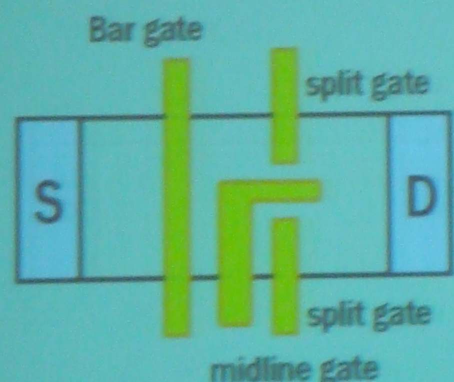
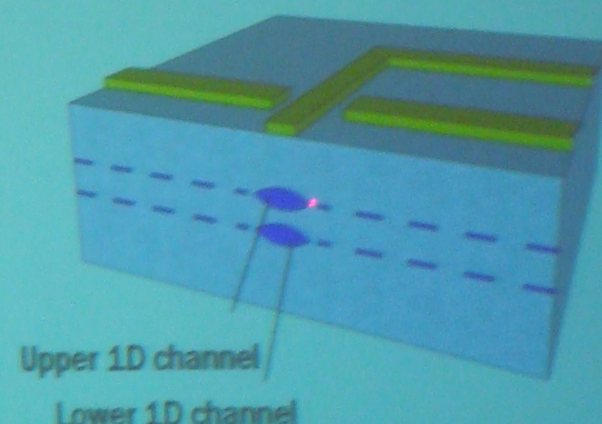
Measurement technique

- Two vertically-aligned 1D channels in a double quantum well GaAs/AlGaAs heterostructure, using split and midline gates (dimensions: split gate - 0.5 μm long, 0.8 μm wide, midline gate - 0.3 μm wide), [for further description see K.J. Thomas et al., Phys. Rev. B 59, 12252 (1999)].
- Quantum wells separated by 30 nm barrier, to prevent tunnelling.
- Lower wire acts as a probe of how effectively the upper wire screens the potential from the midline gate.





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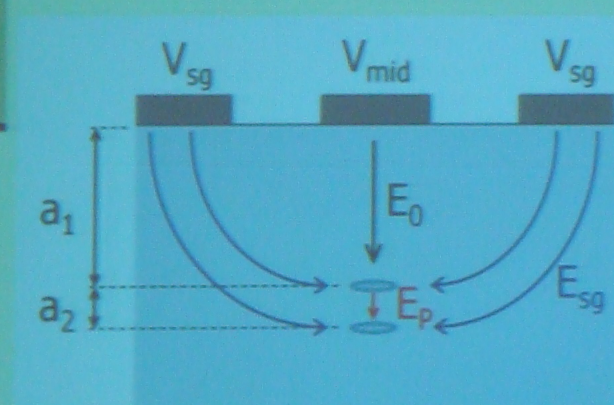
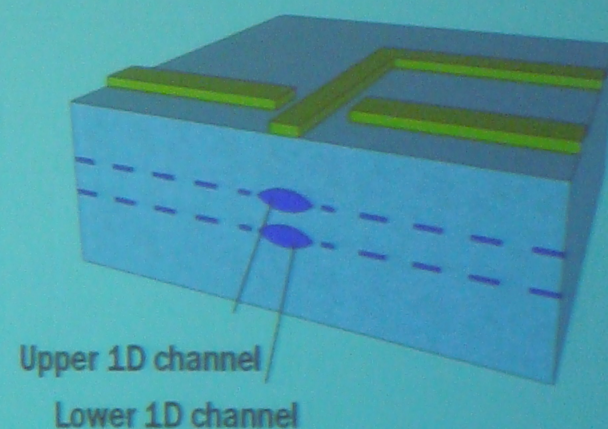


