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# ANNUAL REPORT

2009-2010



**JAWAHARLAL NEHRU CENTRE FOR  
ADVANCED SCIENTIFIC RESEARCH**

**(A Deemed to be University)**

Jakkur, Bangalore – 560 064.

Website: <http://www.jncasr.ac.in>



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# The Centre

## Foreword

It is a matter of great pride to present the Twentieth Annual Report for the year 2009-2010.

The Centre has been emerging as one of the leading institutions in the country for higher learning and research in frontier areas of science and engineering. The Centre has also been recognized as a Deemed University.

This year significant progress has been made in all spheres of academic activities at the Centre. Beginning this academic year, an MS-Ph D in Chemistry and Biology has been launched to facilitate our POCE and POBE students in their pursuit of research degrees. We will also be starting an Integrated PhD programme in Biology from the next academic year.

There is a steady increase in the number of research students at the Centre pursuing various academic programmes. After obtaining the status of Deemed University, 66 students have obtained Ph D Degrees; 21 students M S (Engg.), one student M S (by research) and 09 students M S (Int. Ph D) degrees. The academic, research, fellowship and extension programmes have been progressing as envisaged. The publication record is growing steadily. The faculty members have made significant scientific contributions. Prof C N R Rao, National Research Professor and Linus Pauling Research Professor has received the Queen's Royal Medal. He has also been awarded the August-Wilhelm-von-Hofmann medal for outstanding contributions in chemistry by the German Chemical Society. This is the highest international medal in chemistry and has been awarded to an Indian scientist for the first time. Previously, the medal had been awarded to Nobel laureates and other leaders in chemical research. Prof M R S Rao, President, JNCASR, has been awarded Padma Shri by the Government of India. Many of our faculty members have received recognitions like the Shanti Swarup Bhatnagar Award, National Bioscience Award, B M Birla Prize and Fellowships of the Science Academies.

Based on the decision of the Council of Management, Dr. Manmohan Singh, Hon'ble Prime Minister, and Shri Kapil Sibal, Hon'ble Union Minister for HRD were conferred with the "Honorary Fellowship" of the Centre.

This has been a year of significant scientific discoveries made by our faculty and students; to name a few, Chemists at JNCASR have unveiled a new composite that claims to be harder and stronger than the strongest metal. The new material is a carbon-based polymer reinforced with graphene, and has been developed at the JNCASR after two years of intensive research. The material may be relevant to several commercial applications including building super capacitors, photo voltaic and carbon-based large transistors. A group from MBGU has identified the gene locus causing hot water epilepsy. Researchers from NIMHANS and JNCASR have discovered the gene locus (at chromosome 10q21.3-q22.3) responsible for causing hot water epilepsy is positioned. This is the first identification of a locus for this unusual neuro-behavioural disease. For the first time, researchers of MBGU have found a link between acetylation of the histone chaperone NPM1 and manifestation of oral cancer. There is a drastic enhancement in the level of acetylated NPM1 in malignant oral tissues and hence it might serve as a diagnostic marker for oral cancer progression and abnormal acetylation could be a potential therapeutic target.

The Science Outreach Program has become an important academic component of the Centre. It is heartening to note that many school children and teachers get exposed to the excitement of Science through various programmes at the Centre. The C N R Hall of Science and Education Technology Unit conducted various programmes for children in their endeavour to popularize science among the young students. Prof C N R Rao delivered lectures at various places followed by multimedia presentations on Learning Science.

The Centre has been expanding its formal ties with other research organizations in India and abroad. A Coordination Agreement has been signed for a collaborative project under the Seventh Framework programme of the European Community for the project "Modeling of Nano- scaled Advanced Materials Intelligently (NONAMI). A Memorandum of Understanding (MoU) between Bhabha Atomic Research Centre (BARC) and JNCASR has been signed for the project on Development of Test Facility for different studies. The Centre has also signed MoUs for collaborative research with Genescent Corp (USA); LEOS-ISRO; DRDO; Purdue University, Kagoshima University; University of Twente, The Netherlands; Colorado State University, USA; Computational Research Laboratories -Tata Sons Ltd; WWF Nature-WWF Greater Mekong Cambodia Country Program; and Swedish Research Links Programme, for research grants.

The Centre maintains its vibrant academic activities through conferences, seminars, colloquia and discussion meetings. The infrastructure is being constantly upgraded to meet the academic requirements.

The Centre has also witnessed a tremendous growth in the infrastructural facilities for both scientific and student activities. All these developments would not have been possible without the continuous support from the Department of Science and Technology.

M R S RAO  
President

## INTRODUCTION

The Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, a premier research institute in the country, was established in the year 1989, the birth centenary year of Pandit Jawaharlal Nehru, by the Department of Science and Technology. The objectives of the institute shall be to pursue and promote scientific research and training at the highest level in the frontier and interdisciplinary areas of science and engineering. The number of publications in international journals of repute and the filing of patents are steadily increasing year by year. The Centre, which is just nineteen years old, is creating news regularly in the scientific world with its breakthrough discoveries. The Centre has research collaborations with several national and international institutions. In recognition of the achievements of the Centre, the Ministry of Human Resource Development (GOI) has accorded the status of Deemed University, to enable the Centre to train quality manpower. The faculty members of the Centre have received national and international recognitions. Several faculty members of the Centre are Fellows of National and International science and engineering academies.

Prof C N R Rao, the founder of the Centre, held the office of President from 1989 to 1999. He is presently the Honorary President of the Centre and Chairman of the Scientific Advisory Council to the Prime Minister. Prof V Krishnan, who succeeded him, served as its President from 2000 to 2003. Prof M R S Rao is presently the President of the Centre.

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## OBJECTIVES

The objectives of the Centre are:

- To carry out front-line research in selected thrust areas of science and engineering;
- To promote collaborative research with scientists at the Indian Institute of Science and other institutions in the country;
- To provide a national and international forum for in-depth discussions on important scientific topics in areas of vital interest to scientists of the Centre and in the country at large;
- To organize periodic winter and summer schools in certain areas, where young talented scholars would be associated;
- To provide opportunities for talented young students to carry out research projects;
- To provide facilities to visiting scholars and faculty, from all over India and abroad, to work for extended periods with the faculty of the Centre;
- To publish monographs and reports on frontier and futuristic areas of science as well as monographs of educational value.

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## PROGRESS

The Centre has just completed 20 years encompassing several memorable and exciting moments. In addition to Chemistry and Physics of Materials Unit, Educational Technology Unit, Evolutionary and Organismal Biology Unit, Engineering Mechanics Unit, Geodynamics Unit, Molecular Biology and Genetics Unit, and Theoretical Sciences Unit, new Unit/Centres like the International Centre for Materials Science, New Chemistry Unit, and the Centre for Computational Materials Science have been added. The new Nanoscience Centre is equipped with the state of the art facilities for advanced research in materials science.

The ICMS has established major scientific facilities like Ultra High Resolution Electron Microscope, Pulse Laser Deposition, Molecular Beam Epitaxy System, X-ray Diffractometer, FE-SEM, Technai, Plasma cleaners, Ion Millers and others. A state of the art conference facility named after Nevill Mott and a meeting room named after JC Bose have been created at ICMS. The *I-House* located in the same campus provides residential accommodation to the researchers visiting from various parts of the world.

The Centre is equipped with good quality Library, an excellent computer support facility, Lecture Halls, a Chemical Education Laboratory, Conference and seminar halls, Faculty Offices and the Administrative Office. A seminar hall, a well-furnished accommodation for academic visitors and a Visitor House are also located at IISc campus.

During the year 9 Ph D, 3 M S (Engg.), 1 M S (by research) and 1 M S (Int. Ph D) degrees have been awarded. Currently about 182 scholars are pursuing their research career. The research training at the Centre has led to the award of 73 Ph D degrees, 21 M S (Engg.) 20 M S degrees, one MS (by research) and one M Sc (by research) degree so far. The Centre has emerged as a place for interdisciplinary research, with effective interactions among scientists with backgrounds in biology, chemistry, engineering and physics. The JNC community has been working not only in pursuit of research, but also on dissemination of science-related activities reaching out to the common man.

The Centre's faculty members have received number of national and international recognitions. Prof CNR Rao, Linus Pauling Research Professor and National Research Professor, received the Queens' Royal Medal. He has also been awarded the August-Wilhelm-von-Hofmann medal for outstanding contributions in chemistry by the German Chemical Society. This is the highest international medal in chemistry and has been awarded to an Indian scientist for the first time. Prof M R S Rao, President, JNCASR, has been awarded Padma Shri by the Government of India. Prof Amitabh Joshi has been awarded Shanti Swarup Bhatnagar Prize in Biological Sciences, 2009. Prof R Narasimha has received the Zakir Hussain Memorial Award of the Indian Society of Industrial and Applied Mathematics, Agra, 2009 and Lifetime Achievement Award, Karnataka Academy of Science and Technology, 2009. Prof Swapan K Pati has been awarded the B M Birla Science Prize in Physics, 2008 and Prof Umesh V Waghmare has received IBM Faculty Award, 2009. Dr. A. Sundaresan has been awarded the prestigious Materials Research Society of India (MRSI) medal. In addition, many faculty members have been elected for the fellowships like Indian Academy of Science Fellowship, Indian National Science Academy Fellowship, Ramanujan Fellowship, Swarnajayanthi Fellowship etc.

The Faculty members of the Centre have published around 250 scientific papers in reputed international journals during the year 2009-10, some of them with very high impact factor.

Many patent applications were filed for new inventions. Details are provided in a separate section on "Intellectual Property".

The interactions with academic institutions and universities globally have continued and the Centre is expanding its formal ties in respect of collaborative research, exchange of graduate students and consultancy projects.

Honorary Faculty Members of the Centre have continued to play an important role in guiding academic and extension activities of the Centre.

Summer Research Fellowships, Project Oriented Chemical Education Programme, Project Oriented





Biological Education Programme, Visiting Fellowships, Extension Programmes and Academic Exchange Programmes have attracted wide attention and have been highly successful.

For the Summer Research Fellowships programme, 107 fresh fellowships were awarded. For POCE, 383 applications from 17 states were received and 10 meritorious students from 7 states were offered the fellowship and all of them joined. Under POBE, 351 applications were received from different parts of the country and 10 candidates were offered the fellowship, of which 8 have joined. The POCE and POBE students who have completed their 3-year projects successfully were given Diploma (Chemistry and Biology respectively) from JNCASR.

Seven candidates from R&D institutions have been offered Visiting Fellowships for 2009-2010. Out of the eight candidates who joined DST Postdoctoral Fellowships in Nano Science and Technology – 3<sup>rd</sup> series, seven have been continuing in the programme at JNCASR, IISc, IIT Kanpur, IIT Bombay and SINP-Kolkata.

Since the beginning of the financial year 2009-10, 24 Discussion Meetings/Workshops were supported, either wholly or partially. About 64 seminars, 19 Fluid Dynamics Colloquia, one JNC Colloquia and 5 International Conferences/Workshops/Schools were held. Seven Endowment Lectures by eminent scientists were also held in addition to four guest lectures during the year.

## HIGHLIGHTS OF RESEARCH AND OTHER ACTIVITIES

### Research

**Chemistry and Physics of Materials Unit (CPMU):** With regard to new nanomaterials, single, bi and few layer graphene samples have been produced mainly based on chemical approaches. Several new results have been obtained for graphene functionalisation. Graphene based nanocomposites have been made and their electrical and mechanical properties have been examined. Graphene Analogues of BN and BCN have been synthesised and their properties have been examined. Air sensitive copper nanoparticles have been stabilized using a water soluble aminoclay matrix. Several new methods have been developed for patterning nanomaterials on given substrates. Development of polymer field effect transistors (FET). Bilayer structures consisting of donor and acceptor type molecules were used for fabricating (FETs), Development of Polymer Photovoltaics - Bulk polymer heterostructures were used to fabricate solar cells. After the discovery of surface ferromagnetism in otherwise nonmagnetic inorganic nanoparticles, the research group is exploring the origin of such ferromagnetism by using various experiments. During the past one year, there is much progress in exploring the different functional aspects of metal-organic frameworks (MOFs), viz. gas storage, selective guest accommodation, anion exchange, magnetism etc. During the year, the research group is also interested in assembling the same linker with a metal ion in different way by changing the reaction parameters. The effort resulted in the construction of four Cu-1,4-ndc (1,4-ndc = 1,4-naphthalene dicarboxylate) frameworks by varying solvent and temperature. The group's effort to synthesize magnetic frameworks resulted in the construction of a  $S=1/2$  kagomé compound which has been found to show very interesting temperature dependent magnetic property.

*Light Scattering Laboratory* has been involved in performing various experiments using the Brillouin Spectroscopy, Raman Spectroscopy and High Pressure Research. Further, Brillouin Spectroscopy measurements have been carried out on pyrochlores. Light Scattering group has been strongly involved in the study of biological system with surface enhances Raman Spectroscopy (SERS). During this period two patents associated with antibacterial activities of nanoparticle cellulose composites and SERS based DNA/RNA detection without PCR amplification reached National Phase stages. An experimental soft matter research facility is established. A confocal microscope and rheometer were installed in the first week of January 2010.

As part of *molecular dynamics simulation*, the complex dynamics of a room temperature ionic liquid, 1-n-butyl-3-methylimidazolium hexafluorophosphate ( $[bmim][PF_6]$ ) has been studied using equilibrium classical molecular dynamics simulations in the temperature range of 250K-450K. A correlation between dynamic heterogeneity and intermolecular structure has been established. III-nitride growth by Molecular beam Epitaxy: A sophisticated Molecular Beam Epitaxy system dedicated for the growth of III-nitride thin films is installed and optimized.

**Metal Nanostructure and Surface Phases on Si surfaces:** The research group studied the formation of surface phases and self assembled nanostructures using Silicon surface orientation and surface reconstruction patterns as templates for nanostructure growth.

*Substrate search for epitaxial GaN growth:* Silicon and gallium arsenide substrates have been successfully modified by ion beams into SiC, Silicon nitride and Gallium nitride at room temperature, in an effort to search for substrates compatible for epitaxial Gallium Nitride growth. High Pressure Synchrotron Beam Line in Photon Factory, Japan: Under the DST-Japan joint initiative an Indian Beam Line is being setup for doing synchrotron experiments at Photon Factory. In line with this, there is an interest to develop an High Pressure Beam line for the Indian scientist. This is being done by Light Scattering Laboratory and would be functional in the early part of the next academic year.

**New Chemistry Unit (NCU):** Currently the Unit is involved in three different research projects which are interdependent and complementary. Synthesized chiral unnatural amino acids with metal binding properties (metal binding ligands). The underlying theme of the group's research is the interface between synthetic efforts on small molecules or polymers and macroscopic properties at the materials level, leading to a macro-organic/supramolecular approach to functional materials.

The Unit is involved in setting up a research program that will provide a platform to integrate organic chemistry and material science with biology to combat infectious diseases in a multi-pronged approach namely diagnosis, prevention and treatment. Researchers have contributed extensively to the microscopic understanding of optical, magnetic, opto-electronics and transport phenomena of materials ranging from atoms, molecules to extended systems including biomaterials. A large number of new models are developed by identifying and optimizing parameters responsible for linear and non-linear optical



polarizations and electron and hole mobilities in a large class of organic molecular crystals and supra-molecular systems.

**Education Technology Unit (ETU):** The Unit is actively involved in the concept, production and development of multimedia CD-ROMs and books especially for school students and teachers in various disciplines of science. The Unit has been involved in developing and producing CD-ROMs and books in vernacular Indian languages. The C N R Rao Hall of Science and Education Technology Unit started the Teachers/students programs/ workshops. ETU had taken up the Hindi translation and production of the **Learning Science** series (four parts) both as CD-ROMs and books. The unit collaborated with World Scientific Publishing Co. Pte. Ltd. to bring out the International Edition of the Book titled '**Understanding Chemistry**' (**International Edition**) by Prof. C.N.R. Rao The book is being marketed by World Scientific. The book titled "**Nanoworld: An introduction to nanoscience and technology**" authored by Prof. C.N.R. Rao was completed, designed, formatted and made print-ready by ETU. In the area of science popularization, 'A Celebration of Chemistry', 'Nanoworld', 'Learning Science' and 'Vign yana Kaliyona' (a science popularization program in Kannada for the benefit of Kannada medium school children) programs were conducted. The unit has made presentations at various international fora using excerpts from the multimedia CD-ROMs **Nanoworld**, **Learning Science** and **Understanding Chemistry** and **Vign yana Kaliyona** ( **Samputa 1,2, 3 & 4**).

**Engineering Mechanics Unit (EMU):** Rotor-driven aircraft have become of great interest in recent years because of their much lower fuel consumption and lower carbon foot print, which has become a major concern because of the need to counter climate change through reduction of green-house gas emissions. On a project related to the design of wings for aircrafts driven by turbo-prop engines and propellers, novel wing plan-forms have been developed, exploiting the slip stream of the propeller for reducing the induced drag. A study using optimization techniques has given interesting and promising results.

Under *Complex Fluids and Interfacial Flows*, the volume-of-fluid method was studied in detail, and a new computer code for computing interfacial flows is nearing completion. Droplet shapes were studied and a new class of static stable shapes for pendant drops was found. In the area of *Computational Fluid Dynamics*, a DNS study of the starting plume as a model for cumulus clouds has been initiated. The results from 2D simulations have been published and 3D simulations are being carried out on a powerful computing system. A new program has been initiated on the development of meshless solver, sponsored by the Boeing Company. Another program on Lattice-Boltzmann method has been initiated by a new faculty (Dr. Ansumali). In the area of *Experimental Fluid Dynamics*, the focus was on laboratory simulation of magma-convection, (b) Parametric study of flapping flight to identify optimal wing kinematics and the role of wing-flexibility on lift production, (c) Study of Lifted Temperature Minimum (LTM) and (d) study on designing green buildings with natural ventilation (in collaboration with Prof. JH Arakeri, ME, IISc). Two new programs have been initiated during the last year: (a) the role of aerosols on the radiation heat transfer in nocturnal surface layer (LTM), and (b) the interaction of the wake of self propelled underwater bodies with stratified medium and to characterize its surface signatures (supported by NPOL and DRDO). Under *Geophysical Fluid Dynamics*, studies on the Lifted Temperature Minimum (LTM) in the nocturnal atmospheric surface layer have resulted in a plausible explanation of the phenomenon based on vertical variation of aerosol concentration. In the area of *Granular Matter*, a Landau-type order-parameter theory has been developed for the shear-banding phenomenon and discovered the Takens-Bogdanov and a variety of other degenerate bifurcation scenario in a sheared granular fluid. This order-parameter theory is currently being extended to spatially modulate non-periodic patterns, leading to Ginzburg-Landau amplitude equations. Our linear stability theory has successfully predicted the onset of convection in a granular Rayleigh-Benard experimental set-up. From particle simulations of granular Poiseuille flow, it has been found that the slip velocity and its gradient depend crucially on the mean density, wall roughness and inelastic dissipation. An ongoing analytical investigation has helped characterize the modal response of a vortex column to external disturbances, and in particular, has led to the discovery of inviscid resonances. The complete set of eigenmodes, both regular and singular, characterizing vortex column oscillations, has been found.

**Evolutionary & Organismal Biology Unit (EOBU):** The faculty of the Unit continued their ongoing research in the broad areas of chronobiology, neurobiology, animal behaviour and phylogeography, life-history evolution and population dynamics. Faculty of the Unit were active in delivering invited talks at major international and national meetings and premier institutions of the country, and also participated in outreach activities aimed at students. Major research activities in the Unit during 2009-2010 include continuing studies on (a) the molecular genetic and developmental underpinnings of rapid development in fruitflies, (b) male-female coevolution and gender conflict at genomic level in fruitflies, (c) studies on the formal, molecular genetic and adaptive properties of circadian clocks in fruitflies and ants, (d) comparing the neuronal circuits controlling circadian rhythms in different species of fruitflies through

neuroanatomical and behavioural approaches, (e) role of temperature sensitive ion-channels in entrainment of circadian rhythms to temperature cycles, (f) Huntingtin protein expression in clock neurons in fruitflies as a model to study neurodegeneration and the mechanisms of entrainment, and (g) genetic identification for relatedness studies and behavioural observations on elephants in Nagarhole National Park in an attempt to understand the structure of social organization in these elephants. During 2009-2010, the Unit also initiated new graduate courses, including four new laboratory courses and two new courses on neurogenetics and animal behaviour, respectively. The MS/PhD programme in Evolutionary and Organismal Biology for POBE Diploma holders was also initiated in August 2010.

**Molecular Biology and Genetics Unit (MBGU):** Research in MBGU laboratories spans diverse areas of biology with major emphasis on biomedical research and application. The current areas of research comprise infectious diseases, human genetic diseases, chromatin organization and transcription regulation, stem cells and cardiovascular development and molecular mechanism of chromosome segregation. Chromatin Biology Laboratory has carried out colocalization studies using GC selective DNA binding dyes chromomycin A3 and 7-amino actinomycin D and AT selective dye DAPI indicate that TP2 is preferentially localized to GC rich sequences. Interestingly, as spermatids mature, TP2 and GC rich DNA moves towards nuclear periphery and in the later stages of spermatid maturation TP2 is predominantly localized at the nuclear periphery. Another interesting observation is the mutually exclusive localization of GC and AT rich DNA in the elongating and elongated spermatids. Research in Molecular Parasitology Laboratory is focused towards understanding metabolism in the malaria parasite *Plasmodium falciparum*. Towards this end the enzymes involved in purine nucleotide metabolism in the parasite are being studied. The researchers in Vascular Biology Laboratory derived recently two new sibling human embryonic stem cell (hES) lines from discarded embryos have been derived and differentiated to cardiovascular derivatives that can be cultured to purity. These are called BJNhem19 and BJNhem20 and have been deposited in the UK Stem Cell Bank. Researchers at Molecular Parasitology Laboratory are trying to find out whether DBL domains with specific residues are responsible in cases of severe malaria in Indian patients from various geographical regions. Furthermore, the expression pattern of this and other virulent proteins are being studied. In the HIV Laboratory a large number of Indian clinical samples have been screened and identified an immunodominant B-cell epitope in the cysteine-rich domain of Tat only in the HIV infected people. This finding has a direct relevance for HIV vaccine design. Human Molecular Genetics Laboratory has discovered a novel epilepsy locus at chromosome 3q13.3-q21, was followed by a detailed analysis of genes at 3q13.3-21, leading to identification of several patient-specific mutations in the extracellular calcium-sensing receptor (CaSR) gene (Annals of Neurology 2008). Transcription and Disease laboratory is focusing on understanding the role of epigenetic modifications, histone chaperones and non-histone chromatin proteins in chromatin dynamics and transcription regulation. The researchers in Molecular Mycology Laboratory have been studying structure-function analysis of centromeres in several pathogenic yeasts including *Candida dubliniensis*, *Candida tropicalis* and *Cryptococcus neoformans*. These yeasts cause most of the deaths by fungal infection in immune-compromised patients. We identified centromeres of, *C. dubliniensis* and compared centromere sequences with those of a closely-related yeast *C. albicans*.

**Theoretical Sciences Unit (TSU):** The research conducted in the TSU continued to explore new frontiers in the area of theoretical physics and chemistry techniques applied to various systems. The group of Subir Das carried out and is continuing research on critical dynamics, pattern formation, nucleation phenomena, etc. Kavita Jain and her group continued their efforts to understand the problem of evolution of sex and recombination. They studied the evolutionary dynamics of a maladapted population under mutation, selection and recombination by developing a novel analytical method to calculate the fixation time to the fittest locus. Research in the group of Shobhana Narasimhan was focused on applying density functional theory to study various materials, including magnetic surface alloys, defects in graphene, methane storage in graphene and activated carbons, nanomagnetism and catalysis. One important result was the prediction of new surface alloys composed of bulk-immiscible metals; one of these systems, viz., FeAu/Ru(0001) has subsequently been shown by their experimental collaborators to indeed form an ordered surface alloy. Swapan Pati's group has contributed extensively to the microscopic understanding of optical, magnetic, opto-electronics and transport phenomena of materials ranging from atoms, molecules to extended systems including biomaterials. They developed a large number of new models by identifying and optimizing parameters responsible for linear and non-linear optical polarizations and electron and hole mobilities in a large class of organic molecular crystals and supra-molecular systems. Srikanth Sastry's group performed research on modeling gel formation, protein aggregation, liquid-liquid transition and nucleation in silicon, and length scales in glass forming liquids. Further, analysis of glass formers in different spatial dimensions was carried out using molecular dynamics simulations, and lattice model calculations. NS Vidhyadhiraja and his group have studied the crossover from the Kondo lattice regime to the mixed-valent regime in heavy fermion materials in terms of dynamics, transport and





thermodynamics. They find several novel features in our theoretical studies that corroborate with experiment, and have hitherto been attributed to other extraneous factors such as crystal field splitting. Amongst the research achievements of Umesh Waghmare's group in the past year, they determined the structural origin of the oxygen storage capacity of Sn, Pd and Fe doped CeO<sub>2</sub>; analyzed hydrogen storage in 3D Lanthanide organic frameworks; determined the thermodynamics of H vacancies in MgH<sub>2</sub> from first-principles obtained electric field- temperature phase diagrams of BaTiO<sub>3</sub> and investigated polarization switching, developed a model for ferroelectric SrTiO<sub>2</sub>-BaTiO<sub>3</sub> superlattices, and explained the origin of magnetocapacitance in BaTiO<sub>3</sub> at the nanoscale; he also wrote a review article on Computational Simulations of Nano-structures.

**International Centre for Material Sciences (ICMS):** Being a first centre of this kind everything is being done to make sure that the centre not only fulfils its objectives but also creates new traditions in carrying out research, extension activities and international collaborations. The centre has ongoing research programmes on Solid-State Lighting, Surface Physics, Polymers, High-Resolution Electron Microscopy, Soft Condensed Matter and Chemistry for Materials. ICMS has established major scientific user facilities to serve both in-house researchers and researchers from other universities. This facility houses specialized instrumentation maintained and run by experts. The centre has many collaborative agreements and programmes with various universities, like Cambridge University, Northwestern University, Mesa+ at the University of Twente, National Institute of Materials Science in Tsukuba, Japan and with the Nano Institute in University of Waterloo, Canada. Several young scientists from other countries as well as from India have carried out short term research activities in the centre.

**The Centre for Computational Materials Science (CCMS) :** Molecular dynamics simulations of a series of bis(trifluoromethylsulfonyl)amide anion based room temperature ionic liquids have been carried out in order to identify the effects of the molecular symmetry of the cation on the structure and dynamics of the liquid. Simulations of ionic liquids with imidazolium cation containing varying lengths of alkyl groups were performed. Research on modeling gel formation, protein aggregation, liquid-liquid transition and nucleation in silicon, and length scales in glass forming liquids, analysis of glass formers in different spatial dimensions have been carried out using molecular dynamics simulations, and lattice model calculations. Extensively contributed to, the microscopic understanding of optical, magnetic, optoelectronics and transport phenomena of materials: ranging from atoms, molecules to extended systems including biomaterials. In-depth analysis of the role of quantum fluctuations in controlling the geometrical frustrations in various Kagomé lattices has shed new insights to the magnetic behavior in this emerging class of materials. Studies have been carried out on bio-molecular materials like DNA, their applications in magnetic switching devices and photon up and down-conversion within protein geometry. A model for ferroelectric SrTiO<sub>2</sub>-BaTiO<sub>3</sub> superlattices was developed. A review was written on Computational Simulations of Nano-structures. The origin of magnetocapacitance in BaTiO<sub>3</sub> at nano-scale has been explained. Under the Visitors Programme, 5 students and 1 CCMS associate member have visited for period of about a week to 8 months for research / collaborative work with CCMS members.

#### **Academic**

During the year, 56 students (47 Students for MS/ Ph D, 4 Students for Integrated Ph D), 3 students for Postgraduate Diploma, and 2 students for External Registration Programme were admitted. Nine students were awarded Ph D, 3 students MS (Engg.) one student MS (by research) and one student was awarded MS (Int. Ph D) degree.

