

## Department of Physics, DSB Campus, Kumaun University, Nainital

**1. Name of the Department** : Department of Physics

**2. Introduction** :

Physics Department came into existence in 1951 as one of the premier departments of Thakur Dev Singh Bisht Government Post Graduate College, Nainital. Prof. Devi Datt Pant, the renowned physicist, was the first head of the department and research work in the field of spectroscopy started under his guidance and supervision. The department of Physics got its recognition as a University Department in 1973. Since 1980, new heights in the field of High Energy Physics were achieved under the able guidance of the then HOD, Professor B.S. Rajput. The department is known for its pioneering research work and excellent teaching. The department is actively engaged in research in the field of Astrophysics and Condensed Matter Physics also. The University Grants Commission, New Delhi, recognized it under its Special Assistance Programme for DRS category in 1987, for DSA (Phase I), DSA (Phase II) and DSA (Phase III) categories in 1992, 1997 and 2004 respectively on the basis of its major research contribution and excellent teaching. The department was also approved by UGC for COSIST Programme in 1997. The department received substantial grant for developing work station and high level library under these schemes. In the year 2006-2007, UGC granted ten research fellowships (Fellowships in science for meritorious students) under its RFSMS scheme, for encouraging more research in the department. The department is also recognized by the Department of Science and Technology, New Delhi under its FIST scheme (Level I). Physics department and ARIES (Aryabhata Research Institute of Observational Sciences) has signed a MOU (Memorandum of Understanding) for academic and scientific collaborations.

There is a good collection of books written by renowned author's in the departmental library. The department organises seminar/symposia time to time in which scientists of national and international repute actively take part. Recently, in the year 2009, a three days seminar was organized by the department with the collaboration of ESREP.

Every year many scientists are invited for delivering valuable lectures under DSA Programme at the department. Furthermore, many teachers and students of the department have also been awarded for excellence in research. In 2008-09, Dr. H.C. Chandola was invited for research work under Indo-German Academic Exchange Programme (DAAD) Fellowship at Konstanz University of Germany. In 2009, seven students gained laurels for the department by getting qualified in GATE, NET and JEST examinations.

The department has well equipped laboratories and internet facility. In M.Sc. (F), following specializations are offered:

1. Advanced Electronics
2. High Energy Physics
3. Astrophysics
4. Laser Spectroscopy
5. Condensed Matter Physics

**3. Course Curriculum :** Various courses offered at UG and PG level are as mentions below:

B.Sc.I: Paper -I	Mechanics & Properties of Matter
Paper -II	Electricity and Magnetism
Paper-III	Acoustics, Waves and Oscillations
B.Sc.II: Paper-I	Thermodynamics and Heat
Paper-II	Optics
Paper-III	Solid State Physics and Statistical Physics
B.Sc.III: Paper-I	Quantum Mechanics and Relativity
Paper-II	Modern Physics
Paper-III	Electronics and Solid state Devices
M.Sc.I: Paper-I	Mathematical Methods and Classical Mechanics
Paper-II	Quantum Mechanics and Atomic Spectra
Paper-III	General Theory of Relativity and Elementary Cosmology
Paper-IV	Condensed Matter Physics and Molecular Spectroscopy
Paper-V	Communication Electronics
M.Sc.II: Paper-I	Advanced Quantum Mechanics and Quantum Statistics
Paper-II	Nuclear and Particle Physics
Paper-III	Electrodynamics and Plasma Physics
Paper-IV	Digital Electronics and Computer Architecture
Paper-V(a)	Advanced Electronics
Paper-V(b)	Astrophysics
Paper-V(c)	High Energy Physics
Paper-V(d)	Molecular and Laser Spectroscopy
Paper-V(e)	Condensed Matter Physics

**4. Infrastructure developed and major equipments (for last five years)**

Name of Major Equipments:

- i) FTIR Shimadzu, India
- ii) Fluorescence Microscope with Picosec diode laser Picoquant, Germany
- iii) Gaussian 03 W and Gauss View software: Gaussain Inc. USA
- iv) TCC 900 Card and FAST Software: Edinburgh Instruments Ltd. UK

- v) X-ray set up USB  
complete with accessories
- vi) Scanning Microscope
- vii) Gamma Ray Spectrometer

LD-DIDACTIC GmbH, Germany

Olympus (Japan)  
ECIL (India)

## 5. About the Faculty

At present, the teaching faculty members are as given below:

1. Dr. H.C. Chandola	Head of the Department	High Energy Physics
2. Dr. Sanjay Pant	Associate Professor	Photophysics
3. Dr. Shuchi Bisht	Assistant Professor	High Energy Physics
4. Dr. Alok Durgapal	Assistant Professor	Astrophysics
5. Dr. Bimal Pande	Assistant Professor	High Energy Physics
6. Dr. P.S. Negi	Assistant Professor	Astrophysics
7. Dr. Pramod Kumar Mishra	Assistant Professor	Condensed Matter Physics

## 6. Research activities:

The research activities of the four research groups at the department are as mentioned below:

### (I) High Energy Physics Group:

This research group has made a significant contribution towards the studies related to some of the current problems in the field of High Energy Physics. Some of the important investigations made in this field are as listed below:

- (i) Study of the gauge theory of strong interactions, formulation and analysis of dual QCD models, topological considerations and the associated magnetic structures.
- (ii) Fiber bundle based dual QCD formulation to study the non-perturbative gluonic interactions and colour superconductor structure of QCD vacuum. Study of the dynamical symmetry breaking of magnetic symmetry, the multi-flux tube structure of QCD vacuum and the density effects.
- (iii) Analysis of the magnetic symmetry at high temperatures and the high temperature/high density response of QCD vacuum, relation with the RHIC Collision events and the study of the phase transition at finite temperatures in QCD.
- (iv) Analysis of the interrelationship between quark-hadron phase transition and chiral phase transition at finite temperatures, their implications for QGP, the fate of magnetic condensate in terms of thermal monopoles and the analysis of the thermal seed QCD vacuum above (below) the critical value of the energy disposition for the QGP (hadronic) phases of QCD.
- (v) Correlation of the above mentioned QCD studies with recent lattice QCD studies for evolving a physical picture of QCD phase transitions.

