Physics Pulse

IIT (ISM) DHANBAD

VOL.II No.6 JUNE 24, 2025 PHYSICS NEWSLETTER*

Alumni Visit

One of our alumnus **Dr. Somnath Mahato** (Ph.D. 2012-2016, Micro and Nano Science Laboratory, Supervisor: Prof. A. K. Kar) visited our department on 15 May 2025 and delivered a talk titled "***Metal Halide Perovskite for Light Emitting and Scintillating***".

Dr. Mahato was welcomed by the seminar co-ordinator Prof. Esha Kundu and greeted with a bouquet by the HoD (CD) Prof. S. K. Sharma. Presently he is working as a Research Engineer at Łukasiewicz Research Network PORT Polish Center, Wroclaw, Poland. In his presentation he explained recent advancements and challenges in developing perovskite-based materials for the above applications. Perovskite nanocrystals are emerging as promising materials for next-generation light emitting diodes and scintillators offering significant potential for optoelectronics and radiation detection.

He focuses on Ruddlesden–Popper interfaces in mixed halide perovskites (MHP) which play a critical role in optimizing device performance, and demonstrate how halide migration affects the structural integrity and electroluminescence of MHP-based devices. Audience were stirred and showed great interest in fascinating colourful jello-cube like halide perovskite 3D single crystals which were synthesized employing antisolvent-assisted solvent acidolysis crystallization techniques.

The presentation also highlighted ongoing research into nanophotonic structures, such as photonic crystals and plasmonic structures, that enhance light emission via Purcell effects offering the potential for faster, brighter LEDs and scintillators in future technologies. At the end of the talk Dr. Mahato was felicitated by Prof. Kar with a memento. His visit was also celebrated in his alma-mater laboratory with sweets, gifts, memento and lunch with high enthusiasm.

Congratulations | New HoD

We heartily congratulate **Prof. Vineet Kumar Rai** on his appointment as the Head of the Department with effect from 01 July, 2025.

Prof. Rai has expertise in **Atomic & Molecular Physics, Lasers, Nanophosphors, and Nanophotonics**. His current area of research interest is on synthesis and optical characterization of advanced optical materials and their multi-functional applications.

We also extend our sincere thanks to **Prof. Bobby K. Antony** for his dedicated leadership as the Head of the Department over the past three years.

International Visits

Prof. Tusharkanti Dey recently visited the ISIS Neutron and Muon Source, STFC Rutherford Appleton Laboratory, UK-one of the world's leading large-scale research facilities—to perform muon spin relaxation (μSR) experiments from 16 –21 May 2025.

Interview with Prof. Bijay Agarwalla

Prof. Bijay Agarwalla is a distinguished physicist from Indian Institute of Science Education and Research (IISER) Pune, known for his contributions to non-equilibrium statistical mechanics, quantum transport in low-dimensional systems, and quantum information theory.

Read more »

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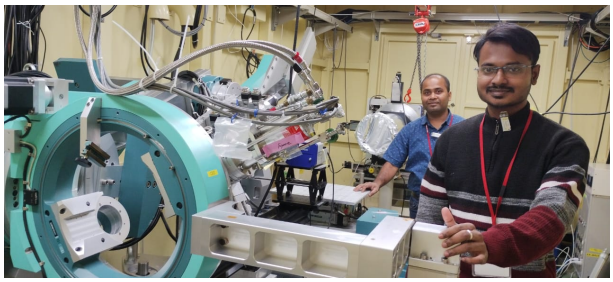
The experiments, carried out on the MUSR instrument, focused on investigating the properties of two novel frustrated quantum magnets based on a triple perovskite structure.

These materials were synthesized by Romario Mondal, a PhD student in Prof. Tushar Dey's group, and the work is part of a collaborative effort with Prof. Avinash Mahajan's group at Indian Institute of Technology, Bombay, and Dr. P. Baker at ISIS.

Access to ISIS beamtime is extremely competitive, with proposals rigorously reviewed by the Facility Access Panels (FAP) and awarded only to projects with the highest scientific merit.

Prof. R.B. Choudhary has participated as Co-Convener of "***International Conference on Industrial Plasma Process and Diagnostics***" (IPPD-2025) during May 18-20, 2025 in the Department ESE at IIT Delhi. The inaugural function was presided by Prof. R. Banerjee, Director, IIT Delhi, and Prof. V.K. Komarala, HOD ESE, and Prof. B.B. Sahu, Convener IPPD-2025.

