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Graphene superlattices in strong circularly polarized fields: Detecting Berry phase without magnetic field HAMED KOOCHAKI KELARDEH, VADYM APALKOV, MARK STOCKMAN, Georgia State Univ — We theoretically explore the electron dynamics of graphene superlattices created by strong circularly-polarized ultrashort pulses. The conduction-band population distribution in the reciprocal space forms an interferogram with discontinuities related to the topological (Berry) uxes at the Dirac points. One of the fundamental problems of topological physics of graphene is a direct observation of the Berry phase. This is related to the fact that the only realistic possibility of observing this phase is self-referenced interferometry of electronic waves in the reciprocal space. However, the Berry phase is $\pm\pi$; the self-referenced interferometry doubles it to $\pm 2\pi$, which does not produce any discontinuities in the interference fringes. The Bragg scattering from the superlattices creates diffraction and which way interference in the reciprocal space reducing the Berry phase and making it directly observable in the electron interferograms. Our finding is an essential step in control and observation of ultrafast electron dynamics in topological solids and may open up a route to all-optical switching, ultrafast memories, and room temperature superconductivity technologies.

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