Australian Institute of Physics NSW Branch (April News)

The April meeting of the NSW branch of the AIP was held at the University of Sydney on Tuesday 28 April 2009 and featured two unique topics in physics to launch the branches second double meeting of the year. Our first speaker Dr Bruce Yabsley is a particle physicist with interests in flavour physics, neutrinos, and statistical methods. In the nineties he worked as part of the Australian team on the NOMAD experiment at CERN, completing a PhD on neutrino oscillations. In 1999 he moved to the K.E.K. lab in Tsukuba, Japan, to join the Belle experiment, which was built to study CP violation (matter-antimatter asymmetries) and cited in the award of a share of the 2008 Nobel Prize to Kobayashi and Maskawa. Bruce held postdoctoral positions with K.E.K. itself and with Virginia Tech, and for many years was convener of the Belle experiment's Charm Studies group. He has presented reviews at international conferences on new physics in charm decays, anomalous quarkonium-like states, and quantum entanglement; and serves on the advisory committee for the International Workshops on Charm Physics. Bruce is currently an ARC Australian Research Fellow at the University of Sydney, where he is pursuing research into the structure of mesons.

His talk gave us an insight into the Standard Model of particle physics – describing the fundamental constituents of matter, and their interactions --- has been extraordinarily successful. Over decades it has passed every test set for it, and even now there are only a handful of measurements in conflict with its predictions: few-sigma effects of the kind that come and go, and are inevitable when many measurements are made. Any one of them might be the first sign of something new ... or they might all evaporate, as other presumed failings have done in the past. And yet we know that the Standard Model is incomplete. The mathematics itself tells us that something else must be going on, but doesn't determine what that "something" is. Experiment has to find a way. There are three broad strategies being pursued at accelerator laboratories around the world, to find that way forward. One can increase the energy of the particles in colliding beams, giving access to shorter distances, and more massive fundamental particles: this is the approach of the Large Hadron Collider at CERN. One can make the beams more intense ("more amps" rather than "more volts") as at labs in California and Japan, using precision measurements to probe for new phenomena hiding in the fine print of the theory. Or one can use neutrinos, whose very difficulty --- they interact only by the weak nuclear force --- makes them sensitive to certain kinds of new physics. In this talk I will review these three approaches, with examples of how they have worked in the past, and of the experiments that are currently bringing them to life. Until it happens, we can't know which approach (all of them with Australian involvement) will be the one to finally break the Standard Model, and show the new physics beyond it.

Photo 1: From left to right, Dr Fred Osman (AIP Branch Chair), Dr Bruce Yabsley and Dr Graeme Melville (AIP Branch Secretary),

The second talk of the night featured Professor Joe Wolfe from the University of New South Wales. Joe has won awards or medals from the acoustical societies of Australia, France and America. Joe is also a composer. His most notorious orchestral work is The Stairway Suite, a set of symphonic variations on Stairway to Heaven, each in the style of a different composer. His talk introduced some of the interesting effects, including multiphonics or chords produced in woodwinds by superposition of standing waves, and the interactions between the resonances of the bore and the vocal tract. Wind instruments have a valve (reed, player's lips, air jet) coupled to two acoustic waveguides: the bore of the instrument (downstream) and the player's vocal tract (upstream). The talk gave an introduction to each of these elements, discussed some of the subtle and interesting effects that arise and illustrated them with demonstrations. The acoustics lab at UNSW has developed techniques for measuring acoustical impedance spectrum, (the ratio of acoustic pressure to acoustic flow) with improved precision or under difficult conditions. Recently, the lab has used these techniques to measure the resonances of the vocal tracts of the players of wind instrument and thus to investigate how these resonances interact with those of the bore of the instrument and with the valve (reed or player's lips).

