SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

Newsletter

Vol. 12, Issue 2 (2022)

Editorial

We are very happy to publish the second issue of Newsletter 2022. Thanks to the great efforts made by the Newsletter support staff and members. We also sincerely thank all the contributors, who have promptly sent their interesting articles (scientific stories) and enriched the Newsletter immensely. The issue covers the academic as well as the non-academic events in the first half of the present year (January - June, 2022). We hope the readers would enjoy it.

We wish you all to keep healthy, stay safe during the pandemic time and all the best for your future endeavors in your respective domains of work.

A view of Bose Archive at S N Bose National Centre for Basic Sciences, Kolkata.

Photo credit: Amit Datta (The Telegraph *online*).

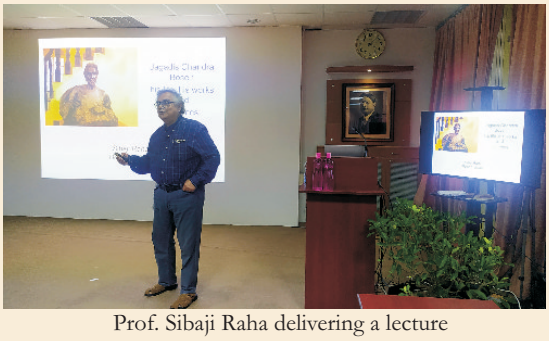
News and Events (Academic)

Colloquium / Named Lectures

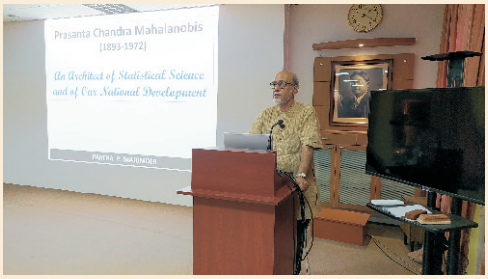
Series of talks on "Illustrious Indian Scientists in Pre-independence Era"

1. Prof. Srubabati Goswami, Senior Professor, Physical Research Laboratory, Ahmedabad, delivered a lecure on the topic "*Remembering a star from another sky*" on 21.01.2022.
2. Prof. Kankan Bhattacharyya, Senior Professor, Department of Physical Chemistry, Indian Institute of Science Education and Research, Bhopal, delivered a lecture on "*C. V. Raman and National Science Day*" on 25.02.2022.
3. Prof. Sibaji Raha, Ramanujan Fellow, Bose Institute, delivered a lecture on "*Jagadis Chandra Bose: His Life, His Times and His Legacy*" on 01.04.2022.
4. Prof. Partha P. Majumdar, National Science Chair (Scientific Excellence), Government of India, Distinguished Professor and Founder, National Institute of Biomedical Genomics, Kalyani, Emeritus Professor, Indian Statistical Institute, Kolkata, Honorary Professor, Indian Institute of Science Education & Research, Mohali, President, Indian Academy of Sciences, delivered a lecture on "*Prasanta Chandra Mahalanobis : An Architect of Statistical Science and Our National Development*" on 06.05.2022.
5. Prof. Bikash C. Sinha, INSA Senior Scientist and ex- Director, Saha Institute of Nuclear Physics and Variable Energy Cyclotron Centre, delivered a lecture on "*Homi J. Bhaba, Colossus, a timeless icon*" on 27.05.2022.

Prof. Kankan Bhattacharyya delivering a lecture



Prof. Sibaji Raha delivering a lecture



Prof. Partha P. Majumdar addressing the audience at SNBNCBS

Bose Colloquium

1. Prof. Bernd Büchner, Director of the Institute for Solid State Research, IFW Dresden and Professor for Experimental Physics at the Dresden University of Technology, delivered a lecture on *"Orbitals, Nematics, and Strain Tuning in Fe based High Tc Superconductors"* on 28.01.2022.
2. Prof. Uwe Bovensiepen, Faculty of Physics, University of Duisburg-Essen, Germany, delivered a lecture on *"Microscopic dynamics of propagating and localized excitations across interfaces analyzed by femtosecondsolid state spectroscopy"* on 11.03.2022.
3. Prof. Manoj Harbola, Professor, Department of Physics, Indian Institute of Technology, Kanpur, and Governing Body Member, delivered a lecture on *"Bubbles, Soda, Whiskey and Wine"* on 31.03.2022.

Prof. Manoj Harbola during his lecture

Institute Colloquium

1. Prof. Gautam Basu, Senior Professor, Dept. of Biophysics, Bose Institute, delivered a lecture on *"Minor conformation-triggered intermolecular interactions"* on 05.04.2022.
2. Prof. Indra Dasgupta, Senior Professor, School of Physical Sciences, IACS, delivered a lecture on *"The Challenges and Prospects in Modeling StronglyCorrelated Systems"* on 06.04.2022.