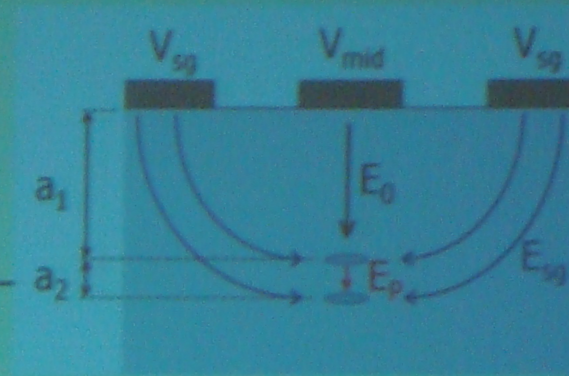


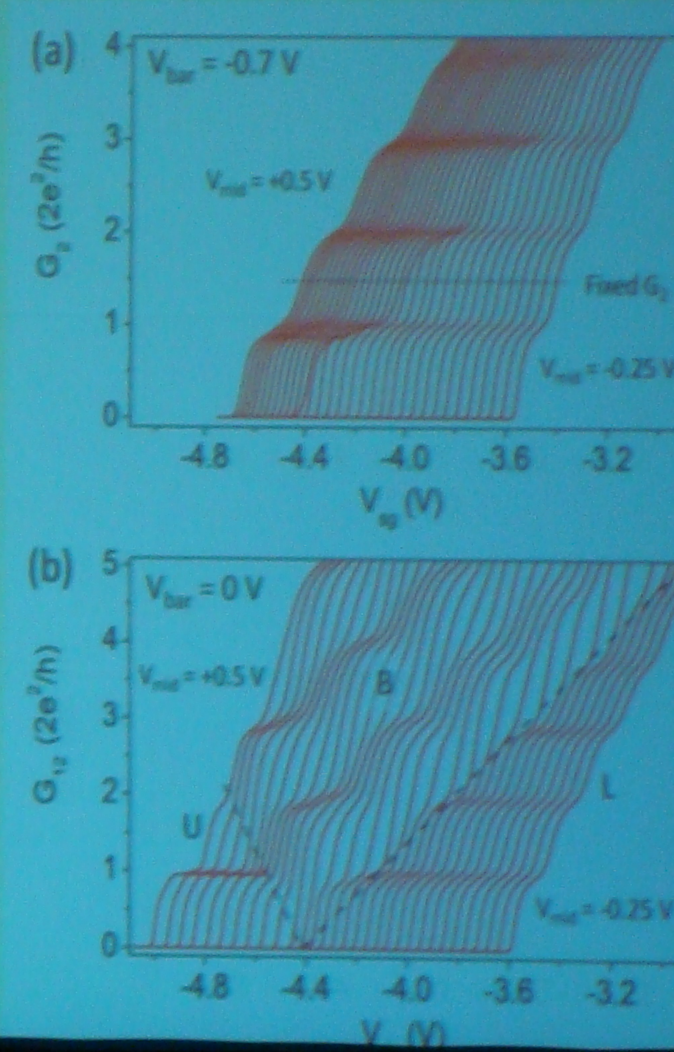
Measurement

- **Bar gate** we independently contact the lower quantum wire, and measure $\mathbf{G_2}$.
- Also measure total conductance $\mathbf{G_{12}}$ between the parallel wires,. The upper layer conductance $G_1 = G_{12} - G_2$.
- Consider fixed G_2, so that the total flux incident on the lower wire is constant.

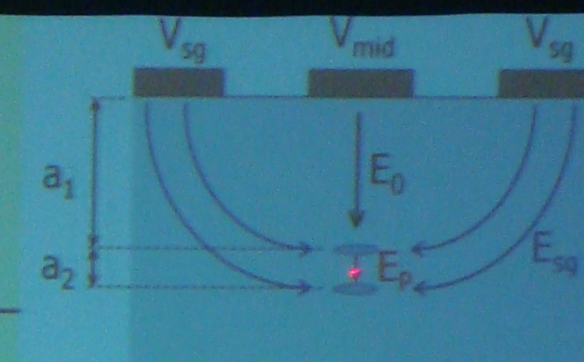
⇒ changes in penetration field ($\boldsymbol{\delta E_p}$) must be compensated by changes in split-gate electric field ($\boldsymbol{\delta E_{sg}}$) to keep G_2 fixed.

