SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

Newsletter

Vol.: 5 | Issue: 3 | Period: January - April 2013, Published on June 30.06.2013

Editorial

This edition of the newsletter of the S. N. Bose Centre highlights different activities in the Centre, the most important being the Bose Fest 2013. This annual function unfolds the academic and cultural talents among the people around in the Centre. The Bose Fest, however, did not cease our normal academic activities which can be found in valuable academic reports and the summaries of the submitted theses. The academic visits, seminars and conferences have been regular events in the Centre which are highlighted in some of the reports.

Contents

Bose Fest 2013

Ranjit Biswas

Bose Fest 2013 was organized during 29-31 January and celebrated with much enthusiasm and whole-hearted participation from both academic and non-academic bodies of the Centre. Bose Fest has become of late an annual event for expression of scientific and cultural activities by the young minds, and this year was also no exception. There were talks and posters thirty nine each by the students, where subject spanned from difficult algebras of theoretical science to complex interactions in chemistry and biology, from subtle atomic arrangements and response in materials to the message encrypted in lights traveling from astronomical distances. Quality of presentation and scientific works reflected the signature of both passion and professionalism. In fact, some of the presentations were as intellectually stimulating as those by any exponent in this profession. All these carry indelible marks that signal talent nurturing and a better scientific growth.

As talent reveals like a flower with many petals, Bose Fest also hosted exhibitions by students who, apart from performing academic task, let their creativity to run either with a camera, or ride on artistry with voice and movements. In the Photo Fest, the vivacity of life amid dust and debris was reflected with all its serenity; subtleties of good photography discussed; the eco-system around remembered; documentary on fishermen's life depicted how river inspires life time and again. Students and faculty members along with non-academic members also produced memorable performances on dance-drama, recitation and other on-stage activities. A magazine by students depicting Centennial Celebration of Indian Science Congress got released. Pandit Dinanath Mishra made a memorable vocal rendition on classical music. Bose Fest 2013 ended with prize distribution and concluding remarks by the Director, Professor Arup. K. Raychaudhuri.

ACADEMIC REPORT

Development of a New Class of Two-Dimensional Magnonic Crystal: Ferromagnetic Nanodot Lattices with Different Lattice Symmetry

Anjan Barman

We have developed a new class of two-dimensional *magnonic crystal* in the form of artificial ferromagnetic nanodot lattices with different lattice symmetry such as square, rectangular, hexagonal, honeycomb and octagonal symmetry. We have used $Ni_{80}Fe_{20}$ as the base material for the artificial crystals consisting of circular nanodots with 100 nm dot diameter and with as low as 30 nm separations between the nearest edges. The circular shape ensures that the individual nanodots do not possess any configurational anisotropy, while the interdot separation ensures that the dots are strongly magnetostatically coupled. Hence, all anisotropic effects will arise due to the interdot magnetostatic interaction, which will be tuned by lattice symmetry. We have demonstrated tunable magnonic spectra in these magnonic crystals by an all optical time domain excitation and detection of the collective precessional dynamics. As the lattice symmetry changes from square to octagonal through rectangular, hexagonal and honeycomb, a significant variation in the magnonic spectra is observed. The single uniform collective mode in the square lattice splits in two distinct modes in the rectangular lattice and in three distinct modes in the hexagonal and octagonal lattices. However, in the honeycomb lattice seven modes covering 2 - 15 GHz bandwidth are observed. Micromagnetic simulations qualitatively reproduce the experimentally observed modes, and the simulated mode profiles reveal a number of new collective modes with different spatial distributions with the variation in the lattice symmetry determined by the magnetostatic field profiles within the crystals. For the hexagonal lattice, the most intense peak shows a six-fold configurational anisotropy with the variation in the azimuthal angle of the external bias magnetic field. Analysis shows that this is due to the angular variation of the dynamical component of magnetization for this mode, which is directly influenced by the variation of the magnetostatic field on the elements in the hexagonal lattice. The developments are important for tunable and anisotropic propagation of spin waves in magnonic crystal based devices.

