

In Coherence

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The New ARC Centre of Excellence Opens!

Wednesday the 19th April saw the University of Melbourne's School of Physics host the official opening of the ARC Centre for Excellence in Coherent X-ray Science (CXS).

From within the elegant surroundings of the Ian Potter Museum of Art in Swanston Street, Centre Director, Professor Keith Nugent, began the evening by explaining the motivations for establishing the Centre and enthusiastically summarising its activities and projects.

The University of Melbourne's Deputy Vice

Chancellor (Research), John McKenzie, introduced the new Centre to the estimated 90 guests included representatives from all participating institutions, as well as CXS members, alumni and friends. Everyone present freely enjoyed served refreshments while socialising and viewing the extensive art collection.

Presentations were made by Glyn Davies, Vice Chancellor, University of Melbourne; Michael Barber, CSIRO Executive Director of Science Planning; and Margaret Clayton, ARC Executive Director of Biological Sciences and

Biotechnology, who described the Centre as, "... a significant change in the way scientists work; bringing together biochemists and physicists, and developing cross-disciplinary programs".

The Centre's official opening proceeded the first meeting of the Scientific Advisory Board, and the first international workshop at the La Trobe University Institute for Advanced Studies.



Prof. Geoff Taylor, Prof. Glyn Davis and Prof. Keith Nugent at the opening of CXS in April 2006

Up & Coming Events:

- ***XTOP 2006, 8th Biennial Conference on High Resolution X-Ray Diffraction and Imaging***
19-22 September 2006, Karlsruhe/Baden-Baden (Germany)
- ***9th International Conference on Biology and Synchrotron Radiation, 13-17 August 2007, Manchester, England***

The Place to be!

Early in 2006, an agreement was reached with the University of Melbourne to renovate a space on level two of the School of Physics to serve as the headquarters and administrative focus of CXS.

A large fraction of the available space has been utilized as a meeting room in order to encourage frequent meetings between members of the Centre.

There is sufficient space to hold group colloquia, board and committee meetings, as well as the inevitable Centre Christmas party.

The building works were completed in June, and the new premises opened for business on 21st July.

The centre has been decorated as a result of a group excursion to Ikea, and has been stocked with all of the usual electronic

equipment needed for productive science. We are also in the process of arranging guest computer access for all members.

So next time you are in the area please visit the facility, as we look forward to welcoming all members of the Centre and hope it will become the focus of our activities.



Associate Professor Mike Ryan, Mitochondria Biogenesis and Disease, La Trobe University, leads the Biological Sciences Program Team



Professor Rob Lewis, Monash Centre for Synchrotron Science leads the Detector and Beamline Development Program Team



Dr. Andrew Peele, Physics, La Trobe University, leads the Experimental Methods Program Team

Biological Sciences Program Team

X-ray crystallography has provided the basis for most of the advances in structural biology over the past eighty years. While this form of analysis is now regarded as routine technology, it is the forming of suitable crystals with biological molecules which presents the greatest obstacles for us to move forward.

To ensure we do, the Biological Sciences Program team, led by Associate Professor Mike Ryan of the Department of Biochemistry at La Trobe

University, will produce and handle suitable membrane protein samples, as well as produce and process contrast-enhanced samples for cellular imaging.

Some progress has already been made in this direction by applying coherent diffractive imaging techniques to the imaging of malaria-transfected blood cells.

The team now intends to obtain a more detailed picture of functionalities within cells by direct

observation using X-ray diffractive imaging than is currently available from simple models.

For further information on the Biological Sciences Program team and their work please email Associate Professor Mike Ryan at m.ryan@latrobe.edu.au or phone on 9479 2156.

Detector and Beamline Development Program Team

In order to be able to complete the scientific goals of the CXS the technical experts of the Detector and Beamline Development Program team aim to develop experimental facilities, and design and assemble the instrumentation for a vacuum beamline endstation at the new Australian Synchrotron, located on Blackburn Road, Clayton.

Led by Professor Rob Lewis of the Monash University Centre for Synchrotron Science, the team will develop detectors that are optimized to the experimental conditions which exist in the CXS X-ray diffraction experiments and will address issues such as sensitivity, response non-linearity, latent memory and readout fidelity.

For further information on the Detector and Beamline Development Program team and their work please email Professor Rob Lewis at Rob.Lewis@sync.monash.edu.au or phone on 9905 3622.

To learn more about the Australian Synchrotron visit their website at: synchrotron.vic.gov.au

Experimental Methods Program Team

Led by Dr. Andrew Peele, the major emphasis of this team is developing techniques that will be used in X-ray imaging experiments, building on their recent successes using curved beam illumination to aid image recovery.

