Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Quasiparticle velocities in 2D electron/hole liquids with spin-orbit coupling[1] DAVID AASEN, STEFANO CHESI, BILL COISH, McGill University — We study the influence of spin-orbit interactions on quasiparticle dispersions in two-dimensional electron and heavy-hole liquids in III-V semiconductors. To obtain closed-form analytical results, we work within the screened Hartree-Fock approximation, valid in the high-density limit. For electrons having a linear-in momentum spin-orbit interaction, we confirm known results based on the random-phase approximation and we extend those results to higher order in the spin-orbit coupling. For hole systems, with a leading nonlinear-in-momentum spin-orbit interaction, we find two important distinctions. First, the group velocities associated with the two hole-spin branches acquire a significant difference in the presence of spin-orbit interactions, allowing for the creation of spin-polarized wavepackets in zero magnetic field. Second, we find that the interplay of Coulomb and spin-orbit interactions is significantly more important for holes than for electrons and can be probed through the quasiparticle group velocities. These effects should be directly observable in magnetotransport, Raman scattering, and femtosecond-resolved Faraday rotation measurements.

[1]prepint arXiv:1110.6661v1

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Date submitted: 08 Nov 2011 Electronic form version 1.4