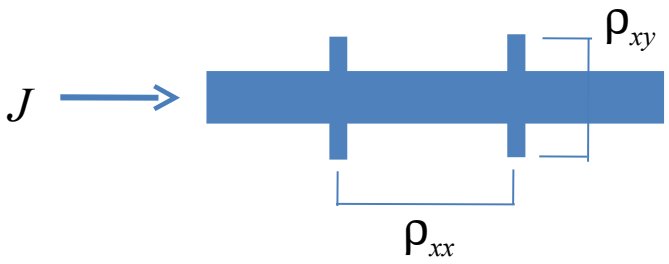
低温物理学

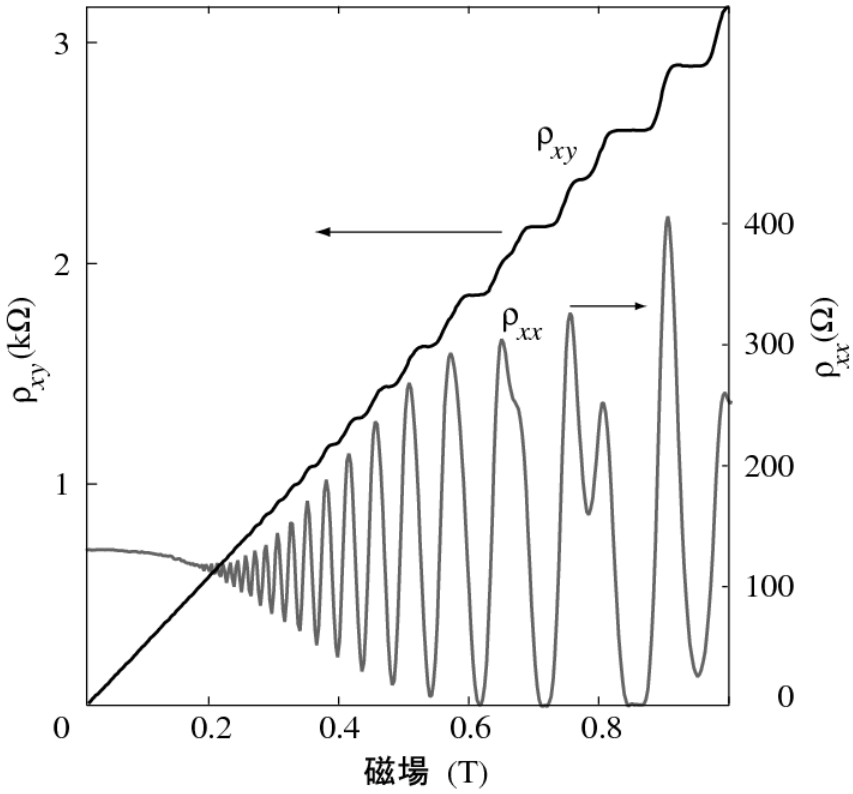
2009年６月４日

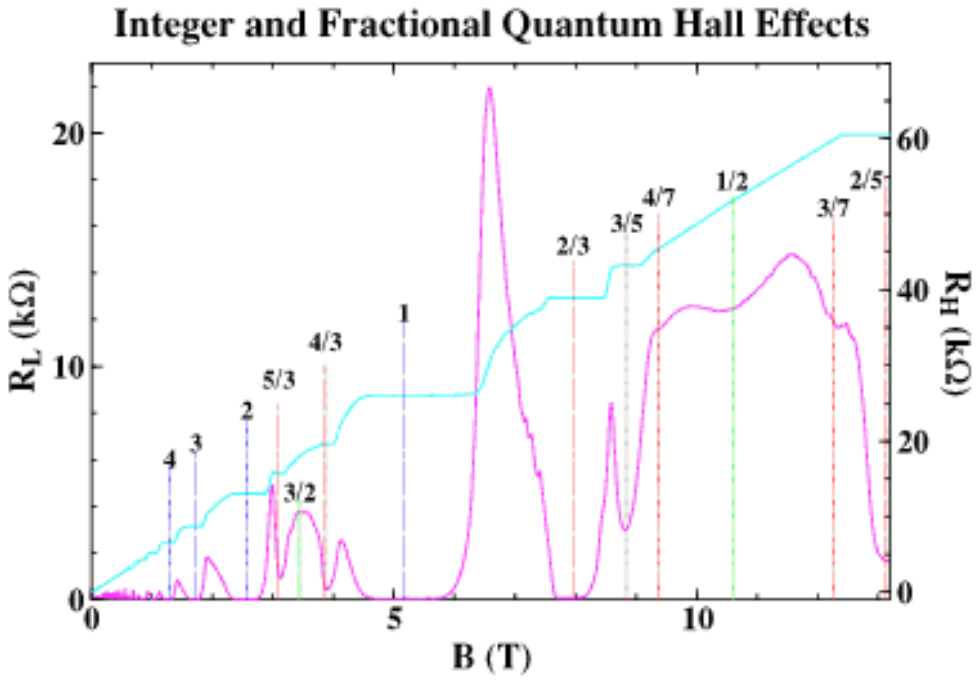
物性研究所

勝本信吾

量子ホール効果


J
ρxy
ρxx

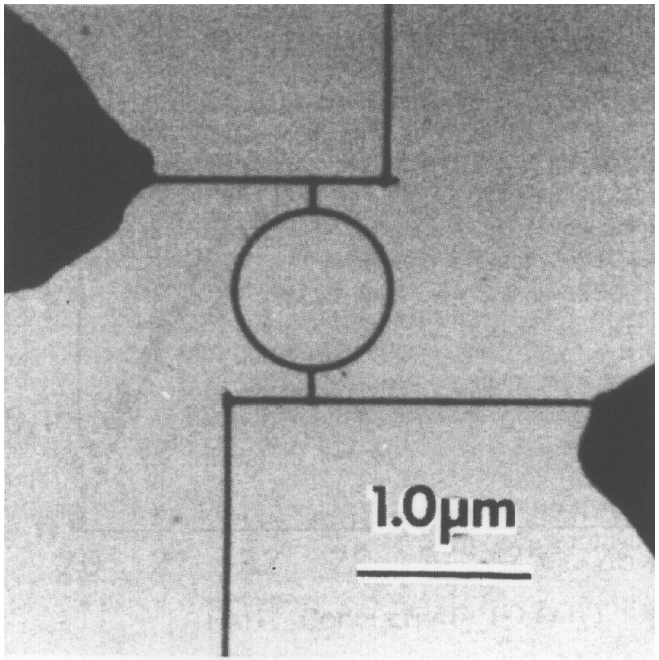

ρxy
ρxx
ρxy (kΩ)
ρxx (Ω)
磁場 (T)
0
0.2
0.4
0.6
0.8
1
2
3
100
200
300
400

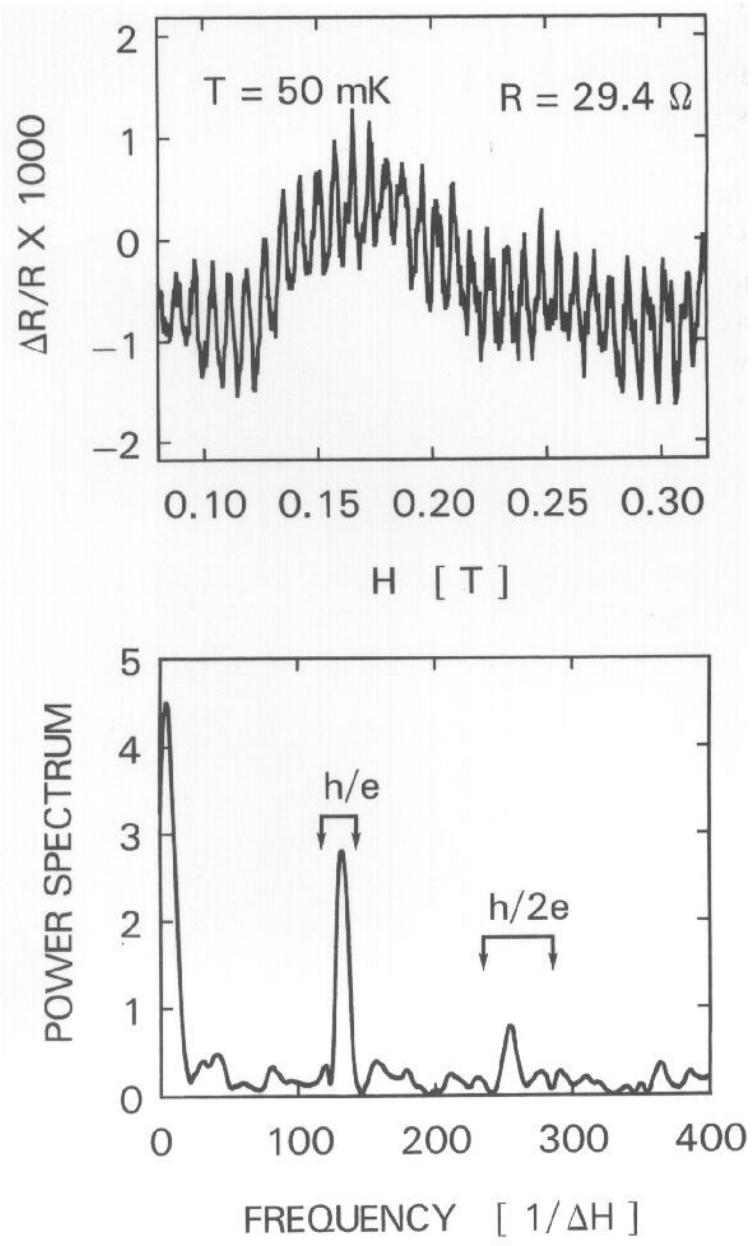

Integer and Fractional Quantum Hall Effects
RL (kΩ)
RH (kΩ)
B (T)
0
5
10
20
40
60
4
3
2
5/3
4/3
3/2
1
2/3
3/5
4/7
1/2
3/7
2/5

