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Spontaneous breakdown of time reversal symmetry in the doped honeycomb lattice with enlarged unit cell ADOLFO G. GRUSHIN, EDUARDO V. CASTRO, ALBERTO CORTIJO, MARíA A. H. VOZMEDIANO, BELÉN VALENZUELA, Instituto de Ciencia de Materiales de Madrid, CSIC, Spain, FERNANDO DE JUAN, Department of Physics, Indiana University, Bloomington, IN — Enlarging the unit cell of simple lattice models is proposed as a simple means to get spontaneous breakdown of time reversal symmetry ($\mathcal{T}$) and to stabilize non trivial topological phases. As a case study we explore the nearest neighbor tight binding model for spinless fermions interacting through short range Coulomb interactions in the honeycomb lattice. Using a variational mean field approach and an enlarged six atom unit cell we obtain a very rich phase diagram as doping and interaction strength are varied. Two broken $\mathcal{T}$ phases, with orbital currents (fluxes) arranged in a Kekulé pattern, show up above the Van Hove filling. One of them realizes a topological Fermi liquid with a finite anomalous Hall conductivity. Instabilities towards charge modulated and superconducting phases are also discussed.

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