Prof. Rajendra Giri and his PhD student, **Mr. Preyash K Bal** visited the Indian Beamline at Photon Factory (KEK, Japan) from 19 - 25 May 2025, and conducted experiments focusing on the X-ray scattering measurements from the model cellular surfaces. The primary objective was to efficiently integrate the graphene nanoparticles onto the biological cell surface models for applications in bioimaging, biosensing, and treatment of diseased cells. They also investigated the biocompatibility of graphene nanoparticles and their structural effects on cholesterol-containing lipid membranes - a key membrane component in understanding interactions at the nano-bio interface.



Utilizing the advanced X-ray synchrotron radiation facility at KEK, the team led by Prof. Giri examined the nanoscale perturbations in membrane architecture induced by graphene integration. This study supports ongoing efforts to assess the safety and effectiveness of carbon-based nanomaterials in biomedical and therapeutic use. Prof. Giri and his team extend their heartfelt gratitude to the DST (GoI) for granting access to the large-scale facility and for their financial support for the visit. The team also thanks IIT (ISM) Dhanbad for providing financial support for the chemicals and other essential materials used in the experiment.

Securing access to the X-ray synchrotron facility at KEK is a highly competitive, where proposals undergo stringent review by a scientific committee and are awarded only to research of exceptional scientific merit. Congratulations to the entire team on a successful experiment and a remarkable collaboration!

Prof. Soumya Bagchi and his PhD student **Mr. Apurbalal Bar** visited the Extreme Light Infrastructure - Nuclear Physics (ELI-NP) and Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN-HH), Bucharest, Romania, from 19 May to 6 June, 2025, and conducted an experiment with a 9 MV Tandem accelerator.

The primary objective of the experiment was to understand the microscopic structures of nuclear states near the particle emission threshold, which have implications for our understanding of nucleosynthesis processes and the equation of state of asymmetric nuclear matter. Utilizing the cutting-edge gamma detector array ($LaBr^3$, $CeBr^3$ and HPGe detectors) and Si detectors, the experiment was conducted smoothly with cooperation with the team at ELI-NP and IFIN-HH.

Gaining access to this state-of-the-art facility is a highly competitive and selective process, with proposals reviewed rigorously by a scientific committee and granted only to research of exceptional scientific merit.

Prof. Ritwik Mondal is visiting Johannes Gutenberg-Universität Mainz, Germany as a part of the PECFAR grant from IGSTC received together with Dr. Alexander Mook. Dr. Mondal will be visiting Germany during 17 May - 11 July, 2025. His collaborative research explores the effect of topology in the spin dynamics including the magnetic inertia and the effect of edge states.

Prof. Bobby Antony visited University of Kent, Canterbury, United Kingdom Research collaboration with Prof. Nigel Mason OBE, University of Kent, UK. during 15 May – 6 June, as part of the Royal Society International Exchange Award.

The aim of the visit was to develop cross-section data for large, chemically complex molecular systems—systems for which experimental studies are currently not feasible but for which such data are needed in a range of applications, from radiotherapy to the study of molecular synthesis on astronomical bodies.

The theoretical studies conducted during the visit will be validated through experiments carried out in the UK, paving the way for more accurate and comprehensive molecular data in challenging regimes.

Congratulations on this exciting partnership!

Prof. Ritwik Mondal visited Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau, Germany for a SPIN+X research seminar on 27 May 2025. He delivered a talk titled "***Inertial Magnons: A New Frontier in Terahertz Spin Dynamics***". He is collaborating with Prof. Dr. Akashdeep Kamra on the microscopic understaning on the origin of spin dynamics.

Interview with Prof. Bijay Kumar Agarwalla

By NEWSLETTER TEAM

In this edition, we are delighted to feature an interview with **Prof. Bijay Kumar Agarwalla** from the **Indian Institute of Science Education and Research (IISER) Pune**.

Prof. Bijay Agarwalla is a distinguished physicist known for his contributions to non-equilibrium statistical mechanics, quantum transport in low-dimensional systems, and quantum information theory. His visit to our department from 3rd to 10th April 2025 provided a valuable opportunity for academic exchange, during which he interacted extensively with students and faculty.