VASP Webinar Series on "Quantum Materials & Devices"

1. Professor Kamran Behnia, ESPCI-Paris Science et Lettres University, delivered a lecture on *"On the origin and amplitude of the T-square resistivity in Fermi liquids" on* 11.05.2022
2. Professor Hidenori Takagi, Max-Planck-Institute for Solid State Research, Germany, Department of Physics, University of Tokyo, Japan, delivered a lecture on the topic *"Towards realization of Kitaev Quantum Spin Liquid" on* 08.06.2022.

VASP Webinar Series on "Statistical Mechanics"

1. Professor Yael Roichman, School of Chemistry, Tel Aviv University, delivered a lecture on the topic *"The equation of state of randomly driven colloids" on* 07.06.2022.

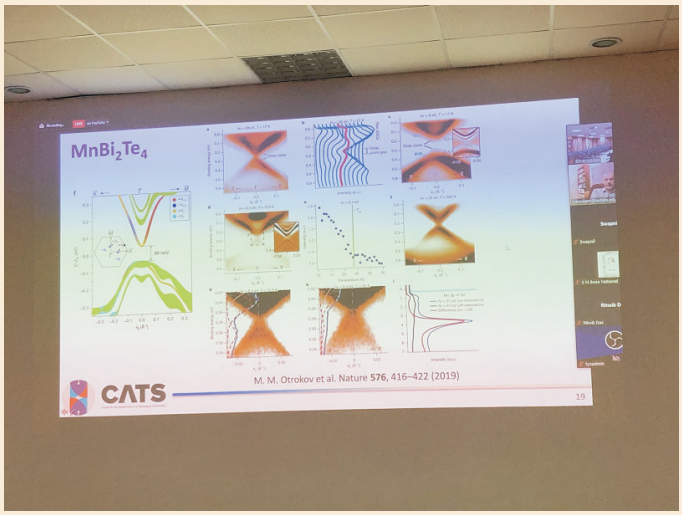
Other Seminars

1. Dr. Surjeet Singh, Associate Professor, IISER Pune spoke on the topic *"Impurities as a probe for determining the superconducting order parameter symmetry in iron-based superconductors"* on 05.01.2022.
2. Prof. Suddhasattwa Brahma, Higgs Fellow, School of Physics and Astronomy, University of Edinburgh, spoke on the topic *"From abstract matrix models to observations in the sky"* on 06.01.2022.
3. Dr. Arghajit Jana, Post Doctoral Researcher, Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan, spoke on the topic *"Exploring the Changing-Look AGNs"* on 07.01.2022.
4. Prof. Ruchi Anand, Professor, Department of Chemistry, IIT Bombay, spoke on the topic *"Allostery in Biological Systems"* on11.01.2022.
5. Prof. Anjan Kumar Gupta, Professor, Physics Department, Indian Institute of Technology, Kanpur spoke on the topic *"Optimization of Nb μ-SQUIDs for single particle nano-magnetism"* on 12.01.2022.
6. Dr. Jyotishman Dasgupta, Associate Professor, Department of Chemical Sciences, TIFR, spoke on the topic *"Transient Raman Spectroscopy for Probing Charge Transfer States"* on 18.01.2022.
7. Dr. Ajay Sharma, Junior Research Fellow, SNBNCBS, spoke on the topic *"Detection of Gamma-rays in Space and on Ground"* on 20.01.2022.
8. Prof. Ranjan Gupta, Professor, IUCAA, Pune, spoke on the topic *"Laboratory Study of Regolith Analogues - relevance to recent Asteroid regolith sample return missions"* on 21.02.2022.
9. Dr. Hirak Chakraborty, UGC-Assistant Professor, School of Chemistry, Sambalpur University, Jyoti Vihar, Odisha, spoke on the topic *"Lipid Composition in Membrane Fusion:A Key Player in Modulating Lipid-peptide Interaction and Beyond"* on 22.02.2022.
10. Prof. Chaitali Mukhopadhyay, Professor, Department of Chemistry, University of Calcutta, spoke on the topic *"Ganglioside GM1 in Model Membranes : in vitro and in silico studies"* on 01.03.2022.
11. Dr. Yogesh Singh, Associate Professor and Head, Department of Physical Sciences, Indian Institute of Science Education and Research, spoke on the topic *"Field Induced Quantum Critical Point in Yb2Fe3Si5"* on 02.03.2022.
12. Dr. Lokesh Dewangan, Assistant Professor, Astronomy & Astrophysics Division, Physical Research Laboratory (PRL), Ahmedabad, India, spoke on the topic *"Probing the physical processes involved in forming massive stars"* on 04.03.2022.

