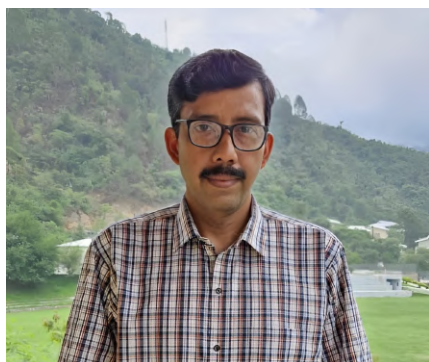

Chairperson's Message

Prof. Suman Kalyan Pal



As the Chair of the School of Physical Sciences, I am thrilled to share the extraordinary achievements

together leading scientists and students from across the country. The positive feedback and active participation to these gatherings have been extremely heartening.

Our department has continued to make good on our commitment to community engagement. Our members have been actively involved in outreach activities, both individually and collectively. In the past year, we organized two teacher training workshops aimed at enhancing the skills and knowledge of school teachers. Our National Science Day celebration was a resounding success, featuring student and faculty research presentations, a poster session, a quiz, and a communal lunch. These activities fostered a vibrant intellectual environment within our department as well as a sense of community.

Our students have made us exceptionally proud this year. We witnessed the highest number of GATE qualifications from our School. Several of our students received PhD offers from prestigious institutions abroad. These achievements are a testament to the hard work and dedication of our students and faculty.

This year has been one of remarkable growth, achievement, and recognition for the School of Physical Sciences. These accomplishments were only possible due to the unwavering commitment and excellence of our faculty, students, and staff. My sincere thanks to these people for their selfless effort. As we look forward to the coming year, I am confident that we will continue to build on this momentum, scaling even greater heights together.

ments and milestones our School has reached over the past one year.

The 'Center for Quantum Science and Technologies (CQST)' was established this year, headed by our very own Dr. Chandrashekhar Yadav. The inception of this pioneering center aligns with the National Quantum Mission of the Government of India, positioning IIT Mandi at the forefront of cutting-edge research and technological innovation.

We are immensely proud of Dr. Ajay Soni, who was admitted as a Fellow of the Royal Society of Chemistry, UK. Dr. Soni's dedication, expertise, and contributions serve as an inspiration to our academic community.

Our department has continued to demonstrate its strong research capabilities, with over 60 publications in top-tier journals in the last year. This prolific output underscores the high quality and impact of the research conducted by our faculty and students.

We organized two national-level conferences and one national-level workshop this year, bringing

Highlights of the Year

Honors and Awards: Faculty Members



Dr. Ajay Soni was selected as The *Fellow* of the *Royal Society of Chemistry*



Dr. Chandrashekhar Yadav joined as the *chairperson* of the *Center of Quantum Science and Technology*, IIT Mandi

Honors and Awards: PhD Students

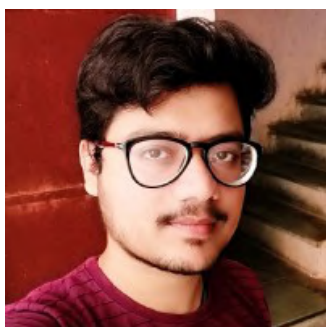


Sunilkumar V., PhD Scholar with Dr. Arko Roy, was selected to attend *Les Houches Predoc School*, France on Ultracold atoms and molecules.

Sunilkumar V. was also awarded the Best Poster award at the National Symposium of Theoretical Sciences held at Thapar Institute of Engineering and Technology.



Sivasankar PM, PhD Scholar with Dr. Arko Roy, was awarded the Best Oral Presentation award at the National Symposium of Theoretical Sciences held at Thapar Institute of Engineering and Technology.



Jaideep Kalani, PhD scholar with Dr. Prabhakar Palni, received the Best Presentation award at the 2nd Hot QCD Matter Conference.



Adesh Singh, PhD scholar with Dr. Gargee Sharma, won the best poster award in the National Physicists Conclave held at SRM University, Chennai.

New Faculty Joinings

- Dr. Ravindra Kumar Yadav joined the School of Physical Sciences on July 1, 2024.