As part of his visit, he delivered two engaging talks: one at the one-day conference on Quantum Information Meets Quantum Many-Body Physics and Quantum Optics held on 4th April and another seminar titled Anomalous Quantum Transport in Low-Dimensional Lattice Systems on 9th April. His deep insights and approachable nature made a lasting impression on the department community. In the following conversation, Prof. Agarwalla shares his research journey, current interests, and thoughts on the evolving landscape of quantum physics. We hope readers will find his perspective both inspiring and intellectually enriching.

Q. *First of all, Professor, thank you for agreeing to give us some time. Let us start by asking how your stay at IIT (ISM) Dhanbad was?*

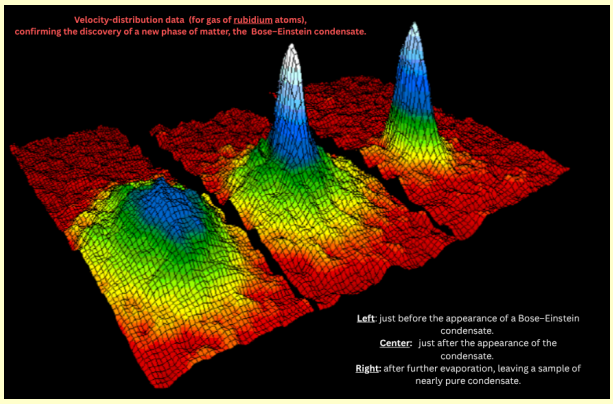
A. It was really, really wonderful. This is the first time I've come here. I found the campus to be quite beautiful. The morning and evening walks were very pleasant. Food was also really good, I must say. And the Physics department is quite active. People are working on the latest problems. So, I thoroughly enjoyed it. The infrastructure also seems to be quite nice and growing. I would be happy to come back again.

Q. *Our students became very interested in your talk. So they want to know if you will be taking students in your group for a PhD?*

A. I'm glad to know that. I am presently not having a big group. I like to work closely with the students, get involved in every project in every detail. That restricts the number of students. I'm still trying to expand it, but I always find it extremely hard. I think with experience, I can see that there is a chance. I have now started following certain guidelines, like having things organised where we can, and even if we're spending half an hour, we want to make it productive. My students keep a summary of plots and equations of their work in an Overleaf file for every meeting. The file keeps evolving, and we never lose the meeting details. These kinds of things make it more productive than if things are scattered in a student's notebook. So, I hope I can increase the group size, but it's still a process. Eventually, probably it will happen, but right now it's limited. Right now, I have two PhD students and two master's students.

Physics in History

- June 01, 1831: J.C. Ross discovered the position of the North Magnetic Pole on the Boothia Peninsula.
- June 05,1995: The first Bose–Einstein condensate was created by Cornell and Wieman.



- June 12, 1824: Carnot published his work on heat engines, laying the groundwork for thermodynamics.
- June 27, 1954: The world's first nuclear power station was opened in Obninsk, Russia.
- June 29, 1905: Einstein published the article "*On the Electrodynamics of Moving Bodies*", in which he introduces special relativity.

Q. *Many PhD students struggle with finding their research direction. What advice would you give to students interested in theoretical physics?*

A. This is a genuine problem. Even when I was a master's student at IIT Bombay, it was a big problem. For some reason, I was also one of the students who wanted to do High Energy Physics. But in IIT Bombay, what used to happen is that your first semester score decides whom you can choose. My first semester was quite bad. And so, most of the top scorers approached people who are working in High Energy. Then

there was Prof. Dibyendu Das who is a statistical physicist and I approached him and realized that I could learn a lot from him. So, I didn't get my first choice, but I didn't miss anything. I really enjoyed it. And in fact, that became my trajectory. I started liking it so much that I never again went back. But you can always do a master's in something, and for a PhD, again, you go back to something else. Non-equilibrium physics was a very hot topic at that point. And he guided me to read about some of the basics and see whether I found it interesting. He thoroughly guided me, and I'm fortunate for that. So I would say one should be a little broad-minded, when even at the level of a master's, one should not be very rigid. I think one should not just decide based on certain buzzwords, and one shouldn't be scared. If you are sincere, focused, hardworking and really trying to understand a problem, no matter which field you are working on, that knowledge is going to help you later, also if you move to something else. Ultimately, it's physics.

