

# Newsletter

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## The Bose Fest 2012

*Saikat Ghosh*

This year 'Bose Fest' was organized over a period of three days, from 27th till 29th of January 2012. As the name suggests, this festival at S.N.Bose Centre is an annual event where all members of our community come together to celebrate the spirit of creativity in science and culture. The basic skeleton of the festival is defined by the wide range of scientific activity in the institute, with students sharing their work through seminars and poster sessions while the evenings are usually marked by cultural events, where the Bose community shares talents in art, music, dance and drama. Accordingly, the most crucial factor for the spirit of the Festival is community participation, which was astounding this time. Over the period of three days we got to hear over 50 scientific presentations all of sublime quality, around 60 student posters



displaying the wide range of scientific activity in the institute, saw a brilliant cultural night topped with a marvellous dance-drama Chitrangada and a one-act play 'Ghare-Baire' in the next day that left the audience spell-bound. All members of the community, students, staff and faculty came together to make this year's Bose-Fest successful.

The festival started with a special session, where the young faculty members presented their research to

get in tune with the rest of the community. The students sessions started in the afternoon. Each student talk had 12 minutes and to everyone's surprise, all of them were on time. However, the real distinctive feature that was common to all the talks were the quality of presentation, which seemed comparable or even surpassing the quality of any full-blown international conference. The poster sessions were organized in the open field during lunch session as well as at the end of the day. The serene beauty of the campus, enhanced by seasonal flowers all around and the soft winter sun added to the environment of stimulating discussion, debate and learning.

There was a cultural program on the first night where members of the community performed in music, dance recitals and a beautifully choreographed dance drama "Chitrangada". The stream of superb talents reminded us repeatedly that creativity is not limited to a field and the same innovative mind can do magic in every field it touches. The second night had two classical musical recitals. The mastero, Pandit Buddhadeb Dasgupta started the evening with Raga Jhinjhoti, which used to be a favourite of S. N. Bose himself and Prof. Bose used to ask Panditji to



## SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

### Editorial

The most significant event that took place during this period is the annual 'Bose Fest 2012'. We have tried to give a glimpse of this multi-pronged event, encompassing both the academic and cultural aspects, through different reports. The high quality academic activities of the Centre is reflected through reports on works which got published in highly reputed journals like the Physical Review Letters, ACS NANO and so forth. The activities of the students outside the normal periphery of the academia is best reflected through a collage of pictures exhibited in the Bose Fest. We are getting better and better instruments, and funding for higher end computers. We also celebrated the 60<sup>th</sup> birthday of a couple of renowned scientists, like Prof. A. K. Raychaudhuri (Director) and Prof. J.K. Bhattacharjee (Presently Director of HRI, Allahabad) in our Centre.



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always play this raga whenever they met. He ended the recital with a Tagore dhun, which also set the stage for classical-Tagore-singer Shounak Chattopadhyay, who was fluent in his art with a brilliant voice and mind to mix the two genres. On the third day afternoon there was a one act play under the direction of Prof. Abhijit Mukherjee that was superbly powerful in all its sectors, the perfect finishing to a vibrant festival.

There are so many people to thank for the success of Bose Fest this year, that it is probably best to settle with one big collective congratulation to all members. A special thanks of course goes to the students for taking directive role in organizing the fest and the panel of judges who sat through every talk, discussed with every poster presenter thereby finishing with perfection, one of the hardest jobs of the entire fest. We wish that this superb spirit of Bose Fest will reflect in all our endeavours and our relations. After all, in the first place, that was the original idea of the event.

## The Photo Fest 2012

*Suman Dutta*

**T**he Photo fest, the very first photo exhibition in S. N. Bose Centre was jointly organised by the Bosonic Students' Society for Academics and Recreation (BOSSAR) and S.N. Bose Centre during the Bose Fest 2012. The contributions came from all ends, including the students, administrative staff and faculty members. The best photographs were chosen based on the viewer and judges votes. The photograph by Dr. Chhayabrita Biswas took over the lead, while that of Tamal Basak won in the Editor's pick category. The applauds from every corner, with inspiration from the Director and the Bose Fest convenor, Dr. Saikat Ghosh, lead the Photo Fest committee to prepare a Photo archive (Presently placed at the SNB Library), including its digital version. The carnival ended with a new promise to arrange such exhibition again.

### Viewer's pick



### Editor's pick



## Cultural programmes during the Bose Fest 2012

*Abhijit Mookerjee*

**C**oming at the end of the academic sessions of the Bose Fest, the cultural programmes of the Centre spanned the last three days. On two of the days the participants were members of the Centre: academics, students and staff. Only on one of the days did we invite professionals.

We began the cultural programmes with a performance of Tagore's dance drama 'Chitrangada'. The choice held a deep significance. Many know Tagore as a bard, a thinker, philosopher, painter and social activist, but few care to know Tagore as a feminist, with gender issues forming the underlying theme in many of his works. In Chitrangada, that feminism reached an important peak. Arjun forsakes his cloying physical attraction towards the Surupa Chitrangada to be enamoured by the heroic warrior princess Kurupa Chitrangada. The interpretation of such an idea-stream required sensitive treatment both in the songs and in the dances of this dance-drama. The staff, students and faculty of the Centre gave quite a consummate performance. Given the lack of proper infrastructure in the pandal which was detrimental for singing and recitation, the impact of the dance drama was beyond expectations. There was just a minor disappointment: it was impossible to find a lad to dance the role of Arjun in our Centre.

Consequently, as is the custom elsewhere in Bengal, a girl had to portray Arjun. The macho maleness of Arjun, which immediately attracted Chitrangada to him, was missing in the portrayal, which had a certain gentleness about it: an attractive portrayal but a bit unsatisfactory in context.

The second performance was again from Tagore : 'Ghare Baire' (Home and the outer World). Ghare Baire illustrates the battle Tagore had with himself, between the ideas of Western culture and revolution against the Western culture. These two ideas are portrayed in two of the main characters, Nikhil, who is rational and opposes violence, and Sandip, who will let nothing stand in his way from reaching his goals. These two opposing ideals are very important in understanding the history of this region and its contemporary problems. Ghare Baire shows "the clash between new and old, realism and idealism, the means and the end, good and evil" within India and southern Asia.