メゾスコピック物理の始まり

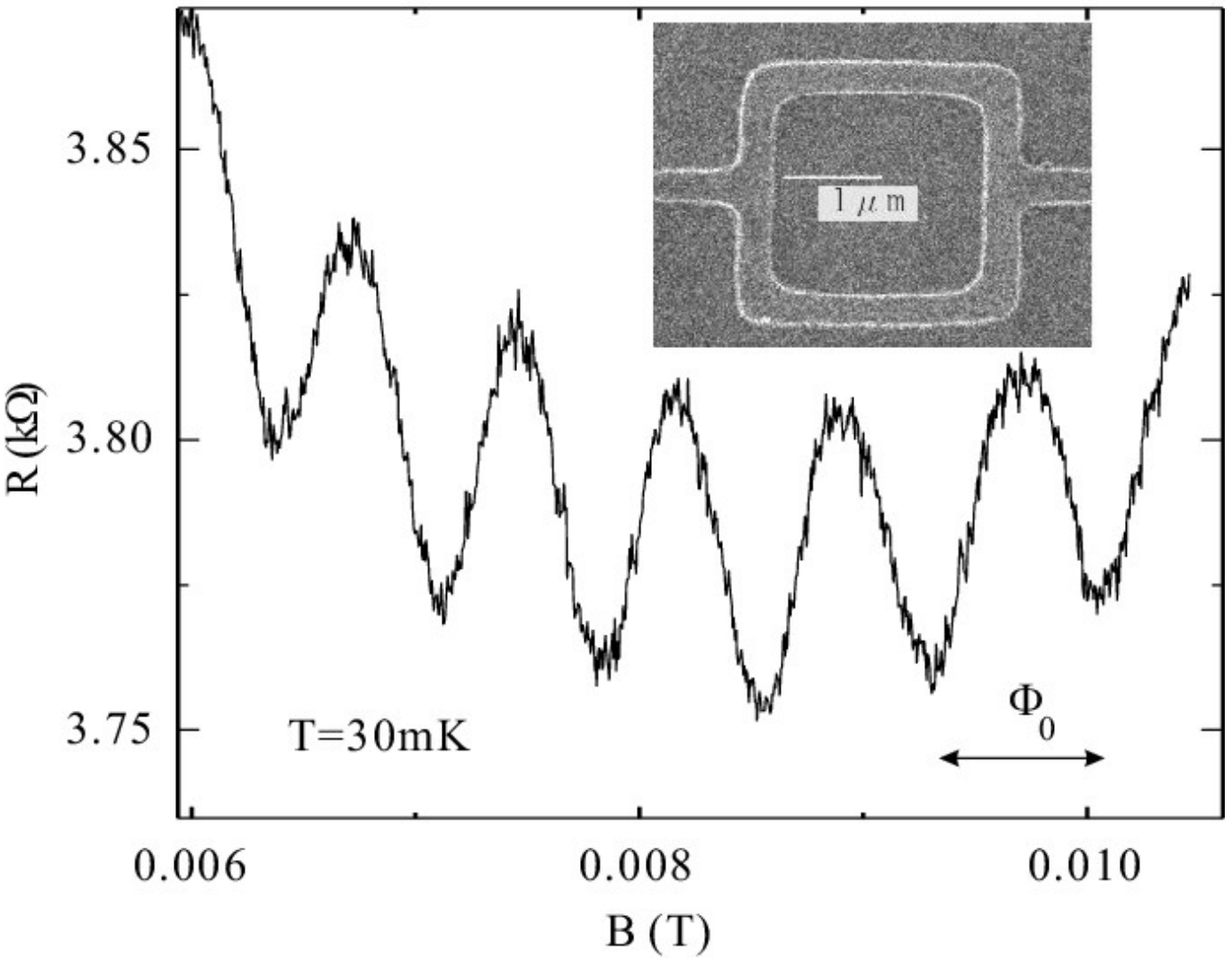
Aharonov-Bohm 効果の観測

R. A. Webb et al. PRL 54, 1610 (1985).

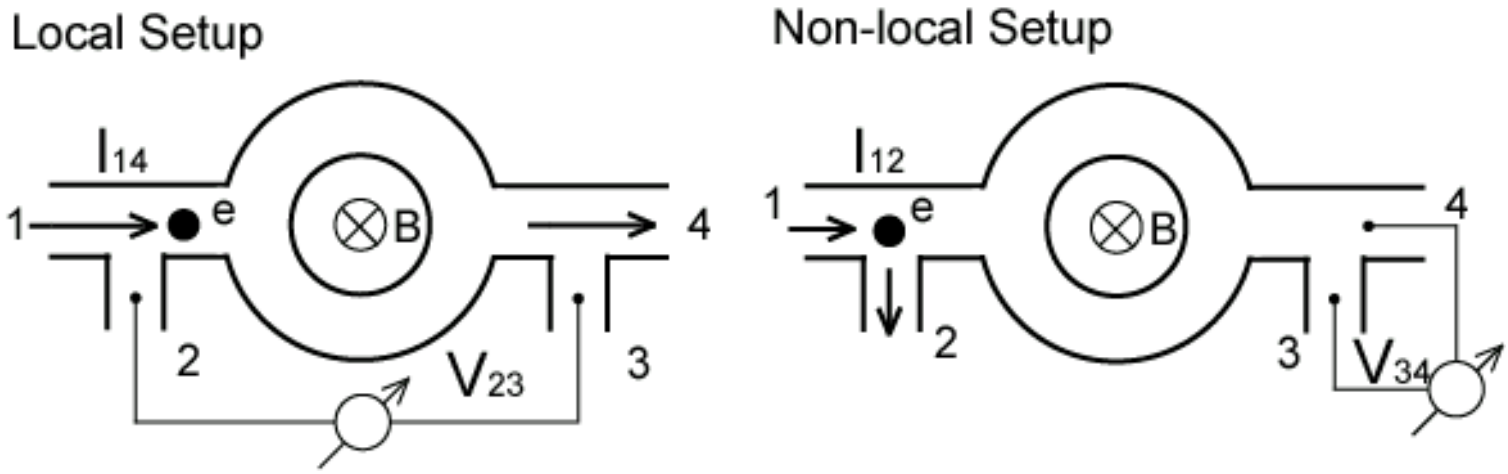




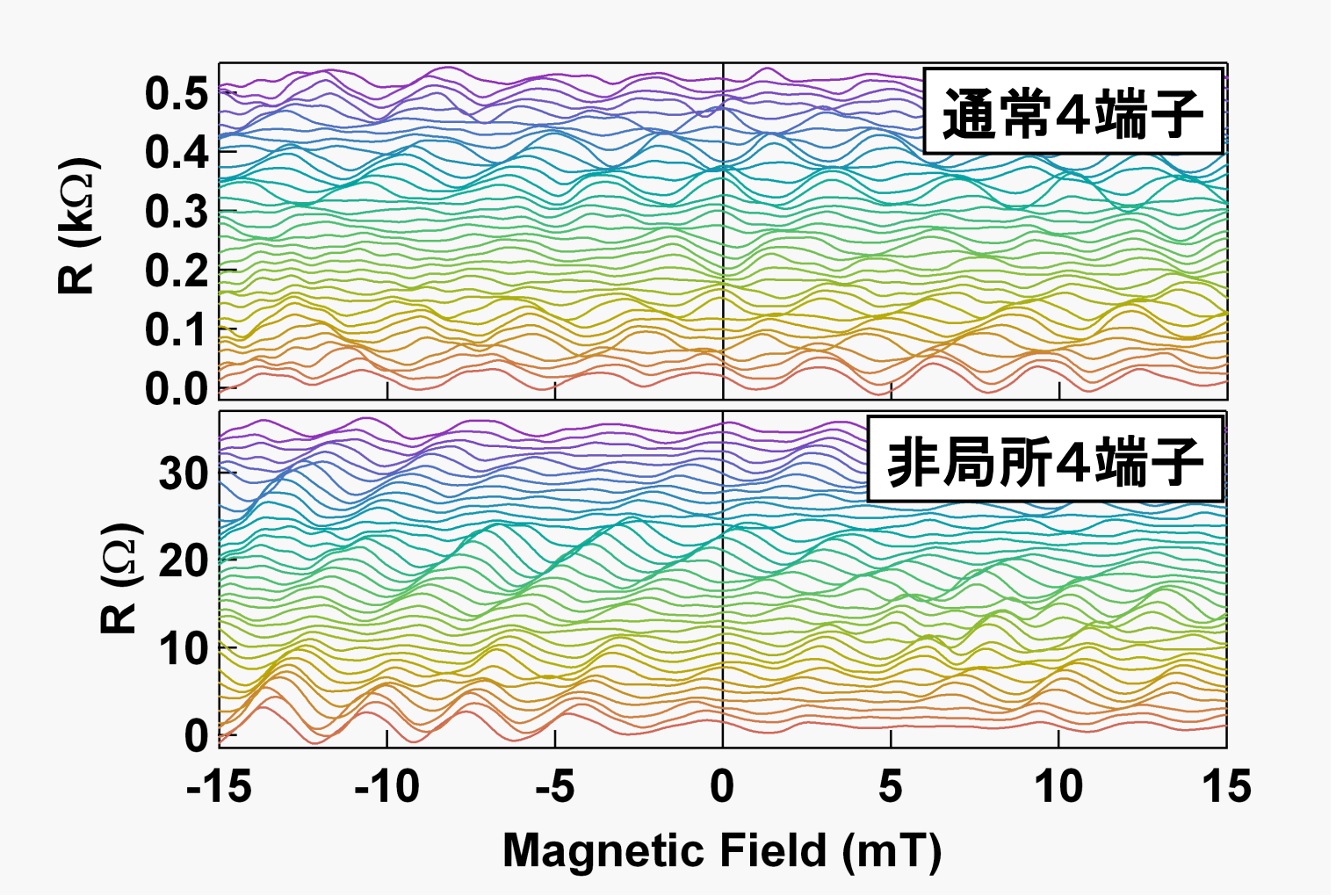
AB ring made of 2DES at a hetrointerface