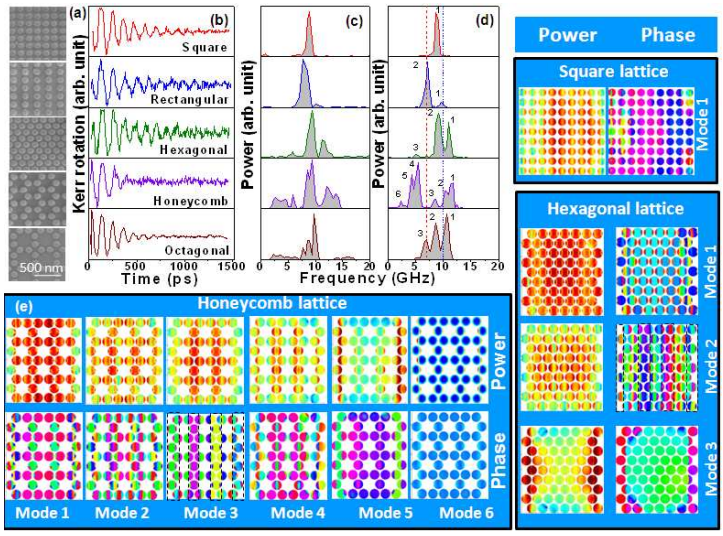


Fig. 1. Tunable magnonic spectra in two-dimensional magnonic dot lattices with different lattice symmetry. (a) Scanning electron micrographs of five different nanodot lattices and (b) experimental time-resolved magnetization dynamics; (c) FFT power spectra of the time-resolved data and (d) simulated magnonic spectra from the nanodot lattices. Note the single mode in the square lattices splits into a number of modes for the hexagonal, honeycomb and the octagonal lattices. (e) Magnonic mode profiles (power and phase maps) of different modes in the above lattices showing the origin of the modes.

Ref: Susmita Saha, Ruma Mandal, Saswati Barman, Dheeraj Kumar, Bivas Rana, Yasuhiro Fukuma, Satoshi Sugimoto, YoshiChika Otani, and Anjan Barman*, Tunable Magnonic Spectra in Two-Dimensional Magnonic Crystals with Variable Lattice Symmetry, *Advanced Functional Materials* **23**, 2378 (2013)

SCIENTIFIC ESSAY

Ocean Acidification: A Serious Threat to the Nature

Sandipa Indra

The growth of the release of carbon dioxide (CO_2) into atmosphere is emerging a serious issue now-a-days. Absorption of the huge amounts of atmospheric CO_2 by the oceans is the reason of ocean acidification. Although about half of this anthropogenic / man-made, CO_2 has been absorbed by the oceans over times and that has benefited us by slowing down the climate change of our atmosphere, the gradual increase of acidity of ocean water on the other hand has become a serious threat to nature in general and marine life in particular by destroying the marine organisms and biogeochemical cycles. It is needless to mention the influence of this imbalance of aquatic ecosystem to our lives.

As the term suggests, ocean acidification is the decrement of pH, meaning the increase of concentration of H^+ ions of ocean water. This can be represented as:

$H_2O+CO_2 <=> H_2CO_3 <=> 2H^+ + CO_3^{2-}$. Scientific research in this area over last few decades has shown that since the industrial revolution, the global average pH of the surface ocean has decreased by 0.11.[1] As pH scale is logarithmic; $pH = -\log_{10}[H^+]$, so this apparent small change in pH has increased ~30 % acidity of the sea water. An estimation of change of H+ ion concentration of sea water starting from 18th century (pre-industrial) to 21st century has been shown in the Fig. 1.[1,2]

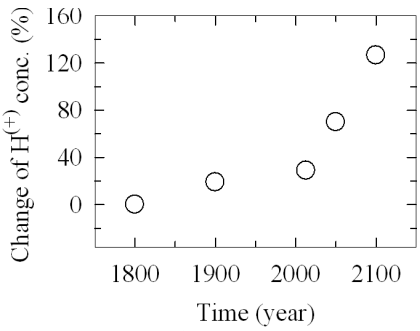


Fig. 1: Plot of estimation of change of H^+ ion concentration (%) against time (year).

