MEETING REPORT

The 55th DAE solid state physics symposium*

The annual, national-level meet of 'condensed matter' researchers, sponsored by the Board of Research in Nuclear Sciences, Department of Atomic Energy (DAE), Government of India (GoI) was held in December 2010 at Manipal University. In his inaugural address, A. K. Sood (Indian Institute of Science (IISc), Bangalore) made a special mention of the generous grant in science, education and research made available by the GoI over the last 15–20 years, which has helped in carrying out many new experiments in the laboratories of several institutions.

A historical perspective of the DAE symposium was delivered by S. L. Chaplot (Bhabha Atomic Research Centre (BARC), Mumbai). He described how this symposium emerged from a combined nuclear and solid state physics symposium (SSPS), which in turn had started out as a low energy physics symposium. R. Mukhopadhyay (Convener of the DAE–SSPS 2010) pointed out the most notable change in the event this year, namely the on-line publication of proceedings by the American Institute of Physics.

The technical session consisted of two plenary lectures, three theme-invited seminars on (i) physics of graphene, (ii) Fe-pnictide superconductor and (iii) renewable energy materials, and 16 invited talks, in addition to oral and poster presentations. In his plenary talk, Jainendra Jain (Pennsylvania State University, USA) spoke on the application of composite fermions in the quantum Hall effect recently observed in graphene. He explained the physics of formation of composite fermions necessary to clarify the phenomenon of fractional quantum Hall effect in the GaAs structure. In the first seminar on graphene, Sood showed the importance of transport and *in situ* spectroscopy experiments, especially the Raman experiment, in the study of graphene. He suggested that the most promising method of preparation of graphene was by chemical methods, e.g. chemical vapour deposition. He described the use of a top-gated field-effect transistor made of bilayer graphene, wherein the transport measurement using Raman scattering helped elucidate the strengths of electron–phonon coupling.

G. Baskaran (Institute of Mathematical Physics, Chennai) explained how the novel Mott insulating states in neutral graphene can be thought of as involving valley spin and real spin degrees of freedom. He also showed how complexity can be dealt with by the simplicity of the carbon electronic structure, and stressed on the important role of hybridization of sigma and pi bonds. The fabrication of high-mobility suspended monolayer graphene devices was described by Mandar Deshmukh (Tata Institute of Fundamental Research (TIFR), Mumbai). Krishnendu Sengupta (Indian Association for the Cultivation of Science (IACS), Kolkata) discussed the physics of Dirac electron in graphene in the presence of magnetic impurities.

The seminar on Fe-pnictide superconductor featured Ashok Ganguly (Indian Institute of Technology (IIT) Delhi) giving a detailed perspective of this new Fe-based superconductor, starting from the discovery of superconductivity in mercury nearly 100 years ago. The discovery of high-temperature superconductivity in Fe-pnictides has ignited a worldwide burst of activity. While experimentalists rushed to characterize the physical properties of these new materials and explore different avenues for further raising the critical temperature (T_c), the theoretical debate seemed to revolve around the similarities and differences between Fe-pnictides and the 20-odd years old cuprate high-temperature superconductors, still the deepest mystery of condensed matter physics. Ganguly reported the enhancement in T_c, critical field (H_{c2}) and critical current density (J_c) induced by the increase of chemical pressure in Y-doped Ce(O/F) FeAs. The similarities and differences between FeAs and cuprate superconductors were highlighted with examples.

A. Bharathi (Indira Gandhi Centre for Atomic Research, Kalpakkam) concentrated on the results from 122 FeAs compounds in the polycrystalline as well as the single-crystal forms. In this case, superconductivity was observed both in the hole and electron doping regimes. Both Ganguly and Bharathi highlighted the role of spin fluctuation on the superconducting properties of these materials. Thamizhavel (TIFR, Mumbai) presented the results on single crystals of $CaFe_{2-x}T_xAs_2$ (T = Co, Ni) grown in his laboratory. The magnetic and superconducting properties were studied using resistivity, magnetization and neutron diffraction measurements.

In the third seminar on 'Materials for renewable energy', G. P. Das (IACS, Kolkata) stressed on the worldwide necessity of renewable and clean energy, and particularly in India. He showed how and why hydrogen could be an alternative clean form of energy and explained the difficulty with its production, storage and uses. He also focused on the design of materials ranging from complex hydrides to various functionalized nanostructures using first-principle calculations. S. Sundar Kumar Iyer (IIT Kanpur) elucidated the physics of solar photovoltaic technology, the efficiency of the cell using different forms of silicon, and the use of organic solar cell. Dinesh Kabra (University of Cambridge, UK) advocated for a hybrid solar cell and explained the necessary steps, from photon incidence to current generation, in such a cell. The behaviour of the HUMO–LUMO gap in organic semiconductors was also introduced.

