DEPARTMENT OF PHYSICS

Physics Pulse

IIT (ISM) DHANBAD

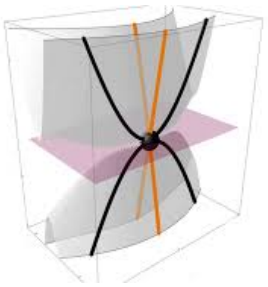
VOL.II No.2 FEBRUARY 15, 2025 PHYSICS NEWSLETTER*

Quasiparticle: Semi-dirac Fermion

By TANISHA SHUKLA

"Quasiparticle" that only has mass moving in one direction

For the first time, researchers have observed a type of quasiparticle that behaves in an unusual way. In one direction, it acts like it has no mass, zipping around as if it were made of pure energy. But turning another way, it carries mass, slowing down and resisting motion. This mysterious entity, called a semi-Dirac fermion, had appeared in theory about 16 years ago but had never been seen inside a real material. After careful experiments, a team made up of scientists from Penn State and Columbia University recently announced its discovery in the journal Physical Review X. The strange quasiparticle was spotted within a crystal known as ZrSiS, which is a type of semi-metal. The team had not set out searching for semi-Dirac fermions but instead stumbled upon them. These findings highlight how some materials harbour unusual particle behaviour that does not match everyday expectations. Inside solid substances, many particles can clump together to form emergent behaviour. It was within these interactions that the researchers identified the odd switch between massless and massive motion.



Quasiparticle: from Theory to Reality

Sixteen years after those predictions, the team caught the semi-Dirac fermion through magneto-optical spectroscopy. They shone infrared light on the crystal while applying a powerful magnetic field and then examined the reflected light to uncover the quasiparticle's properties. "They have studied the optical response, how electrons inside this material respond to light, and then we studied the signals from the light to see if there is anything interesting about the material itself, about its underlying physics". The team exposed their sample of ZrSiS to a field around 900,000 times stronger than the Earth's own. They also chilled the material down to around -452 degrees Fahrenheit, which helped reduce unwanted motion of particles and revealed the subtle patterns of energy levels inside the crystal.

Why does any of this matter?

ZrSiS is made up of layers that resemble other well-known materials such as graphite. Researchers can isolate very thin sheets that show off unusual properties. "It is a layered material, which means once we can figure out how to have a single layer cut of this compound, we can harness the power of semi-Dirac fermions, control its properties with the same precision as graphene," "But the most thrilling part of this experiment is that the data cannot be fully explained yet. There are many unsolved mysteries in what was observed.

Such layered materials have drawn interest for a broad range of uses. Graphene has been studied for cutting-edge energy storage, advanced electronics, and sensitive detectors. ZrSiS, now known to host semi-Dirac fermions, could follow a similar path toward future devices. With careful efforts, it might become a valuable piece of future sensors, energy devices, or other emerging technologies.

Physics Jobs

Postdoctoral Position in Quantum Simulation: The University of Copenhagen (UCPH) is inviting applications for a Postdoctoral Researcher position in the field of Quantum Simulation. This role offers an excellent opportunity to work at the forefront of quantum physics, using advanced theoretical and computational methods, focusing on simulating complex quantum systems.

Physics News

ISRO Marks Historic Milestone with Successful Space Docking Experiment

In a landmark achievement, ISRO successfully conducted its first space docking experiment, SpaDeX, on January 16, 2025, making India the fourth nation to master this critical technology. The mission involved two 220-kg satellites, SDX01 (Chaser) and SDX02 (Target), launched aboard PSLV-C60 on December 30, 2024.

National Conference on Atomic and Molecular Physics was organized

The biennial conference is hosted by IIT (ISM) Dhanbad, India, in partnership with the Indian Society of Atomic and Molecular Physics (ISAMP) from 8th to 11th January, 2025, focusing on key areas within atomic and molecular physics.

