Report on

Faculty Development Program (FDP)

on

Current trends in Theoretical and Experimental Research in Physics

Organized by

Department of Physics under the aegis of Human Resource Development Centre (HRDC),

Integral University, Lucknow

(29^{th} March -5^{th} May, 2025)

The Department of Physics under the aegis of Human Resource Development Centre (HRDC), Integral University, Lucknow organized a five-day (equivalent to one week - 40 hours) Faculty Development Program (FDP) on "Current Trends in Theoretical and Experimental Research in Physics" between 29^{th} March -5^{th} May, 2025 in hybrid mode. This course aims to refresh and update the current knowledge of teachers and researchers to address the rapidly changing educational needs, and provides a platform for them to delve into the latest developments in physics. The primary goal of the FDP was to disseminate knowledge on recent advancements in both theoretical as well as experimental physics. The sessions covered a wide range of topics, including Astrophysics and Cosmology, General Theory of Relativity, Blackholes, Warmholes, Exotic Matter and Quantum Optics, offering a comprehensive program that included Lectures (02 hours), Interactive Discussions (0.5 hour), Literature Reviews (02 hours), Focused Discussion Forum Modules (0.5 hour), Quizzes (01 hour) and Assignments (02 hours). The course was made mandatory for the faculty members from the Department of Physics, whereas advisable/optional participation was sought from the Departments of Mathematics, and various departments of Faculty of Engineering. Eminent speakers from academia delivered lectures on their respective areas of expertise. There was a mandatory requirement to submit a final assignment and quiz for successful completion of the course. Resource persons were invited from University of Lucknow, Aligarh Muslim University, Jamia Millia Islamia, Aliah University and Pacif Institute of Cosmology and Selfology. The details of each session are as follows:

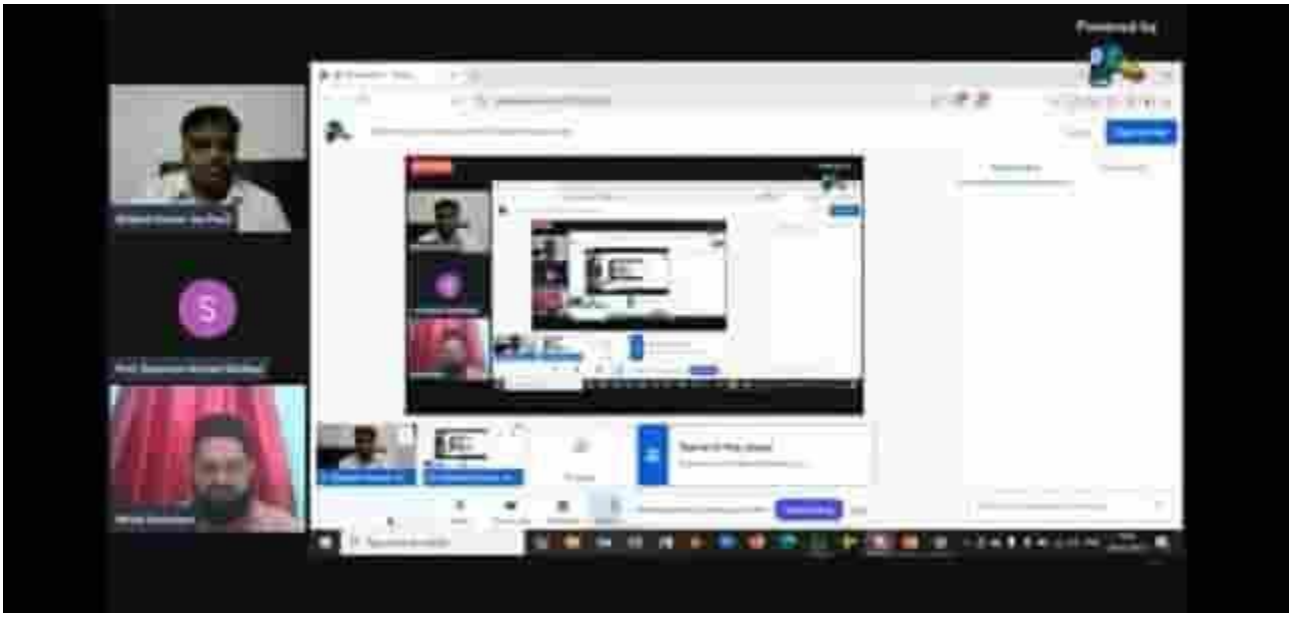
Session I

Date: 29^{th} March 2025

Topic: *Exploring the Universe by diverse perspectives*

The ***first*** session of the course was taken by Prof. Shibesh Kumar Jas Pacif, Pacif Institute of Cosmology and Selfology Sagara, Sambalpur 768224, Odisha, India, at 11:30 AM. In this lecture, Prof. Pacif highlighted the importance of examining the cosmos through multiple lenses-scientific, cultural and philosophical. It emphasized that our understanding of the universe is deepened when we integrate insights from different disciplines and worldviews. By combining advanced astronomical research with cultural narratives and ethical considerations, the lecture encouraged a more holistic and inclusive approach to cosmic exploration. The presentation aimed to inspire curiosity and collaboration, underscoring that the universe is not just a scientific frontier, but a

shared human experience. The session was attended by 7 faculty members and 2 faculty supporting staff of Physics department.



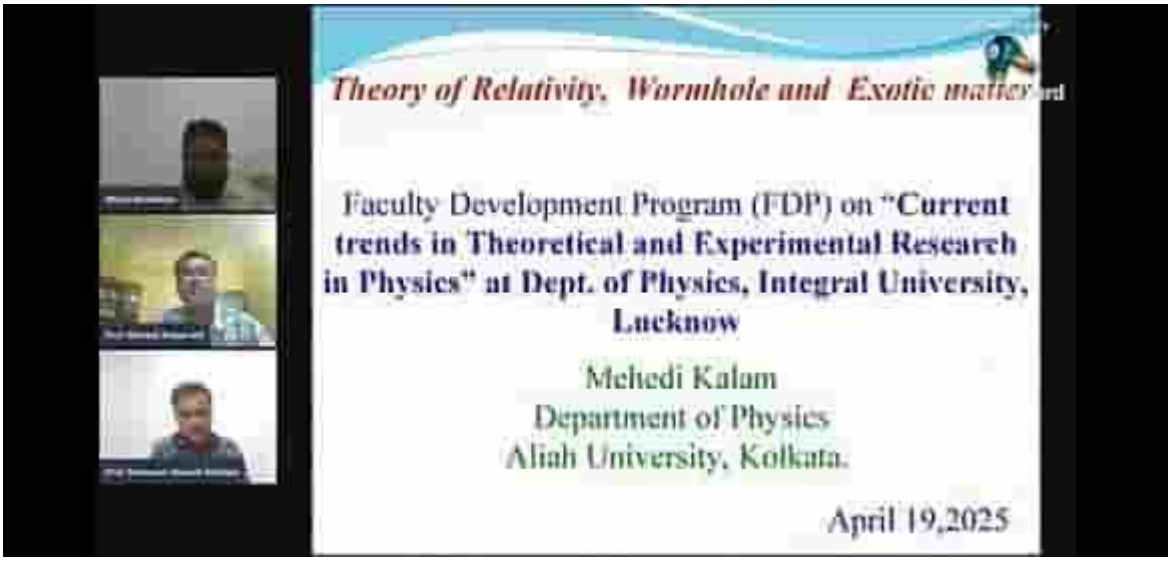
Pic 1: Prof. Shibesh Kumar Jas Pacif Delivering his talk

Session II

Date: 19th April 2025

Topic: Theory of Relativity, Warmhole and Exotic Matter

The **second** session of the course was taken by Prof. Md. Mehedi Kalam, Department of Physics, Aliah University, Kolkata, West Bengal, India at 11:00 AM. In this lecture, Prof. Kalam offered an overview of one of the most fascinating theories in modern physics i.e. General Theory of Relativity. It began with an explanation of Einstein's theory of relativity, detailing both special and general relativity and their implications for space, time, and gravity. Building on this foundation, the speaker introduced the concept of wormholes-theoretical tunnels through spacetime that could potentially allow faster-than-light travel or shortcuts across the universe. The discussion then shifted to exotic matter, a hypothetical form of matter with unusual properties, such as negative energy density, which could be necessary to stabilize wormholes. The lecture bridged theoretical physics with speculative ideas, highlighting ongoing scientific debates and the challenges of proving such phenomena experimentally. Overall, it sparked imagination while grounding ideas in the framework of established physical theory. The session was attended by 7 faculty members and 2 faculty supporting staff of Physics department.



