Review Report

DEPARTMENT OF PHYSICS

January 2014

INDIAN INSTITUTE OF TECHNOLOGY ROPAR

RUPNAGAR, PUNJAB – 140 001

Preamble:

The department of Physics at Indian Institute of Technology (IIT) Ropar was established in 2009 with an ambition to pursue high-level teaching methodologies and research in advanced areas of experimental and theoretical physics, interdisciplinary areas of science & technology. Presently, the department supports B.Tech program of the institute and offers PhD in diverse areas of physical sciences, but are not limited to; flexible nano-structures for renewable energy, ion beam surface modifications, physics of Graphene and nano-devices, low dimensional strongly correlated electron systems, Nonlinear light scattering & interfacial structure of biological relevant interfaces, nuclear reaction dynamics, structure & astrophysics, neutrino physics, mesoscopic physics & opto-mechanics, nano-scale optics & meta-materials, quantum optics, and quantum information & computing.

Our curiosity driven research programs train young scientists to acquire knowledge and mould them as global leaders in science & technology to communicate and engage with the broader society.

The department was started with two faculty members in 2009. Thanks to the physics department of IIT Delhi for the generous guidance and support. In the last four years, the department has seen a significant growth; four faculty members joined the department in 2010, and four more added to the family in 2013. At present, the department has nine faculty members, one postdoc and one project fellow. Faculty members are advising 5 young researchers towards their PhDs.

The department houses a number of state-of-the-art research facilities, such as; Variable Temperature Ultrasonicator, High Temperature Vacuum Furnace, Scanning Probe Microscope, Electrostatic deposition setup for Graphene synthesis, Optical Microscope and wet chemical etching facility for isotropic and anisotropic surface nanostructuring, thus catering to the needs of various ongoing research activities in the department.

Since its establishment, the department has contributed significantly towards teaching and research & development. Research groups have contributed to 17 high ranking international journals and 20 national/international conferences. More than 19 scientists from various research institutes and universities have visited the department for seminars and research discussions. The department has generated financial support of about INR 6 crores through 9 research projects, and have been collaborating actively with various universities and institutes of high academic repute.

Research Groups:

Condensed Matter Physics & Material Science (CMPMS) Group

The scientific activity of the CMPMS group is primarily focused to explore fundamental physics of bulk as well as low dimensional materials, design and development of new frontier materials for next generation applications. We employ advanced techniques to synthesize and probe surface and interface effects in materials, optoelectronic properties of combinatorial thin films, and physics of Graphene and low dimensional systems for nanodevice applications.

Members

Faculties
Dr. Mukesh KUMAR
Dr. Rakesh KUMAR
Dr. Subhendu SARKAR

Research Students
Deepika
Prabhjeet K. DHILLON

Thrust Areas

- Flexible thin films/nano-structures for renewable energy
- Material modifications and machining with the ion beams
- Physics of graphene and nano-devices
- Low dimensional strongly correlated electron systems

Research Facilities

- Variable Temperature Ultrasonicator (2011)
- Scanning Probe Microscopy (2011)
- High Temperature Vacuum Furnaces (2013)
- Optical Microscope (2014)

Recent Research Activities

- Combinatorial amorphous transparent conducting oxide materials
- Wide band gap semiconductor nanostructures
- Mechanical reliability of cathode materials in Li-ion battery
- Nanoscale charge transport in organic solar cell materials
- Band structure calculations of low dimensional systems
- Controlled smooth edge formation of Graphene nanoribbons (theory)
- Synthesis of Graphene using electrostatic deposition
- Development of chemical vapor deposition system
- Nanostructuring alloy surfaces using ion beams
- Early stage wet etching of silicon surfaces
- Topographical length scale studies of hierarchical surfaces
- Cell proliferation studies on rough surfaces

Future Research Programs

- Combinatorial development of thin film materials
- Flexible transparent electrodes
- Unconventional gas sensor devices
- Electrochemical-mechanical stress study of cathode materials in Li ion batteries
- Growth and device application of III-nitride nanostructures
- Electron beam lithography for fabrication of nanodevices
- Fabrication of biosensors, Hazardous gas sensors
- Strongly correlated electron behaviours in layered superconductors

- Synthesis of smooth edged Graphene nanoribbons
- Morphology driven self assembly studies of micro and nanoparticles
- Linear and non-linear phenomena during ion bombardment of stoichiometrically different alloy structures
- Cell growth on chemically patterned surfaces

Collaborations

- PGIMER, Chandigarh, India
- University of Durham, UK
- IMEC, Leuven, Belgium
- NCPV- NREL USA

Light-Matter Interactions & Quantum Information (LMIQI) Group

The focal theme of Light-Matter Interactions and Quantum Information (LMIQI) group is to understand and harness the intriguing phenomena, exhibited and generated by photons in various forms of matter. Our interest lies in the theoretical and experimental studies of classical & quantum manipulation of light-matter interactions, and also in its applications to quantum information.