Read more »

*Send your feedback to: physicspulse@iitism.ac.in

An Interview with Prof. Sudipto Singha Roy

By NEWSLETTER TEAM

Prof. Sudipto Singha Roy has joined our department around a year ago. He has completed his PhD from Harish-Chandra Research Institute (HRI), India. Afterward, he did postdocs in South Korea, Spain, and Italy. His work is primarily on Quantum Information Theory & its interface with quantum many-body systems. Recently, Prof. Roy was awarded a research project entitled "Quantum metrological advantages of non-Hermitian systems." We present a not-so-long conversation with Prof. Roy here. We hope you will enjoy reading it.

Q. *To start with, Professor, would you mind sharing your early education with us?*

A. I did my Bachelor's from Ramakrishna Mission Vidyamandira, Belur, West Bengal, which is under Calcutta University. Then I moved to IIT Bombay for my Master's. And then, I joined the Quantum Information and Computation (QIC) group in HRI for my PhD. I was there for 5 years, from 2012 to 2017. Then I went to Korea (South) for one year for my first postdoc. From there, I moved to Madrid, Spain and stayed there for more than three years for the second postdoc. And lastly, I was in Italy, in Trento for two years. And then I joined IIT(ISM) last February.

Q. *So, how did you, in your early years, decide that you would do a PhD in physics?*

A. I mean it wasn't priorly decided. During MSc, we did not have much idea about the scope of doing PhD in this subject. I think my first interest grew when I did my first summer project after my BSc. I went to HRI and the QIC group was also very new at that time. Prof. Ujjwal Sen and Prof. Aditi Sen (De) had just set up a new group at HRI. I liked the overall environment of HRI. I liked the subject during the summer project, and later I also took the QIC course in my Master's thesis. All of this cumulatively developed my interest. Then this became my plan A. I did not know what would have been plan B. But luckily, this worked out.

Q. *Do you think people should have a plan B?*

A. Yes, of course, they should. It's possible that you may not secure a position in your preferred group, but that should not stop you from doing good research. There could be many reasons why an exam/interview can go wrong. This does not mean you should quit.

Q. *Sir, you mentioned that you lived in so many places, so would you like to share some of your experiences of living in so many different cities?*

A. Well, HRI is a very remote place outside the city. It's actually a village, but the environment is very nice. If you have good friends, the campus life is beautiful. People are very helpful. But sometimes I have seen people may also have problems because it's a very small campus. But my journey was very nice; we had very good academic and non-academic relations with people. The best thing was that there was no hierarchy. The people were very frank. At that time, we used to have Prof. Ashok Sen there. Unless somebody introduces you, you may not get the vibe that he is one of the renowned physicists in India. And that is for all other faculties as well.

In Korea, I actually spent just one year. Did not get much scope to explore many things. But in Madrid, I liked it very much. This is one of the cities in Europe which has nightlife, and the people are very friendly and helpful. So even after coming from there, whenever I got the opportunity, I spent at least one week visiting my past group. I am in touch with them and some collaborations are also going on. And Trento was also a lovely city. It's a small hill town surrounded by the Alps mountain.

Q. *What about the food, Sir, aren't you a 'Mach-e-Bhaat-e Bangali'?*

A. Yes, yes, of course, of course. Getting good quality Fish is a challenge. Luckily, in Madrid, they used to have this other kind of fish called salmon and a variety of seafood options. So I did not have much problem, and I tried to explore even their local cuisines. For example, in Italy, pizza is everywhere.

Q. *Sir, you mentioned that in HRI, everybody was very frank, and the environment was very good. So do you think there is any difference here?*

A. I would say HRI is a very small place; the population was 200 to 250 when I was there. So everyone knows each other. I cannot compare both things. Here we have many students; people may not know each other individually. But people are also very helpful and supportive here. After joining here, the support I have received from the faculties, our HOD, admin, and Deans is remarkable. All the PhD scholars I have met are also very helpful. I interacted with them while doing

B.Tech labs.

Research Highlights

We're excited to introduce the Speckle Image Processing Software developed by the Biomedical Optics Labs, led by Navanit Kumar and Prof. Anil Kumar Nirala!