Publications

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- > Simran Nehra, Sumit Kumar, Shikha Shrivastava, Sunil Gangwar, CS Yadav, A Arora, VK Malik, Anjana Dogra, "Artificial tailoring of MI transition at LAO/STO interface with SrSnO_3 buffer layer," *Materials Chemistry and Physics* 311, 128513 (2024)
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- > P Kour, I Ahmed, KK Haldar, CS Yadav, SK Sharma, K Yadav, " BiFeO_3 /g- C_3N_4 /f-CNF ternary nanocomposite as an efficient photocatalyst for methylene blue dye degradation under solar light irradiation," *Journal of Alloys and Compounds* 960, 171073 (2023)
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- > Divya Rawat, Aksa thomas, Ajay Partap Singh Rana, Chandan Bera and Ajay Soni, "Symmetry breaking and structure instability in ultra-thin 2H-TaS2 across charge density wave transition", *Phys Rev B* 109, 155411 (2024)
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- > Ankit Kashyap, Divya Rawat, Debattam Sarkar, Niraj Kumar Singh, Kanishka Biswas and Ajay Soni, "Chemically Transformed Ag_2Te Nanowires on Polyvinylidene Fluoride Membrane For Flexible Thermoelectric Applications," *Angewandte Chemie International Edition*, 202401234 (2024)
- > Collin Rowe, Ankit Kashyap, Geetu Sharma, Naveen Goyal, J. G. Alauzun, Sean T. Barry, N. Ravishankar, Ajay Soni, Per Eklund, Henrik Pedersen, Ganpati Ramanath, "Nanomolecularly-Induced Effects at Titania/Organo-Diphosphonate Interfaces for Stable Hybrid Multilayers with Emergent Properties," *ACS Applied Nano materials* 7, 10, 11225 (2024)
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 - > Divya Rawat, Aditya Singh, Niraj Kumar Singh and Ajay Soni, “Anisotropic Light-Matter Interactions in Single Crystal Topological Insulator Bismuth Selenide,” *Phys Rev B* **197**, 155203 (2023)
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- Kothari, Rahul and Maartens Roy, “A wide-angle formulation of foreground filters for HI intensity mapping”, *JCAP*, **05** (2024) 089
- Rahul Kothari, Mohit Panwar, Gurmeet Singh, Prabhakar Tiwari, Pankaj Jain, “A study of dipolar signal in distant Quasars with various observables”, *EPJC*, **84** (2024) 1, 75

Post-PhD Positions

- Deepu Kumar of Dr. Pradeep Kumar’s group joined Chung-Ang University -South Korea
- Yogesh of Dr. Arti Kashyap’s group joined University of Nebraska, Omaha, USA
- Ankit Kashyap of Dr. Ajay Soni’s group has joined Rensselaer Polytechnic Institute, Troy, NY
- Dr. Dheeraj of Dr. Kaustav Mukherjee’s group joined IISER Thiruvananthapuram
- Dr. Bharath M of Dr. R. Bindu’s group has joined R.V. University, Bangalore as Assistant Professor
- Nishita Hosea, PhD student working with Dr. Hari Varma, has joined as a visiting scientist for a period of 3 months with Prof. Stephan Fritzsche’s research group at Helmholtz institute, Jena, Germany to work on a frontier research problem in the field of AMO sciences

Grant Awards

- Dr. Gargee Sharma received the Core Research Grant from SERB for the project ”Engineering Majorana Fermions in Two-Dimensional Materials for Quantum Computing”.

Outreach Activities

- Dr. Prabhakar Palni participated in the Yuva Sangma Exchange Student Programme in May, 2023 as a faculty mentor. He led a contingent of 50 students from Himachal Pradesh and Ladakh.
- Dr. Kaustav Mukherjee organised a visit of college students from the Department of Physics, Vallabh Govt.
- Dr. Arti Kashyap delivered a lecture in Jawahar Navodaya School, Pandoh, Mandi
- Dr R. Bindu gave a talk under the topic “Talk by Role Model” at Vigyan Jyoti programme at IIT Mandi in September, 2023.
- Dr. Nirmalya Kajuri delivered an online popular science talk at a student-organized event in IISER Berhampur in Sep, 2023.
- SPS co-coordinated a Teacher Training Program in Science for school teachers (co-organized with SCERT, Delhi) in October, 2023.
- SPS coordinated a Teacher Training Program in Physics for school teachers (co-organized with SCERT, Delhi) in November, 2023.
- Dr. Hari Varma delivered an online talk for the Kerala Theoretical Physics Initiative in Dec, 2023
- Dr. Nirmalya Kajuri delivered an online popular science talk at the student-organized event “Storming Aurora,” in BITS Goa.
- Dr. Prabhakar Palni delivered an invited talk on “Jets and Heavy Flavor Production at the EIC” at the International Workshop on Probing Hadron Structure at the EIC, held from 5-9

February 2024, at ICTS, Bangalore.

