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Supercriticality and screening effects in graphene[1] JINHAI MAO, YUHANG JIANG, GUOHONG LI, Rutgers University, Department of Physics and Astronomy, 136 Frelinghuysen Road, Piscataway, NJ 08855 USA, D. MOLDOVAN, M. RAMEZANI MASIR, F.M. PEETERS, Departement Fysica, Universiteit Antwerpen, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium, EVA Y. ANDREI, Rutgers University, Department of Physics and Astronomy, 136 Frelinghuysen Road, Piscataway, NJ 08855 USA — The chiral nature of charge carriers in graphene prohibits backscattering and prevents confinement by electrostatic potentials, resulting in high electronic mobility and unusual phenomena such as Klein tunneling. This picture breaks down in the presence of charge impurities exceeding a critical value Z_c, wherea qualitative change in behavior leads to the capture of electrons akin to atomic collapse in 3D atoms. Although in graphene Z_c is substantially lower than in 3D atoms, attaining the supercritical regime is difficult because screening can significantly reduce the effective charge of the impurity. We have devised a method of inducing a controllable amount of localized charge whose strength can be tuned by adjusting screening through a gate voltage or a magnetic field. The effect of the impurity on the local electronic structure was monitored with low temperature scanning tunneling microscopy and spectroscopy and with Landau level spectroscopy. By following the evolution of the spectra as a function of the induced charge and comparing with numerical simulations, we are able to pinpoint the onset of atomic collapse and beyond, providing new insights into the physics of supercriticality.

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