

Fall 2023 Colloquium

Department of Physics & Astronomy

Texas A&M University-Commerce

Oct 19, Thursday, 4-5 PM in Science Building 127

(coffee and cookies will be served at 3:50 PM)

AstroPhysics

Revealing the origin of binary black holes with spin precession

Dr. Michael Kesden

University of Texas at Dallas



Dr. Michael Kesden earned his BS in Physics (2000) from Princeton University and his PhD in Physics (2005) from Caltech. His PhD dissertation was primarily on weak gravitational lensing of the cosmic microwave background. He worked as a postdoc at the University of Toronto, Caltech, and NYU, where his research shifted to binary black-hole mergers and tidal disruption events. In 2013, he joined the faculty at the University of Texas at Dallas as a member of the astrophysics group in its Department of Physics. His research profile is available at: <https://profiles.utdallas.edu/kesden>

Abstract

The LIGO-Virgo-KAGRA network of gravitational-wave (GW) detectors observed 90 binary black hole (BBH) and binary neutron star (BNS) mergers during its first three observing runs (O1 – O3), and continues to discover new mergers during its ongoing O4 run. It will observe ~ 100 BBH mergers per year when it reaches design sensitivity towards the end of this decade. The third-generation GW detectors Einstein Telescope and Cosmic Explorer will observe ~ 105 BBH and ~ 106 BNS mergers when they come online in the 2030's. According to the famous “no hair” theorem, astrophysical black holes are fully characterized by their masses and spins. If BBH spins are misaligned with the orbital angular momentum of the binary (as the Earth's rotation axis is misaligned by 23° with respect to the plane of its orbit about the Sun), spin-orbit coupling will cause the orbital angular momentum to precess and nutate. As GW emission is preferentially beamed in the direction of the orbital angular momentum, this precession and nutation will modulate the GWs, allowing observers to constrain the BBH spin directions. I will present a new formalism to describe this precession and nutation and discuss existing observational constraints. Different channels of astrophysical BBH formation predict different BBH spin distributions and thus differing amounts of precession and nutation. I will describe how observations of precession-induced GW modulation can be used to constrain aspects of both the cluster and isolated channels of BBH formation.