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Masses, topological phase transitions and fractionalized particles in graphene SHINSEI RYU, University of California, Berkeley, CHRISTOPHER MUDRY, Paul Scherrer Institute , CHANG-YU HOU, CLAUDIO CHAMON, Boston University — Interaction effects in graphene between electrons or between electrons and phonons, when sufficiently strong, for example when a magnetic field is switched on, can give a mass to the Dirac particles. This phenomenon is the graphene realization of the Higgs mechanism that gives fundamental particles their masses. We classify all possible patterns of symmetry breaking in graphene (i.e., all possible masses). Some of these masses are dual to each other in the sense that they each support defects carrying complementary topological charges. For example, a topological defect in the Kekule pattern binds a unit electric charge at its core, while a superconducting vortex in graphene traps a unit valley-pseudo spin. The topological defects also carry just a fraction of Fermi statistics, when time-reversal symmetry is broken by the anomalous Hall effect. We calculate the charge and statistical angle of topological defects by integrating out the massive fermions and constructing the effective field theory for the system. This duality allows for direct continuous phase transitions between two unrelated symmetry-broken phases through the deconfinement transition of defects, making graphene an ideal testbed for the concept of deconfined criticality.

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