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Cloning of Dirac fermions and hierarchy of Hofstadter states in graphene superlattices

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Superlattices have attracted great interest because their use may make it possible to modify the spectra of two-dimensional electron systems and, ultimately, create materials with tailored electronic properties. It has recently been realised that hexagonal boron nitride can be used to creates a smooth periodic potential for Dirac electrons in graphene. This potential arises due to the lattice mismatch between the two materials and misorientation of their crystallographic axis, which result in the formation of a moiré pattern. When graphene is placed on boron nitride and subjected to a magnetic field, self-similarity appears in the form of numerous replicas of the original Dirac spectrum, and their quantization gives rise to a fractal pattern of Landau levels, referred to as the Hofstadter butterfly. We employ transport measurements and capacitance spectroscopy in magnetic field up to 30 T to probe the density of states and energy gaps in this spectrum. The Hofstadter butterfly shows up as recurring Landau fan diagrams in high fields. Electron-electron interactions lead to suppression of quantum Hall ferromagnetism, a reverse Stoner transition at commensurable fluxes and additional ferromagnetism within replica spectra.