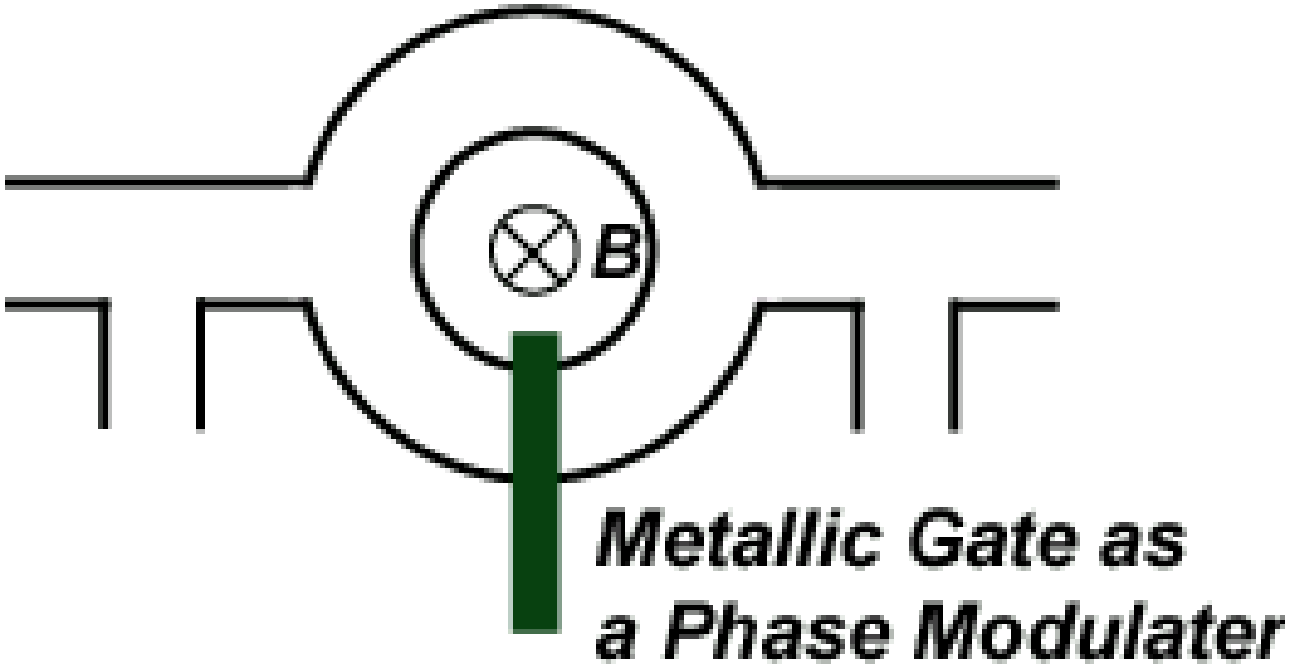
AB効果の非局所測定



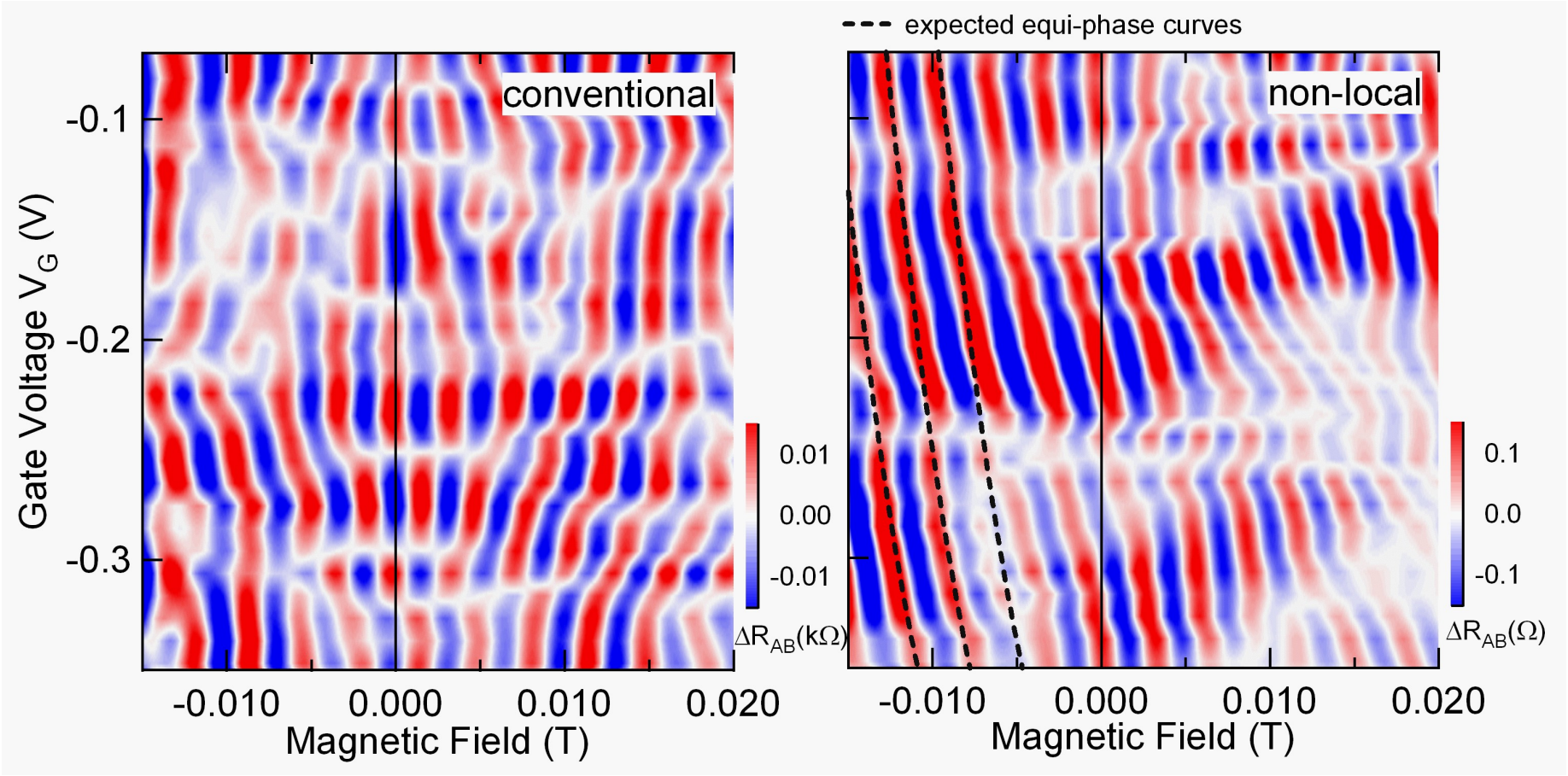
２つの端子配置での位相変化



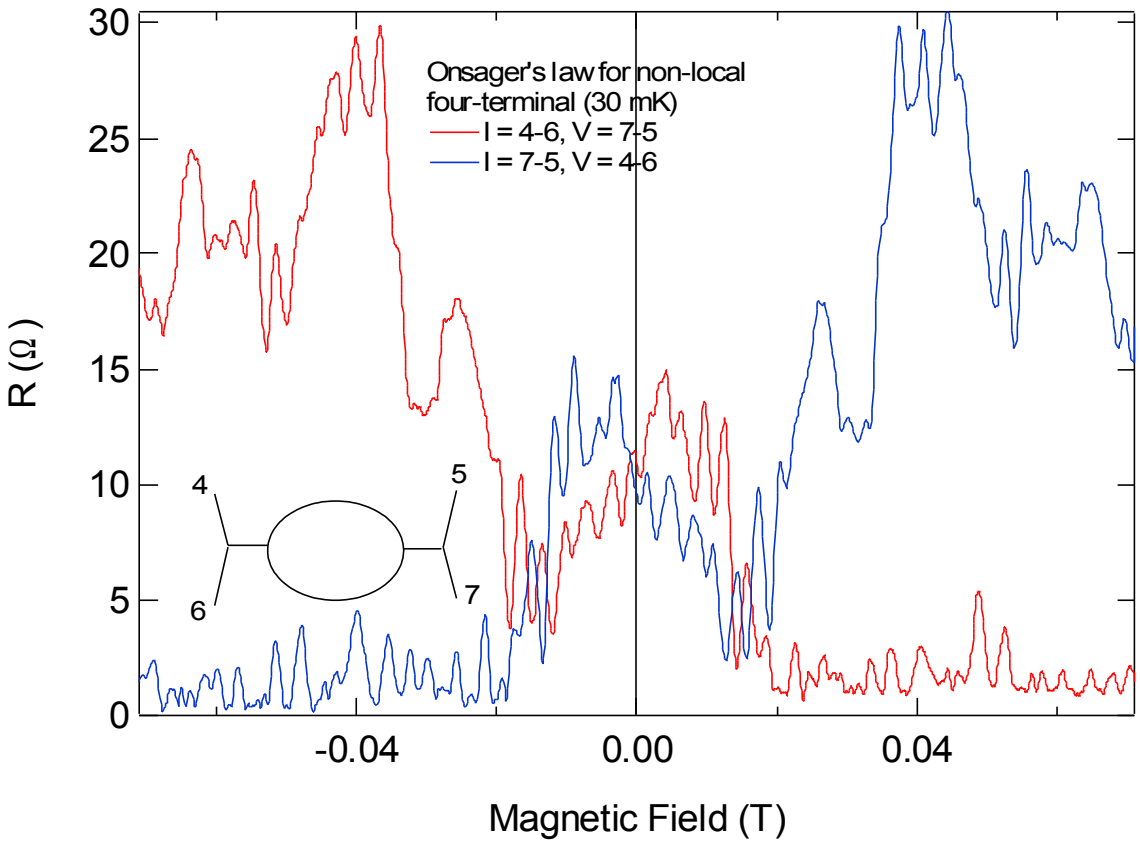
静電的なAB位相制御



AB位相制御

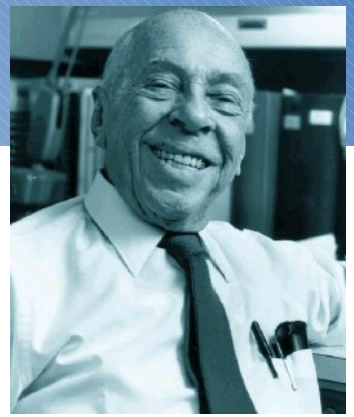

expected equi-phase curves
conventional
non-local
Gate Voltage V_G (V)
-0.1
-0.2
-0.3
0.01
0.00
-0.01
ΔR_{AB}(kΩ)
0.1
0.0
-0.1
ΔR_{AB}(Ω)
-0.010
0.000
0.010
0.020
Magnetic Field (T)