13. Dr. Kamaraju Natarajan, Associate Professor, Department of Physical Sciences, IISER, Kolkata, spoke on the topic *"Condensed matter systems probed through femtosecond spectroscopy and THz spectroscopy"* on 23.03.2022.
14. Dr. Soumya De, Assistant Professor, School of Bioscience, IIT Kharagpur, spoke on the topic *"Insights into structure and dynamics of folded and disordered proteins by NMR spectroscopy"* on 19.04.2022.
15. Prof. Padmakar Singh Parihar, Professor, Indian Institute of Astrophysics, Bengaluru spoke on the topic *"Tools and Techniques for Characterizing a New Astronomical Observatory"* on 26.04.2022.
16. Prof. Ranjit Biswas, Senior Professor, SNBNCBS, spoke on the topic *"Deep Eutectic Solvents: New Excitements and Our Understanding"* on 26.04.2022.
17. Dr. Amit Kumar Agarwal, Associate Professor, Department of Physics, Indian Institute of Technology, Kanpur, spoke on the topic *"Topological phase transitions, Nonlinear transport, and plasmons in Moire superlattices"* on 04.05.2022.
18. Dr. Tanmoy Paul, Assistant Professor, Dept. of Physics, Chandannagar College, spoke on the topic *"Inflationary magnetogenesis with reheating phase from higher curvature coupling"* on 19.05.2022.
19. Dr. Asmita Kumari, Post Doctoral Fellow, Harish Chandra Research Institute, Allahabad, spoke on the topic *"Luders bounds of Leggett-Garg inequalities, quantum channel, PT symmetric evolutionand arrow-of-time"* on 24.05.2022.
20. Dr. Gourab Ghoshal, Associate Professor, Physics and Astronomy, Stephen Biggar '92 and Elizabeth Asaro '92 Fellow in Data Science, University of Rochester, spoke on the topic *"A Physics Approach to Study Urban Systems"* on 20.06.2022.
21. Dr. Shraddha Mishra, Assistant Professor, Indian Institute of Technology, BHU, spoke on the topic *"Role of intrinsic and extrinsic inhomogeneities in active systems"* on 21.06.2022.
22. Dr. Subhankar Bedanta, Associate Professor, School of physics, NISER, Bhubaneswar, spoke on the topic *"Spin to charge conversion with heavy metals, topological insulators and antiferromagnets"* on 22.06.2022.
23. Dr. Sabyasachi Roy Chowdhury, Postdoctoral Researcher, University of South Dakota, Vermillion, South Dakota, USA, spoke on the topic *"Investigating Molecular Geometries of Transition Metal Complexes by Multireference Methods"* on 23.06.2022.
24. Dr. Rupak Mukherjee, Associate Research Physicist, Princeton Plasma Physics Laboratory, Princeton University, USA, spoke on the topic *"How computational physics is shaping nuclear fusion reactors"* on 27.06.2022.
25. Dr. Subhash Bose, Postdoctoral Fellow, OSU Center for Cosmology and Astro-Particle Physics (CCAPP), Ohio State Universirty, spoke on the topic *"Finding extremes and unusuals from all-sky Supernovae surveys"* on 29.06.2022
26. Dr. Abhishek Majhi, DST INSPIRE Faculty, ISI, Kolkata, spoke on the topic *"Resolving the singularity by looking at the dot and demonstrating the undecidability of the continuum hypothesis"* on 30.06.2022.

Special Lectures / Conferences

1. One Day Meeting for Research Collaboration between S. N. Bose National Centre for Basic Sciences and Indian Institute of Technology Bombay on 06.06.2022.
2. Prof. Arun Paramekanti, Professor of Physics, University of Toronto, Toronto, Canada, delivered two lectures, one on *"Electron topology: SSH model and Kitaev chain"* on 14.04.2022 and other on *"Berry phase, polarization, and Chern number"* on 15.06.2022
3. Conference on *Future trends in gravitational physics* held during 08.02.2022 10.02.2022 at the Centre. Conveners: Dr. Sunandan Gangopadhyay and Prof.Amitabha Lahiri of SNBNCBS.
4. *International Conference on the Topology in Condensed Matter Systems* was held during 21.02.2022 23.02.2022 at the Centre. Conveners: Dr. Manoranjan Kumar, Dr. Nitesh Kumar, Prof. Prabhat Mandal and Dr. Thirupathaiah Setti of SNBNCBS.



International Conference on the Topology in Condensed Matter Systems

Academic Events

Open Day 2022

The Centre observed Open Day 2022 on 4th January, 2022 to commemorate the 129th Birth Anniversary of Satyendra Nath Bose. Prof. Jayanta Kumar Bhattacharjee, Distinguished Visiting Professor, IACS delivered popular science talk. Also, visit to the scientific laboratories and S N Bose archive, plant and star watching programmes were also organized. General public as well as scientific researcher actively participated in the event.