The format was neither that of a proscenium drama nor a play reading, but an amalgam of the two. Continuing on theme of feminism, Tagore paints the lives of three women in a traditional orthodox family: Bimala, educated and intelligent, but imprisoned in her traditions, Mejorani, widowed and suffocated in widowhood, but still retaining her joie de vivre and Bararani, also widowed, who spends her time plotting and in ostentatious religious fervour. Bimala wants to live her own self-contained home life, but her modernist husband Nikhilesh wants to mould her into his ideal, emancipated woman. Into this milieu blows in the swadeshis like a summer storm. Bimala's fatal attraction for their leader Sandeep leads to the tragic denouement. 'Ghare Baire' is not an easy subject to present. However, the amateur performers who included faculty,



students and staff of the Centre did a good job, They were lucky to have had an appreciative audience.

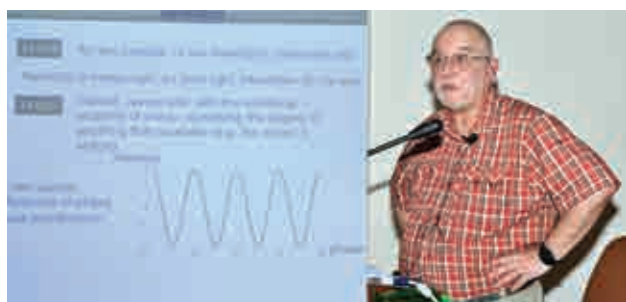
What was also special was that in "Ghare Baire", background music and songs were hardly in the background, they played an intrinsic part in the play. The song rendering by our performers was of a professional level.

For the professional performance we had sarod recital by Budhhdhadeb Dasgupta. The maestro, a lion in winter, gave a mesmerizing performance before a adulatory crowd. The maestro was complemented by Shounak Chattopadhyay who gave an engrossing demonstration on the role of Indian classical music on Tagore's songs.

On both the 'family days' there were many individual performances of singing and recitation. It was heartening to note that in a scientific centre like ours there was no dearth of artistic talent. The programmes were doubly enjoyable because of our appreciative audience. Such group activities outside the sphere of our academic and professional lives are important in a Centre like ours. Cooperative activities not only cement good relations between members, but are also an excellent training for collaborative research. We sincerely hope that such occasions arise regularly in future.

## 10th CK Majumdar Memorial Lecture

*Rudranil Basu*



Sir Michael Berry (Professor, Bristol University) delivered the 10<sup>th</sup> CK Majumdar Memorial lecture this year on 9th March at newly inaugurated Silver Jubilee Hall of our Centre. He is mostly known for his explanation of geometric phases that appear in widely observed phenomena in the fields of quantum mechanics, classical optics and even in stochastic systems. During this highly motivating seminar, he presented the interplay of mathematics and events in the physical world, particularly studies regarding light. Although the focus was to illuminate some apparently non-trivial mathematical tools including knots and fractals among other things, the ease of Sir Berry in the subject never made it feel to be

technical for a general audience. The speaker made use of divergent series or gauss sums in explaining rainbows or complicated diffraction gratings using beautiful illustrations. In his own words the talk was 'intellectual but nontechnical' to the best use of the phrase.

### BRIEF NEWS:

The following students have been awarded Doctoral Degree:

1. Tamoghna Das, Date of Degree Award: 18.01.2012, from West Bengal University of Technology. Title of Thesis: "DYNAMICAL HETEROGENEITIES AND NON-EQUILIBRIUM PROCESSES IN CONDENSED PHASES" under the guidance of Prof. J. K. Bhattacharjee and Prof. S. Sengupta (IACS).
2. Shreemoyee Ganguly, Date of Degree Award: 16.03.2012, from West Bengal University of Technology. Title of Thesis: "A STUDY OF THE EFFECT OF DISORDER AND CONFINEMENT ON BINARY SYSTEMS" under the guidance of Prof. A. Mookerjee.

## Detection of states useful for quantum teleportation

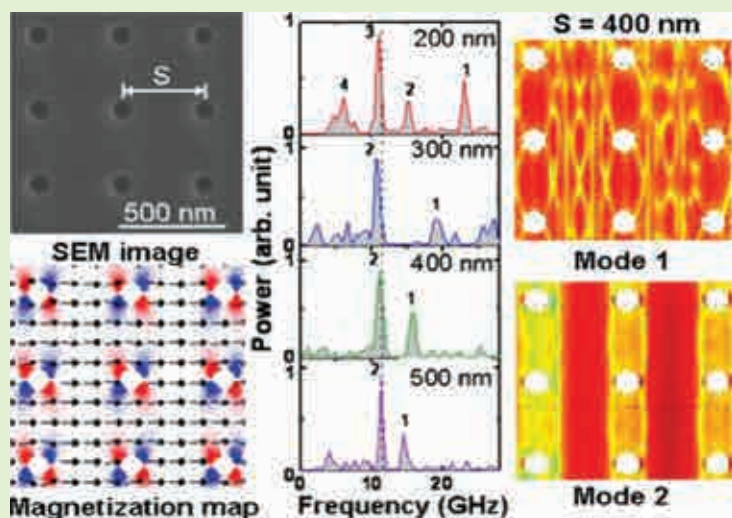
*Archan S. Majumdar*

Once a figment of science fiction, quantum teleportation is a reality today. As with many other quantum information processing tasks, entanglement is the key ingredient which makes quantum teleportation a possibility, a task that is unattainable using classical means. However, not all entangled states prove eligible to act as a teleportation channel. In the present work we characterize the set of all such states which are not useful for teleportation, thus establishing the existence of hermitian observables which enable practical identification of entangled states that are suitable for the teleportation protocol. We use separation axioms from functional analysis which lead to the existence of witness operators demarcating useful entangled states. We provide an example of a teleportation witness operator, a measurement of which in the given state indicates the viability of that state in performing teleportation. The practical utility of the witness operator is underscored by its decomposition in terms of elementary spin observables, rendering it measurable in an experimental situation with the help of polarized photons, and thereby requiring a lesser number of measurement settings than in conventional state identification procedures.