- (vi) Charge-pole interactions study for the evaluation of gauge invariant angular momentum, its analogy with that of a spinning top and the analysis of relativistic effects in charge-pole bound state systems to explore the typical hyperfine structure of atomic energy states.
- (vii) Analysis of the hadronic and glueball trajectories for exploring their intrinsic dissimilarities and constructing Regge trajectories with quantized mass.
- (viii) Quaternionic formulation of supersymmetric quantum mechanics in terms of superpartner of Hamiltonians and supercharges for particle-field interactions in one- and three dimensions, analysis of quaternionic Dirac equation and its supersymmetric version for massive and massless cases and the construction of semi-unitary transformation to obtain supersymmetric partner Hamiltonian for one dimensional harmonic oscillator to analyse its eigen functions and ground state. Investigation of the split octonion wave equation for its interpretation in classical electrodynamics and Zorn's vector matrix realization and the split-octonion formulation for the unified fields of dyons and gravito-dyons in a compact and manifestly covariant manner.

## (II) **Photophysics Group:**

This research group is involved in studying some important photo induced excited state relaxation processes in various Quinoline derivatives and hydrogen bonded molecules. Some of the important studies performed by the group are as listed below.

- (i) Study of the excited state dynamics of organic molecules like cinchona alkaloids both in solution phase and polymeric matrices to decipher the excited state relaxation pathways during the excited state of the molecule and in view of its pharmaceutical applications.
- (ii) Study of the time-dependent fluorescence on the parent compound 6-methoxy quinoline and another isomer quinoline to analyse some specific relaxation processes suggesting that the compounds can not be used as a quantum yield and lifetime standard.
- (iii) Study of the amino derivatives of quinolines as 3-and 5- Aminoquinolines (3AQ, 5AQ) in different solvents with both methoxy and vinyl groups present and a amino group substituted at different positions in quinoline ring, study of the photophysics of 5AQ in acetonitrile-water binary mixture to understand the excited state proton transfer reactions and to observe the excited state intermolecular proton transfer accompanied by intermolecular charge transfer.

## (III) **Astrophysics Group:**

This research group is involved in the following studies of fundamental importance.

- (i) Study of the internal structure of Neutron Stars as one of the important problem of Relativistic Astrophysics.

- (ii) Development of an entirely different formulation to resolve the problems associated with the conventional two-component model for Neutron Stars and related different kinds of glitch mechanisms, thus providing deep insight into the Neutron Star structure and explaining simultaneously the higher and lower values of glitch healing parameter for the realistic mass values of Crab and Vela pulsars. Further, the necessary and sufficient conditions of hydrostatic equilibrium for any realistic sequence of Neutron Star models have also been drawn from a fundamental theorem developed earlier.
- (iii) Observation and processing of some of the open clusters to determine the various parameters of star clusters, luminosity functions, mass function and the dynamical evolution of galactic star clusters, since the star clusters constitute a principal link between the theories of stellar evolution and observable universe.
- (iv) Study of variable stars and the discovery of a few delta scuti stars which further need more time series data to analyse their complicated light waves.
- (v) Study of solar active prominences to analyse their distribution asymmetry in two subdivisions and the MHD modes of oscillations of solar coronal arcades.

#### **(IV) Condensed Matter Physics Group:**

This group has been introduced few years back in the department and is engaged in research in the following fields.

- (i) Study of the equilibrium thermodynamics properties of a linear polymer chain confined to a space between two impenetrable separate walls under various solvent conditions using series analysis and exact enumeration technique to show a non-monotonic behavior and the occurrence of collapse transition at higher temperature.
- (ii) Study of force-induced desorption of a linear polymer chain adsorbed on an attractive surface to show the temperature dependence of critical force of desorption, investigation of the conformational properties of a linear semiflexible homopolymer chain and adsorption behavior in presence of an attractive impenetrable curved surface using lattice models, physics of the conformational behavior of a linear semiflexible homopolymer chain form a DSAW model on a two-dimensional rectangular lattice and the study of the adsorption-desorption phase transition in semiflexible copolymer chain interacting with an impenetrable surface in three-dimensions using DSAW model.

#### **7. Sponsored Research projects:**

- (i) One UGC sponsored major research project in the field of High Energy Physics (2001-04): 3.14 lakhs
- (ii) One DRDO sponsored major research project in the field of Photophysics (2006-08): 14.97 lakhs.
- (iii) One DRDO sponsored major research project in the fields of Spectroscopy/ Photophysics (2009-ongoing): 34.14 lakhs.

**8. Seminars/Symposia/Workshop/Organized (in last 5 years):** 04

**9. List of Publications (during last five years):**

- (a) Number of Papers published in refereed journals: 32  
(b) Number of Books published: NIL  
(c) Number of Research Papers published in Conferences: 04

**10. Details of faculty members :**

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