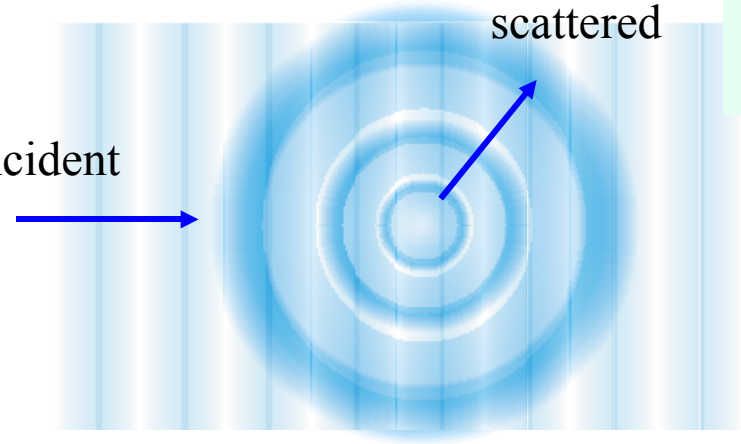
非局所AB効果に対するOnsagerの相反定理



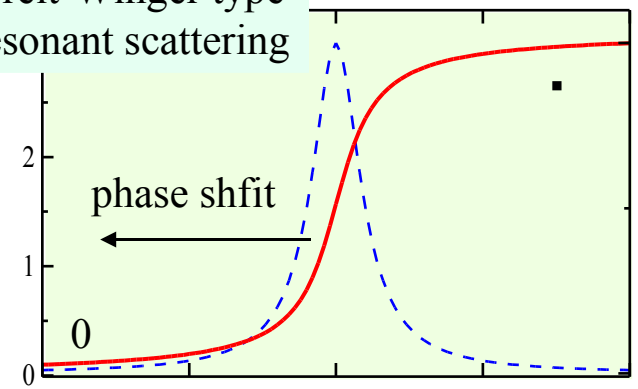
The Fano effect

Ugo Fano





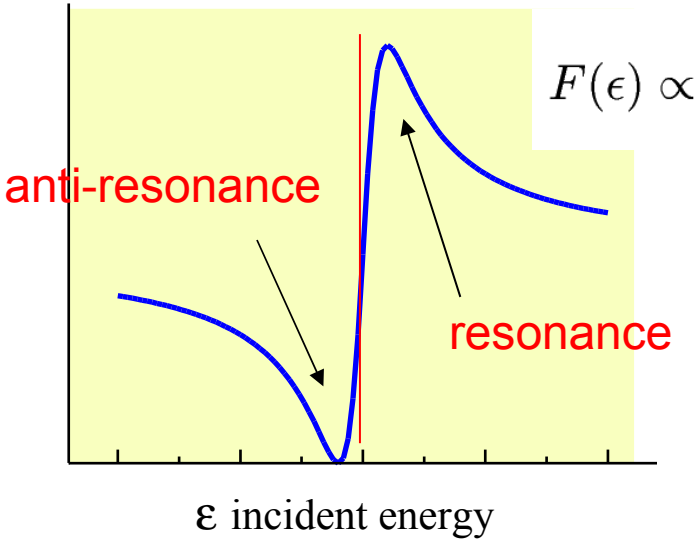
Breit-Winger type resonant scattering



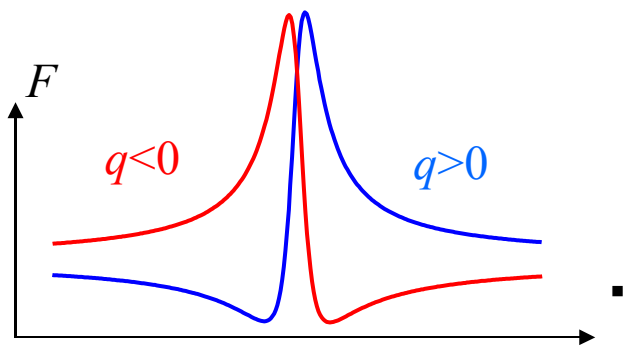
interference

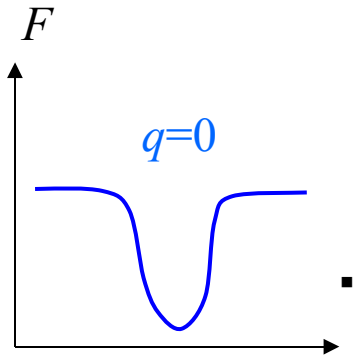
F (ε) : transition probability

Fano parameter

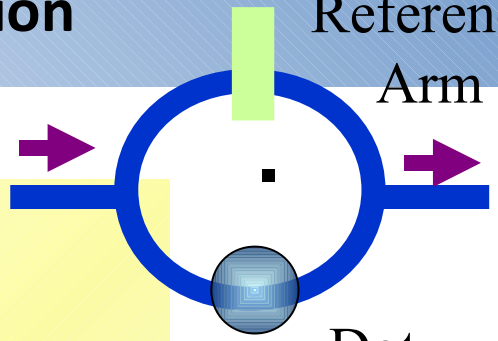


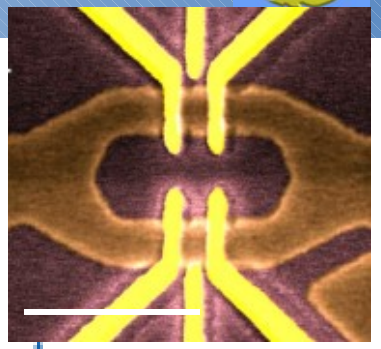
$$F(\epsilon) \propto \frac{(\tilde{\epsilon}+q)^2}{(\tilde{\epsilon}^2+1)}, \qquad \tilde{\epsilon} = \frac{\epsilon - \epsilon_c}{\Gamma/2}$$