Working closely with the Theory and Modelling Program group, the team aims to put in place

effective methods of image recovery in advance of the opening of the Australian Synchrotron facility in 2007. This will allow the CXS to hit the ground running when this national resource becomes available.

The Experimental Laser Research Laboratory is to be located in room D013 of the School of Physics at the University of

Melbourne.

For further information on the Experimental Methods Program Team and their work please email Dr. Andrew Peele at a.peele@latrobe.edu.au or phone 9479 2651.

Theory and Modeling Program Team

There are three strands of research being performed by the Theory and Modeling team, led by Dr. Harry Quiney from the University of Melbourne.

Coherence Physics: The first question to be answered here is whether partial coherence can be turned to our advantage in X-ray diffraction studies.

Algorithms: The core of the activity in this area is the development of theoretical and computational methods to extract structural information from

quasi-periodic or non-periodic systems.

Strong-field Interactions: In the context of X-ray imaging studies lies open questions that can only be answered by detailed modeling of the matter-radiation dynamics. The response of a sample to the electric field of a beam generated by a third-generation synchrotron source is routinely modeled as a "weak perturbation" to the underlying electronic structure. The use of X-FEL radiation undertaken by this team

will require, in contrast, a greatly increased understanding of the fundamental physical interactions between radiation and matter.

For further information on the Theory and Modelling Program team and their work please email Dr. Harry Quiney at quiney@unimelb.edu.au or phone on 8344 8178.



Dr Harry Quiney, School of Physics at the University of Melbourne (aka Dick Dastardly) leads the Theory and Modeling Program Team

Short Wavelength Laser Source Program Team

The Short Wavelength Laser Source Program team based at Swinburne University of Technology's Hawthorn campus and the University of Melbourne's Parkville campus are developing a tabletop source of highly coherent vacuum-ultra-violet, or soft X-rays, using high harmonic generation techniques.

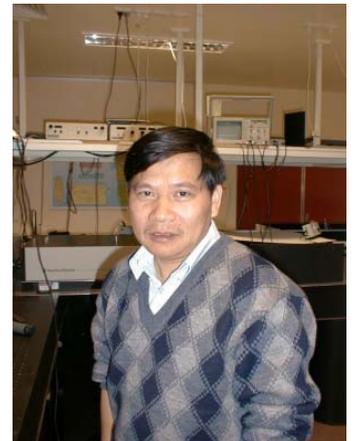
Led by Prof Lap Van Dao,

the team is engaged in developing these compact short wavelength sources as a means to investigate alternatives to the use of X-ray Free Electron Lasers (XFELs) in coherent diffractive imaging.

With the added power of the recently purchased **Ultrashort-Pulse, High-Pulse Energy Laser System**, housed at Swinburne University and funded by

the *Science, Technology and Innovation Initiative*, the team will be investigating the nature of non-linear physical processes in laser-molecule interactions and the use of X-ray free-electron laser sources in imaging applications.

For further information on this program team and their work please email Professor Lap Van Dao at dvlap@swin.edu.au or phone 9214 4317.



Professor Lap Van Dao, Physics at Swinburne University leads the Short Wavelength Laser Source Program Team

Welcoming New Staff

It gives us great pleasure to welcome our most recent appointments:

Tania Smith is to serve as our Chief of Operations (COO), coming to us with a background in management and marketing at Deakin University. Rosslyn Ball also joined us as Personal Assistant to the Director and COO, and hails from the CRC for Clean Power

from Lignite.

Our newly confirmed researcher appointments are:

* Dr Garth Williams: Experimental X-ray physics, coming from the University of Illinois

* Dr Mark Pfeifer: Experimental X-ray physics, coming from the University of Oregon.

* Dr Olena Ponomarenko: Theoretical physics of laser-molecule interactions, coming from the University of Newcastle

* Dr Rotha Yu: Theoretical physics of image recovery algorithms, coming from Monash University

* Dr Anton Barty: Experimental X-ray physics, coming from the University of California



Rosslyn Ball and Tania Smith are two of the latest additions to the CXS team

The CSIRO Teams



Professor Jose Varghese of the Membrane Protein Samples team from the CSIRO Parkville, who along with Professor Steve Wilkins of the Structure Determination Methods team from CSIRO Clayton, form an intricate part of the CXS group

The CSIRO recently announced a research programme in structural biology as part of their Emerging Science Initiative scheme (ESI). Two CSIRO groups led by Prof. Jose Varghese and Prof. Steve Wilkins are funded within ESI, and contribute their internationally recognized expertise to CXS in the fields of structural biology and coherent diffractive imaging.

