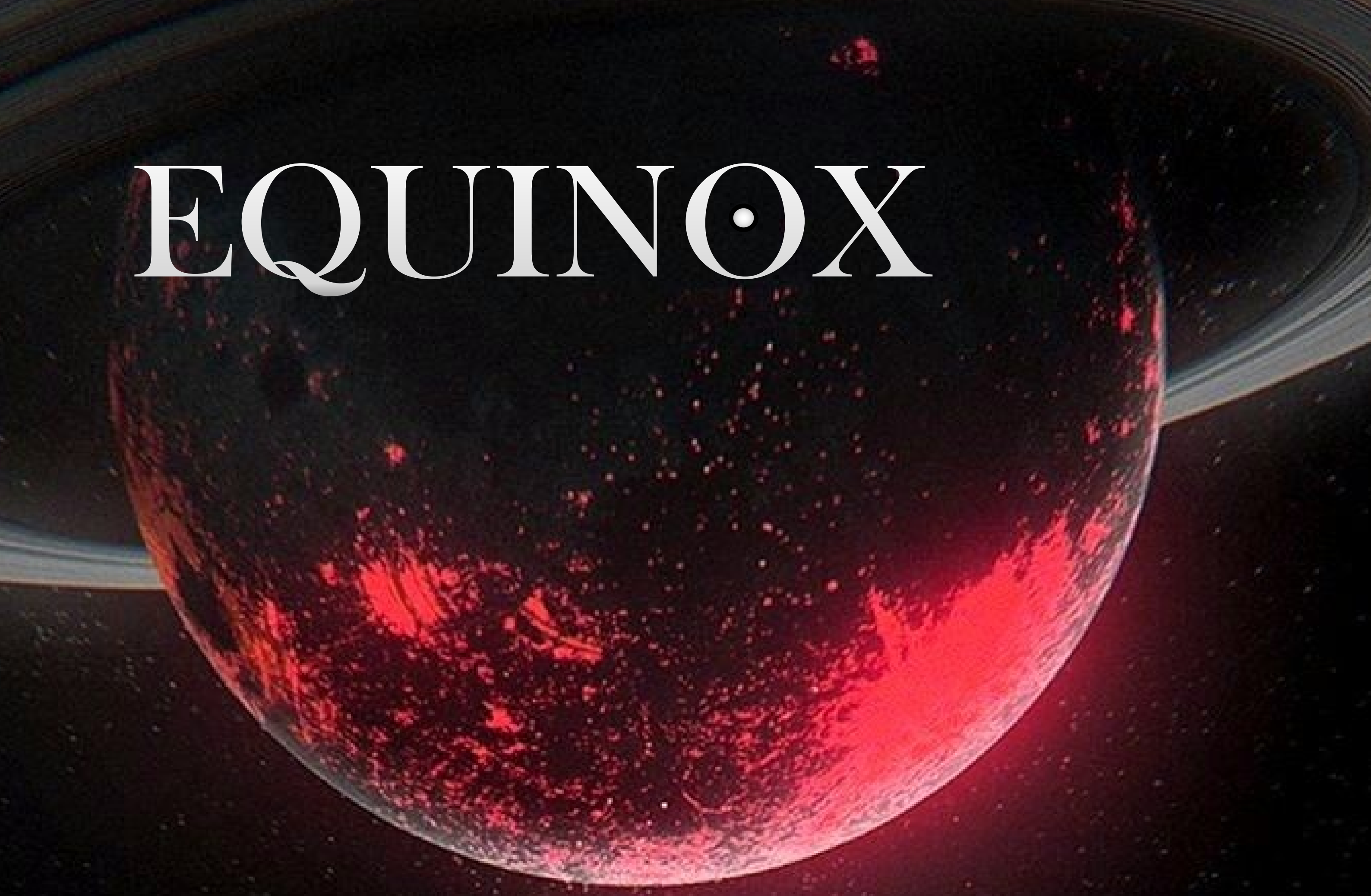
EQUINOX



“ Real science can be far stranger than science fiction, and much more satisfying . ”

~ Stephen Hawking

The Department of Physics

BANGABASI COLLEGE, KOLKATA

EQUINOX

E-MAGAZINE, 2025

BANGABASI COLLEGE

19, RAJKUMAR CHAKRABORTY SARANI,
KOLKATA-700009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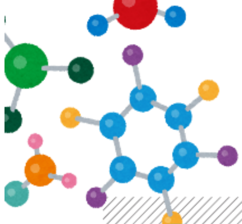

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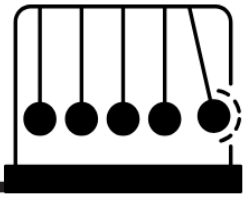
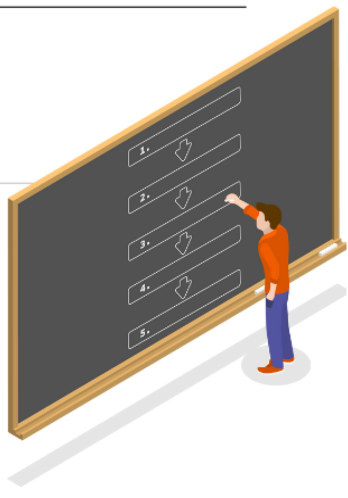


DEPARTMENT OF PHYSICS



DEPARTMENT OF PHYSICS

DEPARTMENTAL TEACHERS

Dr. Lipika Santra
Associate Professor
(HOD)

Dr. Prabal Kumar Sinha
Associate Professor

Dr. Partha Ghosh
Associate Professor

Prof. Somen Biswas
Assistant Professor

Dr. Sayanee Jana
Assistant Professor

Dr. Ankan Mukherjee
Assistant Professor

Prof. Souvik Sau
SACT-1

Prof. Satyajit Roy
SACT-2

Dr. Sucharita Chatterjee
SACT-1

CURRENT STAFFS AND STUDENTS IN THE DEPARTMENT

STAFFS

- Mr. Samay Dey
- Mr. Subrata Ghosh
- Mr.Dillip Mandal
- Mr. Animesh Paik

1ST SEMESTER

- Md. Selim
- Abdul Rhakib
- Roni Das
- Sunanda Biswas
- Somiddhya Banerjee
- Mir Rejwan Hossain

3RD SEMESTER

- Sneha Verma
- Rimjhim Poddar
- Rupsa Saha
- Sneha Sarkar
- Subhrodip Das
- Sreyas Benerjee
- Ritam Deb Barman
- Sumit Das
- Soumik Chatterjee
- Masud Rahaman sardar
- Gopal Kumar Singh
- Pratik Kumar Singh
- Pitam Das
- Rupam Mondal
- Sagar Sarkar
- Sayan Halder
- Ashis Bayen
- Debdut Mondal
- Fahim akhtar
- Sk. Abul Basar Dewan

5TH SEMESTER

- Rudra Prasad Mitra
- Sayan Ghosh
- Sayandeep Ghosh
- Rishab Bhattacharjee
- Subham Bhattacharjee
- Supratim Dhali
- Santanu Kabiraj
- Ankan Hati
- Debjit Saha

FROM THE HEAD OF THE DEPARTMENT OF PHYSICS

Dr. Lipika Santra
Associate Professor
Head of the department of physics
Bangabasi College

Dear Students,

It gives me immense pleasure to address you through this edition of 'EQUINOX', E-MAGAZINE-2025, a canvas that celebrates the vibrancy, creativity, and talent of the students of our department of Physics of Bangabasi College.

Physics, as a discipline, is at the very heart of technological advancements that shape our world. From the marvels of quantum mechanics to the breakthroughs in space exploration, it is a constant reminder that curiosity and persistence can unravel the mysteries of the universe. As Physics students you stand on the cusp of a future that holds endless possibilities, waiting to be explored and transformed by your ideas and ingenuity.

This magazine stands as a testament to your talent, your dedication, teamwork, and innovative thinking. The articles, projects, and creative contributions within these pages reflect your understanding of complex concepts and your ability to apply them in real-world contexts.

I truly appreciate the effort and dedication you put into completing the magazine. Your hard work and commitment have made a significant impact.

Let this magazine be a source of inspiration and a celebration of the vibrant culture at Bangabasi College. May it motivate you to push boundaries and to reach the pinnacle of success.

Best wishes for your academic and cultural endeavors!

EDITOR'S PEN

Rimjhim Poddar
3rd Semester

Dear readers,
Welcome to this edition of our Physics Departmental magazine "**Equinox**"! This is more than just a collection of write-ups — it's a reflection of our shared curiosity, creativity and passion for understanding the subject,the language. As students of physics, we constantly challenge ourselves to think beyond boundaries, question the unknown and push the knowledge circle. Through this magazine, we aim to spark inspiration, celebrate ideas and connect with the wonders of science. Let's keep discovering, learning and growing together as a community.

Sneha Sarkar
3rd Semester

"Welcome to Equinox, the physics department's magazine. As we stand at the intersection of science and innovation, we invite you to join us on a journey of discovery.

In this issue, we delve into the fascinating world of physics, exploring the latest breakthroughs, research, and applications.
As the editor of Equinox, I'm excited to share these stories with you. Whether you're a student, professor, teacher, researcher, or simply curious about the world around you, we hope you'll find inspiration and knowledge within these pages.

Happy reading!

Initiation by Ritam Deb Barman
Cover page- Ritam Deb Barman

Through the

Vintage lens

-Messages from Alumni

Md Maashir Raza
MS.c in Physics
At NITK Surathkal
Batch 2020-2023

A Journey from Bangabasi to NITK Surathkal

I am Md Maashir Raza, an alumnus of Bangabasi College, where I pursued my undergraduate studies in the Physics department. My time at Bangabasi remains a cornerstone of my academic and personal growth, shaping the path that eventually led me to NITK Surathkal for my MSc in Physics.

The three years I spent at Bangabasi were filled with unforgettable experiences. The professors, with their vast knowledge and unwavering guidance, were instrumental in sparking my passion for physics. I particularly remember the way complex concepts were simplified during lectures, making the learning process both enjoyable and inspiring. The professors were more than teachers; they were mentors who constantly encouraged us to question, explore, and innovate.

Equally memorable were the friends I made during my college years. Our late-night study sessions, discussions on assignments, and shared dreams of achieving something meaningful created a bond that transcended the boundaries of classrooms. I still cherish those moments, as they taught me the importance of collaboration and mutual support.

Bangabasi College not only imparted academic knowledge but also instilled values of discipline and curiosity. The culture of academic rigor, combined with opportunities to participate in extracurricular activities, helped me develop a well-rounded personality. From engaging in physics seminars to participating in college fests, every moment contributed to my personal growth.

As I pursue my MSc at NITK Surathkal, I often reflect on the foundation laid at Bangabasi. It was a place that nurtured my love for physics and equipped me with the resilience to tackle challenges in advanced studies. I remain forever grateful to my professors, friends, and the institution for shaping me into who I am today.

Bangabasi College will always hold a special place in my heart as the springboard for my academic journey.

ছাত্রজীবনে গ্রন্থাগার ও স্ব-অধ্যয়নের গুরুত্ব।

2020-2021, কোভিডের প্রকোপ তখন আকাশ ছোঁয়া। এর ফলে প্রফেসররাও অনলাইনে ক্লাস করতে বাধ্য হন কিন্তু যখন সময়ের সাথে সাথে সবকিছু ঠিক হয় এবং কলেজও অফলাইনে শুরু হয়ে যায় আমরা ফিজিক্সে অনেকটাই পিছিয়ে পড়ি এবং পরবর্তী সেমিস্টার এর এডভান্স টপিক গুলো বোঝা খুব কষ্টকর হয়ে ওঠে. Seating place শুরু করে experimental ল্যাব এমনকি একটি বিভাগীয় লাইব্রেরি পর্যন্ত, পদার্থবিদ্যা বিভাগে একজন শিক্ষার্থীর প্রয়োজনীয় সবকিছু রয়েছে। কিন্তু দোতালায় অবস্থিত প্রিন্সিপাল রুমের পাশের মেইন গ্রন্থাগারের গুরুত্ব আমি বুঝতে পারি তৃতীয় সেমিস্টারের .
প্রাথমিকভাবে, আমি কৌতূহলবশত লাইব্রেরিতে প্রবেশ করি, অধ্যয়নের জন্য । ধীরে ধীরে, এটি আমার পছন্দের জায়গা হয়ে ওঠে, যেখানে আমি প্রতিদিন তিন থেকে চার ঘন্টা আমার পড়াশোনা করার চেষ্টা করতাম এবং সময়ের সাথে সাথে লাইব্রেরিয়ান দের সাথেও আমার পরিচয় হয় এবং তারা খুবই হেল্পফুল তাছাড়া ও আমায় বলেন যে বঙ্গবাসী মর্নিং এবং ইভিনিং কলেজের সময়ও যদি আমি আসতে চাই তো আসতে পারি তিনি কথা বলে পারমিশন দিয়ে দেবেন
আমার স্নাতক বছরগুলিতে আমি যা শিখেছি এবং অর্জন করেছি তার বেশিরভাগই সেই লাইব্রেরিতে কাটানো সময়ের জন্য.

দুর্ভাগ্যবশত, অনেক ছাত্র লাইব্রেরি থেকে সংযোগ বিচ্ছিন্ন থাকে। তারা হয়তো বুঝে উঠতে পারেনি লাইব্রেরীতে গেলে কতটা ফোকাস এর সঙ্গে পড়াশোনা করা যায় এবং কতটা রেগুলারিটি মেনটেন করা সহজ হয়ে যায় । কিন্তু একজন ছাত্র যদি তাদের পড়াশোনার জন্য লাইব্রেরি ব্যবহার করা শুরু করে, তাহলে তারা শীঘ্রই এর অপরিসীম মূল্য আবিষ্কার করবে। যদি কেউ অধ্যয়নের জন্য লাইব্রেরীতে যাওয়া শুরু করে, এটি একটি মূল্যবান স্থান হয়ে উঠবে যা তার একাডেমিক এবং ব্যক্তিগত বৃদ্ধিতে স্থায়ী প্রভাব ফেলে।

Kiran Mondal
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Batch 2020-2023

Samiran Bhowmik
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Batch 2020-2023

আমি সমিরণ ভৌমিক,
বঙ্গবাসী কলেজের ফিজিক্স বিভাগের প্রাক্তনী। ২০২০ থেকে ২০২৩ পর্যন্ত, কোভিড মহামারীর সময়ে আমি স্নাতক পাঠক্রম সম্পন্ন করি। এই সময়টা ছিল চ্যালেঞ্জপূর্ণ, তবে শিক্ষণীয়ও। মহামারীর কারণে শিক্ষা ব্যবস্থায় কিছু বাধা সৃষ্টি হলেও, তা আমাকে নতুন পরিস্থিতির সঙ্গে মানিয়ে নিতে এবং কঠোর পরিশ্রমের মাধ্যমে সামনে এগিয়ে যেতে শিখিয়েছে।

বঙ্গবাসী কলেজ আমার জীবনের একটি গুরুত্বপূর্ণ অধ্যায়, যেখানে আমি শুধু একাডেমিক উন্নতি নয়, ব্যক্তিগত বিকাশও অর্জন করেছি। এই কলেজ কেবল একটি শিক্ষাপ্রতিষ্ঠান নয়, বরং একটি পরিবার। আমাদের অধ্যাপকদের সহানুভূতি, আন্তরিকতা এবং সহপাঠীদের সহায়তায় আমি আত্মবিশ্বাসী হয়ে উঠি। তারা শুধু পাঠদানেই সীমাবদ্ধ ছিলেন না, বরং আমাদের জীবনের প্রতিটি সমস্যায় পাশে দাঁড়িয়েছিলেন এবং পথপ্রদর্শক হিসেবে কাজ করেছেন।
বঙ্গবাসীতে শৃঙ্খলা, অধ্যবসায় এবং সম্পর্কের গুরুত্ব শিখে, আমি আইআইটি খড়গপুরে যৌথ MSc-PhD পদার্থবিদ্যা পাঠক্রমে ভর্তি হতে সক্ষম হয়েছি। আইআইটি খড়গপুরের কঠিন পাঠক্রম এবং নতুন পরিবেশ প্রথমে কিছুটা চ্যালেঞ্জিং মনে হলেও, বঙ্গবাসীতে শিখে যাওয়া মূল্যবোধগুলো আমাকে সেখানে এগিয়ে যেতে সাহসী করেছে।
আজও, বঙ্গবাসীর সঙ্গে সংযোগ রাখার চেষ্টা করি এবং গর্ব অনুভব করি যে, আমি সেই প্রতিষ্ঠান থেকে এসেছি। এই ম্যাগাজিনের মতো উদ্যোগগুলো আমাদের কলেজের চিরন্তন চেতনাকে উদযাপন করে, যেখানে প্রাক্তনী, বর্তমান ছাত্র এবং ভবিষ্যৎ প্রজন্ম একসঙ্গে এগিয়ে চলার প্রেরণা খুঁজে পায়।
আমার জুনিয়রদের উদ্দেশে বলি: নিজেদের উপর বিশ্বাস রাখো, কঠোর পরিশ্রম করো এবং সম্পর্কের গুরুত্ব বোঝো। প্রাক্তনী ও সিনিয়রদের বলি: আসুন, একসঙ্গে আমাদের উত্তরাধিকারের ধারাকে আরও শক্তিশালী করি। বঙ্গবাসী কলেজ আমার যাত্রার একটি অধ্যায় নয়, এটি আমার পরিচয়ের মূল ভিত্তি।

Amrita Saha
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Batch 2020-2023

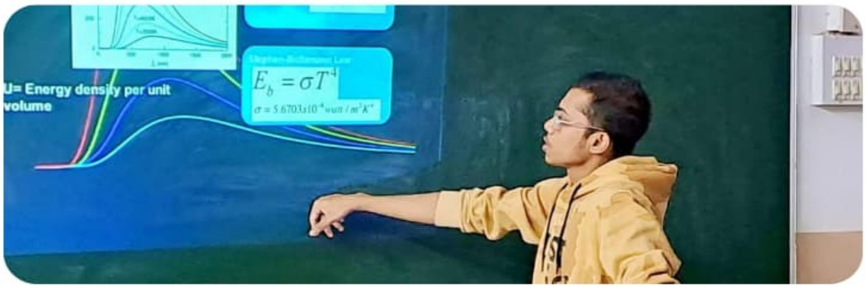
স্মৃতিদের আনাচে কানাচে...

বাড়ির পছন্দের কোণা কিংবা বারান্দা টা যেমন সবুজ দিয়ে ভরিয়ে সতেজ রাখতে ইচ্ছা করে, কিছু ভালো স্মৃতি তৈরী করা বা স্মৃতি রোমন্থন করার জন্য প্রিয় জায়গা হয়ে ওঠে তেমনই বঙ্গবাসী কলেজের ফিজিক্স ডিপার্টমেন্ট আমাদের সেই পছন্দের কোণা ছিল। যেখানে আমরা একসাথে হইহই করে অনেকটা ভালো সময় কাটিয়েছি, পড়াশোনার সাথে সাথে দৃঢ় চরিত্র গঠনের শিক্ষা পেয়েছি।
২০২০ তে লকডাউনে বাড়িতে বন্দী অবস্থায় বঙ্গবাসী কলেজে ফিজিক্স ডিপার্টমেন্টে ভর্তি হয়েছিলাম, তখন শুধুমাত্র স্কুলের স্মৃতিচারণ করেই দিন কাটছিলো। তখনও বুঝতে পারিনি, স্কুলের পরেও আমাদের আরও একটা দ্বিতীয় বাড়ি কখনও কোথাও তৈরী হতে পারে! সেপ্টেম্বরের পাঁচ তারিখ আমাদের অনলাইনে ওরিয়েন্টেশন প্রোগ্রাম হলো...দুঃখজনকভাবে করোনার কারণে আমাদের প্রথম দিন কলেজ যাওয়া হলো না। সেই ওরিয়েন্টেশন প্রোগ্রাম দেখার পর মনে হয়েছিল এতদিনে সত্যি সত্যি নিজের পছন্দের বিষয় সঠিকভাবে জানতে পারব। শুধুমাত্র পুঁথিগত বিদ্যা নয়, রোজকার জীবনযাপনে ফিজিক্সের কোন থিওরি কীভাবে কাজে লাগে, প্রকৃতির সাথে কীভাবে তা মিশে আছে সবটাই স্যার-ম্যাডামদের কল্যাণে ধীরে ধীরে রহস্যের জট খুলে সামনে আসতে লাগলো। তিন বছরের মধ্যে প্রথম দেড় বছর বাড়িতে বসে অনলাইন ক্লাস করতে হয়েছিল, কিন্তু শেষের দেড় বছর যেটুকু সবাই একসাথে থাকার সুযোগ পেয়েছিলাম, তাতে সকলেরই একক পদার্থের কণা হিসাবে থাকার ধর্ম পরিবর্তিত হলো, এবং পড়া না থাকা সত্ত্বেও বোস-আইনস্টাইন কনডেনসেশনের ব্যবহারিক উদাহরণ দেখতে পেলাম আমরা। এখন মনে প্রশ্ন আসতে পারে যে বোস-আইনস্টাইন কনডেনসেশন কী জিনিস?... জানতে হলে চলে আসা যাক আমাদের ডিপার্টমেন্টে। সি বি সি এস পদ্ধতিতে আমাদের প্রথম সেমিস্টারের প্রথম ক্লাস শুরু হয়েছিল পার্থ স্যারের ক্লাসিকাল মেকানিক্স তথা স্যারের সিগনেচার লাইন ' হোয়াট ইজ্ সো ক্লাসিকাল অ্যাবাউট ক্লাসিকাল মেকানিক্স?' দিয়ে। সাথে ছিল সোমেন স্যারের খুব জটিল থিওরি ভীষণ সহজ ভাবে বুঝিয়ে দেওয়ার ক্লাসগুলো। এমন করেই একে একে প্রবাল স্যার, সুচরিতা ম্যাম, সায়নী ম্যামের সাথে অনলাইনেই আলাপ। অনলাইনেই আমরা প্রবাল স্যারের কাছে ম্যাথেমেটিকাল ফিজিক্স, সুচরিতা ম্যামের কাছে মডার্ণ ফিজিক্স আর সায়নী ম্যামের কাছে ল্যাটেক্সের মতো ল্যাঙ্গুয়েজ শিখে নিলাম। এরপরে কলেজে যাওয়ার পরে তো বলাই বাহুল্য, হইহই করে একসাথে ক্লাস করা, প্রফেসরদের সাথে রিসার্চ ইনস্টিটিউট হোক বা সেমিনার ভিজিট করা সবটাই অভিজ্ঞতার ঝুলিতে সঞ্চিত রয়েছে। ধীরে ধীরে সৌভিক স্যার পরিচয় করালেন স্ট্যাটিস্টিকাল ফিজিক্স এবং সত্যজিত স্যার নিউক্লিয়ার ফিজাক্স এর সাথে, লিপিকা ম্যামের হাত ধরে ইলেকট্রনিক্স আর অঙ্কন স্যারের সাথে সলিড স্টেট ফিজিক্সের জগৎ কে চিনলাম। প্রফেসরদের সাথে সাথে সিনিয়র দাদা দিদি দের নানা ভাবে নানা সময়ে পাশে পেয়েছিলা আমরা।
তিন বছরের মধ্যে মাত্র দেড় বছর ক্লাস করে প্রফেসরদের থেকে কম কিছু পাইনি ঠিকই, কিন্তু আফশোস হয় যে আরও ভালো কিছু স্মৃতি হয়তো তৈরী হতে পারতো। ব্যাস এটুকুই বলার, বাকি স্মৃতি না হয় মনের মণিকোঠায় সজ্জিত থাক। অনেক স্মৃতির সমাহার থেকে সামান্য কিছু মাত্র তুলে ধরা রইল সকলের সামনে, এ বড়ো কঠিন কাজ...শব্দেরা তালগোল পাকিয়ে আবার বোস-আইনস্টাইন কনডেনসেশনে চলে যায়। তখন কাকে ছেড়ে কাকে লিখি তা বোঝা দুষ্কর!

