"How does the LIGO detection of gravitational waves test general relativity?"

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Abstract

"On September 14, 2015 at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational-Wave Observatory [LIGO] simultaneously observed a transient gravitational-wave signal" (http://dx.doi.org/10.1103/PhysRevLett.116.061102). The LIGO researchers concluded that the signal emanates from a binary black hole (BBH) system. At the moment, the papers explaining the significance of this signal as a test of general relativity (GR), the statistical significance of the results, and the models used to interpret the results are extremely dense and difficult to interpret. One reason for this is that the mathematical methods, including the statistical methods, being used to interpret the data and to link it to theoretical GR are new or even still in development. After an initial discussion of these recent papers, of the results of the LIGO detection, and of questions in experiment and modeling that arise, I focus on one point in particular: the role of the BBH chirp mass and of the quadrupole formula in constructing a test of GR based on the LIGO observations. At this point, the test of GR based on the LIGO observations is not as rigorous or as heuristic as it could be. I explain why this is the case, and draw inferences from the recent papers about how more rigorous tests could be constructed. Massive resources are likely to be invested in LIGO, LISA, and related projects in the future, so constructing and justifying such tests will be crucial.