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The ARC Centre of Excellence for Coherent X-ray Science (CXS) is an Australian Government Initiative which began in July 2005 to explore what can be achieved with coherent X-ray optics; including an understanding of exotic phenomena such as X-ray phase discontinuities.

CXS headquarters is located at the University of Melbourne in Victoria, Australia, with participating nodes at La Trobe University, Monash University, Swinburne University of Technology and the CSIRO. Its mission is to be the world leader in the development of non-crystallographic techniques for the determination of protein structures.

"In Coherence" is produced quarterly by CXS. Contributions are welcome and should be forwarded to Ms. Tania Smith, CXS Chief Operating Officer, University of Melbourne Vic 3010, fax to +61 3 9347 8912, email: cxsenquiries@ph.unimelb.edu.au or Ms. Rosslyn Ball, Administration, email: r.ball@ph.unimelb.edu.au

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Welcome to the Attosecond Science Program

CXS is pleased to announce that the Attosecond Group from Griffith University is now officially part of the Centre. The new Program which is based at Griffith University, Brisbane, Queensland will be led by Associate Professor Dave Kielpinski and Associate Professor Robert Sang.

The Program will work closely with the Theory and Modelling Group led by Dr Harry Quiney.

Dr Quiney is looking forward to working with the Group stating that "The inclusion of the atomic and laser physics program at Griffith within CXS will enable us to engage in fundamental studies of strong-field interaction physics and attosecond physics in simple atomic and molecular systems."

"The initial focus will be on developing a detailed theoretical description of above-threshold ionization in atomic hydrogen through its interaction with few-cycle laser pulses that is able to account for the experimental data."

"In the longer term, the collaboration between the Theory and Modelling group and the experimental team at Griffith University is expected to develop descriptions of strong-field laser interactions involving molecules, and to provide insights that feed into the broader research goals of CXS involving the imaging of biological structures by coherent X-ray diffraction."

To celebrate the addition of the new node, CXS will hold one of its 2010 Executive Committee meetings at Griffith University, Brisbane to provide Committee members the opportunity to inspect the Group's facilities.

David Kielpinski, CI and Group Leader of the Attosecond Science Program based at Giffith University, Queensland.

In Coherence

Summer 2010 Newsletter for ARC Centre of Excellence for Coherent X-Ray Science

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CXS Sponsors Nobel Prize Winner Dinner

Pictured from left: A/Prof Lisa Martin, Prof Sarah Russell, Dr Briony Forbes, Prof Jenny Martin, Dr Daniela Stock, Prof Leann Tilley, Prof Juliet Gerrard, A/Prof Emily Parks, Prof Ada Yonath, A/Prof Bridget Mabbutt, Prof Alice Vrielink

Professor Ada Yonath, an Israeli crystallographer best known for her pioneering work on the structure of the ribosome, is the current director of the Helen and Milton A. Kimmelman Center for Biomolecular Structure and Assembly of the Weizmann Institute of Science. In 2009, she received the Nobel Prize in Chemistry along with Venki Ramakrishnan and Tom Steitz for her studies on the structure and function of the ribosome. Prof Yonath is the first Israeli woman to win the Nobel Prize, the first woman from the Middle East to win a Nobel prize in the sciences, and the first woman in 45 years to win the Nobel Prize for Chemistry.

Prof Yonath was invited to Australia to present plenary talks at the Lorne Protein Structure and Function Meeting (Feb 7-11) and the Biology of Synchrotron Radiation Meeting (Feb 14-18). Her talk at the Lorne Proteins meeting was a tour de force, explaining that ribosomes are a complex assembly of macromolecules that perform protein biosynthesis. They are made of several RNA molecules, assisted by a number of distinct protein molecules. Prof Yonath also described her work on the determination of the complete high-resolution structures of the two ribosomal subunits. She discovered, within the otherwise asymmetric ribosome, a universal symmetrical region that provides the framework for and navigates the process of polypeptide formation. She describes ribosomes as factories and said that the ribosome has enzyme activity (i.e. it is a ribozyme). It places the tRNA-bound amino acid substrates in the correct stereochemistry to facilitate peptide bond formation. She described the path taken by the nascent polypeptides through the ribosomal tunnel, and the dynamic elements that control the rate of polypeptide elongation and direct the nascent chain into a space where it can begin to fold.

A celebration of both Prof Yonath's Nobel Prize and her remarkable curls!