Q. *Could you explain your research in simple words so that everybody can understand?*

A. I work in non-equilibrium problems, primarily interested in quantum systems. So very simply put, we all studied quantum mechanics where we always describe Schrodinger equation, Hamiltonian dynamics. And we all know that this works for systems that are isolated. But in reality, systems are not sitting in isolation. For example, if I have a coffee cup, it's simply interacting with air molecules. Since you are doing some measurement, your systems are, in general, not isolated. One of the main questions that you can ask is about the evolution of open systems. And if you're looking at it from a quantum perspective, you call it an open quantum system. So my research is primarily in that direction. If you have an isolated system, you solve Schrödinger's equation, and you know everything. But we can't really say that for an open system. So at that level, you still have to make a lot of simplifications. And that part—what kind of simplifications you make, how you extract more information—there's a lot of research going on in that. So basically, once you make the system open, what it does, how you understand its dynamics, how it relaxes—those are the properties we try to understand. This is basically quantum thermodynamics.

Then, of course, you can think of currents flowing through the system. So then you can talk about particle and heat current, and so on, and you can go in the direction of quantum transport and quantum thermodynamics as well. Another part of it is that there's a lot of experimental interest now in designing small-scale machines. Very small, tiny machines—like heat engines, for example—at the quantum scale. And if you have those kinds of small machines, you can have a lot of fluctuations. These fluctuations could be quite large. For example, in classical thermodynamics, we study systems where fluctuations relative to the mean are very small. So if your average is large and the fluctuations are small compared to the average, you can ignore them. But if you have a small system, the fluctuations can be of the order of the mean. So then the question is: what do I do with this fluctuation? Can I minimize it? And more importantly, what kind of information do these fluctuations carry? Turns out, there's a lot of interesting information. I'm talking about non-equilibrium fluctuations. In equilibrium systems, fluctuations—say, in energy—are related to specific heat. But what do non-equilibrium fluctuations give you? You get a lot of valuable information from non-equilibrium fluctuations. This is also something we look at. And then, how do these fluctuations impact the performance of a device? Because if you're making something small, for example, if I make a very small device, then there's some power coming out of it. But if it fluctuates a lot, what's the use, right? The stability is very low. So I have to think about reducing that fluctuation. How do I do that? And so on. There are a lot of such operational questions that you can ask. In our group, we work on both fundamental physics and these practical questions, which help us understand the systems better.

Q. *Do you have any collaborations with experimental work?*

A. Yes, IISER Pune has a group led by Prof. T. S. Mahesh, who works on NMR systems. We have collaborated earlier and are still discussing whether what we see theoretically can be realised experimentally. And there were some collaborations that also happened outside India. I love to take that kind of perspective. Often, you know, certain theoretical work—most often, I actually try to design a problem or think about a problem which is motivated more from an experimental side. But to a large extent, I love to think about problems which are close to experiment, or where the facility may not be there yet, but at least you know that this is possible.

Q. *So is your work connected with quantum computations?*

A. See, yeah, I mean, to a certain extent, yes. Now, that depends on what level. So, for example, you know, when you talk about quantum computation and so on, of course, there are multiple aspects of it, right? I would not say that I am really working on building a quantum computer. But I would say that some of the theoretical questions that we try to address could be helpful in designing quantum computers. But not really in a direct way. I would say my contribution is in a very indirect way towards it. But again, some problems could be motivated for example,I want to prepare a state, how can I quickly prepare it? Or what kind of optimised performance I can do to reach that state. So, motivation comes from there. Maybe with more experience at some point, I would love to work more closely, even in that aspect.

Q. *Are there other fields with which you collaborate?*

A. So largely, I would say yes. Largely, I often talk to the condensed matter community and the statistical mechanics community. I also talk to the Quantum Information community. These are the sort of three different fields I often love to talk to. And then there are experimentalists who are measuring certain relevant quantities that we are looking at in certain kinds of platforms, like, for example, NMR and so on. Largely, the problems I work with fall at the interface of these.

