“From Einstein’s Prediction to LIGO's Triumph”.

In 1915 Albert Einstein posed a set of equations that were simultaneously a generalization of the Newtonian equations describing gravity (they agreed with Newton in "commonplace" situations), and a bold rethinking of the description of gravity: it was now the warping of space - and - time ("spacetime") caused by the presence of matter.

Einstein’s new formulation has survived over a century. As more observations are acquired they all agree with the predictions of Einstein's theory, in many cases to parts in 1000 or better. The gravitational deflection of light, the advance of the perihelion of Mercury, the red shift, the relativistic time delay, frame dragging, all agree with Einstein's predictions to the accuracy with which they can be measured. (The red shift has a real existence in engineering application. Incorrect formulation of the redshift in GPS and other Global Satellite Navigation Systems could lead to positioning errors accumulating to kilometers per day.)

Almost exactly 100 years ago -- in 1916 — Einstein published a paper establishing the existence of gravitational waves. The first direct detection of gravitational radiation was made on 14 September 2015 via LIGO (the Laser Interferometer Gravitational-wave Observatory). Previous studies of the binary pulsar had shown that system to be losing energy at a rate consistent with the gravitational radiation expected from the orbit of its constituent neutron stars. But GW20150914, which is the merger of two massive black holes to a final single spinning black hole, is the first direct observation of this radiation. It is also the first unambiguous observation of a black hole (in fact of two of them) and the first unambiguous observation of a spinning (Kerr) black hole. In the same data run, on December 26 2015, a second event, also the merger of two black holes, was detected by LIGO. This first observing run ended in January 2016. Since then LIGO has been undergoing upgrades to increase its sensitivity, and should begin a second observing run in the next few months.

This talk will provide more of the background and will explain some of the implications of this remarkable triumph of observation.