

QTL analysis in a cross-pollinated species of red clover, in which development and maintenance of mapping population is difficult, and identified the QTL for forage yield persistence and seed yield traits that are difficult to improve through phenotypic selection.

Molecular markers also allow us to dissect genomic regions interacting with environments for phenotypic expression of complex traits. J. W. Snape (John Innes Centre, UK) discussed the strategy of dissecting the gene \times environment interactions affecting wheat yield via QTL and physiological analysis. He used Meta-QTL analysis for yield and yield-contributing traits in a number of populations derived from genotypes adapted in different environments. This led to identification of useful allelic variations for these traits, which can be a focus in future for wheat improvement. Mapping and tagging of gene(s)/QTL(s) controlling root traits in maize, Fusarium head blight resistance in European wheat and nitrogen-use efficiency in sugarcane was discussed by R. Tuberosa (University of Bologna, Italy), H. Burstmayr (BOKU, Austria) and A. Whan (University of Queensland) respectively.

The main aim of molecular mapping is to identify markers that are closely associated with genes controlling desirable traits and are useful in breeding programmes for indirect selection of desirable recombinants in early segregating generations. O. Moullet (ACW, Switzerland) identified and evaluated plants ho-

mozygous at marker loci linked with a major QTL for FHB in wheat, but no significant increase in the level of FHB resistance was observed in these plants probably due to loss of QTL by double recombination, $G \times E$ interactions or epistasis interactions. Similarly, C. Thienpont (Louvaia-la-Neuve, Belgium) suggested the limitations of marker-assisted selection for root morphology in chicory due to strong environmental influence on this trait. However, Biradar obtained positive results when he evaluated several maize near-isogenic lines carrying a major QTL for chilling tolerance introgressed through marker-assisted backcrossing. D. Zamir (The Hebrew University of Jerusalem, Israel) pointed out that although QTL analysis has been widely conducted in plants and animals, its successful use in marker-assisted selection (MAS) is limited. He laid more emphasis on using the accurate phenotyping data in QTL analysis and also suggested development of an integrated phenomic database in each crop, which may unravel some unifying principles about the architecture of complex traits and pave the road for genomic assisted breeding. A. H. Price (University of Aberdeen, UK) discussed the utility of accurate QTL mapping by giving several examples of map-based cloning of major and minor QTL in plants. J. Dolezel (Institute of Experimental Botany, Czech Republic) highlighted the role of flow cytometry in separation of individual chromosomes and chromosome arms and their use in

preparation of chromosome-specific BAC libraries that can be useful in map-based cloning of genes/QTLs.

The applicability of molecular markers for other purposes, including analysis of genetic diversity using microsatellite markers in order to exploit the germplasm for improving the yield capacity of oats (I. Griffiths, IGER, UK) and understanding the molecular mechanism responsible for heterosis in maize (F. Hochholdinger, UT-ZMBP, Germany) was also discussed. Thus, considering the potential of the molecular marker technology for crop improvement, the conference provided a platform to understand the current bottlenecks and challenges in molecular mapping and MAS. The meeting also provided a feedback that mapping of genes/QTLs controlling agronomically important complex traits can be useful for crop improvement, if accurate phenotyping data are taken on mapping populations and used in QTL analysis. A major effort is also needed on molecular mapping of genes/QTLs for yield and yield-contributing traits, especially in major food crops and their exploitation in the development of new and improved genotypes through breeding programmes.

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MEETING REPORT

Neutron Scattering 2008*

The International Symposium on Neutron Scattering 2008 (ISNS 2008) covered various aspects of neutron scattering research and applications in physics, chemistry, biology and materials science. More than 200 participants from 15 countries, including some pioneers of the neutron scattering activity in India, participated in the deliberations.

*A report on the International Symposium on Neutron Scattering 2008, held at the Bhabha Atomic Research Centre, Mumbai during 15-18 January 2008.

There were 48 invited talks out of which 40 were from abroad, including those from ORNL, ANL, LANL, UCSD, NIST, Chalk River, ISIS, PSI, ILL, LLB, HMI, FRM2, FZJ, FZK, JINR, Vienna, Copenhagen, Warwick, JAEA, J-PARC and ANSTO. The talks included topics on new experimental facilities, and studies involving diffraction, magnetism, biological systems, hydrogen and diffusion, dynamics, neutron optics, small-angle scattering, reflectometry, and other applications. Present-day mega-facilities, upcoming as well as proposed ones, were

presented. There were also 90 contributed papers put up as posters. Presentations covered the wide range of science that is being pursued all over the world.

