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Non-saturating magnetoresistance in heavily disordered semiconductors

MEERA PARISH, Princeton University

We present a classical model of the magnetotransport of strongly inhomogeneous semiconductors based on an array of coupled four-terminal elements. We show that this model generically yields non-saturating, quasi-linear magnetoresistance at large magnetic fields, in contrast to the resistance of a homogeneous semiconductor, which increases quadratically with magnetic field at low fields and, except in very special cases, saturates at fields much larger than the inverse of the carrier mobility. We argue that our model provides an explanation for the observed non-saturating magnetoresistance in doped silver chalcogenides and potentially in other macroscopically disordered conductors. Finally, our method may be used to design the magnetoresistive response of a microfabricated array and thus pave the way to the construction of magnetic field sensors with a controllable response.