Probing topological Floquet states in graphene with ultrafast THz STM

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Floquet band engineering enables control of solid-state systems via periodic laser driving. The light-induced anomalous Hall effect in graphene under circularly polarized light [1] has been observed in ultrafast transport measurements [2], and more recently, Floquet replica bands induced by linearly polarized light have been reported using time-resolved photoemission spectroscopy [3]. Here, we propose probing topological Floquet states in graphene using ultrafast scanning tunneling microscopy (THz STM) as a complementary experimental technique [4].

Specifically, we present Keldysh Green's function simulations of the THz STM signal for Floquet-driven graphene. We analyze signatures of light-induced gap openings and the formation of topological edge states, focusing on their imprints in the THz STM response. We further investigate how these signatures depend on key experimental tuning parameters—namely, the pump frequency (ranging from near-infrared to optical) and light polarization (linear vs. circular). Finally, we explore the potential of imaging the topological nature of Floquet states by analyzing their quasiparticle interference (Floquet-QPI) patterns. Our findings highlight ultrafast STM as a versatile and promising tool for probing light-induced topological states in quantum materials.

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