We know that skeletons and shells of many marine organisms are mainly composed of calcium carbonate minerals. So continuous ocean acidification will affect the ability to produce and maintain the shells of these organisms by enhancing the concentration of bicarbonate ions. By combining with carbonate ions (obtained from skeletons of marine organisms) carbonic acid (H2CO3) forms bicarbonate ions as follows:

$H^{+}+CO_3^{2-}+CO_3^{2-}(\text{marine organisms})<=>2HCO_3^{-}$

A prediction shows that if the acidity of sea water increases at the same rate as present, then at the end of this century, a Pteropods (a very common creature of ocean) will come to an end within 45 days. The following photograph (Photo 1) represents the phase of a Pteropods with time at similar concentration of to that predicted at the end of the century.

Photo 1 *Photo Courtesy: National Geographic*

Encounter of this situation to Pteropods not only affects their lives but also the whole marine taxonomy because Pteropods is in the lower part in the lower part of the food chain. It has a great impact on socio-economic system because a large community of people depend economically on the fisheries. So it is a potential food security issue.

This ocean acidification also causes an increase in carbon fixation rates in some photosynthetic organisms (both calcifying and noncalcifying). Chronic exposure to increased CO_2 may have complex effects on the growth and reproductive success of calcareous planktons.[3] The potential for marine organisms to adapt to increasing CO_2 and broader implications for ocean ecosystems are not well known. So these would be higher priorities for future research.

Scientific awareness of ocean acidification is relatively recent, and researchers are just beginning to study its effects on marine ecosystems. But all signs indicate mass awareness is the most important necessity here. Unless humans are able to control and eventually eliminate our fossil fuel emissions, ocean organisms will find themselves under increasing pressure to adapt to their habitat's changing chemistry.

References:

1. "Volcanic carbon dioxide vents show ecosystem effects of ocean acidification"- Nature Lett. 2008, 454, 96-99.
2. "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms"- Nature 2005, 437, 681-686.
3. "Coral reefs under rapid climate change and ocean acidification"- Science 2007, 318, 1737-1742.

THESIS REPORT

PhD Programme

Ph.D. Degree Awardee:

1. Title: Black Holes and the positive cosmological constants by Sourav Bhattacharya from Jadavpur University on 28.01.2013. Supervisor: Amitabha Lahiri.
2. Title: Electronic Structure of Complex Crystalline Solids by Soumyajit Sarkar from University of Calcutta on 01.03.2013. Supervisor: Tanusri Saha Dasgupta.
3. Title: Monte Carlo Simulations of the Advective Inflow and Outflow Around A Black Hole by Himadri Ghosh from Jadavpur University on 12.03.2013. Supervisor: Sandip K. Chakrabarti.

Renormalization Group as a Probe for Dynamical Systems

Amartya Sarkar

Renormalization group (RG) method for dynamical systems was developed by Goldenfeld et al in the mid-90s. Since its advent the method has been successfully applied in wide range of fields, such as | in systematically deriving reduced dynamics, in deriving amplitude equations for pattern formation problems and in general to deduce asymptotic behaviour of various ODEs and PDEs. We apply the RG method for studying the asymptotice dynamics of various oscillators. Usually there are two kind of oscillatory solutions possible in planar systems - limit cycles and centres. Although these two types of solutions are fundamentally different there is no straightforward analytic method to differentiate between the two. We have developed an approach based on the RG method which can differentiate between selfsustained (limit cycles) oscillatory solutions and neutrally stable (centre) solutions. Further this very approach can resolve the centre-focus problem as well. The centre-focus problem has basically to distinguish between centre type fixed point (family of periodic orbits around a fixed point) and a focus (spiralling trajectories onto or out of a fixed point). Till date a satisfactory resolution of both the centre-focus problem and the problem of deducing whether a given system can have limit cycles

and if so how many, are lacking.

Our method provides a practical way to address these two issues perturbatively in a wide range of problems. We have also developed a method to do perturbative RG for systems where a linear unperturbed state is lacking. Taking ideas from equivalent lineariztion and RG we have studied the dynamics of the Ricatti oscillator and found some very interesting transitive properties for the oscillator. Further investigations into the system has led us to identify a class of systems which share dynamical properties with the Ricatti oscillator. We have also studied isochronicity properties using RG of a related system. In fact, we have shown that RG can be used successfully to and conditions of isochronicity. Finally, we have also studied behaviour of various oscillators near resonance using RG approach.