Members:

Faculties
Dr. (Mrs.) Asoka BISWAS
Dr. Shubhrangshu DASGUPTA
Dr. Kailash C. JENA
Dr. Rajesh V. NAIR

Research Students
Anil KUMAR
Pradeep KUMAR
Davinder SINGH

Thrust Areas

- Decoherence in quantum systems
- Quantum information in many-body system
- Implementation of quantum computation in physical systems
- Coherent control in atoms and molecules
- Energy transfer in bacterial photosynthesis
- Nonlinear light scattering
- Interfacial water structure
- Protein folding
- Soft matter interfaces
- Lipid mimicking model systems
- Photonic crystals
- Disordered nanostructures
- Nano-lasers, Metal-dielectric nanostructures
- Micro/nano cavities

Recent Research Activities

- Control of decoherence in spin-boson systems
- Detection, measurement and dynamics of entanglement in many-body system
- Controlled generation of entangled photons from quantum dots
- Coherent control of group velocity in alkali atoms
- Role of ions on the water structure at charged solid surface
- Nanodroplet templating
- Interfacial Water Ordering and Head Group Hydration: the Effect of Charge
- Structure and charge of the hydrophobic/water interface
- Photon scattering and emission studies using nanophotonic structures
- Mesoscopic phenomena exhibited by photons in nanostructures

Future Research Programs

- Measurement of displacement of nano-size mechanical oscillators and squeezing
- Quantum phase transition in many-body systems
- Quantum computing using superconducting qubits
- Control of non-radiative decay in nanocrystal quantum dots
- Weak measurement and its relation to classical interference
- Development of nonlinear light scattering lab,
- Formation and characterization of model membrane systems at soft matter interfaces
- Nano based lipid mimicking model for biotechnology and nanobiotechnology for investigating various intercellular processes
- Engineering the photon density of states
- Disorder induced effects in nanophotonic structures
- Light manipulation using optical cavities
- Hyperbolic meta-materials

Collaborations

- University of Toronto, Canada
- Laboratory for fundamental BioPhotonics, EPFL, Switzerland
- Biophysical Chemistry and Spectroscopy Group, University of Victoria, Canada
- IIT Madras
- IIT Patna
- BARC, Mumbai
- TIFR, Mumbai
- IIT Hyderabad
- Complex Photonic Systems, University of Twente, The Netherlands

Nuclear and Particle Physics Group (NuPPhyG)

The mission of the **Nu**clear and **P**article **Phy**sics **G**roup (NuPPhyG) is to discover, explore, and understand various aspects of neutrinos – the weakly interacting fundamental particles most abundant in the universe next to photons, and nuclear reaction dynamics, structure &

astrophysics. This requires a broad approach to different, but related, scientific frontiers: improving our understanding of the building blocks of matter; discovering the origins of nuclei; and identifying the forces that transform matter.

Members:

Faculties
Prof. P. K. RAINA
Dr. Pushpendra P. SINGH

Postdoc:
Surja K. GHORUI

Research Students
Aru BERI

Thrust Areas

- Nuclear structure theory
- Double beta (ββ) – decay simulations and Nuclear Matrix elements (NMEs) calculations
- Multi-nucleon transfer (MNT) reactions
- Low energy incomplete fusion (ICF)
- Fusion hindrance at extreme sub-barrier energies
- Nuclear structure via Coulex, MNT and ICF reactions

Recent Research Activities

- Neutrinoless ββ-decay transition matrix elements
- Uncertainties in nuclear transition matrix elements for $\beta^+\beta^+$ and $\varepsilon\beta^+$ modes of neutrinoless ββ-decay
- Rotational bands and electromagnetic transitions of some Neodymium nuclei in-projected Hartree-Fock model
- A/Z resolution capability and transmission of Lund-York-Cologne-Calorimeter (LYCCA)
- Onset and influence of low energy incomplete fusion
- Fusion hindrance for positive q-value systems
- Collective nature of low-lying excitations in ^{70,72,74}Zn and structure of ^{35}S

Future Research Programs

- Simulation, NTME Calculation and half life measurement for Double Beta Decay of Sn nuclei
- Computation Nuclear Transition Matrix Elements calculation for neutrinoless double beta decay within framework of different Models
- Development of a state-of-art E-ΔE Detector Array to detect and identify different charged particles in heavy-ion interactions in collaboration with GSI, Germany
- Understanding the transition from dissipation to total kinetic energy loss (TKEL) in nuclear reactions, in IUAC Collaboration
- Setting up a Nuclear Physics Instrumentation Laboratory to deliver hands-on-experience of measurement and detection techniques to the students

- A position sensitive Ge-detector scanning system to characterize HPGe detectors of INGA, and for the precise location profiling for medical applications (DAE-BRNS)

Collaborations

- TIFR, IIT KGP, BARC, SINP, VECC, IOP, PRL, RRI, Univ. of Lucknow for INO
- INFN- Universita II, Tor Vergata, Italy
- IUAC, New Delhi
- R3B, LYCCA, AGATA, PreSPEC, HISPEC, DESPEC for NuSTAR within FAIR, Germany
- MINOS, France

Planned Central Facilities: Please see Annexure - I

Details of the Courses and Teaching Activities:

UG courses

PHP100 | Physics Laboratory (0-0-4) | 2
PHL101 | Electromagnetics (3-1-0) | 4
PHL102 | Quantum Physics (3-1-0) | 4
PHL103 | Classical Mechanics (3-1-0) | 4
PHL104 | Optics and Lasers (3-1-0) | 4
PHL201 | Thermal and Statistical Physics (3-1-0) | 4
PHL202 | Physics of Materials (3-1-0) | 4

Teaching contribution to other departments

EEP 204 | Analog Electronics (Dr. Rakesh Kumar, since AY 2010-11)
EEL 324 | Physical Electronics (Dr. Rakesh Kumar, since AY 2010-11)
CSL 304 | Numerical & Scientific Computing (Dr. S. Dasgupta, 2012-13, 2nd sem.)

