



Reflections from the 2011 Einstein Lecture – Monday 22 August 2011

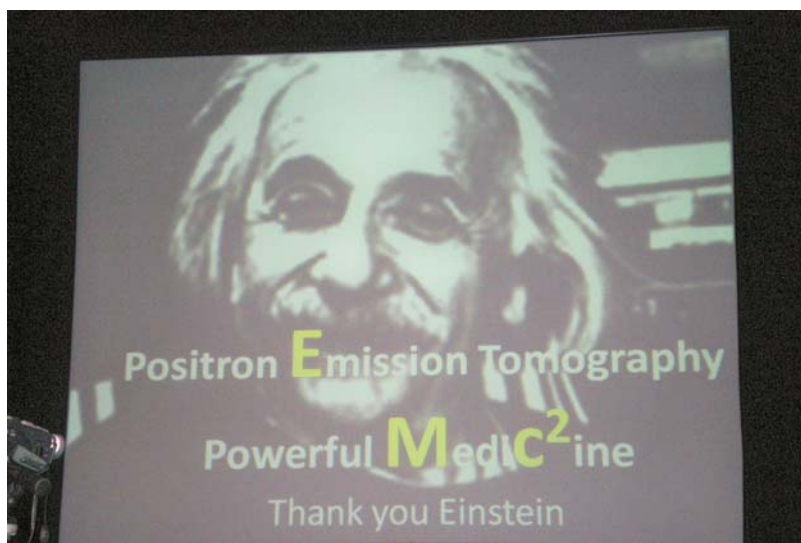
Dr Frederick Osman FACE, NSW Branch President

Supported by the Trinity Grammar School, Mathematics Club and the Australian College of Educators



Presented by the Australian Institute of Physics (NSW) and the Powerhouse Museum as part of the Ultimo Science Festival 2011

Each year the Australian Institute of Physics of New South Wales Branch nominates a distinguished speaker whose work has covered a wide range of topics with an emphasis on Einstein's ideas and their consequences for physics and technology today. This year the Einstein Lecture in conjunction with the Australian College of Educators was held at the Powerhouse Museum on Monday 22 August 2011 and featured Dr Fogwill currently head of science at Tomaree High School on the topic of *Powerful Medicine: Einstein would be proud!*

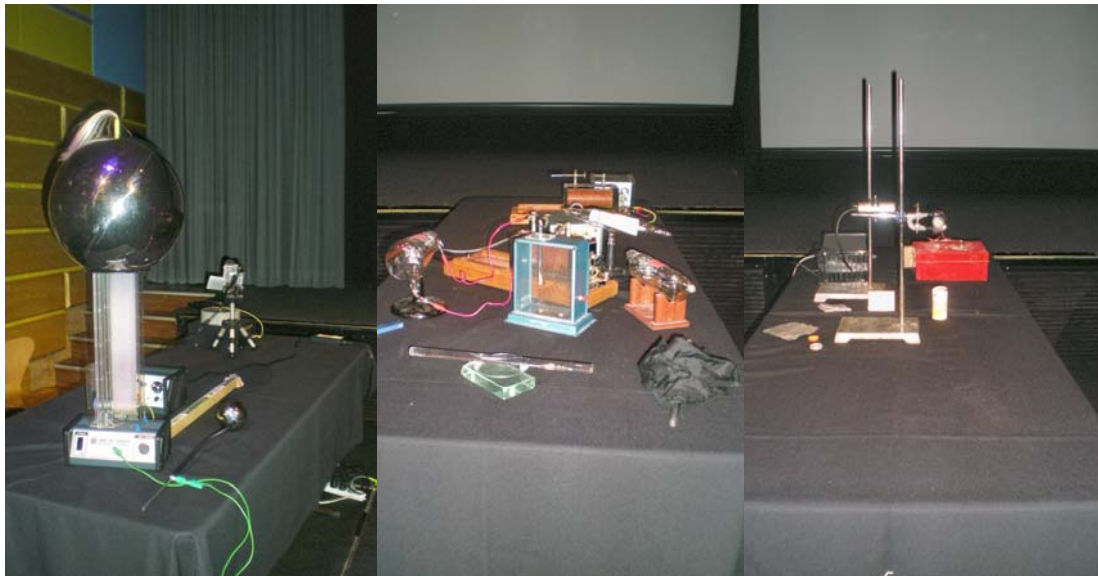


Dr Fogwill has been teaching science for over 30 years and has a keen interest in helping students learn with understanding. In his PhD research, his HSC chemistry and physics students developed and refined their own analogies for many of the difficult concepts in their courses. Dr Fogwill has been actively involved with lectures in regional NSW areas to help students prepare for their HSC Physics examination and runs workshops with talented primary students. Set apart from all other species, humans have an enormous capacity to learn. Progress in medical science has been a journey of learning by dedicated scientists. We now have some amazing medical tools that allow diagnosticians to “see” what is happening inside our bodies without making a single mark. Many of these modern technologies employ the understandings given to us by Einstein. As a pacifist, there is no doubt that Einstein would be pleased his ideas have been put to good medical uses.