In the first technical session there were four talks. The first talk was by Ian S. Anderson (Oak Ridge National Laboratory) entitled 'The spallation neutron source - New opportunities'. The existence of both SNS and HFIR reactor with new cold source and guide hall under a single umbrella at ORNL will provide an opportunity to develop science and instrumentation taking advantage of unique

characteristics of each source. The next talk was by Y Fujii (JAEA Quantum Beam Science Directorate) dealing with 'Small sciences at large facilities'. He mentioned that the 'quantum beams', a recently coined phrase, excellently controlled high-quality beams (neutron, synchrotron X-ray and laser), need large facilities to produce. The facilities are used by relatively small number of researchers related to condensed matter science. This is unlike high-energy physics on an accelerator that is pursued by relatively large groups. The existence of both the neutron sources (JAEA and J-PARC) at the same location is expected to lead to a better user programme in future. Richard Wagner (Institute Laue-Langevin, considered as the Mecca of neutron scattering) gave an excellent overview of the existing facility, and the broad-based science-oriented user programme. Continuous efforts to upgrade ILL instruments have ensured the reactor to be in the forefront to venture into new scientific challenges, particularly in nanoscience and biology. The last talk in this session was by Uschi Steigenberger (ISIS Facility, UK) highlighting ISIS pulsed neutron and muon facility. She announced the achievement of the first proton at the ISIS second target station on 14 December 2007 and planned progress of the seven day-one instruments to be commissioned by October 2008. She also described the steady developments of instruments at the present facility, e.g. by introduction of supermirror guide, how the range of diffraction data has increased that can contribute to more insights drawing the example of C_{60} .

In the post-lunch session, Masatoshi Arai gave a detailed account of J-PARC, the highest-powered proton accelerator to be completed by 2008. Arai reported that there would be 23 neutron-beam ports out of which 10 would be installed by 2008. It was clear that J-PARC is poised to be another international mega facility to cater to researchers in materials and life sciences. Kurt Clausen (Paul Scherrer Institute, Switzerland) highlighted the science pursued at the only CW spallation neutron source (SNS) in the world. Clausen argued that further development of SNS would be the way towards improvement in neutron intensities. Colin Carlile (European Spallation Source Secretariat in Sweden) discussed the possibility of an European spallation source (ESS). In Europe, by 2023, out of

the 15 neutron facilities existing today, only five would be available and this will lead to a shortage crisis of neutrons. Lund in Sweden is being proposed as a serious site contender for the ESS, as the Swedish Government has assured to contribute 30% construction and 10% operation cost for such a facility. A. V. Belushkin (Dubna, Russia) mentioned about the need for a variety of neutron detectors, particularly with the availability of many high-intensity sources all over the world. He described the effort of Dubna towards a variety of neutron detectors for various applications of neutron beam research.

The post-tea session on the first day was on applications of neutrons. In this session, there were four speakers. E. H. Lehmann (PSI, Switzerland) described state-of-the-art neutron imaging and discussed further improvements of methods in neutron imaging: the increased spatial resolution for micro-tomography and options for energy-selective neutron imaging. He also discussed complementarity of using X-rays. W. Treimer (University of Applied Sciences, Berlin) discussed the advances in neutron radiography and tomography. He discussed how a variety of methodologies like refraction, small-angle scattering and polarization are used to reconstruct images. He also mentioned about various facilities at HMI for this purpose. A. M. Shaikh (BARC, Mumbai) gave a detailed account of the in-house detector development facility existing in Trombay, starting from normal Bf_3 to linear PSD, 2D PSD, microstrip and curvilinear detectors for both X-ray and neutron applications. He also covered the radiography facility at BARC catering to various applications, involving nuclear fuel pins, fuel plates, control rods, INSAT-pyrovalves, cable cutters, electric detonators, marker shells, boral composites, hydride blisters in zircaloy-2 and Zr-2.5% Nb PT coupons. The first day ended with a talk by S. Mazumder (BARC) on 'Dynamical scaling laws – A few unanswered questions'. Mazumder indicated the need for investigation, examining the extent and nature of the scaling laws for confined systems subjected to random field, citing the example of maraging steel and variations in observations in hydration of cement with H_2O or D_2O .