Understanding Complex Ordering in Transition Metal Oxides

Abhinav Kumar

In this thesis we have studied various complex ordering that take place in transition metal oxides using a combination of ab-initio calculations as well as a mapping onto model Hamiltonians wherever possible. A substantial portion of this thesis is devoted to the study of ferromagnetic insulators and the microscopic considerations that results in ferromagnetism in an insulating state.

Ferromagetic insulators are rare. In most transition metal oxides, ferromagnetism is usually accompanied by metallicity. $K_2Cr_8O_{16}$ is one such example of a material which exhibits ferromagnetism even in its insulating phase with a metal to insulator transition taking place at a temperature of 95 K. We have proposed charge ordering [1] as one route to explain the ferromagnetic insulating phase. K in the compound behaves like a perfect donor. We expected the doped electrons to occupy all Cr sites equally as there was nothing in the structure that distinguished between them. However, we found that few Cr sites were preferred over others, resulting in the existence of Cr^{3+} and Cr^{4+} sites in the ratio 1:3. The charge ordering we found was governed by a polaronic distortion and electron-electron interactions aided in stabilizing the insulating state. This has recently been confirmed by experiments [2]. We have also captured various aspects of this charge ordering in a microscopic model which uses Cr-d and O-p as its basis [3] as well as constructed a basic model to understand the ferromagnetism [4].

I have also worked on the analogous compound $Rb_2Cr_8O_{16}$ which has the same structure but the ferromagnetic transition temperature is 100 K higher than that of $K_2Cr_8O_{16}$. We have analyzed the electronic and magnetic structure of this compound to understand the origin of the higher ferromagnetic transition temperature using ab-initio calculations. We have also examined the phase diagram within a multiband Hubbard model [5] and we find that a small change in the charge transfer energy is responsible for the difference.

VO_2 is a well known example of a system which has been studied for its metal-insulator transition. While the early work focused on the insulating monoclinic phase, recent studies have found interesting phase transitions in the rutile phase also. In this thesis we have studied Cr doping in the rutile phase of VO_2 which is found to be an insulating ferromagnet. An isovalent substitution of V by Cr would result in Cr adopting the 4+ valence state. However, we find a polaronic distortion taking place resulting in the formation of Cr^{3+} and V^{5+} motifs, with the other vanadiums remaining in the V^{4+} state. This leads to the insulating ground state which is also ferromagnetic[6].

As a part of this thesis we have also examined a set of design principles to generate a class of ferromagnetic insulators. According to a rule originally postulated by Goodenough for perovskite oxides, two different transition metal atoms arranged in a rock salt structure one of which has half filled e_g levels and another with empty e_g levels will be a ferromagnetic insulator. This principle in addition to the introduction of Bi at the A-site of the perovskite was used to generate ferroelectric as well as ferromagnetic Bi_2NiMnO_6. Considering this compound, we first examined whether this compound was a ferromagnetic insulator. Interestingly we found that calculations using GGA for the exchange-correlation functional within density functional theory did not find any magnetic ordering. One had to go beyond GGA level calculations which we did by using an orbital dependent potential in the framework of GGA+U calculations. This was able to explain the ferromagnetic state. The origin of the stabilization of the magnetic state of ferromagnetism is understood in terms of microscopic considerations within a multiband Hubbard model. Having described the ground state magnetic structure we next examined whether the material was ferroelectric. Experimentally this was found to be ferroelectric as it showed an anomaly in the dielectric constant as a function of temperature. Our calculations reveal that this compound is not ferroelectric. Thus the introduction of Bi at the A-site is not sufficient as a design principle [7] in giving a ferroelectric compound.

We have examined the microscopic considerations that result in ferroelectricity in the well-known example of $BaTiO_3$ [8]. The traditional viewpoint has emphasised the role of long-range coulomb interactions in stabilizing ferroelectricity. In this thesis, we show that this viewpoint is not valid.

References:

(1) Charge ordering induced ferromagnetic insulator: $K_2Cr_8O_{16}$: P. Mahadevan, Abhinav Kumar, D. Choudhury and D. D. Sarma: Phys. Rev. Lett. 104, 256401 (2010).

(2) Strong correlations and a weak-coupling gap across ferromagnetic-metal to ferromagnetic-insulator transition in $K_2Cr_8O_{16}$: P. A. Bhobe, A. Chainani, R. Eguchi, M. Matsunami, Abhinav Kumar, P.Mahadevan,D. D. Sarma et. al. (Under preparation) .

