Courses proposed to be offered in the Second Trimester (December'14 to March'15) for PMsc session 2014-15

Theory Division

1. Course: Solvable quantum many-body systems

Teacher: Bireswar Basu Mallick

Outline: Introduction to classical and quantum integrable systems; Coordinate Bethe ansatz and quantum inverse scattering method for solving quantum integrable systems; Supersymmetric quantum mechanics; Spectral properties of quantum integrable models with long-range interaction; Connection of integrable systems with Dunkl operators and quantum groups.

2. Course: Quantum Field Theory-I

Teacher: Shibaji Roy

3. Course: Cosmology

Teacher: Koushik Dutta

Surface Physics & Material Science Division

Theory Course on 'Physics of Nanomaterials' (20 Lectures)

Teachers: Alokmay Datta

Course Content

1. Why study materials? (1 lecture)
2. Why study nanomaterials? (1 lecture)
3. Size Effect - problems with finite systems (6 lectures)
4. Surface Effect - problems with low dimensions (6 lectures)
5. Confinement Effect - emergence of order, distortion and disorder (6 lectures)

Astroparticle Physics & Cosmology (APC) Division

Title of the course: Dark Matter and experimental techniques for its direct detection

Course type : Classroom lectures and laboratory sessions

Teachers: Pijushpani Bhattacharjee and Mala Das

Brief description: A variety of astronomical and cosmological observations

indicate that more than 80% of the total gravitating mass in the universe exists in a form that emits no detectable electromagnetic radiation of any kind and has therefore remained undetected so far in direct astronomical observations. The presence of this “Dark Matter” (DM) is revealed only through its gravitational influence on the dynamics of the observed visible matter. However, if DM is made up of particles that have some kind of weak interaction with normal matter, then it may be possible to directly detect such particles in laboratory experiments specially designed to be sensitive to such weak interactions. Various candidates for such particles have been suggested, most of which involve new physics beyond the Standard Model of particle physics. Several experiments worldwide are currently engaged in efforts to detect these particles through the so-called Direct Detection experiments.

In this course of lectures and laboratory sessions, students will be first introduced to the subject through a set of classroom lectures. This will be followed by laboratory sessions where students will learn the experimental techniques of one specific type of detector, namely, superheated drop detectors (SDDs) currently being used for direct detection of DM particles. The students will have the opportunity to make prototype SDDs in the laboratory and learn how to operate the associated instruments, and perform experiments to record signals due to various kinds of particles that act as sources of background events in DM search experiments. They will also learn how to analyze the relevant data.

Brief course outline:

Lectures: Evidence for DM; various particle candidates for DM; basic idea and phenomenology of direct detection of DM particles; review of various types of DM detection experiments; basic ideas of superheated drop detectors (SDDs) and their working principles; ...

Laboratory sessions: Fabrication of prototype SDDs; operation of related instrumentation for recording and analysis of acoustic signals from SDDs; experiments with background sources; construction of nuclear recoil energy spectrum from the measured acoustic signals; techniques for discrimination of signals due to various types of particles

Plasma Physics Division

Advanced Courses on Plasma Physics (PLP)

Teachers: Nikhil Chakrabarti, M.S. Janaki

Advanced Course - 2nd Trimester
Particle and Fluid behavour of plasmas
A. General Introduction: (Why to study plasma and what is currently happening in
plasma science): (1)
B. Debye shielding, Plasma sheath. Plasma criteria (1)
C. Single particle motion and particle drift in presence of inhomogeneous electric and magnetic fields. (4)
D. Plasma as a Fluid, magnetohydrodynamics (4)
E. Waves in a plasma : Linear waves in un-magnetized and magnetized plasma. (4)
F. Linear instabilities in both un-magnetized and magnetized plasmas. (4)
G. Introduction to Wave particle interactions, Landau damping (2)

Applied Nuclear Physics Division

Basic course: Apparatus Building, Measurements and Reliability
Time: 25 – 30 lectures, Period: December – March (2nd Trimester)

Teacher: Sankar De

Course structure:

1 Basic principles of reliability, human error, and other general issues
2 Basic issues concerning hardware systems - Preventing and solving intermittent problems, Problems caused by vibrations and Moisture, Electricity supply problems, Corrosive atmospheres in chemical labs, Fatigue of materials
3 Obtaining items from commercial sources - Using established technology and designs, Importance of standards, Reliability assessments based on user experiences, Preparing specifications, testing, and transport and delivery, Acceptance trials for major equipment
4 General points regarding the design and construction of apparatus - Commercial vs. self-made items, Time issues, Use of modularity in apparatus design, Virtual instruments, Ergonomics and aesthetics, Mechanical drawing basics
5 Vacuum system leaks and related problems - Common locations and circumstances of leaks, Materials for vacuum use, Contamination and outgassing, Brazing, and soldering, Leak detection and repairs
6 Vacuum pumps and gauges, and other vacuum-system concerns - Primary pumps, High and Ultrahigh vacuum pumps, Vacuum gauges, Bake-out for UHV systems, cooling of electronics in a vacuum
7 Mechanical devices and systems - Design approaches for improving mechanism reliability, Lubrication and wear under extreme conditions, Dynamic seals and motion feedthroughs, Valves, Systems for handling liquids and gases, Water-cooling systems, Cryogenic systems, Problems arising from the use of superconducting magnets
8 Visible and near-visible optics - Temperature variations in optical path, Measures for protecting optics and cleaning, Problems with IR and UV materials caused by moisture, and thermal and mechanical shocks, Fiber optics, Lasers and their reliability issues, Photomultipliers and other light detectors, Alignment of optical systems
9 Electronic systems - Electromagnetic interference, Ground loops, High-voltage: corona, arcing, and tracking, Damage and caused by electrostatic discharge (ESD), Power electronics, Crosstalk between cables, Permanent or semi-permanent electrical contacts, Ground contacts, Connectors, Cables and wiring, cryostat wiring
10 Computer hardware and software - Computers and operating systems, Common causes of system crashes, Compatibility of hardware and software, RS-232 and IEEE-488 (GP-IB) interfaces, Backing up information, Security issues, Network security, Reliability of commercial and open-source software, Commercial data-acquisition software, Graphical languages, Writing software
11 Experimental method - Calibration and validation of apparatus, Control experiments, Chance occurrences as a source of error, Reproducibility of experimental measurements, Low signal-to-noise ratios and statistical signal processing

