

# SEMINAR

## Movies of molecular machines at work: XFELs and fast electron beams

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**Monday 8 February**

**11.00am – 12.00pm**

Science Lecture Theatre S1, Building 25  
16 Rainforest Walk, Monash University

### Abstract and Bio

This talk will review recent applications of the X-ray laser (LCLS) near Stanford to obtain molecular movies of light-sensitive proteins, and discuss related approaches using electron beams for fast diffraction and imaging, and the extension of these methods to proteins not sensitive to light. The work forms part of the NSF's BioXFEL Science and Technology Center, a consortium of seven US campuses devoted to the use of X-ray lasers for biology (<http://www.bioxfel.org>). In a collaboration led by Dr. Marius Schmidt (1) we have used the LCLS to achieve femtosecond time resolution in X-ray snapshot diffraction from nanocrystals of Purple Yellow Protein during the trans-cis isomerisation process which results from the detection of a photon. This is similar to the first event in human vision, involving a conical intersection (degeneracy) of nuclear coordinates. These density maps provided atomic resolution without significant radiation damage by the "diffract-then-destroy" mechanism, which allows us to out-run radiation damage. In a collaboration led by Henry Chapman, a method has been devised for using the diffuse scattering due to static molecular displacements in protein crystals between Bragg reflections to both extend resolution and solve the phase problem. For certain defect structures, this diffuse provides directly the molecular transform (2). The challenges in undertaking similar work using a pulsed electron microscope or diffraction camera will be reviewed, and an optimum scheme proposed for a fast electron microscope design (3). For a review of several new schemes for time-resolved imaging by diffraction, see (4).

#### References

1. Tenboer ....Schmidt. Science 346,1242 (2014). See also Pande K.P. et al Science. Submitted. (2016).
2. Chapman et al Nature (2016). In press.
3. Spence et al J.Phys B. (AMO). 48, 214003. (2015).
4. Spence. Faraday Discussions. Vol 171, p 429 - 434 (2014)

*John C. H. Spence completed a PhD in Physics at Melbourne University in 1972, followed by a postdoc at Oxford UK.*



*He received the Distinguished Scientist award of the Microscopy Society of America for 2006, the Buerger Award of the American Crystallographic Society in 2012, the J.M. Cowley Medal of the International Federation of Societies of Microscopy for 2014, the Burton Medal of MSA and a Humbolt Senior Scientist award. He is a Fellow of the Royal Society (Foreign Member), the American Association for the Advancement of Science, the American Physical Society, the Microscopy Society of American, of the Institute of Physics (UK), and of Churchill College Cambridge, UK. He was Co-Editor of Acta Cryst (A) for North America (Diffraction Physics, 1990-2000) and is Main Editor of IUCRJ (XFEL Science). He has served on Scientific Advisory Committees at LBNL and is a member of the DOE BESAC Committee,. He was chair of the International Union of Crystallography Commission on Electron Diffraction, a member of the IUCr commission on Charge, Spin and Momentum densities. A Festschrift volume of Ultramic appeared*

*in July 2011. The X-ray laser structural biology work with our collaborators was ranked among the top ten scientific breakthroughs of 2012 by Science magazine. John has US and Australian citizenship.*

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