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Spinning Black Holes and Neutron Stars in Dynamical Chern-Simons Gravity[1] NICOLAS YUNES, KENT YAGI, Montana State University, LEO STEIN, Cornell University, TAKAHIRO TANAKA, Kyoto University — In the near future, gravitational waves emitted during black hole and neutron star binary coalescence will allow unprecedented tests in the dynamical, non-linear, strong-field regime. For such tests to be possible we must first construct the waveform observable in theories that deviate from General Relativity, which, in turn, require finding and understanding stationary and axisymmetric black hole and neutron star solutions in these theories. In this talk, I will describe these solutions in dynamical Chern-Simons gravity, the only quadratic curvature theory that intrinsically violates parity with a single axion-like field. I will show how, although the Schwarzschild metric is a solution in this theory, spinning black holes must deviate from the Kerr metric. Similarly, neutron star solutions must deviate from Hartle's solutions for slowly-rotating neutron stars. When accounting for second-order spin corrections in a slow-rotation approximation, these deviations induce a quadrupolar deformation much larger than those previously found in the gravitomagnetic sector to leading-order in the spin. Such solutions are essential to test dynamical Chern-Simons gravity with binary pulsars and with gravitational waves, which could lead to much stronger constraints than Solar system ones.

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