Dr Frederick Osman (NSW ACE President), Dr Stephen Fogwill and Dr Graeme Melville (NSW AIP Chair)

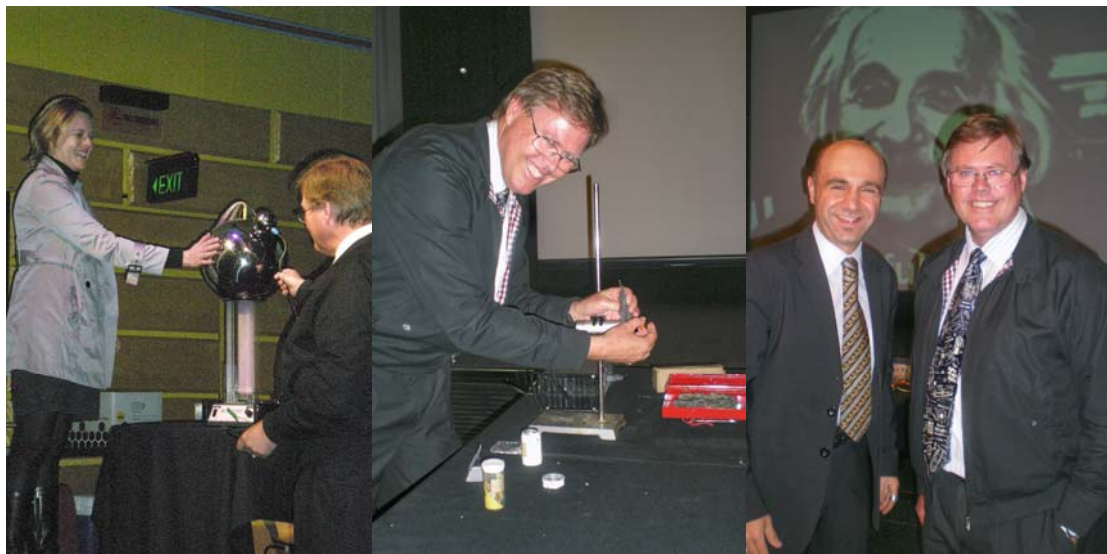
When we teach our HSC Physics students about applications of physics in medical science, we almost take for granted the fantastic knowledge of atomic structure upon which it is based. The theme for the talk was that Science builds on what has been discovered before. Newton's famous quote about "standing on the shoulders of giants" was exploited in terms of our developed understandings about atomic structure, and electrons in particular. Contributions by Dalton, Geissler, Crookes, Thomson, Milikan, Becquerel, Curie, Wilson, Rutherford, Anderson and of course Einstein were described. Our students have an amazing journey through a range of fascinating experiments as they develop their understandings about atoms, electrons, the nucleus and what HSC students come to learn about - matter and antimatter annihilations during positron emission tomography.



Through an interactive range of demonstrations, Dr Fogwill presented this lecture to trace the path of electron discovery and of its antimatter equivalent, the positron. An explanation of how $E = mc^2$ leads to the production of gamma rays during electron - positron annihilation, identified how Einstein's work has led to the powerful medicine of positron emission tomography (PET). A range of demonstrations that are typical of what students do in high schools were included in the presentation. Perspex rods were charged with a dry cloth to create positive charges by ripping electron from the surface of the Perspex. The interactions between charged rods were shown and this led to a demonstration of how a gold leaf electroscope could be charged positively or negatively (by induction) with a positively charged rod. Watching a person's hair stand on end as they touched a charging van de Graaff generator was a highlight as the charging process was described.

Several low pressure gas discharge tubes including a variety of Crookes tubes showed some of the properties of cathode rays which led to them being identified as negatively charged particles (electrons). Discussions about Rutherford's alpha scattering experiment were enhanced by a demonstration using a cloud chamber, kindly lent by Newcastle University. Viewed on the Power House's large screen, the alpha particles streaming from a tiny piece of radioactive lead 210, left clearly identifiable vapour trails. Coupled

with a demonstration of the penetrating abilities of alpha, beta and gamma using a Geiger counter and a variety of materials including paper, aluminium foil and lead sheet, the audience gained an understanding about what students in our schools learn about the nature of emissions from radioactive materials.



Identifying the discovery of positrons by Anderson, using a Wilson cloud chamber, set the scene to discuss matter and antimatter annihilations. The audience was shown how the mathematics of Einstein ($E=mc^2$) and Planck ($E = hf$) can be combined to show that the energy released during positron–electron interactions has a frequency in the gamma range of the electromagnetic spectrum. The final chapter in the lecture identified that positron emitting isotopes such as Oxygen 15, Carbon 11 and Fluorine 18, can be created by bombarding selected elements with protons, accelerated to high speeds, in particle accelerators such as cyclotrons; and how these can be used in positron emission tomography (PET). The ability of PET in identifying the functionality of body organs was identified using a series of PET images showing the brain, the lungs and the heart of healthy and not so health patients



The lecture concluded with a tribute to Einstein which it identified that without his contribution, positron emission tomography would not be one of our very powerful diagnostic tools of medicine. It was also considered that Einstein, as a pacifist would no doubt, be very proud that his ideas had resulted in such powerful, yet peaceful, application to help mankind.

The day, overall, was very successful and Dr Fogwill did a remarkable job in presenting a difficult and not well-understood area of physics. Stephen's flair and communication skills in his presentations kept the audience engrossed from start to finish with question time reflecting their keen involvement and fascination in the lecture.





Dr Stephen Fogwill (2011 AIP NSW Einstein Speaker)

The talk was very well received and geared to scientists and members of the public alike with many discussions continuing later after the lecture. The NSW Branch of the Australian Institute of Physics thoroughly thanks our co-sponsors the Australian College of Educators and the Powerhouse Museum, for their support and use of facilities on hosting the event and Dr Stephen Fogwill for delivering an outstanding and stimulating 2011 Einstein Lecture!

Dr Frederick Osman – NSW ACE President