# Electronic Properties of Lower-Dimensional Electron Systems

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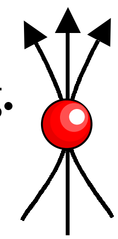
**Theme**: Many, interacting electrons develop unforeseen, new properties, not born out in the individual particle

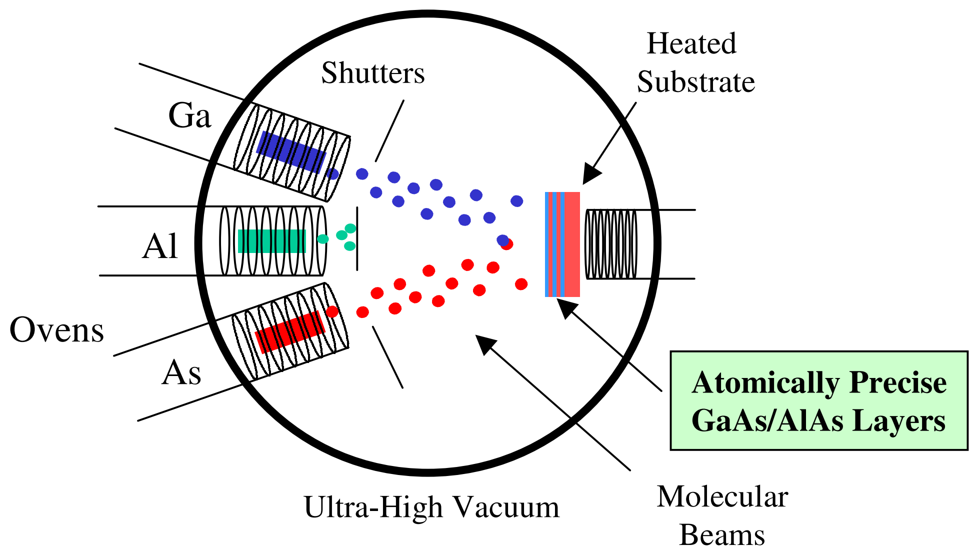
**e.g.**



***Composite particle = electron + magnetic flux quanta***

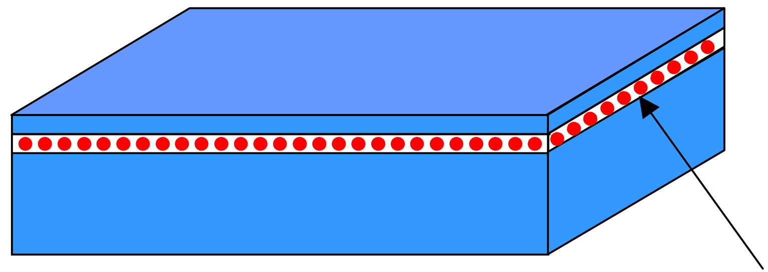
**Materials:** Semiconductors such as Gallium Arsenide, Aluminum Arsenide, Gallium Phosphite, Aluminum Phosphite

**Molecular Beam Epitaxy:** Layer by layer growth of semiconductors in ultra-high vacuum (Bell Labs)



**Systems:**

Electrons are quantum mechanically confined to layers of semiconductor → 2D systems



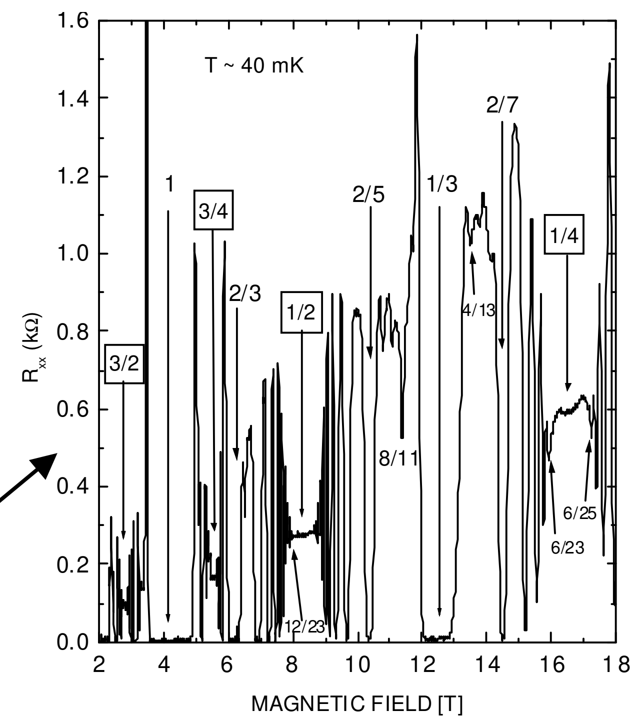

**Extreme Conditions:**

Temperatures down to 1/100 of a degree of absolute zero.
Magnetic fields 1,000,000 times the earth magnetic field