Gaurab Samanta
PhD Student
At University of Strasbourg (2024)
Batch 2018-2021

I am a doctoral student at the IPCMS research unit of the University of Strasbourg. My research topic is the two-dimensional van der Waals hybrid devices. After the discovery of graphene, we all became familiar with the 2D family, and the whole community tried to explore the new physics as well as other interesting 2D materials. We fabricate different nanodevices of 2D material and study the device characteristics; also, we make a few complex structures with different materials in micron resolution to enhance the device properties. These 2D nanostructured materials have been investigated as a potential possibility for the development of new gadget designs and concepts in the future as the demand for their capacity to deal with highspeed electronic applications while consuming little power.
I am grateful to the Bangabasi College Physics Department for their continued assistance and guidance throughout my graduation. I am proud of the support that they provide for my development. I wish a bright future for the department's current students and encourage them to explore different opportunities to push their limits in higher education. The graduation period is the enhancement of the learning process, as it gives the clarity to choose the right direction in upcoming years, and my department students are very efficient in choosing their path. Sometimes it becomes difficult to progress, but it won't be an obstacle to the final destination.

Best Regards.





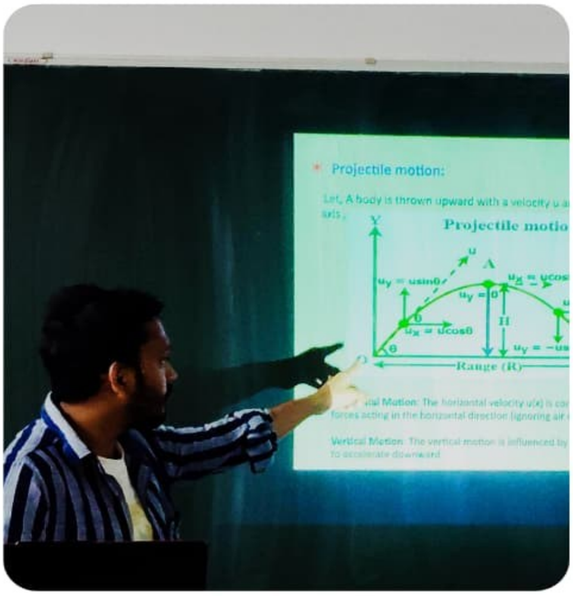




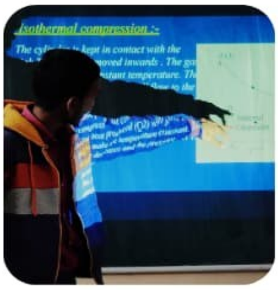
Presentation

By students





ASTRONOMY CLUB OF BANGABASI COLLEGE

Established: 24th June 2024

- ## About Us:

The Astronomy Club of Bangabasi College is a hub for students passionate about exploring the universe. Guided by our esteemed lecturers, Dr. Partha Ghosh(Associate Professor at Bangabasi College), Dr. Gourav Banerjee(Post Doctoral Fellow at Vainu Bappu Observatory) and Sovan Acharya(NASA Citizen Scientist), we aim to foster a deep understanding of astronomy and astrophysics through regular weekly classes

- ## Our Vision:

We strive to equip students with the knowledge and skills to participate in the International Astronomy and Astrophysics Competition(IAAC).

- ## What We Do:

Weekly Classes: Comprehensive sessions on various astronomical topics.

- ## Collaborations:

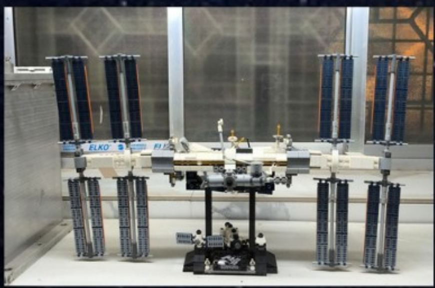
Active partnerships with IAAC (International Astronomy And Astrophysics Competition) and other colleges to promote knowledge exchange.

- ## Future Plans:

Exciting star-gazing tours to observe the night sky up close. Enhanced inter-department and inter-college collaboration for exciting projects and workshops.

JOIN US

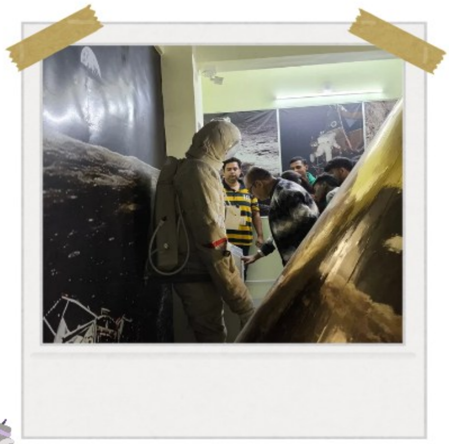
Be part of a journey to unravel the mysteries of the cosmos.

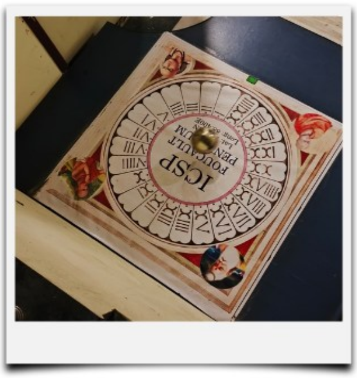


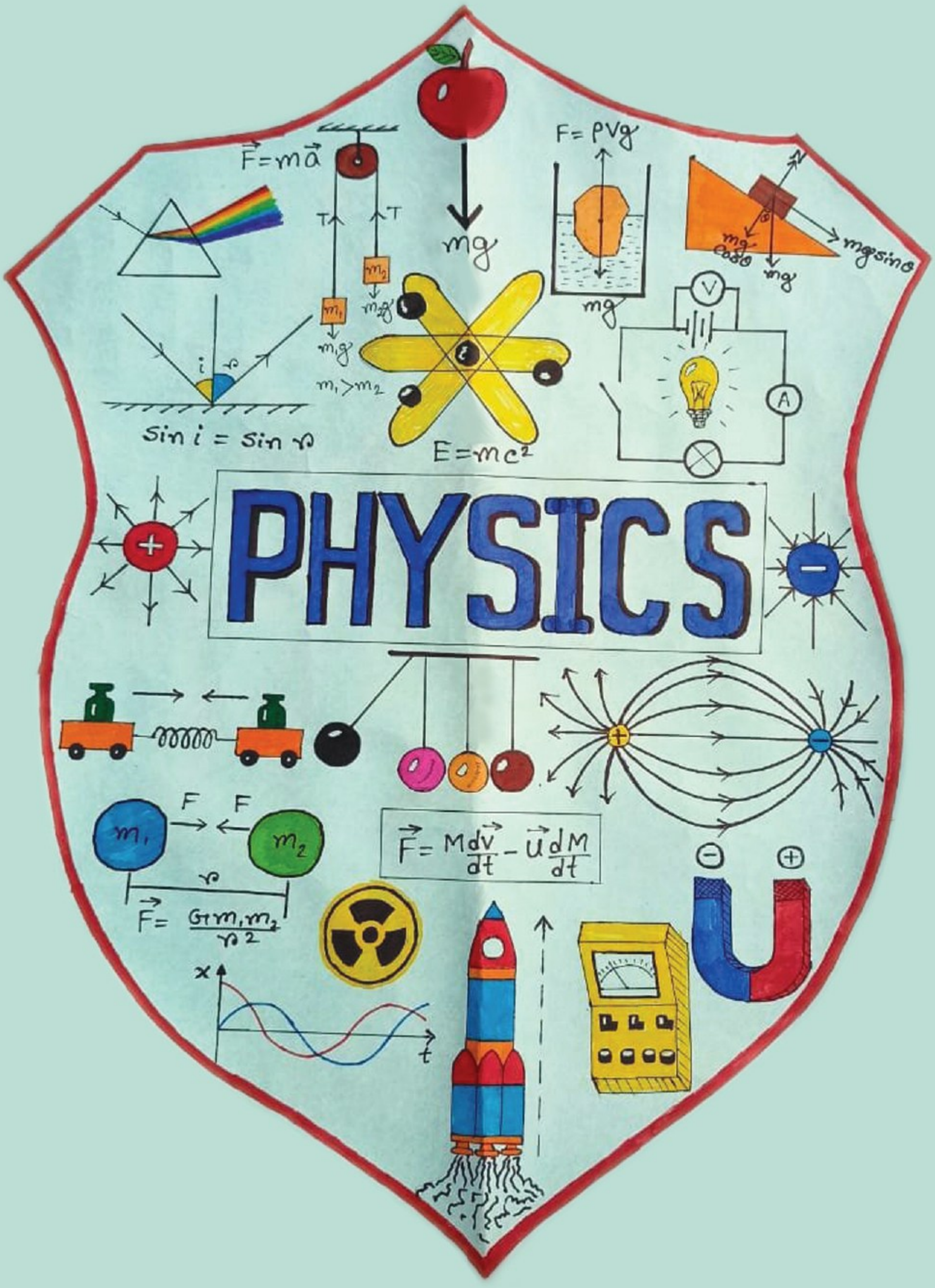
Bangabasi College, Kolkata

DEPARTMENTAL TOUR

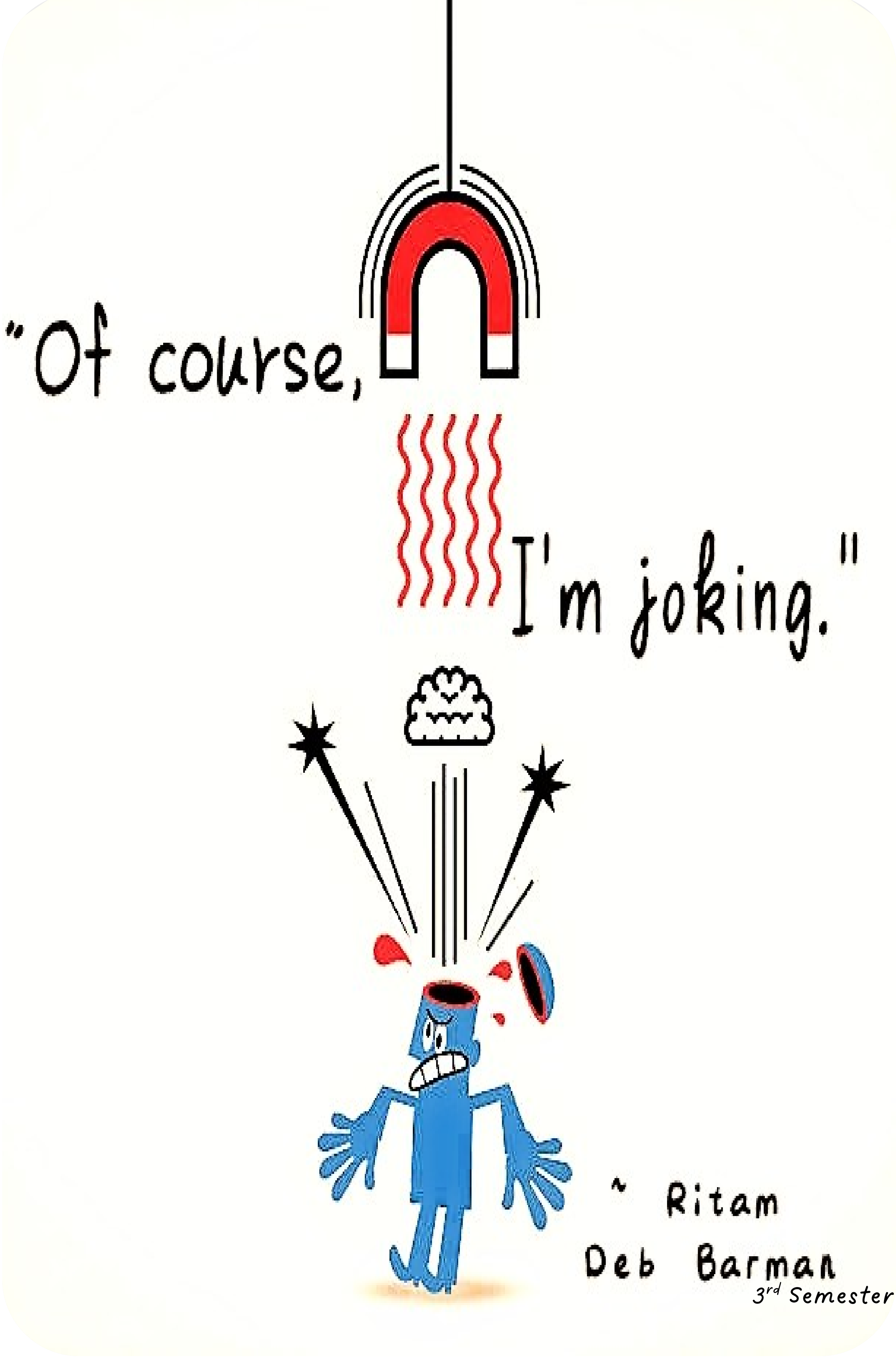
Visit to "Indian Centre For Space Physics"
On dated 30/12/2024







Roni Das
1st Semester



3rd Semester

It took me four years to start speaking clearly. On the other hand, while other children began speaking well at around two or two and a half years old, I took a full four years. Frustrated by my inability to speak, my parents enrolled me in school when I was three and a half. My mother told me that before I could speak, whenever I wanted something, I would signal to her, and if I wanted to call her from a distance, I would make a sound like **"um um,"** but I wouldn't actually say **"Ma".** Later, I learned that Einstein's first words at the age of four were, "The soup is too hot." When asked why he hadn't spoken until then, Einstein replied, **"Because up to now, everything has been fine."** I am not sure if everything was fine four years ago! But after hearing this incident about Einstein, I somehow felt that perhaps I didn't speak all this time because everything was indeed alright.

Anyway, from childhood, many things were different for me compared to other kids. For example, I don't watch cricket or football, and I never developed an interest in them. Nor did I ever go out to play with neighbourhood kids. My entire childhood was spent in my own company—playing with myself, talking to myself, and so on.

Since childhood, I've always had a habit of asking questions: **"How does this happen?", "How does that happen?",** I've always had a strong desire to know everything. This curiosity affected my studies, especially in the places I attended. The teachers who taught me from class five to ten often faced my questions every day. Sometimes, they would get frustrated and say, **"I don't know the answer to that."** That would make me really angry. I was studying under them, and when I asked two simple questions, they would get upset and tell me, **"I don't know the answer!"**

Anyway, I've always been very absent-minded since childhood. Whenever I was sent to buy something from the market, I would bring half the items and forget the rest. Or I would bring five-spice powder instead of black pepper. This absent-mindedness also affected my brain, and to this day, my thoughts are often unorganized. I would come up with many questions, but I would forget them. A long time ago, I had many questions that I never asked because I forgot them before I could.

I still remember, when I was in class 8, I encountered a word from an unknown world—**"Relativity."** At that time, I had no idea about it, but I was really excited to learn. That excitement for learning is still with me today. In class 8, I first heard about Albert Einstein, and on my birthday, my dear friend *Dipankar* gave me a book titled **"Hello Einstein"** by *Moni Bhoumik*. I was so happy to receive it and quickly read it. That's when I learned about Einstein's famous equation **"$E=mc^2$,"** and I found out that this equation is incomplete. I also discovered that a ***"Gamma factor"*** is involved, which I later learned to call the ***"Lorentz factor"*** in my first year of college. The equation might still be incomplete, but I won't go into that now.

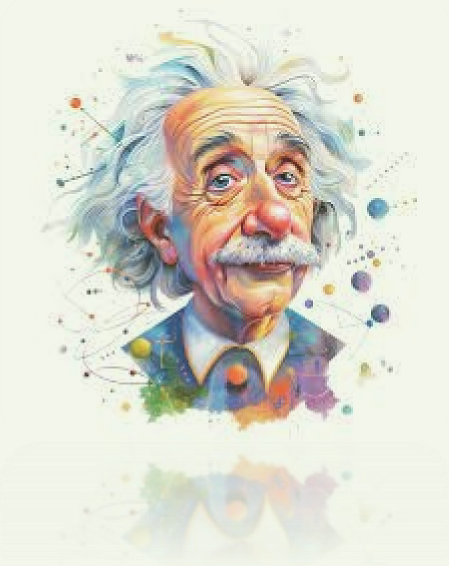
From this , I gained a basic understanding that this might have something to do with time travel. In other words, what I had seen in cartoons all this time might actually be possible in reality! So, at that time, I asked my science teacher about it, but she said, **"You won't understand now. When you grow up, you will learn about it."**

Now, I'm old enough, but I still don't know how much longer it will take to fully understand!

Since that day, I made a resolution that no matter what happens in my life, I will become like Einstein and create a time machine. When I entered class 10 and gradually got my hands on my mother's smartphone, I started searching on Google, trying to figure out how to make a time machine. I tried to understand a little, but I couldn't make much sense of it. There was also a fear in my mind—what if someone else builds a time machine before me? What would happen then? I wouldn't be able to discover anything of my own.

Then, after much hesitation, I parted ways with all my friends in class 11 (I say "parted" because my dear friends went into arts and commerce while I chose science). And that's when perhaps my real journey into physics began.

In class 11 and 12, my understanding of Relativity didn't progress much. On the other hand, I saw the first boy studying quantum mechanics, but I never delved into quantum mechanics because I've had a special attraction to relativity since childhood. When I entered college, I saw that relativity was part of our syllabus in the 4th semester. I felt very bad then, thinking, **"I'll have to wait another year!"**



But after that, I started to understand relativity mathematically because of a presentation competition held by *Partha Sir*. I learned a lot of new things and began to understand many concepts. And if I had to say something about what I have learned, then let's begin.

Let’s first talk about **"time dilation."** That is, if you start traveling at a speed close to the speed of light, time travel will occur. To explain it simply, imagine your girlfriend is waiting for you at Sealdah Station, and you are traveling by train to Sealdah. Your train’s speed is nearly close to the speed of light (let’s say 80% of the speed of light). You inform your girlfriend that you will reach Sealdah at a certain time. But when you finally arrive, you see her staring angrily at you because you arrived late. But the strange thing is, your train didn’t stop anywhere, so why did this happen? This is where time travel happens. According to the special theory of relativity, if you travel at a speed close to the speed of light, time flows more slowly for you relative to your girlfriend, while for you, her time flows much faster. To make it easier to understand, let’s say if you observe your girlfriend through a telescope and wave your hand to say hello, she will see you waving your hand very slowly. On the other hand, when she waves her hand, you will perceive her waving it very quickly.

So, if anything like this ever happens to you, make sure to explain time dilation to your girlfriend.

Now, let’s look at a paradox called the twin paradox. In this case, two identical twins—one of them is sent on a rocket into space while the other stays on Earth. The twin traveling by rocket will move at a speed close to the speed of light. After two years, when the space-traveling twin returns to Earth, his age will have increased by just two years, while his twin on Earth may have aged by 40 years. Time dilation occurs here again. But what’s the paradox? The paradox is that, relative to the twin in space, Earth will be moving at nearly the speed of light in the opposite direction, and similarly, relative to the twin on Earth, the rocket will appear to be moving at nearly the speed of light in the positive direction. So, from both perspectives, the two twins are moving in opposite directions at nearly the speed of light. But whose age will decrease and whose will increase? This question is left for you to answer.

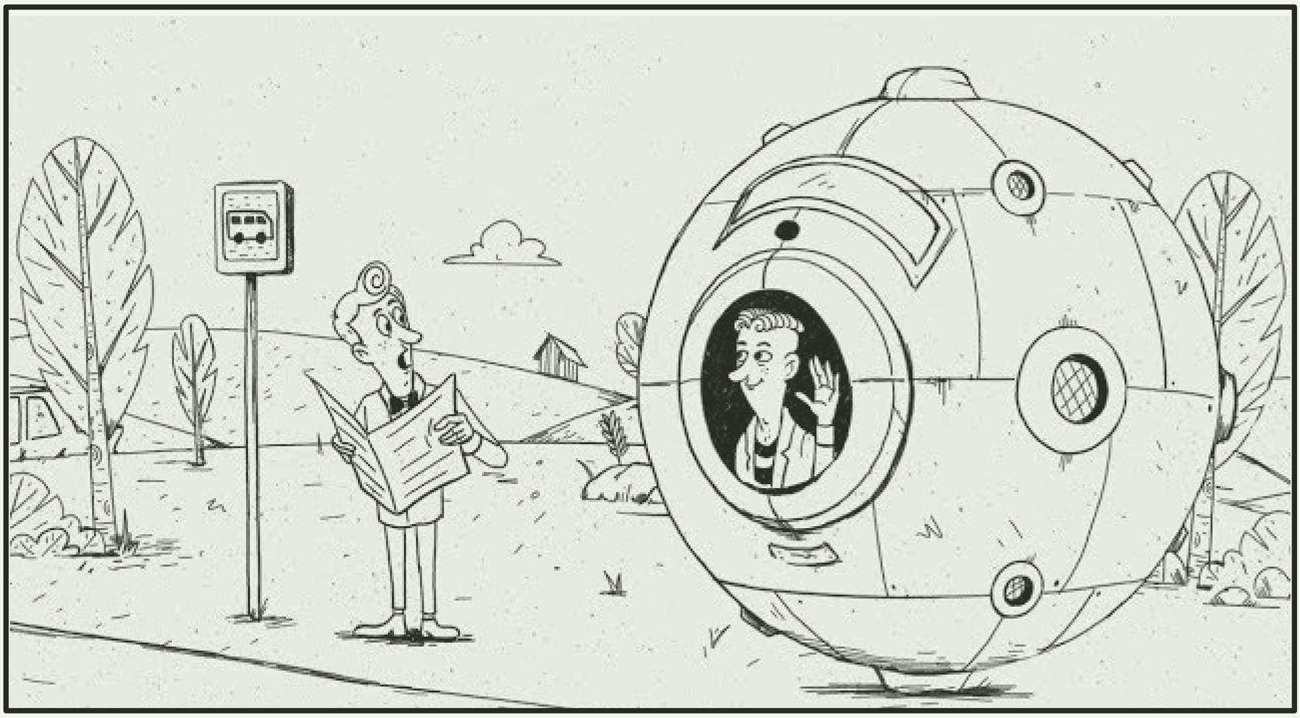
So far, we’ve discussed how we can travel to the future, but can we travel to the past? Many people who have explored this topic say, **"If we surpass the speed of light, we might be able to travel to the past."** I too thought so until then, but I couldn’t understand, **"How is that possible?"**

Later, I learned that Einstein has mathematically proved that surpassing the speed of light is impossible, so traveling to the past is just a luxury.

This brings us to another paradox called the **"Grandfather Paradox."**

Let’s say you’re ready with a knife to go and kill your grandfather. Nothing else, I’m going to gift you a time machine. You will need to travel to the past and kill your grandfather before his marriage. But the problem is, once your grandfather is killed, your father will never be born. And if your father isn’t born, how would you exist? And if you never existed, how could you have travelled to the past to kill your grandfather?

