Dipartimento di Fisica
Università di Cagliari
INFN, Sezione di Cagliari

High Energy Physics Colloquia

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Theoretical Physics Implications of Gravitational-Wave Events

Abstract

The aLIGO gravitational wave observations GW150914 and GW151226 provide the first opportunity to learn about physics in the extreme gravity environment of coalescing binary black holes. The LIGO Scientific and Virgo Collaborations have verified that this observation is consistent with general relativity. We expand their analysis to a larger class of anomalies, highlighting the inferences that can be drawn on non-standard theoretical physics mechanisms. We find that these events constrain a plethora of mechanisms associated with the generation and propagation of gravitational waves, including the activation of scalar fields, gravitational leakage into large extra dimensions, the variability of Newton's constant, a modified dispersion relation, gravitational Lorentz violation and the strong equivalence principle. Though other observations limit many of these mechanisms already, GW150914 and GW151226 are unique in that they are direct probes of dynamical strong-field gravity and of gravitational wave propagation. We also show that GW150914 constrains inferred properties of exotic compact object alternatives to Kerr black holes. We argue, however, that the true potential for GW150914 to both rule out exotic objects and constrain physics beyond general relativity is severely limited by the lack of understanding of the merger regime in almost all relevant modified gravity theories.

Based on: N. Yunes, K. Yagi and F. Pretorius, "Theoretical Physics Implications of the Binary Black-Hole Mergers GW150914 and GW151226," *Phys. Rev.* **D94** (2016), 084002. [arXiv:1603.08955].

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