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Position Space Decoherence From Long-Range Interaction With Background Gas JONATHAN KUNJUMMEN, University of Maryland, DANIEL CARNEY, University of Maryland; Theory division, Fermi National Accelerator Laboratory, JACOB TAYLOR, University of Maryland, National Institute of Standards and Technology — Experiments in matter wave interferometry and optomechanics are increasing the spatial extent of wavefunctions of massive quantum systems; this gives rise to new sources of decoherence that must be characterized. Here we calculate the position space decoherence of a quantum particle due to interaction with a fluctuating classical background gas for several different force laws. We begin with the calculation of this effect for the Newton potential. To our knowledge, this calculation has not been done before. We then solve the same problem in the case of a Yukawa interaction, which interpolates between our long-range force result and the well-studied formula for collisional decoherence from a contact interaction. Unlike the contact interaction case, where the decoherence rate becomes independent of distance for large quantum particle separations, we observe that a long-range interaction leads to quadratic scaling of the decoherence rate with distance even at large separations. This work is relevant to the generation of massive superposition in optomechanical and atom beam experiments, and to conclude we comment on the use of this decoherence signal for gravitational detection of dark matter.

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