Report of October 2014 Meeting
Royal Society
Southern Highlands Branch

Speaker: **Associate Professor Kevin Varvell**
Director of the University of Sydney node of the ARC Centre of Excellence for Particle Physics at the Terascale.

Topic: **What could be neater than spending your working days trying to understand something about the fundamental building blocks of the Universe?**

Associate Professor Kevin Varvell is an experimental particle physicist working in large scale international endeavors such as the ATLAS experiment at CERN's Large Hadron Collider and the Belle experiment at KEK in Japan. Kevin is with a group of Australian scientists who are at the core of the largest and one of the most controversial science experiments in history – recreating conditions at the beginning of the universe.

The $10 billion, 27 km circle of the Large Hadron Collider built by CERN lies 100 metres below ground on the border of Switzerland and France. Particles are accelerated around the most powerful collider in the world until they reach close to the speed of light, then smash together inside a seven-storey high containment chamber known as ATLAS. Scientists are trying to discover the secrets of the origin of the universe, to simulate what happened in the millisecond after the Big Bang, to work out how it led to the creation of stars, organisms and planets.

In 2012, scientists at CERN announced that they had found evidence of the existence of the Higgs-boson particle, the particle that gives mass to all particles. In the experiments which lead to this conclusion, beams of protons are sent in each direction, each beam containing 2800 bunches of protons, and each bunch containing 100 billion protons. Each proton crosses the French-Swiss border 11,200 times per second, the inside of the beam pipe being colder than deep space.

The ATLAS collaboration is truly global, involving 38 countries, 177 institutions and 3000+ scientific authors. The Nobel Prize in Physics 2013 was awarded jointly to Francois Englert and Peter W.Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider."*

Professor Varvell, in discussing our understanding of why particles have mass, spoke of Peter W Higgs' theory from 45 years ago. Part of Higgs' theory predicted that there should be another particle that hadn't yet been found, and which would be responsible for giving all other particles mass. Amazingly it took until 2 years ago for proof that the

predicted particle really existed. The Higgs-boson particle has been found to be extremely short-lived in experiments to date. It seems that it has a life of only 1/10,000,000,000,000,000,000,000 seconds before it decays to other entities.

The new boson's mass has been estimated to be around 135 times that of a proton. Dr Varvell told the 77 person audience that if the Standard Model of physics is all there is, then from galactic rotation curve studies, the Higgs mass should be more like 1,000,000,000,000,000 times the mass of a proton, or even greater. There is clearly much more research to be done.

Currently the composition of the universe is described as 4.6% atoms, 23% dark matter and 72% dark energy. Dr Varvell stated that it is only by understanding what particles are in the universe, or used to be in the universe when it first began, that we can actually understand how the universe changed from what we call the Big Bang to how it looks and behaves today.

Anne Wood