#### **Fellowship & Extension Programmes**

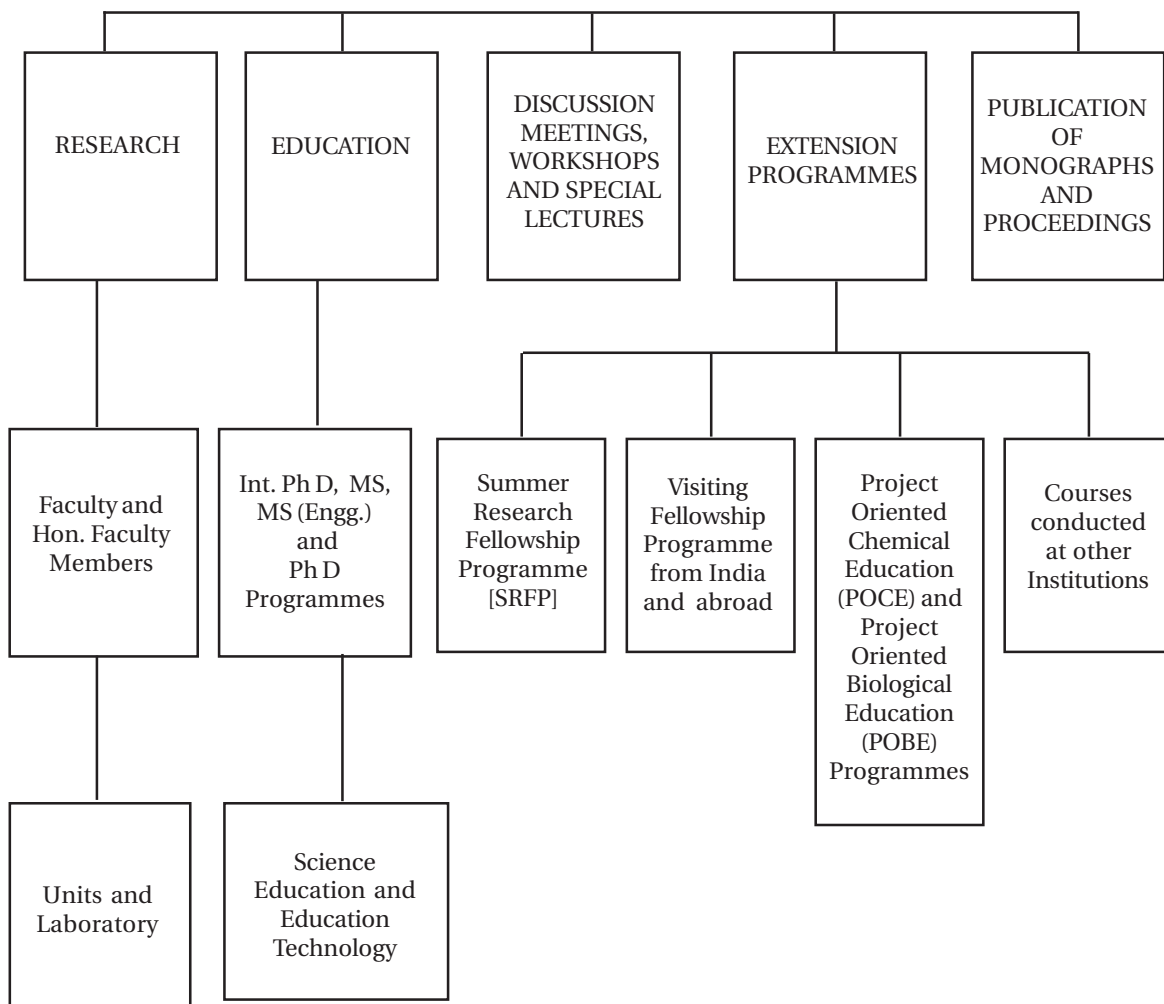
Under the Summer Research Fellowships Programme, 107 fellowships were awarded. For the JNC-TWAS-ROCOSA – Summer Research Fellowships programme, five students from different countries were selected and worked with faculty of various host institutions in the country. For the Project Oriented Chemical Education (POCE) 27 undergraduate students attended the programme. The POBE programme has successfully completed three years with 30 students from various institutions in the country undergoing interactive training and for the year 2009-10. Seven candidates have been offered Visiting Fellowships for 2009-10. Out of 8 candidates joined for DST Postdoctoral Fellowship in Nano Science and Technology programme, 7 were continuing their fellowship.

#### **Reservation, Official Language and Implementation of the judgments/orders of the CAT**

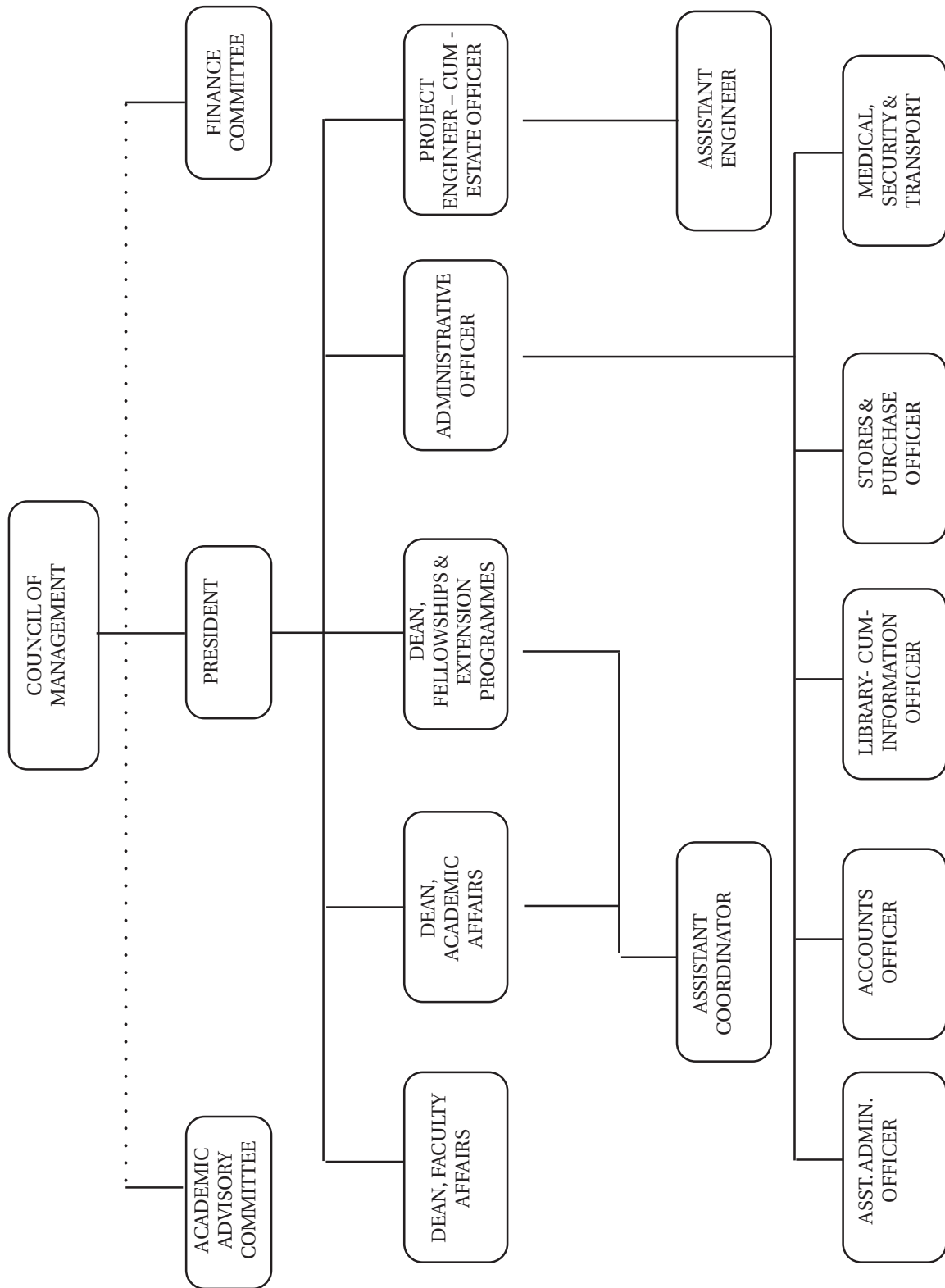
The Centre follows the national policy on reservation and official language as per rules and orders issued by the Government of India with necessary guidelines from the Council of Management from time to time. During the current year there were no cases pertaining to the Centre appeared before the CAT.

# ACTIVITIES CHART

## JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH



# ORGANISATION CHART



## THE ORGANISATION

### 1. Council of Management

Administration and management of the affairs and finances of the Centre are conducted by the Council of Management. The Council of Management of the Centre meets twice a year.

The following are the members of the Council:

<b>P Rama Rao</b> ISRO Brahm Prakash Distinguished Professor, ARCI, Hyderabad	Chairman
<b>M R S Rao</b> President, JNCASR	Member
<b>T Ramasami</b> Secretary, Department of Science and Technology, New Delhi	Member
<b>C N R Rao</b> Linus Pauling Research Professor and National Research Professor, JNCASR	Member
<b>S K Joshi</b> National Physical Laboratory, New Delhi	Member
<b>K P Pandian</b> Joint Secretary & Financial Adviser, Department of Science and Technology, New Delhi	Member
<b>P Balaram</b> Director, Indian Institute of Science, Bangalore	Member
<b>Sinha B</b> Director, VECC & Saha Institute of Nuclear Physics, Kolkata	Member
<b>S Chandrasekaran</b> Indian Institute of Science, Bangalore	Member
<b>A N Jayachandra</b> Sr. Administrative Officer, JNCASR	Secretary





## 2. The Finance Committee

The Finance Committee of the Centre scrutinizes all financial proposals, and makes recommendations to the Council of Management.

The constitution of the Finance Committee is as follows:

<b>M R S Rao</b> President, JNCASR	Chairman
<b>C N R Rao</b> Linus Pauling Research Professor and National Research Professor, JNCASR	Member
<b>K P Pandian</b> Joint Secretary & Financial Adviser, Department of Science and Technology, New Delhi	Member
<b>S Chandrasekaran</b> Indian Institute of Science, Bangalore	Member
<b>Revathi Bedi</b> Finance Officer, JNU, New Delhi	Member
<b>R S Gururaj</b> Accounts Officer, JNCASR	Member
<b>A N Jayachandra</b> Sr. Administrative Officer, JNCASR	Secretary

### 3. The Academic Advisory Committee

The functions of the AAC include planning, execution and coordination of research and other academic activities of the Centre. It also regulates the courses of study, procedure for admission of students, examination, etc. It meets at least twice a year. The Committee makes its recommendations to the Council of Management on all academic matters.

The members of the Academic Advisory Committee are:

<b>M R S Rao</b> President, JNCASR	Chairman
<b>C N R Rao</b> Linus Pauling Research Professor and National Research Professor, JNCASR	Member
<b>Chandan Das Gupta</b> Indian Institute of Science, Bangalore	Member
<b>Dipankar Chatterji</b> Indian Institute of Science, Bangalore	Member
<b>D D Sarma</b> Indian Institute of Science, Bangalore	Member
<b>P Ramachandra Rao</b> (upto 10.01.2010) Hyderabad	Member
<b>K VijayRaghavan</b> Director NCBS, Bangalore	Member
<b>K B Sinha</b> Dean , Faculty Affairs, JNCASR	Member
<b>Hemalatha Balaram</b> Dean, Academic Affairs, JNCASR	Member
<b>N Chandrabhas</b> Dean, Fellowships & Extension Programmes, JNCASR	Member
<b>A N Jayachandra</b> Sr. Administrative Officer, JNCASR	Secretary



## 4. Faculties

All the faculty members are involved in various academic activities of the Centre and assist the Academic Advisory Committee in discharging its functions. The last Annual Faculty Meeting was held in November 2009 which included lectures by the faculty on the advances made in various research areas. Local faculty meetings were held in August 2009 and February 2010 to review the progress and provide inputs wherever required.

## 5. Administration

<b>President</b> M R S Rao	Ph D (IISc), F A Sc, F N A, F N A Sc, FTWAS
<b>Dean, Faculty Affairs</b> K B Sinha	Ph D (Univ. of Rochester), F A Sc, F N A, FTWAS
<b>Dean, Academic Affairs</b> Hemalatha Balaram	Ph D (IISc), F A Sc
<b>Dean, Fellowships and Extension Programmes</b> N Chandrabhas	Ph D (IISc)
<b>Warden &amp; Student Counsellor</b> A Sundaresan	Ph D (IIT Bombay)
<b>Associate Warden</b> Kavita Jain	Ph D (TIFR)
<b>Sr. Administrative Officer</b> A N Jayachandra	B Com (Mysore), ICWA (Inter)
<b>Assistant Administrative Officer</b> C S Chitra	B Com (Bangalore)
<b>Assistant Coordinator</b> Princy Jaison Pereira	Ph D (Gujarat)
<b>Accounts Officer</b> R S Gururaj	B.Sc. (Mysore) M P Ed (Bangalore) Subordinate Accounts Service (IA&AD)
<b>Stores &amp; Purchase Officer</b> K Bhaskara Rao	M Sc (Hyderabad), M Phil (New Delhi)
<b>Library-cum-Information Officer</b> Nabonita Guha	MLIS (Varanasi)
<b>Senior P A to President</b> A Srinivasan	B A (Hyderabad)
<b>Project Engineer</b> S Chikkappa	B E (Mysore)
<b>Junior Engineer (Civil)</b> Nadiger Nagaraj	DCE

**Junior Engineer (Elec.)**

Sujeeth Kumar S

DEE

**Chief Medical Officer**

B S Subba Rao

MBBS (Mysore)

**Consulting Lady Medical Officers**

Kavitha Sridhar

MBBS (Bangalore)

Archana, MLV

MBBS (Bangalore)

**Honorary Medical Officers**

G R Naghabhushan

MBBS (Mysore), FCCP, FCGP,

P G Dip in M&CH

L Sharada

MBBS (DGO (Madras))

C Satish Rao

MBBS (Mysore)

P K Raghupathy

MBBS (RGU)

R Nirmala

MBBS (Madras)

**Honorary Security Officer**

M R Chandrasekhar

B Sc, LLB (Bangalore)



# UNITS, CENTRES, COMPUTER LABORATORY, LIBRARY AND ENDOWED RESEARCH PROFESSORS

## 1. Chemistry and Physics of Materials Unit

With regard to new nanomaterials, single, bi and few layer graphene samples have been produced mainly based on chemical approaches. Several new results have been obtained for graphene functionalisation. Graphene based nanocomposites have been made and their electrical and mechanical properties have been examined. Graphene Analogues of BN and BCN have been synthesized and their properties have been examined. Air sensitive copper nanoparticles have been stabilized using a water soluble aminoclay matrix. The aminoclay shows remarkable permselective behavior allowing only the ionic species to diffuse through it and react with copper nanoparticles. It blocks the neutral molecule oxygen, thereby stabilizing the copper nanoparticles against oxidation for a longer period. In addition, water dispersible aminoclay synthesized in a single step process was used as an inorganic filler for preparing polyvinyl alcohol (PVA)-clay hybrid films. The PVA-clay hybrid films having different weight percentages of aminoclay were obtained by simple mixing and casting of aqueous solutions of clay and polymer. The composite films show excellent retention of ductile behavior of the polymer, PVA, even at higher loadings (20 wt %) of aminoclay. Introduction of aminoclay stabilized Ag nanoparticles significantly improved the mechanical properties of the composite film. The oxygen barrier property of the composite film was improved with the increase in composition of the clay.

Several new methods have been developed for patterning nanomaterials on given substrates. These methods are based on electron beam lithography and soft lithography. Metal nanowire grating patterns have been produced for optical diffraction based sensing of molecules. Besides, self-assembled CNT circuits have been fabricated for their fuse action has been demonstrated.

Development of polymer field effect transistors (FET). Bilayer structures consisting of donor and acceptor type molecules were used for fabricating (FETs), Development of Polymer Photovoltaics - Bulk polymer heterostructures were used to fabricate solar cells. These devices were comprehensively studied for their dynamical responses, Soft polymer based micro-optic elements were designed and studied for their light propagation characteristics.

Solution processable organic semiconductors provide a pathway to low cost electronic devices due to the reduction in processing costs. However, in order to realize the promise of low cost electronics, the performance of organic electronic devices has to be improved. This will be addressed using the toolkit of synthetic chemistry. To move this, a laboratory for synthetic organic chemistry has been established.

After the discovery of surface ferromagnetism in otherwise nonmagnetic inorganic nanoparticles, the research group is exploring the origin of such ferromagnetism by using various experiments. Photoluminescence and positron annihilation measurements showed Mg vacancies in MgO nanoparticles which is in agreement with the theoretical suggestion. The observation of surface ferromagnetism has been further supported by the study of hollow spheres of several nonmagnetic oxides. The research group have looked at several oxide systems which exhibit negative magnetization although they are not superconductors. Detailed experimental studies showed that there is competition between single ion anisotropy and Dyzialoshinsky-Moriya interactions which are responsible for the observed negative magnetization. The group explored Co and Ni doping in  $\text{FeSe}_{0.5}\text{Te}_{0.5}$  superconductors and found that the doping results in suppression of superconducting transition temperature indicating the importance of Fe in these superconductors.

During the past one year, there is much progress in exploring the different functional aspects of metal-organic frameworks (MOFs), viz. gas storage, selective guest accommodation, anion exchange, magnetism etc. During the course of the study, the group also tried to unveil and understand the dynamic behaviour of MOFs which is very important for selective accommodation and separations of different molecules. In a recent report, the research group described the synthesis and structural characterization of a 3D bimetallic framework ( $\text{Ho}^{\text{III}}\text{-K}^{\text{I}}$ ) with permanent porosity and good  $\text{H}_2$  and  $\text{CO}_2$  storage capacity at high pressure and low temperature. Adsorption analyses reveals very high heat of  $\text{H}_2$  sorption (approximately -10 kJ/mol) in MOFs, realized by the interaction of  $\text{H}_2$  molecules with unsaturated K-sites and was confirmed quantitatively

using first-principles calculations. As a continuation of the gas storage capacity of the MOFs, the group synthesized two new three-fold interpenetrated 3D frameworks of Cu(II) using mixed ligand system which were found to be permanently porous. Both the frameworks can store ~1 wt% of molecular hydrogen at 77 K and 15 bar, in particular, the density of adsorbed hydrogen by one of them is one of the highest reported so far in porous MOFs. The frameworks can also store 11.0 and 13.2 wt% of carbon dioxide at 195 K.

During the year, the research group also interested in assembling the same linker with a metal ion in different way by changing the reaction parameters. The effort resulted in the construction of four Cu-1,4-ndc (1,4-ndc = 1,4-naphthalene dicarboxylate) frameworks by varying solvent and temperature. All the frameworks show permanent porosity suggested by the CO<sub>2</sub> sorption studies. Two of the frameworks exhibit gas storage properties whereas another shows highly selective gated MeOH sorption over H<sub>2</sub>O. One of the compounds shows porosity as well as ferromagnetic ordering, suggesting coexistence of multiple functionalities within the same framework. The report was published in “Emerging Investigators Issue” of *J. Mater. Chem.* In another report, where two Cu-frameworks were synthesized from 2,4/2,5-pyridine carboxylate ligand was found to exhibit very selective adsorption of small molecules like, H<sub>2</sub>O and MeOH while completely excluding larger THF and C<sub>6</sub>H<sub>6</sub> molecules.

The research group also synthesized a Cu(I) framework that has a very fascinating six-fold interpenetrated diamondoid structure and exhibit selective reversible anion exchange ability with NO<sub>3</sub><sup>-</sup> anions, but not with the ClO<sub>4</sub><sup>-</sup> and PF<sub>6</sub><sup>-</sup> anions. The highly selective anion exchange ability is correlated with the size and shape of the anions compare to the channel aperture.

The group's effort to synthesize magnetic frameworks resulted in the construction of a S=½ kagomé compound which has been found to show very interesting temperature dependent magnetic property. The 2D kagomé network is made up of triply bridged CO<sub>3</sub><sup>2-</sup> anions and Cu(II) cations. The kagomé network is formed by atmospheric fixation of CO<sub>2</sub> under basic aqueous condition. The 2D net is further pillared by a organic linker, bpe (bpe = 1,2-bis(4-pyridyl)ethane) to generate a 3D framework. Magnetic analysis reveals that the framework exhibits weak antiferromagnetic interaction in the 2D kagomé layer and interlayer ferromagnetic coupling at low temperature. This was the second report on S = ½ kagomé metal-organic framework.

*Light Scattering Laboratory* has been involved in performing various experiments using the Brillouin Spectroscopy, Raman Spectroscopy and High Pressure Research. Further, Brillouin Spectroscopy measurements have been carried out on pyrochlores. These class of compounds are important not only technologically but also for the understanding of frustrated systems. The Dy<sub>2</sub>Ti<sub>2</sub>O<sub>7</sub> family of pyrochlores were taken to perform Brillouin experiments. The interesting result is that the structural transformation as a result of an attempt to order at lower temperature is clearly seen using the Brillouin experiments. These results unequivocally suggest that these disordered systems do make an attempt to order in the ground state. Ambient and High Pressure Raman studies have been carried out on ionic conductors. Ionic conductors are the future materials in the fuel cells and other energy applications. It is important to understand the microscopic picture of the origin of these ionic states, particularly in systems such as KHSO<sub>4</sub>. The latest results suggest that the super ionic state is driven by the disorder in the system purely driven by the rotational instability of the SO<sub>4</sub> units. These rotations open up channels in the highly coordinated systems to allow K ion conduction. Light Scattering group has been strongly involved in the study of biological system with surface enhances Raman Spectroscopy (SERS). The earlier work has been trend setters in the field of drug protein interactions. Based on the success, SERS technique is being used to understand the secondary and tertiary structural changes in Protein in the case of transcriptional activator proteins like C-Proteins. These results are path breaking as hither too it has been difficult to demonstrate with existing spectroscopic tools to show these structural changes due to single cationic substitution. During this period the two patents associated with antibacterial activities of nanoparticle cellulose composites and SERS based DNA/RNA detection without PCR amplification reached National Phase stages.

An experimental soft matter research facility is established. A confocal microscope and rheometer were installed in the first week of January 2010. Work is currently underway to mount the rheometer on our confocal microscope. This will allow us to obtain 3D structural information on soft material subjected to a shear. The research group is also working on coupling a holographic optical tweezer set-up, using a spatial light modulator, to our confocal microscope. The group developed the software for the spatial



light modulator and this is essential for multi-particle manipulation in the optical tweezers set-up. In the high-end microscopy laboratory, the installation of new TITAN microscope and FEG-SEM) is completed. This facility is being used by a large number of researchers.

As part of molecular dynamics simulation, the complex dynamics of a room temperature ionic liquid, 1-n-butyl-3-methylimidazolium hexafluorophosphate ([bmim][PF<sub>6</sub>]) has been studied using equilibrium classical molecular dynamics simulations in the temperature range of 250K-450K. A correlation between dynamic heterogeneity and intermolecular structure has been established.

### Research Projects

**a) Yielding of Crystals:** The research group synthesized temperature tunable colloidal particles for studying processes that govern the yielding and plastic flow of colloidal crystals.

**b) Self-Assembly in Model Dimer Systems:** The group also synthesized Silica-Gold Janus particles. Experiments are currently underway to study the effect of the surface asymmetry of these particles in the self-assembly process.

**c) Flow through Patterned Channels:** Simulations have shown that the Reynolds number at which turbulence sets in for Newtonian fluids, subjected to a Poiseuille flow, can be significantly lowered by patterning the surfaces of the channel. This enhanced turbulence and mixing may be useful in designing more efficient heat-exchangers and blood oxygenators. The research group created nearly sinusoidal surface roughness on the 50 - 100 micron length scale and use these surfaces as the walls of channel. Experiments are underway to test the simulation predictions.

**d) The structural, compositional and morphological aspects of heteroepitaxial growth** and formation of self-assembled nanostructures using surface reconstructions and dislocation pattern as templates, by surface sensitive probes in ultra-high vacuum are undertaken. The thin film systems include heterostructures that find applications in Solid State Lighting, Full Spectrum Photovoltaics, Water Purification, High Electron Mobility Transistors, etc.

**f) III-nitride growth by Molecular beam Epitaxy:** A sophisticated Molecular Beam Epitaxy system dedicated for the growth of III-nitride thin films is installed and optimized. The ultra high vacuum system consists of 10 Knudsen cells, Nitrogen plasma and ammonia sources and *in-situ* characterization by RHEED, Ellipsometer, Cathodo-luminescence and atomic absorption. The temperature dependent growth experiments of GaN, InN and AlN on Al<sub>2</sub>O<sub>3</sub> (0001) and Si(111) surfaces are understood by above *in-situ* and *ex-situ* techniques such as HRXRD, FE-SEM, Photoluminescence, AFM and X-ray Photoelectron Spectroscopy. The results have shown a matrix network formation of GaN nano-walls, due to strain relaxation induced by the lattice mismatch and thermal expansion difference. Under suitable conditions of formation, the matrix opens up and promotes hexagonal and octagonal GaN nanowires and nanotubes of high aspect ratios, in a narrow temperature range. The Ga droplet formation at the bottom of the matrix pits and side walls appear to follow a modified VLS type of mechanism. Further experiments are underway to study the dependence of nitrogen flux and coverage on these nanostructure formation to elucidate the underlying mechanism of this unprecedented size, shape and assembly controlled nanostructure formation.

**g) Metal Nanostructure and Surface Phases on Si surfaces:** The research group studied the formation of surface phases and self assembled nanostructures using Silicon surface orientation and surface reconstruction patterns as templates for nanostructure growth. The adsorption of Pb on Si(111) 7x7 surface has been studied and demonstrated the formation of nano-islands in the monolayer regime depends on the flux rate of arrival of Pb atoms onto the substrate. We have extensively probed the adsorption of In atoms on Si(111) 7x7 surface. The system demonstrates an anomalous growth sequence which consists of clustering and layering. The reentrant phenomenon is visible in the desorption experiments also, showing the subtle effects on this moderately lattice matched system. These studies are performed also on the high index Si(5 5 12) surface that is faceted into well formed atomic grooves. In nanowires are formed in these grooves and the activation energies for the desorption follow a hierarchy due to different bonding energies. Phase diagrams for the In/Si(111) and In/Si(5 5 12) systems have been reported.

**h) Substrate search for epitaxial GaN growth:** Silicon and gallium arsenide substrates have been successfully modified by ion beams into SiC, Silicon nitride and Gallium nitride at room temperature, in an effort to search for substrates compatible for epitaxial Gallium Nitride growth.



## New Programmes Launched

### Micro Brillouin Setup:

With the advent of Nano Science and Technology there has been an increased interest in understanding the mechanical properties of nano systems as is as well as in the device geometry. Brillouin Spectroscopy is a non-contact probe to understand the mechanical properties. At present the laboratory is not equipped to handle samples in the micrometer regime. The laboratory has initiated the development of micro Brillouin Setup this year and would be functional in the early part of the next academic year. This will be a very valuable addition to the LSL capability.

High Pressure Synchrotron Beam Line in Photon Factory, Japan Under the DST-Japan joint initiative an Indian Beam Line is being setup for doing synchrotron experiments at Photon Factory. In line with this there is an interest to develop an High Pressure Beam line for the Indian scientist. This is being done by Light Scattering Laboratory and would be functional in the early part of the next academic year. This will also facilitate the LSL to look at high pressure x-ray experiments in the future.

**Growth and characterization of III-nitrides heteroepitaxial films. Setup** for studies of quantum size effects in the growth of metals on silicon surfaces.

The following are the members of the Unit:

#### Chair

G U Kulkarni Ph D

#### Professors

C N R Rao Ph D, D Sc, F A Sc, F N A, F  
R S, F T W A S,  
Hon. F R S C

K S Narayan Ph D, F N A Sc, F A Sc.

G U Kulkarni Ph D

S M Shivaprasad Ph D

#### Associate Professors

S Balasubramanian Ph D

N Chandrabhas Ph D

A Sundaresan Ph D

#### Faculty Fellows

M Eswaramoorthy Ph D

Tapas Kumar Maji Ph D

#### Technical Officers

V Sreenath (BE), S Srinivas (BE), Usha Govind Tumkurkar  
(M Phil)

#### Lab Assistants

J Anil Kumar (DEE), B S Vasudev (BE),  
Alla Srinivasa Rao (BE)

#### Research Associates

Balaraju P, Diptikanta Swain, Nagaraja C M, Navneet Kaur, Sundarayya  
Yanamandra, Vivek Chand, S R C

#### R & D Assistants

Arivazhagan P, Arun Dhumal Rao, Gopal Krushna Pradhan,  
Josena Justus, Krishna Kumar K, Mahesh, J I, Manohar Rao, N V,  
Sebin Mathew, Vijay Venugopalan





**Technical Assistant**

N R Selvi

**Postdoctoral Fellows (DST)**

Abhay A Sagade, Dattatray J Late, Prashant Kumar

**Research Fellows**

Venkata Prasad S, Jyoti Ranjan Sahu,  
Claudy Rayan Serrao, Gomathi A

**Research Students**

Gopal Krushna Pradhan, Reji Thomas, Venkata Prasad Bhat, Manohar Rao NV, Jyoti Ranjan Sahu, Soumya Saswati Sarangi, Rakesh V, Shipra, Katla Sai Krishna, Monojit Bag, Pranab Mandal, Srinivas Raju G, Gomati A, Partha Pratim Kundu, Prakash Kanoo, Sudip Mohapatra, Radha B, Sabyasachi Mukhopadhyay, Leela Srinivas Panchakarla, Jithesh K, Manoj Kesaria, Subrahmanyam KS, Kalyan Raidongia, Narendra Kurra, Anshuman Jyothi Das, Sandeep Kumar Reddy, Satish Shetty, Venkata Srinu Bhadrani, Jaya Ramulu Kolleboyina, Satyaprasad Premswarup Senanayak, Malleswararao Tangi, Mallikarjuna Rao K D, Bharath R .

Hima K, Nagamanasa, Ravichandran S, Pavan Kumar B.V.V.S, Gangaiah Mettela, Rajdeep Singh Payal.