PG courses

PHL601 | Mathematical Physics (3-0-0) | 3
PHL602 | Numerical Techniques for Engineers and Scientists (3-0-2) | 4
PHL603 | Advanced Experimental Techniques (3-0-0) | 3
PHL604 | Magnetic Materials, Characterizations and their Applications (3-0-0) | 3
PHL605 | Fundamentals of Interactions of Light with Matter (3-0-0) | 3
PHL606 | Fundamentals of Nanoelectronics (3-0-0) | 3
PHL607 | Scattering Phenomenon (3-0-0) | 3
PHL608 | Surface Analytical Techniques (3-0-0) | 3

Physics Courses opted by B. Tech Students:

YEAR 2009-2010:		No. of Students
Sem I:	Physics Lab PHP 100	55
	Electrodynamics PHL101	36
	Classical Mechanics PHL 103	77
Sem II:	Optics and Lasers PHL104	45
	Material Science Laboratory GEL102	92
	Numerical Techniques PHL602	01
	Physics Lab PHP 100	52

YEAR 2010-2011:		
Sem I:	Physics Lab. PHP 100	59
	Advanced experimental techniques PHL 311	39
	Material Science Laboratory GEL102	120
	Advanced experimental methods PHL 603	04
	Numerical Techniques PHL602	09
	Prep. Physics	04
	Prep. Physics Lab.	04
Sem II:	Physics Lab. PHP 100	59
	Scattering phenomenon PHL 701	02
	Quantum Mechanics PHL 102	11
	Classical Mechanics PHL 103	38
	Analog Electronics EEP 204	37
	Prep. Physics	04
	Prep. Physics Lab.	04

YEAR 2011-2012:		
Sem I:	Physics Lab. PHP 100	56
	Electrodynamics PHL101	43
	Quantum Mechanics PHL 102	77
	Advanced experimental techniques PHL 311	39
	Physical Electronics EEL 324	37
	Numerical Techniques PHL602	07
	Prep. Physics	02
	Prep Physics Lab.	02
Sem II:	Physics Lab. PHP 100	54
	Classical Mechanics PHL 103	80
	Quantum Mechanics PHL102	29
	Analog Electronics EEP 204	40
	Magnetic Materials PHL 604	01
	Prep Physics	02
	Prep Physics Lab	02

YEAR 2012-2013:

Sem I:	Physics Lab PHP 100	57
	Electrodynamics PHL 101	46
	Advanced experimental techniques PHL 311	26
	Quantum Physics PHL 102	80
	Physical Electronics EEL 324	32
	Numerical Techniques PHL602	05
Sem II:	Physics lab. PHP 100	60
	Classical Mechanics PHL 103	40
	Analog Electronics EEP 204	32
	Fundamentals of Nano Electronics PHL 606	01
	Interaction of light with matter PHL 605	01
	Numerical and Scientific Computing CSL304	42

YEAR 2013-2014:

Sem I:	Physics Lab. PHP 100	60
	Electrodynamics PHL101	44
	Advanced experimental techniques PHL 701	01
	Quantum Physics PHL 102	80
	Physical Electronics EEL 324	31
	Analog Electronics EEP 204	35
	Numerical Techniques PHL602	05
Sem II:	Physics laboratory PHP100	60
	Classical Mechanics PHL 103	50
	Numerical Techniques PHL602	03

Proposed Academic Programs:

In order to enhance the department's contribution in both research and teaching, the department has identified future thrust areas of research and initiated activities to set up research laboratories at the transit campus. The research facilities are planned for smooth transition from present to the upcoming campus. Further, the department aims to start a B. Tech. in Engineering Physics, an integrated BS-MS program in near future, and an MSc-MS-PhD program as its first priority. The corresponding curricula are already realized. The UG Physics courses for the first year B.Tech students are revised and are subjected to the approval from curriculum revision committee.

Curricula for B. Tech Physics-I and Physics-II: Please see Annexure – II

Laboratories:

UG Labs

- General Physics Laboratory
- Optics Laboratory

PG Labs

- Surface treatment lab
- Graphene synthesis lab

Technical and Office Staff:

Mr. Naveen Mahajan (Jr. Assistant)
Mr. Satish Kumar (Jr. Laboratory Attendant)
Mr. Shiv Sankar Kumar (Jr. Laboratory Attendant)
Mr. Hasimranjeet (Jr. Technician Superintendent)

Invited Talks/Seminars:

1. **P. K. Raina,** Inside the Nucleus : Some Fundamental Scientific Discoveries to probe Micro and Macro Cosmos The Physics and Mathematics of Universe from 11-12 March 2013 at the Gurukula Kangri Vishwavidyalaya, Haridwar

2. **P. K. Raina,** Review of NDBD Activity : Prototype development of cryogenic bolometer for Neutrinoless Double beta decay INO meet VECC Kolkata, July 13 2011

3. **P. K. Raina,** Simulation aspects of double beta decay (DBD/NDBD) INO meet, Madurai INO center Jan 23-25, 2011

4. **S. Sarkar,** International Conference on Nanostructuring by Ion Beams, October 23-25, 2013, Jaipur, India

5. **A. Biswas,** Quantum-Nano Winter School QANSAS 2013, Nov 28-Dec 1, 2013

6. **S. Dasgupta,** Highly efficient quantum-dot biexciton control for entangled photon generation, 3rd DAE-BRNS Biennial Symposium on Atomic, Molecular, and Optical Physics, held at Indian Institute of Science Education and Research (IISER), Kolkata, 14-17 December, 2012

7. **Rakesh Kumar,** "Present and future with Nanoscience and Nanotechnology Science Congress, 15th November 2010, Navodaya Vidyalaya, Sandhuan, Ropar

