Constraining parity violation in gravity with compact binary mergers

Scott Perkins, Remya Nair, Hector O. Silva & Nicolas Yunes

eXtreme Gravity Institute, Department of Physics,
Montana State University, Bozeman, MT 59717, USA

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Presenter: Remya Nair

Parity is violated in the standard model of particle physics, and particle experiments have shown that weak interactions violate this symmetry. It is then natural to extend this question to the gravitational sector and ask: is the gravitational interaction parity invariant? Gravitational wave observations of compact binary mergers provide a test bed with which to answer this question in the extreme gravity regime, where the gravitational interaction is simultaneously dynamical and strong. Although general relativity is parity invariant, there exists a broad class of theories with parity violating actions through a non-minimal coupling between curvature and a massless scalar field. Of these theories, dynamical Chern-Simons gravity is the only surviving member that is consistent, so far [1], with the multi-messenger discovery of the binary neutron star merger event GW170817/GRB 170817A [2] and it is very weakly constrained by Solar system experiments [3]. In this talk, we explore how to constrain this theory with current and future gravitational wave observations with the LIGO/Virgo detectors, and we find that constraints can be roughly 7 orders of magnitude more stringent than current Solar System bounds.

References

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