Kumara Ramanatha Datta K, Neenu Varghese, Ramakrishna Matte H S S. Ritu Gupta, Nitesh Kumar, Urmimala Maitra, Nisha Mariam Bivas Saha, Soumik Siddhanta, Abhay Kumar Tiwari, Piyush Kumar Chaturbedy, Vini Gautam, Arpan Hazra, Chaitanya Sharma Chidambar Kulkarni, Dileep Krishnan, Gayatri Kumari, Pandeewar M, Rana Saha, Sudeshna Sen, Varun Thakur, Dibyajyoti Chakraborty, Darshana Joshi, Prashant Kumar.

## 2. New Chemistry Unit

Currently the Unit is involved in three different research projects which are interdependent and complementary. Synthesized chiral unnatural amino acids with metal binding properties (metal binding ligands). These chiral-amino acid ligands will be used for the 'asymmetric induction' in metal-reagent mediated asymmetric syntheses. This provides a novel methodology to access chiral biologically important natural products and synthetic organic molecules with diverse applications. New chiral-amino acid ligands obtained as mentioned above would also help us to develop 'sensors' for different metal ions in complex fluids and to assess their concentration levels. A new class of oligomers with metal binding ligands will be designed and synthesized. These synthetic oligomers serve as smart-building blocks for the design and synthesis of metal directed assemblies and will find applications as biomaterials. Focused on the design and synthesis of peptide and proteins capable of self-assemble to produce materials which can complement biological materials with comparable or even superior properties.

Functional Organic Materials, Organic-Supramolecular Synthesis and Stimuli Responsive Supramolecular Systems

The underlying theme of the group's research is the interface between synthetic efforts on small molecules or polymers and macroscopic properties at the materials level, leading to a macro-organic/supramolecular approach to functional materials. More specifically, we research organic or supramolecular synthesis of *p*-conjugated systems, organic-inorganic hybrid materials, stimuli-responsive polymers and chiral nanotechnology in our laboratory. Currently we are working on the design of self-assembled functional systems from chromophores or *p*-conjugated oligomers, which are the key ingredients in the integration of electronic components for nano-sized electronics. The research group is synthesizing various *p*-type soluble, regiosymmetric thiophene molecules with planar fused-ring spacers and *n*-type coronene bisimide and tetraimide derivatives with solubilizing alkyl side chains. The group also investigate whether alternate co-assembled nanofibers of donor and acceptor molecules through charge-transfer interactions can be constructed using the supramolecular chemistry design principles. With this objective in mind the self-assembly of various amphiphilic donor-acceptor pairs to nano-fibers and hydrogels were studied. Since the molecular engineering of graphene and tailoring its electronic properties, are some of the challenges for exploring its applications, the non-covalent functionalization of graphene with various aromatic donor and acceptor molecules to form graphene-coronene composites exhibiting molecular charge-transfer and tunable opto-electronic properties has been targeted. Another focus is the design of supramolecular polymeric materials capable of sensing and reversible switching in response to external stimuli. Next to the wish to design new functional organic materials, we also aim at Chiral Nanotechnology.

The Unit is involved in setting up a research program that will provide a platform to integrate organic chemistry and materials science with biology to combat infectious diseases in a multi-pronged approach namely diagnosis, prevention and treatment. The research will focus on a fundamental understanding of material-pathogen interaction that will provide innovative solutions in tackling infections. Initially, the Unit will focus on designing, preparing and exploring various biodegradable and non-toxic antimicrobial agents that can be readily applied for biomedical applications.

The researchers have contributed extensively to the microscopic understanding of optical magnetic, opto-electronics and transport phenomena of materials ranging from atoms, molecules to extended systems including biomaterials. A large number of new models are also developed by identifying and optimizing parameters responsible for linear and non-linear optical polarizations and electron and hole mobilities in a large class of organic molecular crystals and supra-molecular systems. The in-depth analysis of the role of quantum fluctuations in controlling the geometrical frustrations in various Kagomé lattices has shed new insights to the magnetic behavior in this emerging class of materials. The work also encompasses study of bio-molecular materials like DNA, their applications in magnetic switching devices and photon up and down-conversion within protein geometry and pioneered modeling molecular electronics materials both by developing and applying new theoretical techniques for the study of molecular memory and switching devices. The stability of unusual metallic nano-clusters are also analysed and the experimental routes for possible isolation of a new class of all-metallic nano-clusters has been suggested.



## New programmes launched

### Prof. Swapan K Pati:

- a. Organizer of a joint workshop between JNCASR and Northwestern University at JNCASR in Aug, 2009.
- b. Convenor of India-Japan (DST-JSPS) bilateral meeting on “Graphene” at JNCASR in Nov, 2009.
- c. Convenor of ICMS-Cambridge Winter School on Chemistry and Physics of Materials at JNCASR in Dec, 2009
- d. Convenor of I2CAM school and Conference on Emergent Properties and Novel Behavior at the Nanoscale, at JNCASR in Apr, 2010.

The following are the members of the Unit :

#### Chair

Prof C N R Rao

Ph D, D Sc, F A Sc, F N A, F R S,  
F T W A S, Hon. F R S C

#### Faculty Fellows

Dr Subi Jacob George

Ph D

Dr T Govindaraju

Ph D

Dr Jayanta Halder

Ph D

#### INSA Senior Scientist

Prof H Ila

Ph D, FNA, F A Sc

#### Associate Faculty Members

Prof Swapan K Pati (Associate Professor)

Prof A Sundaresan (Associate Professor)

Dr M Eswaramoorthy (Faculty Fellow)

Dr Tapas Kumar Maji (Faculty Fellow)

Dr A Govindaraj (Honorary Faculty Fellow)

#### Research Associates

Nimesh C Mishra, Vijayalaxmi Amareshwar

#### R & D Assistants

Ankit Jain, Jiaul Hoque

#### Research students

Avinash M B, Debabrata Maity ,Venkata Rao Kotagiri,  
Ajmal Shireen P, Ritesh Halder, Yarlagadda Venkateswaralu.

### 3. Education Technology Unit

The Unit is actively involved in the concept, production and development of multimedia CD-ROMs and books especially for school students and teachers in various disciplines of science. The Unit has been involved in developing and producing CD-ROMs and books in vernacular Indian languages.

The C.N.R. Rao Hall of Science and Education Technology Unit started the Teachers/students programs/workshops. The workshops/programs are conducted in different subjects like Physics, Chemistry and Biology. The Unit organized many science popularization programs in various parts of the country.

ETU had taken up the Hindi translation and production of the **Learning Science** series (four parts) both as CD-ROMs and books. The work on the translation, design, creating the graphics/visuals and formatting for the print-ready copies of the books were completed by ETU and print-ready copies were sent to National Book trust for printing. Part 1: **Universe, Solar System and Earth** Part 2 titled **The world of physics and energy: Learning physical principles** comprising topics in Physics and energy, Part 3 titled **The world of chemistry: of molecules and materials, Air around us and All about water**. Part 1 to Part 3 have been published and are being marketed by National Book trust. Part 4 titled **Biology and life** will also be printed shortly.

The unit collaborated with World Scientific Publishing Co. Pte. Ltd. to bring out the International Edition of the Book titled '**Understanding Chemistry**' (**International Edition**) by Prof. C.N.R. Rao. The book is being marketed by World Scientific.

The book titled "**Nanoworld : An introduction to nanoscience and technology**" authored by Prof C N R Rao and was completed, designed, formatted and made print-ready by ETU. This book is intended for students, teachers and others who have a interest in Nanoscience and technology. The book covers various areas like technology, health and other aspects of Nanomaterials.

About 3000 copies have been printed. About 1100 copies of the book and 400 CD-ROMs were distributed to the participants of ICONSAT-2010 held in February at Mumbai.

#### ORGANISATION OF PROGRAMS

The C.N.R. Rao Hall of Science and Education Technology Unit conducted a meeting on May 25, 2009 of the Resource persons for the Teachers-students programs/workshops to be held during June - December 2009 at the Madan Mohan Malaviya Amphitheatre, C.N.R. Rao Hall of Science. At this meeting it was decided that these programs are to be held as part of the Science outreach Programme and will be in Physics, Chemistry and Biology. Most of the resource people were faculty from various units of JNCASR (CPMU, TSU, MBGU). Prof C N R Rao presided over the meeting for the programs conducted between June-December 2009 and the format was discussed and the conveners for the various programs were announced.

The C.N.R. Rao Hall of Science and Education Technology Unit conducted Teachers/students programs/workshops during June-December 2009. The workshops/programs during this period were conducted in different subjects like Physics, Chemistry and Biology. In all the above programs faculty from different institutes were invited to give lectures on a particular theme in the concerned subject and were also invited to participate in an interactive question and answer session at the end of the program. The Programs/workshops organised by the CNR Rao Hall of Science and ETU and conducted at the Madan Mohan Malaviya Amphitheatre were as follows:

On June 30<sup>th</sup>, 2009 as the first program, C.N.R. Rao Hall of Science and ETU conducted a lecture program as part of the C.N.R. Rao Education foundation Prize program for teachers. The distribution of the awards and felicitation function was conducted at the Madan Mohan Malaviya Amphitheatre In the lecture program Prof. C.N.R. Rao gave the first lecture on '**Nanoworld**'. Prof. Prajval Shastri from the Indian Institute of Astrophysics gave the second lecture titled '**The fascinating Cosmos**' and the third lecture was given by Prof. Raghavendra Gadagkar, Indian Institute of Science on '**The Fascinating World of Insect Societies**'.

The following programs were conducted: 'Physics for students and teachers' - July 18, 2009. 'A Celebration of Chemistry' - August 13, 2009, Biology for students and teachers - August 29, 2009, Aspects of Environmental Science for students and teachers - September 30 2009, 'Physics for students and teachers' - October 27,



2009, Biology for students and teachers - November 25, 2009 and 'Chemistry for students and teachers' on January 13, 2010.

In each of the above programs at least 200 students and teachers participated from various schools and colleges in and around Bangalore.

In the area of science popularization, 'A Celebration of Chemistry', 'Nanoworld', 'Learning Science' and 'Vignyana Kaliyona' (a science popularization program in Kannada for the benefit of Kannada medium school children) programs were conducted. The unit has made presentations at various international fora using excerpts from the multimedia CD-ROMs *Nanoworld*, *Learning Science* and *Understanding Chemistry* and *Vignyana Kaliyona (Samputa 1,2,3 & 4)*.

The Inaugural session of Project Oriented Chemical Education - 2009 and Project oriented Biological Education – 2009 was conducted at the C.N.R. Rao Hall of Science where Professor C.N.R. Rao addressed the students. Education Technology Unit participated in POCE - 2009. On May 20, 21 and 22 ETU presented a one hour multimedia presentation of the CD-ROM titled 'Nanoworld' and certain modules from the CD-ROM 'Understanding Chemistry' to the POCE -2009 participants.

The program 'Learning Science' was organised by ETU, JNCASR in association with Indian Institute of Science Education and Research, Mohali on April 9, 2009 at Shivalik Public School, Mohali. Around 800 students and teachers attended the program. Learning Science books were distributed to the schools and teachers. It was conducted in Tezpur University on November 23, 2009. 'A celebration of Chemistry' was conducted at IISER – Bhopal on 4<sup>th</sup> September 2009, at Trivandrum on October 29, 2009 and at the Indira Gandhi Centre for Atomic Research, Kalpakkam on 13 March 2010.

C. N. R. Rao Hall of Science and ETU organised the 'Vignyana Kaliyona' program on April 24<sup>th</sup> 2009 for students and teachers from various schools at the Madan Mohan Malaviya Amphitheatre. Prof. C.N.R. Rao gave the theme lecture 'Vignyana Kaliyona' in Kannada. This was followed by a multimedia presentation of excerpts from the four multimedia series titled 'Vignyana Kaliyona' samputa 1,2, 3 & 4. ETU organised and conducted the visit of the students and teachers to the Chemistry of Materials Exposition and C.N.R. Rao Archives. The participants were presented with a copy of the books 'Learning Science', A biography of Prof C N R Rao and 'Chemistry of Materials: A letter to a young friend' written by Prof Rao. The Program was also conducted at Haveri on January 8, 2010.

On June 20<sup>th</sup> 2009 ETU participated in the programme 'Nano for the young' conducted by the Kuvempu University, Shimoga as part of the Prof. C.N.R. Rao Nano Centre Foundation stone laying ceremony. Prof. Rao gave the theme lecture titled 'Nanoworld' followed by a multimedia presentation by Mrs. Indumati Rao of excerpts from the CD-ROM 'Nanoworld'. Both the presentations were prepared at ETU.

Prof C N R Rao gave the inaugural lecture titled 'Vignyana Kaliyona' at the Student–Scientist interaction program titled 'Karnataka Vijnana Vidya Jagruti (KVJ)' organised by the Vision group on Science and Technology – Karnataka Government for Bangalore north educational district on July 31 and August 1, 2009 at the J. N.Tata Auditorium, IISc. The lecture presentation was prepared by ETU. On August 1 ETU presented excerpts from the multimedia CD-ROM titled 'Rasayana Shastrada Arivu' to the participants for one hour. The Vision group on Science and Technology – Karnataka Government conducted a four week program in different subjects for teachers in the CNR Rao Hall of Science.

ETU-SOP conducted a two-day workshop on Experiments using College Chemistry Kit on April 27<sup>th</sup> and 28<sup>th</sup>, 2009 for Jawahar Navodaya Vidyalaya, Andhra for class XII students and teachers at the C.N.R. Rao Hall of Science. Mrs. Indumati Rao interacted with the students. ETU presented a short film C.N.R. Rao - A lifetime Professor to the participants of the workshop at the Madan Mohan Malaviya Amphitheatre. On 28<sup>th</sup> April, ETU organised and conducted a visit to the Chemistry of Materials Exposition and Prof C N R Rao Archives for the students and teachers attending the workshop.

ETU-SOP conducted a three-day workshop for Chemistry P.G. Teachers of Jawahar Navodaya Vidyalayas – Southern region on July 15, 16, 17 and 18, 2009. As part of the programmes in this workshop ETU participated in the inauguration. Mrs. Indumati Rao addressed the participants. Prof. Chandrabhas Narayana inaugurated the program. ETU conducted a three-hour program on July 15<sup>th</sup> where Multimedia presentation of excerpts from the CD-ROM 'Understanding Chemistry' and a film titled 'A lifetime professor- C.N.R. Rao' by Sanjay

Ketkar was screened for the participants. On July 16<sup>th</sup> two batches of participants were taken around the Chemistry of Materials Exposition and the Prof C N R Rao archives.

### ON-GOING PROJECTS

The unit will be bringing out a book authored by Prof. C.N.R. Rao titled 'Chemistry Today' It will also bring out the Kannada version of the CD-ROM 'Nanoworld' called 'Nanoprancha' and also a book of the same title.

C.N.R. Rao Hall of Science and Education Technology Unit will be organizing teachers/students workshops /programs in different subjects like Physics, Chemistry, Biology, Nanoscience and Programs in Physical Sciences and Life Sciences for teachers during January-December 2010. It is proposed to have lectures and demonstrations with different themes in a particular subject. In all the above programs faculty from JNCASR, IISc and other institutions will participate.

Education Technology Unit will take up a project in Chemistry. It is planned to develop and produce a CD-ROM title and a book.

The following are the members of the Unit:

<b>Incharge</b> V Krishnan	Ph D, F A Sc, F N A, F T W A S
<b>Coordinator (Hon)</b> Indumati Rao	M A, M S, C E
<b>Technical Officer</b> Jatinder Kaur	M Sc
<b>Multimedia Asst. (Hon.)</b> Sanjay Rao	B Sc, Cert. Multimedia





## 4. Engineering Mechanics Unit

### **Aerospace and Atmospheric Fluid Dynamics:**

Rotor-driven aircraft have become of great interest in recent years because of their much lower fuel consumption and lower carbon foot print, which has become a major concern because of the need to counter climate change through reduction of green-house gas emissions. On a project related to the design of wings for aircrafts driven by turbo-prop engines and propellers, novel wing plan-forms have been developed, exploiting the slip stream of the propeller for reducing the induced drag. A study using optimization techniques has given interesting and promising results.

In atmospheric dynamics a wavelet cross spectral analysis has been carried out showing that the effect of solar activity on Indian rainfall is in part mediated through the effect on ENSO. It has also been shown that periodicities in Indian rainfall are more sharply seen in spectrally homogeneous regions. Region SHR7 turns out to be of particular interest as it shows a marked spectral dip in the period band around 3-7 years.

### **Complex Fluids and Interfacial Flows:**

A novel instability arises in a bacterial suspension due to a 'negative viscosity' response to long wavelength perturbations. The orientation dynamics of anisotropic particles reveals a profound asymmetry between rod and disk-shaped particles.

In continuation of our earlier studies on the effects of micro-scale inertia, work carried out with a summer student helped characterize the effects of inertia on the non-Newtonian rheology of a dilute emulsion. Work carried out with a second summer student helped establish the crucial effect of the disperse phase viscosity on the Nusselt number correlation applicable to dilute emulsions. Studies carried out in collaboration with Don Koch at Cornell University examined the evolution of sedimenting particle clouds, and the structure, dynamics and stability of fibrous suspensions at finite Reynolds number.

The volume-of-fluid method was studied in detail, and a new computer code for computing interfacial flows is nearing completion. Droplet shapes were studied and a new class of static stable shapes for pendant drops was found.

The shallow-water equations are shown to be inadequate to completely describe even a weak hydraulic jump. The lowest-order equation in the near-jump region is derived.

### **Computational Fluid Dynamics:**

A DNS study of the starting plume as a model for cumulus clouds has been initiated. The results from 2D simulations have been published and 3D simulations are being carried out on a powerful computing system.

The MKFVS method has been successfully applied to transonic and supersonic flow around 2-D airfoils. The MKFVS method captures the shocks very crisply. This is an Indo-Russian Project. The TKFMG solver has been used to predict flutter for a 2-D blade of a turbine. Energy method has been used in flutter analysis. This is a CARS Project (Jointly with CTFD, NAL).

A new program has been initiated on the development of meshless solver, sponsored by the Boeing Company. Another program on Lattice-Boltzmann method has been initiated by a new faculty (Dr. Ansumali).

### **Experimental Fluid Dynamics:**

The focus was on (a) Laboratory simulation of magma-convection, (b) Parametric study of flapping flight to identify optimal wing kinematics and the role of wing-flexibility on lift production, (c) Study of Lifted Temperature Minimum (LTM) and (d) study on designing green buildings with natural ventilation (in collaboration with Prof. JH Arakeri, ME, IISc).

For continuing experimental work on cloud flows, new and improved version of the apparatus used in earlier work by us has been set up. Preliminary results from the new apparatus are now available.

Two new programs have been initiated during the last year: (a) the role of aerosols on the radiation heat transfer in nocturnal surface layer (LTM), and (b) the interaction of the wake of self propelled underwater

bodies with stratified medium and to characterize its surface signatures (supported by NPOL and DRDO).

### **Geophysical Fluid Dynamics:**

Studies on the Lifted Temperature Minimum (LTM) in the nocturnal atmospheric surface layer have resulted in a plausible explanation of the phenomenon based on vertical variation of aerosol concentration. The current explanation for the Ramdas layer is erroneous; such a layer can only arise in a locally heterogeneous atmosphere. The flux-emissivity formulation, for radiative interactions between non-black surfaces, has been proposed.

Linear and secondary stability characteristics of supersonic compressible plane Couette flow, having relevance in astrophysical fluid dynamics, has been completed. A leading order viscous correction reveals that the neutral and unstable modes are destabilized by the no-slip enforced by viscosity. The viscosity has a dual role on the stable inviscid mode.

Some preliminary flow visualization work on bubble-driven convection has been carried out. This flow will be quantitatively probed using a newly acquired volumetric particle image velocimetry (PIV) system.

### **Granular Matter:**

A Landau-type order-parameter theory has been developed for the shear-banding phenomenon and discovered the Takens-Bogdanov and a variety of other degenerate bifurcation scenario in a sheared granular fluid. This order-parameter theory is currently being extended to spatially modulated non-periodic patterns, leading to Ginzburg-Landau amplitude equations. Our linear stability theory has successfully predicted the onset of convection in a granular Rayleigh-Benard experimental set-up.

From particle simulations of granular Poiseuille flow, it has been found that the slip velocity and its gradient depend crucially on the mean density, wall roughness and inelastic dissipation. An interesting possibility of Knudsen-number-dependent specular coefficient emerges from a comparison of our simulation results with a first-order transport theory for the slip velocity. The results on stresses suggest the presence of normal stress differences whose magnitude increases with increasing dissipation. Interestingly there is a sign-change of the first normal stress difference at some critical density, and the collisional anisotropy seems to be responsible for its sign-reversal.

The formation of density waves has been studied using particle simulations of gravity-driven granular Poiseuille flow. Three basic types of structures are found in moderately dense flows: a plug, a sinuous wave and a slug; a new varicose wave mode has been identified in dense flows with channels of large widths at moderate dissipation; only clump-like structures appear in dilute flows.

The theoretical predictions, based on a linear stability analysis of the kinetic-theory continuum equations, on the form of density waves are in qualitative agreement with simulations in denser flows, however, there are discrepancies between simulation and theory in dilute flows.

### **Stability:**

The effect of a density stratification, even if small, in the vicinity of a vortex, was shown to be large, with centrifugal Rayleigh-Taylor and spiral Kelvin-Helmholtz instabilities, which led to early breakdown into turbulence, and vortex death.

The two-dimensional stability of converging-diverging flows and of wall jets shows a number of interesting features. In particular the dependence of instability wave number on the normal coordinate is seen, which is impossible to find with traditional stability analyses. A converging-diverging channel can behave as an instability ratchet, as revealed in our global instability studies.

In the earlier work it has been shown that channel flow with heated walls could display large amounts of transient growth in two-dimensions. This was surprising, because all known important transient growth situations hitherto had been three-dimensional. A basic understanding of our finding was obtained, and we explain by a simple model how heat can take the place of the normal vorticity, i.e. of three dimensionality.

Different results are obtained for the stability of a spatially growing mixing layer depending on the norm chosen for defining the magnitude of the disturbance level. Thus the instability critical Reynolds number cannot be uniquely defined, and the choice may depend on the particular physical question for answering which the stability results are needed.





An ongoing analytical investigation has helped characterize the modal response of a vortex column to external disturbances, and in particular, has led to the discovery of inviscid resonances. The complete set of eigenmodes, both regular and singular, characterizing vortex column oscillations, has been found.

The following are the members of the Unit:

**Chair**

Rama Govindarajan

Ph D, F N A Sc, F A Sc

**Honorary Professor**

Roddam Narasimha

Ph D, F A Sc, F N A, FTWAS, FRS

**Professor**

Rama Govindarajan

Ph D, F N A Sc, F A Sc

**Associate Professors**

K R Sreenivas

Ph D

Meheboob Alam

Ph D

**Faculty Fellows**

Ganesh Subramanian

Ph D

Santosh Ansumali

Ph D

(DST Ramanujan Fellow)

**Senior Associate**

S M Deshpande

Ph D, F A Sc

**Research Associates**

Anil N, Dhiraj Vilasrao Patil (P),

Mukund Vasudevan, Satya Prakash Ojha,

Vishwanath K P (P)

**R & D Assistants**

Akshay Kumar, Jaikrishnan, V Krithika,

Rohan Subbaiah, Vivekanand Dabade

**Research students**

Harish N Dixit, Ratul Dasgupta, Priyanka Shukla, Anubhab Roy, Gayathri S, Sumesh P T, Dhiraj Kumar Singh, Ponnulakshmi V K, Rakshith B R, Shiwani Singh, Siddharth K, Lakshminarayana Reddy M H., Kopal Arora Dinesh Kumar, Vinay Kumar Gupta, Ujjayan Paul, Ayyappadas AM, Mohammed Istagaul Haque Ansari, Srikanth T, Sakikishan Suryanarayanan, Vybhav GR.

**Visiting Scientist**

Suparna Bhattacharjee

## 5. Evolutionary & Organismal Biology Unit

The faculty of the Unit continued their ongoing research in the broad areas of chronobiology, neurobiology, animal behaviour and phylogeography, life-history evolution and population dynamics. Faculty of the Unit were active in delivering invited talks at major international and national meetings and premier institutions of the country, and also participated in outreach activities aimed at students. Faculty of the Unit have also served the broader scientific community by acting as outside reviewers for manuscripts and research proposals submitted to various national and international journals and funding agencies.

Major research activities in the Unit during 2009-2010 include continuing studies on (a) the molecular genetic and developmental underpinnings of rapid development in fruitflies, especially through investigation of gene expression profiles, energy utilization patterns during metamorphosis and developmental progression of the ring glands in selected and control populations, (b) male-female coevolution and gender conflict at genomic level in fruitflies, (c) studies on the formal, molecular genetic and adaptive properties of circadian clocks in fruitflies and ants, (d) comparing the neuronal circuits controlling circadian rhythms in different species of fruitflies through neuroanatomical and behavioural approaches, (e) role of temperature sensitive ion-channels in entrainment of circadian rhythms to temperature cycles, (f) Huntingtin protein expression in clock neurons in fruitflies as a model to study neurodegeneration and the mechanisms of entrainment, and (g) genetic identification for relatedness studies and behavioural observations on elephants in Nagarhole National Park in an attempt to understand the structure of social organization in these elephants. Many of these lines of work are quite unique in the national context and our Unit is the only place in India where such work is being done.

During 2009-2010, the Unit also initiated new graduate courses, including four new laboratory courses and two new courses on neurogenetics and animal behaviour, respectively. The MS/PhD programme in Evolutionary and Organismal Biology for POBE Diploma holders was also initiated in August 2010.

The following are the members of the Unit:

### Chair

Amitabh Joshi Ph D, F A Sc, F N A Sc

### Professor

Amitabh Joshi Ph D, F A Sc, F N A Sc

### Honorary Professors

Raghavendra Gadagkar Ph D, F A Sc, F N A., F T W A S

Vidyanand Nanjundiah Ph D, F A Sc, F N A

### Associate Professor

Vijay Kumar Sharma Ph D

### Ramanujan Fellows

T N C Vidya Ph D

Sheeba Vasu Ph D

### Research Associate

Punyathirth Dey

### R & D Assistants

Argha Banerjee, Bharti D K, Deepika

L Prasad, Joy Bose, Khunza Meraj,

Pavani Bulusu, Pavan Kumar Jha

(Jr.)Reshmi Raveendran, Sarada Seetharaman.

### Research Students

Koustubh M Vaze, Pankaj Yadav, Snigdhadip Dey,

Shahnaz Rahman Lone, Nisha NK, Priya M P, Soundarya Iyer,

Pavitra Prakash, Argha Banerjee, Nandini R Shetty, Kanika

Mendiratta, Sheetal Potdar, Pooja Shree Mishra, Antara Das, Tata

Dhananjay Sukhanand.



## 6. Geodynamics Unit

### Field Work

Traverses along the rivers Sarsuti and Ghagghar in Haryana in order to gather evidence for palaeolake deposits associated with palaeochannels of the now lost River Saraswati. (November 20-25, 2009)

### Book writing

1. Completed the manuscript of a Hindi book entitled “*Ek Thi Nadi Saraswati*” and submitted to the publisher for printing.
2. Revised the book “*Saraswati, the River That Disappeared*” (2002) and submitted the manuscript to the publisher.
3. Working on a new book “*Geography and Geodynamics of India in Puranas and Ethics*”. Preliminary draft is nearly complete. Drafting of diagrams is being done.

### Lectures

Under the *Science Outreach Programme* of C N R Rao Hall of Science delivered a series of lectures. Delivered lectures in different institutions, colleges and high schools, across the country:

#### (A) Pre-University Students

To 300 to 500 boys and girls students of each of the Intermediate Colleges and High Schools in the following six places in the western part of District Pithoragarh, Uttaranchal: Chaurnunya, Bernag, Pankhu, Birthi, Jabukathal and Gangolihat. (October 21 to 25, 2009)

#### (B) Graduate and Post-graduate Students of Science at the following institutions

- (i) Earth Science Department, IIT Bombay, Mumbai (August – September 2009)
- (ii) Geology-Geography Departments, University of Pune, Pune (September 14-17, 2009)
- (iii) Indian Institute of Science Education & Research, Pune. (September 16, 2009)
- (iv) Earth Science Department, IIT Roorkee, Roorkee. (November 18-20, 2009)
- (v) Department of Geology, BHU, Varanasi. (January 18-21, 2010)
- (vi) Department of Earth Science, IIT Bombay, Mumbai. (February-March, 2010)

### Publications (Books)

Valdiya KS. *The Making of India: Geodynamic Evolution*, Macmillan Publishers India, New Delhi, 816p, 2010.

Valdiya KS. *Ek Thi Nadi Saraswati*, Aryan Books International, New Delhi. (in press)

#### Chair

K S Valdiya

Ph D, F A Sc, F N A, F N A Sc, FTWAS

## 7. Molecular Biology and Genetics Unit

The Molecular Biology and Genetics Unit (MBGU) of the centre is an internationally recognized department for its innovative research programmes in biomedical and biological sciences. With eight laboratories conducting cutting-edge research, MBGU attracts some of the best students from all over India for its PhD and Integrated-PhD research and training programmes. Research in the laboratories spans diverse areas of biology with major emphasis on biomedical research and application. The current areas of research comprise infectious diseases, human genetic diseases, chromatin organization and transcription regulation, stem cells and cardiovascular development and molecular mechanism of chromosome segregation. Research programs at MBGU are supported by grants from several national and international funding agencies and from biotechnology companies.

