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Testing the strong-field dynamics of general relativity with gravitational wave signals from coalescing binary neutron stars

Coalescing compact binaries consisting of neutron stars and/or black holes are among the most likely sources for a first detection of gravitational waves by the Advanced LIGO and Virgo interferometers that are currently under construction. We present TIGER (Test Infrastructure for GEneral Relativity), a Bayesian data analysis pipeline to test the genuinely strong-field dynamics of general relativity (GR) using gravitational wave signals from coalescing binaries. TIGER offers a model-independent test of GR, in that it is not necessary to compare it with any particular alternative theory of gravity. It is well-suited to a regime where most sources have low signal-to-noise ratios. Information from multiple sources can trivially be combined, leading to a stronger test. We focus on binary neutron star coalescences, since for such sources sufficiently accurate waveform models are available which can be generated fast enough on a computer that they can be used in Bayesian inference. By performing numerical experiments in Gaussian, stationary noise, we demonstrate that the pipeline is robust against a number of unknown fundamental, astrophysical, and instrumental effects, such as differences between waveform approximants, a limited number of post-Newtonian phase contributions being known, the effects of neutron star tidal deformability on the orbital motion, neutron star spins, and instrumental calibration errors.

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