["Entanglement witness operator for quantum teleportation", N. Ganguly, S. Adhikari, A. S. Majumdar, J. Chatterjee, Phys. Rev. Lett. 107, 270501 (2011)].

## Optically Induced Tunable Magnetization Dynamics in Nanoscale Co Antidot Lattices

*Anjan Barman*



Magnonic crystals are periodically modulated magnetic mediums, analogous to photonic or phononic crystals in the microwave band, which may open up magnonic bandgaps for the propagating magnons leading towards the applications in on-chip nanoscale microwave communications. Magnetic antidot lattices are exchange coupled magnonic crystals as opposed to the magnetostatically coupled magnetic dot lattices and hence offer much higher propagation velocity and longer propagation length for the magnons than the dot lattices before the excitation is decayed. One of the important issues regarding the various applications of magnetic antidot lattices is the successful fabrication of good quality structures with smaller dimensions and the time-domain detection of the magnetization dynamics in such materials. In addition, the tunability of magnonic bandgaps with the variation of physical parameters of the nanoscale antidot lattices and understanding the origin of such tunability has not been reported in

the literature. We have recently fabricated high quality Co antidot lattice structures with features down to 100 nm by using focused ion beam lithography. We have excited and detected the magnetization dynamics in those antidot lattice structures by a home built all-optical time-resolved Kerr microscope. The dynamics shows two prominent magnonic bands for sparsely packed lattices with a clear bandgap. The bandgap increases with the decrease in the lattice constant and at the lowest value of the lattice constant four distinct magnonic bands appear. The observations are qualitatively reproduced by micromagnetic simulations and the mode profiles of the resonant modes are calculated and interpreted. We further demonstrate the tunability of magnonic spectra in composite antidot structures with varying geometry. The observations are important for potential applications of the antidot lattices in nanoscale magnonic crystals in the form of composite antidot structures with tunable bandgap.

**Reference:** R. Mandal, S. Saha, D. Kumar, S. Barman, S. Pal, B. Rana, K. Das, A. K. Raychaudhuri, Y. Fukuma, Y. Otani, and A. Barman, ACS Nano DOI: 10.1021/nn300421c (2012).

## Dimensional crossover in fluids under nano-meter scale confinement

Amit Das

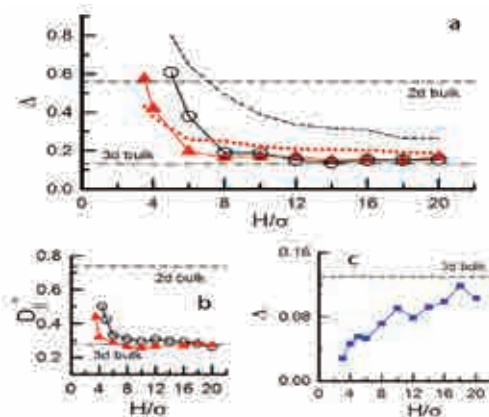


Fig.1: Different quantities as functions of wall separation  $H$  (in units of molecular diameter reflecting (triangles: simulation; dotted line: theory) and repulsive (circles: simulation; dashed line: theory) slits; (b)  $D_{||}$ , reflecting (triangles) and repulsive (circles) slits (c)  $D$ , attractive slits.

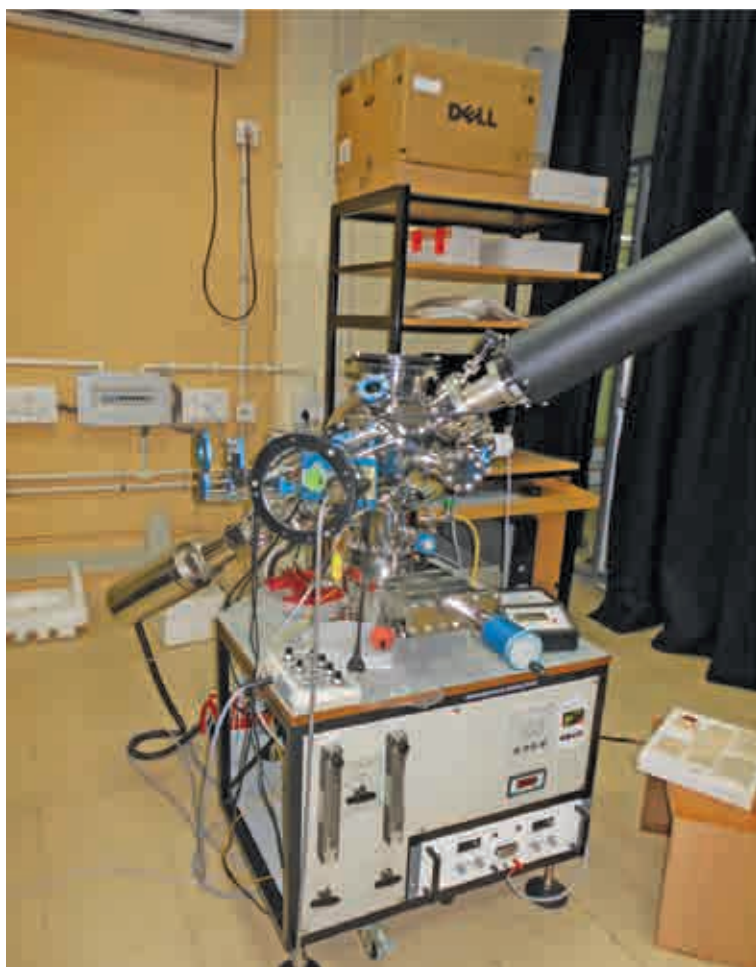
Fluids under confinement are relevant in various branches of science and technology. A bulk 3D fluid is expected to behave as a 2D system when confined to length scale, comparable to molecular size. Several earlier studies(1-3) have shown signatures of 3D to 2D crossover in various static and dynamics properties of a confined fluid, like  $\epsilon_0$ ,  $h$ ,  $D$ , when the confining dimension decreases to about a nanometer (nm). The wave vector dependent density-fluctuations govern majority of these properties. Hence, this crossover should be generically related to that in density-fluctuations. Here, we show that the long-wavelength density fluctuations ( $D$  in a model fluid, kept between two parallel plates, undergo a crossover from 3D to 2D behavior (Fig. 1a), below a confinement extending only about a nm, the same length scale of crossover observed in the experiments. The crossover can be understood as a manifestation of changes in long-wavelength behavior of density-fluctuations due to geometrical constraints. The dynamic density-fluctuations also exhibit similar crossover in the in-plane diffusivity  $D_{||}$  (Fig. 1b). The crossover in solvophobic slit (Fig. 1a and b) is significantly different from that in solvophilic pore (Fig. 1c) due to immobilization of the fluid-particles by strong wall attraction in the later case. Thus, our results(4) provide a clear relation between the crossover of different physical properties and the length scale of confinement and suggest a possible general mechanism for the crossover.

