2014 NIST Precision Measurement Grants

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Determination of Newton's constant G with a new method using extremely high Q simple pendulums in free decay mode

The constant G of Newtons first law is the least well known of natures constants. Some results have quoted uncertainty below 10^{-4}, but discrepancies are greater than that. Most G determinations in history were done with some variation of the Cavendish torsion balance, but other approaches were also adopted more recently to avoid coherence. They include beam balance, free-fall, and static pendulum methods. The free swinging simple pendulum approach of this proposal is an effort to add another degree of diversity in the quest for greater accuracy of G, aiming at the low 10^{-5} level. The method consists in operating two very high Q (10^8) simple pendulums in the free swing-down mode and measure the evolution of their time delay as two active masses are moved alternatively from one to the other. The time slope of such delay is the relative frequency difference of the two pendulums, and the value of G is obtained from the variation of such slope between the two active masses positions. The 10^{-5} accuracy limit projected for G derives from assuming 100 nm uncertainty of the distance between active masses, and may be possibly improved in a well equipped NMI.

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A measurement of the neutron lifetime in a magneto-gravitational bottle

Despite the century-long effort to study fundamental properties of the neutron and to measure its decay lifetime (with an ever-increasing precision approaching 1 s, or a 0.1% level of precision), physicists today still cannot agree on the exact value of the neutron lifetime. In this PMGP proposal, the PI seeks support to carry out detailed studies of neutron dynamics inside a trap using Monte-Carlo simulations, and to construct an *in-situ*, real-time, large-area neutron detector. This effort compliments the existing NIST neutron research program, and impacts the success of NISTs active neutron lifetime experiment using the decay-in-ight beam method: until results of the two methods come into agreement, the state of confusion surrounding the neutron lifetime will remain.