Field:
Physics/Astrophysics/Astronomy

Session Topic:
Quantum Effects of Motion

Chair:
Konrad LEHNERT, University of Colorado and the National Institute of Standards and Technology

Title: Mechanics at the nanoscale

Force and motion are concepts at the center of physical phenomena. The most successful theories describe with astounding precision the motion of objects on the very large scales of planetary orbits and on the very small scale of atoms. At intermediate scales, in the range of human manufacturing, lies a relatively underexplored regime of forces and motion.

In the past 10 years, interest in manufactured mechanical systems has flourished for both practical and fundamental reasons. Of particular interest are micro- and nano- scale structures which have typical dimensions around one millionth of meter. These structures have the potential to yield new sensing, imaging and signal processing technologies, and they may also reveal new aspects of the basic forces of nature. Examples include: three-dimensional imaging of individual biomolecules, processing weak electrical signals with ultralow power, and searching for deviations from Newtonian gravity.

Developing new technology and discovering new physics demands precision control and measurement of the motion of these mechanical systems. Interestingly, the tasks of control and measurement are now both reaching the ultimate limits imposed by the laws of quantum and statistical mechanics. For some applications, reaching these limits implies reaching the limits of what can be sensed. For studies of fundamental forces, reaching the quantum limit opens the possibility of creating a conflict between the laws that govern motion at astrophysical scales, namely gravity, and those that govern atomic scales, namely quantum electrodynamics. Such an investigation would address one of the deepest questions of modern physics—is there a single description of nature that can contain both gravity and quantum mechanics?