National Science Day 2022

The Centre observed National Science Day on 28th February, 2022 based on the theme 'Integrated approach in S&T for sustainable future'. Prof. Gautam I. Menon, Ashoka University was the keynote speaker on this occasion. Research scholars delivered talks on the department-wise research activities of the Centre. Staff and students actively participated in the debate competition on the topic 'Science in pre and post-independence era: are we going uphill or downhill'.

International Women's Day 2022

The Centre observed International Women's Day 2022 on 8th March, 2022. Women postdoctoral fellows working at the Centre shared their experience as a women scientist.

Bose Fest 2022

The Centre celebrated Bose Fest 2022 The annual celebration of science during 27-29 April, 2022. Nominated research scholars and postdoctoral fellows presented their oral and poster presentations. Photo Fest and in-house cultural programme were also organized as part of the celebration.

National Technology Day 2022

The Centre observed National Technology Day on 11th May 2022. Dr. B. N. Jagatap, Professor, Department of Physics, Indian Institute of Technology Bombay, Mumbai and the Chairman, Governing Body, SNBNCBS delivered the welcome address. Prof. Samit K Ray, Adjunct Professor, SNBNCBS briefed on Centre's technological activities. Prof. Indranil Manna, J.C. Bose Fellow and Vice Chancellor, Birla Institute of Technology (BIT) delivered lecture on 'Science-Engineering-Technology Synergy and the Role of INAE'. Prof. Suman Chakraborty, Professor, Mechanical Engineering, Indian Institute of Technology- Kharagpur delivered lecture on 'Flipping with the Flow - Perspectives of Puzzling Fluid Dynamics and Human Health'.

IMPACT-2022: The Alumni Meet

The Centre organized IMPACT-2022, the Alumni Meet on 28th May, 2022 with the aim to renew and reinvigorate the bonding between the past and present researchers. The alumni members shared their academic journey through online and offline mode. There was also a panel discussion for creating new opportunities in learning for future development and self-scrutinize the performance with respect to cutting edge research in academia & industry. The programme was followed by cultural events by the research scholars of the Centre.

Foundation Day

The Centre celebrated its Foundation Day on 13th June. On this occasion, Prof. Umakant D. Rapol, Dept. of Physics, Indian Institute of Science Education and Research, Pune delivered lecture on '*Bose-Einstein Condensation*'.

Summer Research Programme 2022

A total of 56 candidates from different universities/ institutions were selected for the Summer Research Programme under various faculty members of the Centre during May-July 2022. The programme was conducted in both online and offline mode.

Interactive Sessions

Dr. Anuttama Banerjee (Consultant Psychologist) and Ms. Sheena Mishra Ghosh (Consultant Psychologist) conducted interactive sessions to discuss on the mental health condition in the neo normal with the research scholars on 10.02.2022 and 23.05.2022 respectively.

MoU signed by the Centre

1. A MOU has been signed on Science Day, 28th February 2022 between S N Bose National Centre for Basic Sciences (SNBNCBS) and Sidho-Kanho-Birsha University (SBKU). This MOU will benefit the students of rural areas through collaborative efforts in education and research.

2. A Memorandum of Understanding (MoU) has been signed between S. N. Bose National Centre of Basic Sciences (SNBNCBS), Kolkata and IIT Bombay (IITB) on 30.03.2022 to strengthen collaborative research and other academic cooperation.

3. S. N. Bose National Centre for Basic Sciences, Kolkata, India and Leibniz-Institut für Festkörper-und Werkstoffforschung Dresden e.V, Dresden, Germany have signed a MoU, intended for scientific cooperation in the field of Novel Magnetic and Topological Quantum Materials on 5th May 2022.

4. A Memorandum of Understanding (MoU) has been signed between S. N. Bose National Centre of Basic Sciences (SNBNCBS), Kolkata and Presidency University, Kolkata on 24.05.2022 to strengthen collaborative efforts in academic exchange, research training and supervision of students.

Scientific Stories

Computers Predict New Material

Tanusri Saha-Dasgupta

Scientists at the S. N. Bose National Centre for Basic Sciences programme super computers to design path breaking new material.

Humankind's quest for new material is as old as recorded history. The bronze dancing girl of Mohenjodaro, the rust resistant iron pillar in Delhi, stained glass windows in medieval churches, Chinese porcelain, doped semi conductors and of course, the material that defines our age plastics.

Leonardo Da Vinci, the artist whose vision of the future of humankind was expressed through his futuristic designs of flying machines and self propelled carts, had predicted that the future will be the designed material age.

Fabricating the desired material in the laboratory through trial and error process can be expensive and time consuming. But if computers are programmed to predict new material, then experimentalists can take the cue from the computers and validate the predicted material in the laboratory. Time and effort gets narrowed down in the quest for new material. Prof. Tanusri Saha Dasgupta's team at the S. N. Bose National Centre for Basic Sciences is engaged in computationally predicting some of these material.