### References:

1. Khan et al, PRL 105, 106101 (2010).
2. Kim et al, Nano Lett. 10, 1955 (2010).
3. Heuberger et al, Science 292, 905 (2001).
4. Das and Chakrabarti, PRE(Rapid Comm), in press (2012).

## Reflection high-energy electron diffraction (RHEED) system

Barnali Ghosh Saha



Installation of RHEED Gun in Pulsed Excimer Laser Deposition unit. Instrument model: TorrRHEED TM from STAIB instruments, Germany. We have successfully installed High pressure RHEED gun with 35 KeV power, with double differential pumping arrangement to maintain pressure difference between the electron gun and the thin film deposition chamber. It is a technique used to characterize the surface of crystalline materials during the thin film growth. RHEED systems gather information only from the surface layer of the sample, through the use of high energy electrons, unlike conventional Transmission Electron microscope (TEM) which samples the bulk.



RHEED pattern from SrTiO<sub>3</sub> surface

## Conference on Active and Functional Materials, 2012 (AFM 12)

*P.K.Mukhopadhyay*



A national conference was held in the centre on the 1st. and the 2nd. March, 2012 on the topics of different materials of current interest. It was convened by Dr. P. K. Mukhopadhyay and Prof. S. Banerjee from SINP.

The meeting had a large number of participants, with 24 invited speakers, 7 contributed talks and 38 posters. There was a good amount of student participation. The topics deliberated varied from nano materials to quantum dots, oxides to metallic alloys, polymers to statistical mechanics and graphenes. There was a good discussion among the students and scientists during the conference times.

In the dinner of the first day, Prof. A. K. Raychaudhuri, the Director, was felicitated on his 60th. birth anniversary. A show was organized with a specially made video CD with reminiscences on Prof. Raychaudhuri by his family members, his former students, and colleagues.

## Conference on Statistical Physics and Nonlinear Dynamics

*Partha Guha*



We have organised an international meeting on Statistical Physics and Nonlinear Dynamics from 12-16 March, 2012 at the Bose Centre. This meeting felicitated our colleague Prof. Jayanta K. Bhattacharjee on his sixtieth birthday. This week long programme brought together two communities of researchers, viz. the statistical Physics group and the Nonlinear Dynamics group. Prof. Bhattacharjee's scientific influence can be felt mainly in these areas.

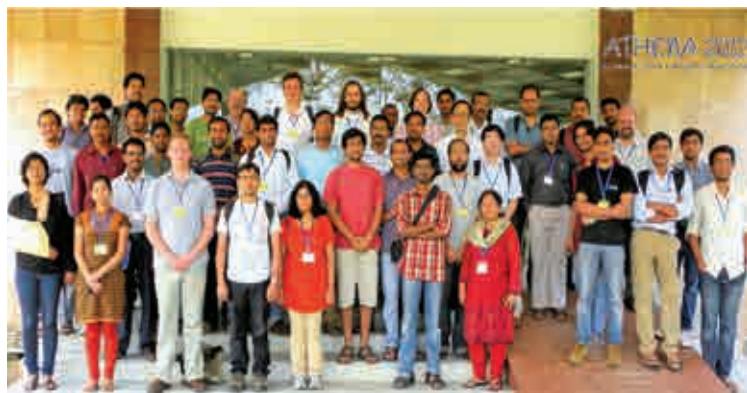
The conference brought together an outstanding collection of researcher from Indian academia. Physicist Sir. Michael Berry, Prof. Sasha Mikhailov and Prof. Peter Leach came from abroad to attend this meeting. The programme consisted of 52 half an hour talks and a poster session.

## Nanoscience and Nanotechnology: Present and Future

*Kalyan Mandal*

The Department of Physics of Kandi Raj College, Kandi and Magnetism Laboratory of S. N. Bose National Centre for Basic Sciences, Kolkata jointly organized a UGC sponsored seminar on "Nanoscience and Nanotechnology: Present and Future" during 12th & 13th January, 2012 at Kandi Raj College, Kandi, Murshidabad. Our former student, Sri Debabrata Pal of Kandi Raj College and Kalyan Mandal of SNBNCBS took the initiative to organize the seminar successfully. Eminent scientists from Saha Institute of Nuclear Physics, Indian Association for the Cultivation of Science, Kalyani University and SNBNCBS delivered lectures on nanoscience and nanotechnology. About 200 students and teachers from various colleges attended the seminar.





*Priya Mahadevan*

An advanced school on modeling transition metal oxides (ATHENA2012) was organised at the S.N.Bose centre from 9 to 12 April, 2012. This was funded by the Indo-EU project ATHENA (Advanced Theories for functional oxides: new routes to handle devices of the future). The school was inaugurated by Prof. A.K. Raychaudhuri who gave an overview of the transition metal oxide activity in the country. This was followed by an excellent journey into the phenomena observed at the surface and interface of various complex oxides, an aspect of fundamental importance especially keeping the device perspective in mind. The underlying theme that while discussing oxides one has to treat the spin, charge and orbital degrees of freedom at the same footing

echoed into the next talk by Dr. Solovyev. This set the tone for the subsequent sessions where first a popular workhorse - density functional theory(DFT), was introduced by Prof. Sanvito which was followed by an introduction to beyond DFT methods such as self-interaction corrected methods as well as hybrid functionals by Prof. Fillipetti as well as Prof. Sanvito. Experimental techniques used to probe the excited states was introduced by Prof. Maiti followed by Prof. Biermann who provided a pedagogical introduction to Dynamical Mean Field Theory. The construction of model Hamiltonians from ab-initio calculations as well as phenomena in various oxides were the theme of the last two days of the school. In addition, we also had four student talks as well as 22 posters. The school was well attended with over 50 student participants and a total of 75 registered participants.

