Abstracts of Lectures

Nonotube dynamo and graphene

A K Sood

Indian Institute of Science, Bangalore

Engineering plants for disease resistance: Challenges and opportunities

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MS University, Baroda

Fungal diseases lead to severe crop losses and are thus a major constraint limiting crop yields. The rice blast fungus (*Maganaporthe oryzae* Couch.) poses a major threat to rice production worldwide. Current methods of control rely on the use of chemicals and deployment of varieties bred for resistance against specific races of a pathogen. Use of chemicals has heavy financial and environmental costs and the resistant cultivars often breakdown because the pathogen strains continuously evolve to overcome host resistance. A long-term solution requires genetic delivery of durable, non-race-specific resistance against pathogens.

In nature, plants are continuously exposed to various invading microorganisms and are likely to be primed for resistance against further attacks. It has been shown that a localized infection in plants can lead to resistance against a subsequent infection with widely different pathogens. Resistance is expressed not only locally at the site of primary inoculation but also systemically in tissues located away from the initial treatment. This form of induced resistance has been called systemic acquired resistance (SAR). This phenomenon of SAR can be compared to immunization in animals and humans, although the underlying mechanisms are different. SAR, besides constitutive defense, contributes to the overall resistance displayed by plants and may provide a selective advantage for survival.

Genes involved in the complex signal networks and underlying expression of inducible resistance mechanisms are being identified through mutational analysis in Mutational analysis in the model plant *Arabidopsis thaliana*. Using an activation tagging approach in *Arabidopsis*, a constitutive disease resistance (CDR1) gene has been identified, the over-expression of which leads to enhanced resistance against bacterial pathogens. CDR1 codes an apoplastic aspartic protease that releases an endogenous peptide elicitor of salicylic-acid-dependent inducible resistance responses.

We isolated a rice homologue of *Arabidopsis* Constitutive Disease Resistance (CDR1), Transgenic, OsCDR1. *Arabidopsis* over-expressing *OsCDR1* accumulated high levels of Salicylic Acid (SA) and showed several fold induction of the defence related genes *PR1* and *PR2*, but not *PDF1*.2. The transgenic plants also exhibited oxidative burst, and this was associated with the establishment of SAR, suggesting a role for *OsCDR1* in SA mediated

disease resistance signalling pathways. This was further supported by the observation that over-expression of *OsCDR1* in transgenic *Arabidopsis* plants enhanced disease resistance against infection by *P. syringae* pv. *tomato* and *Peronospora parasitica* .Over-expression *OsCDR1* in rice led to constitutive activation of defence-related genes such as *PBZ1/PR10*, *PR1* and led to an enhanced resistance against phytopathogens.

Structural Materials of the future: The case of bulk metallic glasses

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Just like we use steels and aluminum, titanium, and nickel alloys today, our grandchildren are likely to use bulk metallic glasses (BMGs), shape memory alloys (SMAs), nanocomposites (among the many new and exciting materials that are being developed in laboratories now) in their time. These materials, being completely different in their constitutive response from those of conventional metals and alloys, require through understanding of their mechanical behavior first. In this presentation, I shall use the example of BMGs to illustrate the scientific challenges in understanding the deformation and fracture behavior in them. This, I shall do with the aid of the experimental and modeling efforts that we have made to tackle specific issues of pressure sensitivity of plastic flow (and how it effects hardness), inhomogeneous flow through shear localization, and the identification of the conditions for the onset of fracture through a fracture criterion.

Metal-oxide based inorganic systems toward practical applications

Samar K. Das

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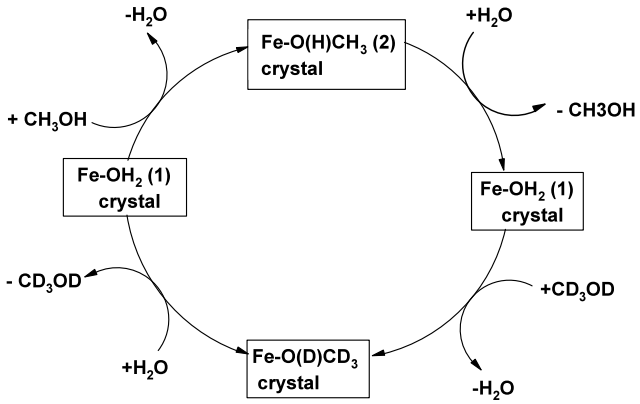
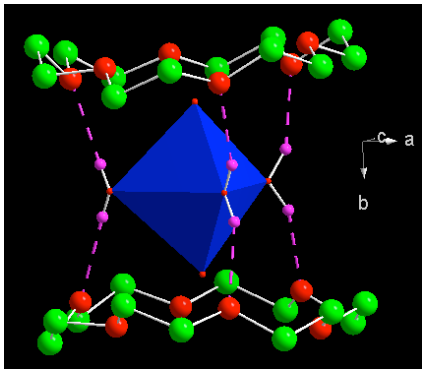
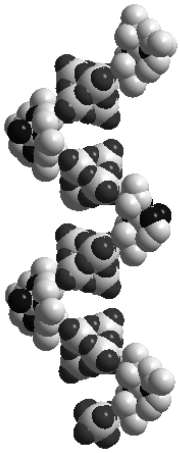
This talk has been arranged under three headings. In the first part, a gas-solid reaction in a single crystal to single crystal transformation would be discussed in the context of methanol detection from its vapor state at an ambient condition.[1] The co-existence of some crown ethers-complex cations and polyoxometalate (POM) anions will be mentioned in the second part of the talk, in which it will be demonstrated that POM cluster anions plan an important role in stabilizing unusual supramolecular structures.[2] Finally, it will be shown, how a POM cluster anion can be used for chiral separation through spontaneous resolution.