Navnit Kumar and Prof. Anil Kumar Nirala

Features of Speckle Image Processing App

- This is a unified graphical user interface application developed over MATLAB.
- It carries most of the image processing algorithms used in the dynamic and biospeckle Image analysis to study the speckle characteristics of any sample.
- One can process the different kinds of biospeckle algorithms at the same interface and compare the results.
- No need to write and edit the image processing algorithms every time for different types of images and folders, all can be done by simply selecting the folder of speckle image and the desired image processing algorithms.
- The Qualitative Image Processing Algorithms tab contains the algorithms as:- Generalized Difference (GD), Parameterized GD, Fujii, Inverse Fujii, Parameterized Fujii, Frequent motion Image(FMI), Temporal Difference (TD), Temporal Contrast(TC), Co-occurrence Matrix (COM), THSP etc.
- The Algorithms for Quantitative results as:- Inertia Moment (IM), Absolute Value Difference (AVD), Average Frequency, Contrast, Correlation, Auto Correlation, Covariance etc.

Q. *Sir, this is your first year as a professor. So how is it different from being a research associate or postdoc student?*

A. Yes, a lot. While in postdocs, your primary focus remains on research. Here we have additional duties, like teaching, guiding students, etc, which are exciting as well as challenging! This is one thing that I am still trying to balance. However, I enjoyed the student interaction that was missing during my postdocs. I taught two theory courses which were also new experiences for me, and I enjoyed it a lot! Whatever I learned from those courses, I will definitely try to implement in my next courses.

Q. *Sir, you have two research scholars and one BTech student, and recently Prof. Avijit Misra has also joined your field. How are you planning to expand the QIC group here?*

A. Yes, he just joined. I know him very well from HRI because he was one year senior. We had one paper, but that's a long time back, in 2015. We have to start something together again. Usually, you don't get people in the department who are almost in the same area, so we really need to use this opportunity! We're also trying to explore the opportunity to build a quantum centre along with other sister departments from IIT(ISM). There are people in the mathematics department and electronics department who work in related areas. If we can bring them under one umbrella that would be nice!.

Q. *Sir, you were doing your B.Sc. and M.Sc. with Ritwik Sir and now you are colleagues. How do you feel about it?*

A. It feels really nice! The fun fact was that, from our B. Sc batch, 10 people went to IIT Bombay for Master's. So, the lab attendant during that time asked, "Do you have any quota from your college?" So, that was fun. At that time we had a lot of fun. After doing Master's from IITB, Ritwik went abroad for PhD. But we have always been in touch. He is here, and Prof. Tushar Dey is also my senior. Although we didn't have a direct overlap during our Bachelor's, he was pursuing his PhD at IITB while I was doing my Master's there. He also had the same trajectory as Belur and IIT Bombay. All the seniors in my department are extremely helpful. I am fortunate in that sense.

Q. *Sir, you were recently awarded a project. Would you like to tell us about it?*

A. Yes, this is a seed grant. It's the initial support provided by the institute to establish a group/buy research-related equipment when a faculty member joins the institute. The thing that we are planning to explore is basically the physics of a non-Hermitian system. In our basic quantum mechanics courses, we are usually introduced to the Hermitian systems. But, we can also have some physical systems where the models are non-Hermitian. One way to realize them is via dissipative quantum systems with some additional constraints. This area has many things to explore in terms of framework, as well as their applications in quantum technologies. At the same time, they also bring new challenges in comparison to Hermitian systems that we also need to take into account.

Q. *Will you tell us something about the challenges?*

A. Let's say you have an optimization problem where your goal is to find the system's lowest energy state. Traditional methods use techniques that confirm you've reached the desired state by monitoring the energy's convergence. However, in non-Hermitian systems, the energy spectrum can become complex and the existing numerical recipes suffer instabilities. Also, you can have eigenstates of the model that are not unique,

which brings the question of what the right "basis states" should be in exploring the physics of non-Hermitian systems.