### Chromatin Biology Laboratory

TP2 is acetylated *in vivo* as detected by anti-acetylated lysine antibodies and mass spectrometric analysis. Recombinant TP2 is acetylated *in vitro* by p300 and PCAF. p300 acetylates TP2 in its C-terminal domain which is highly basic in nature possessing chromatin condensing properties. Mass spectrometric analysis showed that p300 acetylated 4 lysine residues in the C-terminal domain of TP2. Acetylation of TP2 leads to significant reduction of its DNA condensing property as studied by circular dichroism and Atomic Force microscopic analysis. Acetylation also impedes the interaction of TP2 with NPM3, a putative histone chaperone, whose expression is elevated in haploid spermatids. Colocalization studies using GC selective DNA binding dyes chromomycin A3 and 7-amino actinomycin D and AT selective dye DAPI indicate that TP2 is preferentially localized to GC rich sequences. Interestingly, as spermatids mature, TP2 and GC rich DNA moves towards nuclear periphery and in the later stages of spermatid maturation TP2 is predominantly localized at the nuclear periphery. Another interesting observation is the mutually exclusive localization of GC and AT rich DNA in the elongating and elongated spermatids. A combined immunofluorescence experiment with anti-TP2 and anti-TP1 antibodies revealed several foci of overlapping localization indicating that TP1 and TP2 may have concerted function role during chromatin remodeling in mammalian spermiogenesis. Chromatin remodeling factor BRDT has been cloned and expressed in insect cells. The recombinant BRDT shows histone chaperone activity *in vitro*. Gene expression perturbation following down regulation of *mrhl* RNA has been studied. Pathway construction has indicated that *mrhl* RNA plays an important role in the *wnt* signalling pathway. Network analysis has identified CSK21 and PP1A as key connecting molecules between cell cycle associated genes in glioblastoma. PP1A is highly upregulated in GBM tumor samples.

### Molecular Parasitology Laboratory

Research in this laboratory is focused towards understanding metabolism in the malaria parasite *Plasmodium falciparum*. Towards this end the enzymes involved in purine nucleotide metabolism in the parasite are being studied. Comparative structure-function analysis is also being carried out on the homologues from humans and archaea. Adenylosuccinate synthetase from *M. jannaschii* has been characterized biochemically. It is an archaeal enzyme that is 100 amino acids shorter than its counterparts from both eukaryotes and prokaryotes. This thermostable enzyme exhibits a biphasic Arrhenius plot with a switch in the rate-limiting step in catalysis contributing to the bend in the plot. GMP synthetase from *P. falciparum* has been kinetically characterized. Our studies show that the parasite enzyme exhibits different inhibition profile from that of the human counterpart suggesting its suitability as a drug target. Characterization of *P. falciparum* adenylosuccinate lyase indicated that the parasite enzyme has retained its specificity for both the substrates, SAMP and SAICAR. The presence of SAICAR specificity suggests that this is probably the only activity of the de novo purine biosynthetic pathway that is retained in the parasite. Active recombinant *P. falciparum* SIR2 has been successfully expressed and purified. Screening for modulators of Sir2 activity led to the identification of surfactin, a depsipeptide produced by *Bacillus subtilis* as a potent inhibitor of the parasite enzyme competing for the NAD<sup>+</sup> binding site.

### Vascular Biology Laboratory:

Molecular, genetic and developmental analysis of the cardiovascular system. A comparative approach has been taken using embryonic stem cell models, mouse developmental biology and transgenics, and *Drosophila* genetics, to decipher the roles of novel genes expressed early in the cardiovascular and hematopoietic systems. Our approach has given useful insight into gene function as well as ontogeny of



the heart, blood and blood vessels. Analysis of these genes in the context of human development as well as in clinical studies with a focus on tumor angiogenesis and progression has been undertaken. Current studies focus on understanding mechanisms that control cardiovascular development using ESCs and mutant mice. Recently two new sibling human embryonic stem cell (hES) lines from discarded embryos have been derived and differentiated to cardiovascular derivatives that can be cultured to purity. These are called BJNh19 and BJNh20 and have been deposited in the UK Stem Cell Bank. The lines are also listed on the European hESC registry. The laboratory is currently involved in the International Stem Cell Initiative (ISCI) project on accumulation of genetic defects in ES cell cultures. Several induced pluripotent stem (iPS) cell lines have been generated and are being characterized.

### **Molecular parasitology Laboratory**

To establish infection in the host, malaria parasites export remodeling and virulence proteins into the host erythrocytes. These proteins can traverse a series of membranes, including the parasite membrane, the parasitophorous vacuole membrane and the erythrocyte membrane. One such parasite protein is PfEMP 1. This protein is encoded by approximately 60 var genes per parasite, and monoallelic expression of variant forms of the protein is responsible for antigenic variation. The primary structure of PfEMP 1 consists of a large N-terminal domain containing a variable number of Duffy-binding-like (DBL) domains that mediate cytoadherence to various host cell receptors. The cytoadhesion of parasite - infected erythrocytes to a number of host cells is a causative factor in severe pathology of malaria and PfEMP1 is considered the major virulence determinant of *P.falciparum*. Our lab is trying to find out whether DBL domains with specific residues are responsible in cases of severe malaria in Indian patients from various geographical regions. Furthermore, the expression pattern of this and other virulent proteins are being studied. We are also focusing on proteins which are components of trafficking pathway of the parasite and responsible for phenotypic modifications in the erythrocyte membrane required for parasite survival as well as host- pathogen interactions.

### **HIV Laboratory**

Significant progress took place in several projects during the past one year. The laboratory screened a large number of Indian clinical samples and identified an immunodominant B-cell epitope in the cysteine-rich domain of Tat only in the HIV infected people. This finding has a direct relevance for HIV vaccine design. Differential transcription factor binding to several sites in the viral promoter has been delineated in subtype-C HIV-1 promoter region. A clinical trial to examine the efficiency of a *Siddha* medicine to improve the quality of life of sero-positive subjects has been completed.

### **Human Molecular Genetics Laboratory**

(a) Discovery of a novel epilepsy locus at chromosome 3q13.3-q21, was followed by a detailed analysis of genes at 3q13.3-21, leading to identification of several patient-specific mutations in the extracellular calcium-sensing receptor (*CaSR*) gene (*Annals of Neurology* 2008). The CaSR protein is proposed to sense small changes in extracellular calcium levels and integrate this information to intracellular signal transduction pathways in neuronal cells. (b) Identification of another novel epilepsy locus at chromosome 5q12-q14, is an important finding from the laboratory. This locus, located between markers D5S641 and D5S459, is responsible for an age-related, common idiopathic generalized epilepsy (*Human Genetics* 2007). Analysis of several candidate genes at the 5q12-q14 locus suggests that a new and diverse molecular mechanism, which functions apparently independently of the ion channel mechanisms, may underlie the pathophysiology of epilepsies. (c) Deafness genetics is another area of research in the laboratory. Studies of 500 families affected with severe-to-profound deafness wherein six deafness-causing genes have been concluded: *Cx26*, *Cx30* (connexin 26, connexin 30: cochlea-expressed genes encoding gap junction proteins); *TMPRSS3* (transmembrane serine protease 3), *TMCI* (transmembrane cochlear-expressed gene 1), *HAR* (Harmonin) and *CDH23* (cadherin 23) were analyzed. Using an efficient and cost-effective, two-step genetic analysis, the work revealed a spectrum of pathogenic mutations in these genes: 18 mutations in *Cx26*; 8 mutations in *TMCI*; 4 mutations in *TMPRSS3*; 6 mutations in *HAR*; 4 mutations in *CDH23* and one mutation in *Cx30*. Identification of a total of 41 pathogenic mutations have substantially extended allelic heterogeneity at these genes and provided a large collection of mutant alleles for potential use in cell biological, biochemical and structure-function correlation studies. A detailed cell biological and functional analysis of the *Cx26* alleles has recently been published (*European Journal of Human Genetics*, 2008). Knowledge of the relative contributions of these six genes to the load of hereditary deafness has helped



devise an algorithm that has important implications for early detection of this disorder and implementation of suitable intervention therapies.

### Transcription and Disease Laboratory

Transcription and Disease laboratory is focusing on understanding the role of epigenetic modifications, histone chaperones and non-histone chromatin proteins in chromatin dynamics and transcription regulation. These studies are carried out with special emphasis on disease and therapeutics.

**I. Chromatin dynamics and transcription regulation: Role of non-histone chromatin associated proteins and histone chaperones.** (a) The Positive transcription coactivator 4 (PC4) was originally discovered as a potent enhancer of activator dependent transcription. We found that PC4 is a potent coactivator of p53. Recently, we further established that PC4 is a bonafide non-histone chromatin-associated protein responsible for chromatin organization and heterochromatin gene silencing. We are presently elucidating the molecular switch underlying the chromatin organization and transcriptional co-activation ability of PC4. (b) We are also interested to understand the molecular mechanism of histone chaperone NPM1 function. NPM1 was found to enhance acetylation dependent chromatin transcription. Additionally, acetylation of NPM1 was found to be essential for its transcriptional enhancement ability. NPM1 is subjected to multiple post translational modifications. The post translational dependent signaling network link to its transcriptional regulation ability is being investigated now. NPM1 has also been shown by this lab to be a linker histone chaperone and that it is involved in the higher order chromatin organization. We are trying to understand the functional crosstalk between NPM1 and histone H1.

**II. Epigenetic signaling in the manifestation of diseases: Implications in cancer and HIV infection.** Depending upon the origin, type and state of prognosis, a set of epigenetic modifications (both DNA and histones) are altered in different cancers. Presently, we are focusing on the hyperacetylation of histones in oral cancer. The hyperacetylation of histones and histone chaperone, NPM1, in the establishment of oral cancer is being studied now. Interestingly, we have found that upon HIV infection to the model cell line, acetylation of histone chaperone, NPM1 is enhanced in a dose dependent manner. The role of hyperacetylation of chaperones in the HIV pathogenesis is being investigated.

**III. Chemical Biology approach to probe the role of specific chromatin modifications:** Reversible acetylation and deacetylation of nucleosomal core histones and non-histone proteins play crucial role in the regulation of eukaryotic gene expression. The functions of histone acetyltransferases/histone deacetylases are often associated with several diseases. Therefore small molecule modulators which target the histone acetyltransferases (HATs)/histone deacetylases (HDACs) or similar chromatin modifying enzymes would not only help to understand the *in vivo* role of these enzymes but also may serve as a lead compound to design new generation therapeutics. Apart from the continuous effort to isolate as well as synthesize novel, specific and non-toxic HAT modulators (activator and inhibitors), the group is actively working on small molecule modulators of aurora kinases and arginine methyltransferases.

**IV. Nanobiotechnology:** We are also interested to find out the interaction of different nanoparticles with the chromatin and its functional consequences. In this context, we have recently discovered a self fluorescent, cell permeable, carbon based nanosphere that is capable of crossing blood brain barrier, which could cargo the impermeable small molecule activator of histone acetyltransferases in the cellular system and activate the histone acetyltransferase enzyme. Presently, we are trying to understand the mechanisms of the permeability of this carbon nanosphere. We are further exploring the possibility of using this carbon nanosphere as a vehicle for efficient delivery of different other small molecule modulators and SiRNA. We are also studying its interaction with chromatinized DNA in the nucleus. Soon similar studies will also be conducted using clay sandwich.

### Molecular Mycology Laboratory

The researchers in this laboratory have been studying structure-function analysis of centromeres in several pathogenic yeasts including *Candida albicans*, *Candida dubliniensis*, *Candida tropicalis* and *Cryptococcus neoformans*. These yeasts cause most of the deaths by fungal infection in immune-compromised patients. We identified centromeres of, *C. dubliniensis* and compared centromere sequences with those of a closely-related yeast *C. albicans*. These studies indicate that centromeres are evolving at a rate faster than any other genomic region in these two species. The laboratory also launched a new programme to study the



structure-function relation of centromeres of *C. tropicalis*. The centromere structure of *C. tropicalis* is found to be very similar to those of a distantly related species *Schizosaccharomyces pombe* (fission yeast). The other areas of interest of this laboratory include understanding the mechanism of the rapid change in centromere DNA sequence, the relationship between the ploidy and virulence as well as the role of histone H3 variants in genome indexing in *C. albicans*.

The following are the members of the Unit:

**Chair**

Anuranjan Anand Ph D

**Honorary Professors**

Dipankar Chatterji Ph D, F N A Sc, F A Sc, F N A

H Sharat Chandra Ph D, F A Sc, F N A

**Professors**

Anuranjan Anand Ph D

Hemalatha Balaram Ph D, F A Sc

M R S Rao Ph D F A Sc, F N A, F N A Sc, FTWAS

Namita Surolia Ph D, F A Sc, F N A Sc

Ranga Uday Kumar Ph D

Tapas Kumar Kundu Ph D, F A Sc, F N A Sc, F N A

**Associate Professor**

Maneesha Inamdar Ph D

**Faculty Fellow**

Kaustuv Sanyal Ph D

**Technical Officer (Veterinary)**

R G Prakash BVSc & A.H.

**Research Associates**

Arun Pratap Sikarwar, Benaka Prasad,  
Charitha Gangadaran (P), Shrikanth Gadad,  
Swati Sinha, Rahul Modak, Jeelan Basha N, Anand K K,  
Ramesh V, Ravindra KC, Rinki Ratna Priya (P)

**Fellows (DBT)**

Deepti Jain, Uttara Chakraborty, Vasudeva

**R & D Assistants**

Anitha CA, Anil Babu MHKH, Anusha Thota, Arghyashree Roy Choudhury, Gowsica B R, Kavitha Singhy, Lakshmi Swarupa Yalla, Lavanya T, Mohammed Arif, Mohan V, Monalisa Das, Priti Dhareshwar, Rahul MG, Ramachandran B, Ranesh Gadi, Ramesh Reddy, Ramesh Choudhuri, Rashid Ahmed G Maniyar, Rekha S, Snehajyothi Chatterjee, Srivathsa M S, Tushna P Dehnugara, Vasudeva Bhat, Vikram Naik, Vivek Kumar Srivastava, Yogitha Thattikota.

**Research Students**

Vani Kulkarni, Vinay B, Javaid Bhat Yousuf, Shrikanth Gadad , Bharat S, Jayasha Shandilya, Mamta Jain, Mangaiarkarasi A, Ruthrotha Selvi V B Vikru, Surbhi Dhar, Nishtha Pandey, Abhishek Sinha, Laxmi Narayan Mishra, Mahesh B, Jitendra Thakur, Mukti Karthigeyan D, Sujata Kumari, Mohan Krishna DV, Sreyoshi Mitra, Kaur, Raju Pedabaliyarasimhuni P.K, Sanjeev Kumar, Sourav Roy, Ramachandramouli Budida, Nikhil Gupta, Shetty Ronak Kutty, Shanker Rai, Gautam Chatterjee, Anjali Verma, Kalpita Rashmi Karan, Deeti Shetty, Kirthana MV, Yogesh Bhojraj Ostwal, Akhade Rohan Jayant, Hari Raj Singh, Senapati Parijat Ramesh, Vijay J, Verma, Shilpee, Lakshmi Prasoon, Sivani V.

## 8. Theoretical Sciences Unit

The research conducted in the TSU continued to explore new frontiers in the area of theoretical physics and chemistry techniques applied to various systems.

The group led by Dr Subir Das carried out and is continuing research on critical dynamics, pattern formation, nucleation phenomena, etc. Subir Das also visited the Johannes-Gutenberg University of Mainz for collaborative work during the summer of 2009.

Dr Kavita Jain and her group continued their efforts to understand the problem of evolution of sex and recombination. They studied the evolutionary dynamics of a maladapted population under mutation, selection and recombination by developing a novel analytical method to calculate the fixation time to the fittest locus. They also extended their previous work on evolution on uncorrelated fitness landscapes to more realistic models that include correlations. In this context, they obtained exact results for the distribution of the maximum of a set of correlated fitnesses in a model of biological evolution.

Research in the group of Prof Shobhana Narasimhan was focused on applying density functional theory to study various materials, including magnetic surface alloys, defects in graphene, methane storage in graphene and activated carbons, nanomagnetism and catalysis. One important result was the prediction of new surface alloys composed of bulk-immiscible metals; one of these systems, viz., FeAu/Ru(0001) has subsequently been shown by their experimental collaborators to indeed form an ordered surface alloy. Surprisingly, they found that the main stabilizing force for this was provided by magnetism, and not by stress relief as usually believed. Ways of chemically functionalizing activated carbon so as to increase its uptake of natural gas were suggested, Also new strategies of doping oxide substrates so as to increase the catalytic activity of gold nanoparticle catalysts were explored. They also showed that a simple indicator, the effective coordination number, can be used to predict adsorption energies and dissociation barriers for NO on Rh surfaces.

Prof Swapan Pati's group has contributed extensively to the microscopic understanding of optical, magnetic, opto-electronics and transport phenomena of materials ranging from atoms, molecules to extended systems including biomaterials. They developed a large number of new models by identifying and optimizing parameters responsible for linear and non-linear optical polarizations and electron and hole mobilities in a large class of organic molecular crystals and supra-molecular systems. Their in-depth analysis of the role of quantum fluctuations in controlling the geometrical frustrations in various Kagomé lattices has shed new insights to the magnetic behavior in this emerging class of materials. Their work also encompasses the study of bio-molecular materials like DNA, their applications in magnetic switching devices and photon up and down-conversion within protein geometry. They modelled molecular electronics materials both by developing and applying new theoretical techniques for the study of molecular memory and switching devices. They also analyzed the stability of unusual metallic nano-clusters and suggested experimental routes for possible isolation of a new class of all-metallic nano-clusters.

Prof Srikanth Sastry's group performed research on modeling gel formation, protein aggregation, liquid-liquid transition and nucleation in silicon, and length scales in glass forming liquids. Further, analysis of glass formers in different spatial dimensions was been carried out using molecular dynamics simulations, and lattice model calculations.

Dr NS Vidhyadhiraja and his group have studied the crossover from the Kondo lattice regime to the mixed-valent regime in heavy fermion materials in terms of dynamics, transport and thermodynamics. They find several novel features in our theoretical studies that corroborate with experiment, and have hitherto been attributed to other extraneous factors such as crystal field splitting. The issue of multiple avalanches in the thermal and pressure driven hystereses across Mott transitions was explored in detail; they have come up with a new phenomenological random field Ising model that is applicable to a wide variety of metal-insulator transitions. They are also able to explain, using this model, the avalanche statistics observed in experiments. They have also carried out a detailed investigation of the symmetric and asymmetric Hubbard model using two diagrammatic perturbation theory approaches, namely iterated perturbation theory and local moment approach. A part of this work is being written up for publication and the rest is in progress. They have done a comprehensive study of an organic Schottky type position sensing device. They have been able to solve the resulting equations both analytically (in some limits) and numerically (in general)





and have got excellent agreement with experiments. In addition, he is collaborating with Arghya Taraphder on issues relating to chalcogenide materials, and finite magnetic field effects in the Hubbard model. A visiting student from Mysore University has been working on organic bulk-heterojunction photovoltaics. He has looked into a two-diode model for such solar cells and has found a neat way to extract the five parameters of this model without having to solve five coupled non-linear equations.

Amongst the research achievements of Prof Umesh Waghmare's group in the past year are determination of the structural origin of the oxygen storage capacity of Sn, Pd and Fe doped  $\text{CeO}_2$ ; analysis of hydrogen storage in 3D Lanthanide organic frameworks; determination of the thermodynamics of H vacancies in  $\text{MgH}_2$  from first-principles obtained electric field-temperature phase diagrams of  $\text{BaTiO}_3$  and investigated polarization switching, development of a model for ferroelectric  $\text{SrTiO}_2$ - $\text{BaTiO}_3$  superlattices, and explanation of the origin of magnetocapacitance in  $\text{BaTiO}_3$  at the nanoscale. He also wrote a review article on Computational Simulations of Nano-structures.

All the TSU faculty members gave several talks on their research work, at conferences and seminars in India and abroad. They were involved in organizing several conferences and workshops, and have been active in several committees.

Prof Shobhana Narasimhan was one of the organizers of the Summer School on Computational Materials Theory, held at the University of California, Santa Barbara, in July 2010. She has also become a Member of the IUPAP Working Group on Women in Physics. Prof Swapan Pati organized a joint workshop between JNCASR and Northwestern University; he was also the convenor of the India-Japan (DST-JSPS) bilateral meeting on 'Graphene', the ICMS-Cambridge Winter School on Chemistry and Physics of Materials, and the I2CAM school and Conference on Emergent Properties and Novel Behavior at the Nanoscale, all at JNCASR. Prof Srikanth Sastry was a Member of the Working Group, Vision Document on Indian Science, INSA. He was also the co-convenor of three schools held at JNCASR in the past year: "School on glass formers and glasses", "School and conference on Multiscale Modeling and Simulations of Hard and Soft Materials", and "Understanding Molecular Simulation".

Several students from TSU obtained their M S and Ph D degrees during the past year.

#### NEW PROGRAMMES LAUNCHED

In addition to their usual intake of graduate students, this year for the first time two candidates from DRDO were admitted as external registrants.

The following are the members of the Unit:

##### Chair

Shobhana Narasimhan Ph D

##### CSIR Bhatnagar Fellow and Hon. Professor

Kalyan B Sinha Ph D (Univ. of Rochester),  
F A Sc, F N A, FTWAS

##### Professors

Shobhana Narasimhan Ph D  
Srikanth Sastry Ph D  
Swapan K Pati Ph D, F A Sc  
Umesh V Waghmare Ph D, F A Sc F N A Sc

##### Faculty Fellows

N S Vidhyadhiraja Ph D  
Kavita Jain Ph D  
Subir Kumar Das Ph D

**Research Associates**

Hembram K P S S, Siamkhanthang Neihzial, Ganga Periyasamy

**R & D Assistants**

Ankita Goswami, Alex Andrews P, Aparna S, Waim Aftab, Manju ST, Rukhsan-ul-haq.

**Research students**

Shibu Saw, Sasmita Mohakud, Anil Kumar, Sudipta Dutta, Moumita Maiti, Himadri Barman, Mighfar Imam, Shiladitya Sengupta, Madhura Marathe Pradeep, Arup Chattopadhyay, Vishwas V, Prakash Parida, Arun Kumar Manna, Suman Majumder, Gayatri Das, Sutapa Roy, Sananda Biswas, Pramod Kumar, Ulman Kanchan Ajit, , Arun R, Ershaad Ahamed Basheer, Nagamalleswara Rao Dasari, Pralok Kumar Samanta, Shirodkar Sharmila Narendra, Kaushelendra Kumar, Alok Kumar Dixit, Irfan Ahmad Bhat.



## 9. International Centre for Materials Science

ICMS is the first international centre of its kind devoted to high impact, interdisciplinary scientific research, education and extension in materials science, established in the confines of a scientific cum educational institution under the direction of Prof. C. N. R. Rao. The Centre was envisaged by the Department of Science and Technology (DST), Government of India and the plans to establish the Centre got crystallized in 200. The Jawaharlal Nehru Centre for Advanced Scientific Research took the necessary steps to establish ICMS with the financial support of DST. The centre was inaugurated and dedicated to the nation by the Honorable Prime Minister of India, Dr. Manmohan Singh.

Being a first centre of this kind everything is being done to make sure that the centre not only fulfils its objectives but also creates new traditions in carrying out research, extension activities and international collaborations. The centre has ongoing research programmes on Solid-State Lighting, Surface Physics, Polymers, High-Resolution Electron Microscopy, Soft Condensed Matter and Chemistry for Materials.

Objectives of the Centre are:

- Carry out in-house research of high quality in selected areas of materials science.
- Promote well-planned programme of collaboration in research and education with important centres and individuals in India and abroad.
- Provide opportunities to students as well as faculty through exchange programmes between ICMS and other centres.
- Conduct discussion meetings, schools and workshops.
- Organize Winter/Summer Schools on Materials.
- Provide visiting fellowships to teachers and young research workers from other institutions in India.
- Provide sophisticated instrumental and analytical services of the highest quality to facilitate materials research.

ICMS has established major scientific user facilities to serve both in-house researchers and researchers from other universities. This facility houses specialized instrumentation maintained and run by experts. The facility consists of Ultra High Resolution Transmission Electron Microscope, FESEM, Pulsed Laser Deposition, Molecular Beam Epitaxy System, Confocal Microscope, Optical Tweezers, High Resolution Thin film X-ray Diffractometer, NMR, Gas Chromatograph with Mass Spectrometry detector, High pressure liquid Chromatograph/Mass Spectrometer Instruments, Surface Area and related measurements.

The centre has many collaborative agreements and programmes with various universities, like Cambridge University, Northwestern University, Mesa+ at the University of Twente, National Institute of Materials Science in Tsukuba, Japan and with the Nano Institute in University of Waterloo, Canada. Several young scientists from other countries as well as from India have carried out short term research activities in the centre.

Three students are currently carrying out research work under the one year Post-Graduate Diploma programme.

ICMS organizes an annual International Materials Lecture. The first lecture was delivered by Prof. Tobin Marks, Northwestern University on February 4, 2009. The second lecture was delivered by Prof. Stuart Parkin, IBM Almaden Research Center on December 11, 2009. The third lecture of this series will be delivered by Prof. Sir Richard Friend, FRS, Cavendish Laboratory, University of Cambridge on December 7, 2010.

ICMS organizes seminars, schools, workshops and conferences in collaboration with colleagues in JNCASR and elsewhere. To name few, Winter School on Chemistry and Physics of Materials with University of Cambridge, Chemistry of Materials meeting arranged in collaboration with Swedish Academy of Sciences, JNCASR research conference on Materials in Kerala in collaboration with National Institute for Interdisciplinary Science and Technology, Trivandrum and Frontier Lectures on Advances in Materials Science in universities.

## Future activities

- School and Conference on “Emergent Properties and Novel Behaviour at the Nanoscale” April 19-27, 2010
- JNCASR Research Conference, Allepy, Kerala, October 2-5 , 2010
- Winter School on Chemistry and Physics of Materials with University of Cambridge, UK , December 6-10, 2010

### Faculty

#### Director

Prof C N R Rao

Ph D, D Sc, F A Sc, F N A, F R S,  
F T W A S, Hon. F R S C

Prof S M Shivaprasad

Dr Ranjan Datta

Ph D (Karnataka), *Professor*  
Ph D (University of Cambridge),  
*Faculty Fellow*

Dr Rajesh Ganapathy

Dr Sridhar Rajaram

Ph D (IISc.) *Faculty Fellow*  
Ph D (University of Utah)  
*Faculty Fellow*

### Adjunct professorship and other honorary positions

1. Prof Timothy Fisher, Purdue, *Adjunct Professor*
2. Prof Vinayak Dravid, Northwestern University , *Adjunct Professor*
3. Prof Pulickel M. Ajayan, Rice University, *Adjunct Professor*
4. Prof Vinod Subramaniam, University of Twente, *Adjunct Professor*
5. Prof U Ramamurty, Indian Institute of Science, *Hon. Faculty*
6. Prof S M Shivaprasad, Professor, ICMS, *RAK-CAM Sheik Saqr Senior Fellowship*
7. Mr Rakesh V, *RAK-CAM Sheik Saqr Junior Fellowship*

### Incharge Co-ordination

Aruna V Mahendarkar

### R & D Assistants

Mamta Raju Jotkar, Sireesha Kanuri

### Research Students

Loukya Chowdary, Santhosh V, Ramana Reddy, G

### Diploma Students

Manjunatha S, Bello Abdulhakeem, Dzade Nelson Yaw.



## 10. Centre for Computational Materials Science (CCMS)

### Research Achievements:

Molecular dynamics simulations of a series of bis(trifluoromethylsulfonyl)amide anion based room temperature ionic liquids have been carried out in order to identify the effects of the molecular symmetry of the cation on the structure and dynamics of the liquid. Simulations of ionic liquids with imidazolium cation containing varying lengths of alkyl groups were performed. The calculated density and total X-ray scattering function of the liquids agree well with experimental data. Liquids containing symmetric cations ( $[C_n C_n im][NTf_2]$ ) are found to be more structured than those with asymmetric ones ( $[C_n C_1 im][NTf_2]$ ), manifested in greater intermolecular ordering and slower dynamics.

Applying density functional theory to study various materials, including magnetic surface alloys, defects in graphene, methane storage in graphene and activated carbons, nanomagnetism and catalysis. One important result was the prediction of new surface alloys composed of bulk-immiscible metals; one of these systems, viz., FeAu/Ru(0001) has subsequently been shown by experimental collaborators to indeed form an ordered surface alloy. Ways of chemically functionalizing activated carbon so as to increase its uptake of natural gas were suggested, Also new strategies of doping oxide substrates so as to increase the catalytic activity of gold nanoparticle catalysts were explored.

Research on modeling gel formation, protein aggregation, liquid-liquid transition and nucleation in silicon, and length scales in glass forming liquids, analysis of glass formers in different spatial dimensions have been carried out using molecular dynamics simulations, and lattice model calculations.

Extensively contributed to, the microscopic understanding of optical, magnetic, opto-electronics and transport phenomena of materials: ranging from atoms, molecules to extended systems including biomaterials.

Developed a large number of new models by identifying and optimizing parameters responsible for linear and non-linear optical polarizations and electron and hole mobilities in a large class of organic molecular crystals and supra-molecular systems.