Just like the previous question, this one is left for you to figure out.



After all this, I also learned how length changes! In fact, if you travel at the speed of light, your mass could increase! This leads to the equation ***$E=mc^2$***. Then I learned about **Minkowski space-time** and the concept of **4D**.

After reading all this, I finally received some bad news. Then I was very disappointed. The disappointing part was that I had studied ***the Special Theory of Relativity***, but there’s another large and more complex part, which is ***the General Theory of Relativity***. So far, I haven’t tackled that, but I have some basic ideas, which I either learned from the movie Interstellar or somehow knew before, that mass also depends on how much time is dilated or expanded in that region!

Where there is mass, gravity must inevitably exist. This leads to many other concepts, such as ***black holes, the Big Bang, string theory, M-theory,*** and so on. I don’t yet have a full understanding of these ideas, and I know that such knowledge won’t come overnight. However, I truly believe that one day, it will.

While it's impossible to learn everything in a single day, with time and curiosity, it’s certainly achievable.

"Stay hungry, stay foolish."

~ Steve Jobs

The Tale of Two Photons

- Sreyas Banerjee, 3rd Semester

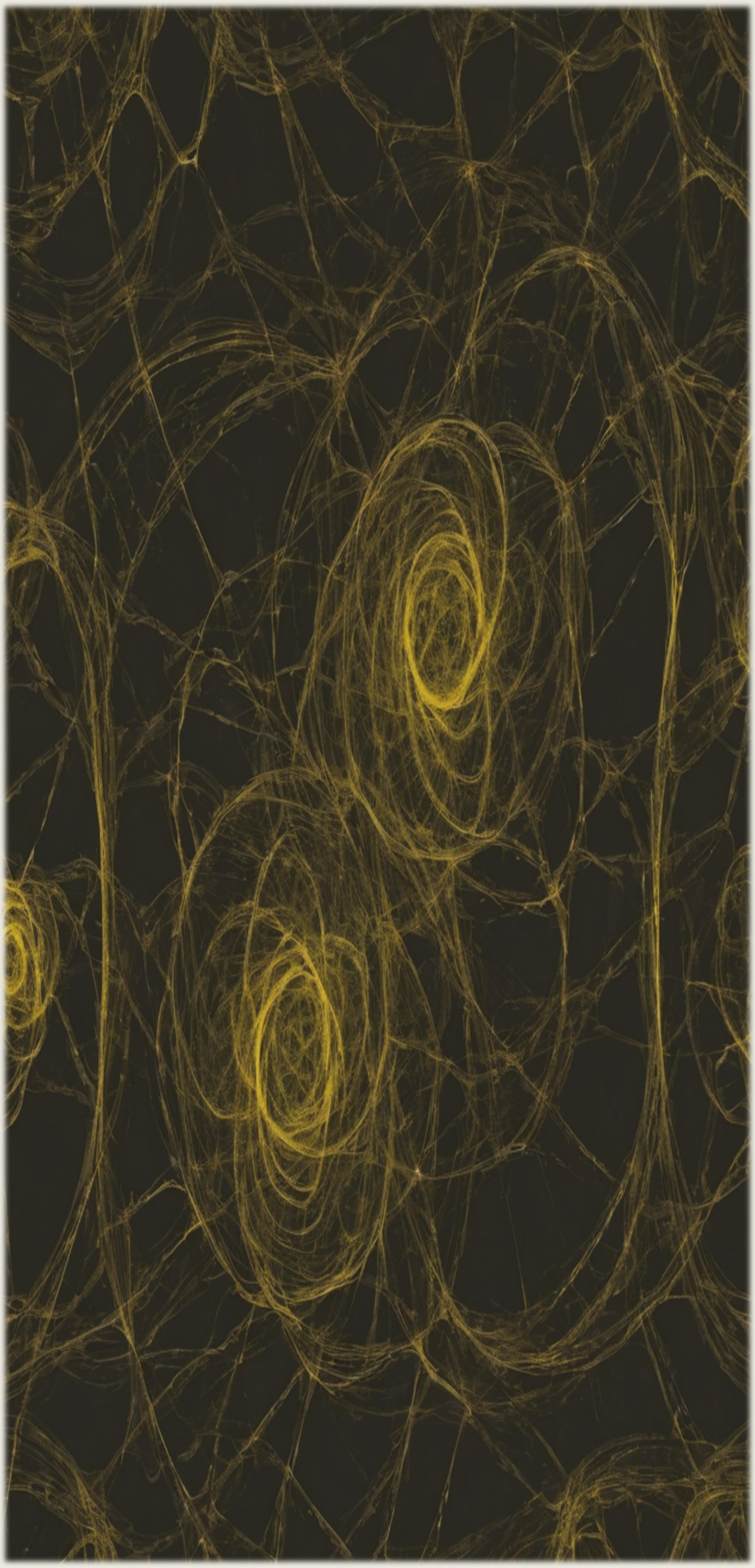
Across the Veil of Light: The Tale of Quantum Entanglement

In a dimly lit observatory nestled in the heart of Calcutta, Dr. Ganguly clasped her steaming cup of tea as raindrops whispered against the glass panes. Before her, a glowing monitor displayed a dance between two entangled photons—particles bound in a mysterious cosmic relationship that defied space and time. Evelyn mused to herself, "*Could these twins of light whisper secrets faster than the stars' journey to Earth?*" She leaned back in her chair, pondering a riddle older than her career: *Can entanglement unlock communication faster than the speed of light?* It was a question that could bend the very fabric of reality, yet its answer seemed to tease the limits of human comprehension.

The Beginning of the Spooky Tale

Long before Ganguly's time, a man named Albert Einstein frowned upon the notion of entanglement. *"Spooky action at a distance!"* he exclaimed, waving his pipe in frustration. To him, the universe was an orderly clockwork, and the idea that particles could instantly affect each other across great distances seemed absurd. But then again, quantum physics had a knack for dancing on the edge of absurdity. Niels Bohr, Einstein's contemporary and rival, found the idea enchanting. "*The universe*," he would say, "*is not as it seems. It is as it must be.*" Where Einstein sought certainty, Bohr embraced mystery. The great debate began, one arguing for hidden mechanisms, the other for the sheer unpredictability of the cosmos. Fast forward a century, and entanglement was no longer a theory; **it was fact**. Experiments had shown that if you tinkered with one photon here on Earth, its entangled partner—be it on the Moon or in the farthest reaches of space—would respond instantaneously. It was as though the universe had woven an invisible thread between them. But what did this mean? Could this thread carry whispers across the stars?

A Dream of Interstellar Love Letters



Dr. Ganguly, now lost in thought, Imagined a scene, centuries into the future. Humanity had ventured beyond the Milky Way, settling on planets that orbited alien suns. The vastness of space had made traditional communication excruciatingly slow—years or decades for a single message. On a distant colony named Aurora, a young poet named Surya awaited word from his beloved, Mou, still on Earth. Each letter took 20 years to arrive, and Surya clung to the hope that Mou's words would outlast the decades. But then, scientists on Earth unveiled a miraculous invention:

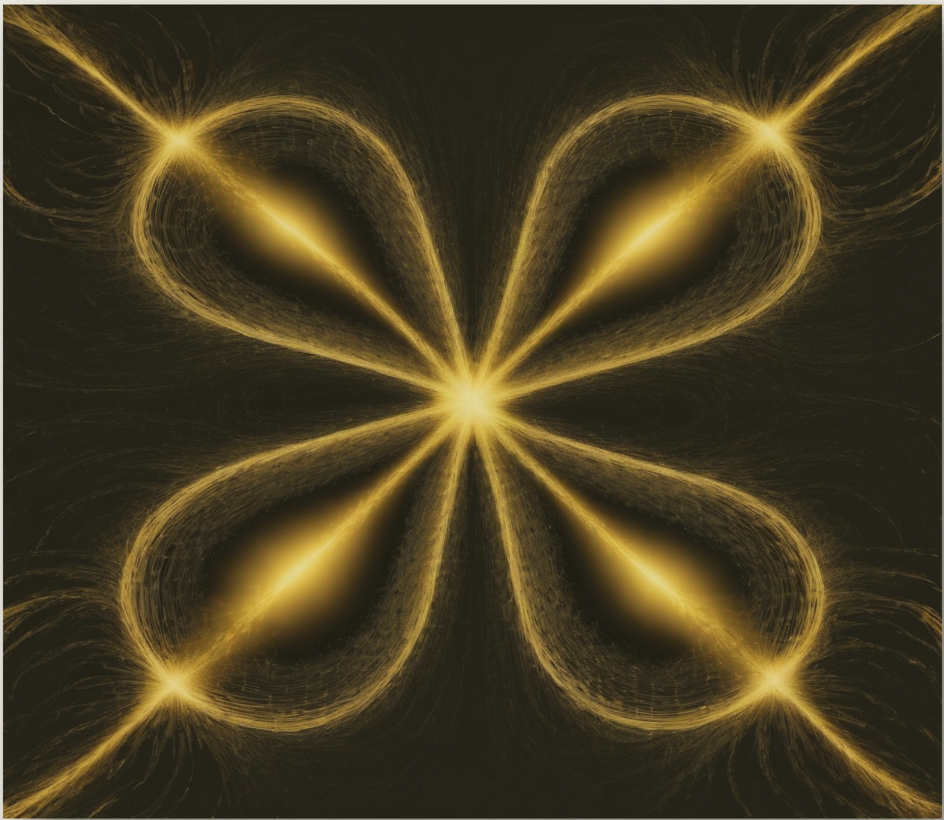
The Entanglement Messenger. By harnessing the instant connection between entangled particles, they claimed, messages could be sent faster than light (p.s did I seriously wrote this). Surya received the first real-time message from Mou on a breezy Aurora morning. "*Do you see the same stars I see?*" it read. His heart swelled. Humanity, it seemed, had finally conquered the tyranny of distance. But was it real? Ganguly knew the flaw in the dream. She whispered aloud, "*Randomness*."

The Trickster Named Chance

You see, the entangled photons were like dice thrown into the air. Their outcomes were perfectly correlated but entirely random. If Ganguly rolled her photon on Earth and got "*spin up",* the entangled twin on Mars would indeed be "*spin down*". But she couldn't control what she rolled. And therein lay the tragedy: **Randomness was the universe's great trickster**. It ensured that while the photons danced in sync, no deliberate message could be encoded in their steps. The dream of instantaneous communication remained out of reach. As Ganguly listened to the gentle whisper of rain outside , she sighed. "*Perhaps Einstein was right,*" she murmured. "*God does not play dice—but the universe certainly does*."

The Infinite Possibilities

Still, Ganguly couldn't stop dreaming. What if the randomness could be tamed? What if future scientists unearthed hidden layers of reality, layers Einstein himself had hoped for? Could entanglement be the tip of an iceberg, concealing a deeper truth that made faster than-light communication possible? She closed her eyes and imagined. In her vision, humanity had unlocked the secret of controlled entanglement. Messages travelled across galaxies and civilizations united in ways once deemed impossible. Entanglement wasn't just a scientific curiosity anymore—it was the backbone of interstellar culture. (p.s will there be other intelligent species also…?)



A Philosophical Whimsy

Ganguly chuckled, recalling the words of physicist Richard Feynman: "*If you think you understand quantum mechanics, you don't understand quantum mechanics.*" It was true. Entanglement, despite its eerie beauty, remained a paradoxical enigma. But Ganguly also found comfort in the words of Arthur C. Clarke: "*Any sufficiently advanced technology is indistinguishable from magic.*" Perhaps, she thought, the universe was full of magic waiting to be discovered.

The Tale Unfolds

As Ganguly's tea grew cold, she scribbled a note in her journal: *The threads of entanglement stretch across the cosmos, connecting particles, dreams, and ideas. They remind us that the universe, in all its randomness and beauty, holds secrets we've only begun to unravel.* And with that, she turned off the lights and walked into the melancholy melody of rain leaving the glowing photons to their silent, eternal dance.

The Sky's Secret Symphony

- Sneha Verma, 3rd Semester

On a cold winter night in Tromsø, Norway, the sky stretched like an unending canvas above. Denver, a physicist turned storyteller, surrounded by a lot of listeners whom Denver promised to tell a story that is not taken by a book but his own journey. Denver smiled and looked at the stars. *"The auroras***",** he said, pointing at the sky. The messages carried to us by the Sun itself. The story is not just about beauty but more about power and chaos.

"*I was a young researcher back then*" he said. "*I was much curious to know how the Sun, ninety-three million miles distant from the earth, could paint the skies with such vibrant colours. My curiosity for auroras brought me north, well beyond the Arctic Circle where I saw them for the first time. It seems like a pale green ribbon with a touch of pink, purple, and even a trace of crimson came into action. It seems like they follow a rhythm***. "**

Denver continued, **"***The Sun continuously emits a stream of charged particles called the solar wind. During solar storms or coronal mass ejections (CMEs), the intensity of these charged particles increases. These particles travel through space at unimaginable speeds, and when they reach Earth, they encounter Earth's magnetic field.***"**

He took a deep breath. **"***The Earth is surrounded by a magnetic field, known as the magnetosphere, which acts as a shield, deflecting most of the solar wind. Near the poles, where the magnetic field is weakest, some charged particles from the solar wind penetrate the atmosphere. When these charged particles collide with gases in Earth's upper atmosphere (thermosphere and ionosphere), they transfer energy to the gas molecules. The excited gas molecules release this energy as light, creating the aurora.***"**

A girl in the group raised her hand. ***“****What makes the colours different?”* , he asked.

Denver smiled. **“***Good question. The colours depend on what the Sun’s particles collide with. Oxygen gives us green and red. Nitrogen gives blue and purple. The altitude of the collision also changes the colours. High up, you get red. Lower down, the green dominates.***”** Denver continued, **“***There is always something much stranger than we think about space. While standing under the auroras, you don’t see science; instead, you feel its magic or something similar in stories.***”**

Denver’s voice grew softer , **“***One night, I stayed out in winter, standing under the auroras. I felt like there is some connecting between the cosmos and earth. They want to tell us some secret that only the heart can understand. They're reminding us that we are not alone in the universe***.”**

Denver finished. His mind echoed with the words of an old poet:

"*The auroras are the soul of the cosmos,*
***unspoken dreams woven into the fabric of night*."**

A Dream That Increased the Love for Science

- Gopal Kumar Shaw, 3rd Semester

One day in the small town of Portland, something very strange happened. It was a sunny morning and kids were playing, riding bikes, and flying kites. But then something happened that changed everything. Meera, an 11-year-old who loved science, was tossing an apple in the air when it didn't come back down. It just floated there! "*Wow*!" Meera exclaimed and called her elder brother Sam. "*Look at this!*" Sam pointed at his basketball, which was also floating in the air. The whole town was in chaos. Oranges were floating in the grocery store, and Mr. Smith, the baker, was running after a loaf of bread that had flown out of his window. Even pets were floating! Lila's cat, Honey, was calmly hovering near the ceiling, as if it was completely normal. Meera, being a science lover, ran to her lab (her dad's garage). "*If things are floating, it means gravity has stopped working!*" she told Sam, who was holding onto a chair to stop himself from floating away. *"But why did gravity stop?"* Sam asked, his feet swinging in the air. Meera grabbed her notebook. She remembered her teacher explaining that gravity is the force that pulls everything toward the Earth. "*It's like the Earth has a giant magnet,*" she explained. "*If the magnet breaks, everything floats!*" They turned on the TV and saw a scientist explaining the problem. "*A rare space event,*" the scientist said, "*is causing gravity to weaken for a few hours. Stay indoors and hold onto something if needed!*" Meera had an idea. "*Sam, let's do something fun!*" She grabbed a helium balloon, tied herself and Sam together with a rope and floated outside. They flew through the air, passing birds and clouds. *"Look, there's our school!"* Sam shouted. They even saw their friends floating near the park, laughing and spinning in the air. By noon, gravity returned. Meera and Sam gently landed in their backyard. Honey plopped onto the couch, annoyed that his flying adventure was over. Just then, Meera woke up and realized it was all a dream. But it was a dream she would never forget. It taught her the importance of gravity. That night, Meera looked at the stars and smiled. "*Science is amazing!*" she whispered. This dream had made her love science even more. She couldn't wait to tell her friends about how, in her dream, gravity took a break—and how much fun she had.

Nexus of Infinity

- Sreyas Banerjee, 3rd Semester

Prologue: The Fractured Mirror

In a corner of the multiverse, where timelines spiralled and tangled like the threads of an unravelling tapestry, there existed a society known simply as *The Nexus*. This was no ordinary civilization. Here, the boundaries between science and philosophy blurred and the very fabric of reality was treated not as a fixed entity but as a canvas to be rewritten. The architects of *The Nexus* had cracked the enigmatic codes of quantum gravity and M-theory, unveiling the vast network of parallel worlds—a multiverse teeming with possibilities. They built the *'Mirror Gates'*, shimmering constructs of light and energy that could transport a soul across these realities. In their hubris, they offered humanity the ultimate temptation: escape from the life they deemed unworthy. But the multiverse was not a benevolent host. It demanded balance. Each crossing left echoes, subtle distortions that rippled outward like cracks spreading across a mirror. It was a lesson learned too late.

Act 1: The Longing of Ayesi

The slums of Shard 47 were a labyrinth of rusted metal and despair. Here, the sun was a forgotten God, its light reduced to a faint orange glow that struggled to penetrate the polluted skies. Among the narrow alleys and broken dreams lived Ayesi, a child of eight whose eyes held a wisdom far beyond her years. She scavenged for food amidst piles of refuse, her tiny frame hunched against the cold. Her world was a symphony of hunger and loneliness, each day bleeding into the next with cruel monotony. Yet, amidst the bleakness, Ayesi dreamed. Her most treasured possession was a battered hologram projector, a relic from a time when her family had still been whole. The device played a single advertisement, its light flickering like a dying star. "*Step through the Mirror Gates*," the polished man would proclaim, "*and find the life you were meant to live.*" The words were etched into Ayesi's mind, a mantra she repeated in the quiet hours of the night. She didn't want riches or power. She wanted something simpler—a family, a hand to hold, a warmth that could shield her from the cold. That night, as the rain poured in relentless sheets, Ayesi stumbled into an alley she had never seen before. There, beneath the faint glow of a malfunctioning streetlamp, stood a man cloaked in shadow. His presence was an anomaly, a ripple in the air that made her skin prickle.

"*You're not supposed to be here*" he said, his voice a low hum that seemed to reverberate through the very atoms of her being. Ayesi stared at him, her heart pounding. "*Can you take me away?*" The man tilted his head, studying her with eyes that gleamed like shards of obsidian. "*Do you know what you're asking, child?*" Ayesi nodded, her voice trembling. "*I just want… to feel warm.*" The man extended his hand, his fingers trailing faint sparks. "*Very well. But know this: the threads of reality are delicate. Pull too hard, and everything unravels.*"

Act 2: Crossing the Threshold

Ayesi's first step through the Mirror Gate was like plunging into a kaleidoscope. Colours and shapes twisted and folded; her body weightless as she tumbled through layers of existence. When she finally emerged, the air was crisp, the sky impossibly blue. She found herself in a bustling city, its streets lined with trees that shimmered with leaves of gold. A woman knelt before her, her face radiant with concern. *"Are you lost, little one?"* the woman asked, her voice warm and soothing. For the first time in years, Ayesi felt the brush of kindness. The woman took her hand and led her home—a place filled with laughter and light. Ayesi was given a bed, warm meals, and a name. She was no longer Ayesi, the orphan of Shard 47. She was Ayesi, the cherished daughter of a loving family. But as days turned into weeks, Ayesi began to notice cracks. Her new mother's face would sometimes blur at the edges, her laughter fading into static. The golden leaves of the trees began to wither, their edges curling into ash. And then, one night, Ayesi heard the hum of reality unravelling.

Act 3: The Fraying Worlds

The man from the alley appeared again, his form shimmering like a mirage. *"You shouldn't have come here"* he said, his voice heavy with regret. "*I just wanted a family,*" Ayesi whispered, tears streaming down her face. "*The multiverse is not a playground,*" he replied. "*Every crossing leaves a scar. You've torn the fabric too many times*." He explained the concept of Quantum Gravity Collapse (QGC)—how every shift between worlds created echoes that destabilized the balance of existence. Ayesi's longing had become a fault line, her desires splitting across countless realities. "*You are an anomaly,*" the man said. *"Your very existence is a paradox."* Ayesi didn't understand the science, but she felt the weight of his words. Her presence in this world was an intrusion, a virus that was eroding the life she had stolen.

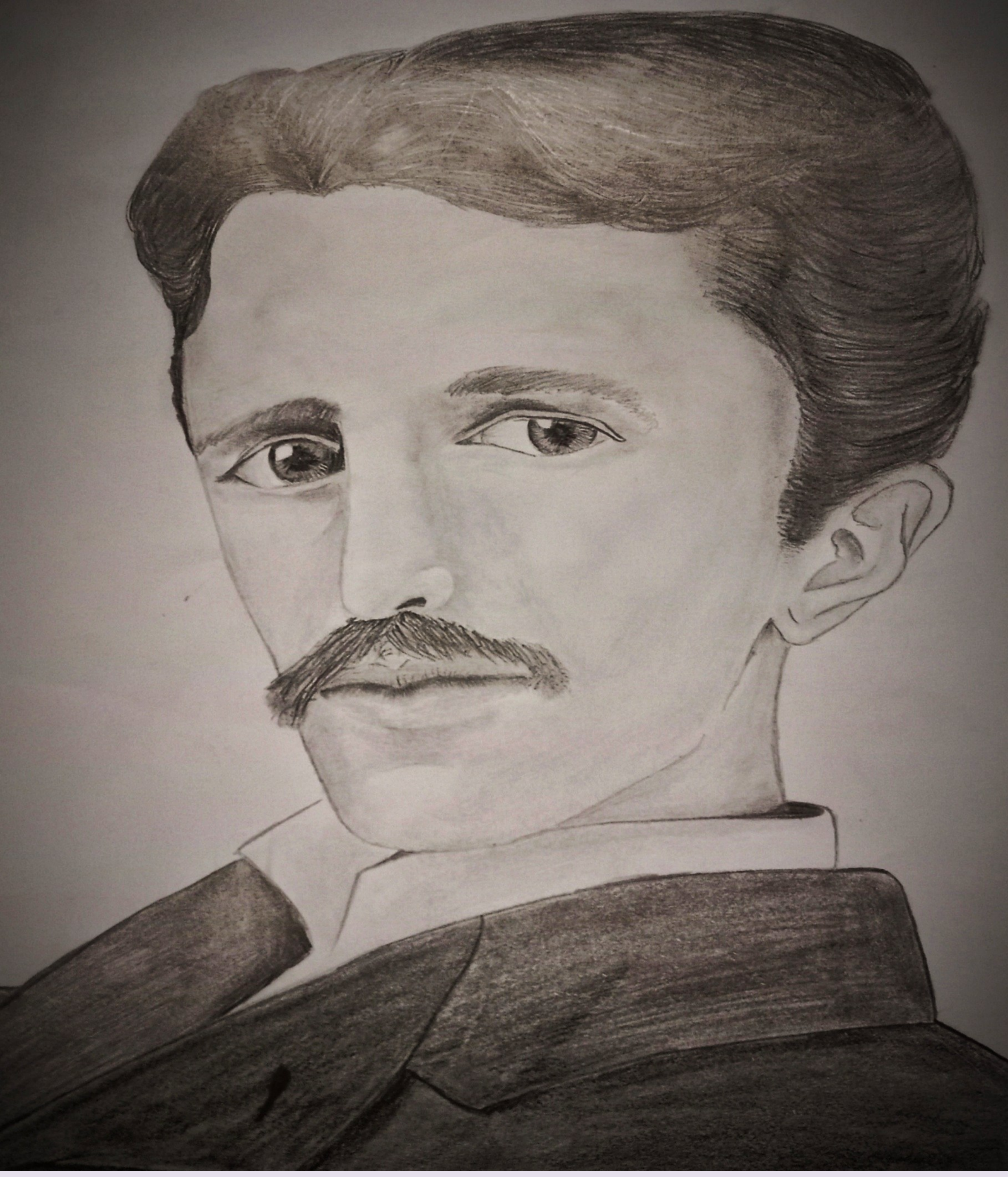
Act 4: The Collapse

The Nexus enforcers came for her the next day. Cloaked in shimmering armour, they moved like shadows, their voices cold and mechanical. *"Ayesi of Shard 47, you are hereby sentenced to reset*," they intoned. She ran, her small legs carrying her through the labyrinthine streets. Reality itself seemed to warp around her, buildings folding and unfolding like origami. The air crackled with the energy of collapsing timelines. In her desperation, Ayesi stumbled back into the alley where it had all begun. The Mirror Gate stood before her, flickering and unstable. The man was there, his expression sombre.