Q. *So, how do you decide that you are reaching the desired state?*

A. In the conventional optimization technique, the algorithm starts with a high energy value and gradually converges to the minimum energy, indicating the system has reached the correct state. In non-Hermitian systems, however, the energy can become complex (as mentioned previously), which introduces instability and convergence issues. Without Hermiticity, eigenvalues can be complex, complicating the definition of energy as a figure of merit for convergence—whether to consider only the real part, the imaginary part, or something else. There's no clear prescription, and the challenge is to find an alternative measure that avoids ambiguity.

Additionally, in Hermitian systems, the left and right eigenvectors are usually the same, but in non-Hermitian systems, they can differ, leading to different physical properties (e.g., magnetization, entanglement) despite having the same energy. This lack of analogy with Hermitian systems makes choosing the correct basis a challenge, what should be the proper basis states to probe non-Hermitian systems? These two issues—defining energy and choosing the correct basis—are the main challenges we aim to address in this project.

Q. *In quantum mechanics, we studied the postulate itself, which states that all the operators are Hermitian. So how can we have non-Hermitian operators, then?*

A. We're not discussing the generalization of all operators (except the Hamiltonian), they are indeed Hermitian. We are talking about a special kind of evolution of the quantum state that results in non-Hermitian dynamics.

Q. *So, Sir, how do you envision computation will change in the future?*

A. There is a common misconception about the role of quantum computers. It's important to clarify that quantum computing will not make classical computers obsolete. Instead, quantum computers will excel at specific tasks where they offer clear advantages over classical methods. This means that, in the future, we will still be using classical computers for many everyday tasks. Recently, significant progress has been made in various fields, including quantum computing, sensing, and communication, where quantum principles provide practical advantages. These developments are poised to have a profound impact on society, especially in areas such as drug design, secure communication, and more. We believe while quantum technologies will transform certain industries, they will complement, rather than replace, existing classical computing systems.

Q. *I don't know many groups or many people from your group but I have seen that the quantum information group of India is very close-knit. Almost everybody knows everybody. I have seen that everybody in that group is very frank and welcoming.*

A. This field began emerging internationally in the 90s, but in India, it gained popularity around 2000, even at that time, there were only a few researchers working on this subject. Things began to change in the post-2000. Our community faced some initial challenges, as many from different areas didn't initially view it as a distinct area of research. However, through persistent efforts, members of the community pushed each other, and gradually, the perception began to change. Now we have many big groups all over India.

Q. *So if somebody is doing PhD or doing research in this field, then there are job aspects also open to them.*

A. In terms of academic jobs, they are similar to other areas. You can see, within the span of 1 year, two faculty members (Avijit and I) were selected for our department! However, India still lags behind in R&D scopes compared to other countries, although things are improving and new startups are coming. Especially with the government's Quantum Mission, there will be more collaboration between academia and industry.

Q. *If somebody is trying to work in this field, is it better for him or her to go abroad now or stay here?*

A. I think this is an important and common question we receive, though I'm not sure there's a clear answer. Even when we were studying, some people were eager to go abroad for their master's. For example, some chose IIT Bombay because it had popular student exchange programs at the time. I'm not sure if going abroad is absolutely necessary, but for a PhD, there are many strong research groups in India. Having said that, I do think it's helpful to get some experience abroad. It's not just about the money but also the chance to work with people from different backgrounds/expertise and take part in challenging projects. There are more opportunities for theory and experimental collaboration abroad, which we don't often see in India.

Q. *Sir, for theoretical physics, we just have to sit on a laptop and work separately. So sometimes, if you are not getting results specifically then it might get very demotivating and maybe sometimes boring also. So how do we get over those phases?*

A. One approach is to work on multiple projects at once. If one gets stuck, you can still make progress on another. Research should be driven by your own interest and learning, but it should also have a plan. If a problem isn't moving forward, it might be too hard—consider other approaches or ways to tackle it. For a PhD, five years can feel both long and short.