1. S. Supriya and S. K. Das, ***J. Am. Chem. Soc.*** **2007**, *129*, 3464-3465.
2. V. Shivaiah and S. K. Das, ***Angew. Chem. Int. Ed Engl.*** **2006**, *45,* 245-248.

Estuaries - an introduction

M Dileep Kumar

National Institute of Oceanography, Goa

Estuaries are landward-dented, semi-enclosed coastal basins where river water mixes with seawater. Mixing between the two end members leads to gradients in salinity and other dissolved constituents, thus creating conditions for high biological productivity and the associated biogeochemical activities. The availability of food resources along the river and estuarine systems facilitated human settlements on their banks throughout the march of civilization. With the growing needs of humanity, the estuarine habitats came under stress, and their current over-exploitation is reaching a flash point. The estuarine systems are interfered with by human

activities in all possible dimensions, and unless they are regulated, the damage will soon be beyond control. For us to sustain the health of these most important habitats and food providers, it is essential that we develop fundamental understanding of these ecosystems.

While India houses some of the world's largest river systems, the study of the estuarine stretch of these systems (the Sundarbans, for example) is yet to bloom. Many attempts have been made in the last several decades to study minor to major estuarine systems distributed along the Indian coastline, but an effort to synthesize this information into a holistic framework, useful for evolving policy on our estuaries, is missing.

The need of the hour is to create awareness of the necessity to maintain the sound health of Indian estuaries in the interest of millions of people who depend on these systems. The lectures in the mini-symposium ***Indian estuaries*** will highlight special characteristics of these estuaries and their problems. **Dr. Dileep Kumar** will introduce the symposium with ***Estuaries under threat***. The other lectures in the mini-symposium are as follows.

Nature of freshwater influx in Indian estuaries

D Shankar

National Institute of Oceanography, Goa

Water flows and fluxes through estuarine systems and river basins are important for understanding regional transport of materials and hydrological balance. This lecture discusses water transports and highlights the differences between the estuarine systems on the east and west coasts of India.

Monsoonal estuaries

S R Shetye

National Institute of Oceanography, Goa

Gradients in dissolved salt are fundamental to estuaries. As Indian rivers are fed by freshwater influx from monsoonal rains during just a few months every year, the mass balances of water and salt in our estuaries are different from those in the better studied estuaries of the temperate regions. This lecture will highlight special features of Indian estuaries.

Biogeochemistry in estuarine systems

V V S S Sarma

National Institute of Oceanography, Goa

Chemical processes in estuaries are controlled by the nature and quantum of materials supplied through various pathways, including biological processes. This lecture discusses factors regulating biogeochemical processes in estuaries, with case studies highlighting human interference through agriculture and dredging activities. Significance of temporal and spatial variability in estuarine processes will also be examined.

Influence of monsoon on estuarine ecosystem

A C Anil

National Institute of Oceanography, Goa

The biological domain in estuaries is determined by nature of influx of materials. The salt content is one of the important determining factors. As the Indian rivers are fed by monsoon river discharge, the success or failure of the monsoon has a strong bearing on the nature of biology of the estuaries. This lecture will explain how different the estuarine biology can be between periods of heavy and weak monsoon rainfall.

Impact of mining on suspended materials on estuaries

V. Purnachandra Rao

National Institute of Oceanography, Goa

Suspended materials in an estuary are believed to be supplied mainly through the river discharge, particularly during the rainy season. This hypothesis may not be universally applicable as other sources and factors might dominate in certain estuaries. This lecture discusses how spillage of solids due to human activities is one way the natural estuarine sediment transports and depositions are modified.

Status of pollution in Indian estuaries

M D Zingde

National Institute of Oceanography, Goa

Concentration of human habitats on the banks of estuarine systems are threatening the health of these systems, thereby affecting availability and quality of food resources. The nature of interference, however, depends on the type of pollutant and the respective estuarine characteristics. The status of pollution in different estuarine systems of India will be discussed in this lecture.

India and the Indian Ocean: In search of a new strategic role

C Raja Mohan

Strategic Affairs Editor, Indian Express Limited, New Delhi

Synergistic mutualism between geology and physics: The case of luminescence geochronometry

A K Singhvi

Physical Research Laboratory, Ahmedabad

In recent years, the use of thermally- and optically- stimulated luminescence (TL and OSL) has occupied centre stage in the studies aimed to understand of the evolutionary history of Earth during the past two Million years (My; the Quaternary Era). These radiation damage based methods offer substantive advantages over other methods like radiocarbon, due to their continuous age range from the present to a My, their applicability to natural ubiquitous minerals like Quartz and Feldspars and their ability to provide ages to a variety of events in the recent Geological past. Consequently, these methods now makes it possible to assign ages to almost every conceivable geological situation, as also have helped in important aspects of personnel dosimetry, retrospective dosimetry of nuclear accident sites, archeology and meteoritics. Application of this method to Geology has also brought to light new physical phenomena in the solid state. Thus for example, anomalously young ages in volcanic materials indicated the presence of quantum mechanical tunneling of charges between defects. Further, long geological sequences permitted examination of the effects of changes in radiation dose rate over extended dose rate (μGy/year – Gy/sec) and dose regimes in the mineral lattices. In this talk, I will discuss the basic elements of the use of the methods, its application and show how the application of this method to geosciences has revealed new physical phenomena.

How do proteins misfold and aggregate?

