CATEGORY TYPE: B3. Approximations, perturbation theory, and their applications

TITLE: Is there chaos during extreme mass-ratio inspirals in dynamical Chern-Simons gravity?

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GRANT: A.C.-A. and N.Y acknowledge financial support through NSF CAREER grant PHY-1250636 and NASA grants NNX16AB98G and 80NSSC17M0041. A.C.-A. also acknowledges funding from Fundacion Universitaria Konrad Lorenz (5INV1).

ABSTRACT:

The recent gravitational wave observations by the LIGO/Virgo collaboration have allowed the first tests of General Relativity in the extreme gravity regime, when comparable-mass black holes and neutron stars collide. In addition, future space-based detectors, such as LISA, will allow tests of Einstein's theory with gravitational waves emitted when a small black hole falls into a supermassive one in an extreme mass-ratio inspiral. One particular test that cannot be carried out cleanly with ground-based instruments is the search for chaos, which is expected to be absent in two-body encounters described in Einstein's theory. In this talk, I will discuss whether chaos is present in parity-violating modified theories of gravity, focusing in particular on dynamical Chern-Simons gravity. I will show how the use of approximate solutions in these theory may lead one to believe that chaos is present, when in reality such chaotic behavior is an artifact of the truncation of the solution. Our numerical findings suggest that the geodesics of the as-of-yet unknown exact solution for spinning black holes in this theory may be integrable, and that there may thus exist a fourth integral of motion associated with this exact solution, which will be relevant to gravitational wave tests with LISA.