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Visualizing Klein tunneling in graphene at the atomic limit CHRISTOPHER GUTIERREZ, Columbia University, LOLA BROWN, EDWARD B. LOCHOCKI, CHEOL-JOO KIM, KYLE M. SHEN, JIWOONG PARK, Cornell University, ABHAY N. PASUPATHY, Columbia University — Graphene has attracted much attention from both the solid-state and high-energy scientific communities because its elementary excitations mimic relativistic chiral fermions. This has allowed graphene to act as a table-top testbed for verifying certain longstanding theoretical predictions dating back to the very first formulation of relativistic quantum mechanics. One such prediction is Klein tunneling, the ability of chiral electrons to transmit perfectly through arbitrarily high potential barriers. Previous transport and point-spectroscopic studies confirmed Klein behavior of graphene electrons but lacked real-space resolution. Here we use scanning tunneling microscopy and spectroscopy (STM/STS) measurements to present the first real-space atomic images of Klein tunneling in graphene. In these CVD-grown samples, quasi-circular regions of the copper substrate underneath graphene act as potential barriers that can scatter and transmit electrons. At certain energies, the relativistic chiral fermions that Klein scatter from these barriers are shown to fulfill resonance conditions such that the transmitted electrons become trapped and form standing waves. These resonant modes are visualized with detailed spectroscopic images with atomic resolution that agree well with theoretical calculations. The trapping time is shown to depend critically on both the angular momenta quantum number of the resonant state and the radius of the trapping potential.

> Christopher Gutierrez Columbia University

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