## THESIS SUMMARY

### Thermodynamics of Black Holes: Semi-Classical Approaches and Beyond

*Sujoy Kumar Modak*

This thesis is focussed to study various aspects of black hole physics. Our approach is a semi-classical type, where, the space-time geometry of black holes is considered to be classical, whereas, the fields moving in the background are quantum in nature. Some notable facets of this thesis are the following. I start the thesis by looking into the issue of generalised Smarr mass formula for arbitrary dimensional black holes in Einstein-Maxwell gravity. We not only derive this formula for these black holes, but also demonstrate that such a formula can be expressed in the form of a dimension independent identity  $K= 2ST$  (where the left hand side is the Komar conserved charge corresponding to the null Killing vector 'K' and in the righthand side S, T are the semi-classical entropy and temperature of a black hole) defined at the black hole event horizon. We also highlight the role of exact differentials in computations involving black hole thermodynamics. In fact results like the first law of black hole thermodynamics and semi-classical entropy are obtained without using the laws of black hole mechanics, as is usually done. The blackbody (Hawking) radiation spectrum for higher dimensional black holes is computed by using a density matrix technique of tunnelling mechanism by considering both event and cosmological horizons. We also provide the modifications to the semi-classical Hawking temperature and Bekenstein-Hawking entropy due to various effects. These modifications are mainly found due to higher order (in  $\sim \hbar$ ) effects to the WKB ansatz used for the quantum tunnelling formalism and non-commutative gravity inspired effects. Finally, in we discuss phase transition phenomena in black holes. We formulate a new methodology based on Clausius-Clapeyron and Ehrenfest's equations to exhibit and classify phase transitions in black holes in analogy to what is done in standard thermodynamics.

### Electronic and Magnetic Properties of Systems without Periodicity

*Rudra Banerjee*

In my thesis I have shown my work on development of configuration average based code and its application on binary and ternary disordered alloys. I have shown the methodology is at par and even for some specific cases, better than CPA, the most used methodology for studying disordered systems. Our numerical development is based on Fortran 2003 standard and so, portable. The code also uses shared memory

parallelization which makes it very fast. We have also taken care to optimize the code. I have applied the code on different binary and ternary alloys to calculate their electronic and magnetic properties. Specially, we have studied magnetic phase of those systems from mean field theory and monte carlo method. We have studied frozen phase (spin glass phase) for the materials. Taking specific cases like in FeNiMo, FeNiW and NiMn, we have compared our results with experiments; which is the best proof of usability of any numerical method. In these work, we have shown our method to yield results comparable to experiments. There is a lot of scope for improvement in the code. I am planning to incorporate short-range ordering and non-collinear magnetism in the code. Incorporation of inhomogeneity and L – S coupling in the code and applying the methodology to confined systems are the next thing I would like to work on.

## SCIENTIFIC ESSAY

### A RANDOM WALK IN THE EARTHQUAKE DOMAIN WITH THE BACKDROP OF RECENT NORTH SUMATRA EARTHQUAKES

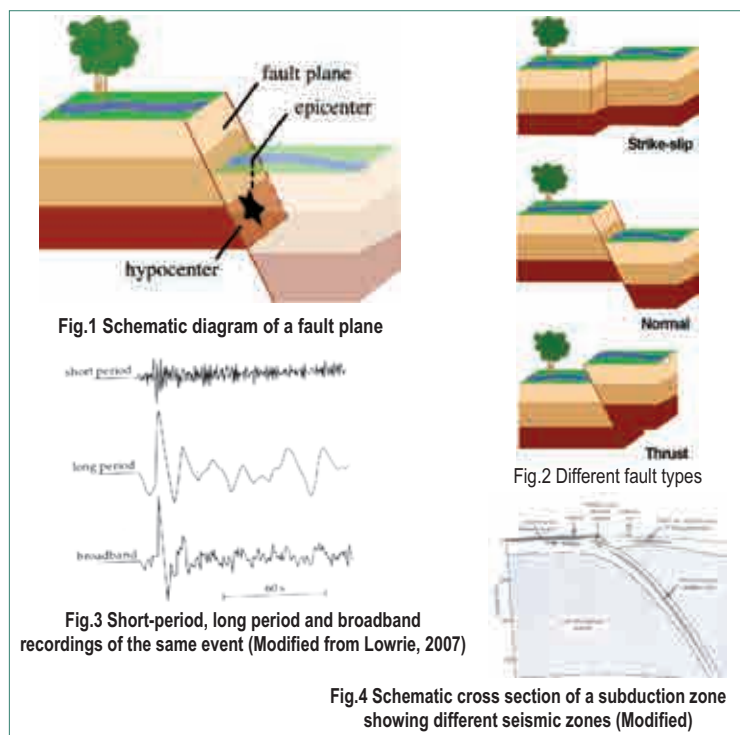
*Bimalendu B. Bhattacharya*

"An earthquake is the way the Earth relieves its stress by transferring it to the people who live on it" graffiti on the door of Santa Monica College, California, USA.

Tectonic earthquakes occur anywhere where there are sufficient stores of elastic strain energy to drive fracture propagation along a fault plane. There are three main types of fault that may cause an earthquake: normal, reverse or thrust and strike-slip (Fig. 2). In normal and reverse faulting the displacement along the fault is in the direction of dip and movement on them involves a vertical component. In strike-slip faults the two sides of the fault slip horizontally past each other. The relative motion between the two blocks leads to increasing stress and therefore, stored strain energy in the volume around the fault surface. This continues until the stress has risen sufficiently to break through the asperity - roughness of surface - suddenly allowing sliding over the locked portion of the fault, releasing the stored energy. This energy is released as a combination of radiated elastic strain seismic waves, frictional heating of the fault surface, and cracking of the rock, thus causing an earthquake. It is estimated that only 10% or less of an earthquake's total energy is radiated as seismic energy. Most of the earthquake's energy is used to power the earthquake fracture growth or is converted to heat generated by friction.