"*There is only one way to fix this*," he said.
"What do I have to do?" Ayesi asked, her voice barely a whisper.
"Let's go," he replied. "Return to where you belong."

Epilogue: The Infinite Embrace

Ayesi stepped through the gate one last time. As the multiverse folded around her, she caught glimpses of the lives she could have lived—a queen, a scholar, a beloved daughter. But in each life, she saw the same thing: cracks spreading, realities collapsing. When she finally emerged, she was back in Shard 47, the rain falling in mournful rhythm. The hologram projector lay in the mud, its light extinguished. Ayesi knelt beside it, her body wracked with sobs. And then, she felt it—a hand on her shoulder, warm and steady. She turned to see the man from the alley, his face soft with compassion. "*Sometimes,"* he said, "*the life we have is the only one that can hold us."* For the first time, Ayesi understood. The warmth she had sought wasn't in another world. It was in the connections she could create, even in the coldest of places. As the rain washed away the echoes of other worlds, Ayesi stood, her heart lighter than it had ever been. *And the multiverse, at last, was still.*



Ritam Deb Barman, 3rd Semester, Bangabasi College

আলোয় আলোয়..

ডাঃ পার্থ ঘোষ
এসোসিয়েট প্রফেসর

বিষয় উৎস লাতিন শব্দ physicos,
বিশ্ব ব্রহ্মাণ্ডে ,জগৎ সংসারে যা বিশ্ব কোষ...
কৌতূহলের চোখ মেলে দেখি অবাক বিস্ময়,
অবলীলায় গণিতশাস্ত্র যেথা রসদ যোগায়।।
বস্তুকনার সঞ্চারপথ আর তরঙ্গ বিকিরণ...
অপূর্ব রামধনুর আলোক বিচ্ছুরণ।।
সপ্তদশ শতাব্দীতে যাত্রা হলো শুরু,
Principia Mathematica নিউটন মহাগুরু।
Lagrange হ্যামিল্টন গ্যালিলিও কেপলার,
যাঁরা দিলেন দিব্য দৃষ্টি গ্রহনক্ষত্র চেনার।।
একে একে উদয় হলেন ফ্যারাডে ম্যাক্সওয়েল,
তড়িৎ চুম্বক কে একই সূত্রে গাঁথলেন।।
নিশ্চুপ আধানের স্থীর তড়িৎ ক্রিয়া,
ছুটন্ত হলেই দেয় চৌম্বক বিক্রিয়া।
ক্লাউসিউস কেলভিন Boltzmann সহায়...
কৃতকার্য রত তাপ গতিবিদ্যায়।।
যতই হোক বর্ণময় Gibbs র ধাঁধা,
সহজ সমাধান দেয় পরিসংখ্যান বিদ্যা।
ক্রমান্বয়ে এলো বিংশ শতাব্দির সূর্যোদয়...
দ্বন্দ্ব প্রকল্পে বিদ্ধ সনাতন পদার্থবিদ্যায়।
ক্ষুদ্র এবং বিশালে কেনই এত ফারাক,
ঈশ্বর কি খেলেন দাবা সবাই ভীষণ অবাক।।
একাকী আইনস্টাইন জটিল আপেক্ষিকতায়,
পাওলি দিরাক Schördinger কোয়ান্টাম বলবিদ্যায়।
দেশকাল ও ভর মোটেই পরম নয়,
পর্যবেক্ষণ র সাথে যা বদলে বদলে যায়।।
ছুটি যদি ভীষণ জোরে আলোর গতিবেগে,
ত্রিশঙ্কু অবস্থায় বড়ই যাবো বেঁকে।।
বিশেষ থেকে ব্যাপক হবে আপেক্ষিকতা,
যদি বদল হয় আমার ধাবতা।।

সমাবর্তন অপবরতন এবং বাতিচার,
যখন আলো ধারণ করে তরঙ্গ আকার।
যদি হয় তড়িৎ ক্রিয়ায় তোমার তুষ্টি,
আলো যেন সেথায় আবার কণার সমষ্টি।।
বড়ই জটিল এই দৈত সত্ত্বা,
কণা ও তরঙ্গের দুটি অবস্থা।।
প্রতিসমমে Noether র উপপাদ্যত,
ভরশক্তি ভরবেগ আধান সদাই সংরক্ষিত।
ভুগতেই যদি হয় অনিশ্চয়তা,
Heisenberg সেখানেই রক্ষাকর্তা।।

বড়ই ছোট এ জীবন, হয়না জানা শেষ..
হকিং বিকিরণ থেকে কৃষ্ণ গহ্বর বিশ্লেষ।।
Hubble ধ্রুবকে যদি ব্রহ্মন্ড স্ফিতমান,
কেমন হবে ভবিষ্যৎ আর এই বর্তমান।।
বিদীর্ণ পরমাণু আজ কোয়ার্ক লেপ্টোন এ,
ফোটন হিগগস গ্লুওন বাড়িয়ে বন্ধনে।।
বন্ধ হোক বিধ্বংসী শক্তির স্বরূপ,
যদি চাই মানুষ আবার মানুষে ফিরুক।।
প্রনাম তোমায় বসু সাহা চন্দ্রশেখর,
এই বিদ্যায় রেখে গেছ তোমার স্বাক্ষর।।
তোমাদের শেখানো পথে চলি বলীয়ান,
আমার পাথেয় হোক পদার্থবিজ্ঞান।।

রিসার্চ পেপার

ধুলো মাখা travelling microscope ,
আর জং ধরে পড়ে থাকা screw gauge..

শুরুটা সেই দিনের ,
যেদিন ভাবতে পারি নি দেখা হয়ে যাবে তোমার সাথে ঠিকই ,
দূরত্ব বাড়লেও যেখানে gravitational force directly
Proportional ঠিকই।
হয়তো কোনো সঠিকতার মাঝে পথ চলে চলে অন্তিমে রাখা
Gravitational waves,
Light এর speed-এ যেখানে বিচরণ করে
Electromagnetic waves
মন্দ তো নয় relativity নিয়ে খেলা !
যদি তুমি থাকো quantum mechanics নিয়ে...
যেখানে black hole ও চাইলে গিলে খেতে পারবে না ,
থাকছে না আর সময় ফিরিয়ে পাওয়ার পথখানা ।
যাচ্ছি তবু না গিয়েও ,
জড়িয়ে ধরে physics ।
ভাবছি যা হবার , থাকবে আমার
তোমায় থাকা Thesis ...

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Electronic Gadgets - The Architects of Modernity or Agents of Complexity?

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Abstract: From shaping how we work and communicate to redefining how we unwind, electronic gadgets have revolutionized modern life. Yet are they the benevolent agents of progress we celebrate or the covert architects of social, physical, and environmental challenges? This paper embarks on a critical exploration of the dual roles these gadgets play in our lives. Through thoughtful inquiry and analysis, we aim to uncover the multifaceted impact of electronic gadgets in today's era.

Introduction: Imagine a day without electronic gadgets. The stillness of a world devoid of smartphones, laptops, and wearables feels almost dystopian in its silence. Yet, as indispensable as these gadgets are, they prompt profound questions:

- Have they truly liberated us, or are we prisoners of convenience?
- What hidden costs accompany their omnipresence?

As we journey through this exploration, we will probe the profound societal, psychological, and environmental consequences of gadgets with an aim to uncover their nuanced truth.

The Proliferation of Electronic Gadgets

The ubiquity of electronic gadgets is driven by rapid advancements (beginning in the mid-20th century) in technology, especially in miniaturization, connectivity, and artificial intelligence. Over 7.33 billion smartphones are in use globally, enabling instant communication and bridging distances. Virtual meetings, social media platforms and instant messaging have redefined relationships, workplaces, and activism.

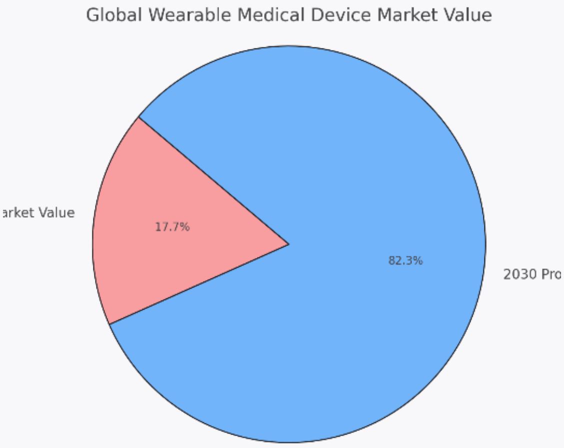
However, this connectivity brings a paradox: Are we more connected or more isolated? Platforms like Instagram and WhatsApp, which claim to bring people closer, are also linked to a surge in loneliness and social anxiety.

A 2022 Deloitte study reveals that 40% of workers feel digitally exhausted. The tension between convenience and privacy also adds to the complexity. Gadgets that foster connection also harvest personal data on an unprecedented scale. This dichotomy fuels one of the defining challenges of the digital age –

Can we trust the tools we depend on?

Act I: The Healthcare Revolution - A New Era of Diagnostics

Wearable technology, such as smartwatches and fitness trackers, has empowered individuals to monitor their health in real-time. The global wearable medical device market, valued at $20.1 billion in 2022, is projected to surpass $93.2 billion by 2030, displaying the immense potential of these gadgets.



- ✓ Heart health monitors detect arrhythmias (irregular heartbeat) early.
- ✓ AI-powered imaging tools revolutionize cancer diagnostics.
- ✓ Telemedicine platforms provide healthcare access to remote areas.

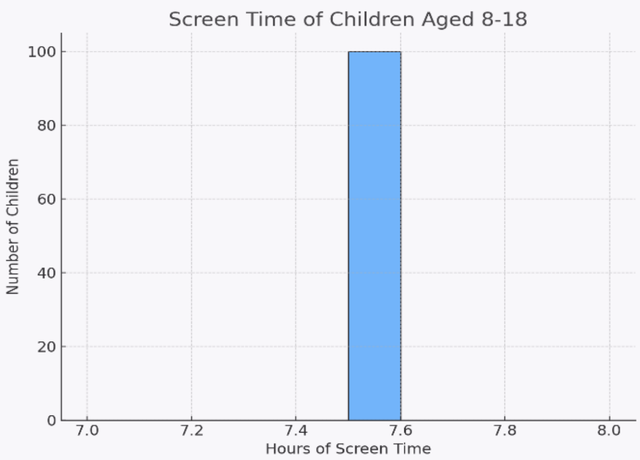
However, the vast involvement of gadgets in healthcare is not without challenges,

Accuracy Issues: Studies indicate a 25% inconsistency rate in wearable measurements and such inaccuracies lead to incorrect diagnoses.

Data Vulnerabilities: With health data increasingly stored online, the risk of cyberattacks looms large.

Act II: The Educational Paradigm Shift – A Boon or a Burden?

The pandemic catalysed a digital transformation in education. Over 1.6 billion students transitioned to online learning. Young students rely on gadgets to access classes, resources, and assessments. These devices democratize education which enables access to global learning platforms like edX and Khan Academy.



Yet, beneath this progress lies a troubling dilemma about the digital divide. A UNICEF report (2023) highlights that nearly 463 million children worldwide lack access to necessary gadgets and reliable internet, exacerbating educational inequalities. Are cognitive abilities being compromised? Children aged 8–18 now spend an average of 7.5 hours daily on screens which raises concerns about attention disorders and reduced creativity.

Act III: The Environmental Toll

The environmental impact of gadgets is an overlooked crisis. From manufacturing to disposal, they contribute significantly to climate change and resource depletion.

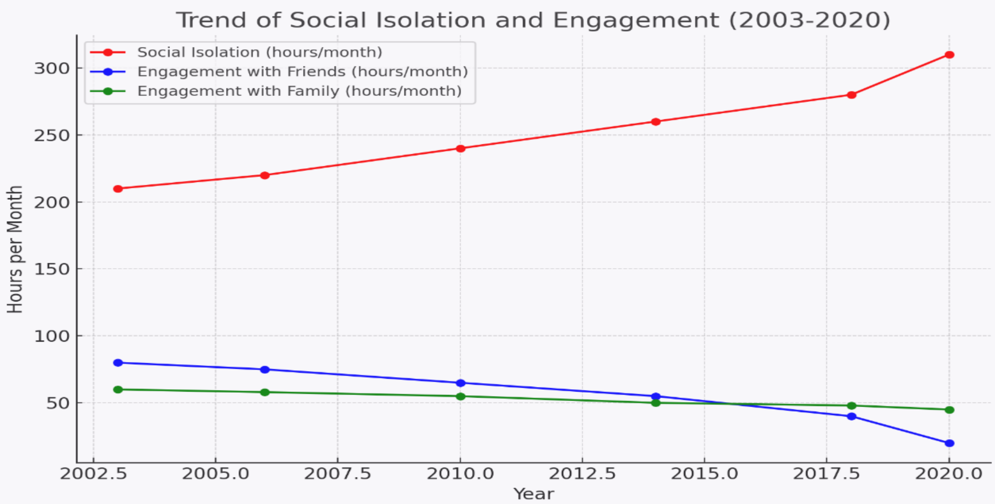
E-Waste Epidemic: The world generates 53.6 million metric tons of e-waste annually. In 2021, the global e-waste total reached 57.4 million metric tons and this figure continues to rise by about 2 million tons annually (Earth.org). Alarmingly, only about 17% of this e-waste is recycled properly (Wired.com). The rest ends up in landfills, leaching toxins into the soil and water.
Resource Exploitation: The extraction of rare earth materials like lithium and cobalt for technological advancements strains ecosystems and fuels geopolitical conflicts.

Act IV: The Psychology of Gadget Dependency - Technostress and Nomophobia

As gadgets embed themselves into daily life, their psychological impacts grow. Nomophobia (fear of being without a mobile phone) now affects over 66% of adults. Social media addiction fosters anxiety, depression, and loneliness (CrownCounseling). Online platforms are designed to exploit the brain's reward system, creating a dopamine loop. This raises a chilling question,

Are we in control of our gadgets or are they controlling us?

While gadgets connect us virtually, they tend to erode real-life interactions. Studies suggest that excessive gadget use diminishes empathy and interpersonal communication skills, particularly in younger generations.



Emerging Solutions,

1. ***Sustainable Innovation***: Companies are leveraging **quantum materials** and **graphene** in the production of gadgets to reduce environmental impact. These materials are not only lightweight but also highly efficient which enables **energy harvesting** and **recycling** of electronics. **Semiconductor recycling** is being driven by advancements in **nanomaterials** that offer improved performance with reduced waste.

2. ***Eco-Friendly Alternatives***: **Nanoelectronics** and **piezoelectric materials** are making strides in creating self-sustaining gadgets where energy is generated from environmental motion. Additionally, innovations in **low-power transistors** reduce the carbon footprint of devices. These promote long-lasting, energy-efficient gadgets.

3. ***Digital Detox Movements***: **Neurofeedback** technologies are being developed to promote healthier gadget use. With the help of **biophysics,** designing of haptic feedback systems limit excessive screen reliance.

Conclusion:

The answer to whether electronic gadgets are the *Architects of Modernity or Agents of Complexity* lies in their duality. They have revolutionized communication, healthcare, and education that offer convenience and innovation. Yet, they pose undeniable risks to mental health, social dynamics, and environmental sustainability.

To thrive in this gadget-driven world, we must adopt a balanced approach, i.e.,

- Foster awareness about their long-term implications.
- Advocate for sustainable practices in production and disposal.
- Prioritize real-life connections over virtual interactions.

References:

1. Ethics of E-Waste: Understanding Tech's Environmental Impact. (OriginStamp)
2. The Environmental & Social Effects of E-Waste (With Facts & Statistics). (Get-Green-Now)
3. Impacts of excessive uses of electronic gadgets on behavioural patterns. (J.Sci)
4. Nomophobia Statistics. (CrownCounseling)
5. Smartphones, Social Media, and Their Impact on Mental Health.(Columbiapsychiatry.org)
6. A Survey on the Use of Haptic Feedback for Brain-Computer Interfaces and Neurofeedback.(hal.science)
7. Picture Courtesy – DALL-E

From Algorithms to the Cosmos: How Machine Learning Revolutionizes Physics

Somiddhya Banerjee, !st Semester, Bangabasi College

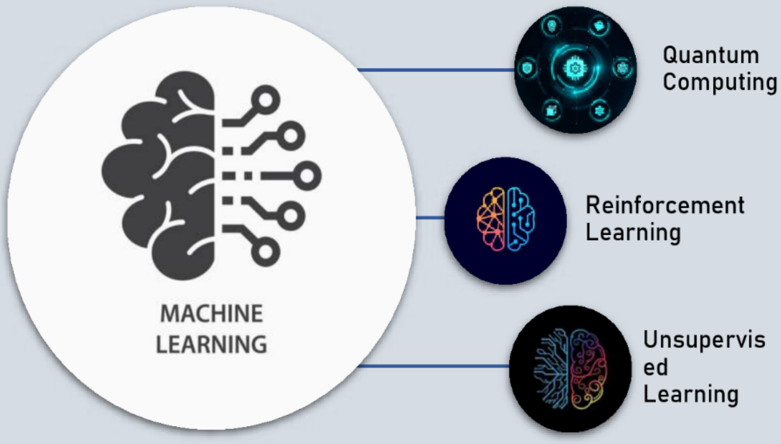
Machine learning (ML) is a branch of artificial intelligence (AI) that focuses on creating systems capable of learning and improving from experience without being explicitly programmed. At its core, machine learning involves algorithms that analyse data, identify patterns, and make predictions or decisions. These systems are widely used in applications such as recommendation engines, image recognition, natural language processing, and even self-driving cars.

Alan Turing with his computer Image Source: Phys.org

The journey of machine learning began with the advent of computers. Early pioneers like Alan Turing laid the groundwork for AI with concepts such as the "**Turing Test**." In the 1950s and 60s, researchers began developing algorithms capable of simple learning, such as Arthur Samuel's checkers-playing program. These early systems used symbolic AI, which relied on predefined rules and logic.

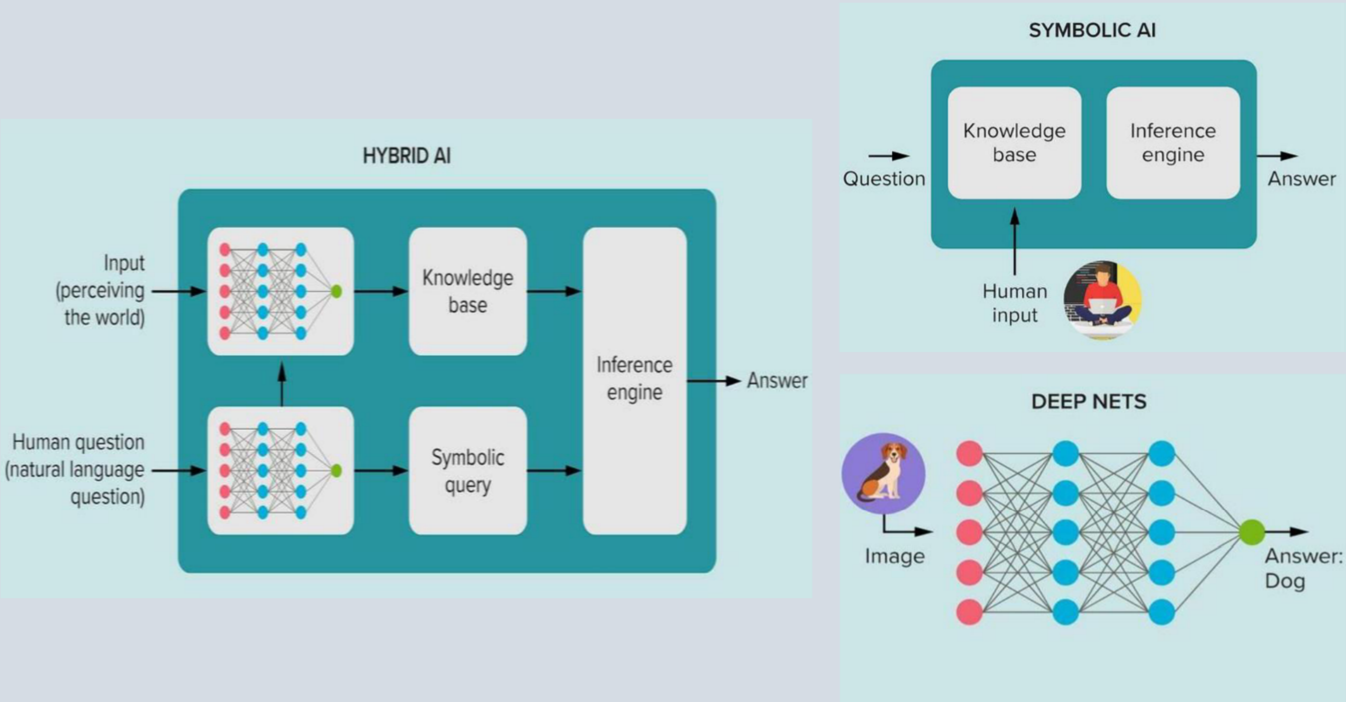
The real breakthrough in machine learning came in the 1980s and 90s, when researchers shifted focus to statistical methods and neural networks. **Backpropagation**, a method for training neural networks, became a key development. However, the computational power of that era limited the complexity of these models.

The 2000s and 2010s saw the explosion of data, often referred to as "**big data**," and an increase in computational power. These advances, combined with improved algorithms, led to the rise of **deep learning**—a subset of ML that uses large neural networks with multiple layers. Deep learning enabled machines to excel at tasks like image and speech recognition, outperforming humans in some cases.



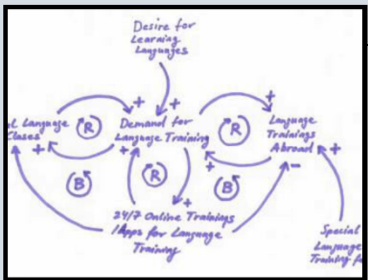
Today, machine learning is an integral part of countless industries, from healthcare to finance. It continues to evolve, driven by innovations in **quantum computing**, **reinforcement learning** and **unsupervised learning**.