Nanotechnology has given designed material a whole new meaning and dimension. In laboratories across the world, there is quest for nano material with desirable optical, magnetic, thermo-physical and electrical properties that will make electronic gadgets lighter and faster, that can be put to

biomedical use and that can replace naturally occurring rare material. When nano clusters are formed with atoms of two metals, the atoms in each nano cluster may be randomly arranged, may get neatly organized in a two faced Janus structure or more interestingly, may get organized in a core-shell type of structure, with atoms of one metal forming a shell around the atoms of the other core metal. (Fig 1)

a.

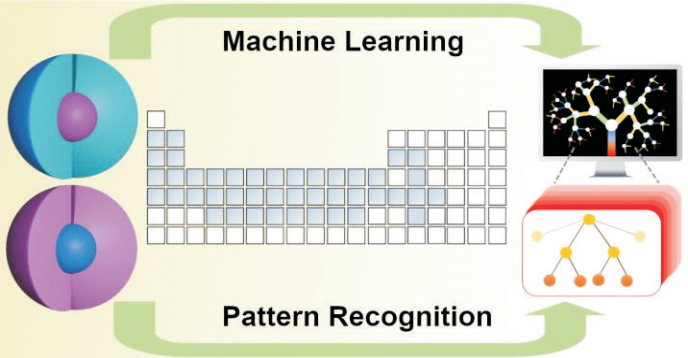


Fig 1a: Machine learning model for core-shell bimetallic nanoclusters.

b.

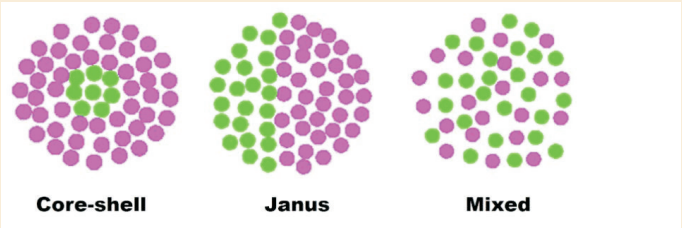


Fig 1b: Binary alloyed nanocluster with core–shell, Janus and mixed structural patterns.

The core-shell nanoclusters have great technological relevance in terms of applications in biomedicine and other areas. But it is important to know under what conditions core-shell structures are formed in the nanocluster alloys and which metal forms the core and which stays on the surface as a shell. A number of factors like cohesive energy difference, atomic radius difference, surface energy difference and electro negativity of the two atoms may play a part in the core, shell preference of the atoms.

The periodic table has 95 metals ranging from alkalis to alkaline earth to transitional metals to post transitional metals and beyond. These 95 metals can potentially form 4465 pairs. It is experimentally impossible to determine the behaviour of 4465 pairs of metals forming nanocluster alloys. But computers can be programmed to predict the behaviour of these pairs and more. The programming is done through a process called 'machine learning'. The machine is taught to recognize patterns by feeding in a number of patterns with well defined attributes. The more the data fed into the computer, more accurate will be the recognition of an unknown data by the computer. And that is where the S. N. Bose Centre scientists faced a stumbling block.

"The primary hindrance to this effort comes from the limited number of experimentally synthesized binary nanoclusters with clear identification of the chemical ordering of constituents and only a few core–shell combinations studied theoretically. Machine Learning cannot be applied with confidence on small data set of sizes less than or around 100", the scientists have written in their paper titled *Understanding the trend in core shell preferences in bimetallic nanoclusters: A machine learning approach*. To circumvent this problem they carried out the DFT (Density Functional Theory) calculations of segregation energy on a variety of possible binary combinations of alkali metals, alkaline earth, basic metals, transition metals and p-block metals to create a large data-set of 903 binary combinations.

The key attributes driving the core–shell morphology were then investigated using the statistical tool of machine learning applied on this large data set. Core-shell structures with lighter metals having lower atomic numbers in the core were classified as Type 1 and those having the heavier metals in the core were classified as Type 2. A number of attributes were built to characterize each data point in the set. The performance of the ML model was tallied with existing experimental data.89.3% of the ML data agreed with the experimental data. Thus the ML model was proved to be reliable.

Having thus established confidence in the ML model, the dominant attributes driving the core-shell pattern were now analysed. Interestingly, it was found that the relative importance of the key factors depends on the subset combinations like alkali metal- alkaline earth, transition metaltransition metal etc. It was also found that if the difference in the cohesive energies between the two types of atoms are very small, the nanoclusters constitute a random mix of both the metals and if the difference in the cohesive energies is very large, the atoms get segregated into a Janus structure.

Thus the attempt to connect ML with nanoscience was successful in understanding the mixing patterns of metal atoms in nanoclusters and formed a basis for the design map of alloys at the nanoscale. This design map will be tested out in the nano laboratories at the Moscow State University and also at the S. N. Bose Centre.

