Theory of Microwave-Induced Magneto-Resistance Oscillations in a Two-Dimensional Electron Gas

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Recent measurements of a 2D electron gas subjected to microwave radiation reveal a magneto-resistance with an oscillatory dependence on the ratio of radiation frequency to cyclotron frequency.[1,2,3] This discovery has attracted considerable theoretical attention.[4,5,6,7,8,9,10,11] and was predicted in the Soviet literature some time ago.[12] We perform a diagrammatic calculation and find radiation-induced resistivity oscillations with the correct period and phase. The experimental results are explained via a simple picture in which the electrons acquire energy from the microwaves and momentum from impurity scattering. The resulting non-equilibrium state modifies the dc resistivity. The resistivity oscillations increase with radiation intensity and can exceed the dark resistivity, resulting in negative-resistivity minima. At high intensity, we predict additional features, likely due to multi-photon processes, which have yet to be observed experimentally. Andreev, Aleiner and Millis[6] have shown that the negative resistivity state is unstable which leads to domain structure in the current distribution. This causes the resistivity to saturate at zero rather than going negative. While these simple pictures appear to capture the essential physics, there are a number of open questions that need to be addressed concerning the inelastic relaxation rate, the role of Coulomb interactions, and the apparently large thermal activation energy for the dissipation.

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