Prof Yonath enthusiastically supports the RNA-world hypothesis; that is that RNA predated both proteins and DNA during the origin of life. She points to evidence for an ancient RNA machinery (a proto-ribosome) residing within the core of the modern ribosome. She believes that this proto-ribosome was the pre-biotic RNA synthesizing machine and that the ribosome was initially an RNA replicase that was hi-jacked by amino acids to produce polypeptides. Indeed the RNA core of the ribosome is highly conserved in all divisions of life, which has led her to the view that there are 1000s of pre-historic machines lying hidden within every cell.

During the Lorne Conference she accepted Prof Leann Tilley's invitation to meet with some of the women protein scientists who had been inspired by her work. Prof Yonath explained that the main requirements for winning a Nobel Prize are curiosity, determination and passion. She has an ability to work super-human hours, a deep interest in people and in human nature, a wide ranging interest in science and an optimistic personality.

CXS is thanked for generously supporting this event.

In Brief

Publications:

Publications for the previous quarter include:

Hanssen E, Carlton P, Deed S, Klonis N, Sedat J, DeRisi J, Tilley L *"Whole cell imaging reveals novel modular features of the exomembrane systems of the malaria parasite, Plasmodium falciparum."* Int J Parasitol, Jan; 40 (1): 123-34 (2010)

Hall CE, Dao L, Koike K, Sasa S, Tan H, Inoue M, Hannaford P, Jagadish C, Davis JA, *"Recombination dynamics and screening of the internal electric field in ZnO/ZnxMg1-xO multiple quantum wells."* Physical Review B, 80, 235316 (2009)

Sheludko DV, McCulloch AJ, Jasperse M, Quiney HM, Scholten RE, *"Non-iterative imaging of inhomogeneous cold atom clouds using phase retrieval from a single diffraction measurement."* Optics Express, 18 (2), 1586-1599 (2010)

Storchi L, Belpassi L, Tarantelli F, Sgamellotti A, Quiney HM, *"An efficient parallel all-electron four-component Dirac-Kohn-Sham program using a distributed matrix approach."* Journal of Chemical Theory and Computation, 6, 384-394 (2010)

Nugent KA,*"Coherent Methods in the X-ray Sciences."* Advances in Physics, Vol.59, pp, 1-99 (2010)

Arhatari BD, Gates WP, Eshtiaghi N, Peele A "*Phase retrieval tomography in the presence of noise."* Journal of Applied Physics, 107, 034904 (2010)

Zatsepin NA, Dilanian RA, Nikulin AY, Gao X, Muddle BC, Matveev VN, Sakata O "*Real time in situ nanoclustering during initial stages of artifical aging of A-Cu alloys.*" Journal of Applied Physics, 107, 024303 (2010)

CXS Visitors:

Dr Garry Rumbles, National Renewable Energy Laboratories, Colorado, USA, visited the Short Wavelength Laser Source Program at Swinburne University.

Viviane Richter, top honours student at UNSW visited the Biological Science Program at La Trobe University.

Conferences & Workshops:

Nor Aziz presented a poster "Coherent diffraction X-ray imaging using high harmonic generation source" at the KOALA Conference in Sydney, November 2009.

Sabastian Bell, Mark Junker and Rob Scholten attended the Australasian Conference on Optical Fibre Technology in Adelaide, November 2009.

Associate Professor Trevor Smith organised and attended the Light in Life Sciences Conference at the University of Melbourne, November 2009.

Ben Morrison presented "Picosecond X-ray source based on femtosecond Ti:Sapphire Laser" at the Ultrafast Laser Users' Workshop, February 2010.

Eric Hanssen was a guest speaker at the CXS X-ray Microscopy Workshop held at La Trobe University, February 2010.

Dr David Vine presented a talk titled "Fresnel Coherent Diffractive Imaging: A new technique for bio-imaging" at the Biology and Synchrotron Radiation, February 2010.

Lachlan McKimmie presented "Three pulse photon echo studies of core-shell semiconductor quantum dots" at the Ultrafast Laser Users' Workshop, February 2010.

Education:

Summer student Camille Mucha completed a project making webpages for the tomography facility with the Experimental Methods Program at La Trobe University.

The Growing Tall Poppies program was unsuccessful at the National Finals of the NAB Schools First Award. Well done on the State award.

Tania Smith was an invited speaker at the University of Melbourne Research Office seminar, *COE's - An Insiders Prespective,* February 2010.