- › Dr. Prabhakar Palni participated in a two-day CERN outreach activity research workshop from 25-26th April 2024 at IIT Madras.
- › As a member of the core committee of Kerala Theoretical Physics Initiative, Dr. Krishnamohan Parattu organized workshops, lectures and panel discussions.
- › Dr. Arti Kashyap published an article in The Indian Express.
- › Dr. Nirmalya Kajuri published two popular science articles in The Hindu and one article in The Indian Express.

Conferences, Seminars and Workshops

- › National Science Day Program organized by SPS on Feb 28
- › Observable Algebras in Field Theory and Gravity-II, Feb 17-18. Local organizer: Dr. Nirmalya Kajuri
- › Electronic Materials: Preparation, Characterization and Applications Workshop, April 20, 2024. Organizer: Prof. Suman Kalyan Pal
- › 2nd Hot QCD matter Conference, July 1-3, 2024. Local organizers: Dr. Amal Sarkar and Dr. Prabhakar Palni

Achievements of M.Sc and B.Tech Students

- › Aridaman Chauhan (Engineering Physics, 2nd year) and Rishi Mittal (Engineering Physics, 3rd year) were part of the 6-member team which won Inter-IIT Quantum Computing 3rd prize.
- › Aridaman Chauhan (Engineering Physics, 2nd year) was selected as a semester exchange student at LMU, Munich.
- › M.Sc student Akash Shivaji Pawar was ranked 134 in CSIR NET.
- › Former M.Sc student Shyam Adat received a PhD position in University of Oslo, Norway.
- › Former M.Sc student Satyanand Kunwar received a PhD position in University of Massey, New Zealand.
- › Former M.Sc student Liz Helen joined PhD in Aalto University, Finland
- › Engineering Physics B.Tech student Pranav Iyenagar received an offer for M.Sc from Imperial College, London.
- › Engineering Physics B.Tech student Hirwa Kanjariya received an offer for M.Sc from Leiden University, Netherlands.

