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Gravitational coupling between millimetre-sized masses: prospects for a quantum Cavendish experiment

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Earth-based experiments have been continuously increasing their sensitivity to gravity phenomena at laboratory scales. A yet unexplored frontier is the regime of microscopic source masses, which enables studies of fundamental interactions and provides a path towards exploring the quantum nature of gravity. We have recently demonstrated gravitational coupling between a test mass and a 90mg gold sphere, the smallest source mass to date in table-top gravity experiments. The miniaturized torsion balance measurement achieves a systematic accuracy of $3e-11$ m/s² and a statistical precision of $3e-12$ m/s². We expect that further improvements will enable the isolation of gravity as a coupling force for objects well below the Planck mass. This is a practical prerequisite for future “quantum Cavendish” experiments that aim to probe probe gravitational phenomena originating from quantum superposition states of a source-mass configuration.

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