Another domain of study for the S.N Bose team has been the heterogeneous structure formed at the junction of two dissimilar semiconductors. Hetero-junctions of two semi conductors are at the heart of devices like LEDs, solar cells and photovoltaic devices. However, the prediction and designing of the desired type of hetero-structure is a difficult material science problem. The S.N Bose team has established that using machine learning, hetero-structure types can be predicted fairly accurately. The key variable is the band structures of constituent semiconductors. In Type 1 hetero-junction of A and B semiconductors, the electron and hole pairs tend to be in

semiconductor A. In Type 2 hetero-junction, the electrons and holes align themselves in A semiconductor and B semiconductor respectively. This is a desirable hetero-structure for semiconductor gadgets.

The ML model designed by the S. N. Bose team predicted 872 unknown semiconductor hetero-structures of types 2.

The third and perhaps the most significant area of study using machine learning is the search for substitutes of rare earth compound based permanent magnets. 17 rare earth elements of the periodic table like Neodymium, Lanthanum etc are found sparsely on the earth's crust. Also, their supply is monopolized by the countries where their mines happen to be located. Rare earth compounds with permanent magnetic properties are used in loudspeakers and computer hard drives. Neodymium, Terbium and Dysprosium are also used in the vibration unit. Some rare earth material are also used in camera and telescope lenses. Thus our live would come to a standstill without a constant supply of rare earth compounds.

S. N. Bose Centre is in search of cheaper substitutes of naturally occurring rare earth material. By painstakingly creating a database of rare earth compounds and their attributes and then constructing a machine-learning model, they have predicted a list of potential candidates for permanent magnets whose cost will be less than $100 per Kg.

The computational work at the S. N. Bose Centre are presently carried out on the Cray Computer, which the Centre had acquired in 2015 (Fig 2). "National Supercomputing Mission will soon assign a Peta flops supercomputer to our centre", informed Dr. Tanusri Saha Dasgupta, Director of SNBNCBS.

Thus supercomputing is adding a whole new drive to humankind's quest for new material.

Fig 2: CRAY computer at SNBNCBS

Our Future with Magnons

Anjan Barman

Sometime in the future, magnons may replace electrons as carriers of our thoughts and commands. Experiments conducted at the Spintronics and Spin Dynamics Lab of S.N Bose National Centre for Basic Sciences will show the way for magnon based computing system and bring about a paradigm shift in computing and communication devices.

You switch on your phone early in the morning. A handful of electrons respond to the potential and get activated. The screen comes alive and shows the time 6 am.

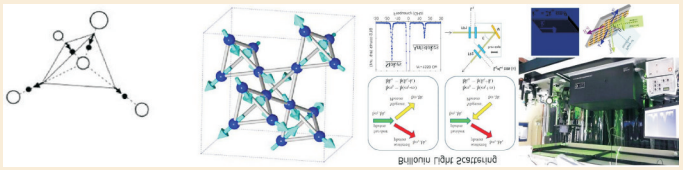
You type "Good morning" on the keyboard of your laptop. With every hit on the keyboard a tiny circuit comes alive inside, activating the electrons sitting dormant in the semiconducting material of the circuit.

Electrons are the lightest known particles, almost two thousand times lighter than the proton and they are the carriers of information in all "electronic" devices. As the electrons drift in the semiconducting device of the CPU, the signal moves almost at the speed of light. The drift of electrons generates heat in the device. The heat has to be fanned out of the CPU.

Are there alternatives to electrons as carriers of information? Scientists at the S. N. Bose Centre say, "Yes. The future belongs to magnons." Magnons are particle avatars of spin waves rippling through a lattice of tiny ferromagnetic particles of nano dimensions. Since magnons are quasi particles, their movement through the material does not generate any heat.

The promise held by magnons have led to magnonics, a new discipline of study that deals with the excitation, propagation, control and detection of magnons or spin waves through periodic magnetic media. Magnonics is a budding research field in nanoscience that addresses the use of spin waves (magnons) to transmit, store, and process information

Research scientists at the Spintronics & Spin Dynamics Lab at the S. N. Bose Centre have recently merged magnonics with "Artificial Spin Ice". Artificial spin ice or ASI are metamaterials made up of coupled nanomagnets arranged on different lattices. In spite of the tag 'ice', all studies are carried out at room temperature. The tag 'ice' comes from the similarity in molecular structure with tetrahedron shaped ice crystals in which two hydrogen atoms are close to the central oxygen atom and two are far. The spin ice material too are made of corner linked tetrahedra. Each vertex of the tetrahedron is a magnetic ion which has a magnetic moment. In their low energy state, they follow a two intwo out arrangement.



