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Tests of general relativity from gravitational wave observations of binary black holes

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Gravitational waves emitted during the coalescence of compact binary systems carry a wealth of information about the merging objects, the remnant object as well as their interaction with space-time. The description of the dynamics of such systems is based on solutions of the theory of general relativity. For any given physical configuration of masses, spins and orbital motion, general relativity predicts the dynamical evolution of the binary system as well as the corresponding gravitational wave signal. During the coalescence of extremely compact objects such as binary black holes, the typical curvature and velocity at play are such that, from the observation of the gravitational wave signal, we can access the most extreme dynamical regimes of gravity. In such conditions, we can test our understanding of gravity by looking for potential departures between the solutions of general relativity and the actual dynamics of space-time. The LIGO observations GW150914 and GW151226 provided wonderful testing grounds for general relativity in the, up to now unaccessible, strong-field dynamical regime of gravity. During my talk, I will review and discuss several of the tests that have been devised to detect violations of the predictions of general relativity from the observation of gravitational waves from coalescing binary systems. The discussion will be based on the results of the analysis of GW150914 and GW151226. Finally, I will conclude by discussing some of the future prospects of extending the current state-of-the-art methodologies to further aspects of general relativity.