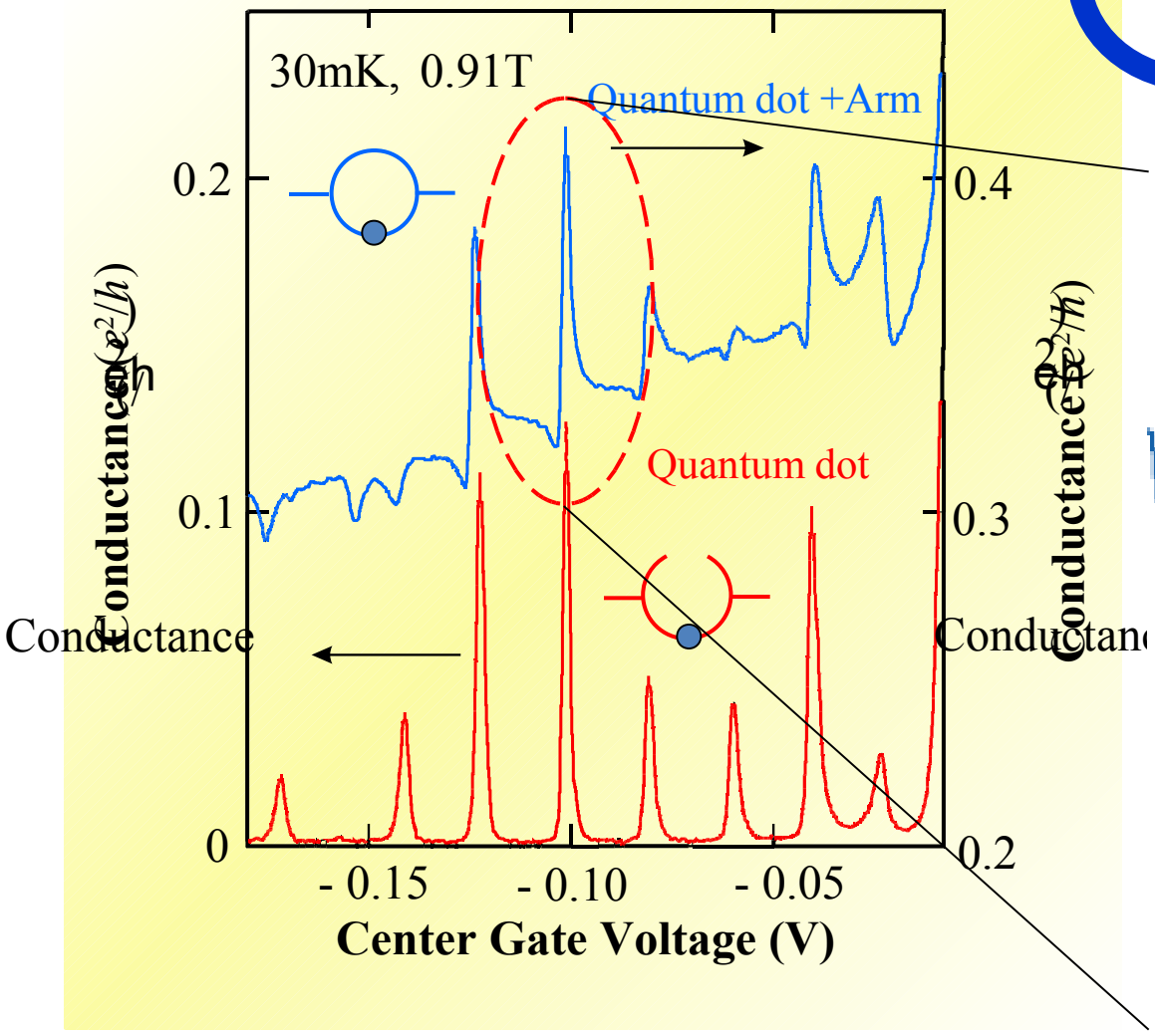


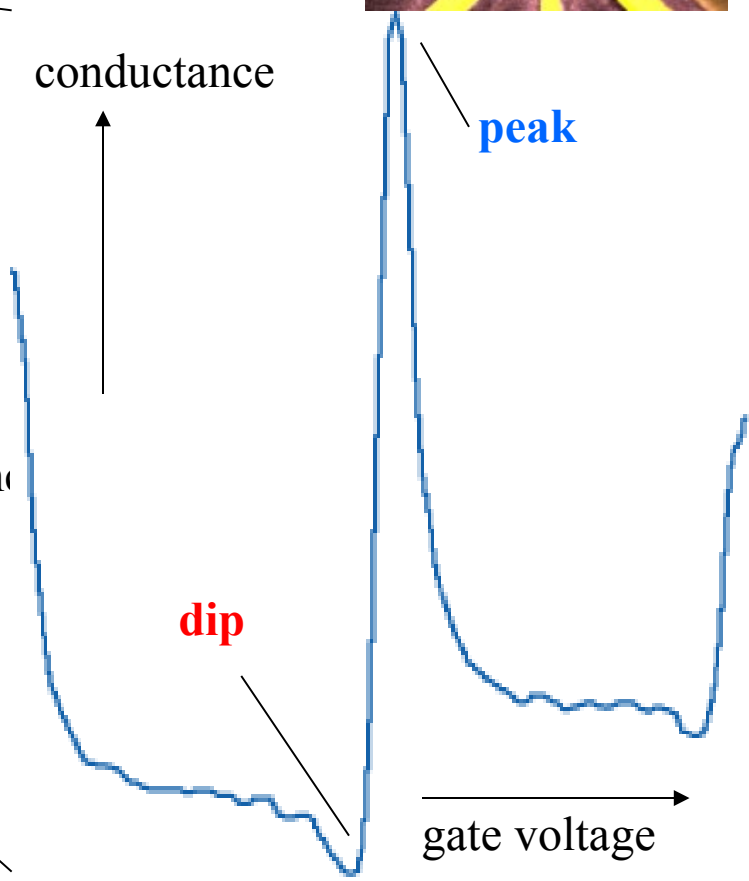


Distortion of Coulomb Oscillation

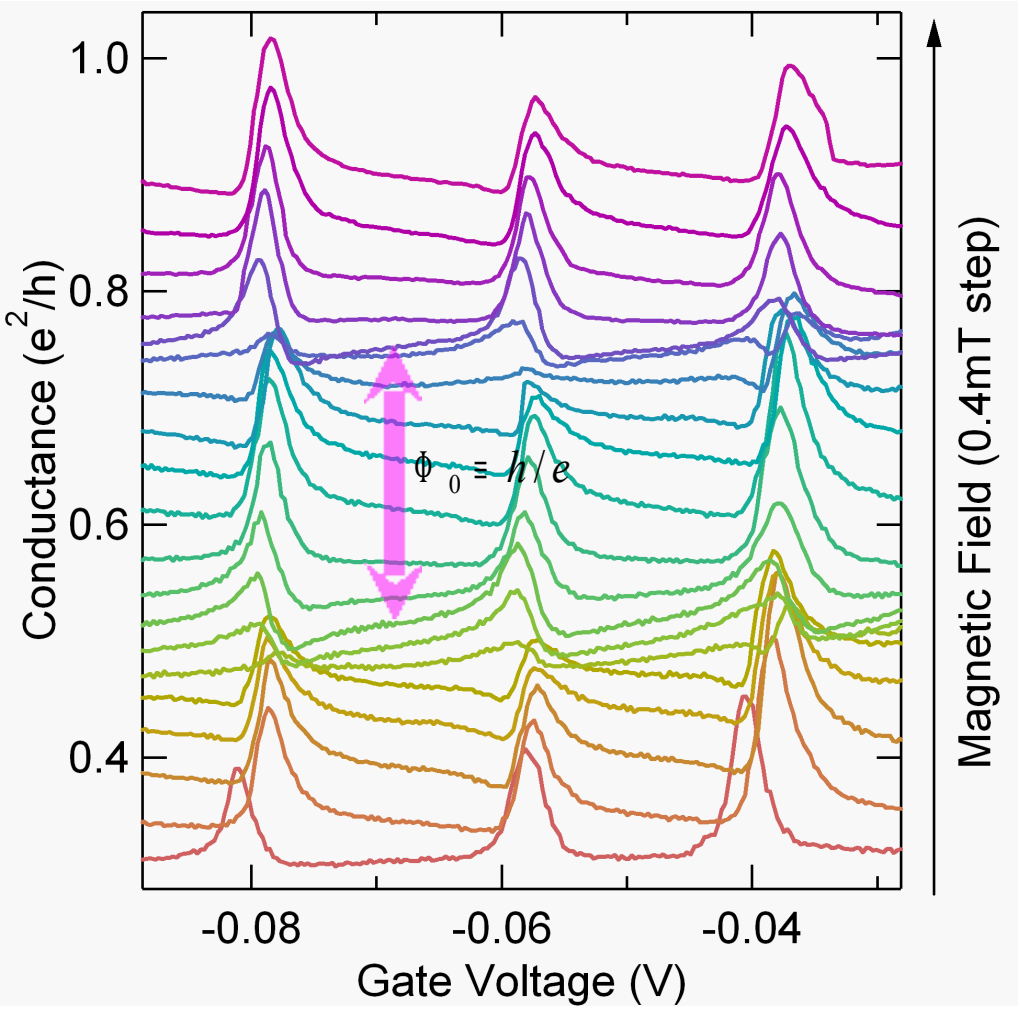


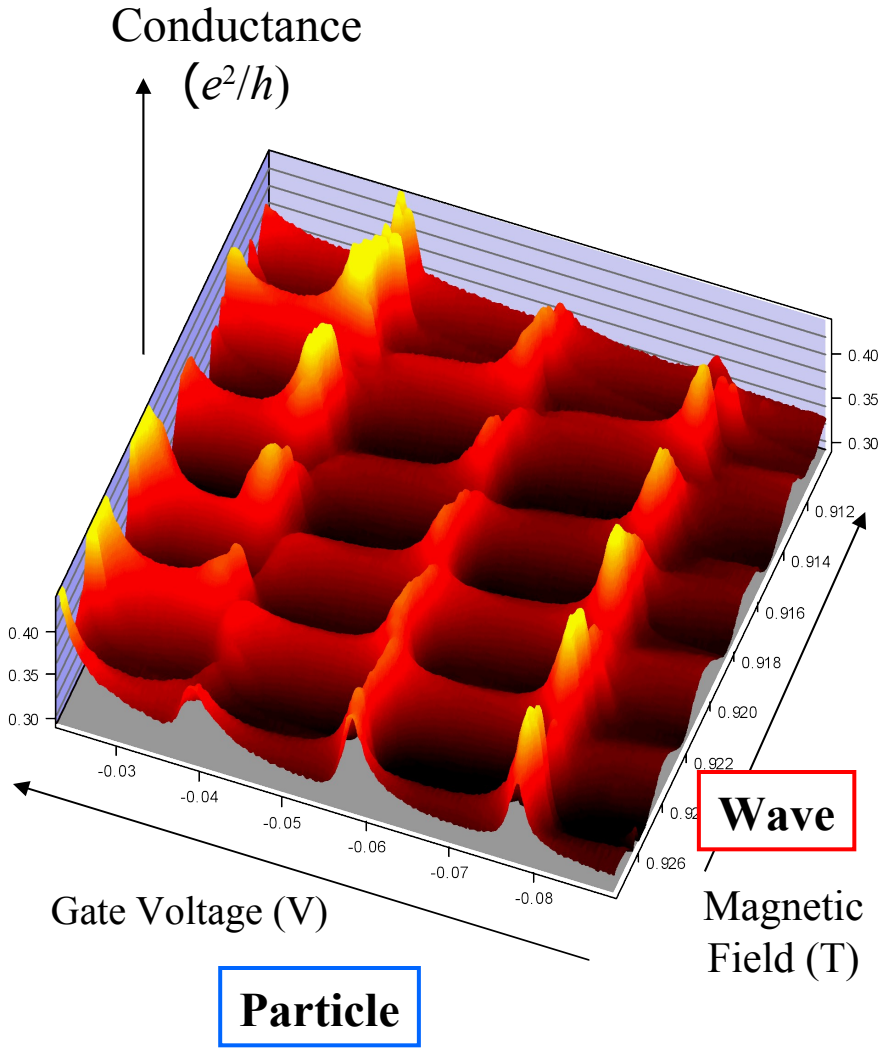






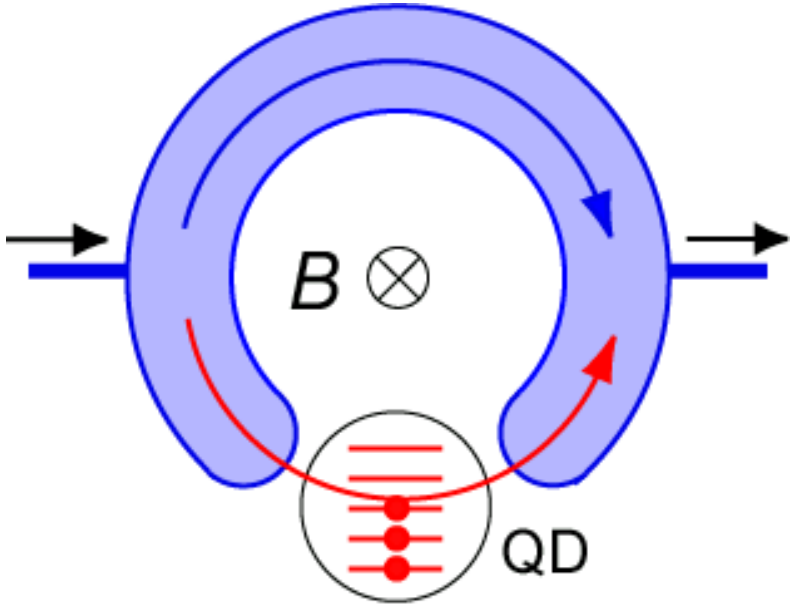
Effect of magnetic flux

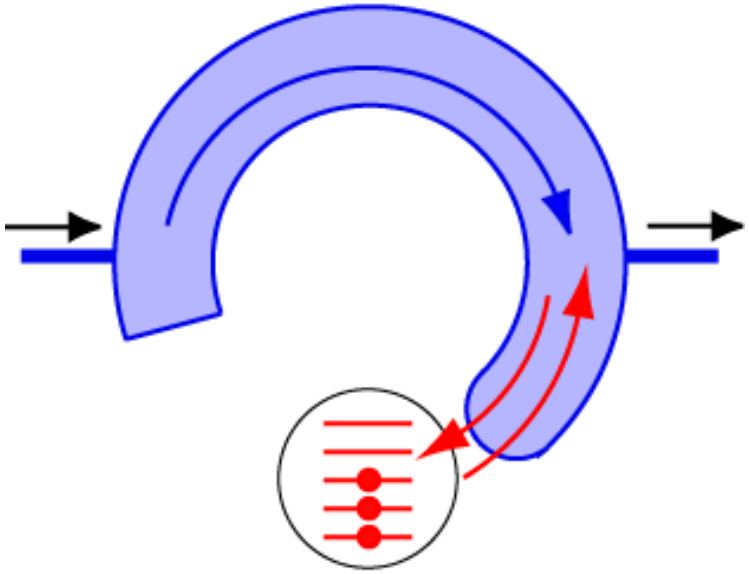




K. Kobayashi et al. PRL 88, 256806 (`02)

Fano effect in side-coupled dot geometry





QD-AB-ring system

Fano effect

in the transmission mode.

(Mach-Zender-like)

