Improving parametrised tests of general relativity using Singular Value Decomposition

Sayantani Datta[1]***, M. Saleem***[1]***, Anjali B. Yelikar***[1]***, K.G Arun***[1] ***and B. S. Sathyaprakash***[2]
[1]Chennai Mathematical Institute, Siruseri, 603103 Tamilnadu.
[2]Institute for Gravitation and the Cosmos, Pennsylvania State University, State College, PA 16802.

Abstract

Parametrized tests of General Relativity (GR) are among the most general tests performed on the gravitational wave (GW) detections so far [1, 2]. In these tests, deformation parameters, which are zero in GR, are introduced at each post-Newtonian (PN) order in the formula for the orbital phase evolution of a compact binary system. The most general test of GR is the one where all the deformation coefficients up to 3.5PN are *simultaneously* measured. But, due to the high degeneracy of the PN deformation coefficients with other source parameters such as masses and spins, this most general test does not yield the best possible constraints. Hence one resorts to a method where one deformation coefficient is estimated at a time together with other source parameters and this test is performed for all the eight deformation coefficients separately. This version of the parametrized tests is what is currently employed to obtain constraints from any departure from GR [3]. Here we propose to use singular value decomposition to obtain a novel combination of the eight deformation coefficients which is measured very accurately. We construct a modified phasing formula which corresponds to a one parameter deformation using this newly obtained linear combination and study the accuracy with which the new parameter may be estimated as a function of total mass, mass ratio and spins. Finally we apply this method on the real GW data using the LALInference parameter estimation package [4] and obtain bounds on the new parameter for the binary black hole mergers GW150914 and GW151226.

References

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