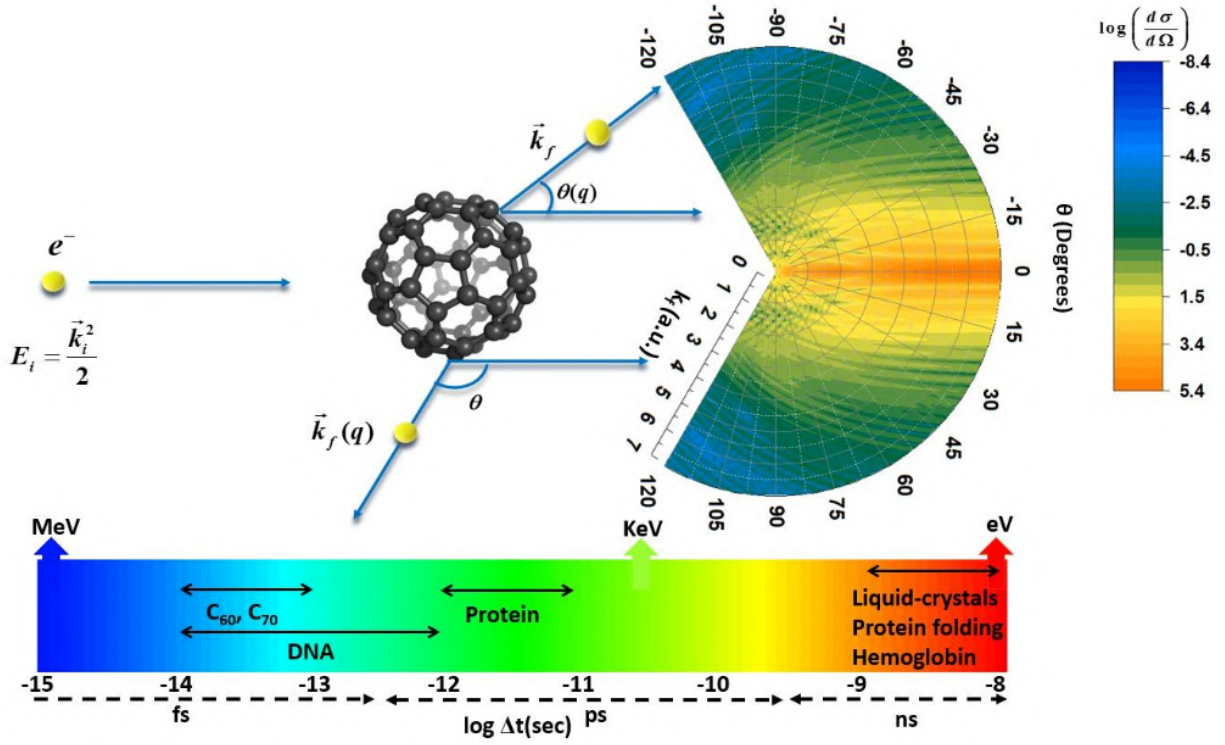
National Science Day Awards

- › Best Talks: Nishita Hosea, Koushik P, Ashish Soni
- › Best Posters: Sivasankar PM, Prakash Pandey, Sandeep Kushawah



A new approach to ultrafast electron diffraction

Dr. Hari Varma



In our recent paper, to appear shortly in Physical Review Letters, we have predicted that the electron-speed controlled imaging of materials in finer resolution opens efficient mode of ultrafast electron diffraction (UED) studies. Our work inspires technology invention to extend UED power.

In electron diffraction, electrons scatter in patterns from the regular arrangement of atoms within a target, and the scattered electrons, when measured with electron beams of fixed energy, are detected on a screen coupled to a charge-coupled device within a wide angle. The analysis of the scattering pattern unravels the target structure. UED on such fixed-energy modes records in real-time the evolution of a target provoked by a laser pulse. The diffraction signal probed by an electron pulse is registered by varying its delay-time from the laser in a controllable manner.

However, the current research reveals an alternative track of accessing electron diffraction by detecting electrons at a fixed scattering angle while tuning the beam energy, or speed. The computation at the Density Functional Theory level simulates scattering from a fullerene molecule. The benefit of the speed-resolved diffraction is the access to finer structural information.

The discovery paves the way for a novel UED approach where the delay of the electron probe is controlled by its speed and can be tuned in nanoseconds to femtoseconds resolutions.

Reference: R. Aiswarya, R. Shaik, J. Jose, H.R. Varma, and H.S. Chakraborty, "Imaging for ultrafast processes in matters by speed-tunable electron scattering," to appear in Phys. Rev. Lett.

Research is Like Driving in the Dark to the Light: Dr. Ajay Soni



Firstly, congratulations! You are now a Fellow of the Royal Society of Chemistry. Can you briefly describe your career trajectory?

Thank you! I did my MSc in physics in 2001 from MLS University, Udaipur, Rajasthan and qualified CSIR-NET in 2002. With a passion towards teaching physics, I started teaching in Govt colleges in Rajasthan on a contractual lectureship. I taught for 3 years (2002 to 2004) and soon, I realized that only teaching was not my primary goal, I wanted a little extra from me and decided to go for higher studies.

I did my PhD from UGC-DAE Consortium for Scientific Research Indore (2004-2009), where I pursued my scientific curiosity for research and developmental work. Completing PhD was not good enough, so I pursued my post-doctoral research at Nanyang Technological University Singapore and National University of Singapore (2009-2013). In 2013, I joined remotely located IIT Mandi as a young faculty member to start my independent academic career.

Coming to your question for recognitions, I feel that the recognitions as a senior member of IEEE (2022) and Fellow of Royal Society of Chemistry, UK (2024) are the results of the work done at IIT Mandi and outcome of the efforts by all my group members.

How did you become interested in your particular area of research?

My interest in experimental condensed matter physics began during my post graduate studies when I first encountered the fascinating properties of materials at the atomic level. A particular moment that stands out was a workshop organized by UGC-DAE CSIR Indore and BARC

Mumbai where I had the opportunity to visit Bhabha atomic research centre in the year 2002. I was keen to work with superconductors and low temperature physics. Witnessing the dramatic effects of temperature on electrical resistance and magnetic properties ignited a profound curiosity about the underlying physical principles of material systems.

However, during the beginning of my PhD (2004), I got fascinated with nanoscience, which had a great potential for new ideas and scope to explore fundamental physics at low temperatures. The mentorship from teachers played a crucial role and helped me see the broader implications of the new area, which made me realize that I wanted to dedicate my research efforts in this direction. I am glad that almost 20 years completed for my research career since I joined for my PhD.