The relationship between machine learning and physics is symbiotic. Physics provides the theoretical foundations and data-driven challenges that push the boundaries of ML, while ML offers tools and techniques that accelerate discoveries in physics.



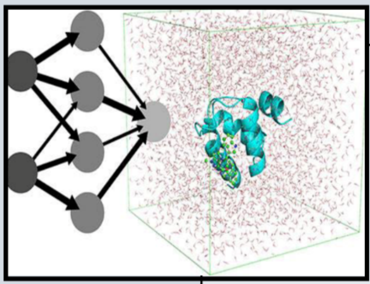
Symbolic AI vs Deep Nets vs Hybrid AI
Image Source: Towards AI

Here are some key intersections:

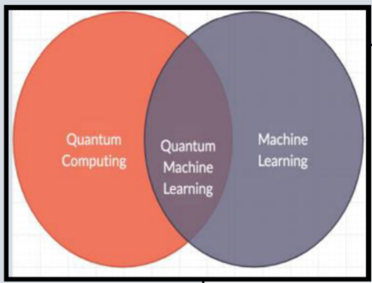


Modelling Complex Systems: Physics often deals with complex systems, such as fluid dynamics, quantum systems, or astrophysical phenomena. Traditional computational methods can be slow or inadequate for these problems. Machine learning can approximate solutions quickly by learning from simulations or experimental data.

Analysing Large Data Sets: Modern physics experiments, like those conducted at **CERN**'s Large Hadron Collider, generate enormous amounts of data. Machine learning algorithms are essential for filtering noise, identifying patterns, and extracting meaningful results.



Accelerating Simulations: Simulations in physics, such as weather models or particle interactions, can be computationally expensive. ML techniques can speed up these simulations by predicting outcomes based on prior results, saving significant time and resources.



Quantum Computing and ML: Quantum physics underpins quantum computing, a field poised to revolutionize machine learning. Quantum algorithms have the potential to solve ML problems exponentially faster than classical algorithms, enabling breakthroughs in both physics and technology.

Machine learning has come a long way from its early days and has become a transformative force in modern science and technology. Its connection to physics exemplifies the potential of interdisciplinary collaboration. By combining the predictive power of ML with the rigor of physics, we can unlock new frontiers of knowledge, solve complex problems, and create a future where machines and humans work together to unravel the mysteries of the universes.

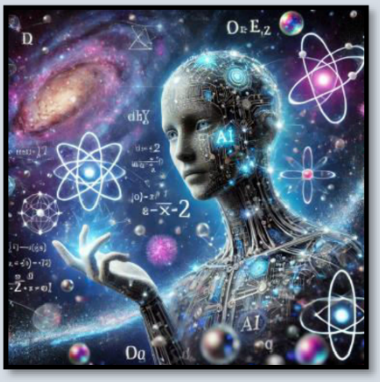


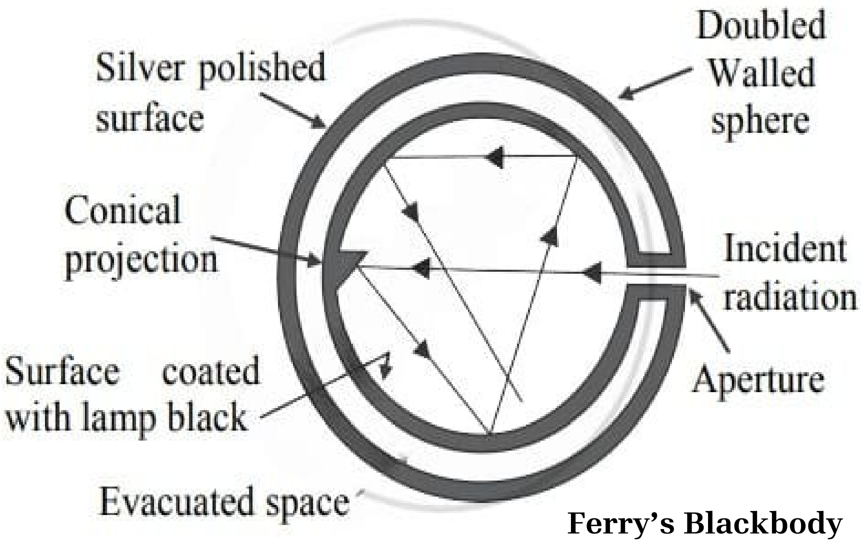
Image Source: ChatGPT 4

Planck's Theory of Blackbody Radiation

Dr. Sucharita Chatterjee, SACT-I , Department of Physics, Bangabasi College

INTRODUCTION: In this article, I will discuss about the phenomenon known as Blackbody radiation. It was in early 20th century when Max Planck, a German physicist gave a revolutionary idea for explaining the energy spectrum of the black body radiation. According to Sir Planck, energy is emitted or absorbed in discrete amounts or quanta, and that is directly proportional to the frequency of the radiation. Energy is emitted or absorbed in discrete amounts, as multiple of $h\nu$, $E = nh\nu$, n is an integer, h is the Planck's constant, $6.62x10^{-34} J.s$, ν is the frequency of the radiation. His theory of black body radiation led to the foundation of Quantum Mechanics.

BLACK BODY RADIATION: A blackbody is an idealised physical body that absorbs all incident electromagnetic radiation regardless of the frequency and the angle of incidence. A black body in thermal equilibrium [i.e., at constant temperature T, when T>T_s (surrounding temperature)] emits electromagnetic radiation known as black body radiation (E.g. Ferry's black body). The radiation is emitted according to **Planck's law**, it has a spectrum that is determined by the temperature, not by the body's shape or composition. The spectral distribution of the thermal energy radiated by a blackbody depends only on its temperature. Classical Physics failed to explain the spectral distribution of radiant energy emitted by a black body (**ultraviolet catastrophe**). Applying the laws of classical electromagnetic theory, **Rayleigh – Jeans** derived an expression for the energy density of radiation as a function of frequency and in terms of wavelength and temperature,



Ferry's Blackbody

$u_\lambda(\lambda,T)d\lambda = \frac{8\pi kT\nu^2}{c^3}d\nu$	$u_\lambda(\lambda,T)d\lambda = \frac{8\pi kT}{\lambda^4}d\lambda$

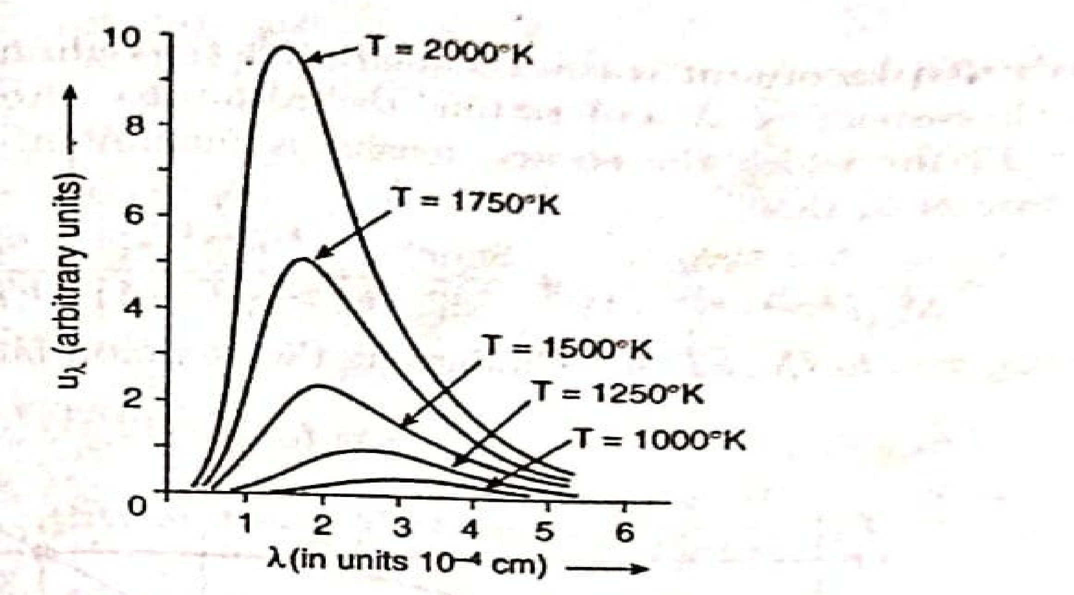
In the high frequency limit, $\nu \to \infty, u_\nu \to \infty$, thus the energy density of radiation diverges and tends to infinity, this is known as **ultraviolet catastrophe.**

Planck successfully removed the discrepancies by introducing his **Quantum hypothesis in 1900**, according to which the material oscillators (charged particles/atoms/ molecules) located on the walls of the black body (or cavity) and oscillating with frequency ν can emit or absorb electromagnetic energy (or to say, the oscillators on the walls of the cavity behaving like harmonic oscillators emit e.m. radiations), not continuously in arbitrarily small amounts but in integer multiples of the quanta of energy $h\nu, \varepsilon = 0$, $h\nu, 2h\nu, 3h\nu, \ldots\ldots, nh\nu$. The constant h is called the **Planck's constant, h**=$6.62x10^{-34} J.s$ (unit of angular momentum). The energy density of radiation (in terms of frequency) inside the enclosure which acts as a black body at temperature T using Maxwell-Boltzmann distribution law is

$$u_\nu\,(\nu, T)d\nu = \frac{8\pi h}{c^3}\,\frac{\nu^3\,d\nu}{(e^{hc/kT} - 1)}$$

The energy density of radiation (in terms of wavelength),

$$u_\lambda(\lambda, T)d\lambda = \frac{8\pi hc}{\lambda^5}\,\frac{d\lambda}{\left(e^{hc/\lambda kT} - 1\right)}$$

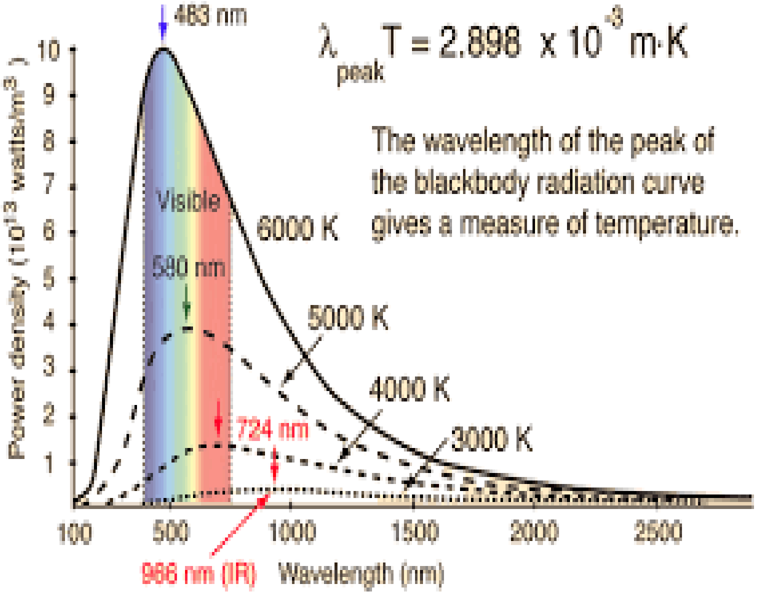


Energy distribution in the spectrum of a black body

The graph drawn for the energy density of radiation emitted against the wavelength reveals the following facts:

I. The blackbody radiation depends only on the temperature of the enclosure only and not on shape, size or nature of the material of the walls of the enclosure.

II. The isothermal radiation is homogeneous and isotropic.



III. Black body radiation has a continuous spectrum of energy distribution. A plot of u_λ versus λ at a particular temperatue T is a continuous curve.

IV. The wavelength of the emitted radiation varies continuously from $\lambda = 0 \ to\ \lambda = \infty$ (there no emission at zero wavelength).

V. As the wavelength increases, the energy emitted from the from the blackbody also increases, reaches a maximum for a particular wavelength λ_m and then decreases with further increase in wavelength.

VI. The wavelength λ_m of maximum emission shifts towards the lower wavelength side as the temperature of the of the blackbody increases. This is denoted as $\lambda_m T = const$. This is known as the Wien's displacement law.

VII. The area under the curve represents the total energy emitted by a blackbody per sec. per unit area over the complete wavelength range at a particular temperature.

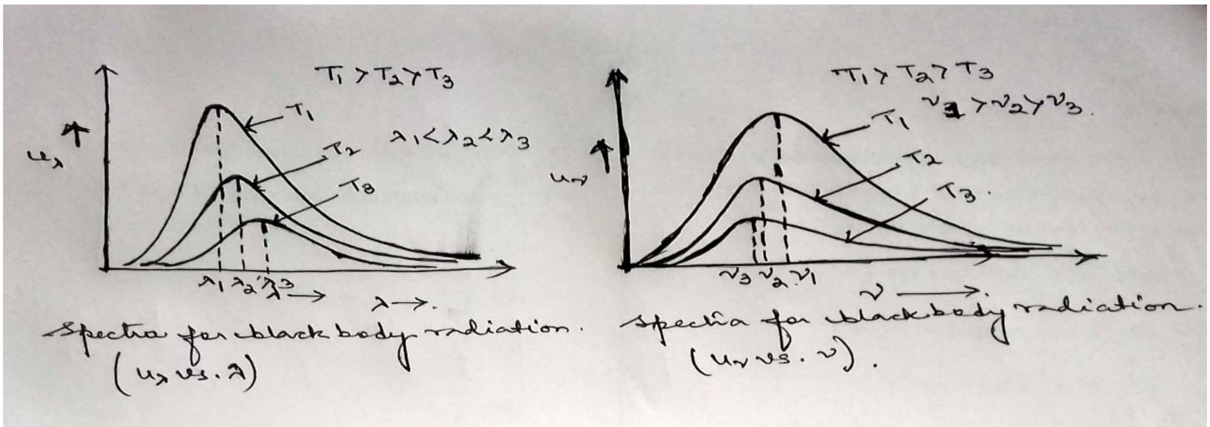
Planck's law of black body radiation reduces to **Rayleigh-Jeans distribution law** in the high wavelength limit (low frequency) and reduces to **Wien's distribution law** in high frequency (low wavelength) limit.

In the high wavelength limit, λ large, $^{hc}/_{\lambda kT}$ ⇢ small,

Rayleigh-Jeans law, $\mu_\lambda(\lambda, T)d\lambda = \frac{8\pi kT}{\lambda^4} d\lambda$

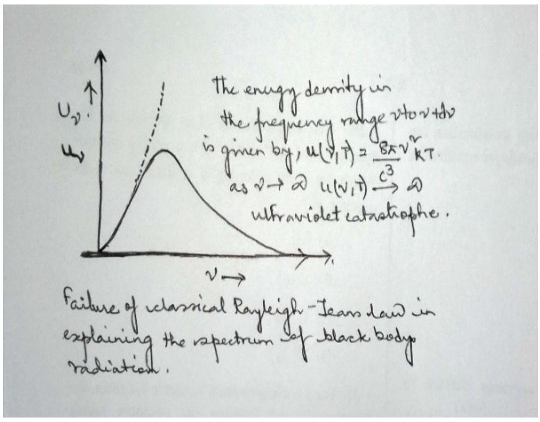
In the low wavelength limit, λ large, $^{hc}/_{\lambda kT}$ - - - > large,

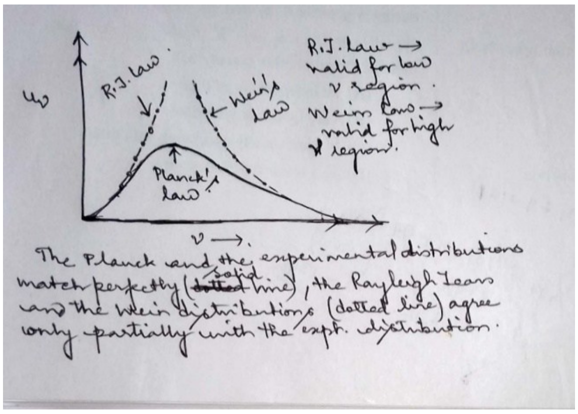
Wien's distribution law, $\mu_\lambda(\lambda, T)d\lambda = \frac{8\pi hc}{\lambda^5} e^{-hc/_{\lambda kT}} d\lambda$



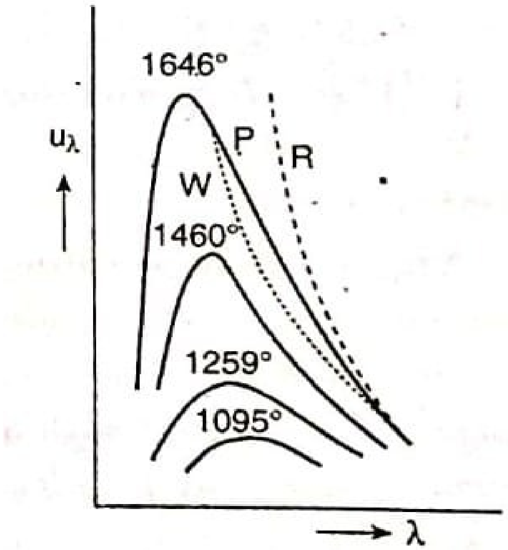
Variation of energy density of radiation with wavelength (λ) and frequency (ν) for different temperatures

It is evident from the graphs, that at a particular temperature, the intensity of the blackbody radiation increases with the increase in λ, becomes maximum (E_{max}) at a particular λ (λ_{max}) and finally decreases with the further increase in λ. It is clear from the plots that with increasing temperature λ_{max} shifts towards lower wavelength, and an opposite behaviour is exhibited for the plots of the intensity of the radiation with the frequency.





It is evident from the graphs, that the curve plotted for the Rayleigh-Jeans distribution law fits very well with the experimental curve in the low frequency region, however it diverges in high frequency region. While the curve plotted for the Wien's distribution law fits very well with the experimental curve in the high frequency region.



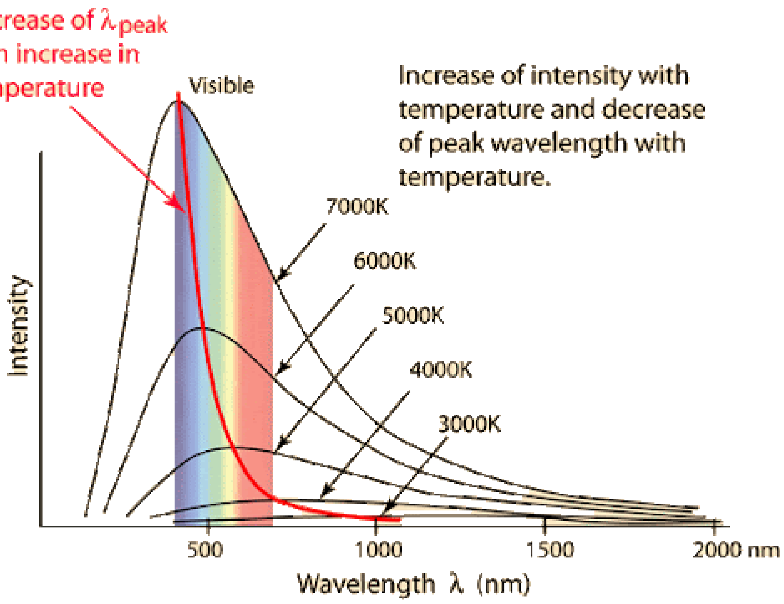
Comparison of Different Radiation Laws

WIEN'S DISPLACEMENT LAW: $\lambda_m T$ = constant

The law states that the peak of the black body radiation curve (μ_λ vs. λ) shifts towards the lower wavelength with increasing temperature.

$\lambda_m T$=constant

$\lambda_m T=0.289\text{x}10^{-2}\text{mK}=2.89\text{x}10^{-3}\text{mK}$



Conclusion:

In this article I tried to introduce a phenomenon which the classical theory was falling short to explain. It was all because of Sir Max Planck that it was possible to explain the energy spectrum of the electromagnetic radiation emitted by the black body. The introduction of h, Planck's constant marked the advent of a new era: physics of a microphysical world. Following Planck Idea of quantization of energy, Einstein was able to explain the long-awaited phenomenon of photoelectric effect (1905). Based on this idea in the following years, other eminent physicists, Compton, de Broglie and Bohr successfully explain many of the outstanding problems that remained unanswered for decades.

Ritam Deb Barman, 3rd Semester, Bangabasi College

The Breaking of the Enigma Code: A Symphony of Physics and Computer Science

- Somiddhya Banerjee, 1st Semester

During World War II, the Enigma machine stood as a symbol of German military ingenuity, an intricate cipher device that encoded messages deemed unbreakable. But history tells us a different story: the Allies cracked the Enigma code, tipping the scales of the war. Behind this monumental achievement lies a tale of intellectual brilliance, teamwork, and the seamless fusion of physics and computer science.

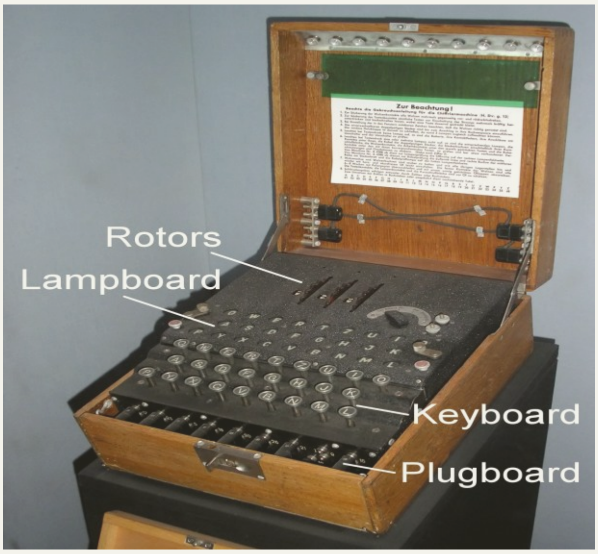
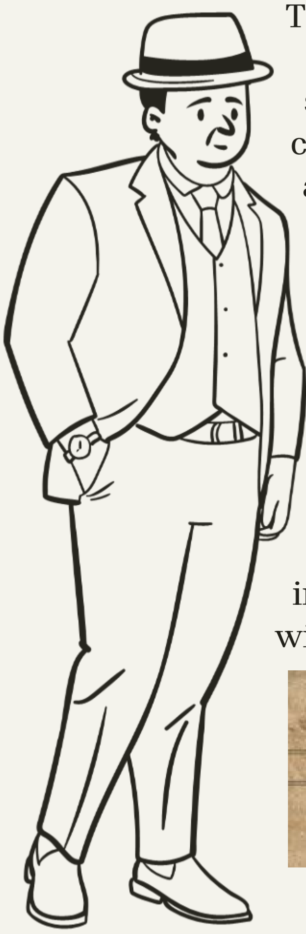


Image Source: Wikipedia
The Enigma Machine

The **Enigma machine** resembled a typewriter but functioned as a cryptographic marvel. Invented by German engineer Arthur Scherbius in the early 1920s, it encrypted messages by substituting letters based on a series of rotors and electrical circuits. Each keypress lit up a different letter on a lamp board, determined by the rotor settings and wiring.



The brilliance of the machine lay in its configurability. With multiple rotors, adjustable starting positions, and plugboard settings, the number of possible configurations exceeded 10^{114} - a number so vast it dwarfs the atoms in the observable universe. The German military relied on this complexity to ensure their communications remained secure. They believed Enigma was impenetrable. But they were wrong.

