Macroeconomics and Microeconomics differ in the functioning, their consolidation will allow us to obtain a complete Economic theory. It is for this reason that the last couple of decades have seen efforts being made to reconcile the two. While a perfect amalgamation has not yet been produced, it is very interesting to see that a startling parallel has been occurring in Physics.

There are two major theories that seek to explain our Universe: Relativity and Quantum Mechanics. While Relativity is able to anticipate the nature of large objects, ranging from footballs to galaxies, Quantum Mechanics deals with the study of the infinitesimal. A key difference between these two approaches is how they view the essence of reality Relativity is deterministic while Quantum Mechanics is probabilistic. While the latter may seem counterintuitive at times, especially with theories such as Schrodinger's Wave Equation and Particle-Wave Duality, Heisenberg's Uncertainty Principle and Quantum Entanglement, it does usually paint a better picture of physical interactions.

In the eternal quest to reduce the Universe's idiosyncrasies into one concise Theory of Everything, physicists have spent the better half of a century trying to unify these two fields, a feat the famous String Theory was attempting to achieve. Relativity doesn't work effectively when brought down to the realm of quantum entities, often giving infinite values for gravity. Similarly, Quantum Mechanics seems to collapse the Universe into a black hole when the concept of Quantum Energy is enlarged to cosmic proportions.

Evidently, this unification of "Big Picture - Small Picture" theories is a recurring theme in both Economics and Physics. Keeping in mind this similarity, a symbiotic relationship can be developed that helps to bridge the respective theories by using techniques borrowed from the other sphere. This observation also gives us insight as to the benefits of having a "Quantum Vision" towards Economics, as has been extensively explained in Ion Iorga-Simăn and Gheorghe Săvoiu's Economic Macro Realism vs. Micro Idealism in Quantum Physics' Vision – A Short Term Plea or a Long Term Defence for the Integration of Quantum Physics' Thought in Economics. It allows us to question the concept of absolute dichotomies (ideas such as profit or loss, inflation or recession) and perceive situations in a state of "both as well as neither". An Economic outlook that deals with probabilities, such as one derived from Quantum Mechanics, also allows models to evolve and make better predictions over time (Iorga Simăn and Săvoiu 2010).

LECTURES TO BINGE

SINGLES

For the Love of Physics
by Walter Lewin

Fun to imagine
by Richard Feynman

The World As Hologram
by Leonard Susskind

The Astonishing Simplicity of Everything
by Neil Turok

A Brief History of Quantum Mechanics
by Sean Carroll

The Law of Gravitation
by Richard Feynman

SERIES

Theoretical Minimum Quantum Mechanics
by Leonard Susskind

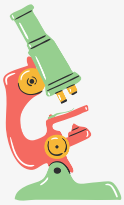
General relativity
by Leonard Susskind

Quantum Physics I
by many on MIT OpenCourseware

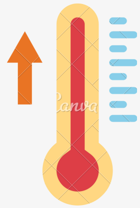
Understanding Einstein: The Special Theory of Relativity
by Larry Randles Lagerstrom

Feynamn's QED lectures
by Richard Feynman (remember the book is way better)

Introduction to Linear Algebra
by Gilbert Strang



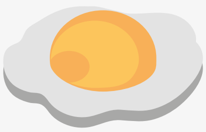
PAUSE AND PONDER



Q1 What really is work, and how is it different from energy?

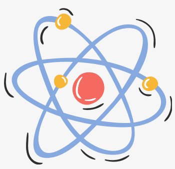
Q2 Is there any law forbidding time travel into the past?

Q3 What is the fundamental difference between conserved and non conserved quantities?

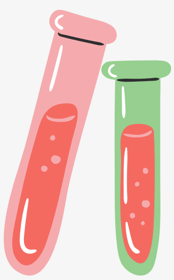


Q4 Which came first the F or the ma?

Q5 If the universe is infinite, did it start off as an infinite universe, or did it become infinite at some point in time?



Q6 Why are some computations hard and others easy?



Q7 Why is something like the three body problem only seen in Gravitation, and not something else like Quantum Mechanics or Solid-State physics?

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Vice President Shantanu Misra XI B

Teachers in Charge
Ripple ma'am
Shampa ma'am
Nidhi 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.

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