In-depth analysis of the role of quantum fluctuations in controlling the geometrical frustrations in various Kagomé lattices has shed new insights to the magnetic behavior in this emerging class of materials.

Carried out study of bio-molecular materials like DNA, their applications in magnetic switching devices and photon up and down-conversion within protein geometry.

Pioneered modeling molecular electronics materials both by developing and applying new theoretical techniques for the study of molecular memory and switching devices.

Analyzed the stability of unusual metallic nano-clusters and suggested the experimental routes for possible isolation of a new class of all-metallic nano-clusters.

The structural origin of oxygen storage capacity of Sn, Pd and Fe doped  $CeO_2$  was determined. Hydrogen storage in 3D Lanthanide organic framework was analyzed. Thermodynamics of H vacancies in  $MgH_2$  from first-principles was determined. Electric field- temperature phase diagrams of  $BaTiO_3$  was determined and investigated polarization switching.

A model for ferroelectric  $SrTiO_2$ - $BaTiO_3$  superlattices was developed. A review was written on Computational Simulations of Nano-structures. The origin of magnetocapacitance in  $BaTiO_3$  at nano-scale has been explained.

New programmes/schools/conferences:

### Prof. Srikanth Sastry was:

1. Member, Working Group, Vision Document on Indian Science, INSA, 2009.
2. Co-Convenor of the "School on glass formers and glasses", JNCASR, Bangalore, India, January, 2010.
3. Co-Convenor of the "School and conference on Multiscale Modeling and Simulations of Hard and

Soft Materials”, JNCASR, Bangalore, India, December, 2009.

4. Co-Convenor of the “Understanding Molecular Simulation”, JNCASR, Bangalore, India, August, 2009.
5. Member, International Advisory Committee, “STATPHYS 24”, Cairns, Australia, July 2010.
6. Co-Coordinator of “The Physics of Glasses: Relating Metallic Glasses to Molecular, Polymeric and Oxide Glasses”, April 12 - July 9, 2010, KITP, Santa Barbara, USA.

**Prof Swapan K Pati was:**

1. Organizer of a joint workshop between JNCASR and Northwestern University at JNCASR in Aug, 2009.
2. Convenor of India-Japan (DST-JSPS) bilateral meeting on “Graphene” at JNCASR in Nov, 2009.
3. Convenor of ICMS-Cambridge Winter School on Chemistry and Physics of Materials at JNCASR in Dec, 2009.
4. Convener of I2CAM school and Conference on Emergent Properties and Novel Behavior at the Nanoscale, at JNCASR in April.

*Prof Umesh V Waghmare* admitted two candidates from DRDO as external registrants in MS and PhD programmes.

**Publications**

About 48 papers were published during April 1, 2009 to March 31, 2010.

**Visitor's Programme:**

During this year, 5 students and 1 CCMS associate member have visited for period of about a week to 8 months for research / collaborative work with CCMS members.

The following are the members of the Unit:

**Coordinator**

Prof Balasubramanian Sundaram

**Members**

Prof Shobhana Narasimhan

Prof Srikanth Sastry

Prof Swapan Pati

Prof Umesh Waghmare

**Technical Assistant**

Amit Kumar Patel

**Programme Assistant**

Venkatesh K



## 11. Chemical Biology Unit

Structure function studies of triosephosphate isomerase, a glycolytic enzyme, have been carried out using *Plasmodium falciparum* and *Methanocaldococcus jannaschii* as models. Kinetic analysis of site specific mutants provides evidence for the involvement of Glu97 in the catalytic mechanism. The role of near active side residues in modulating the enzyme activity has also been explored. The enzyme from *Drosophila Melanogaster* has been cloned and expressed as a model system to examine the relationship between disease causing human mutants and the activity.

The effect of Crowding Agents, Signal Peptide, and Chaperone SecB on the Folding and Aggregation of *E. coli* Maltose Binding Protein has been studied. It has been established that SecB-Mediated Protein Export Need Not Occur via Kinetic Partitioning.

The synthesis and evaluation of a novel class of G-quadruplex-stabilizing small molecules based on the 1,3-phenylene-bis(piperazinyl benzimidazole) system has been studied. The role of capping ligands on the nanoparticles in the modulation of properties of a hybrid matrix of nanoparticles in a 2D film and in a supramolecular organogel has been investigated. Soft functional materials have been designed from small molecular photochromic gelators, and structure and properties of two component hydrogels comprising lithocholic acid and organic amines have been extensively studied.

Self assembly of various bile salt analogues to form fibers and networks has been extensively investigated by rheological, scattering and microscopic techniques. The formation of composite structures of gels and nanoparticles has been investigated. The molecular structure dependence of the sensitivity of bile acid derived PET sensors of cations has been studied in detail.

The following are the members of the Unit:

### Chair

Uday Maitra

Ph D, FA Sc.

### Professor

V Krishnan

(Hindustan Lever Research Professor)

Ph D, FA Sc, FNA, FTWAS

### Honorary Professors

P Balam

G Mehta

Ph D, FA Sc, FNA, FTWAS

Ph D, FA Sc, FNA, FTWAS

### Honorary Faculty

Raghavan Varadarajan

Santanu Bhattacharya

Ph D, FA Sc, FNA

Ph D, FA Sc



## 12. Condensed Matter Theory Unit

The members of the Condensed Matter Theory Unit (CMTU) are engaged in theoretical research on a wide variety of topics in the general area of Condensed Matter Science. During the period from 2009-10, they achieved significant progress on several problems in this area in which support from JNCASR has been acknowledged, and these are summarized below. More details can be gleaned from the publications listed below.

### **Quantum Condensed Matter, especially strongly correlated systems:**

The strong-coupling expansion technique for calculating Greens functions, self energies and correlation functions in strongly correlated models including the effects of confining potentials, and thermal effects developed last year was explicitly applied to experimental systems of cold trapped bosonic atoms.

A novel “fragile fermi liquid” phase was shown to arise as emergent behaviour in an inhomogeneous dynamical mean field theory study of a system with Mott Insulating layers sandwiched between metallic layers.

### **Non-classical rotational inertia of superfluids in complex geometry.**

Significant progress was achieved in understanding the effects of quenching across a quantum critical point or line, transport along edges of quantum Hall systems (with constrictions or line junctions), transport through quantum dots where electrons interact with each other, transport on surfaces of topological insulators with magnetic and potential barriers, and properties of unctions of Tomonaga-Luttinger liquids.

### **Soft Condensed Matter and Nonequilibrium Statistical Physics :**

The nature of translational and rotational motion of water molecules in narrow carbon nanotubes was elucidated.

The first reliable estimates for a growing dynamical correlation length in glass forming liquids were obtained and the role of this length scale in the growth of the relaxation time was analyzed.

The phase diagram of vortex matter in layered high-temperature superconductors with tilted columnar pinning was obtained.

The most detailed and systematic study of spiral- and scroll-wave turbulence attempted so far in four, state-of-the-art mathematical models for cardiac tissue, have been carried out by developing MPI-based parallel programs. These have elucidated the interaction of spiral and scroll waves in these models with conduction and ionic inhomogeneities; we have also examined the suppression of spiral- and scroll-wave turbulence by low-amplitude control pulses. Our central qualitative result is that, in all these models, the dynamics of spiral waves depends very sensitively on such inhomogeneities. Furthermore, we find that a local-pulsing scheme does not suppress spiral turbulence in the presence of inhomogeneities; but a scheme that uses control pulses on a spatially extended mesh is more successful in the elimination of spiral turbulence; this has a direct bearing on defibrillation, the control of life-threatening cardiac arrhythmias such as ventricular fibrillation.

A detailed direct numerical simulation (DNS) of the two-dimensional Navier-Stokes equation with the incompressibility constraint and air-drag-induced Ekman friction has been carried out, to investigate the combined effects of walls and such a friction on turbulence in forced thin films. We examine the forward-cascade regime, extract the isotropic parts of velocity and vorticity structure functions and hence the ratios of multiscaling exponents, and find that velocity structure functions display simple scaling, whereas their vorticity counterparts show multiscaling. We also obtain the probability distribution function of the Okubo-Weiss parameter, which distinguishes between regions with centres and saddles; our results are in quantitative agreement with experiments. We have also extended these studies to examine the turbulence-induced melting of a nonequilibrium vortex crystal imposed by a spatially periodic force on a thin fluid film. Lastly, we have extended significantly our earlier studies of dissipation reduction by polymer additives in fluid turbulence and the dynamic multiscaling of time-dependent structure functions in turbulent fluids. We have also studied dynamo formation as a first-order transition.

Systematic construction and renormalization-group study of the coarse-grained dynamical equations of motion for the orientational order parameter for a two-dimensional active nematic, as found in confluent



specimens of melanocytes, the cells that distribute skin pigment, and vibrated granular-rod monolayers. Discovered a hidden fluctuation–dissipation relation in this nonequilibrium system

Theory for the dynamics of a stiff, tense filament in an active medium with orientational correlations, such as a microtubule in contractile actin. Novel features include activity-induced stiffening, strong violation of the fluctuation–dissipation (FD) relation. Relevant to the dynamics of axons, and formally similar to models for auditory hair cells.

The following are the members of the Unit:

**Chair**

H R Krishnamurthy Ph D, F A Sc, F N A

**Hon. Professors**

Biman Bagchi Ph D, F A Sc, F N A, F T W A S

Chandan Dasgupta Ph D, F A Sc, F N A

N Kumar Ph D, F A Sc, F N A, F T W A S

S Ramasesha Ph D, F A Sc.

D D Sarma Ph D, F A Sc, F N A

**Hon. Faculty**

G Ananthakrishna Ph D, F A Sc

Binny J Cherayil Ph D

Diptiman Sen Ph D, F A Sc

Rahul Pandit Ph D, F A Sc, F N A

K L Sebastian Ph D, F A Sc

Sriram Ramaswamy Ph D, F A Sc

S Yashonath Ph D, F A Sc

**Research Associate**

Sarika Bhattacharya

**R & D Assistants**

Abhijit Hazarika, Ganapati Sahoo,

Nandan Pakhira, Srijan Kumar Saha

### 13. Computer Laboratory

During the previous financial year (April 2009-March 2010), the CompLab was involved in upgrading and enhancing the IT infrastructure at JNCASR. The internet bandwidth has now been increased to 14 MBPS (10 MPBS from BSNL and 4MPBPS wireless connection from SIFY) which will further be increased to 30MBPS during the next two months. The LAN upgradation (from CAT-5 to CAT-6 cables) is almost complete in most buildings of the Campus. The Wi-Fi connection is currently being installed in Students' Hostel and will be operational from February 2010. A centralized data storage system (of 10TB capacity of data) and a new Email-solution (DeepRoot or Zimbra) are currently being procured which will be put in place during the next two months.

The following are the members of the CompLab:

**Head**

Meheboob Alam

Ph D

**R & D Assistants**

Vikas Mohan Bajpai, Vishnu Pradeep PV

**Engineer (Facility Management from Locuz)**

K Nishaj



## 14. Library

The Library presently has a collection of 7870 books and access to over 4000 Scientific Journals. The Library continued to acquire, organize and disseminate information resources to render need based information services to faculty, students and researchers.

### Collection Development

#### Overview of Collection

Books	
Books added during the financial year	1,889
Expenditure for books	₹ 39,40,717.00
Total books in collection	7970
Journals	
Online journals subscribed	116
Print journals subscribed	09
Journals subscribed in Print + Online	09 Journals
Patent database (Derwent Patent Index)	01
Abstracting and Indexing database (Web of Science)	01
Expenditure for Journals	₹1,00,23,658.00
Online journals in collection (Subscription + consortium resources)	Over 4000

#### Books Acquisition and Budget spent

In the financial year 2009-10, 1,889 books worth ₹ 39,40,717.00 ( ₹ Thirty Nine Lakhs Forty Thousand, Seven Hundred and Seventeen only) have been procured in the library based on the recommendations of JNCASR Faculty members. With the procurement of books for the financial year, the total books in stock has reached 7,870 (Seven Thousand Eight Hundred and Seventy) books.

#### Journal Subscription and Budget

The total amount spent for the subscription of both print and online journals for the year 2009-10 is ₹ 1,00,23,658 ( ₹ One Crore Twenty Three Thousand Six Hundred Fifty Eight only).

Following are the library staff members:

#### Consultant

Y. M. Patil

PhD

#### Library-Cum-Information Officer

Nabonita Guha

#### Library Assistants

Nandakumari, E.  
Nagesh Hadimani  
Senthil Kumar, N.

#### Library Trainee

Kalpana S.

#### Helper

Rajeeva, J.

## Endowed Research Professors

**D S Kothari Chair**

M M Sharma

FRS, FASc, FNA

**Hindustan Lever Chair**

TV Ramakrishnan

FASc, FNA, FTWAS

**Linus Pauling Research Professor**

C N R Rao

FASc, FNA, FRS, FTWAS, Hon.F  
RSC



## ACADEMIC PROGRAMMES

### Academic Activities

At JNCASR, research is carried out in six Units: Chemistry and Physics of Materials Unit (CPMU), Evolutionary and Organismal Biology Unit (EOBU), Engineering and Mechanics Unit (EMU), Molecular Biology and Genetics Unit (MBGU), New Chemistry Unit (NCU) and Theoretical Sciences Unit (TSU). The research undertaken is inter-disciplinary in nature.

The Centre offers Ph D, Integrated Ph D, MS (by research) and MS Engg.(by research) degree programmes in Science and Engineering. Students are admitted to the six Units mentioned above. The minimum academic qualification required to apply for the MS/Ph.D programmes of the Centre is MSc/BE/BTech/ME/MTech/MBBS degree/s. Candidates applying for MS/Ph.D programmes should have at least 50% in their highest University examination, and should also have qualified in GATE/UGC-CSIR-JRF/ICMR-JRF/DBT-JRF/JEST/equivalent examinations. Candidates applying for Integrated Ph.D Programme of the Centre should have at least 55% marks in their Bachelor's degree in any area of Science or Statistics.

The Centre selects candidates on the basis of their academic record, performance in GATE/UGC-CSIR-JRF/ICMR-JRF/DBT-JRF/JEST/equivalent examinations, recommendation from referees and performance in the interview. The selected candidates are offered course work, provided with research facilities and on successful completion offered with the degree.

#### (a) Research Admissions

Thirty two students were selected into the MS/Ph D programme, 4 students into the Int. Ph.D Programme, 1 student into the External Registration programme and 3 students into the Post graduate Diploma Programme in Materials Science for the August 2009-10 semester. In the mid-year admission of January 2009-10, 15 students were selected into the MS/Ph.D Programme and 1 student into the External Registration Programme. The present student strength is 182.

#### (b) Degrees Awarded

The Centre is a Deemed University, and awards Ph.D, M.S (by research), M.S(in Chemical Sciences) and M.S (Engg. by research) degrees. Over the past 21 years, 124 students have obtained degrees. Following are the students who have been awarded degrees during April 2009- March 2010:

##### MS (in Chemical Sciences)

HSS Ramakrishna Matte

##### MS (Engg.by research)

Vishwas V

Shruti Badhwar

KS Subrahmanyam

##### MS (by research)

Mr Manjunatha T

##### Ph D

Dinesh Jagadeesan

Pradeepa M M

Krishanpal Karmodia

Rahul Modak

Mohammed Arif

Aparna G

Shampa Ghosh Modak

Vengadesh Kumara Mangalam

Sairam Swaroop Mallajosyula

### New programmes launched

The Centre has introduced the External Registration Programme for scientists from DRDO, with which JNCASR has a memorandum of understanding for Ph.D and MS degrees. Two students have joined under this programme for MS and Ph.D degrees. The Centre has also introduced during this period Integrated Ph.D Programme in Chemical Science and Biological Sciences. In Biological Sciences it is independently offered in *Evolutionary and Organismal Biology* and *Molecular Biology and Genetics*. As part of the Science Outreach Programme, JNCASR had initiated Project Oriented Chemical Education (POCE) and Project Oriented Biological Education (POBE) for students studying in their 1<sup>st</sup> year B.Sc. The POCE and POBE students on completion of their successful training and based on their performance in the interview have been admitted to the MS-Ph.D programme of the Centre, which the Centre has newly introduced during this period. 5 students have registered under this programme.

## Discussion Meetings/Workshops

1. Symposium on “Biology & Pathogenesis of Viruses: Molecular Insights”, May 4-5, 2009, Dr Saumitra Das, IISc.
2. IISc-Centenary International Conference and Exhibition on “Aerospace Engineering” (ICEAE-2009), May 18-22, Prof B N Raghunandan, IISc.
3. Frontier Meeting in Chemical Biology, July 2 -7, 2009, Prof Hemalatha Balaram (JNCASR) and Prof Biman Bagchi, IISc.
4. School on Understanding Simulation, August 17-28, 2009, Prof Srikanth Sastry, JNCASR.
5. Evolutionary Biology in India – Looking ahead, September 11-12, 2009, Prof Amitabh Joshi, JNCASR.
6. Fifth Kannada Vijnana Sammelana, September 15-17, 2009, Prof K I Vasu, Swadeshi Vijnana Andolana (Karnataka).
7. 5th JNCASR Research Conference on “Chemistry of Materials”, October 3-5, 2009, Prof Chandrabhas Narayana, JNCASR.
8. JNCASR-FCBS Workshop for College Chemistry Teachers and Postgraduate students, October 29-31, 2009, Prof V Krishnan (JNCASR) and Dr Suresh Das (NIIST, Tvm).
9. Consortium of Students in Management Research – COSMAR- 2009, November 5-6, 2009, Prof R Srinivasan, IISc.
10. Platinum Jubilee Meeting, November 12-14, 2009, Prof D Balasubramanian, President, Indian Academy of Sciences.
11. Indo-Japan Joint Seminar/Workshop on “Physics and Chemistry of Graphene”, November 17-19, 2009, Prof Swapan K Pati (JNCASR) and Prof Toshiaki Emoki, Tokyo Instt. of Technology, Japan.
12. All India Training Programmes in Industrial Metal Finishing, November 23-28, 2009, Mr Rajeev Deekshit, ECSI.
13. Winter School - (ICMS), November 30 – December 5, 2009, ICMS.
14. Symposium on Modern Trends in Inorganic Chemistry (MTIC-XIII), December 9 – 12, 2009, Prof A R Chakravorty, IISc.
15. Symposium on Applied Aerodynamics & Design of Aerospace Vehicles (SAROD 2009), December 10-12, 2009, Dr A R Upadhyay, NAL.
16. International Conference on Current Trends in Chemistry & Biochemistry (ICCTCB-2009), December 18-19, 2009, Prof Md. Farooq Ahmed, et al., Bangalore University.
17. 46th Guha Research Conference, December 19-23, 2009, Prof Umesh Varshney and Dr Saumitra Das (IISc) and Prof Tapas Kumar Kundu, JNCASR.
18. International Symposium of Molecules & Materials (A Survey of Recent Concepts), December 28-29, 2009, Prof B M Deb, IISER Kolkata.
19. Recent Advances in Many Electron Theories, January 5-7, 2010, Prof. Debashis Mukherjee, IACS, Kolkata.
20. Transient Growth of Instabilities in Shear Flow, January 11-15, 2010, Prof. Rama Govindarajan, JNCASR.
21. International Conference on Understanding and Managing Pathogenic Microbes, January 22-24, 2010, Dr. Girish Sahni, IMT, Chandigarh.
22. JNC Frontier Lecture Series, January 21-22, 2010, Prof S M Shivaprasad, JNCASR.
23. Energy & Climate Development – Pressing Problems of Human Kind, Afro Asia Young Scientist Conclave during February 11-13, 2010
24. 35th Mahabaleshwar Seminar 2009 on Modern Biology, February 21-28, 2010, Prof. Jayant Udgaonkar, TIFR, Mumbai.





## Colloquia

The following special lecture under the series JNCASR Colloquium was held during the period :

### Special Lecture

1. Chandrayaan-1: Technology and Science Perspectives, Prof J N Goswami, Director, PRL, Principal Scientist-Chandrayaan-1; and
2. Dr M Annadurai, Project Director, Chandrayaan-1&2, ISRO, Bangalore, April 21, 2009.

### Fluid Dynamics

The following colloquia were held during the period :

1. Nested multi-block solution method with immersed boundaries and transition in bluff body wakes, Dr Amalendu Sau, Institute of Physics, Academia Sinica, Taipei 11529, Taiwan, April 8, 2009.
2. Instability of developing shear flow: Gaster revisited, Prof P K Sen, Department of Applied Mechanics, IIT Delhi, May 8, 2009.
3. Instabilities and transition in a 3D-boundary layer, Dr Benoit Pier, Laboratoire de mécanique des fluides et d'acoustique - Ecole centrale, France, June 3, 2009
4. The role of Peclet number in 3-D mixing inside drops, Dr N Vinod, Assistant Professor, Department of mechanical engineering, IIT Gandhinagar, July 15, 2009.
5. Application of Batchelor's paradigm for lean pre-mixed combustion, Dr N Swaminathan, Lecturer in combustion CFD & Director of Studies, Robinson College, Department of Engineering, University of Cambridge, August 12, 2009.
6. Interfacial instabilities in adhesion, dewetting, phase-change and atomization, Dr Gaurav Tomar, Post-doctoral scholar, Chemical engineering, University of California at Santa Barbara, USA, September 23, 2009.
7. Data assimilation - Kalman filtering and Bayesian approaches, Dr Amit Apte, Fellow, TIFR Centre for applicable mathematics, Bangalore, October 7, 2009.
8. Shock turbulence interaction : Theoretical analysis and turbulence modeling, Dr Krishnendu Sinha, Department of Aerospace Engineering, IIT Bombay, November 18, 2009
9. The development of the theory of water waves and tides, 1776-1880, Dr Alex Craik, School of Mathematics and Statistics, University of St Andrews, Mathematical Institute, North Haugh, St. Andrews, KY16 9SS, Scotland, December 11, 2009
10. Unfolding of polymeric globules in extensional flow, Prof J Ravi Prakash, Department of Chemical Engineering, Monash University, Clayton, Victoria-3800, December 30, 2009.
11. Single Species Population, Dr Prasad Perlekar, Department of Mathematics and Computer Science, Technische Universiteit Eindhoven, Netherlands, January 8, 2010
12. Statistical Mechanics of the Fluctuating Lattice Boltzmann Equation, Dr Burkhard Dünweg, Max-Planck-Institut für Polymerforschung, Mainz, Germany, January 11, 2010
13. Internal Wave Studies in the Lab, Dr Manikandan S Mathur, Experimental and Nonlinear Dynamics Lab, MIT, USA, January 19, 2010
14. LDV and Micro Optical Sensor, Dr Darius Modarress, MSE, Pasadena, CA, USA, February 11, 2010.
15. Mechanics and micro-mechanism of deformation and failure, Dr Anamika Prasad, Department of Bioengineering, Stanford University, Stanford, CA 94305, February 16, 2010.
16. Thin shear layers - the key to turbulence structure, Prof Lord Julian Hunt University College, London, February 24, 2010.
17. Encapsulated microbubbles for ultrasound imaging/ drug delivery and cell adhesions to biologically activated substrates, Prof Kausik Sarkar, University of Delaware, USA, March 10, 2010.
18. Physical and biological limits of human motor performance, Dr Madhusudhan Venkadesan, Harvard University, USA, March 17, 2010
19. Energy efficient particle removal from surface and the mechanism of its deposition on surfaces, Mr Lalit Kumar, Hindustan Lever Research Centre, India, March 24, 2010.

## ENDOWMENT LECTURES

1. **AV Rama Rao Foundation Lectures in Chemistry : Enantioselective Organocatalytic Aldol Reaction** Prof Vinod K Singh, Director, IISER, Bhopal;
- 1.1. **Prize Lecture: Structure Entropy and Mobility in Liquids** by Dr Charusita Chakravarty, Dept. of Chemistry, IIT, Delhi, on May, 5, 2009.
2. **Prof V Ramalingaswami Memorial Lecture (8th in the series) : Hepatitis B: Mechanisms of persistence and carcinogenesis**, Dr S K Sarin, Dept. of Gastroenterology, G B Pant Hospital, and Project Director, Institute of Liver and Biliary Sciences, New Delhi, July 13, 2009.
3. **C.N.R. Rao Oration Award Lecture, Raman in the age of Materials**, Prof Chandrabhas Narayana, August 7, 2009.
4. **DAE Raja Ramanna Lecture, Science and Technology of Sodium Cooled Fast Reactors and Associated Fuel Cycle**, Dr Baldev Raj, Director, IGCAR, Kalpakam.
- 4.1. **Prize Lecture: Atomically Controlled Surfaces, Inter faces and Nanostructures**, Prof. Bhupendra Nath Dev, Department of Materials Science, IACS, Kolkata, October 9, 2009
5. **Rajiv Gandhi Science and Technology Lecture: What can a Chemist tell you about the origin of Life**, Prof Richard N Zare, Standford University, USA, on October 11, 2009.
6. **ISRO Satish Dhawan Lecture: Science and Sustainable Food Security**, Prof M S Swaminathan, Member of Parliament (Rajya Sabha), November 3, 2009 followed by Conferment of Honorary Fellowship of the Centre on Prof M S Swaminathan.
7. **Michael Faraday Lecture : The advent of mesoscopic solar cells**, Prof Michael Graetzel, Director, Laboratory of Photonics and Interfaces (LPI), Institute of Chemical Science and Engineering, Switzerland, March 31, 2010.

## GENERAL LECTURE

### Guest Lectures

1. *'Retroviral infections in wild Indian primates from Rajasthan'*, Dr Jayashree S Nandi, HIV Drug Resistance Program, National Cancer Institute, National Institutes of Health, Frederick, Maryland, USA. August 3, 2009.
2. *HIV as a tool in the identification of novel host factors: Implications for viral pathogenesis and therapy*, Dr Annapurna Vyakarnam, Senior Lecturer, Division of Immunology, Infection and Inflammatory Disease, King's College London, England, United Kingdom, August 5, 2009.

### Darwin Lecture

1. *Darwinian Explanations of aging: the evolution of mortality rates*, Prof Laurence D. Mueller, University of California, Irvine, September 11, 2009.
2. *New synthetic pathways for inorganic nano-materials by concentrated non-coherent light*, Prof. Jeffrey M. Gordon, Ben-Gurion University of the Negev, Israel, January 28, 2010

### Lectures delivered at the Annual Faculty Meeting by Faculty/Hon. Faculty

1. Nano-mechanical characterization of advanced materials by Prof U Ramamurty
2. Unraveling an eighty-year old mystery – The Ramdas Layer by Prof K R Sreenivas
3. Interplay of strong correlations and magnetic field in heavy fermion materials by Dr N S Vidhyadhiraja
4. Thermodynamic analysis of DNA – Protein interaction with restricted Mobility by Prof Dipankar Chatterji
5. Developmental evolutionary biology: towards a fuller synthesis by Prof Amitabh Joshi

### Seminars

1. A quantum classical approach to explore the photoabsorption spectrum of C<sub>6</sub>H<sub>6</sub> radical cation and the molecule - surface scattering on H<sub>2</sub> - Cu(100) system, Dr Satrajit Adhikari, Department of Physical Chemistry, Indian Association for the Cultivation of Science, Kolkata, April 3, 2009.
2. Multi-Functional Organic Matrix: The Tale of Two Eggshell-Specific Proteins, Dr Rajamani Lakshminarayanan, National University of Singapore, April 6, 2009.