The first cracks in Enigma's armour came not from the British or Americans but from Polish mathematicians *Marian Rejewski, Jerzy Różycki, and Henryk Zygalski*. Using a combination of mathematics and mechanical ingenuity, they reverse-engineered early versions of the Enigma machine in the 1930s. Their breakthrough was possible thanks to espionage, as French intelligence acquired German cipher manuals and shared them with Poland.

Rejewski applied group theory, a branch of mathematics that explores symmetrical structures, to identify patterns in Enigma's permutations. The Poles built devices called "bombe" machines to automate the decryption process. However, as Germany upgraded Enigma with more rotors and plugboard connections, the Polish methods became insufficient. In 1939, just before the outbreak of World War II, the Polish team shared their findings with British intelligence.

Image Source : X (formerly Twitter)

Bletchley Park, a nondescript mansion in the English countryside, became the nerve centre of Allied code breaking. Among its brightest minds was Alan Turing, a mathematician whose work would revolutionize not only cryptography but also the field of computer science.

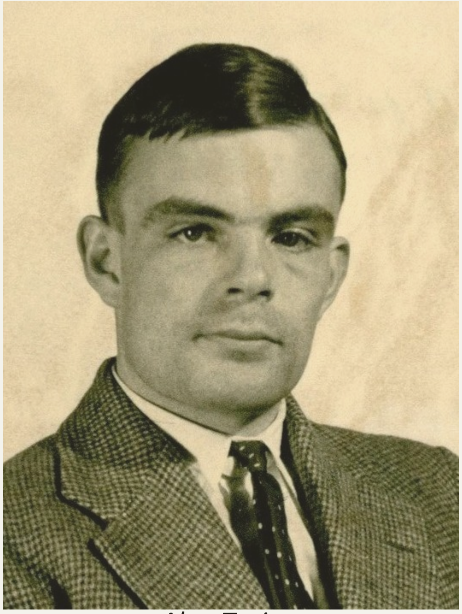
Turing recognized that solving Enigma required more than mathematics—it demanded a mechanical solution that could test configurations faster than any human. He designed an improved version of the **Polish bombe**, a machine capable of testing thousands of Enigma settings per second. This device exploited a crucial weakness: human error. German operators often repeated predictable phrases, such as "*Heil Hitler*" or weather reports, providing clues to the machine's settings.

Image source: Imitation game (Movie)
Alan Turing and his team

Turing's bombe worked by systematically eliminating incorrect rotor and plugboard configurations. Once a likely configuration was identified, human operators completed the final decoding. By 1941, Bletchley Park was decrypting thousands of German messages daily.

The Physics Connection: Electromagnetism and Signal Transmission And the birth of Computer Science

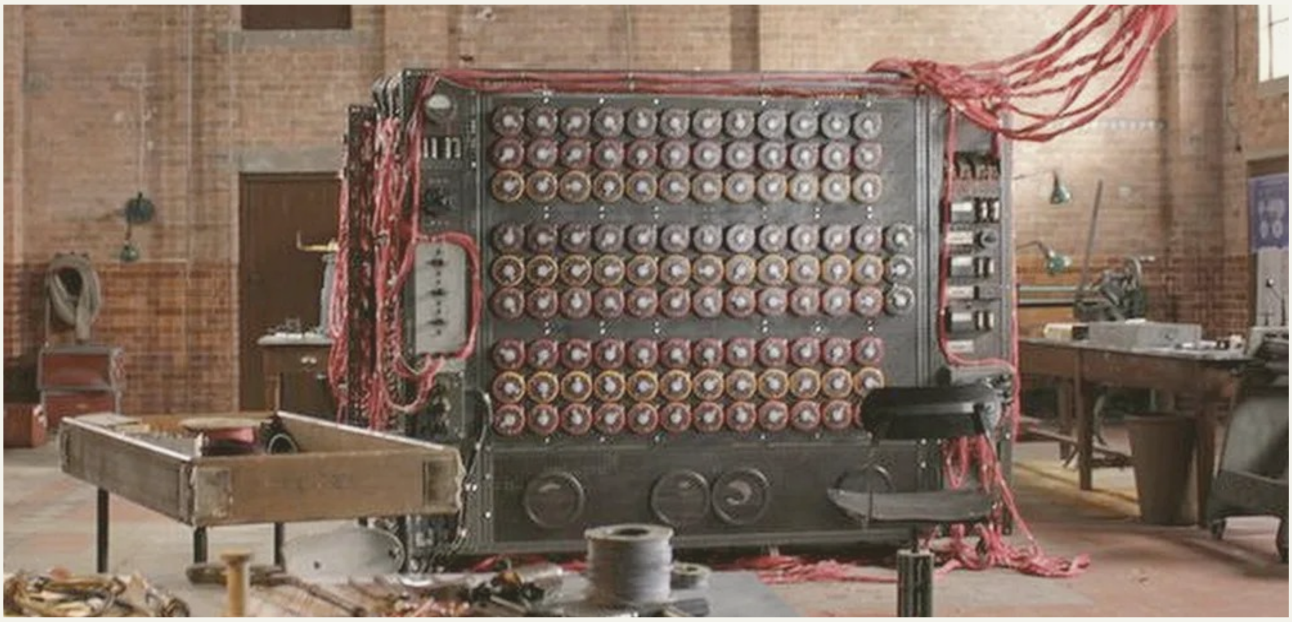
While the Enigma machine itself was mechanical, its operation depended heavily on principles of electromagnetism. Each keypress activated an electrical circuit that passed through the rotors and plugboard, ultimately lighting up a lamp to indicate the encoded letter. Understanding these electrical pathways was essential for reverse-engineering the machine.



Alan Turing
Source: Wikipedia

Moreover, physics played a vital role in the interception of Enigma-encoded messages. German communications relied on radio waves, which propagated through the atmosphere. Allied forces used large antenna arrays to intercept these signals. Radar and radio technologies, grounded in Maxwell's equations and electromagnetic wave theory, allowed the Allies to monitor German communications in real time. Turing's work on the bombe was just the beginning. As the war progressed, cryptographic challenges grew more complex. To keep pace, the Allies developed Colossus, the world's first programmable electronic computer. Designed by engineer *Tommy Flowers*, Colossus used vacuum tubes to process data much faster than mechanical devices.

Although Colossus was initially used to break the *Lorenz cipher* (a more advanced German encryption system), its development was directly influenced by Turing's ideas. The concepts of algorithmic logic and automated computation—pioneered by Turing during his work on Enigma—laid the groundwork for modern computers.



The Bombe Machine
Image Source: WIRED

Why It Mattered: The Impact on the War

The breaking of Enigma provided the Allies with a treasure trove of intelligence, code-named "**Ultra**." It revealed German troop movements, supply lines, and strategic plans. One of the most significant contributions was during the Battle of the Atlantic. Enigma decryption allowed the Allies to locate and evade German U-boats, ensuring the safe passage of supply convoys to Britain. The impact extended to major military campaigns, including **D-Day**. Ultra intelligence confirmed that the Germans believed the Allied invasion would occur at Pas de Calais rather than Normandy. This deception, combined with accurate information about German defences, ensured the success of Operation Overlord.

WWII
Image Source: Netflix(All quiet on the western front)

Historians estimate that breaking Enigma shortened the war by two to four years, saving millions of lives.

Conclusion: Triumph of Human Ingenuity

The breaking of the Enigma code is more than a historical milestone; it's a testament to the ingenuity and perseverance of scientists, mathematicians, and engineers. It exemplifies how theoretical knowledge can be harnessed to solve real-world problems and how collaboration across disciplines can achieve the seemingly impossible.

For students, the legacy of Enigma is an invitation to think beyond boundaries. Whether you're calculating wave functions, writing algorithms, or exploring abstract mathematical structures, remember that these tools—when combined—have the power to change the world.

Alone in the Universe? The Mystery of the Fermi Paradox

Consider this scenario: you're standing in a crowded city at night. The streets are busy with light and song, and you have the feeling that there must be others—people just out of sight, ready to connect. But when you call out, no one responds.

This is the base of the Fermi Paradox: the strange gap between the universe's vast potential for life and the alarming silence we encounter when we look for it.

The statistics are shocking. With around 200 billion galaxies, each containing billions of stars, it seems almost probable that someone, somewhere, is looking back at us. Carl Sagan said it perfectly:

“If it's just us, it seems like an awful waste of space.”

Over 5,000 exoplanets have already been discovered, many of which are in the "**habitable zone**," where situations could support life. Add in the Drake Equation, which estimates the number of civilizations in the cosmos, and you'd expect the sky to be vibrating with communications. Nonetheless, our antennas bring up nothing but static.

Over 5,000 exoplanets have already been discovered, many of which are in the "**habitable zone**," where situations could support life. Add in the Drake Equation, which estimates the number of civilizations in the cosmos, and you'd expect the sky to be vibrating with communications. Nonetheless, our antennas bring up nothing but static.

What's happening? One possible answer? Something is preventing life from spreading far enough to make touch. This "**Great Filter**" may be a universal obstacle at some stage of development:

- The Starting Point Is Rare: Perhaps life's spark—the transition from chemicals to self-reproducing molecules—is almost unattainable. Earth could be one of a billion oddities.
- The End is Quick: Advanced civilizations may destroy themselves. Nuclear war, environmental collapse, or uncontrolled technology may kill them off before they ever gaze at the stars.

Here's the scary part: if the Great Filter is ahead of us, humanity may not have much me to leave its mark.

What if we are not alone, but they avoid us? According to the "**Zoo Hypothesis**," superior civilizations may be keeping their distance, allowing humanity to flourish naturally as animals in a wildlife preserve. Perhaps they are waiting for us to attain a particular degree of maturity before showing themselves.

A darker idea, the "**Dark Forest Hypothesis**," argues that the universe is a deadly place. Consider each civilization as a hunter in a forest, hiding to avoid being discovered by predators. Then, perhaps we are looking for the wrong indications.

For more than a century, we've looked for radio waves, but what if aliens use entirely different technologies? What if their messages are encoded in ways that we cannot understand? They could use quantum entanglement, gravity waves, or something completely novel. It's as if we're attempting to listen conversation in a language we're unaware of.

The Fermi Paradox does not simply question, "Where are they?" It inquires, "Who are we?" Our search for alien life reflects our most basic hopes and concerns. Are we desperate to prove we aren't alone in the universe? Or is the search not truly about them, but about us?

Sneha Verma, 3rd Semester

Tools of Astronomy: A Brief Overview

Dr. Gourav Banerjee, Post Doc Fellow, Vainu Bappu Observatory
Indian Institute of Astrophysics

Most ancient cultures observed and worshipped the sky and tried to understand it. Keeping an eye on the heavens helped human beings to keep track of time and events on the Earth. All the calendars and astronomical instruments rely on the Sun and the Moon, the two most important astronomical bodies for us on planet Earth. Astronomy also plays an essential role in the organization of societies in general. Understanding the cycles of the sun and the moon was an essential condition for the development of our agricultural societies. This need to study the sky became the driving force for ancient people to develop astronomical instruments and tools. Sundial, astrolabe, planisphere, armillary sphere, celestial sphere, orrery, solar motion demonstrator, etc. are few such astronomical tools that were gradually developed and were intensely used by people during the pre-telescopic era.

A **sundial** is a device that tells the time of day when there is sunlight by the apparent position of the Sun in the sky. In the narrowest sense of the word, it consists of a flat plate (the dial) and a gnomon, which casts a shadow onto the dial. As the Sun appears to move across the sky, the shadow aligns with different hour-lines, which are marked on the dial to indicate the time of day. In a broader sense, a sundial is any device that uses the Sun's altitude or azimuth (or both) to show the time. The earliest sundials known from the archaeological record are shadow clocks (1500 BCE) from ancient Egyptian astronomy and Babylonian astronomy. Presumably, humans were telling time from shadow-lengths at an even earlier date, but this is hard to verify. Likewise, **a solar motion demonstrator** is useful in identifying the daily motion of the Sun from any given latitude.

World's oldest sundial from Egypt (1500 BC)

A horizontal sundial commissioned in 1862

In the year 276 B.C, Greek philosopher *Eratosthenes* invented **the armillary sphere**. It was used to demonstrate the motion of the stars around the earth. It has been updated, reinvented and widely used until the present day to determine celestial positions. Next, **the Antikythera Mechanism** was probably invented by Archimedes in around 100 B.C. It's an analogic computer with a geocentric model. The Sun turns around the Earth like a 24 hours analog dial. It is able to predict the Moon phases and eclipses. This instrument remained in the bottom of the sea for more than thousand years. After this mechanism no new instruments approaching this complexity were invented in Europe until the renaissance. A **planisphere** – used to locate the position of stars in the sky was also extensively used.

It is interesting to note that the Middle East was a couple of centuries ahead of Medieval Europe on this subject area. **The Astrolabe** was widely used in the medieval Islamic world. This was an analog calculator that allowed users to determine the time accurately by looking at the stars. It was historically used by astronomers and navigators to measure the altitude above the horizon of a celestial body, day or night.

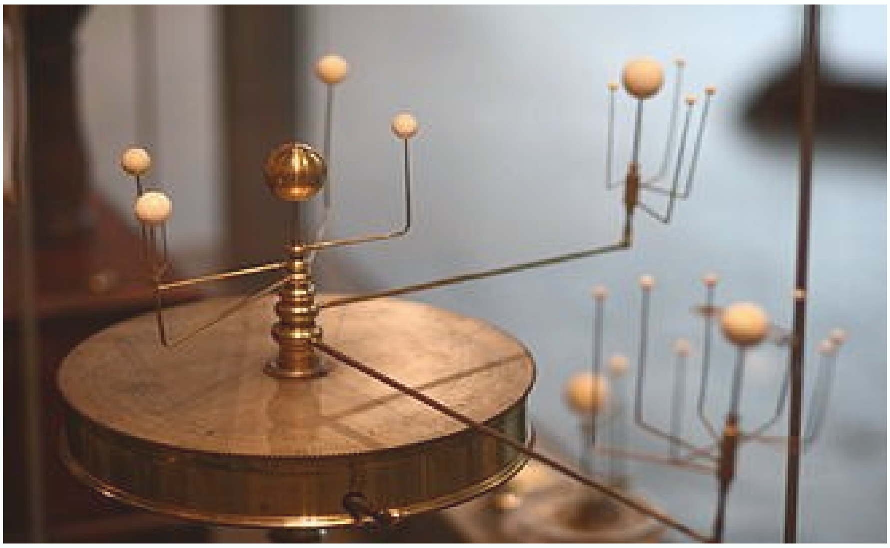
A 16th-century astrolabe

A modern astrolabe made in Iran in 2013

This knowledge was used by governments to make sure that tax collectors did not try to collect taxes before the harvest was in. True astrolabes were made before 400 A.D. and were highly developed in the Islamic world by 800 A.D. and were introduced to Europe from Islamic Spain (Al-Andalus) in the early 12th century.

The first **astronomical clocks** were built in the 13th century. Special mechanisms and dials were used to display astronomical information such as the relative positions of the sun, moon, zodiacal constellations, and sometimes major planets. European astronomical clocks are derived from the technology of the Antikythera mechanism. During the Islamic golden age and in Asia complex mechanisms such as water clocks were made. Some of these master timepieces are still working today.

Then, in the year 1582, **the Gregorian calendar** was introduced, which is still in use today. Following the discovery of the New World and with the beginning of the Renaissance, new instruments were developed. The development of new astrological instruments served to popularize astronomic knowledge. The pieces were built for demonstration, exhibition and education purposes. An example is **the Orrery**. This is a mechanical device that illustrates or predicts the relative positions and motions of the planets and moons in the solar system in a heliocentric model.



An Orrery made by Benjamin Martin in 1766, used at Harvard

An 18th century celestial sphere

Furthermore, **celestial spheres** were used in navigation and became popular for long expeditions overseas. We can find engraved copper spheres from the period following the discovery of the New World until the 18th century. Celestial objects fixed to the inside of a sphere helped to situate and predict star positions in the sky.

Then, during the early 17th century, scientists introduced a new tool for studying the heavens: **the telescope.** The invention of the telescope was a path breaking achievement and was required before astronomy was able to develop into a modern science. Its development and improvement during the following centuries transformed this object into the most popular and essential instrument to explore the sky. Thanks to the telescope, we have learned what the objects in space actually look like, how they move, behave and evolve. In short, it is with the help of telescopes that the Universe revealed itself in full glory.

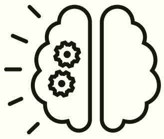
In present days, the main tools used by astronomers are sophisticated telescopes, spectrographs, cameras, computers and even spacecrafts equipped with cutting edge technology to decode the mysteries of the cosmos. Astronomers use many different types of telescopes to observe objects in the Universe. Some are located right here on Earth and some are sent into space. The *Hubble Space Telescope, James Webb Space Telescope*, and several other state of the art space missions are currently in space, becoming the eyes for the universe. Their observations have literally transformed our views of the universe. We are now situated in **the Golden Age of Astronomy**. So let us all look towards the sky, to explore its mysteries, know about the universe and in turn gain a better understanding about our own origin.

The Brain Waves

Dr. Ankan Mukherjee, Assistant Professor, Bangabasi College

Introduction

Brain is the most important part of our body which makes the human significantly different from other creatures on the earth. It is made of millions and trillions of nerve cells closely packed in a small volume. The nerve cells are called **neurons**. The brain is connected to the whole body through the central nervous system and it forms a network of nerves all over the body. The nervous system consists of two parts, one is the **central nervous system (CNS),** and the other is the **peripheral nervous system (PNS)**. Central nervous system consists of the brain and the spinal cord. On the other hand, the peripheral nervous system consists of the nerves outside the brain and spinal cord.

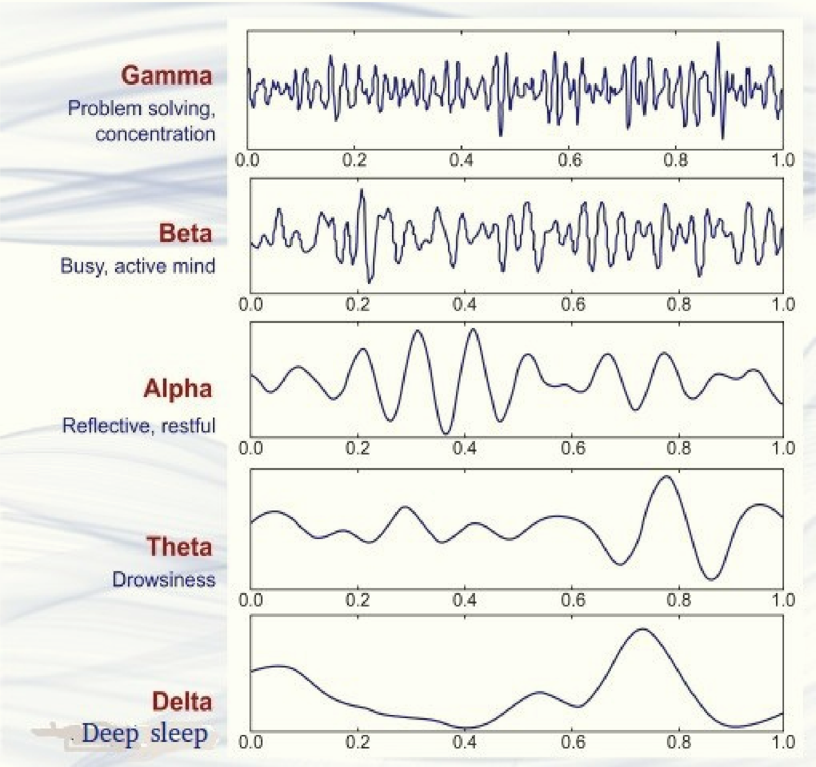


The body functions, like heart activity, movement speech thinking, emotion etc. are all controlled by the brain. Recent studies have revealed an interesting fact that some of the brain functions are controlled by the whole brain. On the other hand, some functions are associated to particular segments of the brain. Though in the present article, we are not going to discuss how the brain controls different activity of human body and mind. Rather we will focus on the measurement of brain activity. The brain activity could be measured by neurological experiments, like the method called **Electroencephalography (EEG)**. The method is based on measurement of small difference of electric potential in different electrodes inserted on head. The electrical signal is generated in the brain or in nervous system due to the flow of ions in the neurons. The signals received in EEG show wave patterns of different frequencies. These are called the **brain waves**. The brain waves are classified depending on their frequencies. It is observed that at a particular time different frequencies could be present in the brain wave, but one frequency must be dominating at a particular time. The classification of brain waves is done based on the dominant frequency present in the wave. In the next section different type of brain waves and their physiological impacts are discussed.

Different type of brain waves and their physiological importance

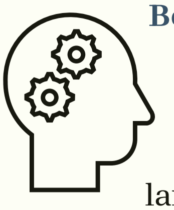
Brain waves are classified in five categories depending on their frequencies. These are Delta wave, Theta wave, Alpha wave, Beta wave and Gamma wave. Different types of brain waves and their physiological importance are discussed in the following:

Delta Wave: It is the lowest frequency brain waves observed in EEG. The frequency range of delta wave is from 0.5Hz to 4Hz. It is the slowest brain wave with highest amplitude. It is observed that the brain is dominated by delta wave during deep sleep. The delta wave dominated phase is very important for regeneration and healing in the whole body.



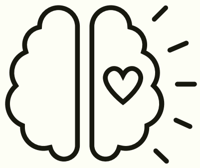
Theta wave: The next range of frequency is named as theta wave. The frequency range is from 4Hz to 8Hz. The mind or brain is dominated by theta wave when it is in a phase of very low activity or in the initial stage of sleep. Actually, in this state, human body gradually becomes inactive (only these activities are stopped which is regulated by active brain function). But the subconscious mind remains active. It is the reason why sometimes we see dreams in sleep, it is actually in theta dominated phase.

Alpha wave: The alpha wave has the frequency range from 8Hz to13Hz. Alpha wave dominated phase is the relaxed mental state when we are not in sleep. When alpha wave dominates the mind we feel ease and calm. Alpha waves play the role of a bridge between the conscious and the subconscious mind. It helps the mind body integration and balance. Creativeness coms when the mind is dominated by alpha waves. Sometimes alpha dominated phase seems to be lazy mental state. It is interesting to note that some amount of laziness is important to be creative in life. But laziness should not occupy the mind completely.



Beta wave: The frequency range of beta wave is from 13Hz to 30Hz. It is the active phase of mind. The mind is dominated by beta wave when we are doing something which requires higher brain activity, like solving maths problems or writing in examination. The beta wave band has a relatively larger range. It can be divided into three segments, the low beta, the mid-range beta and the high beta. The low beta frequency ranges from 13 to 15 Hz. It is relaxed yet focused phase. For example, the mental state when we are reading a book which is not very difficult to understand and also enjoyable. The mid-range beta has frequency range from 15 to 18 Hz. It is an active phase of mind when the mind is busy in thinking as well as aware of self and surroundings. The high beta has frequency range from 18 to 30 Hz. It is an active mental state where agitation comes along with the activity.

Gamma wave: The gamma wave is measured to have the frequency range from 30 to 40 Hz. Other types of the wave are found to be localised in certain parts of the brain, but the gamma wave is generated in every part of the brain. Gamma waves are generated when the brain tries to process information from different parts of the body at the same instant of time. Recent researches in neuroscience have shown that the gamma dominated phase helps in memory formation. But it is found that prolonged gamma dominated phase causes mental agitation and anxiety. Over domination of gamma waves for a long period of time can cause mental instability and different mental disorders.