Jose Varghese is an Australian pioneer of the cross-disciplinary style of research that characterizes the Centre's activities. He studied physics and mathematics at the Universities of Queensland and Western Australia. He joined CSIRO in 1984, where he has worked with protein structures ever since. He was seconded to the Biomolecular Research Institute from 1990 to 2000 then returned to CSIRO to

head the Structural Biology Program.

The current interests of his group at CSIRO Parkville include the investigation of the structure and function of cell receptors, viral antigens and drug resistance in pathogenic organisms. His facilities include an X-ray diffraction laboratory, drug design facility, virology and parasitology laboratories, and a proteomics facility. The contribution of this group to CXS is in the preparation and handling of membrane protein samples and crystallographic analysis of these nanocrystalline samples.

Steve Wilkins joined CSIRO in 1975 and is now a Chief Research Scientist. His research interests include various theoretical and experimental aspects of X-ray diffraction and imaging, as well as the design of new X-ray

instruments, such as *BigDiff* at the Photon Factory, Japan. He is the leader of the CSIRO team at Clayton that has been active in developing novel methods of X-ray imaging, particularly those involving phase-contrast, using both conventional and synchrotron sources.

This group has been instrumental in leading CXS into the area of grazing incidence analysis of layered samples, and recently hosted a workshop in Clayton on this subject. The potential application of these techniques was discussed in the context of the ambitions of CXS towards the determination of membrane protein structures.

For further information on the CSIRO and its work please email Jose at jose.varghese@csiro.au or Steve at steve.wilkins@csiro.au.

International Guests Galore

In April, the first CXS international workshop was held over two days at La Trobe University with approximately 60 attendees.

The Coherent X-ray Imaging in Biology workshop covered the following subjects by our international guests:

Generation and application of synchrotron radiation at SLS - imaging and superconducting miniundulator, presented by Herbert Moser from the National University of Singapore

Synchrotron CD, presented by Bonnie Wallace from Birkbeck College, University of London

Structural biology, presented by Bob Janes of University of London

Softly does it! Cracking lobster shell protein structures and some methodology implications, presented by John Helliwell of University of Manchester

The National Science Foundation Center for Biophotonics, presented by Steve Lane of Lawrence Livermore National

Laboratory, University of California

Coherent Imaging of Biological Samples, presented by John Miao from University of California

Soft x-ray diffraction imaging aimed at whole cells, presented by Chris Jacobsen of Stony Brook University, New York

The workshop coincided with the first meeting of the Scientific Advisory Board designed to assess out future research directions.



Participants of the Coherent X-ray Imaging in Biology Workshop at La Trobe University in April

What's Ahead?

Professor David Ferguson from the Nuffield Department of Pathology, University of Oxford, John Radcliffe Hospital, Oxford, has been invited to visit La Trobe University from 16th October - 4th November, 2006.

David is an expert in electron microscopy preparation techniques and will assist with the work being done by the Biological Science Program team. He is also scheduled to give a talk during his visit with details still under negotiation.

Chris Jacobsen, Professor of Physics at the State University of New York, Stony Brook and leader in coherent diffracting imaging, is visiting La Trobe University to assist in the building of a microscope with the Experimental Methods program team.

Chris will be doing a number of Distinguished Visiting Fellow Public Lectures and will be giving the following seminar:

* *Picking the Right Tools for the Job: X-ray and Electron Interactions, X-ray*

Microscope Systems, and X-ray Optics, 11th August, 4pm, CXS, University of Melbourne (please RSVP via CXS— space is limited)

* *Chemical Imaging at the Nanoscale: Soft X-ray Spectromicroscopy in Biology and Environmental Science* — 23rd August, 11am, room 411, La Trobe's Department of Physics

* *To live and Die in LA (laboratory apparatus): Radiation Damage and its Limitations for High Resolution Imaging* — 28th August, 3pm, Institute of

Advanced Study, La Trobe University

* *X-ray Imaging: From the Hand of Rontgen's Wife, to the Structure and Chemistry of Cells*: IAS public lecture — 28th August, 4 pm, Institute of Advanced Study, La Trobe University

* *Nanofabrication of X-ray Zone Plate Optics*: Seminar for LaTrobe [physics / nanotechnology](#) undergraduates— 29th August, 5 pm, Hooper Lecture Theatre, La Trobe University.

Public Appearances

Late December saw the publication of the first article produced wholly within CXS.