The didjeridu, of course, uses variation in timbre rather than pitch to create musical structure. Large magnitude peaks in the impedance spectrum of the player's tract inhibit bands of harmonics in each frequency range where they occur. The remaining bands of harmonics fall in the same range as the formants of the voice, and so are especially noticeable as they are varied by the player. In another technique, called vocalisation, the lips and vocal folds both vibrate to modulate the flow of air, resulting in complex sound spectra with sum and difference frequency terms. To study this, the vibrations of the lips and vocal folds were measured independently via skin electrodes, which show the increased electrical admittance when the lips and folds make. The team has shown how vocal tract effects are sometimes important on reed instruments. The saxophone has strong resonances only in the lowest 2.5 octaves of its range. Above this range, the player must tune a resonance of the tract near to the frequency of the note played. Tuning of the tract resonance is also required for some exotic effects on clarinet, including the famous glissando in the opening bars of Gershwin's 'Rhapsody in Blue'. Wolfe thanked the team of collaborators and students whose work was reported in this overview talk, including Jer Ming Chen, Paul Dickens, Neville Fletcher, Lloyd Hollenberg, Ben Lange, Alex Tarnopolsky and especially Wolfe's long term collaborator, John Smith.

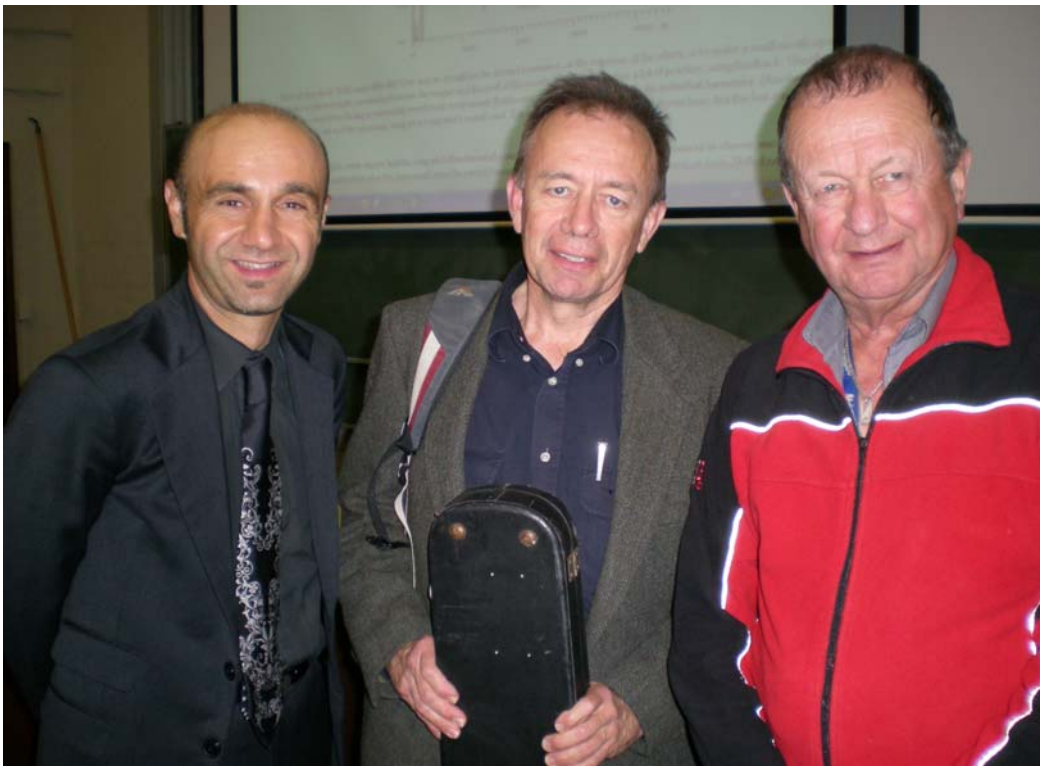

Photo 2: From left to right, Dr Fred Osman (AIP Branch Chair), Professor Joe Wolfe and Mr David Rushton.

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 Yabsley and Prof Wolfe for there outstanding lectures!

Dr Frederick Osman - AIP NSW Branch Chair