Australian Institute of Physics NSW Branch (March News)

The March meeting of the NSW branch of the AIP was held at the University of Sydney on Tuesday 24 March 2009 and featured two unique topics in physics to launch the branches first double meeting of the year. Our first speaker Dr Rob Robinson is the Acting Chief of Research and Head of the Bragg Institute at the Australian Nuclear Science & Technology Organisation, just outside Sydney. His talk gave us an insight into how Australian science is entering a new "golden age", with the recent start-up of bright new neutron and photon sources in Sydney and Melbourne, respectively. Dr Robinson commenced his presentation from "Why Neutrons"

Scatter from nuclei ⇒ different contrast to X-rays
⇒ different isotopes scatter differently (esp. H & D)
⇒ good for oxides, polymers, organic materials,…
Scatter from magnetism in materials ⇒very good for magnetic materials
Interact weakly ⇒ can penetrate into materials, furnaces, pressure cells, etc.
⇒ need lots of sample and beams are large
⇒ shielding is massive
Sources are relatively "dim"⇒ lots of tricks to maximise efficiency e.g. guides, focussing devices
⇒ experiments are relatively expensive
Very simple interaction ⇒ analysis is quantitative & simple. Can use polarised neutron beams (mainly for magnetic materials)

Dr Robinson then explained that the OPAL reactor and the Australian Synchrotron can be considered the greatest single investment in scientific infrastructure in Australia's history. Dr Robinson stated that fuel was loaded into the OPAL reactor in August 2006, and full power (20MW) was achieved in November 2006. The formal user commenced in 2007, and fully analysed data sets have now been taken on all seven of the initial suite of instruments. Three further instruments are in various states of construction, and substantial additional investment is also being made in sample-environment, extra instrumental options and polarised-neutron technology. An update was given on the status of OPAL, the performance of its thermal and cold neutron sources and instruments, and the talk showed the selection of the first scientific results and future plans. Dr Robinson concluded that OPAL ran well at 20MW for first-half 2007, & since May 2008; Cold Neutron Source is working well; Called for proposals on 1st 2 instruments (March 2007); 81 proposals for 357 days; Commissioning licences for 7 instruments; Operating licences for 6 instruments; Full patterns in 7 instruments; 3 more funded; Project cost of ~A$400M (incl. $35M on instruments) and will operate 340 days/yr.

Photo 1: From left to right, Mr David Rushton, Dr Rob Robinson and Dr Fred Osman (AIP Branch Chair).

The second talk of the night featured Professor Roger Lewis from the University of Wollongong. Prof Lewis is an active researcher in the area of terahertz science and technology. (The terahertz region of the electromagnetic spectrum falls between the infrared and microwaves.) The talk covered the areas of fundamentals of terahertz science and technology, the challenges presented, and how these are being addressed by current research. Beyond the rainbow lie "colours" imperceptible to the human eye. "Terahertz", or "T-rays" are a palette of these. T-rays offer a different and unique way of viewing our world. While terahertz (THz, 1012 Hz) radiation has been around for at least as long as the sun has been shining it has in the past been difficult to produce, manipulate and detect – certainly in contrast to the sophisticated technologies that have arisen in the radio and optical regions of the electromagnetic spectrum that bracket it.

Now, thanks to intense research over the past few years, the so-called "terahertz gap" between electronics and photonics is being bridged ever more strongly, opening up a myriad of practical applications. Detectors of THz radiation include the pneumatic Golay cell, pyroelectric and Schottky devices and, most sensitive, liquid-helium cooled bolometers. Each of these detectors has its limitations. THz optical elements are not as advanced as their visible optical counterparts: metallic mirrors are used extensively; lens materials suffer a combination of difficulties due to relatively high refractive index on the one hand and relatively high absorption on the other. Better THz emitters will assist in all applications of THz technology and this has been the subject of intense research lately.

Sources of THz radiation include large-scale national facilities such as synchrotrons and free-electron lasers all the way down to the humble "globar", a rod of silicon carbide heated by passing an electric current through it and acting as a blackbody radiator. A compact, powerful, easy-to-use source does not yet exist. Much interest recently has been in THz emitters pumped by an ultrashort (<100 fs) optical pulse, typically provided by a Ti:sapphire laser. In a suitable pump-probe geometry such emitters permit time-domain spectroscopy. This has the advantage over conventional spectroscopy that the electric field, rather than the power, of the THz radiation is detected, and so both the real and imaginary parts of the optical constants are simultaneously accessed. Many of the new ultrafast THz emitters are based on semiconductor devices and much work has been done at Wollongong over the last few years studying these. The main mechanisms of THz generation are optical rectification, which occurs in crystals with nonlinear optical properties, transient currents (either induced by a surface field or by the photo-Dember effect), which depends on the band structure, and photoconductivity, in which an applied electric field assist in the generation of the radiation. All these types of emitters are under active research to fully explicate the underlying physical mechanisms with the view to engineering new THz devices with improved efficiency.

Practical applications span secure communications, especially for secure local area networks, where the absorption of THz radiation by atmospheric water vapour ensures the signal is highly attenuated and less liable to eavesdropping; security applications, including stand-off detection of concealed weapons and explosives and non-contact scanning of mail for illicit substances; sustainability, in sorting and monitoring plastics; medicine, especially in dental and dermatological applications where additional and complementary information is available than from X-rays; agriculture, in the measurement of hydration in real time.

Photo 2: From left to right, Dr Graeme Melville (AIP Branch Secretary), Professor Roger Lewis and Dr Fred Osman, (AIP Branch Chair).

The talks were very well received and geared to scientists and members of the public alike with many discussions continuing later during dinner at a nearby Italian restaurant. The Australian Institute of Physics thanks both Dr Robinson and Prof Lewis for there outstanding lectures!

Australian Institute of Physics NSW Branch (Student Prize Giving)

The Australian Institute of Physics has been very active each year in acknowledging prizes for the best graduating students from each University in recognition of there outstanding achievements in Physics. This initiative has been set-up to recognize and target students to be involved in future AIP initiatives. On Wednesday 1 April the AIP secretary Dr Graeme Melville attended the UNSW prize giving ceremony and presented a $400 cheque and an AIP certificate to Mr Gidon Jones for his outstanding recognition in attaining the highest aggregate in the Bachelor of Science program. On Wednesday 22 April the AIP secretary Dr Graeme Melville also attended the Macquarie University prize giving ceremony to award the AIP prize to Mr Chris Wood for his outstanding achievements in Physics. The AIP congratulates both students on there achievements.

Dr Frederick Osman - AIP NSW Branch Chair