CSU PHYSICS COLLOQUIUM

"Searching for "Fifth-forces", Dark Matter, and Quantum Gravity in the Lab"

Andrew Geraci

Northwestern University

Monday, Nov. 16th at 4:00pm

Virtual via Zoom (see announcement for link)

Abstract

We normally think of large accelerators and massive detectors when we consider the frontiers of elementary particle physics, pushing to understand the universe at higher and higher energy scales. However, several tabletop low-energy experiments are positioned to discover a wide range of new physics beyond the Standard model of particle physics, where feeble interactions require precision measurements rather than high energies. In high vacuum, optically-levitated dielectric nanospheres achieve excellent decoupling from their environment, making force sensing at the zeptonewton level (10-21 N) achievable. In this talk I will describe our progress towards using these sensors for tests of the Newtonian gravitational inverse square law at micron length scales. Optically levitated dielectric objects and show promise for a variety of other applications, including searches for gravitational waves and Dark Matter. Looking forward, these systems may enable us to examine the role that gravity plays in quantum mechanical entanglement. Finally, I will discuss the Axion Resonant InterAction Detection Experiment (ARIADNE), a spin-dependent "fifth-force" experiment using laser-polarized 3-He gas to search for a notable dark-matter candidate: the QCD axion.

Biography

Andrew Geraci completed his undergraduate work in Physics and Mathematics at the University of Chicago. He completed his Ph.D. in physics at Stanford University in 2007 and subsequently worked as a postdoctoral researcher (2007-2010) at NIST in Boulder, CO. He was a National Research Council postdoctoral Research Associate from 2007-2009. Dr. Geraci joined the University of Nevada Reno physics department as an Assistant Professor in 2011. In 2018 he moved to Northwestern University where he is now Associate Professor of Physics and Astronomy and a member of the Center for Fundamental Physics (CFP) with Tabletop Experiments. He is a Fellow of the American Physical Society (APS) and an elected member of the executive committee for the APS Topical Group on Precision Measurement and Fundamental Constants. His research interests include tabletop tests for physics beyond the Standard Model, experimental gravitation, gravitational wave detection, ultrasensitive force detection, hybrid quantum systems, and quantum optomechanics. Prior accomplishments include work at Stanford achieving the most stringent limits on corrections to the gravitational inverse square law at the 10 micron length scale, in an experiment using highly-sensitive cryogenic micro-resonators. The Geraci research group at Northwestern is developing new sensing techniques for experimental gravitational physics, involving laser cooled and trapped nanospheres which have achieved zeptonewton force sensitivity, an order of magnitude more sensitive than any room-temperature solid-state force sensor to date. Geraci also leads ARIADNE, an international collaboration using NMR-based techniques to search for the QCD axion.