Earthquake generally has foreshocks. These are smaller earthquakes that happen in the same region as the larger earthquake that follows. The largest, main earthquake is called the mainshock. Mainshocks always have aftershocks that follow. These are relatively smaller earthquakes that occur afterwards in the same region as the mainshock. However, some of the aftershocks can be comparable in size to the main earthquake. Depending on the size of the mainshock, aftershocks can continue for weeks, months, and even years after the mainshock!

How do the seismologists measure an earthquake? They use the seismogram recordings by the seismometers at the surface of the earth. Seismometers are designed to react to motion of the earth in a given direction. A seismic signal is composed of numerous



An earthquake (also known as quake or tremor) is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane (Fig. 1). The location below the earth's surface where the earthquake starts is called the focus or hypocenter. It generally occurs at a focal depth many kilometers below the Earth's surface. The location directly above it on the surface of the earth is called the epicenter. About 90% of all earthquakes result from tectonic events, primarily movements on



superposed harmonic vibrations with different frequencies (Fig. 3). Long period seismometers also called a displacement meter is an instrument in which the resonant frequency is very low. It is usually designed to record seismic signals with frequencies of 0.01 – 0.1 Hz (periods 10 – 100 s). The short-period seismometer has a very short natural period and correspondingly high resonant frequency which is higher than the most frequencies in the seismic waves. It is also known as accelerometer as the displacement of short period seismometer is proportional to the acceleration of the ground. It responds to seismic frequencies of 1–10 Hz (periods 0.1–1 s). An accelerometer is suitable for recording strong motion earthquakes as displacement meter in such cases would go off-scale. The range between the strongest and weakest signals that can be recorded without distortion by a given instrument is called its dynamic range. Short-and-long period seismometers have narrow dynamic ranges. This has been tackled by designing broadband seismometers with high sensitivity over a very wide dynamic range.

Earthquake epicenters are not uniformly distributed over the earth's surface. Earthquakes predominantly occur along narrow zones of interplate seismic activity. About 75–80% earthquakes occur in circum-Pacific zone whereas 15–20% occurs in Mediterranean-transasiatic zone commencing from Azores archipelago in the Atlantic Ocean and terminating at the circum-Pacific zone passing through various loops including Hindukush-Himalayan mountain chains and island arcs of south east Asia. The remainder of the earth is aseismic. It should, however, be noted that no region of the earth should be considered as earthquake free. Intraplate earthquakes, remote from major seismic zones, contribute about 1% of the global earthquakes. Very large and damaging earthquakes have occurred due to this type of earthquakes as well.

Earthquakes have been classified according to focal depths. Focal depths of 70 km or less are termed shallow focus, 70–300 km intermediate focus and greater than 300 km deep focus earthquakes. The largest proportion of about 85 % occurs in shallow focus, around 12 % in intermediate focus and 3 % in deep focus earthquakes. Fig. 4 shows a schematic cross-section of epicentral locations of seismic zones in the subducted region.

Earthquake magnitude is an experimentally determined measure of the size of an earthquake. The definition of earthquake magnitude relates it to the logarithm of the amplitude of a seismic disturbance and, therefore, magnitude is also related to the logarithm of the energy. The logarithmic nature means that the energy release increases very rapidly with increasing magnitude. The energy associated with magnitude 1 earthquake is equivalent to kinetic energy of a car weighing 1.5 tons and travelling at a speed of 130 km/h. When magnitudes of two earthquakes differ by 1, their corresponding energies differ by a factor of 28 or 32 on the basis of Bath's and Gutenberg-Richter's equations respectively. In other words it means that a magnitude 7 (M7) earthquake ( $\approx$  energy equivalent of 1 megaton nuclear bomb explosion) releases about 760 to 1000 times the energy of a magnitude 5 earthquake - same as that of the energy

released ( $\approx 4.2 \times 10^9$  joules) by atomic bomb destroying Hiroshima. Magnitude 9 earthquake releases energy equivalent of  $1.8 \times 10^{12}$  kg of explosive.

### North Sumatra Earthquakes

The April 11, 2012, M8.6 and M8.2 earthquakes off the west coast of northern Sumatra, Indonesia, occurred as a result of strike-slip faulting within the oceanic lithosphere of the Indo-Australia plate. Number of earthquakes of magnitude more than M8 is less than 3 per year on an average. The quakes were located respectively 100 km and 200 km to the southwest of the major subduction zone that defines the plate boundary between the India/Australia and Sunda plate's offshore Sumatra. At this location, the India/Australia plates move north-northeast with respect to the Sunda plate at a velocity of  $\approx 52$  mm/yr. Three earlier large strike-slip events had occurred within 50 km of the first large April 11, 2012 event. These earthquakes occurred on April 19, 2006 (M6.2), October 4, 2007 (M6.2) and January 10, 2012 (M7.2). Till 2012, after 2004 massive earthquake (M9.1) no tsunami occurred even for the more than M7 earthquakes mainly due to the nature of fault type. The earthquake of 2004 ruptured a 1300 km long segment of the Sumatran megathrust plate boundary on December 26, 2004 causing devastating tsunami. The earthquake of 2004 released  $20 \times 10^{17}$  Joules, or 475,000 kilotons (475 megatons) of TNT, or the equivalent of 23,000 Nagasaki bombs. The maximum displacement on the rupture surface between the plates is estimated at 15 - 20 m and the instantaneous displacement of sea water is 18 million cubic meters, equivalent of nearly 5000 Olympic size swimming pools of water or 113, 217,000 barrels of oil - a giant field's recoverable reserve, instantaneously drained and dumped upon the coast line of southern Asia. For tsunami of 10 m amplitude, pressure exerted is 49 ton/sq.m. The actual rupture duration on the fault (the time it took for the earthquake to take place on the fault and rupture the entire length) was approximately 3 to 4 minutes. Effect on rotation of earth is much too small, change in length of day: -2.676 microseconds when the length of the day can be measured with an accuracy of about 20 microseconds

Our level of ignorance!!!