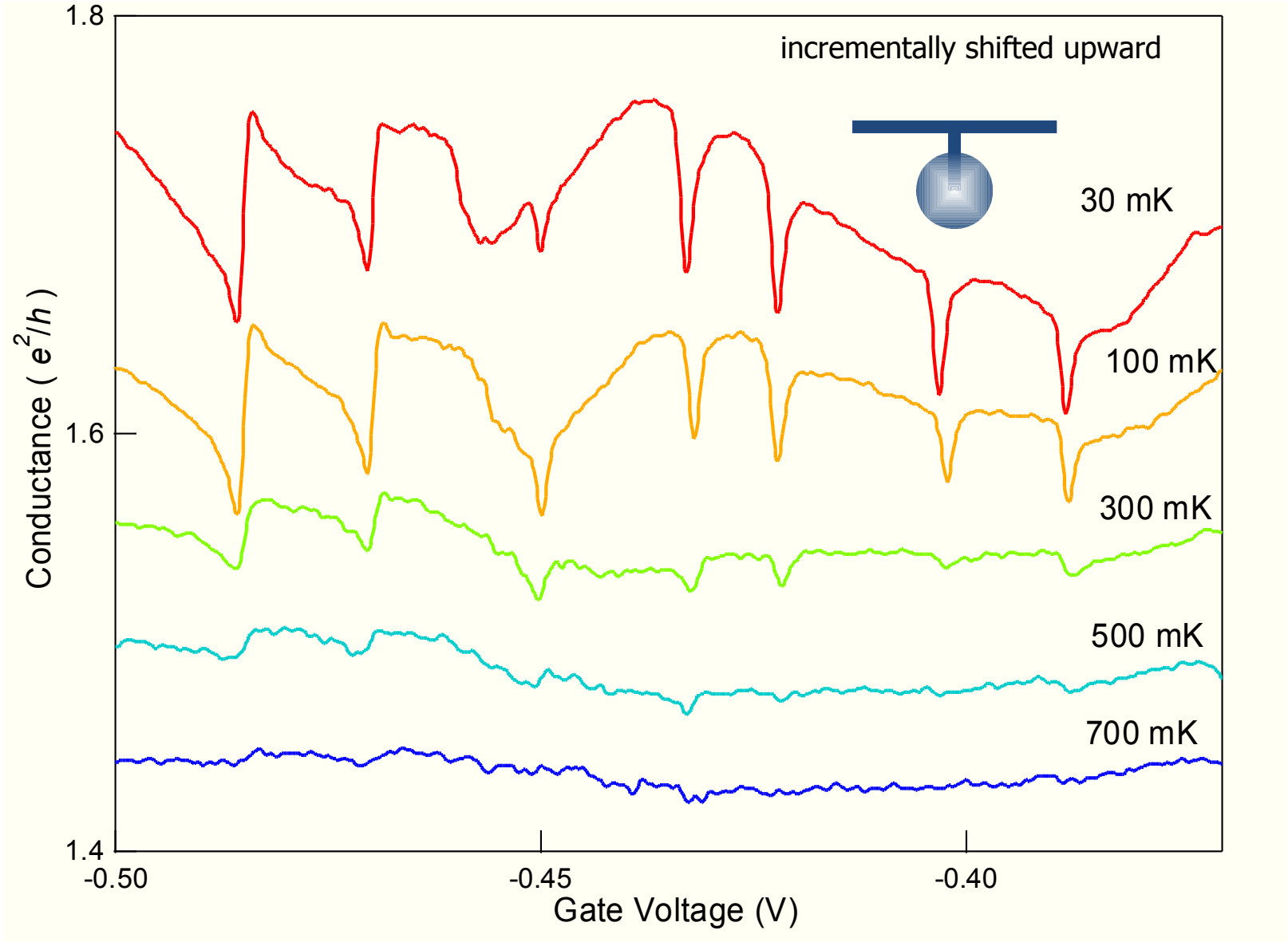
T-coupled quantum dot

Fano effect

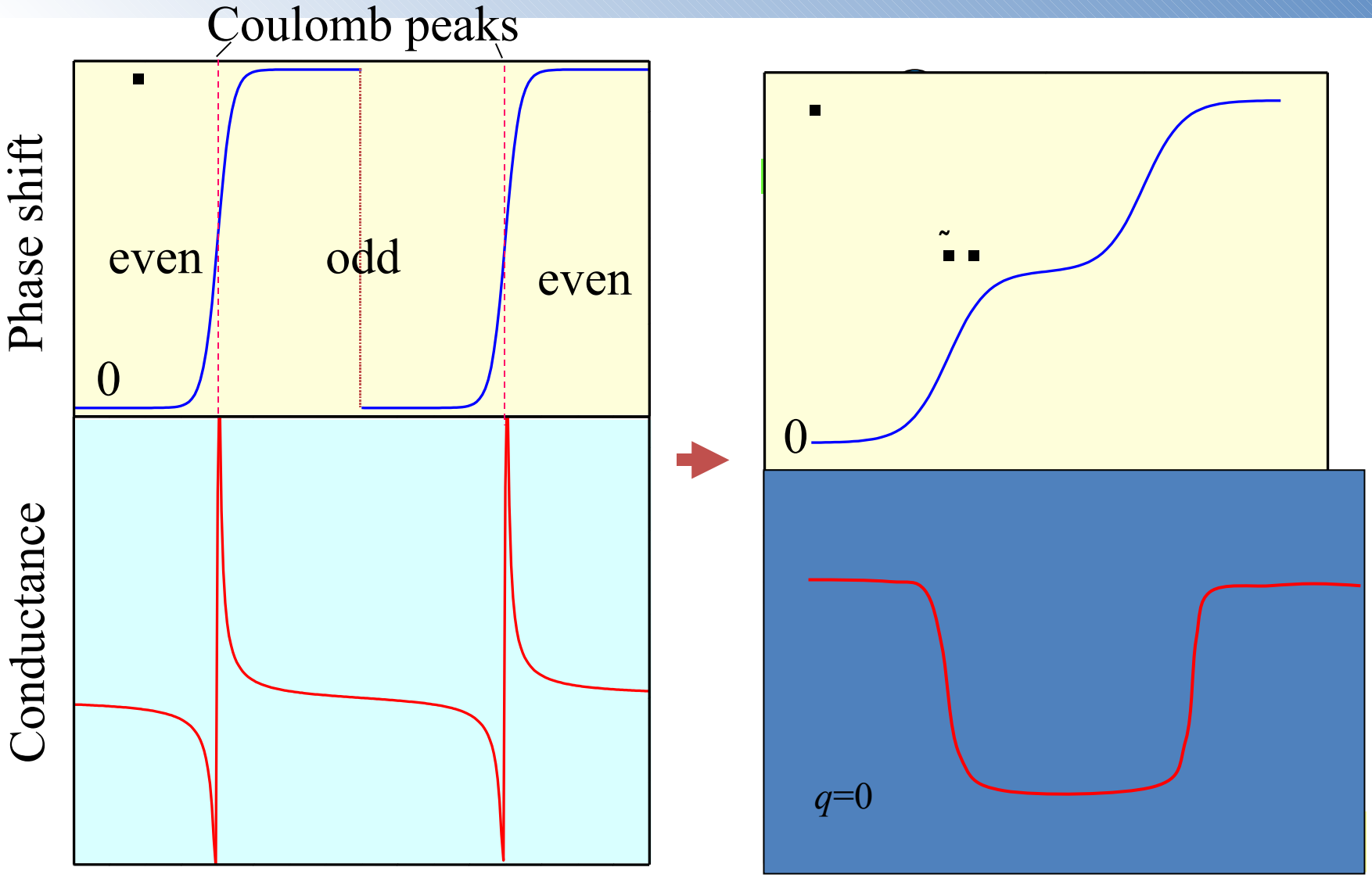
in the reflection mode.

(stub-type or Michelson-type)

Emergence of non-local Coulomb “dips” with Fano distortion



The Fano-Kondo Effect in Transport

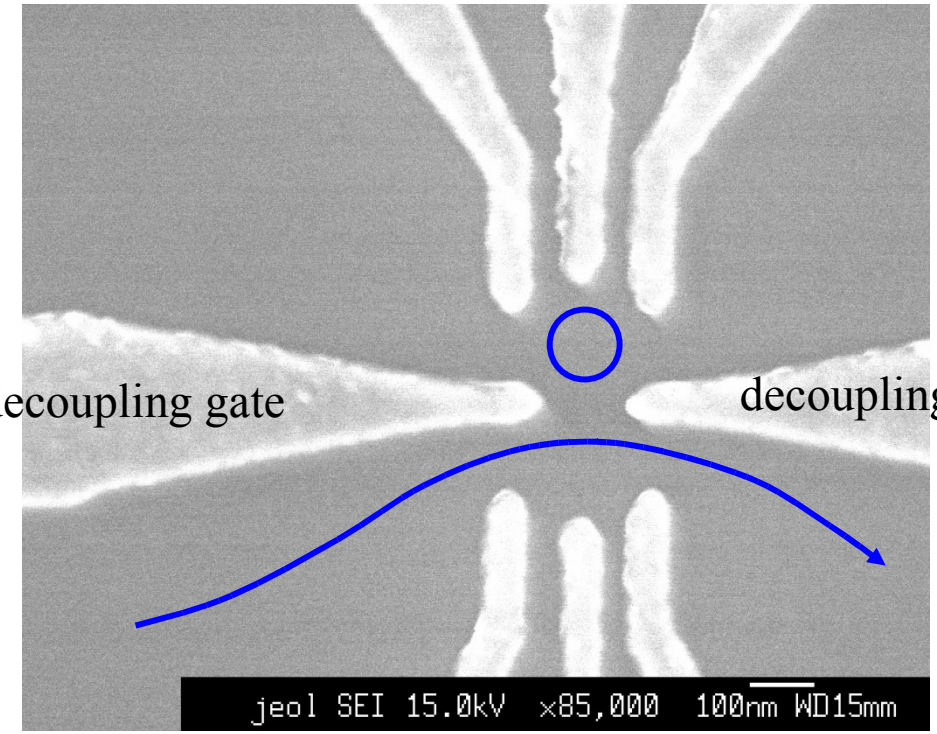


T-coupled Quantum Dot-Wire Hybrid

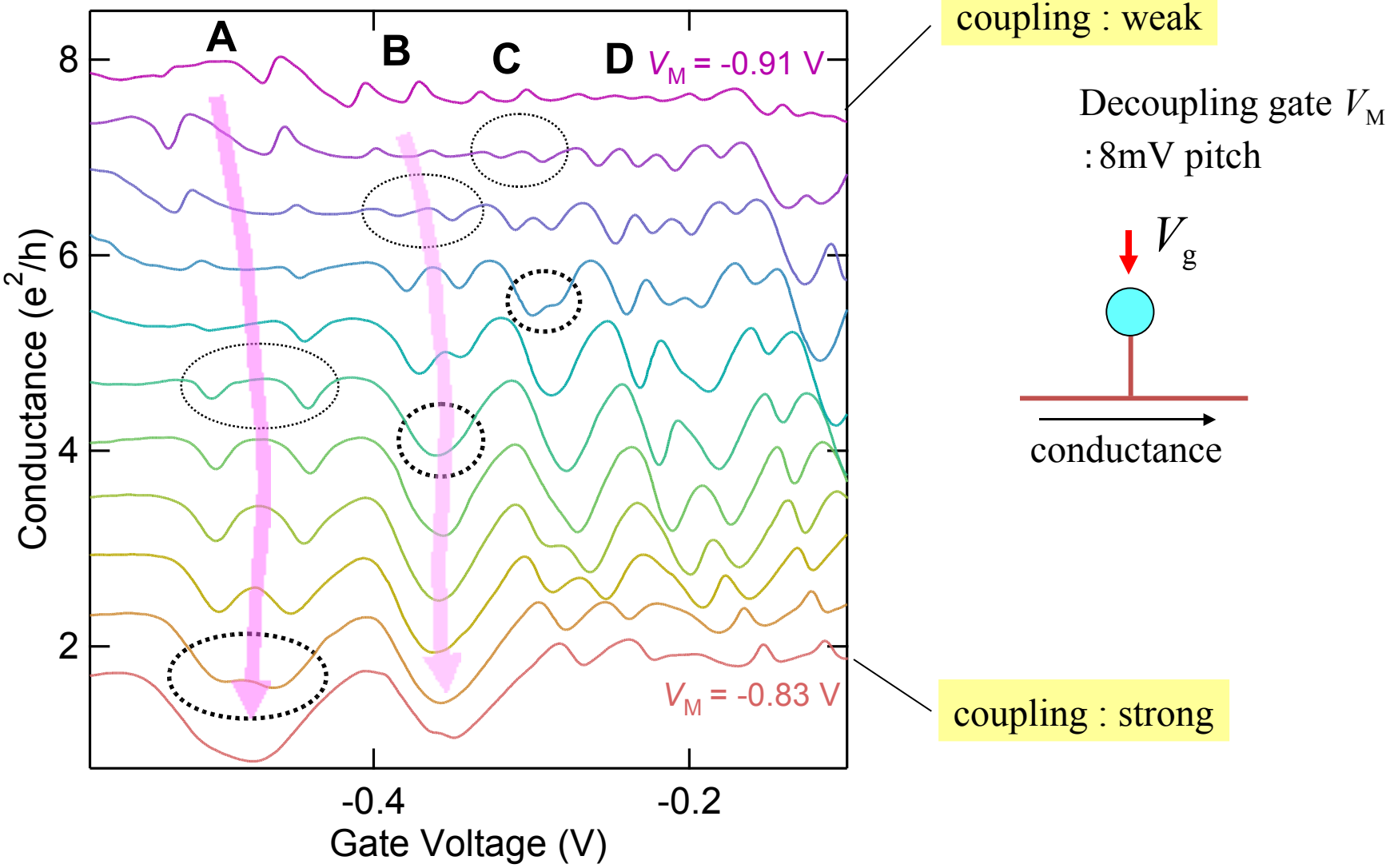
- U = 0.3 - 0.7meV
- Δ = 0.3 - 0.5meV
- Dot diameter ~ 50nm

