Disorder, itinerant ferromagnetism and the anomalous Hall effect in two dimensions

PARTHA MITRA, ARTHUR HEBARD, Department of Physics University of Florida — This talk will describe research motivated by the lack of consensus on what happens in a band ferromagnet such as iron when the itinerancy of the electrons, which carry spin information, is compromised by disorder. We address this challenging problem by performing in situ studies of magnetotransport in a series of films having sheet resistances varying from 50 to 1,000,000 Ohms. In the weakly disordered regime of this two-dimensional system, where the quantum corrections to the conductivity have logarithmic temperature dependence, we find a surprising scaling of the longitudinal and anomalous Hall (transverse) resistances. For higher disorder the scaling breaks down and the anomalous Hall resistance $R_{xy}$ saturates at a constant value near 100 Ohms. These results imply the presence of an anomalous Hall insulating state where the longitudinal $L_{xx}$ and transverse $L_{xy}$ conductivities approach zero with a ratio $R_{xy} = L_{xy}/L_{xx}^2$ that remains constant.