The morning session on the second day had three talks. Michael Steiner (HMI, Germany) spoke about the empha-

sis at HMI towards extreme sample environment and associated instrumentation. He mentioned about the merger of HMI and BESSY from 1 January 2009 to form 'The Helmholtz Centre Berlin for Materials and Energy', a new institute with two large-scale facilities, one of neutrons and the other of photons. Robert Robinson (The Bragg Institute, ANSTO, Australia) in his talk highlighted the entry to the 'golden age' of Australian science. He indicated that the OPAL reactor and Australian synchrotron would essentially be sister facilities with common open ethos. The next talk was on the science done using neutrons. Sunil K. Sinha (University of California, San Diego) dealt with elastic and inelastic neutron scattering measurements on single crystals of HCP 4He at temperatures down to 60 mK. The results showed that solid 4He shares several features in common with the superfluid.

In the post-tea morning session, the talks were on magnetism and high T_c . The speakers were Thomas Bruckel (Forschungszentrum, Jülich), Andrey Zheludev (ORNL), Joel Masot (ETH Zurich and PSI), Lothar Pintschovius (Forschungszentrum, Karlsruhe) and S. M. Yusuf (BARC). Bruckel gave a presentation on magnetic nanostructures using reflectometry, grazing angle SANS, diffuse scattering, etc. Zheludev spoke about 'New physics with new spin ladders', emphasizing the existence of a great deal of exciting physics left in low-D quantum magnetism; to uncover it we need new materials, new high-resolution high-flux TOF instruments, a new high-flux high-resolution cold TAS and proper sample environment. The next talk was by Mesot on high T_c superconductors. He showed that the recent inelastic neutron scattering data indicated the existence of a new energy scale which tracks T_c . Pintschovius talked on anisotropic superconducting energy gap and its relation to phonon as evident from inelastic neutron scattering. Yusuf discussed the magnetic correlations in oxide materials as studied by neutron diffraction and depolarization.

After lunch there was a poster session with about 90 posters, out of which about 60 were on diffraction and small-angle scattering, 14 were on inelastic and quasi-elastic scattering, and 15 on neutron optics, reflectometry, neutron instrumentation and detectors.

In the post-tea afternoon session there were four talks in the category of diffrac-

tion studies. J. P. Hodges (Oak Ridge National Laboratory, US) deliberated the possibilities of *in situ* studies of structures of materials under extreme conditions at SNS. He mentioned about a variety of diffractometers that have been funded at SNS for specialized applications, namely high resolution structural studies, ultra-high pressure studies, engineering materials investigations, disordered materials investigations, small-angle scattering studies, etc. Stephan Rosenkranz (Argonne National Laboratory) spoke about CORELLI, a single-crystal diffuse scattering instrument to be built at SNS, to study complex disorder and nanoscale self-organization. The next talk was by Thomas Proffen (Los Alamos National Laboratory, US) dealing with the study of total scattering for deriving structural information over all length scales, providing the complete structural picture of complex materials. Geetha Balakrishnan (University of Warwick, UK) gave a detailed account of the effort towards growth of large, high-quality single crystals of a variety of oxides, borides and carbides, suitable for neutron experiments.

The third day started with a session specifically on biological systems. The first talk by Dieter Richter gave an account of neutron contribution towards polymer and biopolymeric systems. He mentioned that the neutron spin-echo instrument at SNS, having the best resolution and wide dynamical range, would enable studies in soft matter dynamics. The next talk was by Joseph Zaccai (ILL) about neutron scattering studies on dynamics of proteins, *in vitro* as well as *in vivo*, suggesting that evolutionary selection proceeded via dynamics. John Tomkinson (ISIS) spoke about the current practice on molecular spectroscopy with neutrons, dealing with the contribution from inelastic, quasielastic and recoil spectrometers at ISIS. The post-tea morning session was on hydrogen and diffusion. There were four talks presented by Helmut Schober (ILL), Craig Brown (NIST), Mark Johnson (ILL) and Jose Teixeira (LLB). Schober spoke on 'Ionic conduction in solid oxides fuel cells'. He showed that dynamical instability as evidenced from neutron spectroscopy is responsible for the large ion conduction in $\text{SrFeO}_{2.5}$ and lack of it in isostructural $\text{CaFeO}_{2.5}$. Brown discussed the enhanced uptake of H_2 in metal-organic frameworks, MOF-74 with coordinatively unsaturated metal

centres. Johnson noted that combined neutron scattering and numerical simulation is a successful user programme. He spoke about the structure, vibrations and proton transfer in short hydrogen bonds in enzyme catalysis and DNA. Teixeira's talk was also concerned with hydrogen bonds but in water, particularly the anomalous behaviour of supercooled water. Experimental results indicated two main characteristic times; molecular residence time follows strong non-Arrhenius temperature dependence, while the hydrogen bond lifetime follows the Arrhenius law.

