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Laboratory Tests of the Inverse Square Law of Gravity

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Newton's inverse square force law of gravity follows directly from the fact that we live in a 3-dimensional world. For sub-millimeter length scales there may be undiscovered, extra dimensions. Such extra dimensions can be detected with inverse square law tests accessible to torsion balances. I will present an overview of two experiments that are being conducted at the University of Washington to search for gravitational-strength deviations from the inverse square law for extra dimension length scales smaller than 50 micrometers. One experiment is designed to measure the distance dependent force between closely spaced masses, whereas the second experiment is a null experiment and is only sensitive to a deviation from the inverse square law of gravity. The first experiment consists of a torsion pendulum that is suspended above a continuously rotating attractor. The attractor and the pendulum are disks with azimuthal sectors of alternating high and a low density. The torque on the pendulum disk varies as a function of the attractor angle with a 3 degree period. The amplitude of the torque signal is analyzed as a function of the separation between the pendulum and the attractor. The second experiment consists of a plate pendulum that is suspended parallel to a larger vertical plate attractor. The pendulum plate has an internal density asymmetry with a dense inlay on one half facing the attractor and another inlay on the other half on the side away from the attractor. If the inverse square law holds, the gravitational field of the attractor is uniform and the torque on the pendulum is independent of the gap between pendulum and attractor. The attractor position is modulated between a near and far position and the torque difference on the pendulum is recorded and analyzed for a possible inverse square law violation.