Transport Experiments in Electron-Hole Bilayers The Search for Exciton Condensation

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The system of spatially separated but strongly-interacting two-dimensional electron and hole layers was first proposed in the 1970s.[1] A number of novel effects are predicted to arise from the attractive electron-hole interaction, including condensed phases of excitons and exciton superfluidity.[2] The seminar will begin with an overview of these predictions and how electrical transport measurements may be used to test them.

Fabrication of stable electron-hole (e-h) bilayers for transport measurements is challenging and was not achieved until 1992.[3] More recently, techniques have been developed for making e-h bilayers with interlayer separations of 10-20nm and tuneable carrier densities in the dilute regime where interlayer interactions become significant compared to intralayer interactions.[4,5] Independent electrical contacts to the two layers enable detailed transport studies of these bilayers.[6]

Frictional drag experiments,[7] can measure directly the rate of interlayer momentum transfer due to electron-hole interactions. Recent drag measurements show a departure from Fermi liquid behaviour in the e-h bilayer at temperatures below $\sim$ 1K.[8,9] The transport properties of the individual layers are also strongly influenced by the presence of the other layer, leading to insulating temperature-dependence of the resistivity at resistivity values well below the resistance quantum h/e^2. Possible origins of this behaviour are discussed.

The seminar concludes with a discussion of some unanswered questions and complications around the search for exciton condensation in e-h bilayers, including the further experiments to be done and what is needed to maximise the chance of seeing exciton coherence and superfluidity.

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