It's helpful to have different methods to solve a problem. If an analytical approach fails, try using numerical methods to gain insights. If something isn't working, take a break and focus on something else for a while. Having a plan is key—knowing what you want to achieve and how long to push before moving on. If you've spent two years on a problem with no progress, it's important to know when to stop and what to try next.

Q. *So finally, would you like to tell the students of ISM something?*

A. I don't know what to say exactly, but I've heard that master's students only have to do projects in the fourth semester. Use this time to explore your options—decide whether you want to stay in academia, go for a job, or work in industry. Six months is a lot of time, so don't just focus on your current project. If you get the chance, try online courses or explore other opportunities. It's essential to have a plan and stay

open-minded. If you don't get what you're aiming for now, keep looking for similar opportunities elsewhere. Keep trying, whether it's for a PhD, internship, or job. Don't be discouraged if people don't reply to your emails. Even for PhDs or postdocs, you might send 100 emails and get only one reply, which could even be a rejection. Keep applying and stick to your plan.

The pressure you've faced at IIT will help you handle future challenges. Both industry and academia are demanding, but if you enjoy what you're doing, you'll adapt to the pressure.

One more thing for PhD students: don't compare yourself to others. Everyone comes from different backgrounds with different goals. Some may achieve things later, so comparing progress isn't helpful—it can be demotivating. In PhD, it's important not to compare timelines, especially since setting up experiments or labs can take years. Focus on your own path. Also, try to help each other; PhD can be challenging, and friends are crucial. If you face academic stress or struggles, don't hesitate to talk to your peers. Sometimes parents may not understand, but your friends on the journey will be invaluable.

[*The interview is conducted by Aminul Hussain and Sanchari Biswas, Research Scholars, and Divya Bhengra and Gaurav, M.Sc. 2nd Yr Students. Acknowledgement: Debodyuti Kar*]

Research Talk

Activitiy, scope and career opportunity in the Department of Atomic Energy

An awareness program on various activities and career opportunities in the Department of Atomic Energy (DAE), GoI, was held on 27th and 28th of January 2025 in the Raman Hall of the Department of Physics. Scientists Dr. Tamal Kumar Bhattacharyya and Dr. Dipta Pratim Dutta from Variable Energy Cyclotron Centre (VECC) Kolkata, visited our department to deliver the talks and furnish the exciting world of DAE in front of us. They were greeted by the Head of the Department Prof. Bobby K. Antony. Dr. Bhattacharyya briefly introduced many research and development organizations, public sector undertakings, industrial organizations, service and support organizations, and fully aided research institutions being operated by DAE throughout our country. The speakers provided a comprehensive overview on different activities DAE undertakes in wide fields of nuclear science and technology encompassing power generation, research, development, safety, security, safeguards, environmental protection, concerned international collaborations, and societal applications all over India spanning multiple disciplines of science and engineering. They also enlightened the students, research scholars and faculty members on several academic and research scopes, and career opportunities available in the department through interactive manner.

Physics in History

- February is truly a rollercoaster of a month, starting with a significant low point in the history of the Indian scientific community. On February 1, 2003, we lost a shining star—Kalpana Chawla—along with six other astronauts in the Columbia Space Shuttle Disaster. She was literally among the stars, pushing the boundaries of space exploration, and her legacy continues to inspire generations.
- As the month comes to a close, we see a glimmer of light as February 28 marks the birthday of Sir Chandrasekhara Venkata Raman. India celebrates this day as National Science Day in his honor. At the Department of Physics, IIT (ISM) Dhanbad, we are also commemorating this occasion under the banner of Science Fest.
- February 18, 1930, Clyde Tombaugh discovered Pluto—the unlucky celestial body that is no longer classified as a planet. Fun fact: From the day it was discovered to the day it was demoted from the list of planets, and even to this day, Pluto has yet to complete a single orbit.
- February 3, 1966, the Soviet Union's Luna 9 became the first spacecraft to make a soft landing on the Moon and send back images. Imagine being present in 1966, witnessing this historic moment, and being compared to the person who processed those images of the Moon and shared them with their loved ones.

