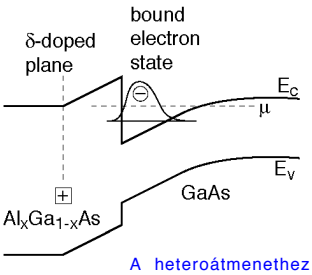
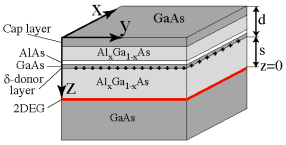
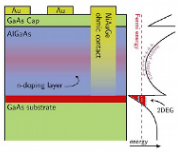
Fabrication

2 dimensional electron gas (2DEG)

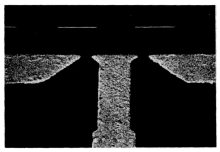


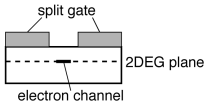


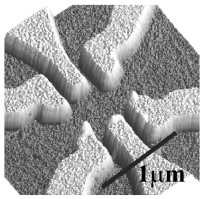


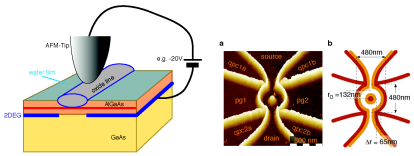
A heteroátmenethez közel egy síkban helyeznek el donor atomokat. A donor elektronoknak kedvező átmenni a kisebb tiltott sávú GaAs oldalra, így egy dipólréteg alakul ki, és az átmenetnél egy 2D elektrongáz jön létre.

Fabrication of nanostructures



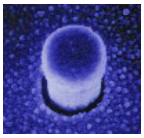




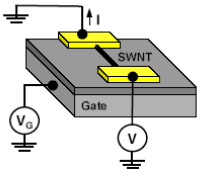


Other types of devices (SET)

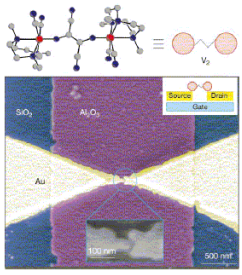
Lateral structures



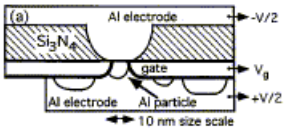
Nanotubes



Vertical dots



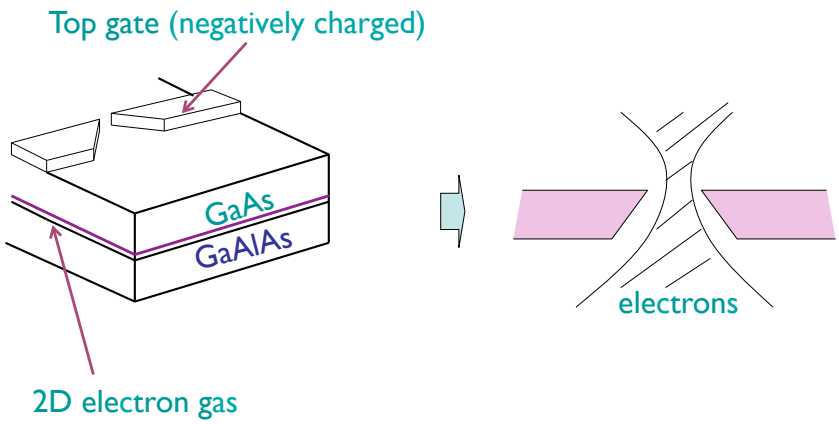
Grains



Molecules

Conductance quantization

Point contacts



Vezetőképesség kvantálás

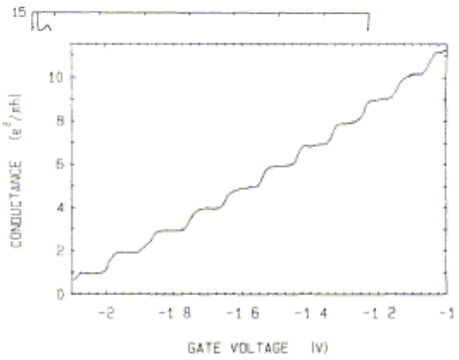
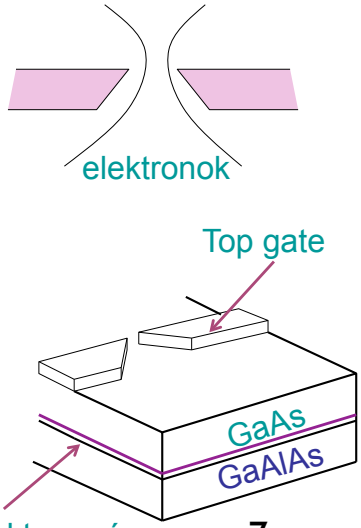


FIG. 2. Point-contact conductance as a function of gate voltage, obtained from the data of Fig. 1 after subtraction of the lead resistance. The conductance shows plateaus at multiples of $e^2/\pi\hbar$.

