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Coulomb drag experiments in dilute p-GaAs double layer systems[1]

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Low density (or dilute) two-dimensional systems, which have large ratios of Coulomb interaction energy to kinetic energy (r_s is roughly greater than 10), are found to exhibit some bizarre transport properties. These include an anomalous metallic temperature dependence and an apparent metal-insulator transition. Furthermore, the application of an in-plane magnetic field, which spin polarizes the 2D system, produces some very unique effects, including a giant magnetoresistance. These unusual transport properties have raised serious doubts regarding the applicability of Fermi liquid theory to the large r_s regime. Despite intense efforts, no conclusive understanding of these transport anomalies currently exists. To gain new insights into the role the strong carrier interactions play in this regime, we have measured the Coulomb drag in low density p-GaAs 2D bilayers. The drag resistivity is directly proportional to the interlayer carrier-carrier scattering rate, and allows us to directly study the carrier interactions in this regime. Our findings are that as the density is lowered into the large r_s regime, the drag resistivity develops a two to three orders of magnitude enhancement over that expected from simple Fermi liquid calculations. We also observe significant deviations from the expected T^2 dependence, which correlate with the anomalous metallic temperature dependence observed in the single layer resistivity. Furthermore, we find that both the single layer resistivity and drag resistivity exhibit the exact same qualitative in-plane magnetic field dependence, with both exhibiting similar features associated with spin polarization. These observations suggest that the origin of these transport anomalies, affects both the single layer resistance and drag resistance in exactly the same way, and is surprising since these are two extremely different transport properties. We conclude by discussing these experimental results in light of recent theoretical interpretations of our data.

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