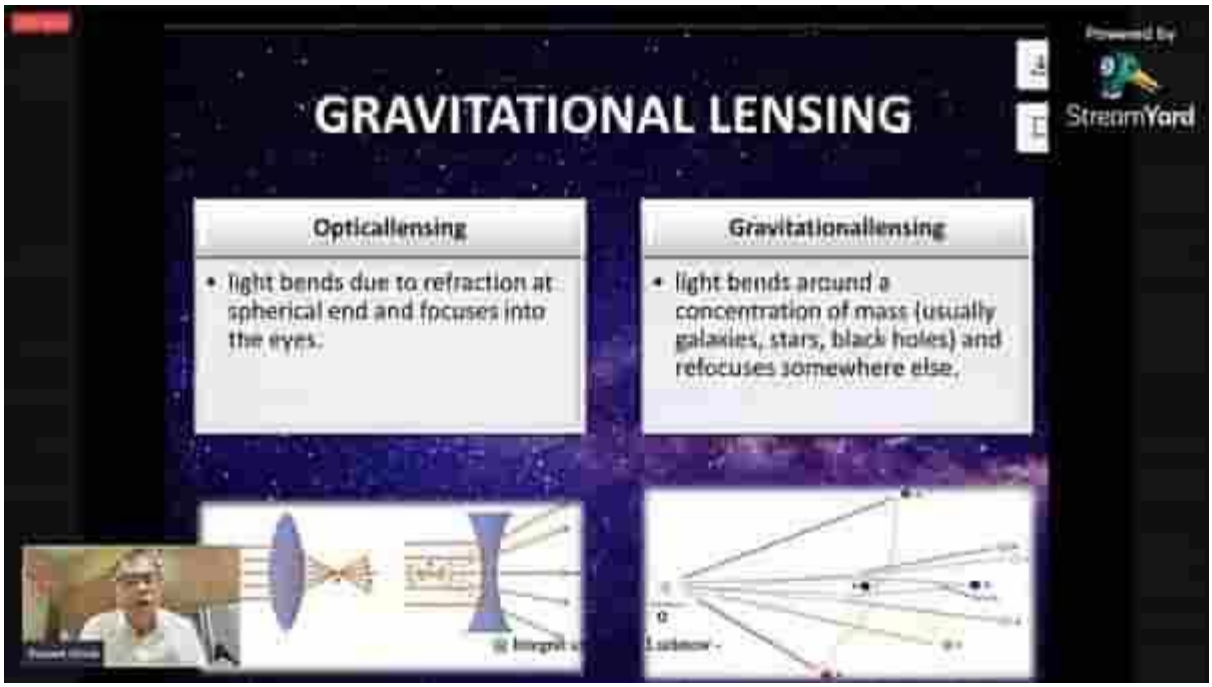
Pic 2: Prof. Md. Mehedi Kalam Delivering his talk

Session III

Date: 24th April 2025

Topic: Seeing the Unseen: Gravitational Lensing by Rotating Black Holes

The ***third*** session of the course was taken by Prof. Sushant G. Ghosh, Professor & Director, Centre for Theoretical Physics, Jamia Millia Islamia, New Delhi, India at 11:00 AM. In this lecture, Prof. Ghosh delved into the physics of gravitational lensing, particularly in the context of rotating (Kerr) black holes. It explained how massive objects like black holes can bend light from distant stars and galaxies due to their intense gravitational fields, effectively acting as cosmic lenses. The speaker focused on how the rotation of black holes adds complexity to this lensing effect, creating distorted, magnified, or even multiple images of background objects. Advanced simulations and observational data, including those from the Event Horizon Telescope, were used to illustrate how scientists are now beginning to see regions of space that were previously hidden. The lecture highlighted how gravitational lensing not only confirms predictions from Einstein's general theory of relativity but also opens new pathways for studying dark matter, distant galaxies, and the structure of spacetime itself. The session was attended by 7 faculty members and 2 faculty supporting staff of Physics department.