Samrat Mukhopadhyay

Indian Institute of Science Education and Research (IISER), Mohali.

Proteins are the workhorses of the living systems. For carrying out specific functions, proteins have to fold up correctly. Incorrect folding (or protein misfolding) can lead to amyloid aggregation and is implicated in a number of human disorders. Additionally, protein aggregation poses a significant bottleneck in biotechnology industry. The molecular mechanism of protein misfolding, aggregation and amyloid fibril formation is poorly understood. Our laboratory is involved in unraveling the mechanism of aggregation of a diverse class of proteins using fluorescence spectroscopy in combination with other modern biophysical tools. Using a diverse array of biophysical techniques, we have embarked upon studies aimed at delineating the steps that are involved in amyloid formation. Our experimental approach involves the detection and characterization of the oligomeric intermediates that serve as precursors to amyloid fibrils. Multiple spectroscopic observables offer a wide range of windows to probe protein conformational changes coupled with the size growth during protein aggregation leading to amyloid fibril formation. Efforts are being made to decipher the mechanism of aggregation of a number of archetypal proteins having different native structures such as all-alpha helical, all-beta, alpha/beta and intrinsically disordered proteins. Our recent results illuminate the commonalities and differences between the aggregation mechanisms of proteins having different native structures.

Neutrinos: A new window to the Universe

N K Mondal

Tata Institute of Fundamental Research, Mumbai

Neutrinos, “the most tiny quantity of reality ever imagined by a human being”, as quoted by its co-discoverer Frederick Reines, never ceased to puzzle physicists.

Wolfgang Pauli introduced neutrino in 1930 as a desperate remedy to save the “law of conservation of Energy”. It then took twenty seven long years to find the first experimental evidence for its existence. The reason for this long wait is its extreme reluctance to interact with matter. Neutrino can pass through the earth, the sun or other astrophysical objects without much interaction.

They interact at the best only one time over one billion in the huge Apparatus built to detect them. This particular property of neutrino however turns out to be a blessing in disguise as it opens up a new window to look at the interior of sun and other astrophysical objects.

Over the last several decades, dedicated neutrino experiments around the globe have looked for neutrinos from the sun, from outer space, from interior of the earth and from man made activities. These experiments have answered many of the questions related to particle physics, astrophysics and even geophysics.

India has a long tradition in neutrino physics. In fact, the first ever cosmic ray produced neutrino was detected in an experiment in the deep mines of Kolar Gold Fields in 1965. India is again planning to setup an experiment called India-Based Neutrino Observatory (INO) to study some of the properties of neutrinos.

In this talk I will describe few of these experiments and their findings. I will also discuss the INO experiment and its physics potential.

Symposium on 'Stem cells in development and regeneration: From the bench to bedside and back"

Local and regulated organization of membrane components during Stem Cell Differentiation

Satyajit Mayor

National Centre for Biological Sciences, Bangalore

The membrane of living cells, a two dimensional fluid-mosaic, is the primary interface that delineates cells from their surroundings. At the same time it is this interface that must reproducibly interpret and respond to a particular niche or microenvironment to transmit information to the cell interior, to maintain a consistent cell-state or trigger a reproducible response to cellular differentiation cues. In fact during stem cell differentiation, recent data from our laboratory suggest that specific membrane components display distinct membrane organization during different stages of transformation. These observations pose fundamental questions regarding the mechanism of regulated organization of membranes components in living cell membranes. In my talk I will put forth a new paradigm regarding how living cells may regulate the organization of membrane lipids and proteins, and discuss how these principles may influence our understanding of stem cell differentiation.

Cell therapy for ocular surface: A successful model of regenerative medicine!

Geeta K Vemuganti,

Stem Cell Biology Laboratory, HERF, L V Prasad Eye Institute- KAR Campus, Hyderabad

Translational medicine is often known as “bench to bedside” – by which the biomedical community attempts to move research discoveries from the laboratory into clinical practice to diagnose and treat patients. One of the emerging fields of translational research is Cell Therapy, most commonly exploiting the potential of stem cells to grow, differentiate and serve the function of the damaged tissue. In ophthalmology, attempts have been made to regenerate ocular surface successfully through cell therapy. The limbus of the eye, a tissue at the junction of the cornea and conjunctiva of the ocular surface is known to harbor the progenitor cells for corneal epithelium hence are extensively used for ocular surface resurfacing in patients with limbal stem cell deficiency. Though clinical use of cultivated limbal epithelium has been in practice more than a decade, the intrinsic and extrinsic factors that govern the growth of these cells is not clearly understood. In an ongoing project approved by the institution IRB, we established a simple, 3T3 feeder-cell free, cost-effective way of culturing the corneal epithelium from limbal tissues within 2 weeks, using human amniotic membrane as a scaffold. Cultivated limbal

