Decoherence-Free Entropic Gravity: Model and Experimental Tests

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Erik Verlinde's theory of entropic gravity, postulating that gravity is not a fundamental force but rather emerges thermodynamically, has garnered much attention as a possible resolution to the quantum gravity problem. Some have ruled this theory out on grounds that entropic forces are by nature noisy and entropic gravity would therefore display far more decoherence than is observed in ultra-cold neutron experiments. We address this criticism by modeling linear gravity acting on small objects as an open quantum system. In the strong coupling limit, the entropic master equation recovers conservative gravity. We show that the proposed master equation is fully compatible with the qBounce experiment for ultra-cold neutrons. Furthermore, the entropic master equation predicts energy increase and decoherence on long time scales and for large masses, phenomena which tabletop experiments could test. In addition, comparing entropic gravity's energy increase to that of the Diosi-Penrose model for gravity induced decoherence indicates that the two theories are incompatible. These findings support the theory of entropic gravity, motivating future experimental and theoretical research.

Further information can be found at arXiv:2012.10626