References:

1 Reliability in Scientific Research: Improving the Dependability of Measurements, Calculations, Equipment, and Software - I. R. Walker (2011)
2 Building Scientific Apparatus 4th ed. - John H. Moore, Christopher C. Davis, Michael A. Coplan, Sandra C. Greer (2009)

High Energy Nuclear and Particle Physics (HENPP) Division

Course: Experimental studies of THGEM in different Ar/CO 2 mixtures

Teacher: Tinku Sinha

The study on the performance of Thick Gas Electron Multiplier (THGEM) will be done for single-mode configuration with Ar/CO 2 gas mixture using 15%, 20% and 30% quencher gas CO 2 at atmospheric pressure using 55 Fe source. The two main properties, the gain and the energy resolution of the indigenously made THGEM will be investigated.
Moreover, the R&D on Read-Out (R/O) will be done to extract the signal using R/O.
The Reference Papers for this work are:
1. Study on the performance of single THGEM gas detector.
T. Sinha et al.: Proceedings of DAE Symp on Nucl. Phys. 55, 684 (2010).
2. Investigation of Double-THGEM in the cascade mode.
T. Sinha et al.: Proceedings of DAE Symp. on Nucl. Phys. 56, 1090 (2012).
3. The Study on the Performance of THGEM using MFC.
T. Sinha et al.: Proceedings of DAE Symp. on Nucl. Phys. 58, 882 (2013)

Courses proposed to be offered in the Third Trimester (April to July'15) for PMSc session 2014-15

Theory Division

1. Course: Quantum Field Theory-II

Teacher: Arnab Kundu

2. Course: Quantum Field Theory at Finite Temperature

Teacher: Munshi G Mustafa

3. Course: General Relativity

Teacher: Amit Ghosh

Surface Physics & Material Science Division

Theory Course on 'Physics of Soft materials'

Teacher: Alokmoy Datta

Course Content(30 Lectures)

1. Hard and soft materials (1 lecture)
2. Mathematical tools (4 lectures)
3. Liquids (5 lectures)
4. Liquid Crystals (8 lectures)
5. Polymers (8 lectures)
6. Granular matter (4 lectures)

Plasma Physics Division

Advanced Course on Plasma Physics

Teachers: Nikhil Chakrabarti, M.S. Janaki

Special topics in Plasma Physics

A. Non linear phenomenon: One dimensional cold plasma model. Large amplitude electron plasma Oscillation, exact solution in Lagrangian variables. Extension of the model to various nonlinear systems. (4)

B. Derivation of the Korteweg-de-Vries equation for nonlinear ion sound wave: solitary wave solution. Drift waves. (4)

C. Thermodynamics and statistical mechanics of equilibrium plasmas. Free

energy of plasmas. BBGKY hierarchy. BGK modes. (4)

D. Tokamaks and other fusion devices. (4)

E. Strongly coupled plasmas (4)

High Energy Nuclear and Particle Physics (HENPP) Division

1. Course: An advanced reading course on "Particle Detectors"

Teachers: Debasish Das (HENPPD), Maitreyee Nandy (CSD).

We intend to expand on one or two of the following detector systems :

A) Gas filled detectors – proportional counters

B) Photo-emission detectors – scintillators and photo-multipliers

C) Calorimetry and Sampling Calorimeters .

2. Course: The Investigation of characteristic of single THGEM incorporating Read-Out

Teacher: Tinku Sinha

The study on the performance of Thick Gas Electron Multiplier (THGEM) will be done for single- mode configuration with Ar/CO 2 (70:30) and Ar/CH 4 (95:5) gas mixture at atmospheric pressure using 55 Fe source . The two main properties, the gain and the energy resolution of the indigenously made THGEM will be investigated incorporating the Read-Out (R/O).

The Reference Papers for this work are:

1. Study on the performance of single THGEM gas detector.
T. Sinha et al.: Proceedings of DAE Symp on Nucl. Phys. 55, 684 (2010).

2. Investigation of Double-THGEM in the cascade mode.
T. Sinha et al.: Proceedings of DAE Symp. on Nucl. Phys. 56, 1090 (2012).

3. The Study on the Performance of THGEM using MFC.

Applied Nuclear Physics Division

Advanced course: Laser Spectroscopy – Wolfgang Demtroder
Time: Reading course, Period: April – July (3rd Trimester)

Teacher: Sankar De

Course structure:

Volume 1: (Selected topics in)

1 Absorption and Emission of Light
2 Widths and Profiles of Spectral Lines
3 Spectroscopic Instrumentation
4 Lasers as Spectroscopic Light Sources

Volume 2: (Selected topics in)

1 Doppler-Limited Absorption and Fluorescence Spectroscopy with Lasers
2 Nonlinear Spectroscopy
3 Laser Raman Spectroscopy
4 Laser Spectroscopy in Molecular Beams
5 Time-Resolved Laser Spectroscopy
6 Coherent Spectroscopy
7 Laser Spectroscopy of Collision Processes
8 New Developments in Laser Spectroscopy
9 Applications of Laser Spectroscopy