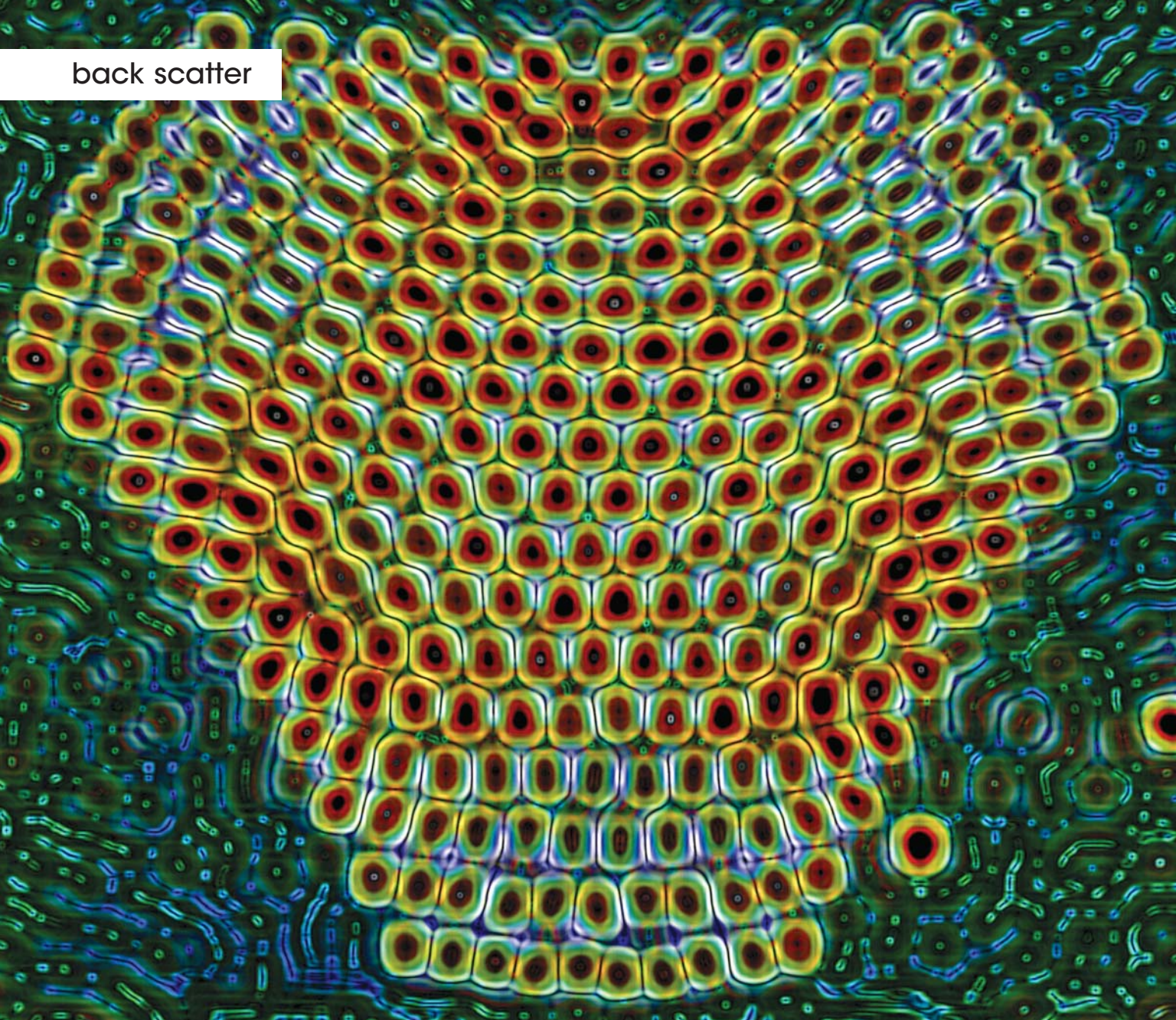




Designer Dirac fermions

The development of ready ways to produce single layers of graphene has opened up a vast new playground for experimental and theoretical physicists alike. The peculiar electronic properties of the material have been of particular interest: Thanks to graphene's honeycomb lattice, the valence and conduction bands touch, producing so-called Dirac cones that imbue the electrons with effectively zero mass (see the article by Andrey Geim and Allan MacDonald in *Physics Today*, August 2007, page 35; see also *Physics Today*, December 2010, page 14). Hari Manoharan (Stanford University) and colleagues have now demonstrated a way to make an artificial form of graphene in which the Dirac states can be materialized, probed, and tailored in novel ways.

To create their "molecular graphene," the researchers use a scanning tunneling microscope to arrange carbon monoxide molecules one at a time on a copper(111) surface. The molecules repel the surface electrons below them, so when the molecules are placed in a triangular array, the electrons are left in a graphene-like honeycomb pattern. With their ability to control every molecule's position, the researchers could craft designer potentials to explore new phenomena. In the example shown here, the dark spots in the topographic image mark the CO positions; the colors correspond to the electron density. The strained honeycomb lattice generates a pseudomagnetic field—with an effective strength of 60 tesla—that creates a quantum Hall state for Dirac fermions in a peculiar, ultraquantized ground state unprecedented in normal graphene. (K. K. Gomes et al., *Nature* **483**, 306, 2012; image by Manoharan Lab, Stanford/SLAC, <http://mota.stanford.edu>.)

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