Tsunamis have well understood equations. Seismic waves produced by earthquakes are also well understood but the earthquake itself - the rupture process, the energetic (both elastic and gravitational) and the regional stress balance - do not have an equation. Tsunamis and earthquakes provide interesting physics in different ways but far we have to go to understand some of the complex phenomena. The problems lie at the interface of material science, continuum mechanics, rheology-science of the deformation and flow of solid materials- and behaviour of planets.

### Source Materials :

Berman, A. E., 2005, Northern Sumatra earthquake: 40 years of ignoring plate tectonics: *First Break*, 23, 77-85.

Lowrie, William, 2007, *Fundamentals of Geophysics*: Cambridge University Press (Second Edition), 382p.

<http://earthquake.usgs.gov/earthquakes/eqinthenews/2012/usc000905e/#summary>

<http://earthquake.usgs.gov/research/shakemap/#intmaps>

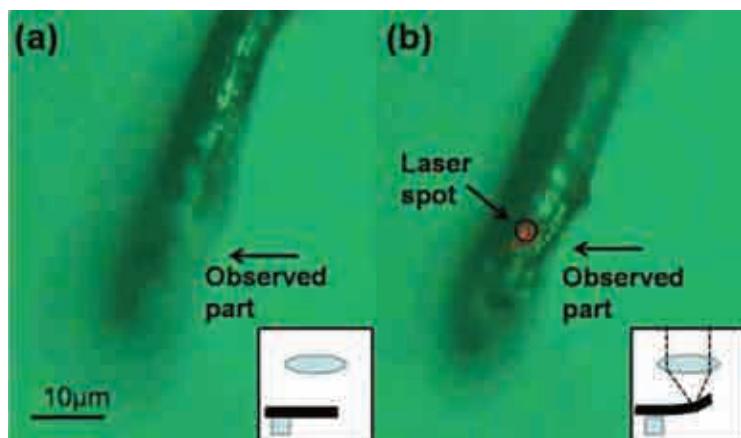
<http://earthquake.usgs.gov/learn/kids/eqscience.php>

## Discovery of a new effect in a smart material

*P.K.Mukhopadhyay*

Recently, Dr. P.K.Mukhopadhyay gave an institute colloquium on March 27, 2012 where in he announced the discovery of a new and amazing effect of photo-induced mechanical actuation on a series of ferromagnetic shape memory alloys, said to be a part of smart material family. These are expected to be the material of the future. The discovery was a joint effort between our centre and the Department of Physics, National University of Singapore.

In a nutshell, the effect that was found was when a low power polarized laser beam impinges on such a material - it showed visual actuation. This was never observed for any inanimate matter and therefore was highly surprising. A lot of experiments were done to understand and characterize the effect, however, it was still not understood fully. In any case, it was expected that there will be a technical use of this discovery.



First photograph of the visual actuation

The colloquium was well attended and received by not only interested faculty members and enthusiastic students, faculties from neighbouring institutions and even practicing cardiologists who came to listen to it. This colloquium got coverage in DD national news and DD Bangla news.

Reference:

"Visible microactuation of a ferromagnetic shape memory alloy by focused laser beam", by Zhibin Hu, B Rajini Kanth, Rajesh Tamang, Binni Varghese, Chong-Haur Sow and P K Mukhopadhyay; Smart Mater. Struct. 21 (2012) 032003.

## Book Exhibition at S. N. Bose Centre

*Saumen Adhikari*



The Library of the S N Bose centre organized a Book Exhibition during 10th January to 12th January 2012 from 10 AM to 5 PM at the dining hall of Krishnachura Hostel. The Exhibition was inaugurated by our honourable Director. Ten Book suppliers participated with a good collection of scientific as well as

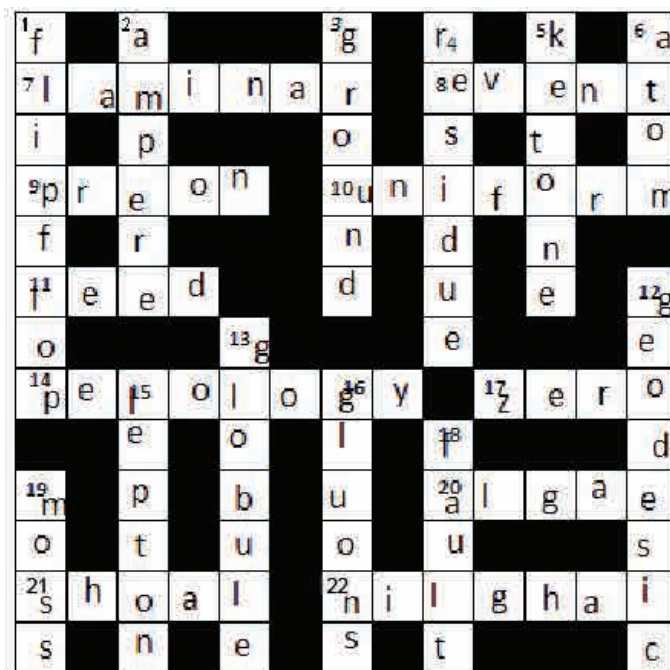
fiction, literature and books of general interests. The faculty members, staffs and students visited the Book Exhibition as per their convenient time and selected more than five hundred scientific books and two hundred books of fiction, literature and books of general interest to enrich the Library collection. The Book Exhibition ended with a grand success.



