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A Modern Measurement of the Neutron Lifetime, Using Ultracold Neutrons in a Magneto-Gravitational Trap

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The precise value of the mean neutron lifetime plays an important role in nuclear and particle physics and cosmology. It is a key input for predicting the ratio of protons to helium atoms in the primordial universe and is used to search for new physics beyond the Standard Model of particle physics. There is a 3.9 standard deviation discrepancy between neutron lifetimes measured by counting the decay rate of free neutrons in a beam (887.7 2.2 s) and by counting surviving ultracold neutrons stored for different storage times in a material trap (878.5 0.8 s). I will describe the UCNtau experiment, which is designed to eliminate loss mechanisms present in previous trap experiments by levitating polarized ultracold neutrons above the surface of an asymmetric storage trap using a repulsive magnetic field gradient so that the stored neutrons do not interact with material trap walls and neutrons in quasi-stable orbits rapidly exit the trap. As a result of this approach and the use of a new in situ neutron detector, the lifetime reported here 877.7 0.7 (stat) +0.3/-0.1 (sys) s is the first modern measurement of neutron lifetime that does not require corrections larger than the quoted uncertainties.