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Tunable Artificial Graphene with an Ultracold Fermi Gas DANIEL GREIF, THOMAS UEHLINGER, GREGOR JOTZU, MICHAEL MESSER, REMI DESBUQUOIS, ETH Zurich, WALTER HOFSTETTER, Johann Wolfgang Goethe University Frankfurt, ULF BISSBORT, Johann Wolfgang Goethe University Frankfurt and Singapore University of Technology and Design, TILMAN ESSLINGER, ETH Zurich — The engineering of systems that share their key properties with graphene, like Dirac fermions and a hexagonal structure, is gaining interest in an increasing number of disciplines in physics. The motivation for engineering graphene-like band structures is to explore regimes that are not, or not yet, accessible to research with graphene or similar materials. We create an artificial graphene system with tunable interactions by loading a two-component ultracold fermionic quantum gas into an optical lattice with hexagonal structure. We study the crossover from the metallic to the Mott insulating regime for increasing inter-particle interactions. For strong repulsive interactions, we observe a suppression of double occupancy and measure a gapped excitation spectrum. A quantitative comparison between our measurements and theory is additionally presented, making use of a novel numerical method to obtain Wannier functions for complex lattice structures. Furthermore, we will show recent results on alternative methods of accessing insulating phases, for example by controlling the tunneling structure.

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