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Quantum Hall Electron Nematics[1]

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In 2D electron systems hosted by crystals with hexagonal symmetry, electron nematic phases with spontaneously broken C3 symmetry are expected to occur in the quantum Hall regime when triplets of Landau levels associated with three different Fermi surface pockets are partially filled. The broken symmetry state is driven by intravalley Coulombic exchange interactions that favor spontaneously polarized valley occupations. I will discuss three different examples of 2D electron systems in which this type of broken symmetry state is expected to occur: i) the SnTe (111) surface [2], ii) the Bi (111) surface [3]. and iii) unbalanced bilayer[4] graphene. This type of quantum Hall electron nematic state has so far been confirmed only in the Bi (111) case, in which the anisotropic quasiparticle wavefunctions of the broken symmetry state were directly imaged. In the SnTe case the nematic state phase boundary is controlled by a competition between intravalley Coulomb interactions and intervalley scattering processes that increase in relative strength with magnetic field. An in-plane Zeeman field alters the phase diagram by lifting the three-fold Landau level degeneracy, yielding a ground state energy with $2\pi/3$ periodicity as a function of Zeeman-field orientation angle. I will comment on the possibility of observing similar states in the absence of a magnetic field.

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[2]Xiao Li, Fan Zhang, and A.H. MacDonald, Phys. Rev. Lett. **1**16, 026803 (2016).
[3]Benjamin E. Feldman *et al.*, Science, **354**, 316-321 (2016).
[4]Xiao Li and A.H. MacDonald, to be published (2017).