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Testing of general relativity at the fourth post-Newtonian order

Gravitational-wave observations are unique means to test general relativity (GR) in the strong-field regime. Parametrized tests of post-Newtonian theory have been very efficient in testing GR in the inspiral phase of compact binary dynamics. In this test, one introduces deformation coefficients at each post-Newtonian order in the inspiral phase of the gravitational wave which by definition are zero in GR. Gravitational wave data is used to obtain posterior distribution on these phase deformation coefficients and consistency of them with zero is assessed.
Recently, the post-Newtonian expansion of the non-spinning inspiral phase of a binary has been extended to 4 PN and 4.5 PN order. These higher PN terms carry information about new physical effects like the tail-of-memory, spin-quadrupolar tails and quartic-tail effects. They help probe the non-linear nature of gravity and take the PN expansion phase ever closer to the high-frequency regime. In our work, we propose extending the parameterized test to include these newly computed PN orders, introducing four additional deformation coefficients. We compute the bounds on these new parameters through the Fisher matrix on these deformation coefficients using a modified IMRPhenomD waveform for the noise sensitivity of AdvLIGO and CE. We conclude that there is the possibility of measuring these deformation coefficients with good precision through GW observations with the present and next-generation GW detectors.

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