8. **Rakesh Kumar,** "Graphene – next generation material"
Science Congress, 23rd November 2011, Navodaya Vidyalaya, Sandhuan, Ropar

9. **Rakesh Kumar,** "Graphene Physics for nanodevcies"
National Conference on Recent Advances in Condensed Matter Physics" 2nd June 2013, NIT Hamirpur, Himachal Pradesh

Awards, Honours, Recognitions:

1. **Ms. Deepika,** T.J. Dhilip Kumar, **Rakesh Kumar** have received **The Best Research Paper Award** at International E-Workshop on Computational Condensed Matter Physics and Materials Science (IWCCMP-2013), IIITM Gwalior, 27th-29th November, 2013

R & D Projects:

1. Investigation of pattern formation in binary alloy systems, 39 lakhs, DST, GOI Duration 2013-16, PI: Dr. S. Sarkar, Co-Investigator: Dr. S. Dasgupta

2. Scaling and related studies on chemically eroded surfaces, 16 lakhs, CSIR, GOI Duration 2013-16, PI: Dr. S. Sarkar

3. Energy and coherence dynamics in photo-synthetic bacteria, INR 13.62 lakhs, DST-SERB, 2013-16 (three years), PI: Dr. Shubhrangshu Dasgupta

4. Feasibility Study of Bolometric Neutrinoless Double Beta Decay Experiment, duration 2013-16, 20 lakh, PI: P. K. Raina, IIT Kharagpur, Co-PI: R. G. Pillay, TIFR Mumbai, P. K. Rath, University of Lucknow, Lucknow and V. M. Datar, BARC Mumbai, Co-I: Vandana Nanal TIFR Mumbai, A. K. Singh, IIT Kharagpur and Aradhana Shrivastava, BARC Mumbai

5. Simulation, NTME Calculation and half-life measurement for Double Beta Decay of Sn nuclei, Sponsored by: DST, GOI and Italian Ministry of Foreign Affairs (MAE), PI from Italy : Dr. Rita Bernabei, Professor, RomaII and INFN, PI from India : Dr. P.K.Raina, Professor, IIT Ropar, Duration: 2012-2015

6. Computation Nuclear Transition Matrix Elements calculation for neutrinoless double beta decay within Deformed Hartree-Fock Model, Sponsored by: CSIR, GOI, Duration: 2012-2015, Rs. 20 lacs, Initiated By DBD National Project group members on search for neutrinoless Double beta decay (DAE for Rs. 4 crores), (TIFR, IIT Kharagpur, Univ. of Lucknow, BARC, SINP, VECC, IOP, PRL)

7. Detection of entanglement in many-spin systems by spin-spin correlations, Funded by DST (Fast Track Scheme), 11.64 lakhs, Duration 2010-2013, PI: Dr. (Mrs.) Asoka Biswas

8. Measurement of small displacement of a nanomechanical resonator: Towards quantum microscopy, Rs. 3.1 lakh, Duration 2010-13, PI: Dr. (Mrs.) Asoka Biswas

9. Quantum control of nonradiative transitions in nanocrystal quantum dots towards an event-ready source of entangled photons, Duration 2009-12, Rs. 5 lakhs, PI: Dr. S. Dasgupta

Publications:

International Refereed Journals

Year 2014

1. High-spin level structure of ^{35}S, S. Aydin, with Pushpendra P. Singh *et al.*, **Phys. Rev. C 89, 014310 (2014)**

2. Influence of 1*n* excess projectile on low energy incomplete fusion, Vijay R. Sharma, Abhishek Yadav, Pushpendra P. Singh *et al.*, **Phys. Rev. C (2014) in Press**

3. Low energy incomplete fusion in ^{16}O+^{130}Te system below 6MeV/nucleon, D.P. Singh, with Pushpendra P. Singh *et al.*, **Phys. Rev. C (2014) in Press**

4. Throwing Salt into the Mix: Altering the Ordering of Interfacial Water by Electrolyte Addition, Paul A. Covert, Kailash C. Jena and Dennis K. Hore, **J. Phys. Chem. Lett., 5, (2014) 143-148.**

Year 2013

1. Neutrinoless ββ decay transition matrix elements within mechanisms involving light Majorana neutrinos, classical Majorons and sterile neutrinos. P. K. Rath, R. Chandra, K. Chaturvedi, P. Lohani, P. K. Raina and J. G. Hirsch, **Phys. Rev. C 88, 064322 (2013)**

2. Uncertainties in nuclear transition matrix elements for $\beta^+\beta^+$ and $\varepsilon\beta^+$ modes of neutrinoless double-β decay within projected Hartree-Fock-Bogoliubov model, P. K. Rath, R. Chandra, K. Chaturvedi, P. Lohani, P. K. Raina and J. G. Hirsch, **Phys. Rev. C87, 014301 (2013)**

3. Non-monotonic roughening at early stages of isotropic silicon etching, P. K. Dhillon and S. Sarkar, **Appl. Surf. Sci., 284, 569-574 (2013)**

4. Highly efficient biexciton preparation for quantum-dot entangled photon generation, Bensky, G., Nair, S. V., Ruda, H. E., Dasgupta, S., Kurizki, G., Brumer, P., **J. Phys. B: At. Mol. Opt. Phys. 46, 055503 (2013)**

Year 2012

1. Rotational bands and electromagnetic transitions of some Neodymium nuclei in-projected Hartree-Fock model S. K. Ghorui, P. K. Raina, P. K. Rath, A. K. Singh, Z. Naik, S. K. Patra, and C. R. Praharaj **Int. J. Mod. Phys. E 21, 1250070 (2012)**

