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qBounce: Ramsey gravity resonance spectroscopy explained

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The qBOUNCE experiment investigates gravity at small distances. This is done using high precision frequency based spectroscopic methods. Ultracold neutrons (UCNs) form macroscopic bound states above a flat surface in the gravity potential of the Earth, connecting the quantum mechanical neutron wavefunction and gravity. Using this system we developed techniques for Gravity Resonance Spectroscopy (GRS). We realized measurements of a Ramsey flip between two states using Ramsey's method of separated oscillating fields with gravitationally bound UCNs. This method can be used to probe all interactions which shift the eigenenergies of the neutron. Previous iterations of the qBounce experiment implemented GRS in a Rabi configuration to set limits on chameleon dark energy, axion-like dark matter and symmetron dark energy scenarios. The current GRS setup aims to improve the energy resolution and, thus, the sensitivity to frequency shifts. The qBounce experiment is located at the UCN source PF2 at the Institut Laue-Langevin (ILL) in Grenoble. After achieving the proof of principle for Ramsey-GRS in 2018 and optimization of experimental parameters during the first half of 2019 we are prepared to take data at a projected sensitivity of 5e-16 eV/day.

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