**Physics:**

**Electrons show bizarre effects:**
fractional electron charge,
quantization of resistance to 1 part in $10^8$,
vanishing resistance,
new particles, Composite Fermions
and lots more…..

electrons at 40mK and in high magnetic fields show many fractions



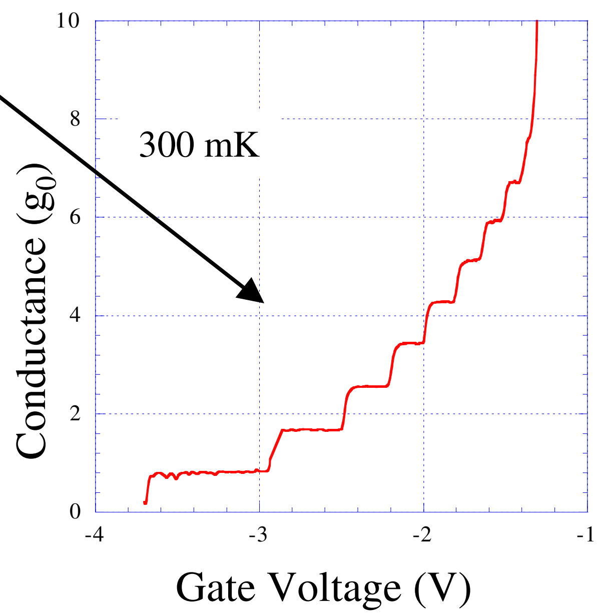
## Now, new and improved:

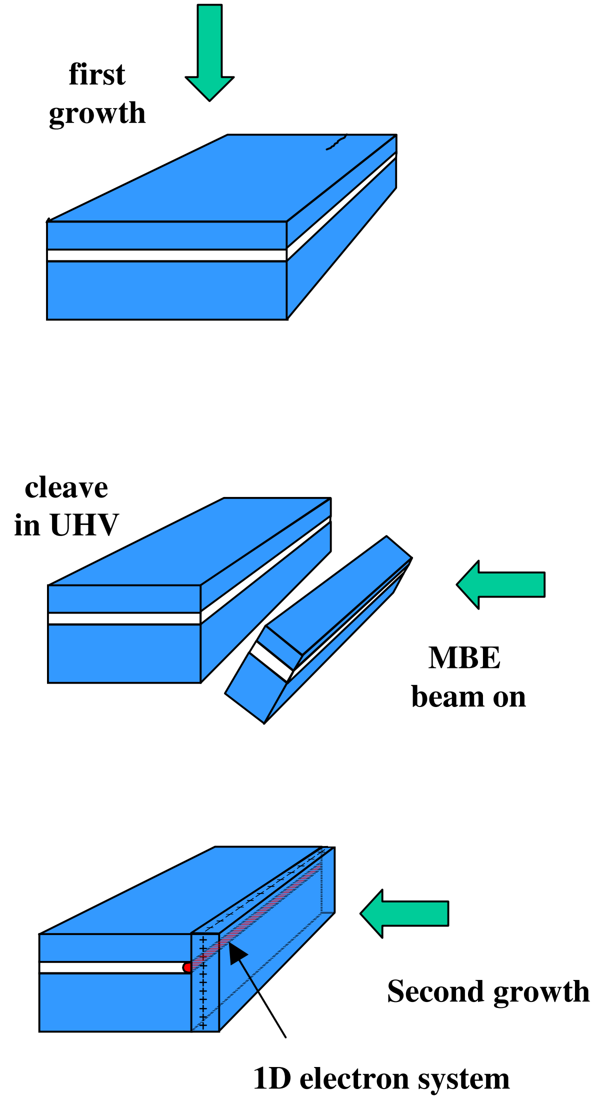
Atomically precise one-dimensional (1D) electron systems can be created by "cleaved edge overgrowth"

## Properties:

Length to width ratio like the Holland Tunnel, very good 1D system

Steps show conductance in 1D is quantized




## Physics:

Electrons fly ballistically like photon through a glass fiber, Electrical conductance is quantized