Spatially compact
-> high coherence

Single connection point
-> small dot size is available



Coupling strength dependence of anti-resonance

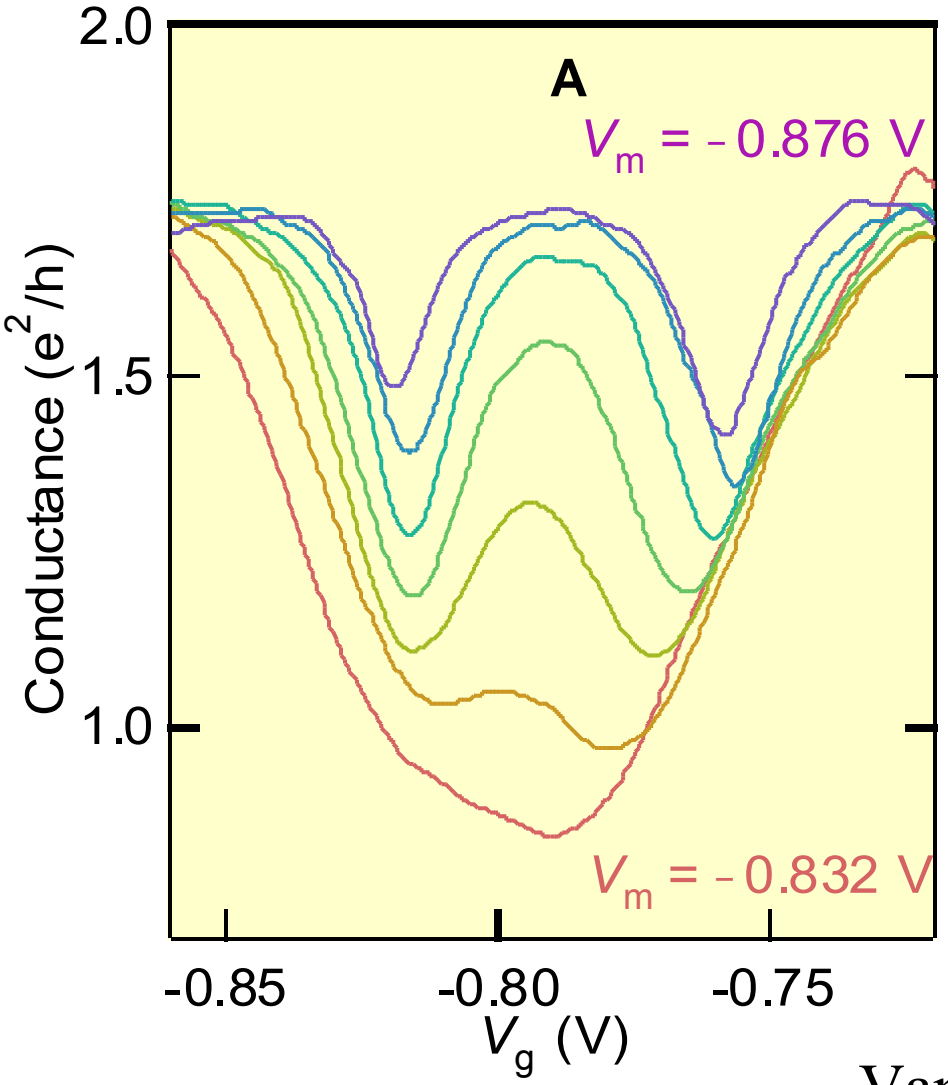


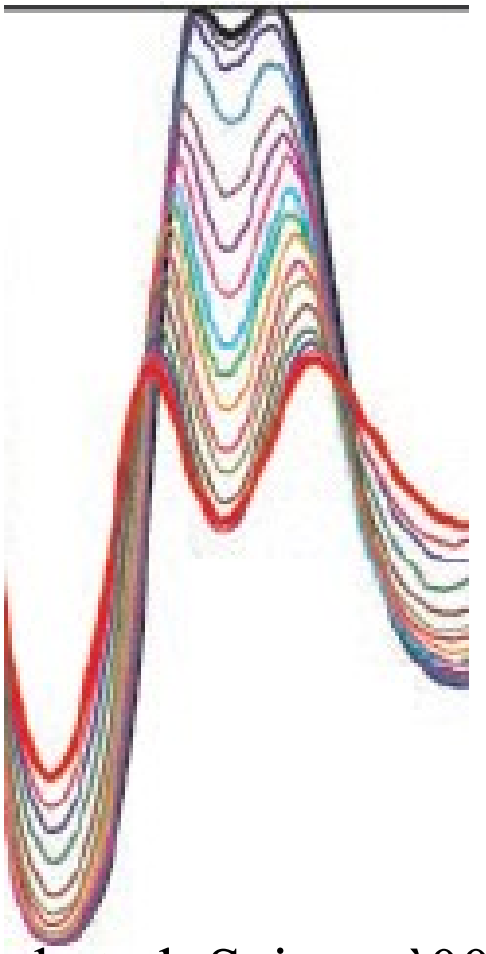
coupling : weak

Decoupling gate V_M
: 8mV pitch

coupling : strong

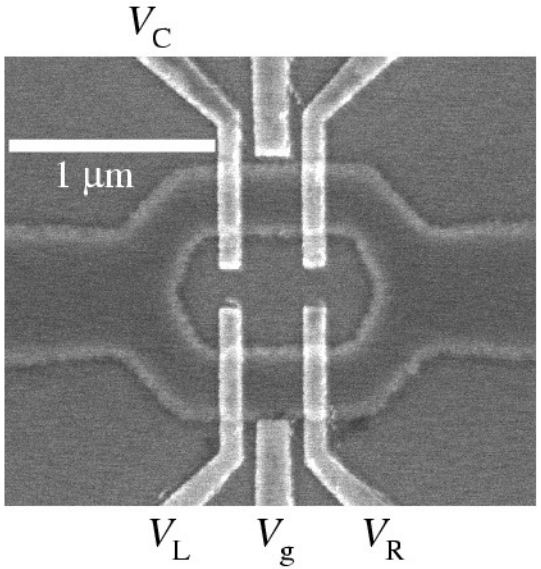
Coupling strength dependence of anti-resonance

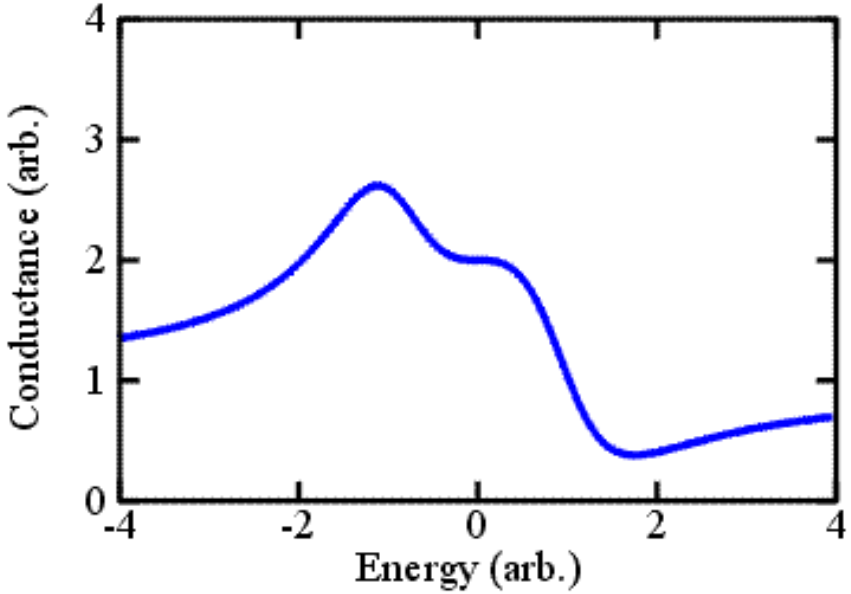




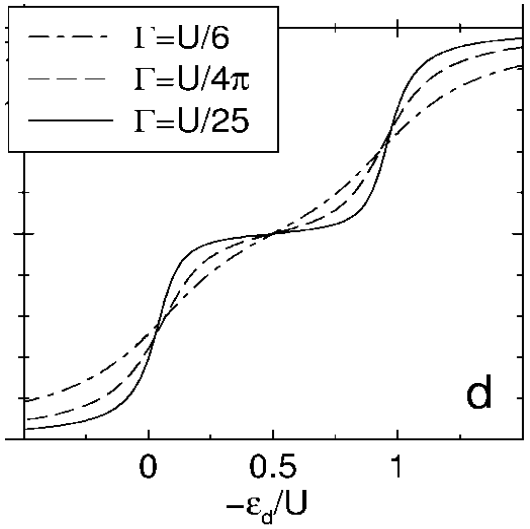
Van der Wiel et al. Science`00

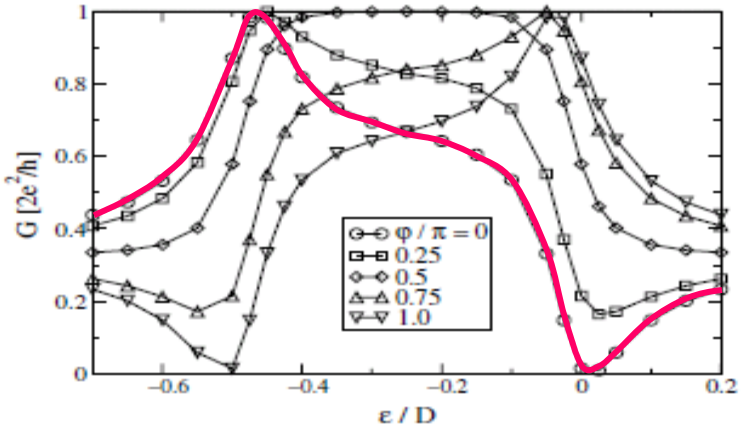
Magnetic Field Tuning of the Fano-Kondo State





Gerland et al. PRL84, 3710(`00)

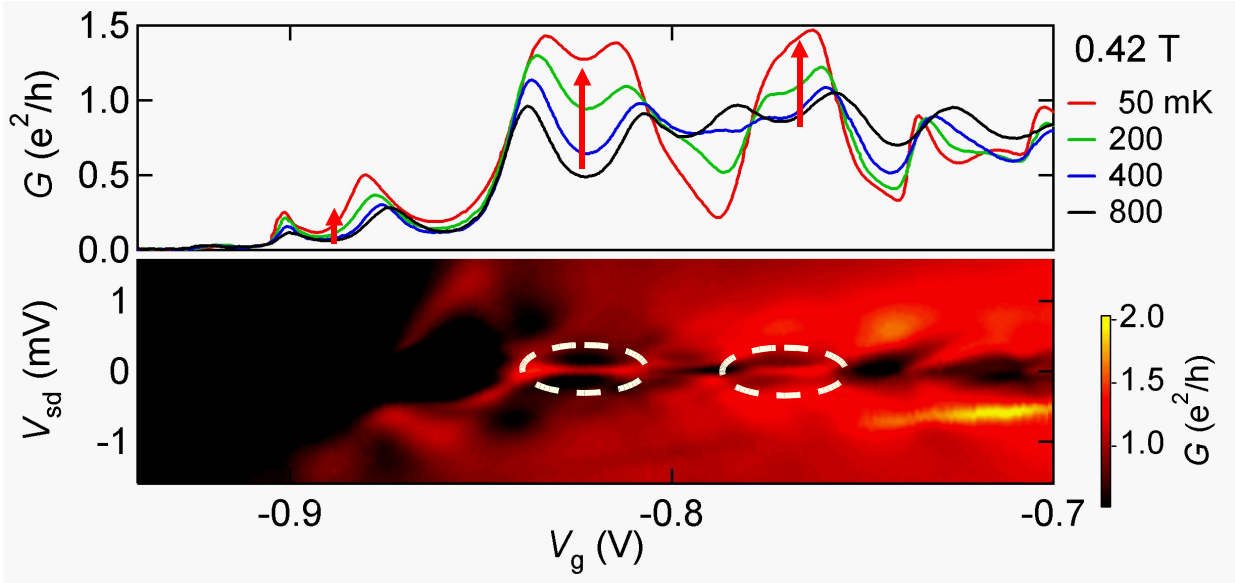




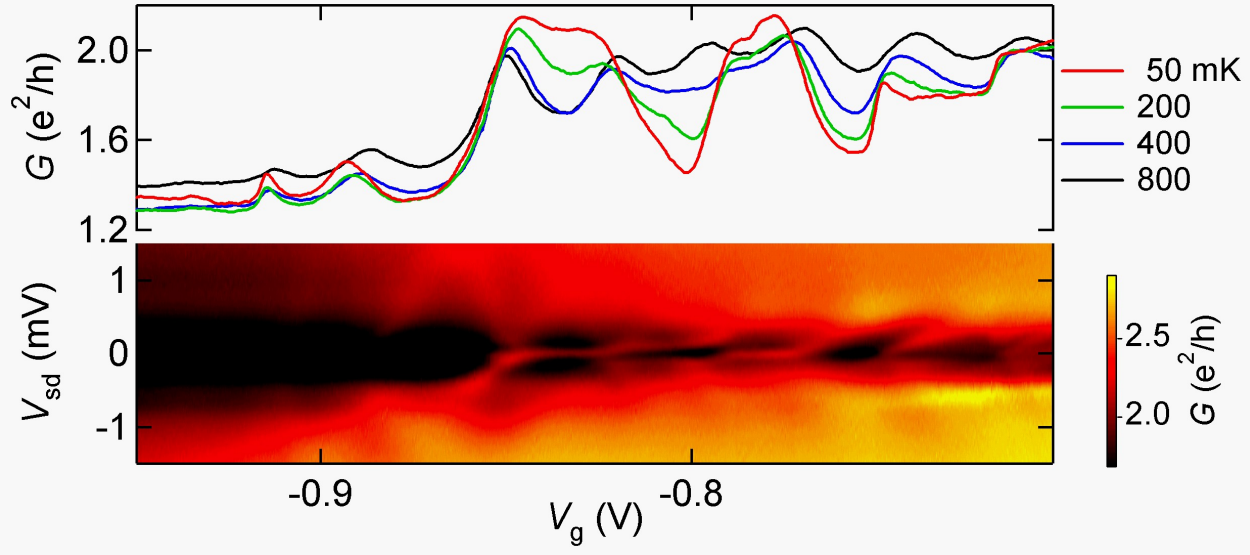
Hofstetter et al. PRL87 (’01)

