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The Observation of Gravitational Waves from a Binary Black Hole Merger

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On September 14, 2015, the two LIGO detectors operating at Hanford, WA and Livingston, LA nearly simultaneously recorded a strong trigger consistent with the passage of gravitational waves. An extensive and thorough analysis by the LIGO Scientific Collaboration and the Virgo Collaboration over the following months determined the gravitational waves to originate from the final stage of the inspiral of two black holes with masses approximately 36 and 29 M_{sun} merging to form a 62 M_{sun} black hole located at a distance of roughly 410 Mpc.

This discovery is remarkable in many ways. In addition to being the first direct measurement of a gravitational wave by an earth-based detector, this is the first observation of coalescing binary black hole system and the first evidence that heavy stellar mass black holes exist. The measured gravitational waveform was determined to be highly consistent with that predicted by general relativity for the merger of two black holes.

In this talk, the first of two in this special session on the discovery of GW150914, I'll cover a number of topics related to the detection, including a brief description of the operation and performance of the Advanced LIGO detectors during the first O1 Observing Run as well as the data quality verification methods used to determine the validity of the detection. Ill also present the searches that were used to find and establish the statistical confidence of the event, as well as provide an estimate of its sky localization. Finally, I will discuss the plans for future observations by LIGO, Virgo and other gravitational wave detectors over the next few years and, time permitting, present the short term and longer term programs for improving the sensitivity and range of gravitational wave detectors over the next ten years.