2. Uncertainties in nuclear transition matrix elements for neutrinoless double beta decay: The heavy Majorana neutrino mass mechanism P. K. Rath, R. Chandra, K. Chaturvedi, P. K. Raina and J. G. Hirsch, **Phys. Rev. C 85, 014398 (2012)**

3. Alain Moussa and Wilfried Vandervorst, Si nanoripples: A growth dynamical study, Prabhjeet Kaur Dhillon, Subhendu Sarkar, Alexis Franquet, **Appl. Surf. Sci., 258, 9579 (2012)**

4. Generic Construction of Kraus Operators: d-level Systems in a Thermal Bosonic Bath, Biswas, A., and Brumer, P., **Israel J. Chem. 52, 461 (2012)**

Year 2011

1. Chemical effects during ripple formation using isobaric ion beams, Subhendu Sarkar, Alexis Franquet, Alain Moussa and Wilfried Vandervorst, **Appl. Surf. Sci., 257, 6424 (2011)**

Year 2010

1. Uncertainties in nuclear transition matrix elements for neutrinoless ββ decay within projected-Hartree-Fock-Bogoliubov model, P. K. Rath, R. Chanra, K. Chaturvedi, P. K. Raina and J. G. Hirch, **Phys. Rev. C82, 064310 (2010)**

2. Qudrupolar correlations and deformation effect on two neutrino $\beta\beta^+$ and β^+EC modes of 156Dy isotope, P. K. Rath, R. Chandra, S. Singh, P. K. Raina and J. G. Hirsch, **J. Phys. G, 37, 055108 (2010)**

3. Overlapping resonances in the resistance of superposition states to decoherence, Asoka Biswas, M. Shapiro, and P. Brumer, **J. Chem. Phys.133, 014103 (2010)**

4. Anodic bonded grapheme, Adrian Balan, Rakesh Kumar, Mohamed Boukhicha, Olivier Beyssac, Jean-Calude Bouillard, Dario Taverna, William Sacks, Massimiliano Marangolo, Emanuelle Lacazze, Walter Escoffier, Jean-Marie Poumirol, and Abhay Shukla, **J. Phys. D: Applied Physics 43, 374013 (2010)**

National/International Conferences

1. Energy controlled edge formation for Graphene nanoribbons, Deepika, T.J. Dhilip Kumar, and Rakesh Kumar, **AIP Conf. Proc. (accepted) (2014)**

2. Manipulating Light Propagation and Emission Using Photonic Crystals, Rajesh V Nair and B. N. Jagatap, **AIP Conf. Proce. (Accepted) (2014)**

3. Understanding the onset and strength of incomplete fusion, Pushpendra P. Singh *et al.*, **Journal of Physics: conference series, Invited talk contribution (in Press) (2014)**

4. Dual erosion phases in HNA etched Si surfaces, P. K. Dhillon and S. Sarkar, **AIP Conference Proceedings, 1536, 361 (2013)**

5. Electronic properties of anodic bonded Graphene, Deepika, Adrian Balan, Abhay Shukla, Escoffier Walter, and Rakesh Kumar, **AIP Conf. Proc. 1512 308 (2013)**

6. Dual growth modes in ion bombarded Si surfaces, P. K. Dhillon and S. Sarkar, **AIP Conference Proceedings, 1447, 757 (2012)**

7. Study of neutrinoless positron double beta decay including induced currents in the nuclear structure calculation within PHFB model, K. Chaturvedi, R. Chandra, P. K. Rath, P. K. Raina, **DAE-BRNS Symp. on Nucl. Phys. 57, 194 (2012)**

8. Low-lying deformed rotational bands in N = 50 Ge nucleus, S. K. Ghorui, S. K. Patra, C. R. Praharaj, P. K. Raina, P. K. Rath, **DAE-BRNS Symp. on Nucl. Phys. 57, 362 (2012)**

9. Large scale shell model calculation for 120–130Sn, Soumik Das, Somnath Nag, P. K. Raina, P. K. Rath, Proce. of **DAE-BRNS Symp. on Nucl. Phys. 57, 356 (2012)**

10. Dual growth modes in ion bombarded Si surfaces, Prabhjeet Kaur Dhillon and Subhendu Sarkar, **56th DAE Solid State Physics Symposium, December 19-23, (2011)**

11. Scaling studies on low energy ion bombarded Si surfaces, Prabhjeet Kaur Dhillon and Subhendu Sarkar, **MICROSTRUCTURE-2011,** IIT Roorkee, **November 4-5, (2011)**

12. Role of short range correlations on nuclear matrix elements of neutrinoless double beta decay, R. Chandra, K. Chaturvedi, P. K. Rath, and P. K. Raina, **AIP Conf. Proc. 1405, 340 (2011)**

13. Two-neutrino Double Beta Decay of 76Ge and 82Se within Deformed Hartree-Fock Model S. K. Ghorui, P. K. Raina, A. K. Singh, C. R. Praharaj, P. K. Rath, **DAE Symp. on Nucl. Phys. (2011)**

14. Spectroscopic study of Double Beta Decay Nuclei within Deformed Hartree-Fock Model S. K. Ghorui, P. K. Raina, A. K. Singh, P. K. Rath, C. R. Praharaj, **DAE Symp. on Nucl. Phys. (2011)**

15. K-isomeric Bands of highly deformed neutron-rich Neodymium Nuclei in PHF Model S. K. Ghorui, Z. Naik, S. K. Patra, A. K. Singh, P. K. Raina, P. K. Rath, C. R. Praharaj, **DAE Symp. on Nucl. Phys. (2011)**