The behaviour of hydrogen in extreme conditions was discussed by N. Subramanium (IGCAR, Kalpakkam). He presented the *P–T* diagram of hydrogen, the possibility of the elusive idea of metallization of hydrogen, and the difficulty in confinement of hydrogen at high pressure in the diamond anvil cell. Abhishek Dhar (Raman Research Institute, Bangalore) talked about the importance of phononic heat conduction in disordered harmonic crystals. His discussion focused on a microscopic look at the Fourier law of heat conduction, showing that for 1D and 2D systems, the Fourier law was not valid. The heterogeneity in polymer thin films, studied using X-ray and neutron reflectivity techniques, was discussed by

*A report on the '55th DAE Solid State Physics Symposium (DAE–SSPS)' held during 26–30 December 2010 at Manipal University, Manipal, and jointly organized by the Bhabha Atomic Research Centre, Mumbai and Manipal University.

Toshiji Kanaya (Kyoto University, Japan). His findings show that the transition temperature of glass decreases with increase in film thickness. He also found negative thermal expansion in some of these films.

New and unusual properties of Sr_2FeMoO_6 was the topic of D. D. Sarma (IISc, Bangalore). This ordered double perovskite shows uncommon aspects in: (i) magnetism, (ii) geometrical aspects of disorder, (iii) its effect in electronic and magnetic structure, and (iv) magnetoresistance. A new idea based on the kinetic energy-driven mechanism has been applied with success in understanding several of these properties. S. Patnaik (Jawaharlal Nehru University, New Delhi) spoke on the role of spin frustration in multiferroic materials. Generally, ferroelectricity and magnetism are mutually exclusive. He showed how in some materials, e.g. $Bi_2Fe_4O_9$ and $Ni_3V_2O_8$, ferroelectricity is driven by magnetism and that the spins were frustrated.

Attila R. Imre (KFKI Atomic Energy Research Institute, Hungary) delivered a talk on 'Condensed matter under absolute negative pressure'. He explained how upon expansion, both solids and liquids can cross the $p = 0$ state. Under moderate negative pressure, states are generally metastable. If the stability limit is crossed, they may be stabilized in a second phase. For pure water, the limit at room temperature is –120 MPa; if impurity is present, the metastabilty can break earlier. He also showed some examples where the negative pressure plays a crucial role. Xavier Marie (Université de Toulouse, France) gave an exposition of the optical and electrical spin injections in semiconductor nanostructures. Electronic and nuclear spin polarizations in semiconductor quantum dots are two important subjects for future spintronic and quantum information devices. In this system, the classical spin relaxation mechanisms are absent. So the injected spin (either by optical or electrical means) confined to quantum dots has a chance to interact strongly with the nuclear spin system via hyperfine interactions.

The results of compounds such as propane and acetylene adsorbed in ZSM5 zeolite, studied using quasielastic neutron scattering and molecular dynamics simulation, were presented by S. Mitra. The role played by size and shape of the guest molecule, and the interaction of the guest molecule with the host framework were discussed. Pratap Raychaudhuri (TIFR, Mumbai) explained the importance of amplitude and phase factor in the BCS theory. Using a scanning tunnelling microscope, the details of phase fluctuation in disordered epitaxial thin films of NbN were determined. He showed that phase fluctuation inhibits superconductivity, though the superconducting gap persists well above the superconducting transition temperature. Saurav Giri (IACS, Kolkata) discussed the phenomenology of exchange bias effect and illustrated how this may be used to characterize the different types of coexisting magnetic phases in structurally single phase alloys and compounds.

Ashok K. Verma (BARC, Mumbai) spoke about the first-principles density functional theory-based investigations of defect in different minerals, and the favourable conditions for different defect formations. The results, both *ab initio* and model-based calculations, of electron transport in quantum well and quantum wire were reported by A. C. Sharma (The Maharaja Sayajirao University of Baroda, Vadodara). It was stated that electron scattering rates in a disordered system are mainly governed by effective dimensionality, carrier concentration and dynamical screening effects. Somobrata Acharya discussed the synergistic tunability of fluorescence using coupled quantum dots.

In the concluding session of the symposium, as in the previous symposia, awards were presented in the 'Young achievers awards', 'Ph D thesis awards', 'M Sc projects awards' and 'Best poster awards' category, to encourage young scientists.

Amitabha Ghoshray, Saha Institute of Nuclear Physics, 1/AF, Bidhannagar, Kolkata 700 064, India.
e-mail: amitabha.ghoshray@saha.ac.in