[van Wees et al. PRL 60, 848 (1988)]



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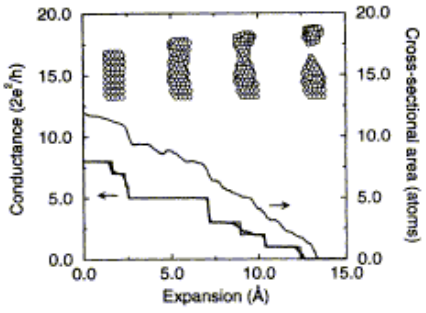
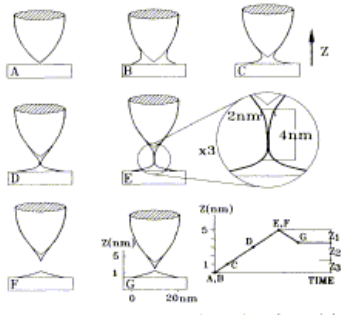
Atomi kontaktus





Conductance fluctuations

Mesoscoic fluctuations

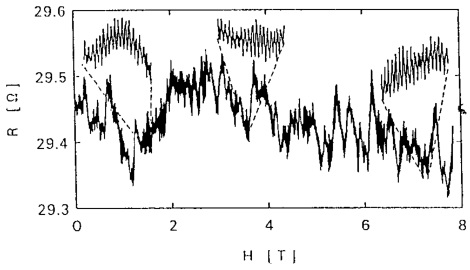
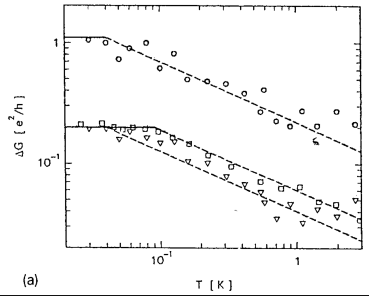


Fig. 7. Aharonov h/e periodic oscillations superimposed to aperiodic fluctuations observed the magnetoresistance of a gold ring of 0.5 μm diameter. (From Washburn et al. [60].)



Non-locality

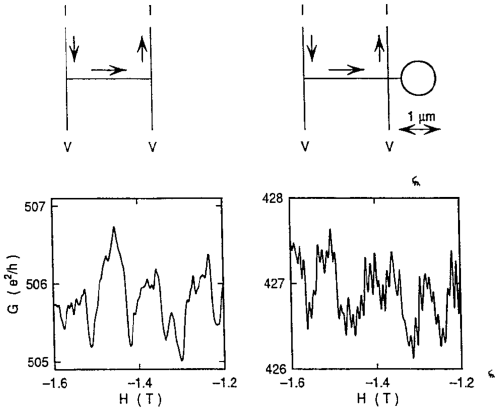
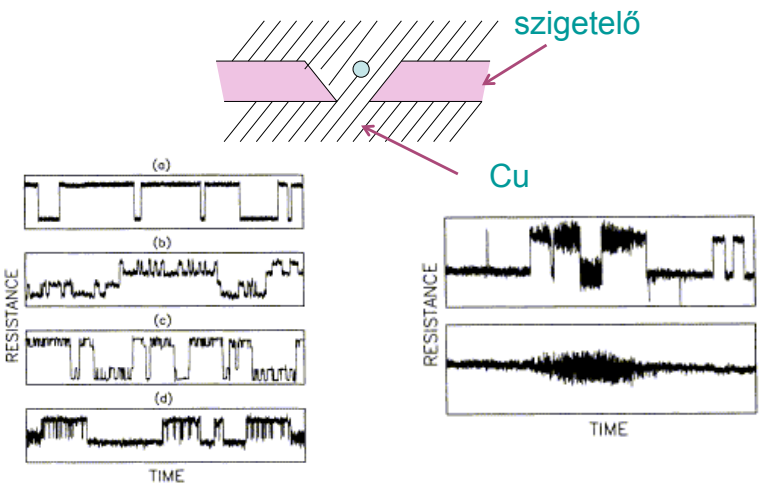


Fig. 1. Measurement of non-local Aharonov–Bohm oscillations in conductance by Umbach et al. [17]. For sample with loop attached outside the current path the periodic A–B oscillations are superimposed on the aperiodic universal conductance fluctuations. Adapted from [18].