The post-lunch session was on reflectometry and SANS; three talks were presented in this session. Zin Tun (Canadian Neutron Beam Centre, Chalk River) spoke on zirconium oxidation as studied by electrochemistry and neutron reflectometry, simultaneously providing complementary information on migration of neutral atoms and conduction of charges. The next talk by Saibal Basu (BARC) dealt with specular neutron reflectometry in polarized and unpolarized mode to obtain information on interface roughness and alloying from deep, buried layers. The last talk in this session was by Jyotsana Lal (IPNS, Argonne) on SANS studies of polymer chain confined in porous media. The remaining part of the day was devoted to a visit to the neutron scattering facility at Dhruva.

The first session on the last day was on neutron optics. Helmut Rauch (Atom-Institut, Vienna) spoke about non-classical states of neutron as characterized by non-Gaussian distribution functions and negative parts of the related Wigner functions, as produced in neutron interferometer and neutron spin-echo systems. This was followed by A. G. Wagh (BARC) who discussed his achievement of the sharpest angular profile neutron beam to-date, facilitating super-ultra-SANS measurements in the Q-range of 10^{-5} \AA^{-1} . After the tea break, the session was on dynamics, with four talks. R. Mukhopadhyay (BARC) spoke on molecular diffusion in confined media. He discussed QENS results of molecular motion confined in porous media like clays, gels, etc. and also in cages like zeolites and molecular sieves. The next talk was by Catherine Pappas (HMI, Germany) on non-exponential relaxation as encountered in canonical glasses, spin-glasses, etc. The new results from classical Cu-Mn spin-glass and other systems showed that the magnetic behav-

our should be characteristic of superparamagnetism. Narayani Choudhury (BARC) spoke on neutron scattering and lattice dynamics of minerals and functional materials. Her talk dealt with calculations, which extended to very complex systems with ~ 100 atoms/unit cell. She also discussed results obtained in a variety of systems and comparison of data as obtained in Trombay and at mega facilities. The next talk was by R. Mittal (BARC, presently at Julich Centre for Neutron Science, Garching, Germany) on negative thermal expansion as observed in some framework compounds. He dealt with successful description of the observed phenomenon via lattice dynamical studies and its confirmation by neutron experiments.

The post-lunch session was on magnetism with five talks by J.-M. Mignot and Sylvain Petit (LLB Saclay), Tapan Chatterjee, and A. P. Murani (ILL Grenoble) and Mohana Yethiraj (ANSTO Australia). Mignot dealt with multipole interactions in *f*-electron systems like $\text{Ce}_x(\text{Pr/Nd})_{1-x}\text{B}_6$ series as studied by neutron diffraction at magnetic fields up to 7 T and temperature down to 100 mK. Chatterjee reviewed their work on a variety of multiferroic materials (RMnO_3 and RMn_2O_5 ; R: rare-earth element) as studied by elastic and inelastic neutron scattering. Murani's talk emphasized the use of epithermal neutron to elucidate anomalous rare earth systems: α -Ce and α -Ce-like compounds. Multiferroic RMnO_3 manganites were also the topic for Petit. He mentioned about the polarized as well as unpolarized inelastic neutron measurements, indicating the existence of spin-lattice coupling in hexagonal YMnO_3 . Yethiraj talked about her work done at ORNL, on the relation of the excitations to the superconducting transition in V_3Si .

The last session of the symposium was on SANS. Kell Mortensen (University of Copenhagen) showed that the ordered nanoscale phase in soft materials is highly sensitive to external fields and impurities; the fcc-structure is stabilized by diblock impurities in suspension of triblock copolymer micelles, and fluctuation and/or shear destabilize complex phases. W. A. Hamilton (Bragg Institute, ANSTO) spoke about Poiseuille shear response of a surfactant sponge phase in which both dynamics and geometry have their roles. The last talk was by V. K. Aswal (BARC) on structural evolution of different phases leading to crystalliza-

tion, denaturation and gelation in protein solution as studied by SANS.

