2017 NIST Precision Measurement Grants

Prof. David Kawall, University of Massachusetts, Amherst, MA

CeNTREX: a tabletop experiment to search for time and parity violating physics in a nucleus

The Cold Nuclear Time Reversal Experiment (CeNTREX) collaboration proposes a new effort to measure a nuclear Schiff moment (SM) in ^{205}TlF, with projected 20-fold improvement over the state of the art sensitivity to the fundamental QCD θ parameter in a first-generation experiment. This parameter is closely associated with the unexplained matter-antimatter asymmetry in the universe. In many widely-favored theories of physics beyond the Standard Model this new sensitivity to θ will provide significant potential for evidence of new particles and forces that explain this outstanding mystery. Quite generally, it will probe energy scales well beyond the reach of the Large Hadron Collider. This approach, based on using the strong internal electric field in a polarized molecule to maximize sensitivity to the Schiff moment, also opens the potential for several additional orders of magnitude improvement in future generations of the CeNTREX experiment. Kawall proposes to use NIST PMG funding to develop robust, high voltage electric field plates with low-magnetic Johnson noise, essential for pushing this and other spin precession measurement experiments to greater sensitivities. During the 3-year time scale of NIST PMG funding, they plan to design, fabricate, assemble, test, and commission the complex experimental apparatus required to achieve the initial goal.

Prof. Holger Müller, University of California, Berkeley, CA

Measurement of h/m and the fine-structure constant with cesium atoms.

Both the Guellati-Khélifa group at Laboratoire Kastler-Brossel (LKB, France) and Müller's group at Berkeley are measuring the fine-structure constant α by measuring h/m, the ratio of the Planck constant and the mass of an atom. The NIST precision measurement grant will allow Müller to establish a long-term collaboration by hiring a shared graduate student, who will spend approximately equal time at each institution, and whose cost will be shared. The collaboration will allow the groups to jointly study systematic effects and share many specialized techniques. It is expected that it will strongly accelerate work at both institutions. It will further the knowledge of fundamental constants necessary for the international system of units (SI) and will improve the utility of atom interferometers worldwide by characterizing and solving new effects at the frontiers of precision. At Berkeley, Müller is planning to publish a 0.2-0.3 part-per billion (ppb) measurement of α within months. NIST support will insure that the experience gained thereby will not be lost. It will allow the group to reduce the error bar further to 0.1 ppb and to develop a future apparatus that will even reach 0.01 ppb.