- Derivative $\mathbf{dV_{sg}/dV_{mid}}$ is therefore related to δE_p and to the **screening ability of the wire.**



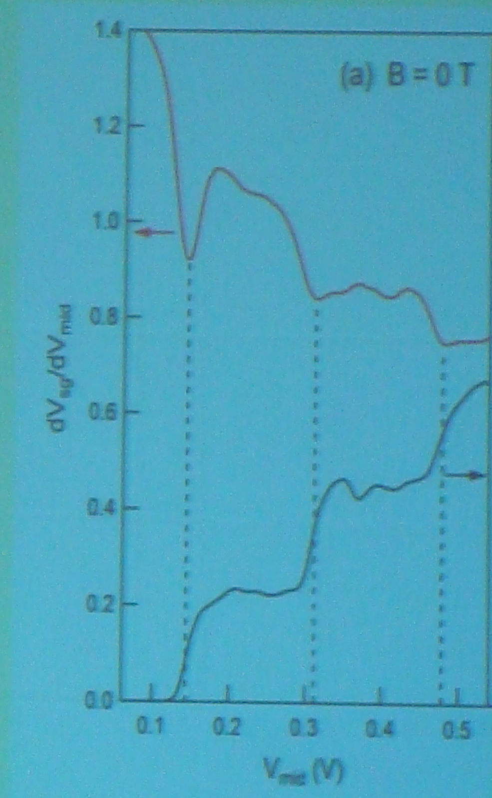


The results:



- Minima in compressibility signal $\mathbf{dV_{sg}/dV_{mid}}$ coincide with the population of 1D subbands, due to the high density of states at subband edges.

- At $\mathbf{dV_{sg}/dV_{mid}}$ minima, E_0 from midline-gate well screened by the quantum wire, ⇒ compressibility is maximum.



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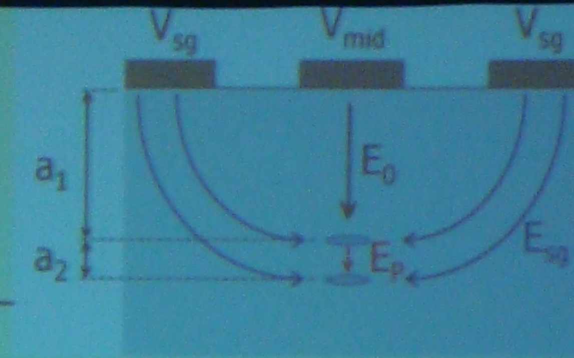

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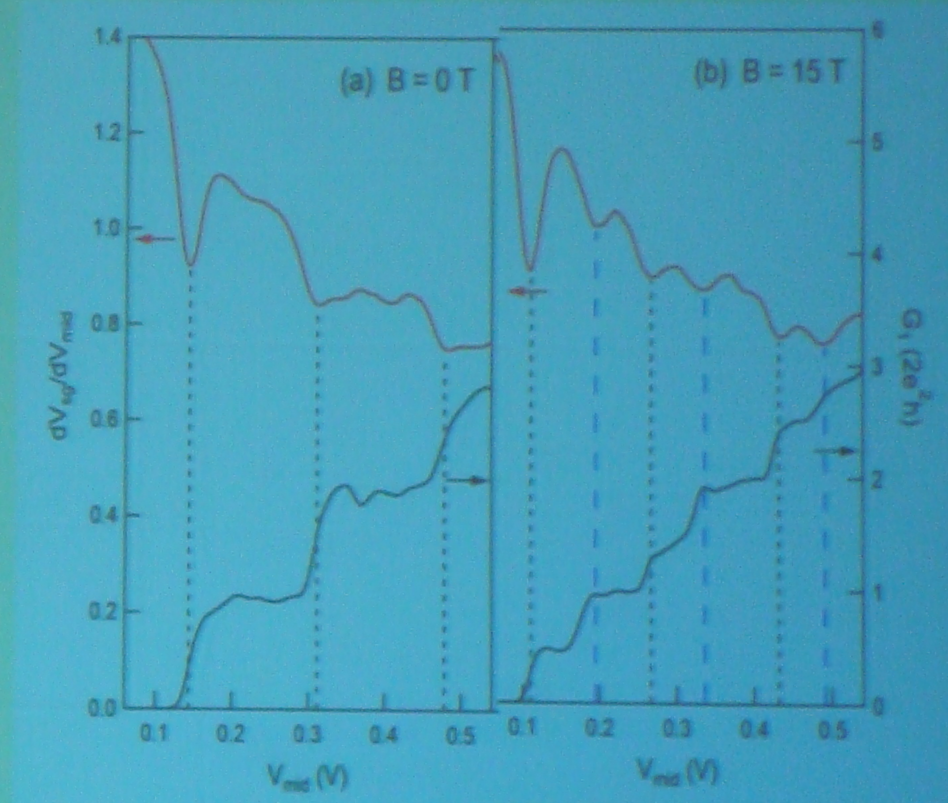
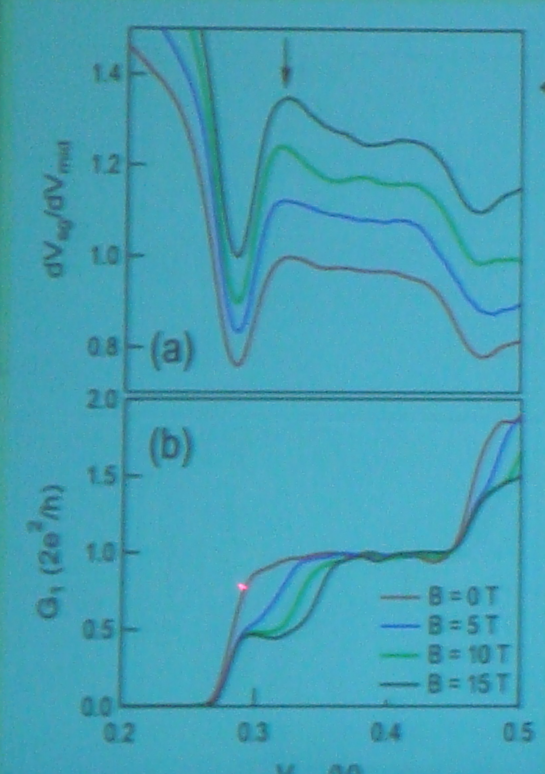