16. Double Beta Decay Study of Tin Isotopes Soumik Das, S. K. Ghorui, A. K. Singh, P. K. Rath and P. K. Raina, **DAE Symposium on Nuclear Physics 2011**

17. Data analysis for double beta decay processes in natural tin Akhilesh Ranjan, Soumik Das, S. K. Ghorui, Ramesh Chandra, A. K. Singh, P. K. Rath and P. K. Raina, 7th International Workshop on **Neutrino-Nucleus Interactions in Few-GeV Region (NuInt11), Dehradun, India, March 7-11 (2011)**

18. Simulation and Sensitivity Study of Double Beta Decay of ^{136}Ce using $CeCl_3$ Scintillator, S. K. Ghorui, F. Cappella, R.Cerulli, A. K. Singh, P. K. Rath and P. K. Raina, 7th International **Workshop on Neutrino-Nucleus Interactions in Few-GeV Region (NuInt11), Dehradun, India, March 7-11 (2011)**

19. Role of short range correlation on nuclear transition matrix elements of neutrinoless positron double beta decay R. Chandra, K. Chaturvedi, P. K. Rath and P. K. Raina, 7th International **Workshop on Neutrino-Nucleus Interactions in Few-GeV Region (NuInt11), Dehradun, India, March 7-11 (2011)**

20. Uncertainties in nuclear transition matrix elements of neutrinoless positron double beta decay within PHFB model R. Chandra, K. Chaturvedi, P. K. Raina and P. K. Rath, **DAE Symposium on Nuclear Physics 55, 34, (2010)**

Books/Book Chapters:

1. S. Sarkar, Low energy ion induced pattern formation in Si-Ge alloy in *Nanofabrication by Ion-Beam Sputtering - Fundamentals and Applications* edited by T. Som and D. Kanjilal, Pan Stanford Publishing, Singapore (2012), ISBN-10: 9814303755, ISBN-13: 978-9814303750.

Visitors to the Department of Physics:

1. **Dr. Narendra Sahu**, Université Libre de Bruxelles, Brussels, Belgium, " Direct and Indirect Search of Dark Matter Interacting via Higgs Portal", on January 31, 2011

2. **Dr. Subhadeep De,** Joint Quantum institute, National Institute of Standard and Technology & University of Maryland, College Park, USA, "Facility to produce ultra cold degenerate Bose and Fermi gases", on August 9, 2011

3. **Dr. Ranber Singh,** Max Planck Institute, Stuttgart, Germany, "Semiconductor quantum dot as a source of on demand single photons and entangled photon pairs", on August 10, 2011

4. **Dr. Amandeep Sood**,University of Nantes, France, "Isospin effects in heavy-ion collisions" on August 30, 2011

5. **Dr. Siba Prasad Das,** Department of Physics, Visva-Bharati University, Shantiniketan, India, " Signature of Neutrinos and Higgses at Large Hadron Collider", on June 8, 2012

6. **Dr. Md. Manirul Ali,** Research Center for Applied Sciences, Academia Sinica, Taiwan, "Quantum-Bit Engineering and some Novel Quantum Phenomena" on August 3, 2012

7. **Dr. Amitava Moitra,** Department of Chemical Engineering, The Pennsylvania State University, "Magnesium Alloy Design: A Perspective on Multi-scale Modelling" on August 30, 2012

8. **Dr. Harsha Raichur,** Raman Research Institute, Bangalore, "What can we Learn from Neutron Star X-Ray Binaries?" on October 30, 2012

9. **Dr. Amar Nath Gupta,** NINT, University of Alberta, Edmonton, "Direct Observation of Protein Folding/Misfolding using Single-Molecule Force Spectroscopy" on November 16, 2012

10. **Dr. Kartick Tarafder,** Materials Science Division, Lawrence Berkeley National Laboratory, California, USA, "Theoretical Investigation of metal organic interfaces: An approach from first principles" on January 4, 2013

11. **Dr. Vidhu S. Tiwari,** School of Electrical Engineering & Computer Science, University of Ottawa, Canada, "Hollow core photonic crystal fiber based surface enhanced Raman scattering (SERS) bio-sensors" on January 11, 2013

12. **Dr. Pintu Das,** Institute of Physics, J. W. Goethe University, Germany, "Magnetization dynamics in nano/micro-structures using micro-Hallmagnetometry" on January 18, 2013

13. **Dr. Sudhir Kumar Sharma,** Centre for Nano-Science and Engineering, Indian Institute of Science, Bangalore, "Implementation of NiTi Shape Memory Materials for Micro-device Applications" on February 21, 2013

14. **Dr. Swastik Mondal,** University of Bayreuth, Germany, "Unraveling mysteries of boron-rich solids through electron-density analysis" on March 1, 2013

15. **Dr. Pushpendra Kumar,** National Institute of Technology Delhi, "Mesoporous Silicon Formation and its use as Template for Organic and Inorganic Materials" on March 22, 2013

16. **Dr. Kanan Kumar Datta,** Astronomy Dept., Stockholm University, "Shedding light on the universe's first sources of light through radio observations of neutral hydrogen" on April 05, 2013

17. **Dr. Kailash Chandra Jena,** Laboratory for Fundamental Biophotonics, Institute of Bioengineering, Switzerland, "Nonlinear light scattering spectroscopy and its relevance for probing the biological molecules at hidden soft matter and planar interfaces" on April 5, 2013

18. **Dr. Dinesh Kumar Shukla,** PETRA III, Deutsches Elektronen-Synchrotron (DESY), Germany, "Resonant and non-resonant x-ray scattering studies on the rare earth iron borate multiferroics and on the iron chalcogenides" on April 12, 2013