(3) Microscopic model for charge ordering in $K_2Cr_8O_{16}$: Abhinav Kumar, A. K. Nandy and P. Mahadevan. (Under preparation).

(4) Magnetism in $K_2Cr_8O_{16}$: A. K. Nandy, Abhinav Kumar and P. Mahadevan and D.D. Sarma (Under preparation).

(5) Origin of higher Curie temperature in $Rb_2Cr_8O_{16}$: Abhinav Kumar and P. Mahadevan (Under preparation).

(6) Origin of ferromagnetic insulating state in Cr doped VO_2 : Abhinav Kumar and P. Mahadevan. (Under preparation).

(7) Is Bi_2NiMnO_6 a multiferroic ? : Abhinav Kumar and P. Mahadevan (Under preparation).

(8) A model for ferroelectricity in BaTiO3 : Abhinav Kumar, H. K. Chandra and P. Mahadevan (Under preparation).

A Study of Quantum Correlations from Different Perspectives

Ashutosh Rai

My thesis covers different aspects of nonlocal feature observed in quantum correlations. Bell's theorem decisively proved that non-locality is fundamental to quantum mechanics and cannot be ascribed to any deeper local-realistic theory. Entangled states act as resource for generating nonlocal quantum correlations though the converse is not always true. Inspired by Werner's local-realistic model for certain entangled states, we provide the set of POVM measurements (possibly optimal) for which the singlet state statistics can be generated from pre-shared local resources (local hidden variables). Next, we study the Leggett's nonlocal-realistic model for entangled states which tries to assign sharp properties to constituent subsystems. Leggett's model leads to testable inequalities which are violated by quantum mechanics. However, success of Leggett's model in reproducing the correlations observed in standard Bell-CHSH tests (with co-planer observables) motivated new experiments for testing this model vis-a-vis quantum mechanics. We derive two new forms of Leggett-type inequalities which, unlike the previous derived forms, put no geometrical constraints on the relevant measurement settings. These forms may be useful for future tests of Leggett's model. Next, we discuss a physical situation where the no-signaling condition is applied to derive a constrained relation within quantum mechanics. The non-locality that can be extracted from quantum correlations respects the no-signaling condition; however, there are many other supra-quantum correlations which obey the no-signaling principle. Then, a natural question is to look for physical principles that can help to distinguish between quantum and supra-quantum correlations. The principle of non violation of information causality is one such proposal. We apply this principle to study Hardy-type nonlocal correlations for two two-level systems. Finally, we point to some interesting questions to be addressed in future works.

References:

[1] R. F. Werner, Physical Review A 40, 4277 (1989).

[2] A. Rai, MD. R. Gazi, M. Banik, S. Das and S. Kunkri, J. Phys. A: Math. Theor. 45 (2012) 475302 (8pp).

[3] A. J. Leggett, Found. Phys. 33, 1469 (2003).

[4] A. Rai, D. Home, and A. S. Majumdar, Phys. Rev A 84, 052115 (2011).

[5] D. Home, A. Rai and A. S. Majumdar, Physics Letters A 377 (2013) 540–545.

[6] M. Pawlowski, T. Paterek, D. Kaszlikowski, V. Scarani, A. Winter, and M. Zukowski, Nature 461, 1101 (2009).

[7] L. Hardy, Phys. Rev. Lett. 68, 2981 (1992).

[8] L. Hardy, Phys. Rev. Lett. 71, 1665 (1993).

[9] A. Ahanj, S. Kunkri, A. Rai, R. Rahaman, and P. S. Joag, Phys Rev A 81, 032103 (2010).

[10] MD. R. Gazi, A. Rai, S. Kunkri and R. Rahaman, J. Phys. A: Math. Theor. 43 (2010) 452001.

