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Valley-skyrmion and Wigner crystals in graphene RENE COTE, JEAN-FRANCOIS JOBIDON, Universite de Sherbrooke, HERBERT A. FERTIG, University of Indiana — At low-energy, the band structure of graphene can be approximated by two degenerate valleys (K, K') about which the electronic spectra of the valence and conduction bands have a linear dispersion relation. An electronic state in this band spectrum is a linear superposition of states from the A and B sublattices of the honeycomb lattice of graphene. In a quantizing magnetic field, the band spectrum is split into Landau levels with level $N = 0$ having zero weight on the $B(A)$ sublattice for the $K(K')$ valley. Treating the valley index as a pseudospin and assuming the real spins to be fully polarized, we compute the energy of skyrmion crystals in the Hartree-Fock approximation. We show that skyrmion crystals have lower energy than Wigner crystals i.e. crystals with no pseudospin texture. The collective mode spectrum of the valley- skyrmion crystal has three linearly-dispersing Goldstone modes in addition to the usual phonon mode while a Wigner crystal has only one extra Goldstone mode with a quadratic dispersion. We comment on how these modes should be affected by disorder and how, in principle, a microwave absorption experiment could distinguish between Wigner and skyrmion crystals.

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