epithelial cells, at the end of 2 weeks of culture, consisted of a mixed population of stem cell or progenitor cells (ABCG2, p63) progenitor cells and differentiated cells (K3/K12, E-cadherin), with evidence of stratification both in vitro and in-vivo. The interim results of a clinical trial involving 700 patients with severe unilateral and bilateral LSCD revealed 70% success at the end of 3 years, 55-60% at the end of five years. Survival, integration and stratification of the transplanted cells were provided by clinical, histological studies of the corneal buttons obtained from patients who underwent corneal transplantation, status post cultivated limbal epithelial transplantation. Attempts have been made to transplant autologus conjunctiva and oral to reconstruct the ocular surface but with limited success. Our experience of cultivating the LEC on denuded human amniotic membrane using a feeder cell free method, led to identification of mesenchymal like cells of limbus (MLC-L), which showed phenotypic resemblance to bone marrow derived mesenchymal stem cells (MSC-BM). The data shows that these cells are not derived from limbal epithelial cells, rather are derived from limbal stroma within the explanted tissue and bears a striking resemblance to bone marrow derived mesenchymal stem cells (MSC-BM), including the down regulation of HLA DR expression and the gene expression profile. High expression of certain growth factors (e.g. FGF 1, 2, 7) and their corresponding receptors (eg FGFR2) on LECs supports the nurturing roles of the MLC-L.. The lineage specific signatures, evidence of interdependent pathways with limbal epithelial cells, striking resemblance to the signature of bone marrow derived mesenchymal cells support our hypothesis that the limbal stromal cells act like intrinsic feeder cells or the nurture cells, and could possibly be an important component of limbal niche. Thus use of cultivated limbal epithelial cell transplantation for severe ocular surface disease can be considered as a successful model of cell therapy that fulfills the pre-requisites for cell therapy, ie the desired cells can be grown in sufficient amounts, survive, integrate, network with the host tissues with functional recovery and cause no harm to the recipient. It also led to identification of stromal cells that could possibly be the niche cells of limbal stroma

How stem cells build the brain

Shubha Tole

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We have discovered a key regulator of the development of the most complex brain structure, the cerebral cortex, the seat of our higher cognitive and perceptual functions. The cerebral cortex arises from a sheet of neural stem cells. A protein Lhx2, that functions as a transcription factor, appears to act at the earliest stage of specifying the neural stem cells to a cortical fate. We showed that in the absence of Lhx2, the entire cortex is lost. Instead, an adjacent non-cortical structure, the hem, is expanded. Using embryonic stem cell chimeras, we created a salt-and-pepper embryo of Lhx2-knockout and normal cells. In these chimeras, we discovered Lhx2 functions cell-autonomously, acting as a “cortical selector” gene.

Our embryonic stem cell chimeras also revealed the mechanism by which the hippocampus, a structure crucial for learning and memory, is formed in the brain. Chimeras made from normal and Lhx2-knockout cells produce multiple patches of hem (since Lhx2 knockout cells cannot form cortex but instead form hem). The extra hem patches in turn induce multiple hippocampi instead of the normal bilateral pair. This provides definitive functional evidence for the cortical hem as an organizer in the brain.

References: Mangale et al., Science, 2008;

Funding support: A Wellcome Trust Senior International Fellowship, a Swarnajayanti Award (Department of Science and Technology, Govt. of India), intramural funds from TIFR.

Adult neural stem cells: Relevance to the treatment of psychiatric disorders

Viditha A Vaidya

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The fact that the adult mammalian brain can generate new neurons, at least in discrete regions,throughout the lifespan of the organism has generated immense excitement for both basic neurobiologists and clinicians interested in the promise that this discovery holds. In distinct neurogenic zones in the mammalian nervous system, stem cells/ progenitors divide to give birth to immature neurons that then migrate and integrate functionally in the neuronal circuitry. The process of adult neurogenesis has been observed in a number o f mammalian species including rodents, marmoset and macaque monkeys, as well as humans. In addition to observing new neuron birth in vivo, these neuronal stem cells have also been isolated from living tissue and maintained in vitro.The ability to regulate the process of neurogenesis in vivo holds immense promise in the repair of neuronal damage and indeed several studies suggest that the adult mammalian brain is not as restricted in it's ability to repair damage as had been previously thought.

Animal models of depression are reported to exhibit a decline in new neuron production in the hippocampus and show reduced trophic factor expression in key limbic brain regions. In contrast, adult hippocampal neurogenesis and trophic factor expression are enhanced following chronic antidepressant treatments, and have been shown to be required for some of the behavioral effects of antidepressants in animal models. The 'neurogenic' and 'neurotrophic' hypotheses of depression raise the intriguing possibility that key adaptive changes in hippocampal neurogenesis and trophic support contribute to the treatment of depressive disorders. However, these adaptive changes arise only in response to sustained antidepressant administration and are slow in their onset, which may contribute to the delay in the therapeutic effects of antidepressants. I will discuss findings from my lab that have shown the key role of noradrenergic receptors in regulating the neurogenesis in the hippcoampus. We find that using strategic approaches to specifically influence key noradrenergic receptors, we can substantially speed up the neurogenic, trophic and behavioral effects of antidepressants. These studies bear relevance to the identification of key targets for faster acting antidepressant treatments.

Stem cells and the brain

Shyamala Mani

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During development of the nervous system, a vast array of neurons and glia are born in appropriate numbers and at specific locations. This process depends both on cell intrinsic programming and on the environment in which it is present. Proneural genes are one of the

most important classes of genes coding for the basic helix-loop-helix (bHLH) containing transcription factors, which are both necessary and sufficient to initiate neural lineage and to promote generation of progenitors committed to differentiate into neurons. These bHLH transcription factors also integrate positional information into the neurogenesis process and contribute to the specification of progenitor-cell identity during neurogenesis. Thus the bHLH genes have been shown to specify neuronal subtypes. MATH-1 is a bHLH gene that is critical for the development of cerebellar granule cells (CGC), the most abundant cell types in the brain. Cerebellum is crucial for various functions such as movement coordination and balance, sensory discrimination and cognitive processing. Many cerebellar disorders are associated with progressive loss of the cerebellar granule neurons with resulting movement and cognitive disorders. Cell replacement therapy could be an important approach for treatment of such disorders. In our laboratory we are interested in exploring whether cell replacement therapy can be used in cases where cerebellar granule cells degenerate early in life and in cases of brain damage during development.

