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Spin incoherent effects in momentum resolved tunneling, transport, and Coulomb drag in Luttinger liquids[1]

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In a one dimensional electron gas at low enough density the magnetic exchange energy J between neighboring electrons is exponentially suppressed relative to the Fermi energy, E_F. At finite temperature T, the energy hierarchy $J << T << E_F$ can be reached, and we refer to this as the spin incoherent (SI) Luttinger liquid state. By using a model of a fluctuating Wigner solid, we theoretically explore the signatures of spin incoherence in the single particle Greens function[1], momentum resolved tunneling[2], transport[3], and Coulomb drag[4]. In the SI Greens function the spin modes of a Luttinger liquid (LL) are thermally washed out leaving only singular behavior from the charge modes. The charge modes are broadened in momentum space by an amount of order k_F and the energy dependence of the tunneling density of states qualitatively changes from the low energy suppression of the LL regime to a possible low energy divergence in the SI regime. Such a state may be probed directly in momentum resolved tunneling between parallel quantum wires. Deep in the SI regime, the physics of transport and Coulomb drag can be mapped onto spinless electrons. Various crossovers in temperature and for finite systems connected to Fermi liquid leads are discussed. Both transport and Coulomb drag may exhibit interesting non-monotonic temperature dependence. [1] G. A. Fiete and L. Balents, Phys. Rev. Lett. 93, 226401 (2004). [2] G. A. Fiete, J. Qian, Y. Tserkovnyak, and B. I. Halperin, Phys. Rev. B 72, 045315 (2005). [3] G. A. Fiete, K. Le Hur, and L. Balents, Phys. Rev. B 72, 125416 (2005). [4] G. A. Fiete, K. Le Hur, and L. Balents, Submitted, cond-mat/0511715.

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