Can you briefly describe your research area?

Sure, this is very simple if I answer in a few words. I wanted to challenge myself to take the fundamental understanding of the materials physics and chemistry to the advanced technological solutions. Nanomaterials have tremendous potential for learning new quantum phenomena and interesting properties which are still unknown and the field is continuously growing.

After joining, I started working on thermometric and optoelectronic materials for harvesting the heat and light for sustainable energy solutions. With a basic theme of experimental condensed matter physics, we are focusing on the fundamental aspects of optical, electrical and thermal properties of the materials for developing functional devices and applied physics understanding of new technologies.

What are the future applications of this area of research?

Research in thermoelectricity, optoelectronics and charge density waves have significant potential for future applications across various fields. Thermoelectric materials can convert waste heat into electricity while the optoelectronic materials can convert light into electricity, which can pro-

vide efficient solutions for development of multifunctional devices that simultaneously generate power and perform electronic functions, all within a single material system.

You are one of the most admired teachers in IIT Mandi. What is the secret of your success as a teacher?

Thank you for the kind words! I am glad and thankful to be known for this. If I am considered one of the most admired teachers at IIT Mandi, I believe that the following reasons have contributed to my success. My genuine enthusiasm for science and teaching is something I try to convey in every discussion be it a lecture or general conversations. When students see that you are passionate about the subject, they are more likely to become interested and engaged. Breaking down difficult concepts into simpler ways using real-world examples helped me to make students grasp the subject more effectively. Because connection to the day to day life is important, which makes the learning process more enjoyable and also helps in developing critical thinking skills.

I aim to mentor my students in their overall personal and professional development, beyond academic learning. I am of the opinion that teaching is not just about exchange of knowledge but also about empowering students and scholars to reach their full potential by working on their core strength.

What would you advise students interested in research?

It is very simple for me, asking curious questions, testing hypotheses and finding out the answers/solutions is the primary foundation of scientific and engineering research. This is also a scientific way of thinking about all the routine life problems and making decisions. Scientific research is often built up on failures and obstacles, but we can keep in mind that innovation is the result of thinking outside the box. Research is like driving a car in the dark, you can't see more than 5 meters ahead but can reach destinations

by adding these 5 meter journeys in a continuous manner. All significant discoveries and breakthroughs have taken a good amount of time and consistent efforts, thus be patient.

For the students interested in research, let me tell them that though scientific research is extremely satisfying and interesting but becoming highly competitive these days, thus they have to stay updated with the latest developments in their areas of interest. They can do this by reading journal articles, scientific news articles, attending seminars, taking relevant courses, engaging in laboratory work, internships and research projects. I would rather insist that they make a habit of reading every day and not be afraid to explore different topics, unconventional ideas/approaches and areas of interest before settling on a specific field. By unconventional, I meant research must have integrity and ethics, inherently.

It is also important to develop strong writing skills for drafting research papers, proposals, reports and importantly learn to communicate, present your research clearly and confidently in a very impactful way. They must choose research topics that genuinely interest and excite them and I am sure that their passionate hard work will drive their motivation and creativity.

If they are unsure about which way to proceed, even at university level, then they can find a right mentor who is experienced in the area of their interest. The guidance by the mentors can help them to navigate their career objectives in the research. They must ensure to have a strong understanding of the fundamental concepts in their chosen field, which will be extremely crucial for tackling hard problems at a later stage.

At last, I encourage students to maintain a healthy balance between research and personal life by taking care of their mental and physical health. They must keep nurturing their hobbies and extracurricular interests side by side. I wish them all the best.

(Interview: Nirmalya Kajuri)



Visual Vignettes

National Science Day Celebrations



Guest of Honor Dr. Ananth Venkatesan receiving a warm welcome



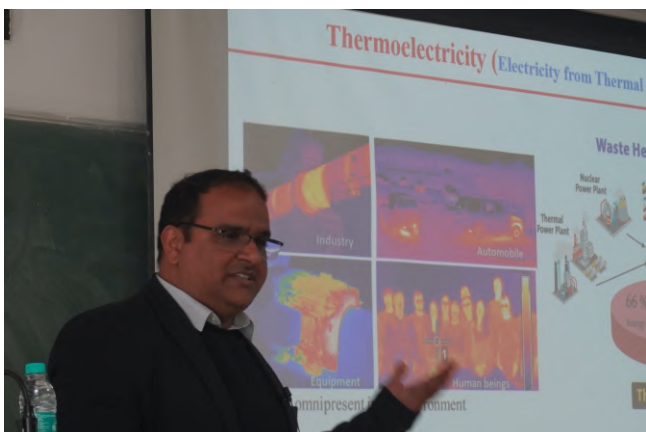
Prof. Suman Kalyan Pal delivering the chairperson's address