Marine gas hydrates - an untapped non-conventional energy resource

Pawan Dewangan

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Gas hydrates are ice like crystalline solid in which methane or lighter hydrocarbon molecules are trapped within the water molecules. Gas hydrates are formed when gas concentration exceeds its saturation limit and are stable under high pressure and low temperature. Along the Indian continental margins, gas hydrates are widely present in continental slope environment where a deep water column exerts enough pressure to stabilize gas hydrate. Gas hydrates has drawn considerable attention to the scientific community due to its importance as an alternative energy resource and its impact on submarine slope stability and climate change. The occurrence of gas hydrates is inferred from the presence of anomalous Bottom Simulating Reflectors (BSRs) on conventional seismic data. The BSR shows distinctive characteristic such as mimicking the seafloor, show opposite polarity with respect to that of seafloor and crosscut the existing geological strata. In the eastern continental margins of India, BSRs are identified in Krishna-Godavari (KG), Mahanadi and Andaman offshore basins. The drilling/coring activities onboard JOIDES Resolution under the aegis of National Gas Hydrate Program (NGHP) has confirmed the presence of gas hydrates in the KG, Mahanadi and Andaman basins. The analysis of coring results along with other geophysical data suggests that accumulation of gas hydrates is not uniform and shows strong dependence on lithology and tectonics. In KG basin, gas hydrates are preferentially deposited along the fault and fracture networks formed due to shale diapirism whereas in Mahanadi basin they are deposited in the sandy channels and in Andaman basin gas hydrates accumulate preferentially within the volcanic ash layers. These observations suggest that the occurrence of gas hydrates is scattered in nature rather than a continuous homogeneous deposit as inferred from the analysis of conventional seismic data. Therefore, the conventional seismic investigations may be advantageous for mapping gas-hydrates on a regional scale but for detail characterization of gas-hydrates deposit seismic data having high vertical and horizontal resolution are required.

Molecular design for manipulation of organic material properties

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It is the molecular structure that embodies all attributes of reactivity and molecular organization. This is the thesis of our research. By a rational design at molecular level, we have demonstrated how both thermal as well as photochemical reactivities can be controlled.[1] By applying the riches of crystal engineering to molecular design, it is possible to control molecular order as well as prohibit crystallization; the latter is of great utility in developing amorphous molecular materials–a bright advantage of what is otherwise a 'dark-side of crystal engineering'. Through a rational design of molecular modules, we have developed i) porous organic materials based on tri- and tetraarylarenes that exhibit kaleidoscopic guest inclusion,[2] and ii) amorphous organic molecular materials based on 3-dimensional bimesityl core, which display high glass transition temperatures for application in organic light emitting diodes.[3]

I shall present some results of our *de novo* approaches to the control and otherwise of the organic molecular ordering aimed at functional materials.

References:

1. a) Singhal, N.; Koner, A. L.; Mal, P.; Venugopalan, P.; Nau, W. M.; Moorthy, J. N. *J. Am. Chem. Soc.* **2005**, *127*, 14375; b) Moorthy, J. N.; Samanta, S.; Koner, A. L.; Saha, S.; Nau, W. M. *J. Am. Chem. Soc.* **2008**, *30*, 13608. C) Moorthy, J. N.; Singhal, N.; Senapati, K. *Tetrahedron Lett.* **2008**, *49*, 80, and unpublished results.

2. a) Moorthy, J. N.; Natarajan, R.; Venugopalan, P. *J. Org. Chem*. **2005**, *70*, 8586. b) Natarajan, R.; Savitha, G.; Moorthy, J. N. *Cryst. Growth Des.* **2005**, *5*, 69. c) Natarajan, R.; Savitha, G.; Dominiak, P.; Wozniak, K.; Moorthy, J. N. *Angew. Chem. Int. Ed.* **2005**, *44*, 2115. d) Moorthy, J. N.; Natarajan, P.; Venugopalan, P. *J. Org. Chem*. **2009**, *74*, 8566. e) Moorthy, J. N.; Natarajan, P. *Chem. Eur. J.* **2010**, *16*, 7796.

3. a) Moorthy, J. N.; Natarajan, P.; Venkatakrishnan, P.; Huang, D-F.; Chow, T. J. *Org. Lett.* **2007**, *9*, 5215. b) Moorthy, J. N.; Natarajan, P.; Venkatakrishnan, P.; Huang, D-F.; Chow, T. J. *Chem. Comm.* **2008**, 2146. c) Moorthy, J. N.; Natarajan, P.; Venkatakrishnan, P.; Natarajan, P.; Huang, D-F.; Chow, T. J. *J. Am. Chem. Soc.* **2008**, *130*, 17320. d) Moorthy, J. N.; Natarajan, P.; Venkatakrishnan, P.; Natarajan, P.; Huang, D-F.; Chow, T. J. *J. Org. Chem*. **2010**, *75*, 2599.