Vibrational Properties and Phase Stability of Disordered Alloy

Rajib Kumar Chouhan

The theoretical study of vibrational properties for disordered systems is always a difficult task due to presence of disordered off-diagonal terms in the dynamical matrix. The presence of off-diagonal disorder in force constants cannot be dealt within a single site mean-field approximation. The problem becomes even more complicated if one introduces a short range ordering effect in the system. Very few detailed first-principles study has been done for phonons in disordered systems. We established a new way to deal with configurational disorder and the dynamical matrices extraction techniques. The methodology is based on Augmented space recursion(ASR) and special quasi-random structure(SQS). This method was successfully applied by us on different kind alloys (like Fe-Cr, Re-W, Ni-Pt etc) having fcc and bcc kind of symmetry. We have presented a new technique of extracting the disordered dynamical matrices based on SQS. Since in SQS the distribution of distict local environment is maintained, the force constant matrix based on this calculation gives us a real picture of lattice. We have shown the distribution of forces and nearest neighbour environment effect for NiPt (fcc symmetry) and Ta-W (bcc symmetry) with which the phononic properties matches well with the experement.

For Fe-Cr alloy we did a thermal conductivity and diffusivity study using Kubo-Greenwood-type formula combined with a generalized Feynman diagrammatic technique. Here both conductivity and diffusivity shows the dip without any use of approximation at very small energies which was reported by Feldman et. al. For x=0.25 % Cr $\kappa(T)$ = 22.8W/mK which matches well with the experimental value [κ(expt) ~ 22 W/mK].

Another work we studied the magnetic phase of CuMn alloy. The detailed experimental work of Gibbs et al.[13] established the magnetic phase diagram of CuMn clearly: at concentration -> 70% Mn the alloys exhibited anti-ferromagnetism, at <-70% Mn the alloy has lack of magnetic long-range ordering, while at low Mn concentration alloy shows Spin Glass behavior.

Using the generalized perturbation approach which expands the total band energy in terms of composition fluctuations, obtain the pair energies and locate the temperatures where the perturbation destabilizes the system. Identifying this with the phase boundaries we showed that these are in fair quantitative agreement with experiment.

References:

(1) A. Mookerjee, J. Phys. C , Solid State Physics 6, L205 (1973).

(2) A. Zunger, S. H. Wei, L. G. Ferreira, and J. E. Bernard, Phys. Rev. Lett. 65, 353 (1990).

(3) Rajiv Kumar Chouhan, Aftab Alam, Subhradip Ghosh and Abhijit Mookerjee, J. Phys. Condensed Matter 24 (2012) 375401.

(4) Aftab Alam, Rajiv Kumar Chouhan, and Abhijit Mookerjee, Phys. Rev. B 83, 054201 (2011).

(5) Aftab Alam, Rajiv K. Chouhan and Abhijit Mookerjee, Phys. Rev. B 84, 224309 (2011).

(6) Rajiv Kumar Chouhan, Aftab Alam and Abhijit Mookerjee, Conference Proceedings of the 31st International Thermal Conductivity Conference and the 19th International Thermal Expansion Symposium 2011.

(7) Rajiv Kumar Chouhan, Abhijit Mookerjee, Journal of Magnetism and Magnetic Materials 323 (2011) 868-873.

EVENTS

FM 2013

The International Conference on Functional Metalorganics (FM 2013) was organized during 8-10 February, 2013, at the Vedic Village. Convened by Tanusri Saha-Dagupta and Peter Oppeneer (Uppsala University, Sweden). This followed up a conference that was held in Uppsala, Sweden during May 30 - June 01, 2011. The present conference focused on a recent upsurge in scientific enthusiasm concerning metalorganic materials and other hybrid materials involving organic molecules. A wide range of topics starting from first-principle theoretical studies (yielding microscopic understanding) of these materials to more application oriented activities like molecular electronics devices and functionalities of metalorganics were covered. The event was made successful by a large number of participants both from India and abroad, who attended it. The list of speakers include N. Ballav (Pune, India), S. Bluegel (Julich, Germany), V. Chandrashekar (Hyderabad, India), R. Clérac (Bordeaux, France), A. Ghosh (Bangalore, India), T. A. Jung (PSI, Switzerland), L. Kronik (Weizmann, Israel), W. Kuch (Berlin, Germany), T. Maji (Bangalore, India), S. Mandal (Kolkata, India), J.S. Miller (Utah, USA), J. Moodera (MIT, USA), R. Murugavel (Bombay, India), K. Raman (Bangalore, India), S. Ramasesha (Bangalore, India), A. K. Raychaudhuri (Kolkata, India), H. Wende (Duisburg, Germany), J. Yakhmi (Mumbai, India) and a special lecture was delivered by C.N.R. Rao (Bangalore, India).

