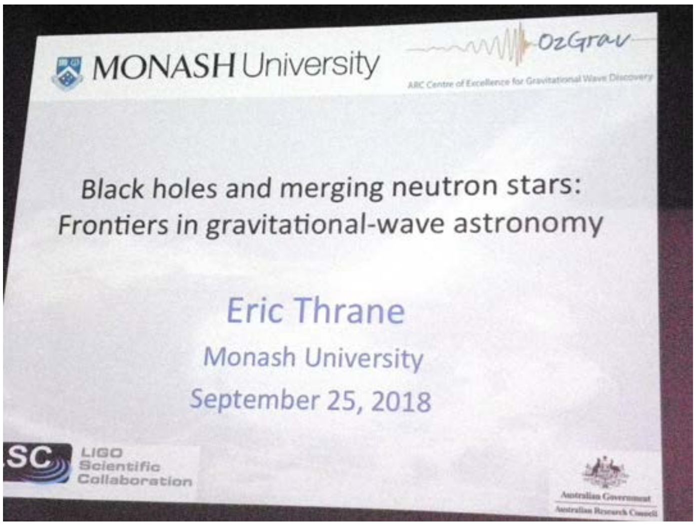
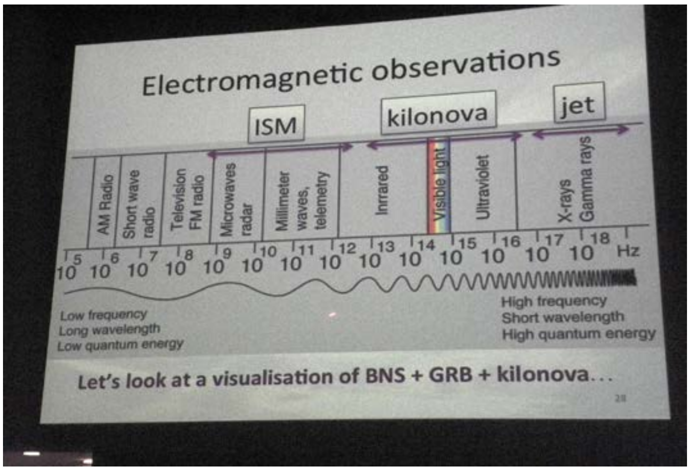
FRONTIERS IN GRAVITATIONAL ASTRONOMY

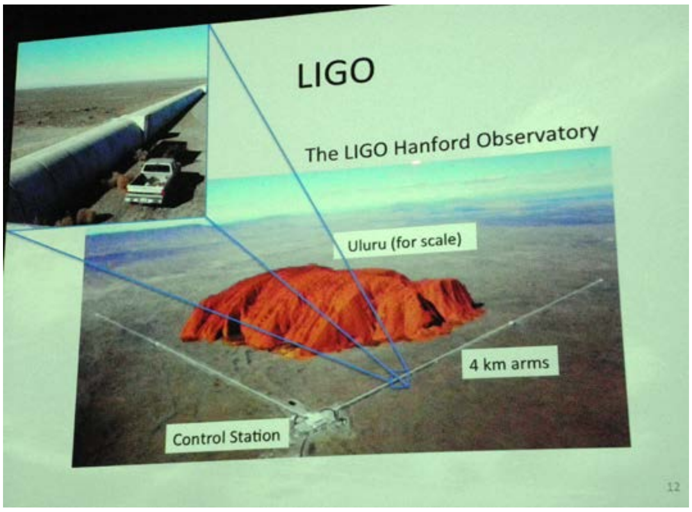


This was the title of a talk we attended on 25 September in a Lecture Theatre on the Rainforest Walk at the Monash University. Ursula and I had trouble finding a rain forest on the University Campus, but with the help of a very kind student guide we made it on time.

The talk was mainly on developing awareness regarding Neutron Stars and Black Holes, through the art of detecting their various radiations. Why does the matter in stars keep on condensing to the unbelievable density of Neutron Stars, where a spoonful alone weighs millions of tons, and into the mysterious Black Holes. **We are told the mass of the Earth as a Black Hole would be the size of a pea. Is it all due to Gravitational Attraction?** All the information we have about these things comes from the range of radiation caused by the varying temperature of the bodies as they increase in mass and density. And, because all those exotic creations are a very long way away from us (perhaps a good thing?), the detection is very seldom easy.



Einstein's General Theory of Relativity predicts that rapid changes in mass or density will generate Gravitational Radiation, which will spread out through space all around the source. Merging Neutron Stars are the biggest change in mass imaginable, and at least one facility, built to detect such events, claims to have detected waves from such a merger. It must be realised that these signals, coming from a very long distance and time ago, are exceedingly weak, but on 17 August 2017 a LIGO Facility within the United States, announced the actual detection of such a signal. A LIGO - Laser Interferometer Gravitational Wave Observatory - consists of a Control Station from which two evacuated tunnels extend at right angle for four km. A high frequency laser signal generated at the Control Centre is split and one half projected out into each of the two arms of the tunnels. Mirrors at the end of the tunnels reflect the signals back to the Control Centre, where they are combined again to see if they still match perfectly. If one of the arms changes in length due to a change of space with a gravitational wave running this way, the amount of mismatch of the two projected signals will cause a phase shift discrepancy in accordance with the size of the gravitational wave. The signal detected in August last year was incredibly small and at the limit of detection. At a strain of 10^{-21} it is about 1 over 1000st the diameter of an atomic proton for a km sized detector. There are two of these LIGO detectors in the USA, one in Hanford near Washington and one at Livingston in Louisiana. Timing the exact arrival of the signal helps defining the direction of the source in the universe.



A size comparison with ULARU at the centre of Australia

The Monash University mission is to capitalise on this historic first detection of gravitational waves to help understand the extreme physics of Black Holes and Warped Spacetime. It is hoped this new window into the Universe will help inspire the next generation of Australian scientists and engineers.

AK, with Notes from Eric Thrane, 'OzGrav' Monash University