Critical Currents in Excitonic Electron Bilayer Systems

L Tiemann[1], W Dietsche[1], M Hauser[1], K v Klitzing[1]
[1] *Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, 70569 Stuttgart, Germany*

Electron correlation effects in two-dimensional electron systems (2DES) under strong perpendicular magnetic fields are responsible for a variety of states, such as the fractional quantum Hall effects. A very unique correlated state can emerge between two closely-spaced 2DES when the filling factor in each 2DES is close to 1/2. The ground state at this total filling factor of one is believed to be a Bose condensate of (quasi-)excitons. This correlated state can be investigated via magneto-transport or interlayer tunneling experiments. The latter have shown an I/V characteristic which has an astonishing resemblance to one of the Josephson effect of superconductivity [1]. Despite several similarities between the common superconductivity/superfluidity and the double quantum well system at a total filling factor of 1, certain aspects have failed to appear so far, such as a critical behavior. In our DC interlayer tunneling experiments, we could observe such a critical behavior [2] when then total current I becomes too large. For $I < I_{critical}$, the four-terminal interlayer resistance is very small but abruptly increases by many orders of magnitude once $I > I_{critical}$. The nearly vanishing 4-terminal interlayer resistance is most likely the direct consequence of the (interlayer) phase-coherence associated with the Bose condensation of excitons. It appears that the condensate changes the tunneling electrons into quasiparticles which are easily transferred between the layers.

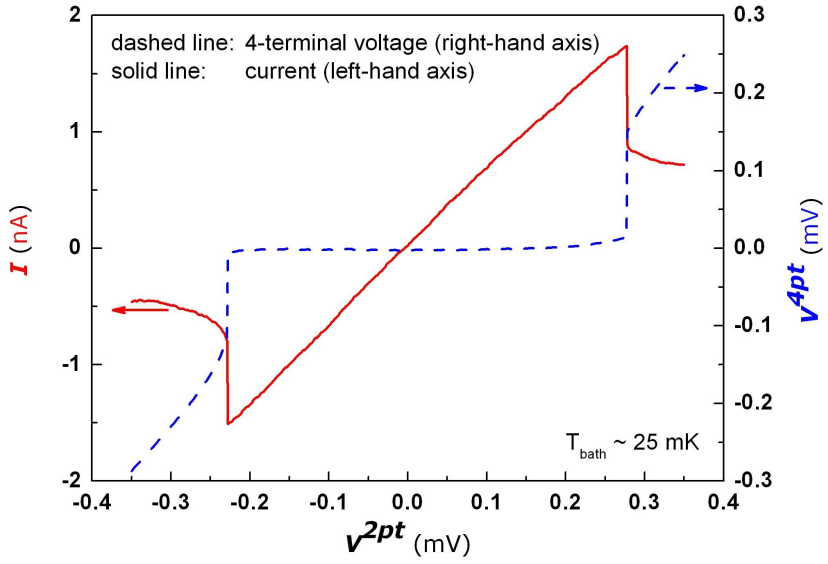

Figure 1: *DC current and 4-terminal voltage versus the applied 2-terminal bias voltage. The small 4-terminal voltage jumps to a finite value as soon as a critical current is exceeded. If the current is plotted versus the 4-terminal voltage, the curve collapses onto a Josephson effect-like characteristic.*

References

[1] Spielman I B *et al.*, *Phys. Rev. Lett.* **87**, 036803 (2001).

[2] Tiemann L *et al.*, *New J. Phys.* **10**, 045018 (2008).