Proofreading during translation of the genetic code

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A high fidelity is required for processes involved in transfer of genetic information like replication, transcription, and translation of the genetic material. During translation (RNA-protein), aminoacyl-tRNA synthetases (aaRSs) are responsible for attaching the correct amino acid to the corresponding tRNA thereby playing a crucial role. Proofreading/editing of noncognate amino acids attached to tRNA is essential because aaRSs that are editing-defective form proteins with incorrect sequences leading to global misfolding of proteins and hence are linked to disease conditions such as neurodegeneration. We have identified a unique editing domain similar to D-aminoacyl deacylases, which specifically removes D-amino acids attached to tRNA, attached to the translational apparatus. The study provided a model for how nature could have enforced and perpetuated homochirality in proteins i.e. the presence of only L-amino acids. Further mechanistic insights highlight the role of RNA molecule playing a major role in cognate/noncognate discrimination thus questioning the paradigm of 'steric exclusion' as proposed in the text book 'Double Sieve Model'. In order to provide a structural model for editing defective synthetases leading to disease conditions, we used a mutant proofreading module to obtain editing defective complexes. The structural analyses provide valuable clues as to how a small change in the editing domain could result in cross-reactivity during the error correction process. The study therefore offers a completely new perspective to the deleterious effects caused by mutations in the proofreading modules that can potentially lead to disease conditions.

Vortices in density gradients: Mergers, split-ups and death

Rama Govindarajan

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Vortices often occur in combination with density stratification, e.g. in the atmosphere and in the ocean. (i) The Boussinesq approximation, usually made in such studies, amounts to neglecting centrifugal effects. We show that this is not good close to a vortex even when density variations are weak, since centrifugal forces can drive unexpected instabilities, e.g. a super-exponential spiral Kelvin-Helmholtz instability, and send the vortex to an early demise. (ii) Since centrifugal forces result in outward motion of heavy portions of the fluid, one would expect light-cored vortices to be stable. We however show them to be destabilised and split under certain circumstances, and explain this by a wave-interaction mechanism. (iii) The merger of like-signed vortices is affected non-monotonically by density stratification. This will be discussed.

Distant relationships amongst protein domains

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The knowledge-based approach to protein structure-and-function prediction exploits the property of strong structural convergence and distant relationships where it is estimated that there may be only 1000 protein folds in the entire universe (Chothia, 1992). There has been a constant quest to bridge the gap between protein sequences and structures. Availability of databases permits the systematic analyses, structure prediction and search for potential members of 'protein superfamilies' in genome databases. We analyse alignments of protein domain superfamilies to identify structural motifs on the basis of conservation of structural criteria like amino acid preference and solvent accessibility. Specific scoring of the order and spacing of conserved motifs is useful for the recognition of domains involved in circular permutation and extensive insertions. It is now possible to identify structurally conserved spatially interacting motifs using automatic servers (Imot, Bhaduri *et al*., 2004). In this talk, I will also discuss how cascaded sequence searches (Sandhya *et al*., 2005) can enable the connection of distantly related protein families and to improve function association of unknown gene products from mere sequence information.

References

Chothia, C. (1992) Proteins. One thousand families for the molecular biologist. *Nature*, **357**, 543-544.

Bhaduri, A., Pugalenthi, G., Gupta, N. and Sowdhamini, R. (2004) iMOT: an interactive package for the selection of spatially interacting motifs. *Nucleic Acids Research,* **32**, W602-W605.

Sandhya, S., Chakrabarti, S., Abhinandan, K.R., Sowdhamini, R. and Srinivasan, N. (2005) Assessment of a Rigorous Transitive Profile Based Search Method to Detect Remotely Similar Proteins. *J. Biomol. Strc. Dyn*. **23**, 283-98.

Game theory in everyday life

Kaushik Basu

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The dynamics of host-pathogen interactions in TB Infection

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The vast majority of pathogens of the human hosts have co-evolved along with the host so as to be able to successfully infect the target cells, and survive in them. They are able to do so by adapting to the intracellular milieu through complex interplay with host cell machinery. This host-pathogen interplay manifests at every level of cellular regulatory machinery including signaling network, metabolic network and transcriptional regulatory network. Pathogen-derived molecules tend to co-opt these regulatory modules and influence them in a manner that facilitates their survival within the host cell. This is especially true of *Mycobacterrium tuberculosis* (Mtb), which has evolved elaborate strategies to survive within the endocytic vesicles of human macrophages. Subversion of the host cell by the microbe has been shown to be mediated through interactions with proteins secreted by the intracellular pathogen. Our thesis, therefore, is that an approach that can disrupt the key molecular interactions that promote this adaptation may provide an alternate strategy for chemotherapy**.** To explore this, we have adopted a two-phase strategy where the first phase involves the generation of a complete 'parts list' of the host cell regulatory molecules that are either targeted or influenced by the pathogen. For this, we are currently performing a genome-wide siRNA screen of human macrophages infected with Mtb. This information obtained from this screen is also being employed to identify the molecular axis that is involved in regulating pathogen survival. It is our hypothesis that the components of such an axis will also serve as a list of candidate targets for the development of chemotherapeutic strategies aimed at disabling the adaptive mechanisms of the pathogen. Thus our present approach seeks to extend systems biology, towards a translation-oriented exercise that could perhaps be termed as 'systems pharmacology.' The talk will focus on the progress made in these experiments, as well as elaborate on the novel concepts emerging from this screening exercise.

Magnetizing the Universe

K Subramanian

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The origin of large scale magnetic fields in the universe is reviewed, focusing on their generation and maintenance by turbulence. In the astrophysical context this generation is usually explained by a self-excited dynamo, which involves flows that can amplify a weak seed magnetic field exponentially fast. Particularly interesting is the nonlinear saturation of the dynamo. A fluctuation dynamo generically operates in any turbulent environment, and can explain fields correlated on the scale of the turbulence as seen in galaxy clusters. Disk galaxies however have magnetic fields correlated on scales larger than the stirring. This typically requires dynamo action by turbulence which lacks mirror symmetry. Such large-scale helical dynamos produce small scale helical fields as a waste product that quench the large scale

dynamo. The role of magnetic helicity fluxes in alleviating this quenching and mechanisms for such fluxes are reviewed.

