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Comparison of three geometries of balances dedicated to the monitoring of gravitational interactions

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“The gravitational constant is one of nature’s most fundamental numbers, but humanity still doesn’t have an accurate value for the gravitational constant. And, bafflingly, scientists’ ability to pinpoint G seems to be getting worse” [1]. In the attempt to find the value of G and its variations, a series of vertical pendulums with one degree of freedom have been designed and tested. The selection of rotation axis of each pendulum is very critical. We have compared torques of several pendulums weighting from few kilograms. Each of those pendulums has a unique axis of rotation. The position of pendulum is precisely controlled by an electrostatic feedback. Symmetric geometry of the pendulum with axis located at the center of mass rejecting the coupling between references translations and the instantaneous motion of the axis of rotation. The sensitivity of the balance is monitored by a reference calibrated torque (Γw). This torque Γw is induced by a watch fixed on the pendulum. The needles of watch are turning horizontally in the Earth’s gravity field (g). The g is well determined at the level nm/s2 by absolute gravimeters, in addition, the period and the mass of the needles is measured in a high accuracy. Thus the Γw can be determined at 10 ppm. By a comparison with the reference torque (Γw), the Newtonian gravitational attraction torque is obtained. Then the gravitational constant and its variation are inferred. The experiments have been conducted with three different systems G1, G2 & G3 installed at the Royal Observatory of Belgium. The results from three experiments will be presented.
[1] Elizabeth Gibney, Gravity rivals join forces to nail down Big G, Metrologists meet to design the ultimate gravitational-constant experiment, Nature, Vol.514, Issue7521 (2014),