Kolkata-Moscow Symposium

This International Symposium, held during 22-23 January, 2013, was organised by the Centre. The symposium aimed to provide a platform for a number of researchers from both Kolkata and Moscow to discuss about the ongoing research on material science. There were 15 lectures, focussed on various topics of research in material science. The symposium was attended by participants and speakers from abroad as well as within India. The speaker list included Y. M. Mukovskii (NRTU, Moscow), A. Vasilev (MSU, Moscow), as representatives from Moscow. The list also included A. Barman (SNBNCBS), T. Saha Dasgupta (SNBNCBS), D. Bhattacharya (CGCRI), S. Majumdar (IACS), P. Mandal (SINP), B. N. Dev (IACS), S. K. Pal (SNBNCBS), A. Singha (Bose Institute), as the eminent researchers from various institute in Kolkata. Apart from the academic talks, there was very encouraging welcome address by Prof. A. K. Raychaudhuri (Director, SNBNCBS). The symposium was fruitful in the scientific point of view.

119th Birthday Celebration of Prof. S. N. Bose

The Centre celebrated Satyendra Nath Bose's 119th birthday on 1st January 2013. The bust of Satyendra Nath Bose was garlanded by the Director and other senior faculties and sweets were distributed.

64th Republic Day Celebration

On 26th January 2013, Prof. Arup Kumar Raychaudhury, Director of the Centre hoisted the national flag to celebrate the 64th Republic Day. National anthem was sung by students and staff members present and parade was performed by the Centre's security personnel. On this occasion small replicas of national flag were distributed amongst the members present in the gathering and tea and snacks were served in the canteen.

Superannuation of Mr. S. K. Deb

Mr. Sunish Kumar Deb, Deputy Registrar (Academic) superannuated on 28th February 2013. During his tenure in the Centre spanning for approximately 25 years, he gave guidance, encouragement and actively participated in framing policy decisions. Mr. Deb has exhibited utmost dedication and sincerity in handling the administration and the academic section.

Report on Institutional Digital Repository

Saumen Adhikari

As the journal publishers are doing monopoly business and every year they have been increasing journal price, therefore it is the global requirement to develop Institutional open access repository. The Digital Institutional repository has been developed in our Centre with a search engine. To avoid copyright problem, the preprint version of the published papers of SNBNCBS are stored. The repository can be searched by title, author, subject key words, publisher, reference etc. So far 2009, 2010, 2011 and 2012(partial) papers have been uploaded. Institutional repository link is available in the Library page of the Centre's website. Other back years' papers shall be uploaded gradually. Ultimate goal is to develop a repository where all the publications of S.N. Bose Centre will be stored and it should be accessible by the common public through internet.

Book Exhibition

Saumen Adhikari

The Library of the Centre organized a Book Exhibition during 13th to 14th February, 2013 from 10 am to 5pm in the Students'Common

Room. The Exhibition was inaugurated by the honourable Director of the Centre, Professor Arup Kumar Raychaudhuri. Seven book suppliers took part in the exhibition with a collection of books on different research areas along with fiction, literature, reference and other books of general interest. The Faculty members, staffs and students visited the Book Exhibition as per their convenient time and selected more than five hundred books for the enrichment of library collection. The Book Exhibition ended with a grand success.

EVLP REPORT

Special Lectures

- Girijesh Kumar Mehta, Honorary Eminent Scientist, IUAC, New Delhi, *"Innovative R & D with Nuclear Accelerators"*, 22.02.13

Institute Colloquium /Seminar

- Subir K. Das, Assistant Professor, Theoretical Sciences, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, *"Accurate Simulation and Analysis of Phase Transition Kinetics"*, 24.01.13
- Subrata Ghosh,National Institute for Materials Science, Japan, *"Design and synthesis of a nano-submarine: from brain-like computing to the invention of non-chemical drug for unprecedented medical science"*, 11.02.13
- YoshiChika Otani, Professor -Institute for Solid State Physics, University of Tokyo and Quantum Nano-scale Magnetics Laboratory FRS RIKEN, *"Giant Spin Hall Effect induced in copper by doping small amount of impurities with large SO coupling"*, 13.02.13