The Kondo Effect

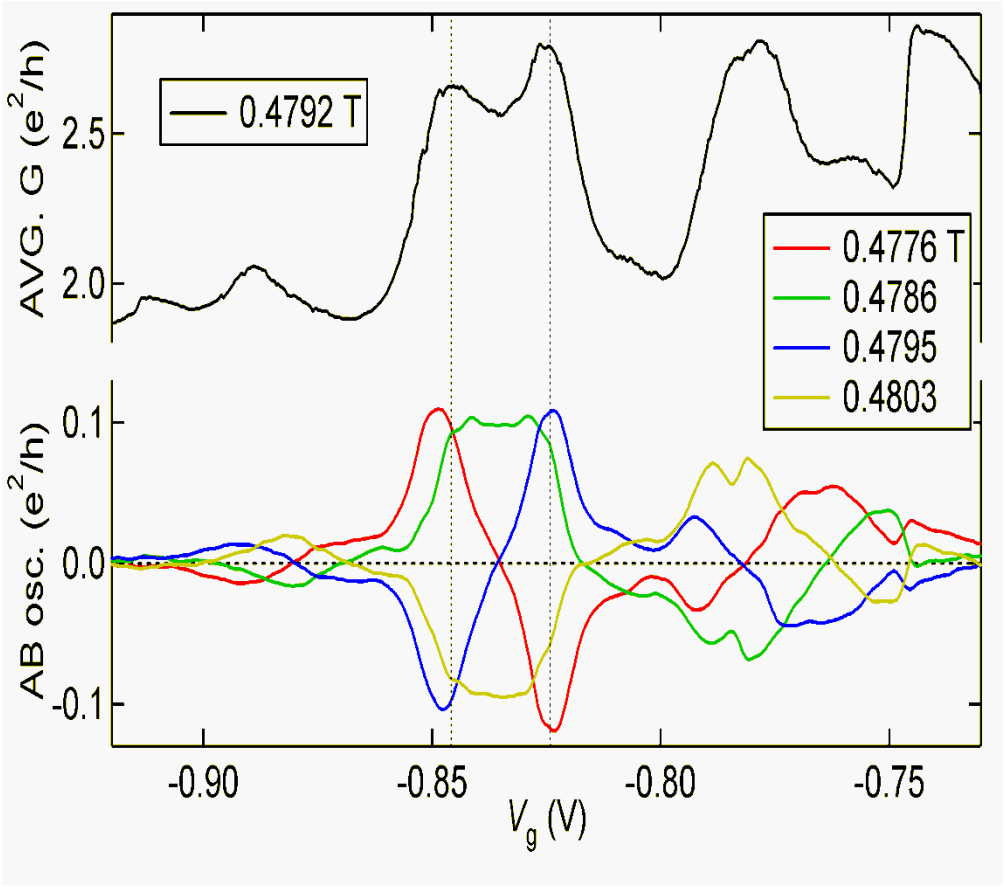
Without reference

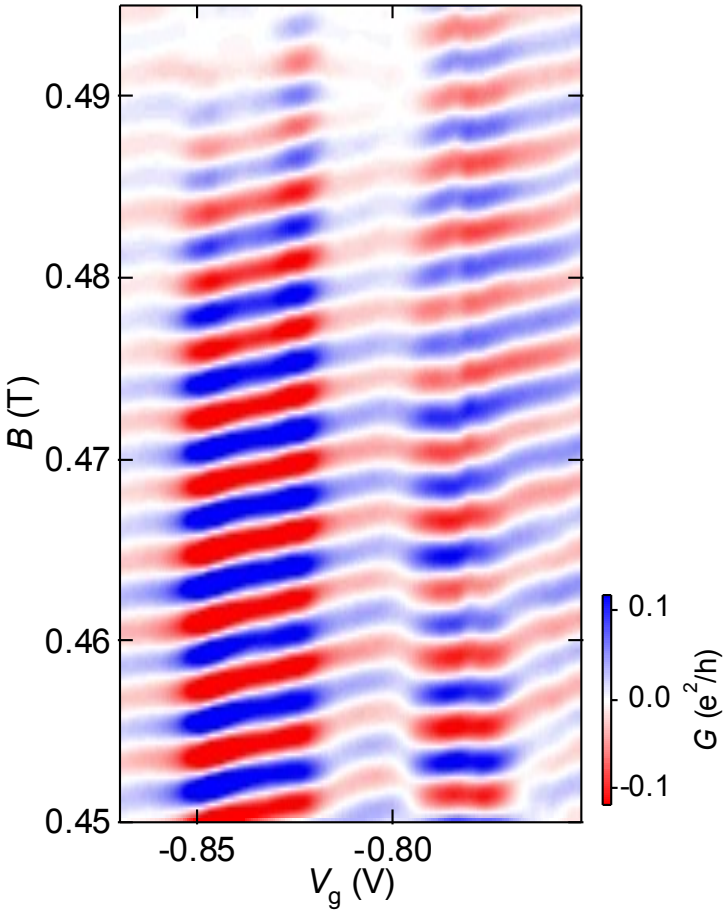


With reference

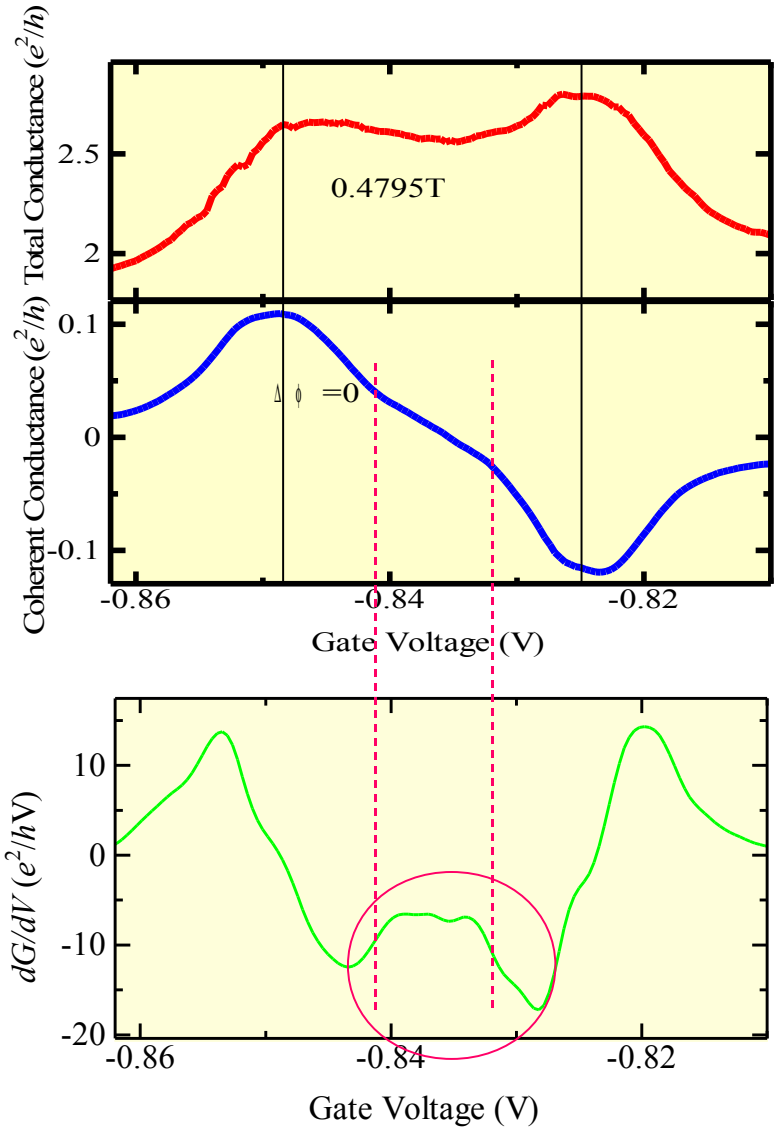


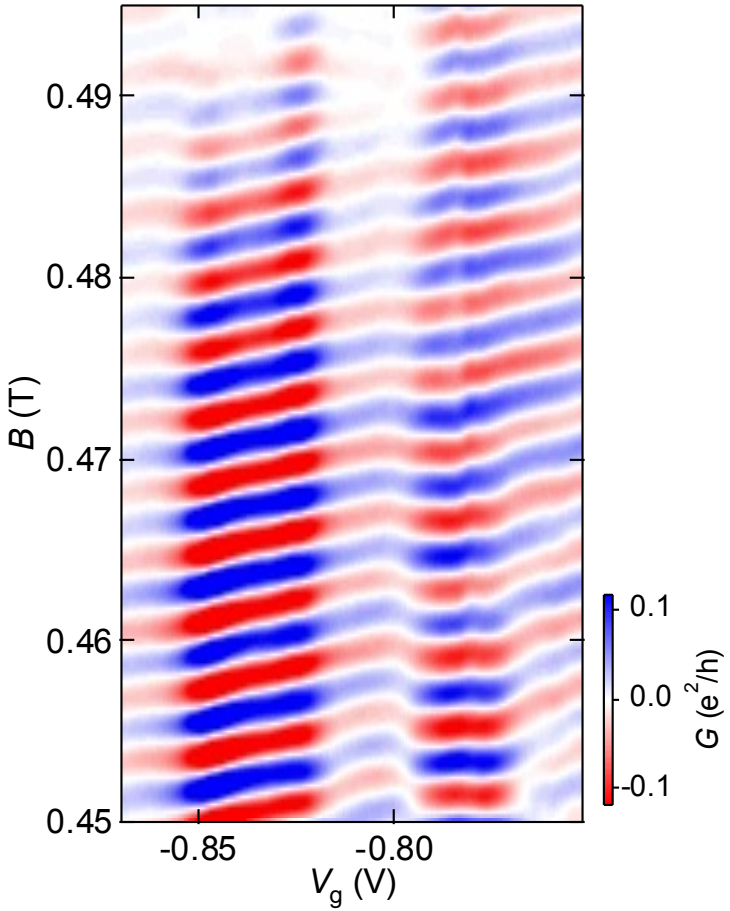
“Coherent” component and the Fano-Kondo Effect





“Coherent” component and the Fano-Kondo Effect





“Coherent” component and the Fano-Kondo Effect