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Universality of quadratic to linear magnetoresistance crossover in disordered conductors[1] SILVIA LARA, Yale-NUS College, NAVNEETH RAMAKRISHNAN, National University of Singapore, YING TONG LAI, SHAFFIQUE ADAM, Yale-NUS College — Many experiments measuring Magnetoresistance (MR) showed unsaturating linear behavior at high magnetic fields and quadratic behavior at low fields. In the literature, two very different theoretical models have been used to explain this classical MR as a consequence of sample disorder. The phenomenological Random Resistor Network (RRN) model constructs a grid of four-terminal resistors each with a varying random resistance. The Effective Medium Theory (EMT) model imagines a smoothly varying disorder potential that causes a continuous variation of the local conductivity. In this theoretical work, we demonstrate numerically that both the RRN and EMT models belong to the same universality class, and that a single parameter (the ratio of the fluctuations in the carrier density to the average carrier density) completely determines both the magnitude of the MR and the B-field scale for the crossover from quadratic to linear MR. By considering several experimental data sets in the literature, ranging from thin films of InSb to graphene to Weyl semimetals like Na3Bi, we show that this disorder-induced mechanism for MR is in good agreement with the experiments, and that this comparison of MR with theory reveals information about the spatial carrier density inhomogeneity.

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