Associates & Short Term Visitors

- Nilotpal Ghosh, Associate Professor, Vellore Institute of Technology, Tamilnadu visited during 13.12.12 – 03.01.13
- Molly De Raychaudhury, Lecturer, Department of Physics, West Bengal State University, Barasat, Kolkata, 21.01.13 – 02.02.13

Open Talk by Associates & Short Term Visitors

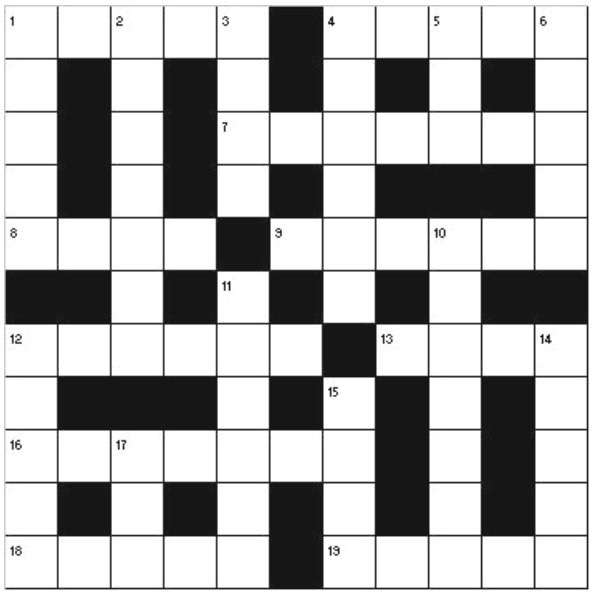
- Chorng Haur Sow, Department of Physics, Faculty of Science, National University of Singapore, *"A Focused Laser Beam: Useful Tool for Nanoscience Research"*, 28.02.13

PDRA joined the Centre during the period

1. Dr. Sudhakar Upadhyay, PDRA-I, Mentor - Dr. Rabin Banerjee, Department of Theoretical Sciences, Date of Joining - 31.03.13
2. Dr. Tilak Das, PDRA-II, Mentor – Prof. Tanusri Saha Dasgupta, Department of Condensed Matter Physics and Material Sciences, Date of Joining – 19.04.2013

CROSSWORD

Mahua Mitra & Mitali Bose

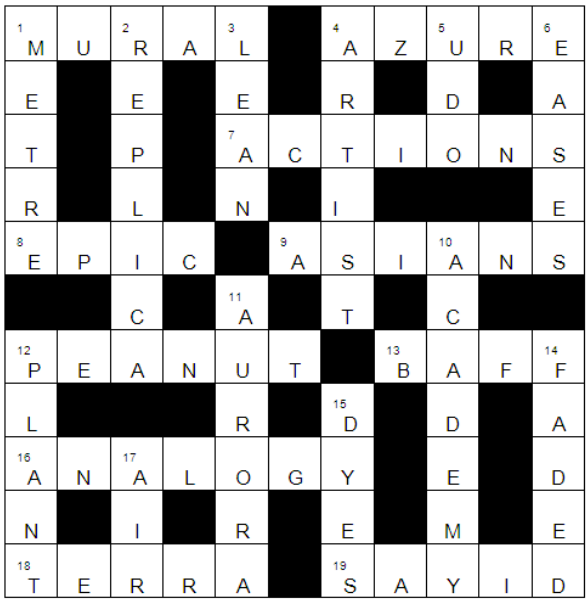


Across

1. Enchantment
4. Desirous
7. A Jewish scholar
8. Not under the control or in the power of another
9. A young swan
12. Method
13. Sour
16. Assembly
18. A carol is a festive song
19. Playing cards

Down

1. Pattern
2. Contrivance
3. Frizzle
4. Corrode
5. A broad sash worn around the the waist of a Japanese kimono
6. Case
10. Atomic
11. Ethereal
12. Blackbuck
14. Cipher
15. One
17. Seam



Solution of Vol.5, Issue 2 Crossword

PHOTOGRAPHY

Snehasis Daschakraborty

"Paradise regained"

Satyendra Nath Bose National Centre for Basic Sciences
Block-JD, Sector-III, Salt Lake
Kolkata - 700098