Getting Close to Gravity: Developing a Superconducting Torsion Balance to Test the Inverse Square Law of Gravity

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Abstract

At the University of Birmingham we have been developing a superconducting torsion balance.[1] This is being done with an aim to test Newton's inverse square law of gravity at mass separations of the order of $10\mu m$, by measuring the gravitational torque on a levitated test mass. Current experimental results cannot exclude a value of Newtons constant that is some six orders of magnitude larger at a distance of $10\mu m$ than the value measured at ranges of the order of $10cm$.[2,3] Our proposed experiment will allow us to directly test some theories that predict that gravity should deviate from the inverse square law, such as in String Theory, in which there can exist large extra dimensions.[4] This could help explain not only the apparent weakness of gravity, but also allow its unification to the other fundamental forces at lower energies.

Such tests are out of the reach of previous experimental efforts using conventional torsion balances, due to the difficulty of controlling the position of the suspended mass. Past work provides motivation for developing a superconducting torsion balance which allows more precise control of the degrees of freedom of the suspended mass.[5] I will discuss the current state of the experiment, including the work on modelling the magnetic forces in the superconducting elements and on a novel capacitive sensor for the suspended mass that acts against the adverse effects of stray-capacitance.[6]

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