19. **Dr. Bhaskar Kaviraj,** International Center for Materials Nanoarchitectonics (MANA), National Institute of Materials Science (NIMS), Japan, "Noise Correlations in three-terminal superconducting hybrid nanostructures" on May 29, 2013

20. **Dr Gautam V. Soni,** Kavli Institute of Nanoscience, TU Delft, The Netherlands, " Nanopore Biophysics, From Gene Sequencing to Gene Silencing", on August 5, 2013

21. **Dr. Santanu Karan,** Dept of Chemical Engg, Imperial College of Science Technology and Medicine, UK, "Superpermeable membranes with ultra thin nanosheet selective layer", on August 7, 2013

22. **Dr Rajendra S. Dhaka,** Paul Scherrer Institut, Switzerland, "Electronic structure of Iron-based high-temperature superconductors probed by angle-resolved photo-emission spectroscopy", on August 8, 2013

23. **Dr Praveen Kumar,** Universidad Politcnica de Madrid, Spain, "Heteroepitaxy of III-Nitrides: Role of surface modifications", on August 30, 2013

24. **Dr Navinder Singh,** Reader, Theoretical Physics Division, Physical Research Laboratory, Ahmedabad, "A statistical mechanical model of the pseudogap state of high T_c cuprate superconductors", on September 13, 2013

25. **Dr Sunil P. Singh,** Department of Polymer Science and Engineering, University of Massachusetts Amherst, Amherst, Massachusetts, USA, "Structural and dynamical behavior of complex fluids under flow", on October 7, 2013

26. **Dr. Rajesh Sharma,** Paul-Drude-Institut , Berlin, Germany, "Transport and lasing characteristics of terahertz quantum-cascade lasers", on October 28, 2013

27. **Dr. Manjari Bagchi,** TIFR, IISc Campus, Bangalore: "Binary Radio Pulsars: Prospects and Problems", on November 14, 2013

28. **Dr. Nrusingh C. Biswal,** Medical Physics and Advanced Imaging Division, Rush University Medical Center, Chicago, USA, "Theranostic Responses of Magneto-fluorescent Gold Nanocomplexes for Breast Cancer" on 27th January, 2014

29. **Prof. Vandana Nanal** of Department of Atomic and Nuclear Physics, Tata Institute of Fundamental Research, Mumbai: "Double-beta-decay and status of INO" on January 21, 2014

30. **Prof. Jainendra K. Jain,** Evan Pugh and Erwin W. Mueller Professor of Physics, Department of Physics, Pennsylvania State University, USA, "Exotic Particles in Silicon MOSFETs: An intriguing road to quantum computation ?", on August 31, 2013

31. **Dr. Pierluigi Belli, Director,** Research INFN, Italy, "Investigations on Dark Matter by DAMA/LIBRA and results on some other rare processes", on December 16, 2013

32. **Prof. Gurinder Pal Singh**, HGST, San Jose, California, "Progress in Magnetic Data Storage Technology and Future Challenges", on December 23, 2013

Membership of Professional Societies:

- Rajesh V. Nair, Life Member, Indian Science Congress Association
- Shubhrangshu Dasgupta, Member, Optical Society of America
- Shubhrangshu Dasgupta, Member, American Physical Society
- Asoka Biswas, Member, American Physical Society
- Asoka Biswas, Member, Optical Society of America

Institutional Activities of Faculty Members:

- Dr. S. Sarkar is co-ordinating, Research and External Relations at IIT Ropar
- Dr. S. Sarkar is the Indenter and faculty-in-charge, Scanning Probe Microscope and High Temp Vacuum Furnace (Central Research Facilities)
- Dr. S. Sarkar has been the faculty-in-charge for campus maintenance and development, 2009-2011

- Dr. S. Sarkar has been a member of ACUGS, 2009-2012
- Dr. S. Sarkar has been a member of Library Committee during 2009-2010
- Dr. (Mrs) Asoka Biswas is the departmental representative to RPEC, and member of the Library Committee
- Dr. S. Dasgupta has been the UG Lab-in-charge till December, 2013, is the coordinator for seminars and faculty recruitment in the Department, and member of Editorial Board for the Newsletter, "Prajwalam"
- Dr. Rakesh Kumar is the co-ordinator of preparatory program at the institute
- Dr. Rakesh Kumar is the co-ordinator of faculty recruitment in Physics, 2010-2013
- Dr. Rakesh Kumar, Member of ACUGS committee from 2013
- Dr. Rakesh Kumar has been coordinator for departmental seminar since 2010.
- Dr. S. Dasgupta has been a convener of Medical Committee during 2010-12 and is presently a member of Medical Procurement Committee since 2013
- Dr. Rakesh Kumar, Member of Hindi cell from 2010
- Dr. Rakesh Kumar, Incharge of Graphene synthesis laboratory and Nanoscience laboratory.
- Dr. Mukesh Kumar is the UG Lab-in-charge since January, 2014.