Pic 3: Prof. Sushant G. Ghosh Delivering his talk

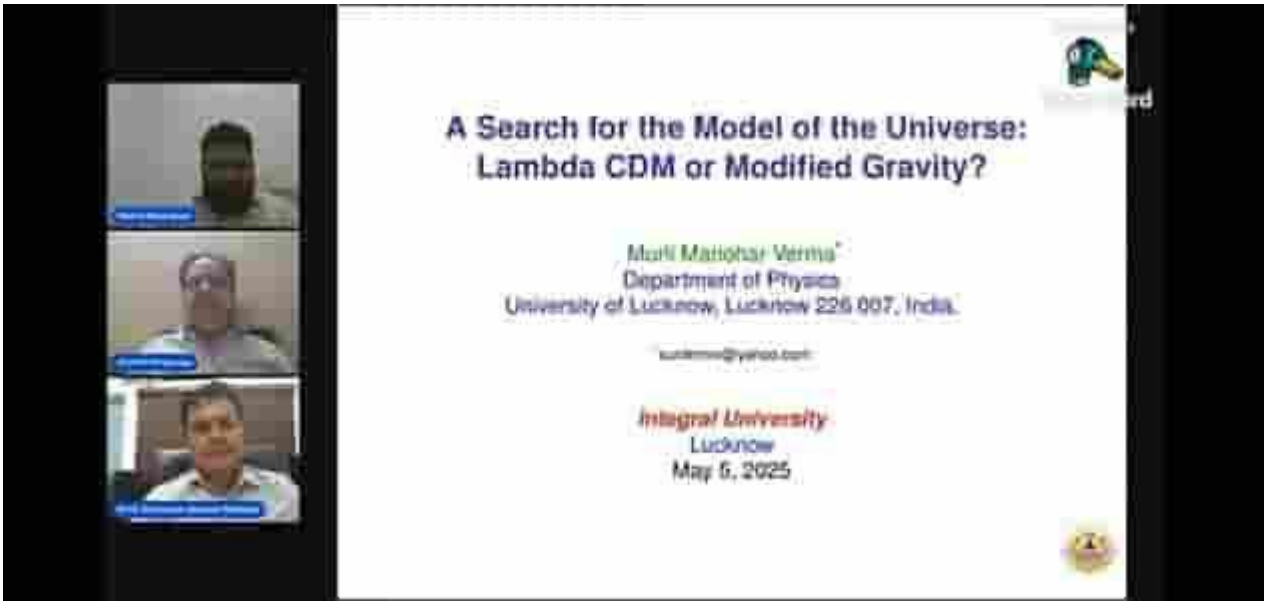
Session IV

Date: 26th April 2025

Topic: What is light? A classical wave or a quantum particle known as a photon.

The ***last*** session of the course was taken by Prof. Murli Manohar Verma, Professor, Department of Physics, University of Lucknow, Lucknow at 11:00 AM. In this lecture, Prof. Verma discussed the large-scale structure and evolution of the universe. It began with an overview of the Lambda-CDM model, the current standard model in cosmology, which combines dark energy (Lambda) and cold dark matter (CDM) with general relativity to successfully describe cosmic expansion, structure formation, and the cosmic microwave background. However, the speaker also highlighted key challenges and observational tensions-such as discrepancies in Hubble constant measurements—that have prompted researchers to explore alternative theories, particularly those involving modified gravity.

The lecture introduced several modified gravity theories including f(R) gravity, explaining how they attempt to account for galactic rotation curves, gravitational lensing, and cosmic acceleration without invoking unseen forms of matter or energy. The talk concluded by emphasizing that ongoing and future astronomical observations, such as those from the James Webb Space Telescope and large-scale galaxy surveys, will be crucial in testing these models and possibly reshaping our understanding of the fundamental laws governing the cosmos. The session was attended by 7 faculty members and 2 faculty supporting staff of Physics department.



Pic 5: Prof. Murli Manohar Verma Delivering his talk

Session	Date	Resource Person	Title
I	29th March 2025	Prof. Shibesh Kumar Jas Pacif Pacif Institute of Cosmology and Selfology, Sagara, Sambalpur 768224, Odisha	Exploring the Universe by diverse perspectives
II	19th April 2025	Prof. Md. Mehedi Kalam Department of Physics, Aliah University, Kolkata, West Bengal	Theory of relativity, warmhole and exotic matter
III	24th April 2025	Prof. Sushant G. Ghosh Professor & Director, Centre for Theoretical Physics, Jamia Millia Islamia, New Delhi	Seeing the Unseen: Gravitational Lensing by Rotating Black Holes
IV	26th April 2025	Dr. Faraz Ahmed Inam Associate Professor, Department of Physics, Aligarh Muslim University, Aligarh	What is light? A classical wave or a quantum particle known as a photon.
V	5th May 2025	Prof. Murli Manohar Verma Professor, Department of Physics, University of Lucknow, Lucknow	A search for the model of the universe: Lambda CDM or Modified gravity?