Concluding Remarks,

So far we have discussed about different brain waves and their physiological importance briefly. We have seen that the regeneration and healing of human body happens in delta wave dominated phase. So, it is very important to have delta dominated phase during our sleep. It only occurs when the sleep is deep enough. Neurological studies have shown that the sleep cycle has time period of 90 minutes and five to six cycles is required for a complete sleep. The delta phase activates for some times during the period of uninterrupted sleep. So deep sleep is really important for a healthy life. Recent studies have also shown that the practice of meditation helps to synchronise the brain waves resulting mental peace and well management of stress and anxiety.

References:

[1] S. Siuly, Y. Li, Y. Zhang, EEG signal analysis and classification, (New York, NY: Springer Berlin, Heidelberg, 2017), ISBN 9783319476520.

[2] 5 Types of Brain Waves Frequencies: Gamma, Beta, Alpha, Theta, Delta [online], in:

[5 Types Of Brain Waves Frequencies: Gamma, Beta, Alpha, Theta, Delta]

TRAILBLAZER OF TOMMOROW: CURRENT STUDENTS' ACHIEVEMENT

Rudra Prasad Mitra
Won the second prize in Poster presentation
Topic- "Lens to Pixels: The Untold Story of Smartphone Camera Technology"
Date-05/12/2023

Rimjhim Poddar
Visit to HBCSE-NIUS,TIFR, Mumbai
for on-site workshop in June 2024

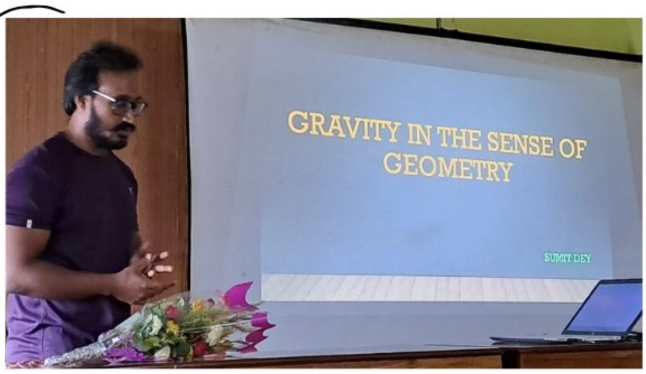
Ritam Deb Barman
Won the first prize in departmental presentation
Topic- Principles Of The Special Theory Of Relativity
Date-22/12/2023

VISIT TO SEMINERS

Attended “মহাবিশ্বের ভবিষ্যৎ”
by Dr. Somak Roychowdhury
on dated 09/12/2022
Participants: 1st and 2nd semester of Bangabasi College
Location: Presidency University, Kolkata

Attended “Exloration Of The Solar System” by Dr. Triha Pratim Das on dated 24/04/2024
Participants: 6th semester of Bangabasi College
Location: Bangabasi Collage, Kolkata

Attended “Supermassive Black Holes And Career In Astrophysics” by Dr. Sibashis Laha on dated 09/08/2023
Participants: 1st semester of Bangabasi College
Location: Presidency University, Kolkata



Attended “Gravity In The Sense Of Geometry” by Dr. Sumit Bera on dated 11/10/2023
Participants: 1st semester of Bangabasi College
Location: Bangabasi Morning Collage, Kolkata

Attended “গ্যালাক্সির অশনি সংকেত”
by Dr. Biman Nath on
dated 30/11/2023
Participants: 1st & 3rd semester of Bangabasi College
Location: Presidency University, Kolkata

Attended “Astronomy In India a Present and Future Prospects” by Dr. Gourav Banerjee on dated 01/10/2024
Participants: 2nd & 3rd semester of Bangabasi College
Location: Bangabasi Collage, Kolkata

Supercapacitor: Revolutionizing Energy Storage for a Sustainable Future

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Introduction

With the beats of modernization and revolution in the industrialization process, recent interest turned towards minimization of environmental pollution and meeting the demands of huge energy and power supply. Nanomaterials play a pivotal role in this regard, improving energy storage and conversion efficiency due to their high surface to volume ratio [1]. One of the most promising solutions in this space are supercapacitor - innovative devices that are reshaping the way we store and use energy. Unlike batteries, which store energy through chemical reactions, supercapacitor store energy electrostatically, enabling them to charge and discharge much faster, longer lifespan, high energy density and perform efficiently in a wide range of applications [2]. With their unique advantages, supercapacitors are becoming essential in applications ranging from electric vehicles to renewable energy systems, offering a pathway to a cleaner, more efficient, and more sustainable energy future.

Fundamentals of Supercapacitor

A supercapacitor consists of two high surface area electrodes (usually made of activated carbon or graphene) that store energy electrostatically. These electrodes are separated by an electrolyte, which can be either liquid or solid, allowing ions to flow during charging and discharging. A separator, typically a porous insulating material, prevents direct contact between the electrodes. Current collectors connect the electrodes to the external circuit, enabling energy transfer. The entire assembly is enclosed in a protective casing to maintain stability and safety. The term "super" comes from the ability to store significantly more energy than regular capacitor, offering higher capacitance values and delivering rapid power output. This fast charging and discharging capabilities, along with a long cycle life, make them ideal for application that need rapid power delivery [2]. According to the charge storage mechanism, supercapacitor can be broadly classified into two primary categories. The first category comprises electric double-layer capacitors (EDLCs), typically constructed using carbon-based materials [1]. EDLCs store energy by accumulating ions at the electrode/electrolyte interface, without any electrochemical reaction through a non-Faradic process (Fig. 1a). Since no chemical reaction occurs during the charge/discharge, for this reason, EDLCs exhibit high power density and excellent cycle stability, and have stable operation even in a low-temperature environment [3]. The second category consists of pseudocapacitors (PCs) which rely on Faradic electrochemical processes occurring at the electrode surfaces to store and discharge ions (Fig. 1b). pseudocapacitors promise higher specific capacitance and energy densities, due to involvement of the surface redox reaction, they exhibit lower cycling stability and power densities compared to EDLCs. Another type of capacitor, called a hybrid capacitor, combines the advantages of both supercapacitors and batteries [2]. Similar to the pseudocapacitors, hybrid capacitors promise high energy densities with a high operating voltage window, yet, due to the presence of a battery-like electrode, they exhibit poor cycling stability and low power densities (Fig 1c).

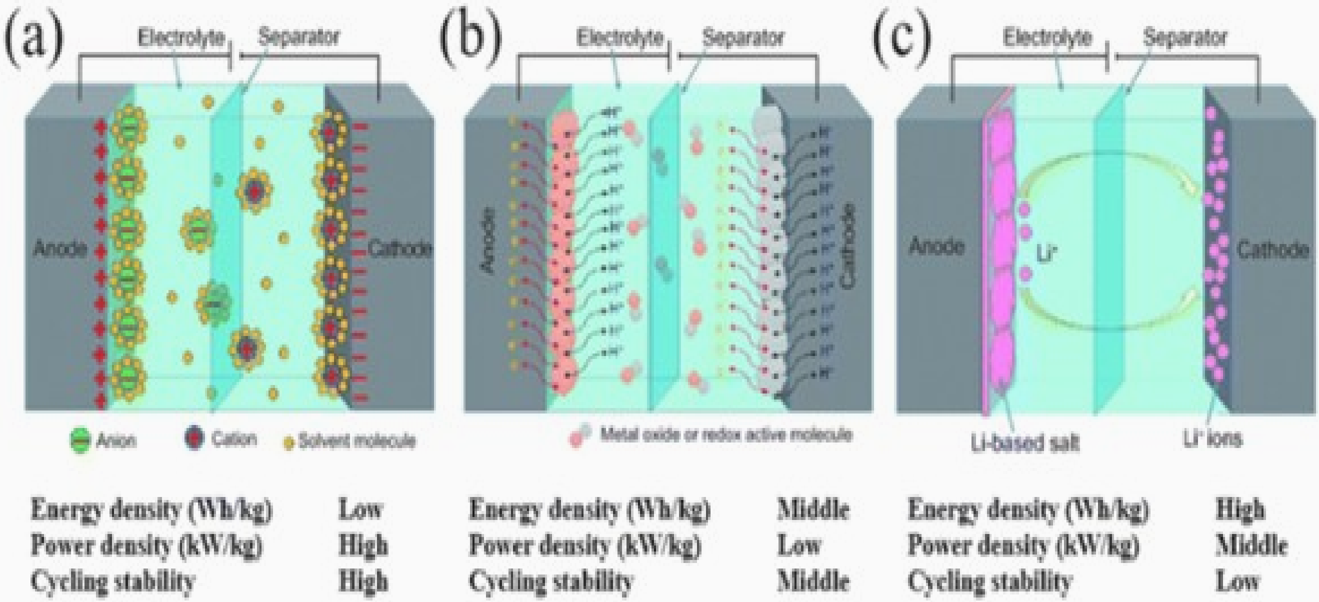


Figure 1: Schematic representation of (a) electric double-layer capacitors (EDLCs) and (b) pseudocapacitors (PCs), (c) hybrid capacitor.

Advancement of Supercapacitor

Electric Transportation

Supercapacitors play a crucial role in electric transportation (ET), providing quick bursts of power for acceleration and regenerative braking. They complement traditional batteries by handling short-term power needs, which improves vehicle performance, extends battery life, and reduces charging frequency. Additionally, supercapacitor enhance energy efficiency by capturing energy during braking and releasing it rapidly during acceleration, promoting smoother and more sustainable driving. The Siemens Velaro, a high-speed train series from Siemens Mobility (Fig. 2a), is designed to reach speeds of up to 400 km/h (250 mph). Known for energy efficiency, it features regenerative braking and supercapacitor for energy storage, enhancing performance and reducing energy consumption. These trains operate in countries like Spain, Germany, China, and Russia. Their **Solaris Urbino 12 Hybrid** buses utilize supercapacitor for energy storage, enabling efficient regenerative braking and reducing fuel consumption. Additionally, **Proterra**, an American electric bus manufacturer, also uses supercapacitor in its buses to enhance energy efficiency and extend battery life (Fig. 2b).

Figure 2: Supercapacitors used in (a) high speed train (b) electric bus (Proterra) (c) smart phone charger

Portable Electronics

Supercapacitor are used in portable electronics, such as smartphones (Fig 2c), cameras (Fig 2d), and wearable devices, to provide quick bursts of power for features like displays, cameras, and sensors. They help extend battery life by handling short-term power demands, allowing the main battery to focus on longer-term energy storage.

(d) Dash cam S500 3K HRD (e) car Dash cam (f) Kiepe Electric's hybrid energy storage system for wind farms (g) solar power plant (h) pacemakers (i) defibrillators. [All images included in this document were sourced from Google Images.]

Renewable Energy Systems

Supercapacitors are used in renewable energy systems to store excess energy generated by sources like solar and wind power. They help smooth out fluctuations in energy supply by quickly absorbing surplus energy during peak production and releasing it when demand is high, or generation is low. This ensures a stable and reliable power supply, improving the efficiency and integration of renewable energy into the grid. An example of supercapacitor in renewable energy is **Kiepe Electric's hybrid energy storage system** for wind farms (Fig 2f), where they store excess energy during high-wind conditions and release it during low-wind periods to stabilize the grid. Similarly, supercapacitors are used in **solar power plants** to store surplus energy and provide power when solar generation drops (Fig. 2g)

Healthcare Equipment

Supercapacitors are widely used in healthcare equipment, particularly in devices such as pacemakers (Fig. 2h) and defibrillators (Fig 2i). These devices require quick bursts of energy to function effectively during emergencies, and supercapacitor provide that rapid power without delay. Unlike traditional batteries, supercapacitor can charge and discharge quickly, making them ideal for life-saving medical applications. They also have a long lifespan and can endure many charge cycles, reducing the need for frequent replacements in critical devices. By ensuring reliable and immediate energy delivery, supercapacitor play a crucial role in enhancing the performance and safety of healthcare equipment.

Conclusion

Supercapacitors are becoming a key part of the energy landscape due to their ability to charge and discharge rapidly, along with their long lifespan of millions of cycles. They offer a sustainable, reliable, and cost-effective energy storage solution for applications ranging from electric vehicles to renewable energy systems. However, their lower energy density and relatively high cost remain challenges. With ongoing research and development, these issues may be overcome, paving the way for supercapacitors to play an even greater role in creating a cleaner, more efficient future. Despite these limitations, supercapacitors have the potential to significantly transform energy storage and sustainability.

References

1. S. Sau, M. Kundu, S. Biswas, I. Mondal, B.K. Paul, P. Halder, N. Ghosh, D. Mondal, S. Das, Tailoring ZnMnO3 nanostructures: A promising strategy for high energy density asymmetric supercapacitors, J. Energy Storage 85 (2024) 111069. https://doi.org/10.1016/j.est.2024.111069.
2. M. Kundu, D. Mondal, I. Mondal, A. Baral, P. Halder, S. Biswas, B.K. Paul, N. Bose, R. Basu, S. Das, A rational preparation strategy of phase tuned MoO3 nanostructures for high-performance all-solid asymmetric supercapacitor, J. Energy Chem. 87 (2023) 192–206. https://doi.org/10.1016/j.jechem.2023.08.014.
3. I. Mondal, P. Halder, M. Kundu, B.K. Paul, S. Biswas, A. Pal, S. Sau, D. Mondal, P.K. Paul, S. Das, Energy-efficient sintering-free Chemically synthesized carbon nanofibers for high-performance supercapacitors, Mater. Today Chem. 35 (2024) 101905. https://doi.org/10.1016/j.mtchem.2024.101905.

“লেন্স থেকে পিক্সেল : স্মার্টফোন ক্যামেরা প্রযুক্তির অজানা কাহিনী”

প্রাথমিক ধারণা_

স্মার্টফোনের যুগে আমরা প্রায় সবাই প্রতিনিয়ত নিজেদের মোবাইল ক্যামেরায় দুনিয়াভরের দৃশ্যাবলী, অভিজ্ঞান এবং মুহূর্তের অনুভূতিগুলি অভ্যন্তরীণ চিত্রশক্তির মাধ্যমে বন্দী করে চলছি । এই স্মার্টফোন ক্যামেরার পিছনে কীসের যাদু আছে, তা বেশ একটি রহস্যময় অধ্যায় যা আমাদের সহজেই বিস্মিত করে। এই নিবন্ধে, আমরা বুঝতে চেষ্টা করবো কিভাবে স্মার্টফোন ক্যামেরাগুলি কাজ করে এবং আমাদের ক্লিক করা ছবিগুলির জন্য কেমন প্রযুক্তি ব্যবহার করা হয়।

ইতিহাস ও বর্তমান

একটি প্রথাগত ক্যামেরায় প্রয়োজন একটি লেন্স এবং তথ্য নথিভুক্ত করার জন্য কোনো পদার্থ। আগেকার ক্যামেরায় ফিল্ম কাগজ ব্যাবহার করা হতো । এই ক্ষেত্রে একটি কাগজ একবার মাত্রই ব্যাবহার করা সম্ভব ছিল। আলোকরশ্মি রাসায়নিক বিক্রিয়া করতো কাগজটির সাথে এবং পরবর্তী ধাপে এটিকে উপরন্তু সংশ্লেষ করে অবশেষে ব্যবহারযোগ্য ছবি পাওয়া যেত । তবে বর্তমানে এই পদ্ধতি আর ব্যাবহার করা হয়না। এখন কাগজের বদলে ক্যামেরার সেন্সর ব্যবহৃত হয়। এই সেন্সর আলোর সাথে ডিজিটাল ভাবে বিক্রিয়া করে এবং একে বারংবার ব্যাবহার করা যায়। আগে কাগজের ক্ষেত্রে যান্ত্রিক শাটারের প্রয়োজন হতো, এখন একে বৈদ্যুতিক শাটার দিয়ে প্রতিস্থাপন করে দেওয়া হয়েছে ।

স্মার্টফোন ক্যামেরা

- **লেন্স বদল:**

স্মার্টফোন ক্যামেরাতে এখন কমপক্ষে দুটো করে লেন্স থাকেই , কিছু ক্ষেত্রে তা তিনটে বা চারটেও। তবে প্রথাগত ক্যামেরাতে আমাদের যেমন একটি লেন্সকে সম্পূর্ন খুলে ফেলে তারপর আরেকটি লাগাতে হতো, স্মার্টফোন ক্যামেরার ক্ষেত্রে এই বদলটির জন্য সফটওয়্যার ব্যাবহার করা হয়ে থাকে।

- **জুম:**

এই ক্ষেত্রে দুধরনের জুম দেখা যায়, অপটিক্যাল জুম এবং ডিজিটাল জুম। অপটিক্যাল জুম হলো লেন্স এবং সেন্সরের মধ্যে দূরত্ব বাড়িয়ে পাওয়া বিববর্ধন এবং ডিজিটাল জুম আসলে হলো আসলে ক্রপিং প্রক্রিয়া। এখন অপটিক্যাল জুম-এর ক্ষেত্রে ছবির মান খারাপ হয় না বলে একেই পছন্দ করে থাকে সবাই । DSLR এর মত ক্যামেরাতে কিছুকিছু লেন্স পরিবর্তনশীল বিবর্ধনে সক্ষম হয়, তবে স্মার্টফোনে এর জন্য প্রয়োজনীয় জায়গা না থাকায় এখানে আলাদা আলাদা লেন্স ব্যাবহার করা হয় একএকটি দূরত্বের অপটিক্যাল জুম এর জন্য। এর আর কোনো পরিবর্তনের প্রয়োজন হয় না এবং ব্যাবহৃত লেন্সকে Telephoto Lens বলা হয়। সম্প্রতি APPLE কোম্পানি নিজেদের প্রোডাক্টে লেন্স ও সেন্সরের এর মধ্যে কতগুলি আয়না দিয়ে আলোকরশ্মির অতিক্রান্ত দূরত্ব বাড়িয়ে অপটিক্যাল জুম আরো বাড়িয়েছে ।

- **ফোকাস দৈর্ঘ্য :**

স্মার্টফোনের এর স্পেসিফিকেশন লিস্টেএই ফোকাস দৈর্ঘ্যের অর্থ হলো আলংকারিক ভাবে বিবর্ধনের কথা। এই বিবর্ধন তুলনা করার জন্য একটি সার্বজনীন একক। তবে এককথায় বলতে গেলে আলাদা আলাদা ফোকাস দৈর্ঘ্য আলাদা নান্দনিক ছবি তৈরি করতে সক্ষম।

- **রেজোলিউশন:**

স্মার্টফোনে সচরাচরই দেখা যায় , সমস্ত কোম্পানি তাদের ক্যামেরার গুণগত মান কতটা ভালো তা বোঝাতে পিক্সেল সংখ্যার উল্লেখ করে থাকে। এখন ফোনের এত স্বল্প জায়গাতে ১০০ বা ২০০ মিলিয়ন পিক্সেল থাকলে, প্রত্যেকটি পিক্সেলে এত কম পরিমাণে আলো পৌঁছাবে তাতে কোনো ব্যবহারযোগ্য ছবিই তৈরি হবে না । তাই এখানে ব্যাবহৃত হয় "পিক্সেল বিনিং " নামক এক পদ্ধতি । পাশাপাশি সংলগ্ন পিক্সেল একসাথে জুড়ে তাদের গড় মান নেওয়া হয়ে থাকে।

- **সেন্সরের আকার:**

স্মার্টফোন ক্যামেরার ক্ষেত্রে সেন্সর যত বড় হবে, ততই ভালো ছবি উঠবে । কারণ তাতে বেশি আলো গ্রহণ করা সম্ভব হবে ।

- **স্টেবিলাইজেশন:**

এটি দুই প্রকারের হয়ে থাকে, অপটিক্যাল ইমেজ স্টেবিলাইজেশন এবং ইলেকট্রনিক ইমেজ স্টেবিলাইজেশান। প্রথমটির ক্ষেত্রে লেন্সকে নাড়িয়ে চলমান বা ভিডিও ছবিকে সুস্থিরকরা হয়। তবে এখন সেটি আরও উন্নত হয়ে সেন্সর movement এ পরিণত হয়েছে | এক্ষেত্রে ভিডিও কোয়ালিটি ক্ষতিগ্রস্ত হয়না। অপরদিকে ইলেকট্রনিক ইমেজ স্টেবিলাইজেশানে পাওয়া ভিডিওতে এর থেকে বেশি ক্ষেত্র রেকর্ড করা সম্ভব হয়ে থাকে; তবে এতে ভিডিওর মান ক্ষতিগ্রস্ত হয়, অপটিক্যাল ইমেজ স্টেবিলাইজেশনের তুলনায়। ~অ্যাপারচার: ক্যামেরায় অ্যাপারচার হলো লেন্সের আকৃতির বদল করা, যাতে প্রয়োজনানুরূপ বেশি বা কম আলো গ্রহণ করা যায়। এটি এক্সপোজার ও ডেপথ অফ ফিল্ডকে প্রভাবিত করে। একটি স্মার্টফোনের ক্ষেত্রে অ্যাপারচার যত চওড়া হবে, ততই ভালো।

“ক্যামেরা মোডস”

HDR

HDR এর পুরো কথা হলো High Dynamic Range , এই ক্ষেত্রে আমরা দেখতে পাই একবারটি ক্লিক করাতেই ছবি উঠছে। কিন্তু এখানে আসলে অনেককটি ছবি একসাথে তোলা হয় আলাদা আলাদা এক্সপোজারের এবং তারপর এদের একসাথে মার্জ করে ফাইনাল ছবিটি পাওয়া যায় । কিছু কিছু ফোন সমস্ত কাজ ওই ক্লিক করার মুহূর্তে না রাখার জন্য ক্যামেরা খোলার সাথেসাথেই ছবি তোলা শুরু করে দেয়; কিন্তু আমরা সেটা দেখতে পাইনা ।

Portrait

প্রথমে দুটো আলাদা লেন্স ব্যবহার করে ডেপথ আন্দাজ করা হতো, তবে এখন নির্দিষ্ট ডেপথ সেন্সর ব্যবহার করা হয় যা সঠিক ভাবে গভীরতা মাপতে সক্ষম। ইদানিং আরও উন্নত A.I. ব্যাবহার করা হয়।

Night mode

এ হলো স্মার্টফোন ক্যামেরার একটি আশ্চর্য ফিচার। খালি চোখে যা দেখা যাচ্ছেনা, ফোনের ক্যামেরাতে তা পরিষ্কার ধরা পড়ে যাচ্ছে । এখানে HDR পদ্ধতি ছাড়াও এমনকি জাইরোস্কোপ এবং কিছু ইমেজ সেন্সর ব্যবহার করা হয়, কতটা সময় ক্যামেরা ধরে থাকতে হবে সেটাও ফোন বলে দেয়। তবে সবথেকে উন্নত পদ্ধতি হলো Semantic Segmentation এর ব্যবহার। প্রত্যেক পিক্সেলকে আলাদা করে চিনতে পেরে, সেইখান থেকে কেমন ভাবে আলো প্রতিফলিত হবে তা উন্নত A.I. এর দ্বারা নির্দেশিত থাকে।

উপসংহার_

স্মার্টফোন ক্যামেরা আসলে একটি উন্নত প্রযুক্তির জাদুকাঠি। যত দিন যাবে, আরো উন্নত হয়ে উঠবে এটি। ভবিষ্যতে আরো কিভাবে এটিকে ব্যাবহার করা যাবে, তা সময়ই বলে দেবে আমাদের।

Rudra Prasad Mitra
5th Semester

The Science of Music - From Symphonies to Sound Waves

- Rupsa Saha, 3rd Semester

Music is a universal language that links us in ways that words cannot. It evokes feelings and tells stories. However, there is an interesting scientific tale with physics at its core that is hidden beneath the enchantment of melodies and harmonies. Vibrating particles, moving sound waves, and resonating systems create the symphonies that give us goosebumps and the rhythms we stamp our feet to. Let's explore the physics underlying music, revealing its artistic allure while preserving its wonderful intact.