Logical stochastic resonance: Exploiting the interplay between noise and nonlinearity to enhance computations

Sudeshna Sinha

Indian Institute of Science Education and Research, Mohali

We discuss how to obtain reliable logic elements by exploiting the interplay of nonlinearity and noise. Our central observation is this: when one presents low amplitude inputs to a two-state system, the response of the system can produce a logical output (NOR/OR) with a probability controlled by the noise level. As noise is increased, the probability of the output reflecting a NOR/OR operation increases, from nearly zero, to unity in a window of moderate noise, and then decreases again to zero at higher noise levels. Changing the nonlinearity (i.e. the thresholds) of the system changes the system's output into another logic operation (NAND/AND) whose probability displays analogous behavior with respect to increasing noise levels. So the cooperative effects of nonlinearity and noise yield robust logic behavior in the presence of a noise-floor, and furthermore one can morph the logic function by simple manipulation of nonlinearity/threshold. Lastly, we indicate how such a "Logical Stochastic Resonance" (LSR) may be observed in a large class of physical, chemical and biological systems.

If there is space, you can perhaps add the references I list below, after my abstract. Needless to say, in case of space constraints, please leave them out.

References:

1. K. Murali, Sudeshna Sinha, W.L. Ditto, A.R. Bulsara, Physical Review Letters, v. 102 (2009) 104101

2. Sudeshna Sinha, J. M. Cruz, T. Buhse and P. Parmananda, Europhysics Letters, v. 86 (2009) 60003

3. K. Murali, I. Raja Mohamed, Sudeshna Sinha, W.L. Ditto and A.R. Bulsara, Applied Physics Letters, v. 95 (2009) 194102

4. D. N. Guerra, A. R. Bulsara, W. L. Ditto, Sudeshna Sinha, K. Murali, and P. Mohanty, Nano Letters, v. 10 (2010) 1168

5. H. Ando, Sudeshna Sinha, R. Storni and K. Aihara, "Synthetic Gene Networks as flexible parallel Logic Gates" (submitted)

Design and optimization problems in wireless sensor networks

Anurag Kumar

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In our projects in the Indian Institute of Science, we have recently worked on designing wireless sensor networks (WSNs) for human intruder detection and for industrial sensing. The effective design of WSNs for such applications requires novel algorithmic techniques in signal processing, communication and networking. I will provide an overview of the area and a glimpse of some of our work on the following two problems. (i)Wireless mesh network design for industrial WSNs: We have addressed the problem of optimal relay placement with performance objectives such as minimum number of relays, end-to-end packet delay bound, and network lifetime. (ii) Distributed event detection: We have extended and solved classical change detection formulations to incorporate communication delays and node energy.

Brief Biography of Speaker

Anurag Kumar obtained his B.Tech. degree from the Indian Institute of Technology at Kanpur (where he was awarded the President's Gold Medal) and the PhD degree from Cornell University, both in Electrical Engineering. He was then with Bell Laboratories, in New Jersey, for over 6 years. Since 1988 he has been with the Indian Institute of Science (IISc), Bangalore, in the Dept. of Electrical Communication Engineering, where he is now a Professor, and is also the Chair of the Electrical Sciences Division. From 1988 to 2003 he was the Coordinator at IISc of the Education and Research Network Project (ERNET), India's first wide-area packet switching network. His area of research is communication networking, specifically, modeling, analysis, control and optimisation problems arising in communication networks and distributed systems. Recently his research has focused primarily on wireless networking. He has been elected Fellow of the IEEE, the Indian National Science Academy (INSA), the Indian National Academy of Engineering (INAE), and the Indian Academy of Science (IASc). He received IISc's Award for Excellence in Engineering Research for 2008. He was an associate editor of IEEE Transactions on Networking, and of IEEE Communications Surveys and Tutorials. He is a coauthor of the postgraduate textbooks "Communication Networking: An Analytical Approach," (published in 2004) and "Wireless Networking" (published in March 2008), both by Kumar, Manjunath and Kuri, and published by Morgan-Kaufman/Elsevier.

Hemoglobin endocytosis in *Leishmania*: a novel target.

Amitabha Mukhopadhyay

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Leishmania donovani is the etiological agent of Kala-azar, a chronic and fetal form of visceral leishmaniasis, affecting millions of people worldwide. Major thrust is given to identify the new therapeutic target against leishmaniasis because of development of drug resistant strains as well as current resurgence of the diseases. Trypanosomatid parasites, *Trypanosoma* and *Leishmania*, lack the heme biosynthetic pathway and need to acquire heme from external sources for survival. Our studies have shown that *Leishmania* endocytosed host hemoglobin (Hb) through a clathrin-dependent endocytic process and transport the internalized hemoglobin to lysosomes for degradation [***J Biol Chem*** (1999) 274: 2758; ***J Biol Chem*** (2005) 280: 5884].

These results suggest the intriguing possibility that parasites acquire heme from the degradation of Hb for its growth. Recently, we have characterized the intercellular route of hemoglobin and their regulation in the parasites by different Rab GTPases. Our results have shown that Rab5 regulates the early step of Hb endocytosis [***EMBO J.*** (2003) 22: 5712] whereas targeting of Hb to the late compartment is mediated by Rab7. Interestingly, we have found that cells overexpressing GDP locked negative mutant (Rab7:T21N) inhibit transport of internalized Hb to the lysosomes and these cells grow at a much slower rate than wild type *Leishmania* suggesting that Hb transport to the lysosomes to generate intracellular heme [***Proc. Natl. Acad. Sci. USA***. (2008) 105:3980] is required by the parasites. Consequently, we have shown that the pharmacological agent which inhibits lysosomal degradation suppress the growth of the parasites. Therefore, discovery of this new receptor system for acquiring heme by *Leishmania* is significant not only to the biology of this group of intracellular parasites but also as a potential new target against these parasites.

