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Wavepacket tunneling and causality: a relativistic QFT approach

Monday, 23 June 2025 15:15 (15 minutes)

Recent results on electron tunneling across a potential barrier, inferred from experimental observations or obtained from theoretical models, have suggested superluminal or instantaneous barrier traversal times. We will argue, by linking the QFT property of microcausality to the wave-packet second quantized state that the tunneling dynamics is fully causal, precluding instantaneous or superluminal effects. This holds for regular or Klein tunneling across a standard or a supercritical potential: the transmitted wave packet remains in the causal envelope of the propagator, even when its average position lies ahead of the average position of the corresponding freely propagated wave packet. We will also present some numerical illustrations obtained by employing a space-time resolved QFT framework for Klein-Gordon and Dirac fields. Ref: M. Alkhateeb, X. Gutierrez de la Cal, M. Pons, D. Sokolovski, and A. Matzkin, Phys. Rev. A 111, 012222 (2025).

Primary author: MATZKIN, Alex (Lab. For Theoretical Physics and Models (LPTM), CNRS and CY Cergy Paris Univ)

Presenter: MATZKIN, Alex (Lab. For Theoretical Physics and Models (LPTM), CNRS and CY Cergy Paris Univ)

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