Fémes pont kontaktusbeli vezetőképesség fluktuáció



[Ralls and Buhrman, PRL 60, 2434 (1988)]

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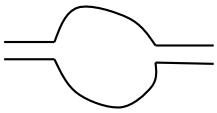
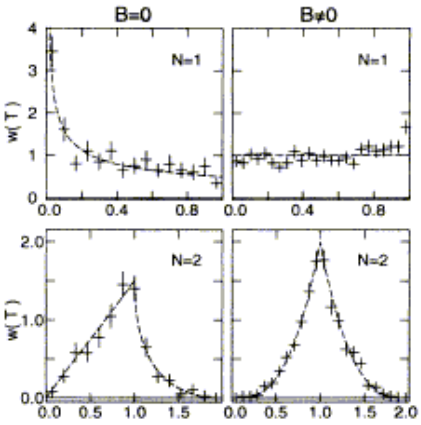
Vezetőképesség eloszlás kaotikus üregben



$G = ?$



$$G = \frac{2e^2}{h} Tr(t^+ t)$$

Transzfer mátrix

Véletlen mátrix elmélet

[Baranger and Mello, Phys. Rev. Lett. 73, 142 (1998)]

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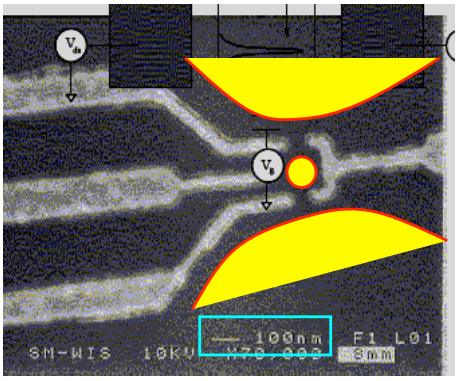
Coulomb blockade

Single electron dot



[Goldhaber-Gordon et al, Nature (1998)]

energy of adding an electron

$$E_C \sim \frac{e^2}{\varepsilon\, d} \sim \frac{1}{13}\frac{a_0}{d}\frac{e^2}{a_0} \sim 10\ K$$

wavelength $\lambda_F \sim 10\,nm$

# of electrons

$$N = \left(d/\lambda_F\right)^2 \sim 100$$

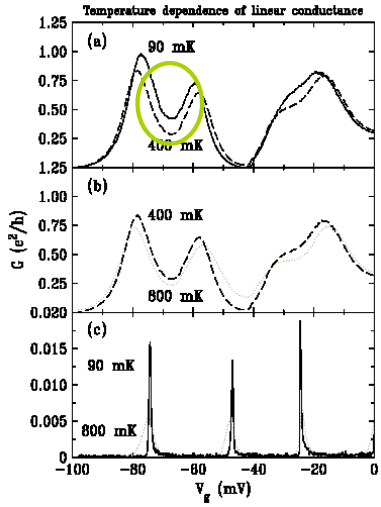
Fermi energy

$$E_F \sim \hbar^2/(\lambda_F^2 m^*) \sim 100K$$

Level spacing

$$\Delta \sim E_F / N \sim 1K$$

Kondo effect: experiment

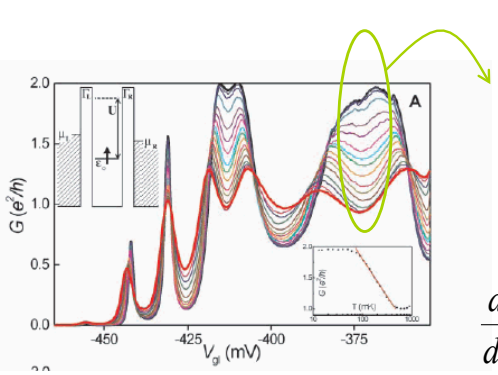


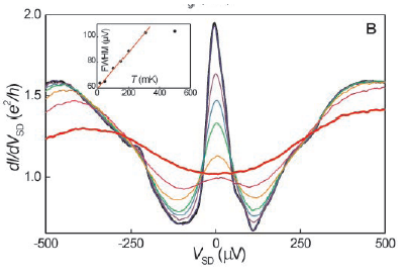
Strong tunneling

Weak tunneling

[Goldhaber-Gordon et al, Nature (1998)]

Delft experiment



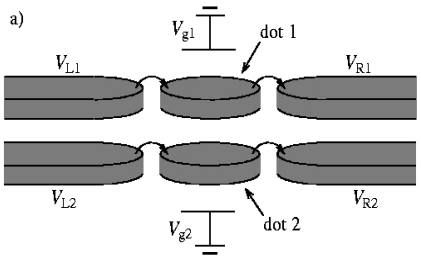


$$\frac{dI}{dV} \sim N(eV)$$

Tunneling density of states

[W.G. van der Wiel, Science **289**, 2105 (2000)]

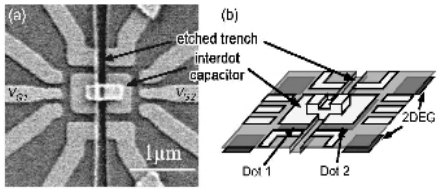
Capacitively coupled double dots



U.Wilhelm et al., Physica (Amsterdam) **14**E, 385 (2002).