- Apply $B_{\parallel} \Rightarrow$ spin splitting of 1D subbands resolved in compressibility for first time.

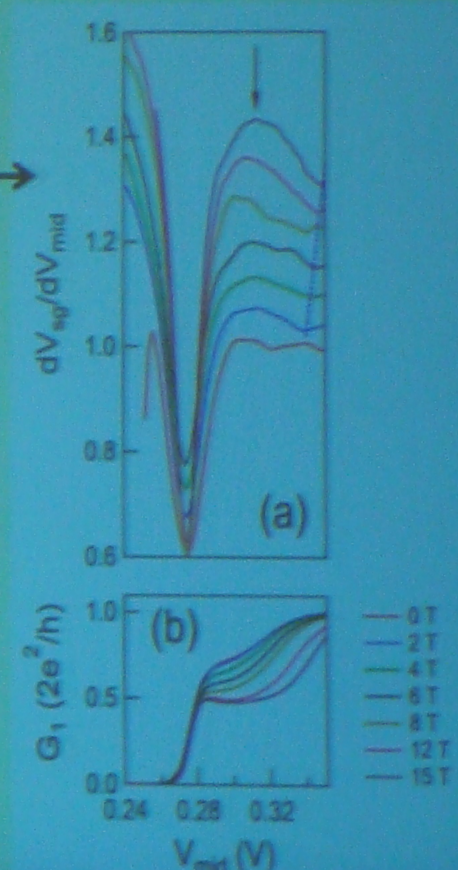
The 0.7 structure:

- Look at magnetic-field dependence of lowest subband, at T = 25 mK.
- **Peak** emerges in the compressibility signal as B increases.
- **Peak** is clearly related to the onset of spin polarization, since it develops in line with the $0.5(2e^2/h)$ plateau.



← T = 25 mK

T = 500 mK →



The compressibility data are offset vertically for clarity. Two different measurement protocols used to obtain the data, with identical results.

A signature of Kondo?

- Compare data at T = 25 K, B = 0 T with DFT calculations by Lüscher et al., Phys. Rev. Lett. 98, 196805 (2007).

- Axes aligned horizontally so that conductance data overlaps.
- Vertical axes aligned so that depth of first minima are equal, to compare data on the same scale.

- Calculations predict **dip in compressibility** as signature of quasibound state, needed for Kondo effect: **this dip is not observed in our measurements**.