Abstract:
Several tabletop low-energy experiments are posed to discover a wide range of new physics beyond the Standard model, where feeble interactions require precision measurements rather than high energies. In our experiments, high-Q resonant sensors enable ultra-sensitive force and field detection. In this talk I will describe two applications of these sensors in searches for new physics, based on techniques in atomic-molecular-and optical (AMO) physics. First, I will discuss an experiment which uses laser-cooled optically trapped silica nanospheres to search for corrections to Newtonian gravity at micron distances. In high vacuum, optically levitated dielectric particles achieve excellent decoupling from their environment and experience minimal friction. Hence they can be used for such sensitive force measurements, as well as searches for high-frequency gravitational waves. Second, I will discuss a new precision magnetometry experiment to search for a notable dark-matter candidate: the QCD axion. The Axion Resonant InterAction Detection Experiment (ARIADNE) is a collaborative effort to search for short-range spin-dependent couplings between nuclei resulting from axion exchange, using a technique based on nuclear magnetic resonance. The aim is to detect monopole-dipole interactions between the spin of laser-polarized 3He nuclei and a rotating unpolarized tungsten attractor. I will discuss the basic principle of the experiment and its current status.

Bio
Andrew Geraci completed his undergraduate work in Physics and Mathematics at the University of Chicago (A.B. Physics, 1998). He received a Ph.D. in physics at Stanford University in 2007 under the direction of Aharon Kapitulnik. His dissertation was entitled, “Developments in the search for non-Newtonian gravity below the 25 micron length scale.” He subsequently worked as a postdoctoral researcher (2007-2010) at NIST in Boulder, CO in the group of John Kitching, where he worked on interfacing cold atoms with mechanical resonators for potential applications in quantum information science and quantum limited sensing. 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. His research interests include atomic physics, precision measurement, laser-cooling and trapping, quantum opto-mechanics, gravitational physics, and searches for Dark Matter. His current experimental work involves using optically trapped laser cooled microspheres for ultrasensitive force measurements and tests of gravity at the micrometer length scale. Dr. Geraci is also PI of the ARIADNE (Axion Resonant InterAction Detection Experiment) collaboration, which uses nuclear magnetic resonance to search for the Axion, a notable Dark Matter candidate.