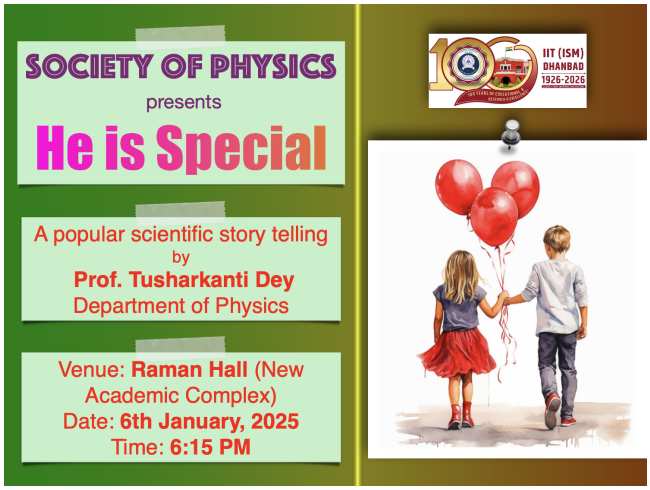
Prof. Sudipto Singha Roy and Prof. Avijit Misra launched a seminar series "***Advances in Quantum Theory and its Frontiers***" to mark the 100th anniversary of Quantum Mechanics in collaboration with Prof. Anindita Bera, Department of Mathematics at BIT Mesra, Ranchi, Jharkhand. This event combines the Centenary Celebration of IIT (ISM) Dhanbad and

BIT Mesra's Platinum Jubilee. The series will cover cutting-edge topics in quantum information, computation, many-body physics, photonics, sensing, and materials, featuring experts around the world. Seminars will be held in hybrid mode (in-person and online) twice a month, with sessions recorded and live-streamed on YouTube.

Prof. Tusharkanti Dey delivered a talk titled "He is Special"—a title that immediately sparked curiosity among the audience. Who/What is "He"?

The answer: **Helium!**

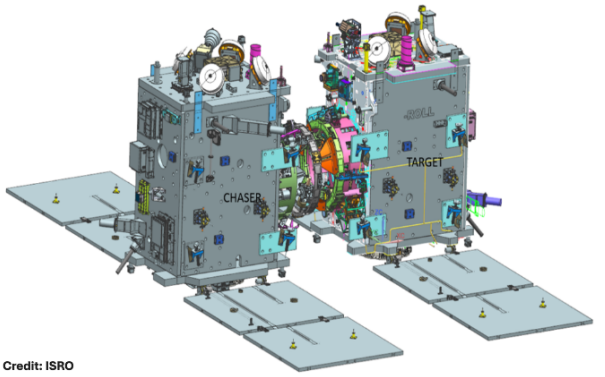
In the first part of his talk, Prof. Dey took the audience on a journey through the history of Helium's discovery and the fascinating race in cryogenic/low-temperature physics. The second half delved into the properties of liquid Helium, superfluidity of helium-4 and helium-3, the principle of dilution refrigerator, and how these play pivotal roles in various fields, from scientific discovery to cutting-edge technologies! The talk was organized under the banner of the Society of Physics, Department of Physics, IIT (ISM) Dhanbad on 6th Jan 2025.



Physics News

ISRO Marks Historic Milestone with Successful Space Docking Experiment

In a landmark achievement, ISRO successfully conducted its first space docking experiment, SpaDeX, on January 16, 2025, making India the fourth nation to master this critical technology. The mission involved two 220-kg satellites, SDX01 (Chaser) and SDX02 (Target), launched aboard PSLV-C60 on December 30, 2024. After precise maneuvers, the satellites docked successfully, marking a historic milestone. Space docking is vital for satellite servicing, space stations, and interplanetary missions. This success strengthens India's space exploration efforts, supporting future projects like Gaganyaan and the planned space station. PM Modi praised the scientists, calling it a stepping stone for future missions. This achievement reaffirms India's rising status as a space power.