Water ice crystal Fragment of spin ice

In this state, the sum of all spins in the vertex is zero. Interestingly, just like water ice, spin ices exhibit residual entropy. This means, in a sample of spin ice, all the tetrahedra do not have a single minimal energy state. If the orientations of the magnetic ions are three-in one-out or three-out one-in, then the tetrahedral unit has a magnetic moment and it behaves like a magnetic monopole. The monopole - antimonopole pairs are linked by what is known as Dirac strings.

Artificial spin ice (ASI) systems replicate the principles of the spin ice systems. According to the scientists, "The successful use of ASI as a functional magnonic crystal will depend upon the efficient reconfigurability of their magnonic microstates and the ensuing spin wave properties." This precisely is the crux of their research.

The study is a collaboration between S. N. Bose Centre and Imperial College, London. While the ASI structures have been fabricated at the Imperial College in the laboratory headed by Dr. William.R Bradford, Prof. Barman's team is studying the behaviour of magnons in these ASI structures.

Using an experimental set up developed in house, the S. N. Bose Centre scientists are studying the samples through BLS or Brillouin light scattering. BLS is an inelastic light scattering phenomenon of light quanta photons from quasiparticles like magnons or phonons. This method helps in understanding spin wave propagation and dispersion under the influence of an external magnetic field. Earlier experiments had mainly used the FMR or ferromagnetic resonance technique, which helped in studying the global or large-scale behaviour of ASI. Hence, the BLS method is a breakaway from the earlier experimental methods. Experimental observations using BLS are consolidated and extrapolated through simulations.

The first round of results have been published in a paper titled "Comparison of spin-wave modes in connected and disconnected ASI nanostructures using Brillouin light scattering spectroscopy". The paper writes, "Key findings are distinct differences between spin wave mode localization with modes well localized in specific array elements for the dipolar coupled disconnected case and a combination of low frequency spatially localized and higher frequency spatially dispersed modes in dipole-exchange mediated connected system." This means that the resonant spin wave modes are distributed differently in the two ASI systems under study.

Thus, the studies show that the ASI systems can potentially give rise to a huge variety of magnetic microstates which can be globally or locally controlled by a magnetic field. This would lead to access to different magnetic textures in the ASI (i.e., effective formation of different magnonic crystals) by subtle change in external magnetic field more like an origami or a kaleidoscope. Therefore, different functions of magnonic circuit components can be performed in the same active element or magnonic crystal only by externally tuning a modest magnetic field, saving huge cost and energy.

These findings will help in broader design and engineering of reconfigurable functional magnonic crystals. In a not too distant future, when we switch on our lighter and faster mobile phones at 6 am, we shall send magnons in motion, rather than electrons.

The equipment at the Spintronics & Spin Dynamics Lab of S. N. Bose Centre have been fabricated in house by Prof. Anjan Barman's team.

Ph. D. Degree Awarded/Submitted

Ph. D. degree awarded

1. Ananda Gopal Maity, Thesis title: Study of Various Quantum Information Theoretic Resources and Their Applications. Supervisors: Archan S Majumdar & Manik Banik.
2. Aniruddha Adhikari, Thesis title: Studies on Therapeutic Potential of Various Nanomaterials and Ethnobotanical Ingredients in Preclinical Disease Model. Supervisor: Samir Kumar Pal.
3. Suraka Bhattacherjee, Thesis title: Study of Generalized Spin and Charge Stiffness Constants of Doped Quantum Anti-Ferromagnets on Low Dimensional Lattices Based on T-J-Like Models. Supervisor: Ranjan Chaudhury.
4. Chandan Samanta, Thesis title: Synthesis, Physical Properties And Applications of Metal Oxide Semiconductor Nanostructures and Thin Films. Supervisor: Barnali Ghosh (Saha).
5. Subhamita Sengupta, Thesis title: Investigation of Temperature and Frequency Dependent Electrical Transport Phenomena at he Interface of Bilayered Ferromagnetic Ferroelectric Thin Films and Related Issues. Supervisor: Arup K Raychaudhuri.
6. Sayan Kumar Pal, Thesis title: On some theories on quantum space-time and matter and their plausible implications. Supervisor: Biswajit Chakraborty.