Annexure – I
Planned Central Facilities in the Department of Physics

High Performance Computing (HiPerCom):

A computer farm of 32 node units, each consists of 16 CPUs is planned to cater following research needs of the department;

- Computational Electromagnetics
- Computational Bio-Physics
- Monte-Carlo Simulations
- *Ab initio* electronic structure calculations
- Electronic band structure calculations of 2D and 3D materials
- In-line, on-line data transfer and analysis

Physics users: Dr. Rakesh Kumar, Dr. S. Dasgupta, Dr. A. Biswas, Dr. Pushpendra P. Singh

e-beam lithography:

The Physics Department together with other departments are jointly planning an "electron beam lithography" setup as a central facility for nano-fabrication and nano-patterning of samples for fundamental studies as well as their applications. It would greatly help in the studies of the following:

- Micromachining
- Patterning
- Applications in optics
- Dot arrays for biology
- Ultrafast systems
- Nanophotonics
- Photomask and substrates
- Thin film studies
- Nanostructures

Features:

- High resolution (of the order of nano meter)
- Direct writing, no mask needed
- Arbitrary size, shape and order

Keithley electronic characterization systems (4200 SCS)

We propose 4200 semiconductor characterization technique, a great tool for the electronic characterizations of two dimensional materials and nanodimensional materials. It would allow us to do the following characterizations of sample patterned using electron beam lithography.

- IV characterization,
- CV characterization, and
- Pulsed IV characterization of nano dimensional materials.

It would greatly help in exploring fundamental Physics as well as in electronic applications as Field effect transistors, and sensors. These characterizations are not possible with the conventional electronic characterization technique. It would also help in teaching as well as giving on hand training to the undergraduate and postgraduate students from science and engineering background on electronic characterizations of nano dimensional materials. The students would also be able to carry out their thesis dissertation and research projects towards electronic applications of nanomaterials.

Spectrophotometer:

We are planning to procure a spectrophotometer in the UV, visible and NIR regions for the optical characterization of various kinds of materials. This intended facility is useful for many research activities in the institute involving synthesis of materials to applications. This instrument is capable for measuring reflectivity at different angles of incidence, absorption/transmission of light and diffuse scattering using an integrating sphere.

Annexure – II
Curricula of Physics-I and Physics-II

Course contents: PHL | Physics-I (3-1-0) 4

Basic Classical, Quantum and Relativistic Mechanics:

Mechanics of classical systems, Constraints, virtual work and D'Alemberts principle, Generalized coordinates and Lagrange's equation, Hamilton's principle and Lagrange equations. Cyclic coordinates, conservation laws. Central force and analysis using effective potentials, Kepler's problem, Small oscillation theory, nature of equilibrium and normal modes, Rigid body motion, body and space coordinates, Euler angles, non inertial frames. Eulers theorem, moment of inertia tensor, principal axis transformation and Euler'equations of motion. Centrifugal and Coriolis force. Precession and nutation of rigid bodies.

Mechanics at large speed (non-constancy of length and mass), Special Theory of Relativity: Result of Michelson-Morley Experiment. Postulates of STR, Galilean transformation, Lorentz transformation. Simultaneity. Length contraction. Time dilation. Four vector formalism. Relativistic addition of velocities.

Mechanics at the micro scale, Quantum Mechanics: Failure of classical concepts. De Broglie's hypothesis. Davison and Germer's experiment. Uncertainity Principle, Wave packets. Phase and Group velocities. Schrodinger equation. Probabilities and Normalization. Expectation values. Eigenvalues and eigenfunctions. Application in one dimension: Particle in a box, Finite Potential well, Steps and Barriers, Harmonic oscillator.

Suggested texts and reference materials (If any)

1. Grant R. Fowles and George L. Cassiday, Analytical Mechanics, Harcourt College Publishers.
2. Stephen T. Thornton and Jerry B. Marion, Classical Dynamics of Particles and Systems, Thomson.
3. R. Resnick, Introduction to Special Relativity, John Wiley, Singapore, 2000.
4. Stephen Gasiorowicz, Quantum Physics, Wiley.
5. A. Beiser, Concepts of Modern Physics, Tata McGraw-Hill.

Course contents: PHL | Physics-II (3-1-0) 4

Waves and Oscillations:

Vector Calculus: Gradient, Divergence and Curl. Line, Surface and Volume integrals. Gauss's divergence theorem and Stokes' theorem in Cartesian, Spherical polar and cylindrical polar coordinates. Dirac Delta function.

Electrodynamics: Coulomb's law and Electrostatic field, Fields of continuous charge distributions. Gauss's law and its applications. Electrostatic Potential. Work and Energy. Conductors, capacitors. Laplace's equation. Multipole expansion, Dielectrics. Polarization. Bound charges. Energy in dielectrics. Boundary conditions. Lorentz force. Biot-Savart and

Ampere's laws and their applications. Vector Potential. Force and torque on a magnetic dipole. Magnetic materials. Magnetization, Bound currents. Boundary conditions. Motional EMF, Ohm's law. Faraday's law. Lenz's law. Self and Mutual inductance. Energy stored in magnetic field. Maxwell's equations. Maxwell's equations in four vector and four tensor formalism.

Optics: Huygens' principle. Young's experiment. Superposition of waves. Concepts of coherence sources. Interference by division of wavefront. Fresnel's biprism, Phase change on reflection. Lloyd's mirror. Interference by division of amplitude. Parallel film. Film of varying thickness. Colours of thin films. Newton's rings. The Michelson interferometer. Fraunhofer diffraction. Single slit, double slit and N-slit patterns. The diffraction grating. Fresnel diffraction, Polarisation

Suggested texts and reference materials (If any)

1. M. R. Speigel, Vector Analysis, Schaum
2. D. J. Griffiths, Introduction to Electrodynamics, Prentice Hall
3. E. M. Purcell, Electricity and Magnetism, Berkeley Physics Course, Vol 2
4. Eugene Hecht, Optics, Addison Wesley
5. F. A. Jenkins and H. E. White, Fundamentals of Optics, McGraw-Hill
6. A. Ghatak, Optics, Tata McGraw-Hill