What Is Sound, really? Imagine plucking a guitar string. That one act initiates a chain reaction. The string vibrates and shakes the air around it. The air molecules collide, forming tiny zones of compression (where molecules stay together) and rarefaction (where they spread out). These alternating zones spread outward like ripples on a pond before reaching your ears as a sound wave. However, sound waves are not the same as ordinary ripples. They are longitudinal waves, with particles moving in the same direction as the wave. They have three main characteristics:

- **Frequency:** How fast the wave vibrates, dictating pitch (high or low notes).
- **Amplitude**: How powerful the wave is, determining volume.
- **Wavelength:** The distance between two wave peaks, which affects how we hear sound.

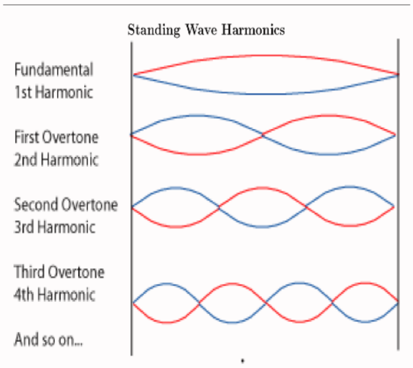
Think of frequency as the note, amplitude as the loudness, and wavelength as the "*texture*" of the sound.

The Instruments: Transforming Physics into Art

Strings: Harmonic Vibrations

Have you ever noticed how tight, thin violin strings sound high-pitched, yet big, loose bass guitar strings sound deep and mellow? That's physics in action. Whenever you pluck, bow, or strike a string, it vibrates in portions. The entire string vibrates at its fundamental frequency, while smaller parts resonate at higher frequencies, resulting in overtones. They work together to create a rich, layered sound that is unique to the instrument.

The pitch is controlled by three factors:



- **Length**: Shorter strings vibrate faster, producing higher notes.
- **Tension**: Tighten the string, and the pitch rises.
- **Mass per unit length**: Thin strings vibrate more easily, creating higher-pitched sounds.

This is why, in an orchestra, violins carry the melody while cellos and basses provide the depth.

Wind Instruments: Blowing into a flute or clarinet does more than just make noise; it also excites the air column inside the instrument and causes it to vibrate. The pitch is determined by the length of the air column; decreasing it (by pressing keys) raises it, and lengthening it lowers it. Resonance is the secret sauce here. When the natural frequency of the air column equals that of the sound wave, they magnify each other, resulting in the clear, ringing tones associated with wind instruments.

Percussion: Beats from Vibration Drums, cymbals, and xylophones are percussion instruments that adopt a different approach. When you strike a drumhead, its surface vibrates, resulting in intricate patterns of sound waves. These patterns include fundamental tones and overtones that combine to create the drum's distinctive sound. The drumhead's material, size, and tension all determine its pitch and timbre. This explains why a snare drum sounds snappy and punchy, whereas a bass drum echoes deeply.

The Sweet Science of Harmony

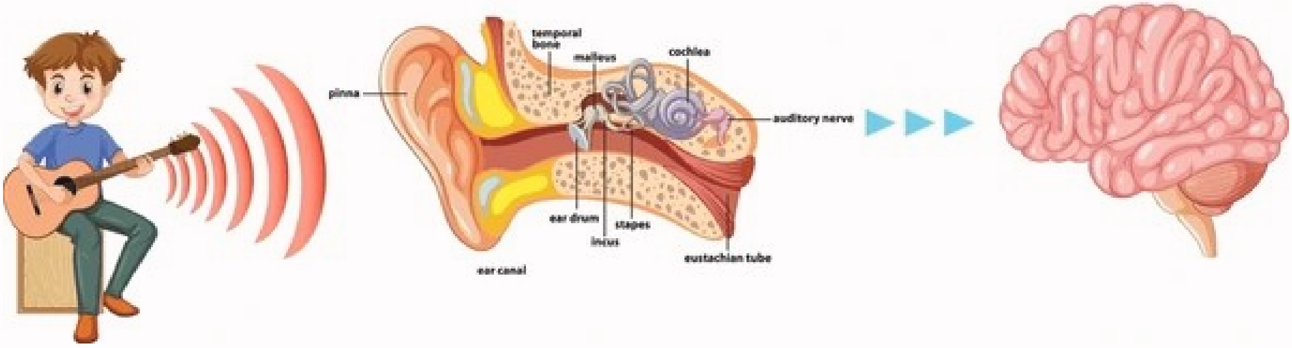
Why Do Some Notes Sound Good Together?

When two notes sound pleasing together, it's not just luck—it's math. Their frequencies often form simple ratios, like 2:1 (an octave) or 3:2 (a perfect fifth). These ratios create patterns in the air waves that our brains interpret as harmony. For example, when a violin plays an A (440 Hz) and a cello plays an E (660 Hz), their waves sync up every third vibration, producing a sense of balance and beauty. When harmony turns into dissonance. However, frequencies can occasionally collide. If two notes have similar frequencies but are not identical, their waves interfere, resulting in beats—a type of wobbling sound. Depending on the context, this might bring richness or be jarring.

From Instrument to Your Ears: The path of music doesn't end with the instrument. It moves through the air, bouncing off walls, ceilings, and floors before reaching your ears. Concert venues, for example, are intended to maximize sound waves. Architects employ physics to manage sound reflection, absorption, and diffraction. *What's the goal?* To create an acoustic atmosphere in which every note, from the gentlest flute trill to the most powerful timpani boom, sounds flawless.

Your Brain: The Final Instrument

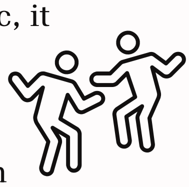
When sound waves enter your ear, your eardrum vibrates. These vibrations go through tiny bones in the middle ear and into the cochlea, a spiral-shaped organ containing fluid and tiny hair cells. Similar to piano keys, each hair cell is set to a certain frequency. The cochlea converts these vibrations into electrical signals that your brain interprets as music. The amazing part is that your brain does more than just hear music; it also feels it. According to research, music triggers emotional areas in the brain, which explains why a sad song may make you cry while a joyful beat can make you dance.



Physics in modern music: Today's music is physics-based in ways Bach and Beethoven could not have imagined. Microphones convert sound waves into electrical signals, whereas speakers reverse this process to recreate sound. To ensure accurate reproduction, digital audio breaks down sound into data using sampling and quantization. Understanding sound waves and how they interact influences how we edit music, including adding reverb, altering pitch, and mixing sounds.

Why does music move us?

Here's the beautiful irony - while physics describes the mechanics of music, it cannot fully explain its charm. Why do some chord progressions make us cry? Why does rhythm cause our hearts to race? The answer lies at the crossroads of science and art. Music is more than simply music; it's an emotional experience. It gets into our memories, emotions, and humanity in ways that no calculation can.



Conclusion: The next time you listen to your favourite song, remember that you're experiencing a symphony of physics at work. Vibrations, waves, and frequencies combine to create something greater than the sum of its parts—a universal language that speaks directly to our hearts. Physics gives music its structure, but it's the human spirit that gives it life.

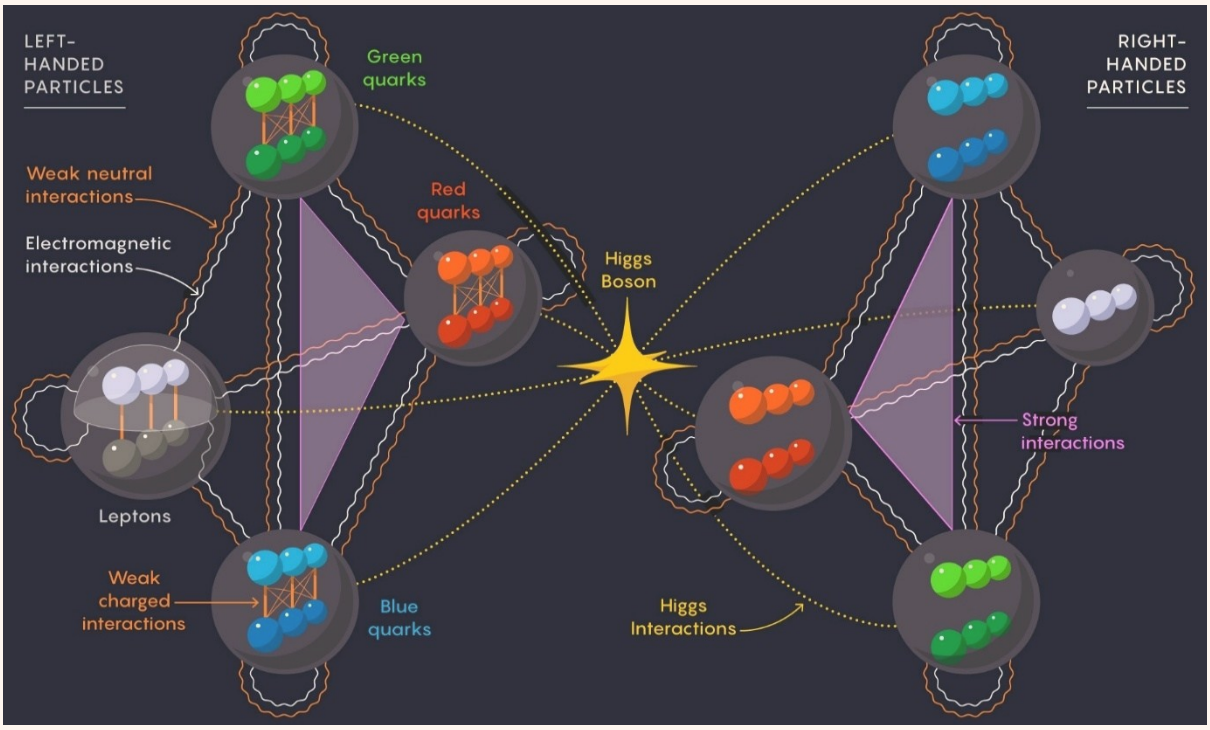
Inside the Nucleus: Exploring the Quarks and Forces that Shape the Universe

Prof. Satyajit Roy, SACT-2

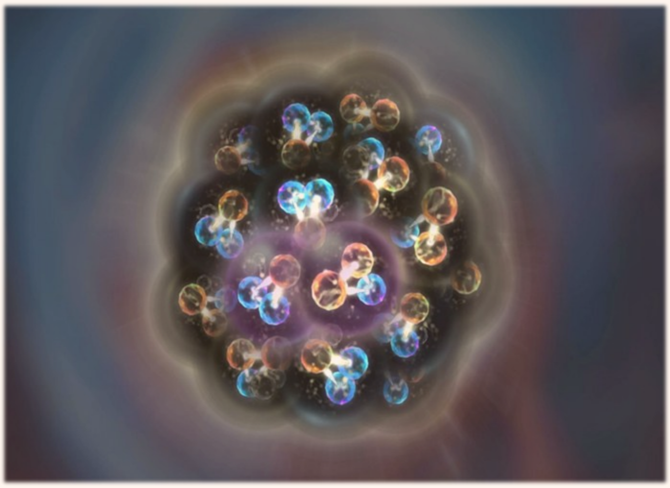
The nucleus, the tiny yet dense heart of an atom, is one of nature's most fascinating marvels. Despite its size—about one-millionth the width of a human hair—it contains nearly all the mass of an atom and holds the secrets of the universe's building blocks. At the centre of every atom lies this dense core, composed of protons and neutrons, collectively called nucleons. Protons carry a positive charge, while neutrons are electrically neutral. Surrounding the nucleus are negatively charged electrons, which balance the positive charge of the protons. Together, these components form the foundation of matter.

However, protons and neutrons themselves are not fundamental particles. They are made of even smaller entities called quarks. Quarks come in six flavours: up, down, charm, strange, top, and bottom. In everyday matter, up and down quarks dominate. A proton is composed of two up quarks and one down quark (uud), while a neutron consists of two down quarks and one up quark (udd). The heavier quarks, such as charm and strange, as well as top and bottom, are fleeting visitors to our world, appearing only under extreme conditions like those created in particle accelerators.

Quarks are bound together by the strong nuclear force, one of nature's fundamental forces. This force is mediated by particles called gluons, which act as the "glue" holding quarks together. Remarkably, the strong force becomes even stronger as quarks are pulled apart—a phenomenon known as colour confinement. Quarks also carry a unique property called colour charge, analogous to electric charge, but with three types: red, blue, and green. These colours combine to form colour-neutral particles such as protons and neutrons.

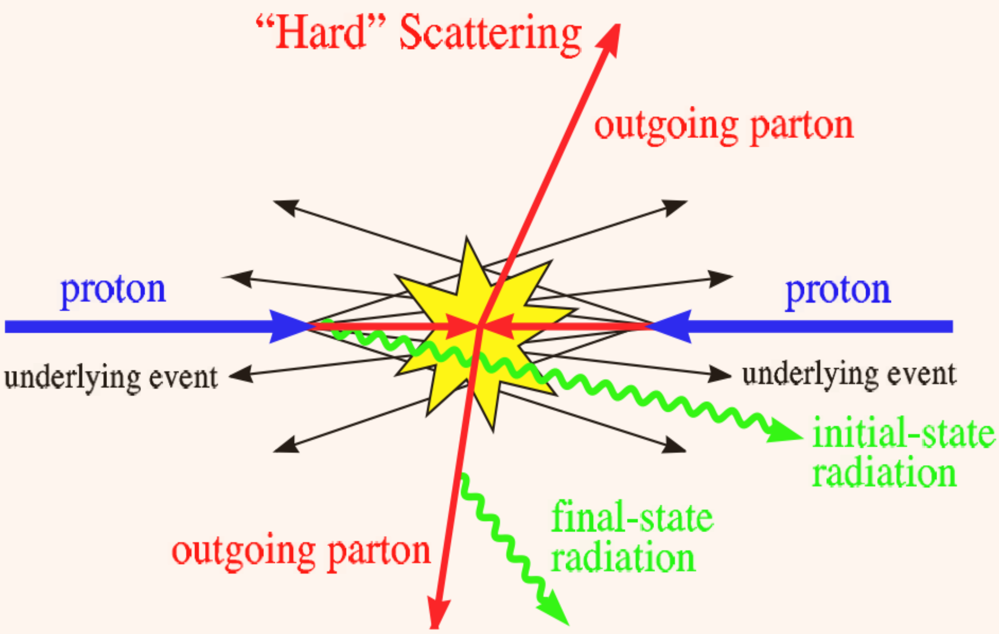


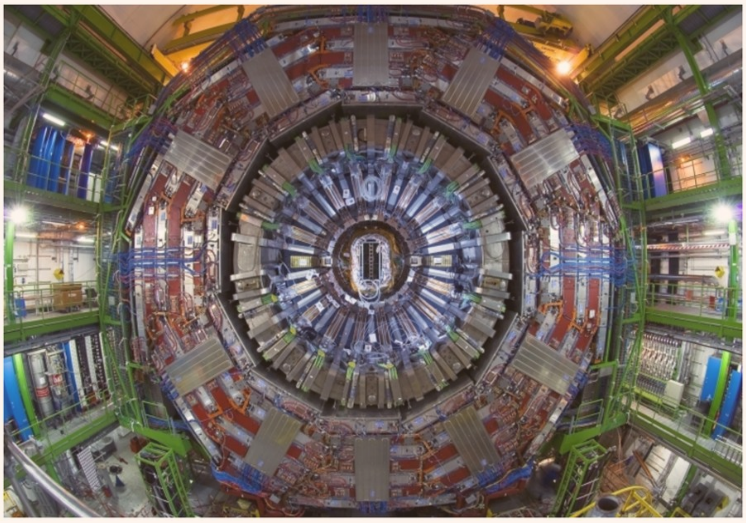
The strong nuclear force not only binds quarks within protons and neutrons but also holds protons and neutrons together in the nucleus. This force overpowers the electromagnetic repulsion between positively charged protons, preventing the nucleus from flying apart. Meanwhile, the weak nuclear force plays a crucial role in processes like beta decay, where a neutron transforms into a proton, emitting an electron and a neutrino. These interactions are vital for phenomena ranging from radioactive decay to the energy dynamics of stars.



Beyond the quarks and gluons that make up the nucleus, modern physics hints at even deeper layers of reality. Some theories propose that quarks, gluons, and all other particles are not the ultimate building blocks of matter. Instead, they may be manifestations of tiny, vibrating one-dimensional strings. This idea, known as string theory, envisions these strings vibrating at specific frequencies to give particles their unique properties, such as mass and charge. If true, string theory could unify all fundamental forces—gravity, electromagnetism, and nuclear forces—into a single, elegant framework, bridging the gap between quantum mechanics and general relativity.

To explore these fundamental questions, scientists rely on high-energy particle accelerators like the Large Hadron Collider (LHC), the world's most powerful accelerator located at CERN near Geneva. In its 27-kilometer circular tunnel, protons are accelerated to nearly the speed of light and then smashed together in high-energy collisions. These collisions recreate conditions similar to those just after the Big Bang, allowing scientists to peer into the building blocks of the universe.





The LHC is equipped with advanced detectors such as ATLAS and CMS, which analyse the debris from these collisions. These detectors have enabled groundbreaking discoveries, including the Higgs boson, a particle that gives mass to other particles. They also allow researchers to study the behaviour of quarks and gluons under extreme conditions, search for new particles predicted by theories like supersymmetry and investigate exotic states of matter like quark-gluon plasma.

Quark-gluon plasma is a fascinating state of matter that occurs when the boundaries of protons and neutrons dissolve under extreme energy, releasing their quarks and gluons. This plasma is believed to have existed in the first microseconds after the Big Bang. By studying it, scientists hope to unravel the mechanisms that shaped the early universe and led to the formation of matter as we know it.

The nucleus, with its intricate interplay of quarks, gluons, and forces, is a gateway to understanding the universe's most profound mysteries. Through experiments conducted at facilities like the LHC, humanity is delving deeper into the nature of reality, bridging the quantum and cosmic scales. As we continue to explore, the nucleus remains an endless source of wonder and inspiration, holding the potential to expand our horizons and unlock the ultimate secrets of the universe.

Student's Gallery

Batch of 2018-2021

Teachers & Seniors
Batch 2019-2022 & 2020-2023

Batch of 2021-2024

Batch of 2024-2028

Batch of 2023-2027

Batch of 2022-2025

CROSSWORD PUZZLE

Find the words hidden in the wordsearch below!

Across Clues:

- Branch of physics studying the smallest particles.
- Energy conservation law in thermodynamics.
- Framework combining quantum mechanics and topology.

Down Clues:

- Study of chaotic systems with sensitivity to initial conditions.
- Particles behaving as waves phenomenon.
- The continuum of space and time.
- Physics of collective behavior in solids and liquids.
- Wavefunction equation in quantum mechanics.
- Physicist known for the theory of relativity.

P	A	R	T	I	C	A	L	P	H	Y	S	I	C	S
M	S	U	F	I	R	S	T	L	A	W	R	E	C	D
C	T	O	P	O	L	O	G	I	C	A	L	Q	F	T
H	O	R	A	S	I	O	N	M	A	R	O	S	C	G
A	U	C	I	P	R	R	E	C	N	U	N	C	T	S
O	C	N	U	A	A	R	P	O	T	C	C	H	N	C
S	O	U	I	C	E	O	S	N	A	O	A	R	O	Z
D	M	C	A	E	E	R	U	D	E	W	M	O	I	E
U	E	R	T	T	U	N	S	E	I	A	U	D	T	J
A	D	T	U	I	U	T	T	N	N	S	S	I	A	N
L	Y	A	O	M	R	C	R	S	S	E	I	N	M	B
I	C	T	H	E	I	L	L	E	T	H	C	G	I	K
T	I	H	I	S	T	O	R	D	E	Y	A	E	N	O
N	U	A	D	V	E	N	T	U	I	E	L	R	A	M
S	F	A	F	Q	V	O	V	W	N	M	H	K	B	F

Sreyas Banerjee
3rd Semester

CROSSWORD PUZZLE

ADVANCE PHYSICS

Across Clues:

1. The particle associated with the field that gives particles mass.
2. A significant phenomenon in quantum mechanics involving correlation.
3. The branch of physics that studies the large-scale structure of the universe.

Down Clues:

4. A key feature of quantum particles allowing linked states across space.
5. Theory explaining the evolution and content of the cosmos.
6. An advanced topic studying quantum states of matter under extreme conditions.

H	I	G	S	S	B	O	S	O	N	K	F	H	G	B
R	S	E	N	T	A	N	G	L	E	M	E	N	T	P
C	O	S	M	O	L	O	G	Y	B	C	N	L	F	E
O	V	E	U	B	P	J	T	Z	R	X	T	Y	O	Q
N	N	A	M	I	G	W	O	L	P	D	A	Z	Q	X
D	E	Y	T	G	N	H	J	V	M	S	N	C	R	I
E	O	C	N	B	G	R	P	Z	T	F	G	Q	N	Y
N	B	P	O	A	R	E	J	G	E	T	L	K	L	A
S	T	Y	W	N	W	P	L	Y	V	Q	E	B	N	E
E	E	G	M	G	S	T	P	F	A	Y	M	J	H	D
D	A	M	A	D	S	N	V	N	F	I	E	C	A	Z
E	A	W	N	B	E	R	R	L	B	N	N	K	P	A
D	Q	H	C	T	N	O	O	P	T	N	T	I	D	K
F	H	R	I	S	T	M	T	O	O	M	G	A	X	W
A	D	I	H	B	A	D	L	D	P	P	H	I	T	Q

Sreyas Banerjee
3rd Semester

MEME
OF THE MAGAZINE

SOLUTION GUIDE

CROSSWORD PUZZLE

P	A	R	T	I	C	L	E	P	H	Y	S	I	C	S
			F	I	R	S	T	L	A	W				
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SOLUTION

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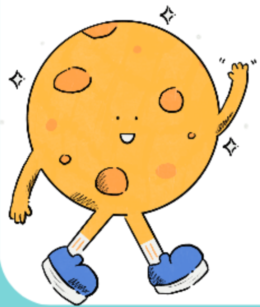

EPILOGUE

Equinox – 2nd Edition,2025

And just like that, we've reached the final page of Equinox, 2025 edition! What a journey it has been—packed with ideas that made us think, stories that moved us, and creativity that left us in awe. We would like to congratulate all the students and faculty who have contributed in this magazine to make it what it is today. This magazine isn't just about science; it's about us—our dreams, our growth and our shared love for discovery.

To the next generation, here's the deal —
THIS is your stage now. Make it bigger, bolder, and uniquely yours. Don't just follow in our footsteps—dance your own path, scribble outside the margins and push the boundaries of what this magazine can be.

The Equinox is more than pages filled with scientific write-ups...it's a legacy of curiosity and connection. Keep it alive, make it fun, and let it shine brighter with every turn.

Until next time, stay curious, stay creative!

The Editorial Team
Equinox, 2025 Edition


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BANGABASI COLLEGE
1887
BANGABASI COLLEGE
(Affiliated to University of Calcutta)
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Teachers Day & Fresher's Welcome
Department of Physics, Bangabasi College

Bangabasi College

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