3. Teaching “Old” Dogs “New” Tricks: Synthesis and Nanopatterning of Multifunctional Oxides, Prof. Vinayak P. Dravid, International Institute for Nanotechnology, Northwestern University, USA, April 20, 2009.
4. Multi-Facets of One-Dimensional Coordination Polymers, Prof. Jagadese J. Vittal, Department of Chemistry, National University of Singapore, Singapore, April 24, 2009.
5. Complete Jamming Landscape for Confined Hard Discs, Dr. Ashwin S. S, University of Saskatchewan, Saskatoon, Canada, May 6, 2009.
6. Prokariotic cell fate and division control: A tale of two unorthodox regulators, Dr Sunish Radhakrishnan, Dept. of Molecular Biology and Microbiology, School of Medicine, Case Western Reserve University, Cleveland, OH 44106, May 8, 2009.
7. On clinical and genetic aspects of Parkinson's disorder, Dr. Uday Muthane, Parkison's Foundation, Bangalore, May 20, 2009.
8. Surface Functionalization of Silicon-based Detectors for Sensor Applications, Dr. Manish Dubey, University of Washington, May 22, 2009 (ICMS)
9. Nanomaterials for Catalytic and Biomedical applications, Dr. Sangaraju Shanmugam, School of Advanced Science and Engineering, Waseda University, Japan, June 25, 2009 (ICMS)
10. Controlling metamaterial properties, Prof. Anantha Ramakrishna, Indian Institute of Technology, Kanpur, June 30, 2009
11. LES of a stratified boundary layer under an oscillatory current, Dr Bishakhdatta Gayen, Department of Mechanical and Aerospace Engineering, University of California, San Diego, CA 92093-0411, USA, July 6, 2009
12. Rational Nanowire Synthesis for Applications in Nanoscale Spintronics and Photonics, Dr. Kumar S. K. Varadwaj, Hokkaido University, Japan, July 22, 2009 (ICMS)
13. Modular Oxazoline Ligands: Synthesis And Application In Asymmetric Catalysis, Dr. Sridhar Rajaram, University of California, Berkeley, July 30, 2009 (ICMS)
14. Phosphonate Cavitands: Harnessing Molecular Recognition in Materials Science, Prof. Enrico Dalcanale, Department of Organic and Industrial Chemistry University of Parma, Italy, August 6, 2009
15. Vertical, Templated Carbon Nanotube Arrays: Synthesis and Applications, Prof. Timothy Fisher , Purdue University, USA and Adjunct Professor, ICMS, August 10, 2009.
16. Hybrid Nanocrystals: Synthesis, Characterization and Applications, Dr. Sasanka Deka, Nanochemistry division, Italian Institute of Technology, Via Morego 30, 16163 Genova, Italy, August 12, 2009.
17. The role of post-synaptic density proteins in AMPA receptor trafficking, Dr. Samarjit Bhattacharyya, Department of Psychiatry and Behavioral Sciences, Stanford University, USA, August 17, 2009.
18. Micro-Scale Dynamics of Precision Actuators Coupled with High-Speed Continuous Structures, Dr. Kartik V, August 20, 2009.
19. Polarized, Resonant Radiation Interactions with Matter: The birth and potential of a New Field of Materials Science, Dr. Manju Lata Rao, Materials Research Laboratory, The Pennsylvania State University, University Park, PA 16801, USA, August 20, 2009. (ICMS)
20. Tunnel current fluctuations in the Scanning Tunnelling Microscope: what can they reveal? Dr. Joy Mitra, Queen's University, Belfast, UK, August 24, 2009. (ICMS)
21. A Framework for Comprehending the Nature of the Protein Universe Dr. Sri Krishna Subramanian, Joint Center for Structural Genomics, La Jolla, CA, September 17, 2009.
22. Some new paradigms in near-field enhanced Raman microscopy, Dr. G. V. Pavan Kumar, Bindley Bioscience Center, Discovery Park, Purdue University, USA, September 17, 2009
23. Adsorption on Nanostructured Surfaces: The Case of Ethene on Cu(410), Dr. Vinay Venugopal, Institute of Physics, Bhubaneswar-751005, September 23, 2009.
24. Scanning tunneling spectroscopic studies of low-dimensional electronic systems, Dr. Sangita Bose, Max Planck Institute for Solid State Research, Stuttgart, Germany, October 7, 2009. (ICMS)

25. Methodological developments in NMR and their applications in lithium(ion) batteries, Dr. Rangeet Bhattacharyya, SUNY Stony Brook. NY, October 8, 2009 (ICMS)
26. Charge transport through disordered polymeric media, Dr N.S. Vidhyadhiraja, JNCASR, October 13, 2009.
27. Self-Organized Nanostructures at Surfaces, Professor Sylvie Rousset, CNRS and University Paris Diderot, France, November 4, 2009.
28. Turbulence in Thin Fluid Films, Prof. Rahul Pandit, IISc, November 9, 2009
29. The Immunoglobulin Super Family protein RIG-3 prevents synaptic potentiation in *C.elegans*, Dr. Kavita Babu, Department of Molecular Biology, Massachusetts General Hospital, Richard B Simches Building, Boston, MA 02114, November 10, 2009
30. Size-induced structural changes, Dr. Pushan Ayyub, TIFR, Mumbai, November 10, 2009
31. India-Japan (DST-JSPS) Workshop on Graphene, Indian and Japanese Scientists, November 17, 2009
32. Defect production in quantum critical systems, Prof Krishnendu Sengupta, Indian Association for the Cultivation of Science, November 19, 2009
33. On the origin of self-incompatibility alleles: genomic conflict under absolute linkage, Prof. Marcy K. Uyenoyama, Biology Department, Duke University, November 27, 2009
34. Hot-Wire Chemical Vapor Deposition: from Fundamentals to applications, Dr. Jean-Eric Bouree, Laboratoire de Physique des Interfaces, at des Couches Minces, Ecole, Polytechnique, Palaiseau, France, December 7, 2009
35. Towards Organic Injection Laser Diode, Dr. Dinesh Kabra, Herchel Smith Research Fellow, Cavendish Laboratories, Cambridge UK, December 8, 2009
36. Genome-wide patterns in the evolution of gene expression, Prof. Daniel L. Hartl, Department of Organismic & Evolutionary Biology, Harvard University, December 9, 2009
37. Soft Porous Crystals from Porous Coordination Polymers, Prof. Susumu Kitagawa, Synthetic Chemistry and Biological Chemistry, Kyoto University, Japan, December 10, 2009
38. The Spin on Electronics, (International Materials Lecture), Prof. Stuart Parkin, Director, IBM-Stanford Spintronic Science & Applications Center (SpinAps), December 11, 2009 (ICMS)
39. Structure and stability of proteins upon adsorption to hydrophobic surfaces, Mr. Sumit Sharma, Department of Chemical Engineering, Columbia University, December 15, 2009
40. Biomimetic assembly with minimum components, Dr. Surajit Ghosh, European Molecular Biology Laboratory, Heidelberg, Germany, December 15, 2009
41. Molecular modelling challenges in computational enzymology, Dr Guillaume Lamoureux, Concordia University, Canada, December 15, 2009
42. Chemo and phototactic nano/microbots, Prof. Ayusman Sen, Penn State University, December 16, 2009.
43. Complexity breeds complexity: hierarchical sociality in African elephants as a response to the interaction between genes, environment, competition and fitness, Dr. George Wittemyer, Assistant Professor, Colorado State University, Colorado, USA, December 17, 2009
44. Biomedical nanomagnetism: A Spin through new possibilities, Prof. Kannan M. Krishnan, Department of Materials Science, University of Washington, December 21, 2009
45. Controlling photochemistry with weak non-covalent forces and confined spaces, Prof. V. Ramamurthy, University of Miami, December 21, 2009
46. Material challenges for the next generation: Role of synthetic solid state and materials chemistry, Dr. Tapas Kumar Mandal, University of Glasgow, December 22, 2009
47. Time to wake up! Cell autonomous light sensing in arousal neurons in *Drosophila*, Prof Todd C Holmes, University of California, Irvine, December 24, 2009
48. Unfolding of polymeric globules in extensional flow, Prof. J. Ravi Prakash, Department of Chemical Engineering, Monash University, Clayton, Victoria-3800, December 30, 2009



49. Inhibition of HLA-B27 Homodimer - Receptor Ligation: Implications for Homodimer functions in Ankylosing Spondylitis, Sravan K. Payeli, January 4, 2010.
50. Evolutionary and ecological approaches to circadian neurogenetics, EOBU Special Seminar, Prof. Charalambos P. Kyriacou, Leicester University, January 08, 2010.
51. The “Easy” Approach to Self-Assembly: Teaching new tricks to old molecules and nanoparticles, Dr Srinivasa R. Raghavan, Department of Chemical & Biomolecular Engineering University of Maryland College Park, MD 20742, January 12, 2010.
52. Electrochemically driven sequential machine: an implementation on copper rotaxanes based on computational studies, Dr. Ganga Periyasamy, University of Liege, January 21, 2010.
53. Sperm limitation as a driver of morph diversification, Dr. Priya Iyer, IISER, Pune, January 22, 2010
54. Evolutionary and ecological approaches to circadian neurogenetics, Dr. Wayne Linklater, Senior Lecturer, Centre for Biodiversity and Restoration Ecology, Victoria University of Wellington, New Zealand, January 27, 2010
55. Complex dynamics of polymer translocation: Effect of folded configurations and charge distribution, Prof. Anatoly B. Kolomeisky, Associate Professor of Chemical and Biomolecular Engineering, Rice University, Dept. of Chemistry, Houston, USA, January 28, 2010
56. Roles of PIP and UBZ domains of Pol $\zeta$  in trans-lesion DNA synthesis (TLS): Lesson Learned from XPV, Dr. Narottam Acharya, Department of Biochemistry and Molecular Biology, University of Texas, Medical Branch, Galveston, February 16, 2010.
57. Colloidal crystallization between two and three dimensions, Dr Rene Messina, Institut fur Theoretische Physik II - Soft Matter, Heinrich-Heine-Universitat Dusseldorf, Germany, February 23, 2010.
58. High-pressure synthesis and physical properties of new iron-based superconductors, Dr. P. M. Shirage, National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Central 2, Umezono, Tsukuba, Ibaraki, 305-8568, Japan, February 25, 2010
59. Sensing structural phase transitions with conductivity noise, Prof. Arindam Ghosh, Department of Physics, IISc, March 2, 2010
60. Unravelling effects of surface density profile of PEG linked carbohydrates interaction with proteins using XPS and SPR, Dr. Marshal Dhayal, CCMB, Hyderabad, March 9, 2010
61. Synthesis and characterization of novel glycopolymers via controlled/ “living” radical polymerization glycopolymers, Dr. Sharmila Muthukrishnan, March 9, 2010
62. Encapsulated microbubbles for ultrasound imaging/drug delivery and cell adhesion to biologically activated substrates, Prof. Kausik Sarkar, Department of Mechanical Engineering, University of Delaware, March 10, 2010
63. Dissecting the mechanisms of insect flight behavior, Professor Sanjay P. Sane, Insect Flight Lab, National Center for Biological Sciences, Bangalore, March 23, 2010.
64. Genomic rearrangements and variable neurodevelopmental phenotypes, Dr. Santhosh Girirajan, Department of Genome Sciences, University of Washington, Seattle, WA, USA, March 30, 2010.

#### **International Conferences/schools/workshops**

1. School - Understanding Molecular Simulation (UMS2009), August 17-28, 2009
2. NU-ICMS Joint Symposium - Northwestern University, USA and JNCASR, Bangalore, September 1 and 2, 2009
3. International Conference and School on Multiscale Modeling and Simulation of Hard and Soft Materials (MSM-2009), December 7-20, 2009.
4. School on Glass Formers and Glasses (glass2010), January 4-20, 2010.
5. Conclave of Afro Asia Young Scientists organized by TWAS-ROCASA, February 11-13, 2010.



## EXTENSION ACTIVITIES

### Summer Research Fellowships/ Department of Science and Technology Fellowships/ Rajiv Gandhi Science Talent Research Fellowships

#### Summer Research Fellowships Programme

The Centre offers summer fellowships for two months to bright undergraduate and M.Sc students (renewable for a second year for selected students). This programme has proved to be popular and competitive; each year, about 5000 students from all over India apply for the 100-120 fellowships awarded. 100 fellowships are supported by the Department of Science & Technology, Government of India, fifteen by the Rajiv Gandhi Institute for Contemporary Studies, New Delhi, and the rest by the Centre. Students are placed with research groups at the Centre or with scientists elsewhere in India. They are paid travel expenses and a stipend of Rs. 5000.

Category	No. of applications Received (for 2010)	No. of Fellowships offered in 2010	No of fellowships offered in 2009	No of fellowships utilized in 2009
Life Sciences	815	23	31	22
Engineering Sciences	520	28	30	23
Atmospheric Sciences	40	02	03	03
Physical Sciences	380	20	21	14
Chemical Sciences	265	27	34	27
Mathematics	135	05	05	04
Materials Sciences	242	02	07	07
Total	2397	107	131	100

#### TWAS-SRFP

The TWAS-SRFP 2010 has been announced on the JNCASR website and relevant information has been communicated to the representatives of different countries. Under the TWAS SRFP programme a Nepalese student who had already completed his project training under Prof. Waghmare, TSU, during 2008 has come back to work on a project for 2 months. The TWAS had funded his stay at the Centre.

#### JNCASR-CCSTDS FELLOWSHIP

This Fellowship programme is jointly instituted by the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) Bangalore and the Centre for Co-operation in Science & Technology Among Developing Societies (CCSTDS), Chennai to encourage mobility of scientists from developing countries. CCSTDS is a Unit of the Indian National Science Academy (NISA), supported by the Department of Science & Technology, New Delhi. This programme aims to promote co-operation among developing regions.

The fellowship cover short-term research, training or participatory research work in physical, chemical, biological or engineering sciences in reputed scientific institutions in India including JNCASR. The applicant must be a scientist, teacher or a research scholar, affiliated to a scientific or academic institution in a developing country in Asia (other than India), Africa, Latin America and Arab region. Travel support in the form of a prepaid Ticket Advice (PTA) will be provided for selected candidates. The duration of the fellowship is for 3 months. The fellowship covers boarding, lodging (for the individual only) at the affiliated institution and other subsistence expenses in the form of an adequate allowance in Indian currency.



The fellowship was announced during 2009-10 and the following were selected under this programme:

No	Name	Country	Host Institution
1	Dr. Atinuke M. Agunloye	Nigeria	CMC, Vellore
2	Mr. Nkurunziza Theoneste	Rwanda	NEERI, Nagpur
3	Mr. Gazi Md. Arifuzzaman Khan	Bangladesh	NCL, Pune
4	Dr. Zar Ni Tun	Myanmar	IISc, Bangalore
5	Dr. Martins Emeje	Nigeria	Tezpur University, Assam

#### Project Oriented Chemical Education ( POCE)

Advertisement for POCE-2010 has been placed in nine newspapers and on the website of JNCASR. The last date for the receipt of applications was 26th February 2010.

During the mid semester break of 2009, two students (of POCE-2008 & POCE-2009), worked under the faculty members on small projects for ~ 3 weeks. Four former students of POCE have joined Ph.D/Int. Ph.D programme in India/abroad.(Till now ten former students of POCE have joined Ph.D / Int. Ph.D programmes at different places). Students from POCE 2008 will be receiving their Diploma certificates this summer on successful completion of their 3 year project training.

#### Project Oriented Biological Education (POBE)

Advertisement for POBE-2010 has been placed in nine newspapers and on the website of JNCASR. The last date for the receipt of applications is 26th February 2010. Batches of 2008 and 2009 will be returning for their training in May 2010. Students from POBE 2008 will be receiving their Diploma certificates this summer on successful completion of their 3 year project training.

#### Visiting Fellowships

For the year 2009-10, the advertisement had appeared in "Current Science" on June 10, 2009. Out of 11 applications received, 10 were from Physical Sciences and one from Life Sciences category. Seven candidates were selected of which 6 are from Physical Sciences and one from Life Sciences category.

Sl.No	Name of the Visiting Fellow	Affiliation; Guide's Name
1	Dr. Lokendra Kumar	University of Allahabad Prof. K.S. Narayan, CPMU
2	Dr. Nandakumar Kalarikkal	Mahatma Gandhi University, Kottayam Prof. A. Sundaresan, CPMU
3	Dr. Sukhprit Singh	Guru Nanak Dev University, Amritsar Dr. M. Eswaramoorthy, CPMU
4	Dr. S. Senthil Kumar	VIT University, Vellore Dr. T. Govindaraju, NCU
5	Dr. Amaraneni Sreenivas Rao	PESIT, Bangalore Prof. Hemalatha Balaram, MBGU
6	Dr. Umesh A. Palnitker	Univ. of Mumbai, Navi -Mumbai Prof. C.N.R. Rao, ICMS
7	Dr. Papia Chowdhury	Jay Pee Institute of Information Technology University, Uttarpradesh Prof. C.N.R. Rao , ICMS



### **National Science Day**

The National Science Day was held on 25th February 2010. Around 150 students and 15 teachers attended lectures by faculty from JNCASR ranging on topics like inspecting animal societies, the weapons of chemistry to battle infectious diseases, aerodynamics of bird and insect flight, soft matter : from sand grains to DNA at JNCASR. The theme for the National Science Day this year was “Gender Equity for Peace and Prosperity”. JNCASR had also sponsored the celebration of this theme at three prominent educational institutions/ college of Bangalore. Debates and discussions were held at these colleges and prizes were given away to the best speakers and the event was successfully held simultaneously on the same day.



## INTELLECTUAL PROPERTY

The Intellectual Property Management Committee addresses all issues concerned with securing, protecting, maintaining and valorizing the Intellectual Property generated by the Faculty of the Centre. The Committee facilitates the scientific community through an institutional mechanism for obtaining IPR and its commercialization.

During the year, the IPM Committee met four times and reviewed a number of inventions and approved filing of patent applications for eight inventions. Out of these, seven national and three international patent applications and one Indian design application have been filed. Most of the inventions are in the licensing stage. A couple of inventions were licensed to Companies in India, Switzerland and USA. Nominal royalty on the licensed products were received. Negotiations are on with a number of Companies for further licensing of the inventions. The titles of the applications filed are given below:

### International Patent Applications Under PCT

- PCT/IN2009/000266, filed on 4/5/2009 for the invention 'A template free metal, polymer free metal nanosponge and a process thereof', inventors being Eswarmoorthy M, Saikrishna K.
- PCT/IN2009/000284, filed on 14/5/2009 for the invention 'Tat DNA sequences, gene constructs, vaccine and processes thereof' inventor being Ranga U.
- PCT/IN2009/000710, filed on 9/12/2009 for the invention 'SERS active paper substrate, a process and a method thereof' inventors being Kulkarni GU, Gupta A, Karthick B and M/s. Yash Nanotech Ltd. as Joint Applicant.

### National Phase Applications

#### India (Patents)

- Wings for propeller driven aircraft, inventors being Narasimha R, Deshpande SM, Praveen C, Rakshith BR and Tata Institute of Fundamental Research as Joint Applicant.
- Derivatives of curcumin and methods thereof, inventors being Kundu TK, Arif M, Mantelingu K, Gopinath KS.
- Marker for detection of carcinoma and processes thereof, inventors being Kundu TK, Jayasha S, Swaminathan V, Ramesh C, Shrikanth SG, Gopinath KS.
- A synthetic cyclic peptide and a process thereof, inventor being Govindaraju T.

#### India (Design)

- Aircraft wings, inventors being Narasimha R, Deshpande SM, Praveen C, Rakshith BR and Tata Institute of Fundamental Research as Joint Applicant.

#### USA, Europe and South Africa

- USA Application No. 12/515,766, filed on 21/5/2009; European Application No. 07866744.1, filed on 7/5/2009; South African Application No. 2009/03128, filed on 6/5/2009 for the invention 'A high sensitivity assay for molecular typing of biological sample, probes and a kit thereof' inventors being Ranga U, Chandrabhas N and Jayasuryan N.

# RESEARCH PROGRAMMES

## RESEARCH AREAS

There are ongoing research programmes in several frontier, interdisciplinary areas of science and engineering. The main areas of research interest at present are:

- Chemistry of materials
- Nanomaterials, nanofabrication, molecular crystals
- Molecular modelling of materials
- Raman and Brillouin spectroscopy in the study of materials
- Nanomaterials and catalysis
- Organic electronics & optoelectronics, device-physics & photophysics, solution processing & patterning, soft matter & hard properties, biophotonics.
- Magnetism, superconductivity and multiferroicity
- Surface science, heteroepitaxy and nanostructures
- Self-assembled molecular materials: Metal-Organic Coordination Networks (MOCNS)
- Instabilities and interfacial flows
- Aerospace and atmospheric fluid mechanics
- Granular matter and other complex fluids
- Complex fluids and flows
- Minimal molecular dynamics
- Fluid mechanics and heat transfer
- Computational fluid dynamics
- Evolutionary genetics and population ecology
- Circadian rhythms in fruit flies and ants
- Neuronal circuits in fruit flies
- Large mammal behaviour and phylogeography
- Neotectonics and environmental geology
- Soft materials
- Materials of the future
- Organic materials and organo catalysis
- Organic synthesis
- Peptide and protein chemistry
- Bionanotechnology (biomaterials)
- Antimicrobial research
- Functional organic and supramolecular materials
- Designing new ways to 'small molecule heterocyclic scaffolds'
- Molecular mechanisms of human genetic disorders
- Chromatin biology and genomics
- Mechanisms underlying
- Host-pathogen interactions in malaria
- Protein engineering and molecular parasitology
- Molecular, genetic and developmental analysis of the cardiovascular system
- HIV
- Transcription regulation and chromatin dynamics; implications in disease and potential therapeutics
- Mechanism of chromosome segregation: a molecular approach
- Novel physics and chemistry at the nanoscale
- Non-commutative probability and geometry: mathematics of quantum mechanics
- Advanced quantum theory: molecules to materials
- Phase transformations and dynamics in soft condensed matter, and biological systems
- Addressing materials challenges of the future
- Correlated electron systems and organic electronics
- Statistical physics of equilibrium and nonequilibrium condensed-matter systems
- Nonequilibrium statistical physics of complex systems
- Electronic structure, especially strongly correlated electron systems
- Equilibrium and non-equilibrium statistical mechanics of soft condensed matter and other complex systems



## RESEARCH FACILITIES

The Centre has procured the following research equipment/facilities during the year 2009-2010:

- Multiprep Precision polishing system, Twinprep grinder with accessories
- Sorvall RC-6 Plus Super speed refrigerated centrifuge with accessories
- VT Eye laser scanning confocal imaging system, laser merge module, accessories
- ABTON PAAR Rheometer
- LECIA DM16000B Inverted Microscope
- Argon Laser head, power supply, He Ne Laser 543nm 1mW
- Imaging spectrometer Model lhr550-3g-IX
- Mini DVTM System, frequency shifting for mini LDV
- 800mW CW IR collimated single frequency laser with power supply
- Nanion Port a patch electrophysiology workstation
- Auruba 3400 scalable upto 64 access points
- HPC Cluster comprising of Head Node superserver, compute node, Infiniband switch, storage
- Volumetric Velocimetry System
- UCD 200ft. Bioruptor with accessories
- 1700Deg. Max Temp single zone horizontal tube furnace
- Refrigerated Table top centrifuge 5804R
- Smart 2 Pure PV UF Reverse Osmosis ultra pure Ion exchange system
- RF Plasma Generator, matching network, RF Cable assembly
- Bio safety Cabinet Class II with motorized front window, UV Light and base stand
- Argon Laser head, power supply, He Ne Laser 543nm 1mW
- Standard XY Phase series spatial light modulator, matlab software 7 labview software kit
- Compact turbo pump, double stage rotary vane pump
- Nikon Japan Inverted Research microscope with halogen lamp 6V30W
- NBS Benchtop Refrigerated incubator
- Olympus Live Cell Imaging system
- ML HG-2 Conversion kit with accessories
- Profinia Protein Purification system with accessories
- ND2000 Spectrophotometer
- Deep freezer -86Dec. C Model 4186S
- Sun Fire X 2250 Server with Accessories (4 Nos.)
- Cisco Catalyst
- Intel Core 2 Quad Computer System
- Dell Precision Desktop Computer System
- Power Oscillator, Digital Vibration & Accelerometer
- CO-27 Mossbauer Sources
- Dell Precision Desktop Computer System
- Intel Core 2 Duo Processor Computer
- Circulating water bath, magnetic stirrer, dry bath, hot plate & rocker
- Vacuum Chamber
- Gas line systems
- Zoom Microscope
- Fabrication of cold room
- Canon Photocopier
- Server upgradation
- Centrifuge
- Starter pack Transfection system
- Magnetic Stirrer, Filtration pump, lab jack & rotavap
- IU Rack Mount Server
- Sartorius Electronic Balance
- Ultra Low Immersion Cooler & Refrigerated & Heating Circulator
- Lyophilizer Freezer Dryer
- Ultra-low immersion cooler
- Laboratory Furniture

## Sponsored Ongoing Research Projects

Sl. No.	Investigator	Title	Funding Agency	Duration
1	A Sundaresan	Atomic Engineering of High to Super-conductors by layer by-layer deposition of $\text{AcuO}_x$ (A=Ba, SR, Ca) infinite layers	CSIR	3 years
2	A Sundaresan (Dr. Y. Tanka - NIAIS, Japan)	India-Japan co-operative programme (DST-JST) 2007 - joint project entitled "Feasibility study on the application of multiple order parameters in materials to information processing".	DST- JST	3 years
3	Anuranjan Anand	Whole Genome-based Studies to Identify Novel Molecular Genetic Pathways Causing Human Epilepsy Syndrome - DAE-SRC Outstanding Research Investigator Award	DAE	5 years
4	Anuranjan Anand	National Bioscience Award for career development 2008 project entitles "Towards isolation of a novel gene for non-syndromic hearing loss at the 11p14.2-q12.1 locus"	DBT	3 years
5	C N R Rao	The Science Outreach Programme	DAE/ BRNS	3 years
6	C N R Rao	Collaborative projects between JNCASR and DRDO	DRDO	5 years
7	C N R Rao	CSIR-COE	CSIR	5 years
8	C N R Rao	National Facility on Ultra High Resolution Aberration-Correlated Transmission Electron Microscope	DST & ICMS	5 years
9	Co-ordinated by JNCASR	Postdoctoral Fellowship in Nano Science and Technology	DST	5 years
10	Co-ordinated by JNCASR	Unit on Nano-Science & Technology- UNANST-DST	DST	5 years
11	Education Technoilogy Unit	Vision Group on Science & Technology, Govt. of Karnataka	VGST	1 year
12	G U Kulkarni	Design fabrication of an injection system for patterning of metal cup structures	YNDYM	1 year
13	G U Kulkarni	ICPC Nano Net Coordination and support action	ICPNN	2 years
14	G U Kulkarni	Indo-Italian Research Project: "Innovative catalytic patterns for nanowire growth"	DST	3 years
15	G U Kulkarni, Hemalatha Balaram, M Eswaramoorthy	Extended applications of Highly Sensitive Nanometal Raman substrates, Paper based Nano Silver/Gold SERS Substrates (Plain Substrates, Au/Ag metal sponge based SERS Substrates), Specialised Substrates Bio-Chip, Nano silver - Antibacterial Products	Yash Nanotech Pvt. Ltd.	1 year



16	G U Kulkarni, Timothy S Fischer (Purdue Univ.)	Indo-US joint networked R&D centre on "Nanomaterials for Energy"	IUSSTF	2 years
17	H. Ila	INSA Senior Scientist	INSA	5 years
18	Hemalatha Balaram	Structure-function studies on <i>Plasmodium falciparum</i> and <i>Methanococcus jannaschii</i> guanosine monophosphate (GMP) synthetase: enzymes with ammonia channels	DBT	3 years
19	Hemalatha Balaram	Examination of the metabolic fate of fumarate a TCA cycle intermediate in <i>Plasmodium falciparum</i>	DST	3 years
20	K B Sinha	Bhatnagar Fellowship – 2005 "Quantum mechanics – A Mathematical tool to study non-equilibrium Processes and dissipative systems in Physical Sciences, Geometry and Information Theory"	CSIR	5 years
21	K B Sinha	Evaluation of Impact of DST-FIST Scheme	DST	1 year
22	K B Sinha	British Council Grant "Quantum probability, Noncommutative Geometry and Quantum information"	LANCAS	3 years
23	K R Sreenivas	Investigation of Lift and Thrust in Asymmetric Flight	DST	3 years
24	K R Sreenivas	Lift Generation Mechanisms in Flapping Flight	AOARD	2 years
25	K R Sreenivas	Design, development and establishment of experimental facility at NPOL for studies on internal wake and wave fields generated by self propelled bodies in stratified water medium	NPOL	10 months
26	K R Sreenivas	Experimental studies on the generation of internal wakes by the motion of self propelled under water bodies in stratified water medium and their characteristics: Observations measurements with visualization techniques and optical probes	NPOL	10 months
27	K S Narayan	Studies of organic FETs and 3- terminal structures for switching memory and imaging Applications	DST	3 years
28	K S Narayan	DAE-SRC Outstanding Research Investigator Award for R/P "Electronic, optoelectronics and photonic properties in soft matter and device exploration"	DAE	5 years
29	Kaustuv Sanyal	Characterization of factors required for determining centromere identity using human pathogenic yeast <i>candida albicans</i> as a model system	DST	3 years
30	Kaustuv Sanyal	Functional Analysis of Dynamic Kinetochore-Microtubule Interaction in the human pathogen <i>candida albicans</i>	DBT	3 years

31	Kaustuv Sanyal	Characterization of an evolutionarily conserved kinetochore protein Mtwlp: A tool to analyse kinetochore structure of the human fungal pathogen candida albicans	CSIR	3 years
32	M R S Rao	Chromatin Biology: Epigenomics of chromatin and chromatin remodelling during male germ cell differentiations and glioma progression	DBT	3 years
33	M R S Rao	J C Bose Fellowship to Prof M R S Rao	DST/JCB	5 years
34	M R S Rao	NMITLI Project on "A prospective study to correlate gene signatures with clinical outcome of astrocytomas and identification of potential therapeutic target(s) under the New Millennium Indian Technology Leadership Initiative Scheme	CSIR	5 years
35	Maneesha S Inamdar	Training and research facility for human embryonic stem and human embryonic carcinoma cells	DBT	4 years
36	Maneesha S Inamdar	Gene targeting of the mouse asrij locus to generate knockout mice for functional analysis	DST	3 years
37	Maneesha S Inamdar	Analysis of conserved functions of rudhira in development, homeostasis and lifespan	DBT	3 years
38	Maneesha S Indamdar	Lineage specification and differentiation from single embryonic stem cells tracked by live cell imaging of reporter gene expression	DBT	3 years
39	Meheboob Alam	Contract to establish a partner group of the MPI-MM "Partner Group for Topography Formation"	MPI	2 years
40	Meheboob Alam	MoU between BARC and JNCASR "Development of Test Facility for Thermal Hydraulics studies/Basic research Salt Water /Fine Hydrogen Bubble Test Facility for simulation of Hydrogen Transport – Management/Fire safety behaviour/ Containment thermal hydraulics/ pollution dispersion studies"	BARC	3 years
41	Namita Surolia	X-ray Crystallographic Analysis of the Proteins involved in the Fatty Acid Biosynthesis of <i>Plasmodium falciparum</i>	DBT	3 years
42	Namita Surolia	Genetic manipulations and apcoplast targeting studies with Plasmodium Type II FAS Proteins	DBT	3 years
43	Namita Surolia	Structure-activity relationship of <i>Plasmodium falciparum</i> B-Ketoacyl-ACP reductase(FabGO)	DST	3 years
44	Namita Surolia	Functional Genomics based approach to novel anti-malarial targets and agents	ICMR	3 years
45	Namita Surolia	"Understanding pathogenesis of Malaria and strategies to treat it"	DBT	3 years