Q. *During your stay, did you find any similarities or differences with your institute here?*

A. One of the first things that struck me here is the architecture. This campus has a long history, and many of the buildings reflect that legacy. I personally love this older style of architecture—it brings a sense of character and timelessness that

newer campuses often lack. That said, there's also a contrast: for instance, IISER Pune was established in 2006, so it's still relatively new. Even though it's now approaching its 20th year, it feels more modern by comparison. Another major difference I noticed is the size of the campus. Now, some might not agree, but I actually appreciate a moderately sized campus. On very large campuses, it can take 15 to 20 minutes just to walk from one building to another. That can be tiring and inconvenient. This campus strikes a good balance. It's not too small—about 300 acres, from what I've heard—so it doesn't feel cramped. But it's also not so vast that things feel disconnected. For reference, IISER Pune spans around 100 acres, so this feels more expansive while still being walkable. I think it's quite well-optimised. Of course, if the institute grows substantially in the future, space might become a constraint. But at this point, it seems to be functioning very well within its size. One delightful surprise for me has been the food! I've been staying at the guest house, and I must say—I've really enjoyed the meals. Honestly, I love the food here. Perhaps it's because I'm from Bengal, and the cuisine has some overlap, but it's been genuinely enjoyable. I find that makes a big difference in day-to-day experience. As for the people, I've found the students to be active and engaged. They're attending conferences and participating in academic events, which is always a positive sign. It reflects an intellectually vibrant environment. Another interesting feature is the layout of the academic buildings. In many traditional institutions, departments are housed in separate buildings: chemistry in one, physics in another, and so on. But here, everything is integrated into a single building or a central complex. This fosters a different kind of academic culture—one that encourages interdisciplinary interaction. In fact, even at IISER Pune, we have a similar model. Take fields like biophysics, for example. There's a great deal of overlap between the languages and tools used in biology and physics. When faculty and students from different disciplines share the same space, casual conversations can lead to collaborative ideas. You run into people, you chat, and new connections are made. That's harder to achieve when departments are siloed. Overall, I genuinely feel that this institution is on a very promising trajectory. Given the kind of faculty joining and the infrastructure being developed, I see a lot of potential.

Q. *So, are there any schools or some kind of facilities that our students can apply to in your institute?*

A. There is a summer program that happens every year. Students can work with faculty for at least two to three months via this route. The project can also be extended if something good comes out of it. I definitely encourage summer projects as students cannot go anywhere during the semesters.

Q. *As you have lived in Singapore, the US, Canada, India and studied in so many places, would you tell India to imbibe and implement something for bachelor's, master's programs or improve the research environment?*

A. I did my bachelor's and master's here in India, and I honestly felt that we have one of the best curricula. So I don't really see much change required at the undergraduate level. At the level of PhD, yes, I think quite a few changes could be brought that would be nice. For example, I can see the difference between when I did my PhD abroad and when students are doing their PhD here. One of the major differences is that when you are abroad, there is a lot of funding. So, in terms of attending conferences, going anywhere was just a triviality. Things are getting better, though.

Another point is the mobility within India. We have many good institutes, but there should be more interaction between students and faculty across institutes. Research is expanding so vastly, and it's important to talk to people, discuss problems, and share ideas. Even within India, we should know who is working on overlapping problems. It's important to go and talk to them, discuss the direction of the field, and not just work in isolation. In places like Singapore, there were lots of visitors and exchanges, and I think India could benefit from encouraging more mobility and interaction. Additionally, students should be more independent in discussing their research. In my experience, students abroad seem to become independent more quickly. Here, there seems to be some shyness in discussing their work. I think students should overcome this fear of judgment and be confident in talking about their research. Even if someone doesn't find your problem interesting, it's important to get feedback. Research is about learning, and discussing your work can lead to ideas that propel your project forward. It's about being honest and open to improvement. Communication skills are also crucial. Research isn't just about good ideas; it's also about being able to present them effectively. When I was a student, I used to give talks at various institutes, not necessarily because my research was groundbreaking, but because I wanted to improve my presentation skills. This is a key quality for personal growth and for when you're eventually a faculty member. People will judge you not just on your research but also on how you communicate it.

Q. *What are your thoughts on the "quality vs quantity" debate?*

A. The debate about quality versus quantity is common, but quality is not just about getting a paper published in a prestigious journal like PRL. It's about choosing problems that will help you learn something new and challenge yourself. If you're always working on small incremental improvements, it might be time to push yourself further. I believe quality is about substantially learning new things and continuously challenging yourself.