Ph.D. thesis submitted

1. Bihalan Bhattacharya, Thesis title: Various Aspects of Positive Maps in Quantum Information Theory. Supervisor: Archan S Majumdar.
2. Alik Panja, Thesis title: A Multiwavelength Study of Galactic Star-forming Regions. Supervisor: Soumen Mondal.
3. Dhrimadri Khata, Thesis title: Understanding Physical Properties Of M-dwarfs: Optical and Near-IR Spectroscopic Studies. Supervisors: Soumen Mondal & Ramkrishna Das.
4. Samrat Ghosh, Thesis title: Understanding the Atmosphere of Brown Dwarfs and Low Mass Stars. Supervisor: Soumen Mondal.
5. Saikat Pal, Thesis title: Some Studies on the Effects of Crowding Agents on The Structure, Functionality and Activity of Biomolecules. Supervisor: Rajib Kumar Mitra.
6. Arpan Bera, Thesis title: Spectroscopic Studies on Functional Nanohybrids and Their Potential Biological Applications. Supervisor: Samir Kumar Pal.
7. Partha Pyne, Thesis title: Studies of Some Biophysical Processes Using Ultrafast Spectroscopic Techniques. Supervisor: Rajib Kumar Mitra.
8. Dipanjan Mukherjee, Thesis title: Microfluidic-Assisted optical Spectroscopic Studies on Biomolecular Recognition in Physiologically Relevant Engineered Environments. Supervisor: Samir Kumar Pal.
9. Avisek Maity, Thesis title: Synthesis, Characterization, Physical Property Studies & Applications of Perovskite Halide. Supervisor: Barnali Ghosh (Saha).
10. Koushik Mandal, Thesis title: Theoretical Investigations of Superconducting Pairing Mechanisms in Correlated Fermionic Systems. Supervisors: Ranjan Chaudhury & Manoranjan Kumar.
11. Sourav Karar, Thesis title: Aspects of Holographic Entanglement Entropy and Complexity. Supervisors: Sunandan Gangopadhyay & Archan S Majumdar.
12. Souma Mazumdar, Thesis title: Generalised Entropy In Dynamical System and Information Theory. Supervisor: Partha Guha.

News and Events (Administrative)

Distribution of COVID-19 Medicine

In commemoration of "India@75: Azadi ka Amrit Mahotsav", National Institute of Homoeopathy, an Autonomous Institute under Ministry of Ayush, Govt. of India provided the Centre bulk quantities of Arsenicum album 30C on 19.01.2022. The Arsenicum album 30C is an immune booster for prophylaxis against Covid-19 infection as informed by the Director, National Institute of Homoeopathy. The representatives from Administrative Section of the Centre distributed the globules to all interested staff and students of the Centre.

Celebration of the Republic Day

The 73rd Republic Day was celebrated at Centre on 26th January, 2022 by following Covid-19 restrictions. The National Flag was hoisted by the Director, SNBNCBS at 10.30 a.m.

Swachhta Pakhwada Observed

As per directives received from AI Division, Department of Science and Technology, New Delhi, the Centre observed 'Swachhta Pakhwada' within its premises from 1st May to 15th May, 2022. On 02.05.2022 the programme was inaugurated by Director, SNBNCBS by a mass pledge taking ceremony, mass cleaning of Centre premises, mass cleaning of pavement area (adjacent to surrounding walls). Posters titled 'Zero Plastic Green Campus' was pasted in all Notice Boards and all prominent places. On 03.05.2022 weeding out of old records was carried out. On 04.05.2022 cleanliness drive of administrative block and canteen of the Centre was carried

out. On 06.05.2022 an essay writing competition on "How can we make clean and healthy India" for the staff, students and research scholars was organized. On 10.05.2022 a motivational talk/lecture on "Solid and Liquid Waste Management" was delivered by Ms. Reema Banerjee, Programme Director-East & Biomedical Waste Management, Centre for Environment Education, Buroshibtala, Kolkata. On 11.05.2022 'National Technology Day' was observed at the Centre. On 12.05.2022 deep cleaning of overhead tanks was carried out. On 13.05.2022 a short drama on Swachhta in Workplace (in Bengali) was organized by the staff and students of the Centre.

Foundation Day Celebrated

The Centre celebrated its Foundation Day on 13.06.2022.

International Day of Yoga Celebrated

On 21.06.2022 the Centre celebrated International Day of Yoga (Yoga for Humanity). The staff and students participated in the programme with pomp and gaiety.

Hindi Workshop Organized

One Hindi Workshop held on 11.03.2022 on the topic "Hindi ka Mankikaran & Computer par Bharatiyon Bhashaon ka Prayog". The Speaker was Shri Rajesh Chaturvedi, Mukhya Prabandhak (Rajbhasha), State Bank of India, Kolkata.

Ashu Bhasan Pratiyogita

On 24.06.2022 the Centre in collaboration with Nagar Rajbhasha Karyannayan Samiti, Kolkata organized an "Ashu Bhasan Pratiyogita" in the Silver Jubilee Hall of the Centre.

Hindi Workshop Organized

One Hindi Workshop held on 29.06.2022 on the topic "Hindi Tankan ke Bibidha Rup aur Karyalayeen Patrachar me Hindi ka Sahaj Prayog". The Speaker was Shri Jitendra Prasad, Deputy Director (Tankan/Ashulipi), Hindi Shikshan Yojana (East), Rajbhasha Bibhag, Griha Mantralaya, Nizam Palace, Kolkata.

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