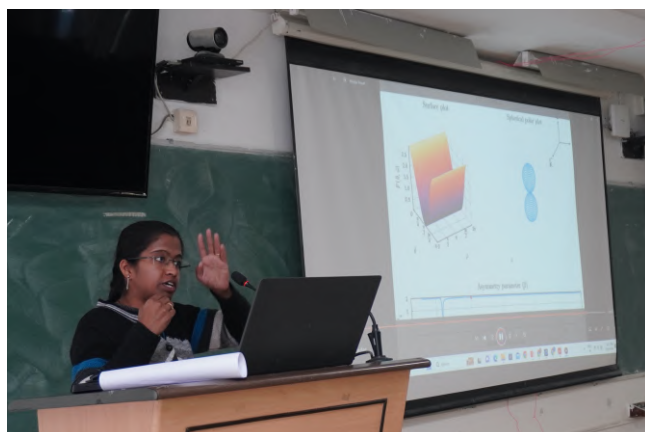
Director Prof. Behera delivering the inaugural speech



Dr. Venkatesan presenting his research on mesoscopic systems



Dr. Ajay presenting a seminar on phonon engineering



PhD scholar Nishita Hosea gave a talk on her research on non-dipole effects on photoionization



M.Sc student Himanshu Tripathi explained Raman Effect in Hindi



M.Sc scholar Gurleen Kaur spoke about her work on experimental particle physics



PhD scholar Himanshu Pant explaining his poster to Dr. Harsh



PhD scholar Sandeep Kushawah receiving a poster award

Observable Algebras in Physics Workshop



Workshop Group Photo

Electronic Materials Workshop



Electronic Materials Workshop in full swing



Organizers and Guests of the Workshop



Prof. Suman Pal and Dr. Kaustav Mukherjee

Hot QCD Conference



Prof. Suman Pal welcoming the delegates



Inauguration by Director Prof. Behera



Prof. Suman Pal with invited speaker Prof. Rajiv Gavai (TIFR)



L-R: Prof. Hiranmay Mishra (NISER), Prof. Rajiv Gavai (TIFR), Director Prof. Behera, Prof. Suman Pal, Dr. Santosh Das (IIT Goa), Dr. Amal Sarkar, Dr. Prabhakar Palni



PhD student Jaideep Kalani receiving Best Presentation award



Conference Group Photo





School of Physical Sciences: Overview

List of Faculty Members

- > Ajay Soni
- > Amal Sarkar
- > Arko Roy
- > Arti Kashyap
- > Bindu Radhamany
- > Chandra Shekhar Yadav
- > Gargee Sharma
- > Harsh Soni
- > Hari Varma
- > Kaustav Mukherjee
- > Krishnamohan Parattu
- > Nirmalya Kajuri
- > Prabhakar Palni
- > Pradeep Kumar
- > Pradyumna Pathak
- > Prasanth P. Jose
- > Rahul Kothari
- > Ravindra Kumar Yadav
- > Suman Kalyan Pal(Chair)

List of Staff Members

- > Aditi Thakur
- > Anugraha Rawat
- > Devesh Sharma
- > Gunjan Kapoor

Areas of Research

- > Atomic, Molecular and Optical Physics
- > Condensed Matter Physics
- > Soft Matter Physics
- > High Energy Physics
- > Astronomy and Cosmology

Programs

- > B.Tech (Engineering Physics)
- > M.Sc (Physics)
- > Integrated PhD
- > Dual Degree(PG+PhD)
- > PhD

Contact Information

Chairperson,
3rd floor, Academic Block A7, IIT Mandi, School of Physical Sciences,
South campus, IIT Mandi, Kamand, Himachal Pradesh 175075, India.

Phone: ☎ +91-1905-267169(Chair), +91-1905-267812(Office)

Email: ✉ chairsp@iitmandi.ac.in (Chair), spsoffice@iitmandi.ac.in (Office)

Website: 🌐 sps.iitmandi.ac.in

Youtube: 📺 @physicsiitmandi