## STUDENTS' PAGE

### Solution to last issue's crossword:

*Chandreyee Roy, Shauri Chakrabarty*



## हँसी के छींटे

हरेक रात का वो चोर अँधेरा  
घुस आता था, खिड़की फलांग कर  
मेरे ताकिये तक।  
और मेरी बूढी तन्हाई  
पसरी रहती मेरे बिस्तर पर,  
न जगह थी मेरे  
सोने को न बैठने।  
दरिये के दो किनारों  
जैसी मेरी पलकों पर,  
अचानक एक गीली हँसी  
के छींटे से पड़े।  
थके अंतर्मन ने  
बुलावा भेजा चेतना को,  
पलटा तो बादल जा  
चुका था।  
बदलते मौसमों में,  
आँखें तकती उस  
बादल को।  
और वो बादल आसमा के  
पन्नो पर,  
नयी नयी कवितायें  
लिखता रहता।  
शाम को घर लौटते वक्त  
कुछ शब्द,  
उसी कविता के  
मुट्टी में ले आता। और  
बिस्तर पर पसरी उसी तन्हाई  
के कानों में कह देता,  
और कुछ रोज़ उसी तन्हाई के  
पैरों को दबाती मेर सोच के  
कानों में भी।  
और खुद अंतर्मन  
भी उन कविताओं में,  
डूबता और उतराता।  
एक रात तन्हाई ने अंगड़ाई ली  
और अगली शाम वो,

मेरा बिस्तर छोड़  
मेरी सोच का तकिया बना कहीं जा चुकी थी।  
आज मेरे कमरे में,  
उन्हीं कविताओं  
के सुर गूँजते हैं।  
और वो बादल भी मेरे कमरे की  
खिड़की से वोही गीले छींटे,  
बरसाता है अन्दर  
हर रोज़।  
हर सुबह वोही गीले छींटे  
मुझे नींद से उठाते हैं।  
उन्हीं में नहाकर,  
मैं निकलता हूँ  
घर से।  
फिर उन्हीं कविताओं को  
गुनगुना लेता हूँ,  
जब एक कदम भी वापस  
आता है पथ से।  
तुम ही तो हो वो बादल,  
वो गीले छींटे भी तुम्हारी,  
हँसी के ही हैं.....

कपिल गुप्ता

## IN NATURE

### Orange headed thrush (*Zoothera citrina*)

*Prosenjit Singha Deo*

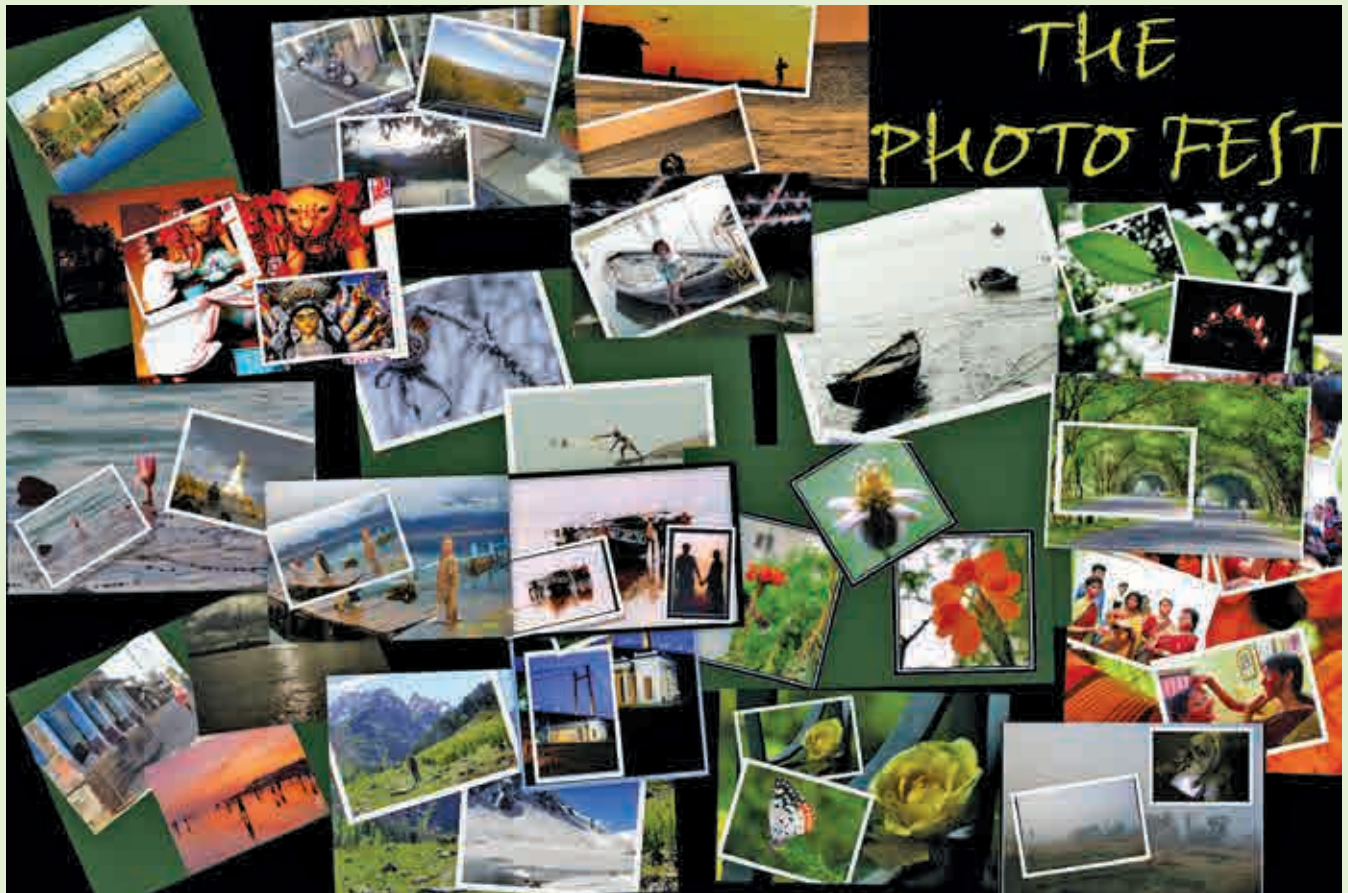


Although this bird is not difficult to see, very few people actually come across it. Essentially, because it lives in a typical habitat that non-birdwatchers do not visit. If one goes to Chintamani Kar bird sanctuary in

March-April, one will see it. Other times of the year it may be difficult. It is one of the most beautiful birds of our area. As big as a mayna. The south Indian subspecies looks slightly different with some additional marks on the cheek. I photographed this last sunday (8.4.12) at Chintamani Kar bird sanctuary.



## "Life beyond the drops" *Snehasis Daschakraborty*



*Collage by Suman Dutta*

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