M. Pi et al., Phys. Rev. Lett. **87**, 066801 (2001).

Theory: T. Pohjola et al., Eurohys. Lett. **54**, 241



I.H. Chan *et al.*, Appl. Phys. Lett. **80**, 1818

Coherent spin control [Nowack et al, Science **318**, 1430 (2007).]

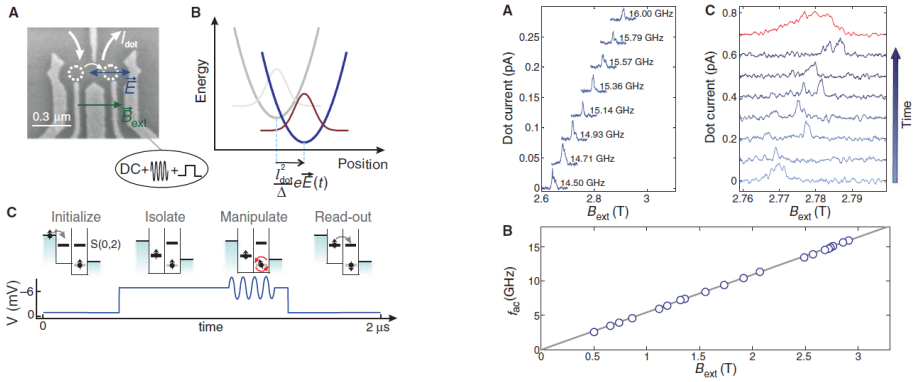
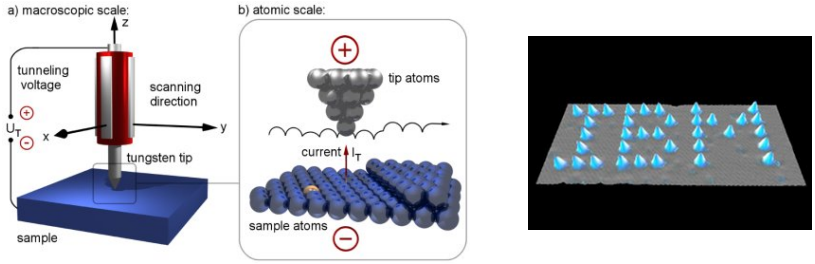
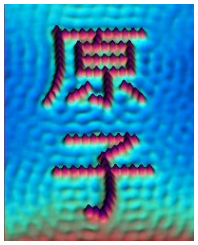
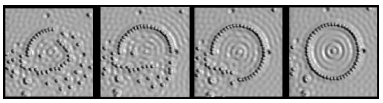


Fig. 3. (**A**) Rabi oscillations at 15.2 GHz (blue, average over five sweeps) and 2.6 GHz (black, average over six sweeps). The two oscillations at 15.2 GHz are measured at different amplitudes of the microwaves V_{mw}, leading to different Rabi frequencies. (**B**) Linear dependence of the Rabi frequency on applied microwave amplitude measured at f_{ac} = 14 GHz.

Fabrication of nanostructures

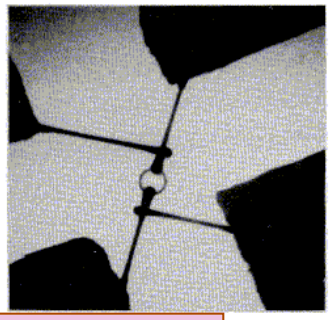






Arranging atoms with STM tip

Rövid drótok: Univerzális vezetőképesség fluktuációk



$$\delta G \approx \frac{\delta R}{R_0^2} \sim \frac{e^2}{h}$$

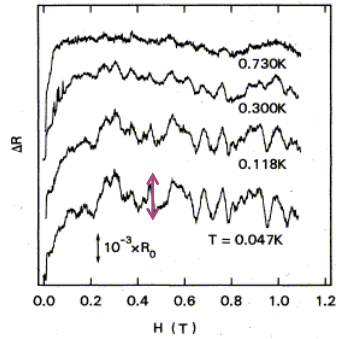


FIG. 2. Temperature dependence of the magnetoresistance from 0–1.2 T of the Au ring shown in Fig. 1. The zero-field resistance of the ring, R_0, was 7.7 Ω.

Umbach et al., Phys. Rev. B 30, 4048 (1984)

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