The concluding session was held to provide a feedback. Most participants felt that it was a well-organized symposium; they appreciated that parallel sessions were avoided which enabled a broad exposure to all the major fields of neutron scattering for everyone.

Researchers from universities and other academic institutions utilize the National

Facility for Neutron Beam Research at BARC regularly. Several research projects have been carried out under the aegis of UGC–DAE–CSR. In addition, the Facility has been extensively used by BARC for basic research in condensed matter science. The international symposium enabled useful scientific discussions among the national and international researchers, and was of immense benefit to the above research and development ac-

tivities at BARC. In particular, informal discussions included possibilities of our participation in international collaborations with some of the most advanced research centres and in a proposed Asia–Oceania Neutron Scattering Association.

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MEETING REPORT

Marine biology to marine biotechnology: A leap forward*

India has a long coastline of approximately 4667 km, offering scope for fisheries and aquaculture. Mumbai, being the economical hub associated with research and development has potential to develop into a marine biotechnology research centre.

The national conference on marine biology and biotechnology held recently, had more than 200 participants. There were in all 24 speakers who delivered informative lectures.

The Chief Guest A. D. Sawant (University of Mumbai) in his talk emphasized the need for building up infrastructure for development of marine biotechnology and stressed the need for application of research at college and university-level.

Joe Baker (Department of Primary Industries and Fisheries, Australia) gave a keynote address titled 'Towards 2020 – A vision of the enormous potential of marine biotechnology for the social, environmental and economic benefit of India'. Baker brought forth many opportunities for the efficient development and use of marine biotechnologies. His talk aimed to stimulate thought on the enormous potential of marine biotechnologies for food, nutraceuticals, fibre, biofuels, bioactive substances, bioplastics, bioremediation and for enhancement of the ser-

vices traditionally provided by the oceans.

In the session on 'Marine Ecology and Microbiology' Anna Godhe (University of Gotenberg, Sweden) gave an account of the application of molecular genetic studies to understand phytoplankton distribution and ecology. Ann Sofi Rehnstam-Holm (University of Gotenberg, Sweden) threw light on 'Human pathogens in the coastal environment'. B. B. Nayak (CIFE, Mumbai) gave a lecture on 'Viable nonculturable bacteria in marine environment'. He elaborated on the significance of these bacteria in spreading diseases.

The next session was on 'Fishery and Aquaculture'. Indrani Karunsagar (UNESCO Centre for Marine Biotechnology, Mangalore) in her speech on 'Bacteriophage therapy and its application in aquaculture', shed light on various microflora associated with larval stages of shrimp that could affect the health and development of the larvae. M. K. Sajeewan (FSI, Mumbai) briefed about the application of marine resources for the production of a wide range of products and also the application of biotechnology in fisheries, such as brood stock development, germplasm conservation, management of aquatic animals, etc. K. V. Rajendran (CIFE, Mumbai) dealt with 'Molecular diagnostics for shrimp viruses', as shrimp aquaculture has witnessed spectacular growth and has become a central economic engine for the global food-production sector. Deepak Apte (BNHS, Mumbai) deliberated on 'Conserving giant clams through establishment

of conservation reserve in Lakshadweep'. He discussed about Project Giant Clam, which emphasizes on three aspects, i.e. research, community education and livelihood issues.

Baker contemplated on 'Ecosystem change vs climate change' for the Brainstorming session. He elaborately discussed about global warming and its drastic effects on the ecosystem. He presented different types of ecosystems and also on how the climate change, invasive species, over explosion, and pollution have an effect on different ecosystems.

Rakesh Kumar (NEERI, Mumbai) dealt with the impact of climate change on marine resources. India, with its long coastline and a large population supported through fisheries-related resources, will be at great risk due to climate change. He deliberated on the various threats hovering over the marine resources due to climate change. Yasuwo Fukuyo (University of Tokyo, Asian Natural Environment Science, Japan) elaborated on 'Harmful algal blooms and molecular biotechnology for their research'. Several tonnes of unicellular microalgae species produce highly potent toxins and they are called toxic microalgae. He gave an overview of probes to identify these harmful algal species which are usually more specific than morphological identification and labour-saving methods.

Arvind Lali (UICT, Mumbai) emphasized the use of biofuels such as bioethanol and biodiesel from renewable sources, which holds special promise. Use of algal systems for production of hydrogen or algal oil has been projected as the fu-

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