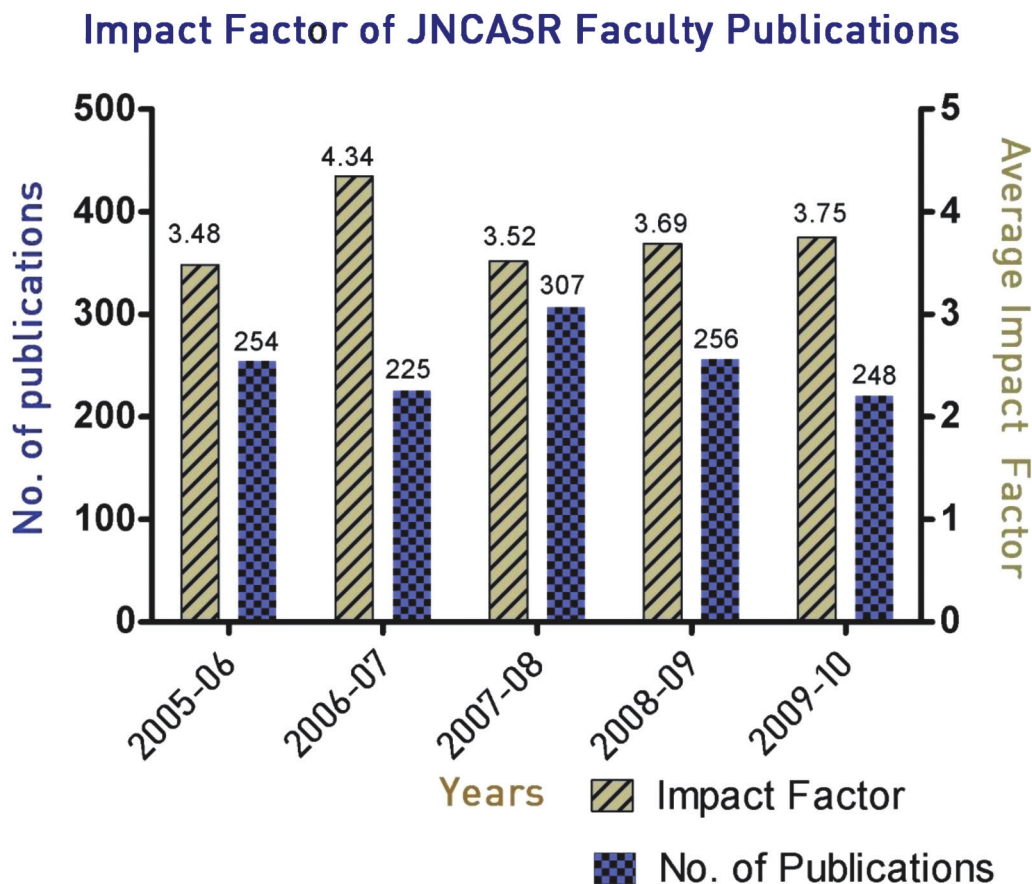
46	Namita Surolia	Development of triclosan for treating human malaria and inhibitors of fatty acid synthesis especially enoyI-ACP reeducates of as anti-malarial agents	DBT	2 years
47	Namita Surolia	Setting up of National Facility for "Screening drugs and their biological effects for Cancer, AIDS and Malaria"	DBT	3 years
48	R Narasimha	Research Programme on Flow Instabilities	DRDO	5 years
49	R Narasimha	Optimization of wing for RTA-70	NAL	1 year
50	Rama Govindarajan	An analysis of the vertical density stratified flows	NPOL	2 years
51	Ranga Udaykumar	Efficacy and safety evaluation of siddha Medicines HIVS-2003 for HIV/AIDS	DST and Vedic Drugs Ltd.	4 1/2 years
52	Ranga Udaykumar	Delineating viral determinants of HAD using SCID mice	AECOM	2 1/2 yrs
53	Ranga Udaykumar	Design and characterization of stable folded fragments/derivatives of HIV env for use as Immunogens	DBT	3 years
54	Ranga Udaykumar	Immunological and molecular characterization of HIV-1 Tat and long terminal repeat (LTR) cloned from Indian patient with and without dementia and/or opportunistic infection	ICMR	3 years
55	Ranga Udaykumar	Pathogenic relevance of Extracellular tat in the body fluids of HIV-I seropositive subjects to disease progression	DST	3 years
56	Ranga Udaykumar	"Evaluation of molecular and immune status of the blood lymphocytes of subject who participated in the Siddha Clinical Trial CTRI/2008/091/000021" at JNCASR	DST	7 Months
57	Ranga Udaykumar	Optimization of the performance of DNA vaccine by engineering molecular strategies: use of HIV-1 tat as model antigen	ICMR	3 years
58	S Balasubramanian	Centre for Computational Materials Science	DST	5 years
59	S Balasubramanian	Swarnajayanthi Fellowship	DST	5 years
60	S M Deshpande	NMITLI Project on "Mesoscale modeling for monsoon related weather predictions Phase II"	CSIR	2 ½ yrs
61	S M Deshpande	Numerical simulation of multiscale supersonic flows with low dissipative shock capturing schemes	DST	2 years
62	S M Deshpande	Development of TKFMG solver and its application to flutter prediction in turbo Machines	GTRE	3 years
63	S M Shivaprasad, N G Galkin	National Bioscience Award for career development 2008 project entitled "Towards isolation of a novel gene for non- syndr omic hearing loss at the 11p14.2-q12.1 locus"	DST	2 years

64	Santosh Ansumali	Ramanujan Fellowship	DST	5 years
65	Sheeba Vasu	Ramanujan Fellowship	DST	5 years
66	Shobhana Narasimhan	Effect of Local Environment on Catalytic Activity – Indo-Italian Research project Under the AEGIS of Indo-Italian POC in S&T 2005-07	DST	3 years
67	Shobhana Narasimhan	Self-organized nanostructures at surfaces	IFCPAR	3 years
68	Shobhana Narasimhan	MOU between MIPL & JNCASR - Consultancy and Research	MIPL	3 years
69	Shobhana Narasimhan	Theoretical Investigation of Oxide Supported Metal Nanoparticle Catalysts	DST	3 years
70	Srikanth Sastry	India-European Union Research Project “MONAMI Modeling of Nano-scaled Advanced Materials Intelligently”	DST	3 years
71	Swapan K Pati	Swarnajayanthi Fellowship	DST	5 years
72	Swapan K Pati	Opto-Electronic Properties of conducting Polymers	CSIR	3 years
73	Swapan K Pati	Molecular Electronics and its Application (AOARD-08-4008)	US Airforce Lab, Dayton	1 year
74	Swapan K Pati	Quantum magnetic mixing effects in fully frustrated magnets – India-Japan Cooperative Science Programme	DST	2 years
75	Swapan K Pati Vinayak P Dravid	(Northwestern University) Centre of Excellence in “Advanced Materials Research”	-US joint Research IUSSTF	Indo 3 years
76	Swapan K Pati, Anna Painelli	Indo-Italian research Project: “Designing Novel Photosystems for Enhanced charge Transfer efficiency: A detailed theoretical modeling”	DST	3 years
77	T Govindaraju	Developing new synthetic routes for the preparation of unnatural amino acids and their use as metal (Bio-) sensors and chiral ligands in the asymmetric catalysis	DST	3 years
78	T N C Vidya	Ramanujan Fellowship	DST	5 years
79	T N C Vidya	Dominance Relationships in Female Asian Elephants	CSIR	3 years
80	T N C Vidya	MOU between JNCASR & WWF-Cambodia project entitled “Asian elephant molecular mark-recapture censusing in the Eastern Plain Landscape, Mondulkiri Province, Cambodia”	WWF	09 months
81	T N C Vidya	Dominance relationships in female Asian Elephants	NGS	1 year
82	Tapas Kumar Kundu	Chromatin modifications (Methylation, Acetylation, Deacetylation) – a new target for Cancer therapy and diagnostics	DBT	3 years

83	Tapas Kumar Kundu	Structure-Function analysis of histone chaperones: Role in chromatin dynamics and transcriptional regulation	IFCPAR	3 years
84	Tapas Kumar Kundu	Bovine Mastitis: Unraveling molecular details of host-microbe interaction and development of molecular diagnostic methods	ICAR	3 years
85	Tapas Kumar Kundu	Role of multifunction human histone chaperone NPM1 in transcription and stress associated chromatin dynamics: Relevance in cancer manifestation	DBT	3 years
86	Tapas Kumar Kundu	Structure function analysis of Tumor suppressor, p53 interacting proteins: structural basis of p53 activation	DBT	3 years
87	Tapas Kumar Kundu, M Eswaramoorthy	Cellular Interaction of Nano-particles; Effect on epigenetics and thereby its role in gene expression: Implications from Drug delivery to diagnosis	DBT	3 years
88	Tapas Kumar Maji	Microporous metal-organic coordination networks(MOCNs): Application towards H <sub>2</sub> -storage – SERC fast track scheme	DST	3 years
89	Umesh V Waghmare	MOU between MIPL & JNCASR Consultancy and Research	MIPL	3 years
90	Umesh V Waghmare	DAE-SRC Outstanding Research Investigator Award for R/P “Multi scale modeling and simulations of functional Materials	DAE	5 years
91	Umesh V Waghmare	Density functional theory calculations	Procter & Gamble	1 year
92	Umesh V Waghmare	IBM Faculty Award 2009	IBM	1 year

## PUBLICATIONS

The Centre has registered a very good progress in its publications. A chart showing the year-wise publication and the impact factor thereof is appended below:



### CHEMISTRY AND PHYSICS OF MATERIALS UNIT

1. Zhao W, Leroy F, Heggen B, Zahn S, Kirchner B, Balasubramanian S, Muller-Plathe F. Are there stable ion-pairs in room-temperature ionic liquids? Molecular dynamics simulations of 1-n-butyl 3-methylimidazolium hexafluorophosphate [bmim][PF<sub>6</sub>], *Journal of the American Chemical Society*, 131, 15825 – 15833, 2009.
2. Balasubramanian S, Kohlmeyer A, Klein ML. Ab initio molecular dynamics study of supercritical carbon dioxide including dispersion corrections, *Journal of Chemical Physics*, 131, 144506 – 99999, 2009.
3. Sarangi SS, Bhargava BL, Balasubramanian S. Nanoclusters of room temperature ionic liquids: A molecular dynamics simulation study, *Physical Chemistry Chemical Physics*, 11, 8745 – 8751, 2009.
4. Vishnu Shanker, Saroj L. Samal, Pradhan GK, Chandrabhas Narayana, Ganguli AK. Nanocrystalline NaNbO<sub>3</sub> and NaTaO<sub>3</sub>: Rietveld studies, Raman spectroscopy and dielectric properties, *Solid State Sciences*, 11, 562-569, 2009.
5. Mangalam RVK, Chandrabhas Narayana, Sundaresan A. Pressure-dependent phase transition in the ordered BaBi<sub>0.7</sub>Nb<sub>0.3</sub>O<sub>3</sub> perovskite, *High Pressure Research*, 29, 272-277, 2009.
6. Pradhan GK, Swain D, Row TNG, Chandrabhas Narayana. High-Temperature Phase Transition Studies in a Novel Fast Ion Conductor, Na<sub>2</sub>Cd(SO<sub>4</sub>)<sub>2</sub>, Probed by Raman Spectroscopy, *Journal of Physical Chemistry A*, 113, 1505-1507, 2009.



7. Johnsy G, Datta KKR, Vallayil S, Shanmugam S, Amarinder B, Eswaramoorthy M. Aminoclay: A designer filler for the synthesis of highly ductile polymer-nanocomposite film, *ACS Applied Materials & Interfaces*, 1, 2796 – 2803, 2009.
8. Raidongia K, Hembram KPSS, Waghmare UV, Eswaramoorthy M, Rao CNR. Synthesis, structure and properties of mesoporous B/C/N microspheres, *ZAAC*, 636, 30 – 35, 2009.
9. Dinesh J, Eswaramoorthy M, Rao CNR. Investigations of the Conversion of Inorganic Carbonates to Methane, *ChemSusChem*, 9, 878, 2009.
10. Lewis J, Burroughes L, Ohmori Y, Narayan KS. Organic Electronics, *Proceedings of the IEEE*, 97, 1555 – 1556, 2009.
11. Das Anshuman J, Narayan KS. Observation of Bessel beams from electric field induced patterns on polymer surfaces, *Optics Letters*, 34, 3391 – 3393, 2009.
12. Rao Manohar, Narayan KS. Studies of charge transfer processes across Donor-Acceptor interface using a Field effect transistor geometry, *Applied Physics Letters*, 95, 183306, 2009.
13. Gupta D, Vidyadhiraja NS, Narayan KS. Transport of Photogenerated Charge Carriers in Polymer Semiconductors (Invited Paper), *Proceedings of the IEEE*, 97, 1558 – 1569, 2009.
14. Biswas K, Rao CNR. Characterization of nanomaterials by physical methods, *Ann. Rev. Anal. Chem.* 2, 435, 2009.
15. Rao CNR, Biswas K, Subrahmanyam KS, Govindaraj A. Graphene – the new nanocarbon, *J. Mater. Chem. (Highlight)*, 19, 2457, 2009.
16. Rao CNR, Govindaraj A. Synthesis of inorganic nanotubes, *Adv. Mater.* 21, 4208, 2009.
17. Panchakarla LS, Subrahmanyam KS, Saha SK, Govindaraj A, Krishnamurthy HR, Waghmare UV, Rao CNR. Synthesis, structure and properties of boron- and nitrogen-doped graphene, *Adv. Mater.* 21, 4726, 2009.
18. Rao CNR, Sood AK, Subrahmanyam KS, Govindaraj A. Graphene: A new two-dimensional nanomaterial, *Angew. Chem. Int. Ed.* 48, 7752, 2009.
19. Prasad KE, Das B, Maitra U, Ramamurthy U, Rao CNR. Extra-ordinary synergy in the mechanical properties of polymer matrix composites reinforced with two nano-carbons of different dimensionalities, *PNAS*, 106, 13186, 2009.
20. Matte HSSR, Subrahmanyam KS, Rao CNR. Novel magnetic properties of graphene: Presence of both ferromagnetic and antiferromagnetic features and other aspects, *J. Phys. Chem. C (Letter)*, 113, 9982, 2009.
21. Maitra U, Prasad KE, Ramamurthy U, Rao CNR. Mechanical properties of nanodiamond-reinforced polymer-matrix composites, *Solid State Commun.* 149, 1693, 2009.
22. Das B, Prasad KE, Ramamurthy U, Rao CNR. Nanoindentation studies of polymer matrix composites reinforced by few-layer graphene, *Nanotechnology* 20, 125705, 2009.
23. Subrahmanyam KS, Voggu R, Govindaraj A, Rao CNR. A comparative Raman study of the interaction of electron donor and acceptor molecules with graphene prepared by different methods, *Chem. Phys. Lett.* 472, 96, 2009.
24. Das B, Maitra U, Biswas K, Varghese N, Rao CNR. SERS of molecules adsorbed in nanocrystalline Au and Ag films formed at the organic-aqueous interface, *Chem. Phys. Lett.* 477, 160, 2009.
25. Bhat SV, Vivekchand SRC, Govindaraj A, Rao CNR. Photoluminescence and photoconducting properties of ZnO nanoparticles, *Solid State Commun.* 149, 510, 2009.
26. Subrahmanyam KS, Panchakarla LS, Govindaraj A, Rao CNR. A simple method of preparing graphene flakes by an arc-discharge method, *J. Phys. Chem. C (Letter)*. 113, 4257, 2009.
27. Ghosh S, Rao CNR. Separation of metallic and semiconducting single-walled carbon nanotubes through fluorine chemistry, *Nano Research*, 2, 183, 2009.

28. Gomati A, Hoseini SJ, Rao CNR. Functionalization and solubilization of inorganic nanostructures and carbon nanotubes by employing organosilicon and organotin reagents, *J. Mater. Chem.*, 19, 988, 2009.
29. Subrahmanyam KS, Ghosh A, Gomati A, Govindaraj A, Rao CNR. Covalent and non-covalent functionalization and solubilization of graphene, *Nanosci. Nanotech. Letts.*, 1, 28, 2009.
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#### CHEMICAL BIOLOGY UNIT

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## CONDENSED MATTER THEORY UNIT

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## RESEARCH PUBLICATIONS OF HON. PROFESSORS /HON.FACULTY/ENDOWED PROFESSORS

1. Prasad R, Singh P, Chattopadhyay A. Effect of Capsaicin on Ligand Binding Activity of the Hippocampal Serotonin1A Receptor, *Glycoconj. J.*, 26, 733-738, 2009.
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3. Haldar S, Chattopadhyay A. Green Fluorescent Protein: A Molecular Lantern that Illuminates Cellular Interior, *J. Biosci.*, 34, 169-172, 2009.
4. Paila YD, Chattopadhyay A. The Function of G-protein Coupled Receptors and Membrane Cholesterol: Specific or General Interaction, *Glycoconj.J.*, 26, 711-720, 2009.
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32. Sabareesh V, Sarkar P, Sardesai AA, Chatterji D. Identifying N60D mutation in omega subunit of *Escherichia coli* RNAPolymerase by bottom-up proteomic approach, *Analyst*, 2010.

#### **BOOKS/PROCEEDINGS AUTHORED/EDITED BY FACULTY**

1. Biswas K, Rao CNR. Use of ionic liquids, liquid-liquid interfaces and other novel methods for the synthesis of inorganic nanocrystals, in "Advanced wet-chemical synthetic approaches to inorganic nano-structures" (Ed. D. Cozzoli), 79 (2009).
2. Narayan KS - Guest Editor for Special Issue in Organic Electronics - Proceedings of the IEEE (October 2009 issue) along with J. Lewis, J. Burroughes, and Y. Ohmori.
3. Valdiya KS. *The Making of India: Geodynamic Evolution*, Macmillan Publishers India, New Delhi, 816p, 2010.
4. Valdiya KS. *Ek Thi Nadi Saraswati*, Aryan Books International, New Delhi (in press)
5. Pandi-Perumal SR, Warren Spence D, Sharma VK. Aging and circadian rhythms: general trends. In: *Principles and Practice of Geriatric Sleep Medicine*. Cambridge University Press, Cambridge. 2009.

#### **BOOKS/PROCEEDINGS AUTHORED/EDITED BY HON. PROFESSORS/HON. FACULTY**

1. Haldar S, Chattopadhyay A. "Hydration Dynamics of Probes and Peptides in Captivity" in *Reviews in Fluorescence 2009* (Geddes, C.D., Ed.), Springer, New York, 2010 (in press).
2. Special issue *International Journal of Modern Physics B* with the proceedings of the International Conference on Materials for Advanced Technologies (ICMAT 2009), Symposium U: Mechanical Behavior of Micro- and Nano-Scale System, 28 June – 3 July 2009; Editors: Kaiyang Zeng, Yong-Wei Zhang, Zhong Chen, Ming Dao and Upadrasta Ramamurty Volume: 24, Issues: 1-2 (20 January 2010)



## AWARDS/DISTINCTIONS

The following faculty and honorary faculty members of the Centre have received various honours and awards both at the national and international level in recognition of their significant contributions to the progress of science and technology.

### Awards & Honours

#### **Prof C N R Rao**

The Royal Medal (Queen's Medal) from Royal Society, London for Contribution to Natural Knowledge  
Doctor of Science (honoris cause), University of Liverpool  
Doctor of Science (honoris cause), Colorado State University  
August-Wilhelm-von-Hofmann Medal by German Chemical Society

#### **Prof M R S Rao**

Padma Shri by the Government of India

#### **Prof Bikash Sinha, Member, Council of Management**

Padma Bhushan by the Government of India

#### **Prof Amitabh Joshi**

Shanti Swarup Bhatnagar Prize in Biological Sciences, 2009.

#### **Prof N Chandrabhas**

C N R Rao Oration Award 2009

#### **Prof R Narasimha**

Trieste Science Prize TWAS, 2008  
Desikothama from Visva Bharati University, 2008  
PhD (h.c) from Visweswaraiya Technical University, Belgaum, December 2008  
Zakir Hussain Memorial Award of the Indian Society of Industrial and Applied Mathematics, Agra, 2009  
Lifetime Achievement Award, Karnataka Academy of Science and Technology, 2009.

#### **Prof Swapan K Pati**

B. M. Birla Science Prize in Physics, 2008 by B. M. Birla Group, in 2010 .

#### **Prof Umesh V Waghmare**

IBM Faculty Award, 2009

#### **Prof Chandan Dasgupta**

UGC National Hari Om Ashram Trust Award, entitled Sir C.V. Raman Award for Research in Physical Sciences.

#### **Prof Sushanta Dattagupta**

C V Raman Medal (2010) of INSA

#### **Dr R A Mashelkar**

D.Litt., University of Goa (2009)  
D.Litt., Mahatma Gandhi Kashi Vidyapeeth (2009)

### FELLOWSHIPS

#### **Prof C N R Rao**

Honorary Fellow, Chinese Academy of Sciences, China, 2009.

#### **Prof K S Narayan**

Department of Atomic Energy SRC – Fellowship, 2009  
Fellow, Indian Academy of Science, 2010

#### **Prof R Narasimha**

Honorary Fellow, Indian Institute of Science, 2008

#### **Prof Rama Govindarajan**

Fellow, Indian Academy of Science, 2010

**Prof Swapan K Pati**

Fellow, Indian Academy of Science, 2010.

**Prof S M Shivaprasad**

RAK-CAM Senior Fellowship for 2010-2012.

**Dr Jayanta Haldar**

Ramanujan Fellowship, Department of Science and Technology, 2010.

**Dr Santhosh Ansumali**

Ramanujan Fellowship, Department of Science and Technology, 2009.

**Dr Subir K Das**

Ramanujan Fellowship, Department of Science and Technology, 2009.

**Dr Rema Krishnaswamy**

Ramanujan Fellowship, Department of Science and Technology, 2009.

**Prof U Ramamurty**

Fellow of the Indian Academy of Sciences, 2010.

Fellow of the Indian National Academy of Engineering, 2010.

Elected Plenary Speaker, Fifteenth International Conference on the Strength of Materials (ICSMA15), held in Dresden, Germany in 2009.

**Dr Tapas Kumar Maji**

Has been chosen as the Emerging Investigators of the Materials Science by the Journal of Materials Chemistry.

**Prof Diptiman Sen**

Elected Fellow, Indian National Science Academy, New Delhi, in 2010.

Elected Fellow, The National Academy of Sciences, India, Allahabad, in 2009.

**Prof Govindan Rangarajan**

Elected Fellow, Indian Academy of Sciences

**MEMBERSHIPS/APPOINTMENTS**

**Prof Amitabh Joshi**

Adjunct Professor, IISER Mohali.

**Prof R Narasimha**

Member, Advisory Committee for International Science and Engineering, US National Science Foundation, 2010

**Prof Vijay Kumar Sharma**

Visiting Professor, University of Leicester, UK, 2009.

Member, Planning Committee DST-SERC School on Clocks, Rhythms and Behaviour (2008-2010)

Co-convenor, DST-SERC School on Chronobiology, 2010.

Vice-President, Indian Society for Chronobiology

**Dr T N C Vidya**

Invited Member, IUCN SSC (World Conservation Union's Species Survival Commission) Asian Elephant Specialist Group.

**Prof Amitabha Chattopadhyay**

Appointed as Adjunct Professor, Indian Institute Science Education and Research, Mohali, India.

**Prof Diptiman Sen**

Recognized by the American Physical Society as an Outstanding Referee, in 2009.

**Prof H R Krishnamurthy**

Member, Management Board of the International Centre for Theoretical Sciences.

**Dr R A Mashelkar**

Visiting Professorship, Sir Louis Matheson Distinguished Visiting Professor, Monash University, 2009.



**Prof Sriram Ramaswamy**

Vice Chair, Commission C3 (Statistical Physics) of the IUPAP

Member, Steering Committee for Statphys24

Member, Editorial Board of European Physical Journal E since Dec 09.

**Prof N Satyamurthy**

Elected Vice-President (International Affairs), Indian National Science Academy

**EDITORIAL BOARDS****Prof Amitabh Joshi**

Chief Editor, Journal of Genetics

Member, Board of Editors, Resonance, International Journal of Evolutionary Biology, and Journal of Theoretical Biology.

**Prof Vijay Kumar Sharma**

Member, Editorial Board of Journal of Circadian Rhythms, Frontiers in Sleep Research and Chronobiology, and Journal of Genetics.

Editor-in-chief of the News Letter of the Indian Society for Chronobiology.

**Prof Diptiman Sen**

Member, Editorial Board of Physical Review Letters for the period 2009-12.

**Prof Amitabha Chattopadhyay**

Elected as Member, Editorial Board of Biophysical Journal (Cell Press), 2009-present.

Elected as Review Editor, Frontiers in Membrane Physiology and Biophysics (Frontiers Research Foundation), 2010-present

**Prof N Satyamurthy**

Appointed a member of the Editorial Board, European Journal of Physics D, Springer-Verlag

**LECTURESHIPS****Prof Swapan K Pati**

Distinguished Lectureship Award, Chemical Society of Japan, in Asian Symposium in Tokyo, 2009.

**Dr Tapas Kumar Maji**

Distinguished Young Lecturership Award by the Chemical Society of Japan, 2009

**Prof Sushanta Dattagupta.**

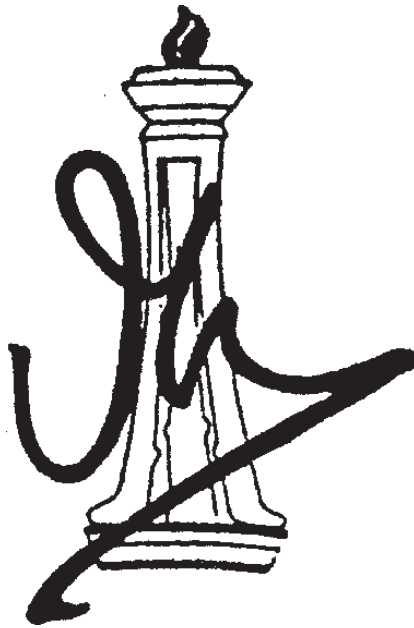
C V Raman Award Lecture of the Indian Physics Association (IPA) – 2009

☆☆☆





# FINANCIAL STATEMENTS



**Name** : JAWAHARLAL NEHRU CENTRE FOR  
ADVANCED SCIENTIFIC RESEARCH

**Address** : JAKKUR POST, BANGALORE – 560 064

**Year Ended** : 31<sup>st</sup> MARCH 2010

**Assessment Year** : 2010-11

## Auditor's Report to the Members of the Governing Body of Jawaharlal Nehru Centre for Advanced Scientific Research

We have audited the attached Balance Sheet of **Jawaharlal Nehru Centre For Advanced Scientific Research** as at March 31, 2010 and also the Income & Expenditure Account for the year ended on that date and the Receipts and Payment account for the year ended on that date annexed thereto. These financial statements are the responsibility of the management of Jawaharlal Nehru Centre for Advanced Scientific Research. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with auditing, standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by Management as well as evaluating the overall financial statements presentation. We believe that our audit provides reasonable basis for our opinion.

### We report that:

1. We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
2. In our opinion proper books of accounts as required by law have been kept by Jawaharlal Nehru Centre For Advanced Scientific Research so far as it appears from our examination of those books.
3. The Balance Sheet , Income and Expenditure Account and Receipts and Payment Account dealt with by this report are in agreement with the books of account.
4. The Balance Sheet and Income and Expenditure Account dealt with by this report are prepared in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India subject to the following observations:
  - (i) Non-Provisions of accrued liability in respect of leave encashment which is not in conformity with the Accounting Standard 15 [Accounting for retirement benefits in the financial statements of Employers] issued by the Institute of Chartered Accountants of India. [Refer Note No.3 of Schedule No.24]
  - (ii) The amount spent on acquisition of fixed assets has been deducted from the total grants/ subsidies received in the Income & Expenditure account. This is not in conformity with the Accounting Standard- 5 issued by the Institute Of Chartered Accountants of India. It has been explained that this format has been consistently used to present the accounts before the authority who grant the funds.
5. In our opinion and to the best of our information and according to the explanations given to us and subject to notes on accounts and our qualifications in para 4 above, the said accounts give a true and fair view in conformity with the accounting principles generally accepted in India:
  - (a) in the case of Balance Sheet, of the state of affairs of the Jawaharlal Nehru Centre for Advanced Scientific Research as at March 31, 2010; and
  - (b) in the case of Income and Expenditure Account, of the excess of Income over Expenditure for the year ended on that date.