An invitation to the geometry of higher dual spaces

T S S R K Rao

Indian Statistical Institute, Bangalore

This talk deals with the geometry of Banach spaces. A non-reflexive Banach space embeds canonically in its second dual and the process continues, giving raise to a strictly increasing chain of Banach spaces. A well known example of a geometric phenomenon that is preserved in this chain, is that of being (isometric) a C*-algebra. We consider several geometric properties and thier behaviour in higer duals.

Puzzles in magnetism

Kalobaran Maiti

Tata Institute of Fundamental Research, Mumbai

Magnetism attracted great attention for many centuries due to its wonderful properties of attraction and repulsion commonly observed in our daily life. The future of technology also depends on efficient use of magnetic materials. Microscopically, magnetism depends on two objects; (i) magnetic moment and (ii) mediators (delocalized electrons) that couple them. Almost all the magnetic materials consist of elements possessing partially filled f (rare-earths: Eu, Gd, Tb, Dy etc.) or d (transition metals: Fe, Co, Ni etc.) bands among the highest occupied energy bands those satisfy these two conditions. Interestingly, some recent studies discovered materials exhibiting ferromagnetism (Curie temperature ~ 600 K) although they do not contain magnetic elements. On the other hand, the presence of magnetic element in a material does not ensure magnetism (Kondo effect). Employing high resolution photoemission, we observe signature of localized states in the low density electron systems that can lead to ferromagnetism. On the other hand, correlated systems exhibit signature of Kondo compensation pushing the system towards the absence of magnetism.

Genes associated with embryogenesis and abiotic stress tolerance in wheat

Paramjit Khurana

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Embryogenesis is one of the most important, yet the least understood plant processes. To understand the molecular basis of embryogenesis, a somatic embryogenic system in wheat has been used to study the early changes during transition of the vegetative cell to the embryogenic pathway. Based on transcriptome analysis several genes and their possible interactions have been speculated employing a systems approach. The *auxIAA* gene family was analyzed which codes for short-lived transcriptional repressors. One of these, *TaIAA1*, a nuclear localized protein, has been characterized in detail. The expression of *TaIAA1* is induced within 15-30 min of exogenous auxin application, is calcium-mediated, light-sensitive and tissue-specific. The genes encoding somatic embryogenesis receptor-like kinases (SERK) have also been characterized from wheat. Analysis of this gene family in rice has provided evidence for their role in other plant developmental processes besides embryogenesis.

Wheat being a temperate crop, is prone to heat stress during the grain filling stages (seed maturation/embryogenesis) in the northern regions, while heat stress during seedling stages is more prevalent in the mid-western regions of India. Hence, a program has been initiated to understand the gene expression profiles of wheat under heat stress. Transcriptome analysis of heat stress response has led to the isolation and characterization of a seed preferential Heat Shock Factor (HSF), a chloroplastic small HSP26, and several novel genes for abiotic stress tolerance. Regulation and characterization of wheat chloroplastic small HSP26 revealed its expression in all plant tissues within few minutes of heat stress. Over-expression, knockout studies and promoter analysis in *Arabidopsis* revealed that this chloroplastic HSP not only protects PSII from heat stress induced damage but also takes part in seed germination and seed development.

Parallely, wheat transgenics with *HVA1* gene have been developed for their tolerance against water stress to confer drought and salinity tolerance. Use of dihaploids has led to creation of homozygous T4 population thus preventing segregation of the trait in the progeny.

To mix or not to mix? Assembly of donor and acceptor chromophores

Mijanur Rahaman Molla, Anindita Das and Suhrit Ghosh*

Polymer Science Unit, Indian Association for the Cultivation of Science, Kolkata

Supramolecular-assembly in donor and acceptor mixed system can primarily be of two types; (*i*) Segregated assembly and (*ii*) Alternate donor-acceptor type stacking. Effective and robust supramolecular strategy for achieving control over the mode of self-assembly is of interest due to their relevance in various opto-electronic device applications. We envisaged that this can be achieved by the following molecular design, wherein the donor and acceptor π-systems are functionalized with bis-amide derivatives and the *distances between the two amide functionalities are varied in donor and acceptor derivatives* (Scheme 1). In such a situation, it is conceivable that if the distance matches for a particular pair donor-acceptor pair alternate

stacking will be favoured. On the other hand if the distance does not match, segregated assembly will be the pronounced one to gain the synergistic effect of inter-molecular hydrogen bonding and π-π interaction.

To test this hypothesis, we synthesized a bis-amide functionalized DAN-derivative (**D1**) and a similar NDI-derivative (**A1**) wherein the distance between the two amide functionalities was not matching. We also synthesized another NDI-derivative (**A2**) in which the distance between the two amide functionality was almost identical to that in **D1**. Supramolecular polymerization of **D1**, **A1** and **A2** were examined in solution by solvent and temperature dependent UV-visible and CD spectroscopy. These studies clearly revealed self-sorted assembly for the mixture of **D1** and **A1**, wherein signature of charge-transfer interaction was evident for **D1** and **A2** mixture.
In this presentation, self-assembly process of this donor-acceptor π-systems and its relevance in the context of broader applicability will be discussed.

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