We began as we intend to continue, and chose the prestigious journal *Nature Physics*. This article, entitled *Diffractive Imaging of Highly Focused X-ray Fields* by H.Quiney, A.Peele, Z. Cai, D Paterson and K. Nugent appeared in volume 2, February 2006 edition.

Other articles published include:

Phase-Space Reconstruction of Focused X-ray Fields by C.Tran, A.Mancuso, B.Dhal, and K.Nugent, published in the *Optical Society of America Journal* Vol.23, No. 7, July 2006

Three-dimensional mapping of a deformation field inside a nanocrystal by M.Pfeifer, G. Williams, I. Vartanyants, R. Harder

& I. Robinson, published in *Nature* Vol 442 | 6 July 2006

Commentaries have also been made about CXS in the media, including:

X-Ray Eyes, Campus Chatter, The Age, July 18th, 2005

New Centre to Look at Approaches to Imaging Proteins, Australia Biotechnology News August 8th, 2005.

Biological Team Dives Right in!

The biological program team has provided samples of malaria-transfected blood cells for use by the Experimental X-ray Program team.

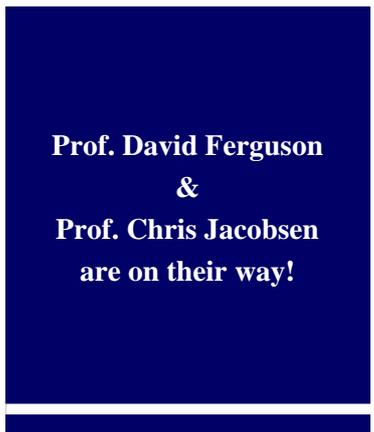
They have also been interacting with the Experimental Methods Program team to determine the optimal staining techniques to achieve high-definition images

from diffraction data.

These samples have now been the subject of two experimental campaigns conducted by Jesse Clark, Andrew Peele, Lachlan Whitehead, Garth Williams and Eric Hanssen at the Advanced Photon Source at Chicago and have yielded low-resolution images.

The Experimental group

are now in the process of analyzing the over 30,000 images to enhance the resolution of the reconstructions.



Left to Right: Jesse Clark, Dr Garth Williams, Dr Eric Hanssen, Dr Andrew Peele and Lachlan Whitehead at the Advanced Photon Source in Chicago

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Associate Professor Ian Gentle from the University of Queensland's Molecular & Microbial Science School was guest speaker at this years CSIRO Workshop

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 monthly by the CXS. Contributions are welcome and should be forwarded to Ms. Tania Smith, CXS Chief of Operations, University of Melbourne Vic 3010, faxed +61 3 9347 8912, Email: tnsmith@ph.unimelb.edu.au or Ms. Rosslyn Ball, Administration, Email: r.ball@ph.unimelb.edu.au

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The Matter of the Scatter

A workshop was held at the CSIRO in July to explore the possibilities of Grazing Incidence Small-Angle X-ray Scattering experiments in structure determination of two-dimensional crystals of membrane proteins.

This Workshop drew together experts from within CXS as well as a guest speaker, Professor Ian

Gentle of the University of Queensland, whose work in the use of this technique in the surface analysis of multi-layered materials makes him the recognized national authority in this area.

This workshop was held as a direct response to suggestions made by members of the International Scientific

Advisory Board. They felt it was prudent to accelerate our assessment of this approach within the planned program of research, since local facilities were capable of collecting data that potentially is amenable to structural analysis.

And the Winner is?



Clare Henderson and Dr. Andrew Peele at work in the CXS meeting facility.

"This is better than winning the grant for the Centre of Excellence!", Andrew said when he heard he had won the competition.

The first edition of our Centre's newsletter was the talk of CXS - but what were we to call it?

We asked you to provide the catchiest title ideas you could come up with and we were inspired by over 50 responses, largely focusing on the use of the beloved acronym.

But there was also titles that produced great imagery, quite a few play on words - and even a reference to sexing us up a bit!

After a thorough voting process the lucky winner, who claims a personally

selected bottle of wine to the value of \$50, is Andrew Peele from the Department of Physics at La Trobe University.

Congratulations to Andrew, who's title "In Coherence" took first place in a very tight race.

Other close runners include:

X-ray Vision
Julie Warden, UM & Samantha Deed, LT

Wave Front
Steve Wilkins, CSIRO

Lucidity
Harry Quiney, UM

Speaking Coherently
Rob Lewis, MU

CXSI
Steve Wilkins, CSIRO

Scintilla
Tania Smith, CXS

Reciprocal Space
David Paterson, ASP

Thanks to all of you who entered and keep reading "In Coherence" for more opportunities to win quizzes and competitions!