Credit: ISRO

National Conference on Atomic and Molecular Physics NCAMP-2025

From January 8th to 11th 2025, IIT(ISM) in collaboration with Indian Society of Atomic and Molecular Physics (ISAMP), conducted a 4-day conference NCAMP-2025 (National Conference on Atomic and Molecular Physics) in Penman Auditorium, IIT (ISM) Dhanbad. The conference bought together scientists from all over the country under the common agenda of developing Atomic and Molecular science. Under Prof. Bobby Antony's (Convenor, NCAMP-2025) supervision, the International Year of Quantum was marked. Keynote speakers Prof. P K Mohanti and Prof. P C Deshmukh delivered insightful lectures on quantum technology and India's contributions. Prof. P. M. Sarun, Prof. S. Bagchi, Prof. T. K. Dey and Prof. R. John, were the co-convenors of NCAMP 2025.

National Visits

Prof. Umakanta Tripathy visited SRM University, Andra Pradesh to deliver an invited talk as a keynote speaker. SRM University – AP, in association with Physical Research Laboratory Ahmedabad, National Physical Laboratory New Delhi, University of Tartu, Estonia, Optica (formerly OSA) and Optical Society of India is organized "1st International Conference on Emerging Trends in Optical Technologies" (ETOT-I) during 02-04 January 2025 at Amaravati, India.

Sanchari Biswas visited International Centre for Theoretical Science (ICTS - TIFR), Bengaluru to attend Hearing beyond the standard model with cosmic sources of Gravitational Waves held from 30.12.2024 to 10.01.2025.

Prof. Tusharkanti Dey and Prof. Ritwik Mondal visited Garhbeta College, West Bengal for an invited talk at a Science Seminar on January 31, 2025, hosted by the Physics Department of Garhbeta College.

Prof. Mondal delivered a talk titled "***Light on Einstein and Einstein on Light***", shedding light on the fascinating analogies used by scientists to explain complex phenomena. His focus on Einstein's contributions to the understanding of light quanta. Prof. Dey's talk titled "***He is Special***" dived deep into the story of helium (He) — from its discovery to its role in superconductivity, superfluidity, and its crucial place in the quantum revolution. The seminar saw enthusiastic participation from college students and even schoolchildren from nearby schools (Standards 9 & 10), all eager to dive into the wonders of science!

Prof. P. M. Sarun visited the Department of Physics, Manipur University, Imphal, as the External examiner to conduct the third-semester M.Sc. Physics Practical examination for the Nuclear Physics Lab from 27.01.2025 to 29.01.2025. He was invited by Prof. Angom Dilip Kumar Singh, Head, Department of Physics, Manipur University, Imphal.

Research Publications

1. Arpita Dutta, Christian Tzschaschel, Debankit Priyadarshi, Kouki Mikuni, Takuya Satoh, **Ritwik Mondal**, Shovon Pal, and Ritwik Mondal, Evidence of Relativistic Field-Derivative Torque in Nonlinear THz Response of Magnetization Dynamics, Advanced Functional Materials

2. Meenu Pandey, and **Bobby Antony**, Computation of electron interaction with halide precursors, Radiation Physics and Chemistry

3. R. S. Arun Raj, Aruna Joseph, Shamima Hussain, Mohd Fahad, Tuhin Maity, **P. M. Sarun**, and Lija K. Joy, Frequency and temperature dependent dielectric properties of $CoFe_{2-x}Y_xO_4$: polarization and conduction mechanisms related to crystallographic symmetry and electronic transitions, Journal of Materials Chemistry C

Editorial Board: **Chief Editor:** Prof. Bobby Antony (HOD), **Editors:** Prof. P. M. Sarun, Prof. Tusharkanti Dey, **Assistant-Editor:** Mr. Mithilesh Mishra, **Student Editors:** Mohana Priya. T, Rishit Raj, Surajit Das, Alwin S. S., Deep Karmakar, Vishnu Nayak, Divya Bhengra, Gaurav, Himanshu, Sanchari Biswas, Aminul Hussain, Prashant Singh Lohiya

Article Submission: CLICK HERE
your feedback to: physicspulse@iitism.ac.in