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Quantum decoherence by Coulomb interaction[1] ALEXANDER STIBOR, Lawrence Berkeley National Laboratory, NICOLE KERKER, ROBIN RÖPKE, LEA-MARINA STEINERT, ANDREAS POOCH, University of Tübingen, Germany — A basic understanding of the transition from a quantum to a classical state is a fundamental key aspect in quantum physics and described by the theory of decoherence. With the rise of novel techniques and instruments in quantum electronics, the question of decoherence introduced by the Coulomb force between charged particles and an environment becomes highly relevant. Unfortunately, this kind of decoherence mechanism is not well understood yet, several competing theoretical approaches exist. Here, we clarify the current uncertain situation in the literature by performing an experimental decoherence analysis with free electrons in a superposition state aloof a semiconducting and metallic surface in a biprism electron interferometer. The decoherence was determined through a contrast loss at different beam path separations, surface distances and conductibilities. We compared four theoretical models to our data and could rule out three of them. Good agreement was achieved with a theory based on macroscopic quantum electrodynamics. The results will allow the specific calculation and minimization of decoherence channels mediated by the Coulomb force, enabling the design of novel quantum instruments in communication, metrology or microscopy.

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