Welcoming New Members:

Gabrielle Fejes, MSc student, Ultracold Plasma Source Program, University of Melbourne.

Marc Kvansakul, NHMRA CDA Fellow, of the Biological Sciences Program at La Trobe University.

Catherine Palmer, PhD student, Biological Science Program at La Trobe University.

Kendra McPherson, Hon student, Biological Science Program at La Trobe University.

Thanh Ngoc Nguyen, Hon student, Biological Sciences Program at La Trobe University.

Henry Kirkwood, MSc student, Experimental Methods Program at University of Melbourne.

Daniel Wells, MSc student, Theory and Modelling Program at University of Melbourne.

Member Departures:

Professor Robert Lewis of the Detector and Beamline Development Program at Monash University.

Dr Chris Hall of the Detector and Beamline Development Program at Monash University.

Dr Garth Williams of the Experimental Methods Program at the University of Melbourne.

Sam Flewett of the Experimental Methods Program at the University of Melbourne.

Dr Olena Ponomarenko of the Theory and Modelling Program at the University of Melbourne.

Dr Eric Hanssen of the Biological Sciences Program at La Trobe Univesity.

CXS End of Year Overview 2009

Delegates relax in the sunshine over a Christmas BBQ lunch

CXS held its annual End of Year Overview Day on 4 December 2009 in the Yasuko Hiraoko Myer Room of the Sidney Myer Asia Centre in Melbourne.

About 50 delegates enjoyed the day which included a delicious BBQ lunch under the Asia Centre's enormous awning. The weather was ideal and the venue delightful as everyone tucked in to enjoy their lunch.

The day's proceedings commenced with the Director's welcome and a summary of the activities emanating from the CXS retreat, followed by presentations from all CXS program teams.

The Growing Tall Poppies outreach session was conducted by Dr Eroia Barone-Nugent. Three students, Tess Kurginis, Kate Latkoska and Breana Casuillo from Santa Maria College provided an program and their candid and refreshing answers to questions from the floor delighted the audience. This was followed by Francesca Calati presenting a short clip of the CXS video project at La Trobe University.

Deputy Director, Professor Leann Tilley conducted the wrap up sessions at the conclusion of the proceedings. Afterwards, to complete a most informative and enjoyable experience, refreshments were served.

An insight into Andrei Nikulin

Andrei Nikulin, a member of the CXS Experimental Methods Program, works for the School of Physics, Monash University, where he leads a research program in fundamental x-ray diffraction physics.

The group's activities include the development of novel diffraction-based techniques for detailed profiling of nano-scale structures. Recent developments include quantitative profiling of the structure factor of SiGe quantum dots and local strain in GaAs nano-scrolls, determination of size and shape of PbS nano-particle assemblies, studies of the effect of degree of coherence on the quality of shape-reconstruction of polymer and gold nanowires, radiation heat load in diffraction experiments with nano-structures, experiments in coherent diffraction at a 90-degree Bragg reflection, to name a few. Andrei also plays a very active teaching role within the School of Physics at Monash.

Andrei received his PhD in Solid State Physics from the USSR Academy of Sciences. His PhD project was a part of the original development of the Bragg-Fresnel Optics.

He has worked at the Institute of Microelectronics Technology, USSR Academy of Sciences, at the Tokyo Institute of Technology (as a JSPS Fellow), and at the University of Melbourne. He has held a visiting appointment with Riken/SPring-8 (1999-2004) and a visiting professorship with the National University of Singapore and SSLS (2008).

Andrei joined Monash University as a Logan Fellow in 1996, and since established a state-of-the-art Phase-Retrieval Diffractometry laboratory at the School of Physics. The facility is now equipped with an Ultra-Bright rotating anode generator, which is, coupled with advanced multilayered and crystalline optics, capable of producing a coherent x-ray beam of spectral brightness that is on par with a second generation 2.5 GeV synchrotron. There are two experimental beamlines attached to the generator dedicated to experiments in diffraction nanoscopy.

Andrei is a very active user of international synchrotron facilities, mainly SPring-8, with 18 years of extensive experience in synchrotron experiments. He is a part of a wide and active network of international collaborations that are dedicated to advanced diffraction x-ray imaging of nano structures.

Andrei's son, Dmitri, works as a software engineer for the Monash Centre for Synchrotron Science and as a researcher for the Faculty of IT. Recently, Dmitri participated in his first synchrotron experiment at the Australian Synchrotron.

Associate Professor Andrei Nikulin

Experimental Methods Program