For M/s G R Venkatanarayana  
Chartered Accountants

Sd/-

(G R Venkatanarayana)  
Partner

Membership No. 018067  
Firm Regn. No. 004616S

Place : Bangalore  
Dated: 13.09.2010



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**  
**BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2010**

Description	Schedule	Current year		Previous year	
		2009-10		2008-09	
		Rs.	Ps.	Rs.	Ps.
<b>LIABILITIES</b>					
Capital Fund	1	1,416,934,717.54		1,173,065,129.54	
Reserves & Surpluses	2	326,214.16		1,489,467.77	
Earmarked and Endowment Funds	3	156,708,169.05		140,946,710.15	
Secured loans and Borrowings	4		0.00		0.00
Unsecured loans and Borrowings	5		0.00		0.00
Deferred Credit Liabilities	6		0.00		0.00
Current Liabilities and Provisions	7	11,830,468.28		7,905,034.14	
Other Funds		39,541.00		39,541.00	
Scheme Balances		106,630,809.46		106,846,299.16	
<b>Total</b>		<b>1,692,469,919.49</b>		<b>1,430,292,181.76</b>	
<b>ASSETS</b>					
Fixed Assets ( gross )	8	1,416,934,717.54		1,173,065,129.54	
Investments-Endowment Funds	9	140,178,858.00		136,505,750.00	
Investment - Others	10		0.00		0.00
Current Assets, Loans, Advances etc.	11	135,356,343.95		120,721,302.22	
<b>Total</b>		<b>1,692,469,919.49</b>		<b>1,430,292,181.76</b>	
Significant accounting policies	24				
Contingent Liabilities & Notes on Accounts	25				

Schedule 1 to 25 form integral part of Accounts

For Jawaharlal Nehru Centre for Advanced Scientific Research

This is the Balance sheet referred to in our report of even date.

for M/S G R Venkatanarayana  
Chartered Accountants  
Sd/-  
(G R Venkatanarayana)  
Partner  
Membership No. 018067

Sd/-  
R S Gururaj  
Accounts Officer

Sd/-  
Prof M R S Rao  
President

Place : Bangalore  
Date : 13.09.2010

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH  
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31<sup>ST</sup> MARCH 2010**

Description	Schedule	Current year		Previous year	
		2009-10		2008-09	
		Rs.	Ps.	Rs.	Ps.
<b>Income</b>					
Income from services	12	812,605.00		840,499.00	
Grants/Subsidies received	13	487,959,748.00		395,016,136.00	
		488,772,353.00		395,856,635.00	
Less: Extent of fixed assets procured		243,869,588.00		260,253,308.00	
		<b>244,902,765.00</b>		<b>135,603,327.00</b>	
Income from Fees/Subscriptions etc	14	1,070,756.00		921,483.00	
Income from investments	15		0.00		0.00
Royalty Income,Publication,Licence fee etc	16	197,016.87		568,579.91	
Interest earned	17	758,855.57		29,165,340.18	
Other income	18	18,129,347.50		19,749,245.48	
Increase/decrease in stocks	19		0.00		0.00
<b>Total</b>		<b>265,058,740.94</b>		<b>186,007,975.57</b>	
<b>Expenditure</b>					
Establishment expenses	20	124,095,711.00		92,579,259.00	
Other administrative expenses	21	137,098,430.55		124,505,090.46	
Expenditure on Grants,Subsidies etc	22		0.00		0.00
Interest & bank charges	23		27,853.00		46,198.33
<b>Total</b>		<b>261,221,994.55</b>		<b>217,130,547.79</b>	
Excess of Income over Expenditure		3,836,746.39		-31,122,572.22	
Balance brought forward		<b>1,489,467.77</b>		<b>62,612,039.99</b>	
		<b>5,326,214.16</b>		<b>31,489,467.77</b>	
Transferred to Corpus Fund Account		5,000,000.00		30,000,000.00	
Balance carried to Balance sheet		<b>326,214.16</b>		<b>1,489,467.77</b>	
Significant accounting policies (Enclosed)	24				
Contingent Liabilities & Notes on Accounts	25				

Schedule 1 to 25 form an integral part of Accounts

For Jawaharlal Nehru Centre for Advanced Scientific Research

This is the Income and Expenditure account referred to in our report of even date.

for M/S G R Venkatanarayana  
Chartered Accountants  
Sd/-  
(G R Venkatanarayana)  
Partner  
Membership No. 018067

Sd/-  
RS Gururaj  
Accounts Officer

Sd/-  
Prof MRS Rao  
President

Place : Bangalore  
Date : 13.09.2010



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH  
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31.03.2010**

OPENING BALANCES & RECEIPTS	2009-10 Rs	2008-09 Rs	2009-10 Ps	2008-09 Ps
<b>I. Opening Balances:</b>				
a. Cash in hand & Imprest at centre	561,864.00	273,565.00		124,095,711.00
b. Bank balances:				137,098,430.55
<u>In savings bank Accounts:</u>				2,285,846.00
At Canara bank	8,308,064.06	5,268,086.18		263,479,987.55
At Union Bank of India	1,631,688.00	756,295.00	0.00	0.00
<u>In Deposit accounts:</u>				
At IDBI bank		600,000.00		
At HDFC trust	12,125,000.00	12,125,000.00	0.00	0.00
At GOI Bonds [SHCIL & SBI]	47,900,000.00	0.00		
At Union Bank of India	76,480,750.00	20,000,000.00		
At Canara Bank	147,007,366.06	98,981,750.00		0.00
		138,004,696.18	0.00	0.00
<b>II. Grants Received:</b>				
From DST travel grant	0.00	247,970.00		
From DST-Grant in aid	480,000,000.00	385,800,000.00		
From DST for Collaborative programmes	3,600,000.00	0.00		
From DST for Meeting/Seminars	2,086,498.00	8,968,166.00		243,869,588.00
From Other International Agencies	2,273,250.00	0.00		
From Reliance Industries	0.00	5,000,000.00		
From Prof.CNR Rao & Smt.Indumati Rao	0.00	1,000,000.00		
On behalf of Endowments	482,000.00	249,700.00		
	488,441,748.00	401,265,836.00	0.00	15,927,567.59
<b>III. Income on Investments from:</b>				
A. <u>Interest on FD's:</u>				
a. From Earmarked/Endowment Funds	8,353,197.00	7,903,947.00		
b. From Own funds	186,841.47	28,884,292.00		46,198.33
	8,540,038.47	36,788,239.00		
<b>IV. Interest received:</b>				
a. On Bank S.B A/c	572,014.10	281,048.18		
<b>Balance Carried Over</b>	644,561,166.63	576,339,819.36	507,377,428.55	494,247,703.38

(Contd...)



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH  
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31.03.2010 (Contd....)**

OPENING BALANCES & RECEIPTS	2009-10 Rs	2008-09 Rs	2009-10 Ps	2008-09 Ps
<b>V. Other Income:</b>				
Balance Brought Forward	644,561,166.63	576,339,819.36		494,247,703.38
a. Royalty	57,678.87	434,214.91		0.00
b. Licence Fee	139,338.00	134,365.00		72,100.00
c. Collections from Visitors, Guest room etc	3,538,045.50	2,438,742.00		0.00
d. From fee, subscription etc	1,070,756.00	921,483.00		0.00
e. CSIR fellowships, SRFP reimbursements	1,007,802.00	10,916,484.00		0.00
f. From services	812,605.00	840,499.00		0.00
g. From others	3,583,500.00	394,019.48		0.00
<b>VI. Amount borrowed</b>	<b>10,209,725.37</b>	<b>16,079,807.39</b>	<b>0.00</b>	<b>561,864.00</b>
<b>VII. Other receipts:</b>				
Overhead Recoveries from Schemes/ Projects	10,000,000.00	0.00		8,308,064.06
Earnest money received	0.00	1,435,454.69		1,631,688.00
Cont adv/ Advances Returned back-staff	0.00	28,320.00		76,480,750.00
From Sundry creditors	8,769,776.73	0.00		12,125,000.00
Other Advances recovered	205,839.00	0.00		0.00
<b>TOTAL</b>	<b>18,975,615.73</b>	<b>1,638,084.69</b>	<b>673,746,507.73</b>	<b>99,107,366.06</b>
			<b>TOTAL</b>	<b>594,057,711.44</b>

PAYMENTS & CLOSING BALANCES	2009-10 Rs	2008-09 Rs	2009-10 Ps	2008-09 Ps
<b>VII. Other payments:</b>				
Balance Brought Forward	507,377,428.55			494,247,703.38
Earnest money deposit returned	4,549,518.00			0.00
Staff advances	100,250.00			72,100.00
Caution money deposit returned	294,824.69			0.00
TDS on Interest on Bonds	490,729.00			0.00
Other advances paid	0.00			630,542.00
Other advances given- Vijyoshi prog	6,928,825.00			0.00
<b>VIII. Closing Balances:</b>				
a. Cash in hand & Imprest at centre	12,364,146.69			702,642.00
b. Bank balances:				
<i>In savings bank accounts:</i>				
Canara Bank	17,484,984.49			8,308,064.06
Union Bank of India	77,692.00			1,631,688.00
<i>In deposit accounts:</i>				
At canara bank	84,941,750.00			76,480,750.00
At GOI Bonds				
At HDFC trust	12,125,000.00			12,125,000.00
<b>TOTAL</b>	<b>154,004,932.49</b>	<b>154,004,932.49</b>	<b>673,746,507.73</b>	<b>99,107,366.06</b>

This is the Receipts and payments account referred to in our report of even date.

for M/s G.R.VENKATANARAYANA  
Chartered Accountants

Sd/-  
(G.R.VENKATANARAYANA)  
Partner

Membership No. 018067  
Place : Bangalore Date : 13.09.2010

For Jawaharlal Nehru Centre for Advanced  
Scientific Research

Sd/-  
R.S.Gururaj  
Accounts Officer

Sd/-  
Prof.M.R.S.Rao  
President



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**

**Schedule forming part of the accounts**

Description	2009-10		2008-09	
	Rs.	Ps.	Rs.	Ps.
<b>SCHEDULE 1- Capital Fund</b>				
Balance as at the beginning of the year	1,173,065,129.54		912,811,821.54	
	<b>1,173,065,129.54</b>		<b>912,811,821.54</b>	
Less : Depreciation up to the end of previous year	246,580,248.30		198,294,845.30	
	926,484,881.24		714,516,976.24	
Add : Addition to Fixed Assets during current year	243,869,588.00		260,253,308.00	
	<b>1,170,354,469.24</b>		<b>974,770,284.24</b>	
Less : Depreciation for the current year	59,848,691.00		48,285,403.00	
	<b>1,110,505,778.24</b>		<b>926,484,881.24</b>	
Add : Depreciation Reserve per contra	306,428,939.30		246,580,248.30	
<b>TOTAL</b>	<b>1,416,934,717.54</b>		<b>1,173,065,129.54</b>	
<b>SCHEDULE 2- Reserves and Surpluses:</b>				
<b>General Reserve:</b>				
Surplus In Income and expenditure Account	326,214.16		1,489,467.77	
<b>SCHEDULE 3- Earmarked / Endowment Funds:</b>				
<b>A : Infrastructure Corpus Fund</b>				
Opening Balance	97,097,051.65		61,198,549.65	
Additions during the year	5,000,000.00		30,000,000.00	
Funds-Income from Investments made	10,052,288.00		5,898,502.00	
<b>Total : Infrastructure Corpus fund</b>	<b>112,149,339.65</b>		<b>97,097,051.65</b>	
<b>B : Other funds</b>				
Opening Balance of the Funds	43,849,658.40		41,970,609.40	
Add : Additions :				
Funds/Donations/Grants/Royalties	482,000.00		249,700.00	
Funds-Income from Investments made	2,513,017.00		2,565,629.00	
	<b>46,844,675.40</b>		<b>44,785,938.40</b>	
Less : Funds-utilisation/Expenditure incurred	2,285,846.00		936,280.00	
<b>Total: Other Funds</b>	<b>44,558,829.40</b>		<b>43,849,658.40</b>	
<b>Grand Total - Infrastructure Corpus and Other Funds</b>	<b>156,708,169.05</b>		<b>140,946,710.05</b>	
<b>SCHEDULE 4-Secured Loans And Borrowings:</b>		0.00		0.00
<b>SCHEDULE 5-Unsecured Loans And Borrowings:</b>		0.00		0.00
<b>SCHEDULE 6-Deferred Credit Liabilities:</b>		0.00		0.00
<b>SCHEDULE 7- Current liabilities and Provisions</b>				
Sundry Creditors EMD	815,545.00		5,365,063.00	
Sundry Creditors CMD	59,185.00		354,009.69	
Sundry Creditors for others	10,955,738.28		2,185,961.45	
Statutory Liabilities	0.00		0.00	
<b>TOTAL</b>	<b>11,830,468.28</b>		<b>7,905,034.14</b>	

Sd/-  
**RS Gururaj**  
 Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**  
**Schedule forming part of the accounts**

Description	2009-10		2008-09	
	Rs.	Ps.	Rs.	Ps.
<b>SCHEDULE 8- Fixed Assets:</b>				
Land - Free Hold	17,715,351.00		17,715,351.00	
<b>Buildings :</b>				
General	79,658,165.26		79,658,165.26	
Hostel Building	15,570,835.00		15,570,835.00	
New Lab Building - AMRL	25,930,339.00		25,930,339.00	
Animal House	6,787,344.00		6,787,344.00	
Staff Housing	4,156,168.00		4,156,168.00	
ETU Building	2,048,814.00		2,048,814.00	
Engineering & Mechanical Unit Block	7,426,272.00		7,426,272.00	
Other buildings like extn to Hostel, College etc.,	11,883,626.00		11,883,626.00	
Nano Science Block	7,042,909.00		7,042,909.00	
Extention to Pauling Building - Biology Block	4,680,084.00		4,680,084.00	
Dining Hall & Kitchen Block	12,404,330.00		10,155,893.00	
Radio Active Lab	203,233.00		203,233.00	
International Centre for Material Science	45,408,202.00		40,550,264.00	
Lecture Hall & Academic Block	9,636,712.00		9,636,712.00	
Hostel Phase II	19,552,377.00		19,552,377.00	
STP Building	291,699.00		291,699.00	
Hostel Phase III	19,005,471.00		18,765,243.00	
International House	20,845,705.00		18,231,179.00	
CNR Rao Hall of Science	10,186,569.00		8,661,132.00	
Extention to HIV lab	1,016,085.00		1,016,085.00	
Security Office Block	90,373.00		90,373.00	
Animal House - Additional Block	8,275,189.00		3,964,783.00	
Residential Quarters ( Sr.AO )	1,097,925.00		0.00	
Child Care Centre	343,644.00		0.00	
Extention to old Biology Lab	11,146,723.00		0.00	
Hostel Phase IV	16,841,044.00		0.00	
	<b>341,529,837.26</b>		<b>296,303,529.26</b>	
<b>Infrastructure Facilities:</b>				
Roads, Streetlights, Drainages, partitions etc.,	68,488,873.32		58,370,100.32	
Tubewells and water supply	248,912.00		248,912.00	
	<b>68,737,785.32</b>		<b>58,619,012.32</b>	
<b>Plant/Machinery/Equipment:</b>				
Scientific Equipments/Plant/Machinery	600,230,563.45		547,745,761.45	
ICMS-Laboratory equipments & facilities	63,752,358.00		23,653,181.00	
	<b>663,982,921.45</b>		<b>571,398,942.45</b>	
<b>Others :</b>				
Vehicles	2,018,246.00		1,356,527.00	
Furniture and fixtures	45,587,937.87		42,507,663.87	
Office equipment	7,009,106.63		5,491,101.63	
Computer/peripherals	48,964,989.00		41,714,390.00	
Electrical installations	103,891,761.00		33,226,058.00	
Library Books	20,856,762.21		18,116,192.21	
Library Journals	96,640,019.80		86,616,361.80	
<b>TOTAL</b>	<b>1,416,934,717.54</b>		<b>1,173,065,129.54</b>	
<b>Less - Depreciation up to the end of previous year</b>	246,580,248.30		198,294,845.30	
Depreciation for the current year	59,848,691.00		48,285,403.00	
Written down value of the assets as at the year end	1,110,505,778.24		926,484,881.24	
<b>Add - depreciation reserve per contra</b>	306,428,939.30		246,580,248.30	
<b>TOTAL</b>	<b>1,416,934,717.54</b>		<b>1,173,065,129.54</b>	

Sd/-  
**RS Gururaj**  
Accounts Officer



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**  
**Schedule forming part of the accounts**

Description	2009-10		2008-09	
	Rs.	Ps.	Rs.	Ps.
<b>SCHEDULE 9- Investments -Earmarked/Endowment Funds:</b>				
<b>Long Term Deposits</b>				
Fixed Deposits with HDFC	12,125,000.00		12,125,000.00	
Govt of India 8% Savings Bonds 2003 [SHCIL & SBI]	38,900,000.00		47,900,000.00	
Fixed Deposits with Canara bank	84,941,750.00		76,480,750.00	
Interest accrued on Fixed Deposits with Banks	4,212,108.00		0.00	
<b>TOTAL</b>	<b>140,178,858.00</b>		<b>136,505,750.00</b>	
<b>SCHEDULE 10- Investments - Others</b>		0.00		0.00
<b>TOTAL</b>		<b>0.00</b>		<b>0.00</b>
<b>SCHEDULE 11 Current Assets, Loans, Advances etc.,</b>				
<b>Cash &amp; Bank Balances - Schemes</b>				
Cash in hand - Schemes Account	52,354.00		42,300.00	
Cash at Bank -Schemes - Canara Bank	42,677,240.63		10,586,539.33	
Cash at Bank -Schemes - State Bank of India	1,922,046.83		238,291.83	
Fixed deposit with Canara Bank ( Schemes )	61,979,168.00		95,979,168.00	
	106,630,809.46		106,846,299.16	
<b>Cash &amp; Bank Balances - Centre</b>				
Cash in hand at Centre	84,157.00		121,529.00	
Cash at Bank - Canara Bank	17,484,984.49		8,308,064.06	
Cash at Bank - Union Bank	77,692.00		1,631,688.00	
Imprest balance	27,472.00		36,652.00	
Imprest with Faculty	363,877.00		403,683.00	
	18,038,182.49		10,501,616.06	
<b>Loans and Advances</b>				
Advances to staff	290,317.00		190,067.00	
Contingent Advances	0.00		95,000.00	
Advances - VIJYOSHI	6,928,825.00		0.00	
Other advances	1,198,926.00		1,213,926.00	
TDS receivable	1,235,252.00		744,523.00	
Amount receivable from Income Tax Department	461,473.00		461,473.00	
Interest receivable ( Endowment Account )	572,559.00		560,184.00	
Linus and CPF accounts	0.00		108,214.00	
	10,687,352.00		3,373,387.00	
<b>TOTAL</b>	<b>135,356,343.95</b>		<b>120,721,302.22</b>	
<b>SCHEDULE 12-Income from sales / services</b>				
Consultancy fee	657,005.00		416,749.00	
DNA sequencing fee	155,600.00		423,750.00	
<b>TOTAL</b>	<b>812,605.00</b>		<b>840,499.00</b>	

Sd/-  
**R S Gururaj**  
Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**

**Schedule forming part of the accounts**

Description	2009-10		2008-09	
	Rs.	Ps.	Rs.	Ps.
<b>SCHEDULE 13 - Grants/subsidies :</b>				
Grants - DST	480,000,000.00		385,800,000.00	
Grants - Discussion meetings/Seminars	2,086,498.00		8,968,166.00	
Grants - Travel grants		0.00	247,970.00	
Grants - DST towards Indo Iran collaborative programme	3,600,000.00			0.00
Grants - Other international agencies	2,273,250.00			0.00
<b>TOTAL</b>	<b>487,959,748.00</b>		<b>395,016,136.00</b>	
<b>SCHEDULE 14-Income from Fee/Subscriptions etc :</b>				
Income from fee, subscriptions,medical contribution etc.,	1,070,756.00		921,483.00	
<b>TOTAL</b>	<b>1,070,756.00</b>		<b>921,483.00</b>	
<b>SCHEDULE 15-Income from investments;</b>		0.00		0.00
<b>SCHEDULE 16-Royalty Income,Publication,Licence fee etc :</b>				
From Royalty	57,678.87		434,214.91	
Licence fee	139,338.00		134,365.00	
<b>TOTAL</b>	<b>197,016.87</b>		<b>568,579.91</b>	
<b>SCHEDULE 17-Interest earned:</b>				
From Term deposits	186,841.47		16,970,578.00	
From SB accounts with nationalised banks	572,014.10		134,569.18	
From interest from others		0.00	146,479.00	
<b>TOTAL</b>	<b>758,855.57</b>		<b>17,251,626.18</b>	
<b>SCHEDULE 18-Other income:</b>				
Donations - Reliance Industries towards Hall Of Science		0.00	5,000,000.00	
Donations - Prof.CNR Rao & Smt.Indumati Rao		0.00	1,000,000.00	
From Visitors house,Guest rooms,Students residence etc,	3,538,045.50		2,438,742.00	
CSIR Fellowships, SRFP reimbursement etc.,	1,007,802.00		10,916,484.00	
Overhead recoveries from Schemes/ Projects	10,000,000.00		11,913,714.00	
From others( tender fee & other fee collected)	3,583,500.00		394,019.48	
<b>TOTAL</b>	<b>18,129,347.50</b>		<b>31,662,959.48</b>	
<b>SCHEDULE 19 - Increase / Decrease in stock:</b>		<b>0.00</b>		<b>0.00</b>

Sd/-  
**R S Gururaj**  
Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**

**Schedule forming part of the accounts**

Description	2009-10		2008-09	
	Rs.	Ps.	Rs.	Ps.
<b>SCHEDULE 20 Establishment Expenses:</b>				
Salaries & Scholarship to students	97,011,550.00		74,904,569.00	
Wages	17,483,695.00		10,795,653.00	
Allowances ( Medical reimbursements etc.,)	3,301,569.00		2,898,623.00	
Bonus	203,128.00		255,442.00	
Contribution to CPF	2,141,666.00		2,603,973.00	
Contribution to New Pension Scheme	904,690.00		629,036.00	
Retirement & terminal benefits	989,672.00		21,610.00	
Contribution to Group Gratuity Scheme	1,462,198.00		0.00	
Leave encashment benefits	168,551.00		0.00	
LTC	428,992.00		470,353.00	
<b>TOTAL</b>	<b>124,095,711.00</b>		<b>92,579,259.00</b>	
<b>SCHEDULE 21- Other Administrative expenses</b>				
Electricity & Power	27,779,057.00		19,929,882.00	
Water charges	4,066,577.00		953,811.00	
Insurance	453,097.00		409,089.00	
Repairs & Maintenance	21,489,323.00		16,495,995.00	
Rents,rates & taxes	2,881,979.00		1,609,621.00	
Vehicles running & maintenance	1,601,160.00		4,084,997.00	
Postage, telephone & communication	3,328,744.00		3,321,730.00	
Printing & stationery	2,041,628.00		3,103,473.00	
Travelling and conveyance	6,990,307.18		5,353,982.46	
Expnses on Seminars/workshops/discussion meetings	8,305,986.00		17,735,861.00	
Subscriptions	167,321.05		399,348.00	
Fees towards training etc.,	85,000.00		115,000.00	
Professional charges	9,724,907.00		6,435,829.00	
Laboratory Consumables	34,944,924.67		29,276,894.00	
Frieght Inwards	3,392,456.00		2,782,128.00	
Other consumables	671,025.00		971,813.00	
Advertisement & Publicity	1,403,179.00		2,363,334.00	
Other miscellaneous expenses	938,358.55		1,097,779.00	
Statutory Audit fee	44,120.00		35,000.00	
POBE prgramme	250,277.00		229,220.00	
Student Research Fellowship Programme	159,511.00		1,031,744.00	
Fellowships - Department of Bio-Technology	21,910.00		76,230.00	
ICMS - Workshops, Schools etc.,	1,701,059.10		964,342.00	
ICMS - Visitor Programmes ( National & International)	387,000.00		486,253.00	
ICMS - Recurring expenses	2,888,640.00		4,811,776.00	
ICMS - Scientists & Supporting Staff	1,380,884.00		429,959.00	
<b>TOTAL</b>	<b>137,098,430.55</b>		<b>124,505,090.46</b>	
SCHEDULE 22-Expenditure on grants, subsidies Etc:		0.00		0.00
SCHEDULE 23- Interest and Bank charges:		27,853.00		46,198.33
<b>TOTAL</b>		<b>27,853.00</b>		<b>46,198.33</b>

Sd/-  
**R.S.Gururaj**  
Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**

**SCHEDULE 24**

**Significant Accounting Policies**

- 1 The fixed assets are stated at cost. The Centre has identified depreciation on Fixed Assets, and since they are created out of Grant in Aid Funds, they have been classified in the Balance Sheet under Capital Fund and also under the Fixed Assets schedule respectively
- 2 Grants received and utilised for procurement of Fixed Assets have been reduced from the total Grants received in the Income and Expenditure Account and the same have been included under Capital Fund Account
- 3 Leave encashment to staff members is accounted as and when it is paid
- 4 Investments of the Centre are stated at cost. The interest on investments is accounted on accrual basis
- 5 The foreign currency transactions are translated at the rates prevailing on the date of transaction.
- 6 Royalty income has been accounted as and when received

Sd/-  
**RS Gururaj**  
Accounts Officer





**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**  
**Schedule forming part of the accounts**  
**SCHEDULE 25**

Contingent Liabilities and Notes on Accounts

A Contingent Liabilities

	Current Yr	Previous Yr
	Rs.	Rs.
1 Claims against the entity not acknowledged as Debts	Nil	Nil
2 Letters of Credit Outstanding	Nil	Nil

B Notes on Accounts

- 1 Previous year's figures have been regrouped and reclassified wherever necessary to read in conformity with current year figures
- 2 Estimated amount of contracts remaining to be executed on capital account and not provided for
  - a. In respect of Equipments
  - b. In respect of Buildings
- 3 The Expenditure listed under Schedule 20 as Establishment Expenses include the salaries to faculty, Scientific and Research Personnel. The Expenditure listed under Schedule 21 as Administrative Expenses include the expenses towards Laboratory Consumables and Seminars / Workshops / Discussion Meetings exclusively incurred for research purposes.
- 4 No Provision for income tax has been made as the Institution is exempt under section 35 (1) (ii) of the Income Tax Act, 1961 and hence the entire income of the Institution is exempt from income tax.

Sd/-  
**R.S.Gururaj**  
Accounts Officer



**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH**  
**CPF & NPS FUND STATEMENT OF AFFAIRS FOR THE YEAR ENDED ON 31.03.2010**

Particulars	Rs.	Ps.	Particulars	Rs.	Ps.
<b>CONTRIBUTORY PROVIDENT FUND:</b>			<b>INVESTMENTS OF FUNDS:</b>		
<b>SUBSCRIPTIONS</b>			<b>INVESTMENTS IN:</b>		
Opening Balance			Government of India 8 % Bonds ( SHCIL)	17,000,000.00	
Add :Subscriptions received during the year	5,656,252.00		State Government Securities (25 lakhs)	2,640,416.67	
Loan repayments	929,280.00		Fixed Deposits at Canara Bank	20,000,000.00	
Interest on subscriptions	1,917,167.00		Fixed Deposit at HDFC	5,000,000.00	44,640,416.67
Less: Loans granted during the year	2,232,131.00		Closing Cash and Bank Balance :		
Less: Withdrawals on retirement/death	494,823.00		Cash at Bank :		
Closing Balance		30,401,103.00	SB A/C No.17513		
			Canara Bank, IISc branch		7,425,714.10
<b>CONTRIBUTION</b>			TDS on investment in GOI Bonds		325,648.00
Opening balance	4,616,225.00				
Add : Contribution during the year		15,487,483.00			
Interest on total contributions	1,231,759.00				
Less: Withdrawals on retirement/ death		5,847,984.00			
Closing Balance		21,335,467.00			
<b>NEW PENSION SCHEME</b>					
<b>SUBSCRIPTION</b>					
Opening Balance	1,405,157.00				179.00
Add :Subscriptions received during the year	179,296.00				
Interest on subscriptions		1,683,976.00			
Closing Balance		1,584,453.00			
<b>CONTRIBUTION</b>					
Opening balance		3,268,429.00			
Add : Contribution during the year	1,410,324.00				
Interest on total contributions	97,764.00				
Closing Balance		1,282,933.00			
Surplus during the year 2009-10		268,274.77			
<b>TOTAL</b>		<b>55,146,962.77</b>			<b>2,755,005.00</b>
<b>TOTAL</b>			<b>TOTAL</b>		<b>55,146,962.77</b>

For Jawaharlal Nehru Centre for Advanced  
Scientific Research

This is the Receipts and payments account  
referred to in our report of even date,  
for M/s G.R.VENKATANARAYANA  
Chartered Accountants

Sd/-  
**(G.R.VENKATANARAYANA)**  
Partner

Membership No. 018067  
Place : Bangalore Date:13.09.2010

Sd/-  
**R.S.Gururaj**  
Accounts Officer

Sd/-  
**Prof.M.R.S.Rao**  
President