Q. *We will end the interview by asking you if you had any advice to give your younger self, what would it be?*

A. Be a little less scared and more open. I myself have been extremely shy. I was afraid of talking to people who are pioneers in their field, but I've seen that whenever I have interacted with them, I've had great experiences. So, I really encourage students to please go ahead. Don't let that fear of judgment stop you. If that stops you, how will you grow? You have to talk to brilliant minds. That's one very easy and good way to grow. Of course, you can grow by reading papers and all that, but hearing from people who have really worked on it makes a lot of difference. Let people judge. Even when I go to my undergraduate classes, there are students who ask brilliant questions, and I say, "I don't know," but I try to figure it out the next day. Sometimes I can, sometimes I cannot. So, the

point is, everything stops when you say, "This is an interesting question, but let me not think about it." That's where you stop your growth, and that shouldn't happen. As long as the question excites you, think about it. It might be uncomfortable at first. Write it down, think a little bit. You won't have to have an answer immediately. But the process should be there: let me think. If you stop, that's a blunder. Get rid of the fear of judgment. People will judge you in various parts of life, not just in academics, but you need to be clear from your end that you're doing your best. Be comfortable with being uncomfortable. And stay focused. I believe in the principle of hard work. If someone is super smart, you can replace that with hard work. You really have to have patience, hard work, and focus. There's no replacement for these things.

This is something I've noticed—students don't ask questions as much now. I think there's a generation gap happening, but it's not a good thing. If you don't ask questions, it doesn't mean you haven't understood. But that challenge should be there. You should feel comfortable saying, "This is not making much sense. Can you elaborate?" I really enjoy such discussions. In a class, if I give a 50-minute lecture with no questions, I feel extremely bored. But if there are interesting questions from students, it gives me motivation. As teachers, we also need a lot of motivation, and we get it from students when we see they're thinking and grasping the concepts. But many students don't ask questions because they fear judgment or think their question is stupid. We need to throw that thought out of our minds completely. So what if it's a stupid question? Who's going to define you by that? If you don't understand, ask. Simple. It requires a strong sense of self. You're doing science because you're passionate about it. It's a pure thing, and you shouldn't dilute it with fears about what other people will think. People will always judge, but you should be clear about your goals. If you don't understand, say so. Talking to people, sharing your problems—it really helps. I was also afraid of opening up, but once I started, I saw how much difference it made.

The interview was conducted by **Aminul Hussain, Sanchari Biswas, Prashant Singh Lohiya**, Research Scholars, and **Divya Bhengra**, M.Sc. 2nd Yr Student.

Physics Openings

1. **Semiconductor Manufacturing Materials Expert**: Tata Electronics is hiring a materials expert to source, evaluate, and qualify key semiconductor materials—wafers, chemicals, gases, photoresists, and more. This role involves strategic supplier management, cost optimization, and ensuring material compliance with industry standards. Work closely with cross-functional teams to support high-quality, timely, and cost-effective procurement.
2. **Intern at Global Foundries**: Global Foundries, a leading semiconductor manufacturing company, is actively seeking talented and passionate Engineers to join their innovative team. They have exciting openings in multiple areas, including: **Intern- Fab Engineering, Intern Supply Chain, Intern- Design Engineering**
3. **Battery Design & Structures Engineer**: Caterpillar Inc. is hiring a Structural Simulation Engineer to lead high-fidelity FEA simulations for battery systems. You'll model, validate, and optimize structural components under various loads, and support design through simulation-led insights. Collaborate across design, materials, and testing teams to drive performance and innovation. Shape the future of battery systems with robust, simulation-backed design solutions.
4. **TIFR Mumbai calls for** scientific officer and Scientific assistant.
5. **Project Associate at JNCASR Bengaluru**: Project title: Soft electrodes and substrates for interfacing.

Research Publications

1. **Mohd Mehkoom**, Farman Ali, Amit K. Pradhan, Prasanta K. Datta, **Umakanta Tripathy**, *Enhanced ultrafast cubic nonlinearity in the carbazole-picric acid complex for potential applications in photonic devices: Kerr nonlinearity with two-photon absorption*, Physical Chemistry Chemical Physics.
2. **J. Bauri**, **R.B. Choudhary**, and K. Karak, *Ameliorated photophysical properties of ZrO_2 nanoparticles derived PCz/ZrO_2 based nanocomposite as an emissive layer material*, Optical Materials.