TRANSPORT PROPERTIES OF SEGMENTED GRAPHENE NANORIBBONS

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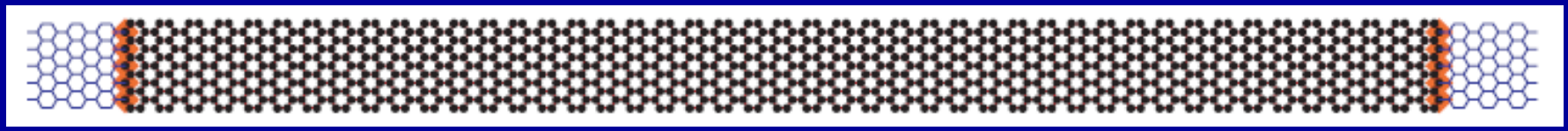
APS, March 2014

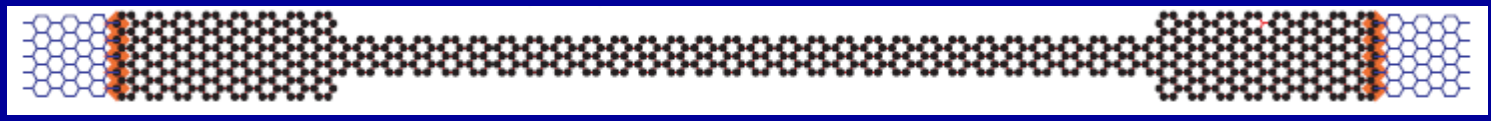
Supported by the U.S. DOE (FG05-86ER45234)

ARMCHAIR GRAPHENE NANORIBBONS

Uniform



Segmented



FABRICATION: BOTTOP-UP ATOMICALLY PRECISE

Cai et al, Nature **466**, 470 (2010); Blankenburg et al., ACS Nano **6**, 2020(2012)

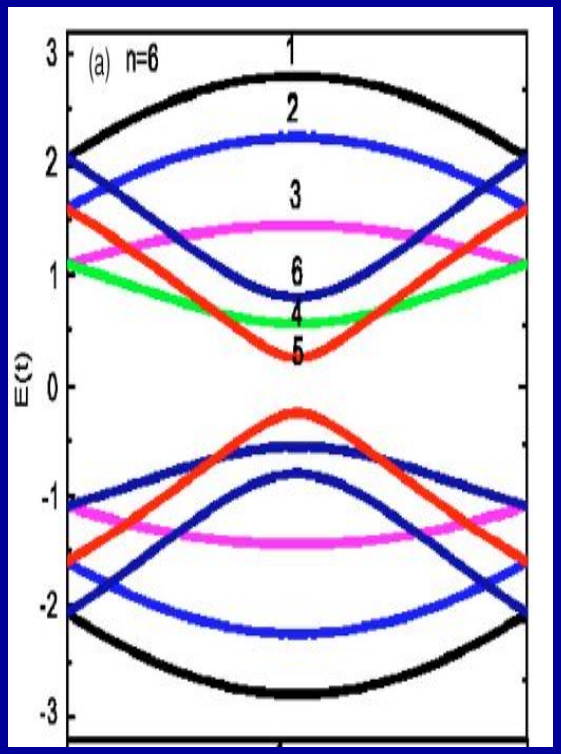
ADVANTAGE: INTRINSIC TRANSPORT PROPERTIES OF GRAPHENE LATTICE

TOP-DOWN: ROUGH EDGES, DISORDER, QUANTUM DOTS, COULOMB BLOCKADE, Guettinger et al., Rep. Prog. Phys. **75** (2012)

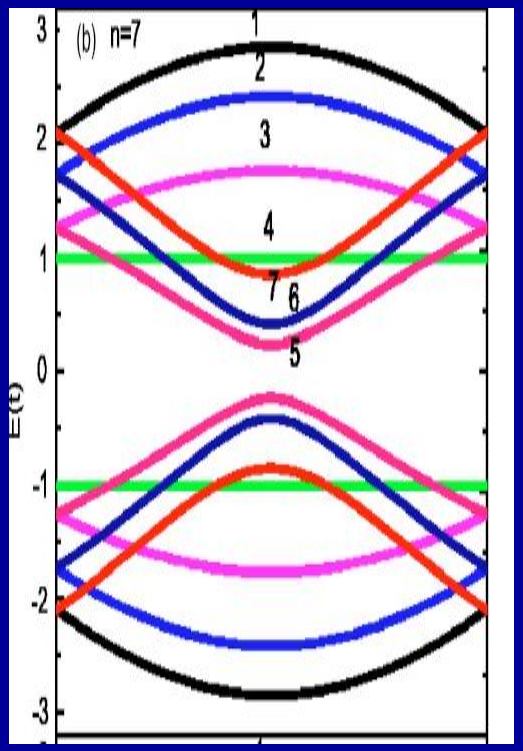
CB OVERSHADOWS RELATIVISTIC GRAPHENE PHYSICS

Uniform Armchair Nanoribbons

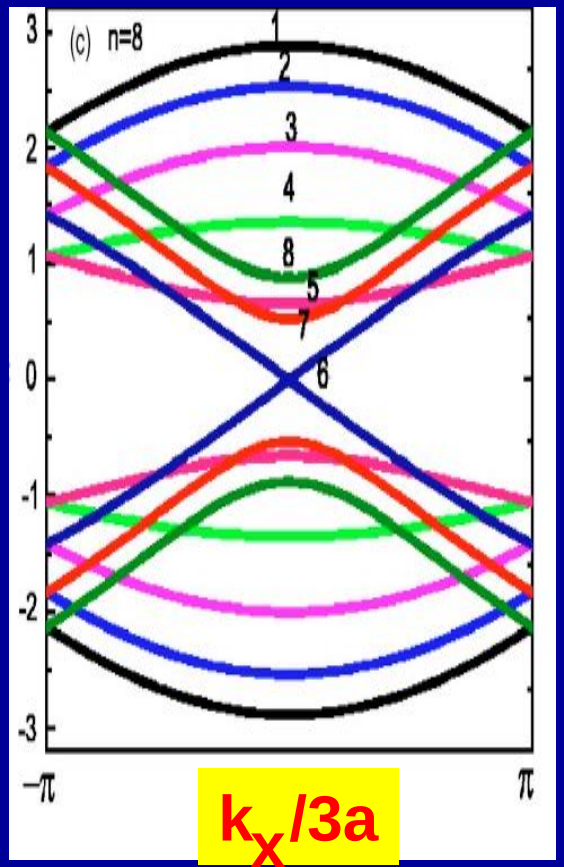
Energy (t = 2.7 eV)



N=3m (Class I)
Semiconductor

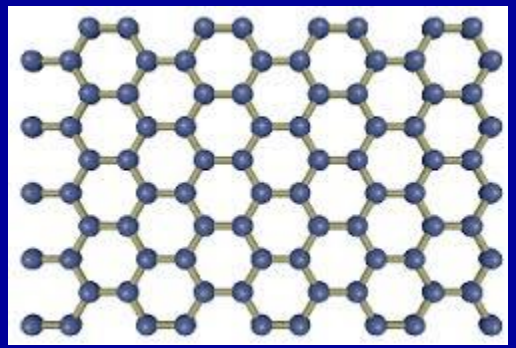


N=3m+1 (Class II)
Semiconductor



N=3m+2 (Class III)
Metallic

TB



X

DFT?

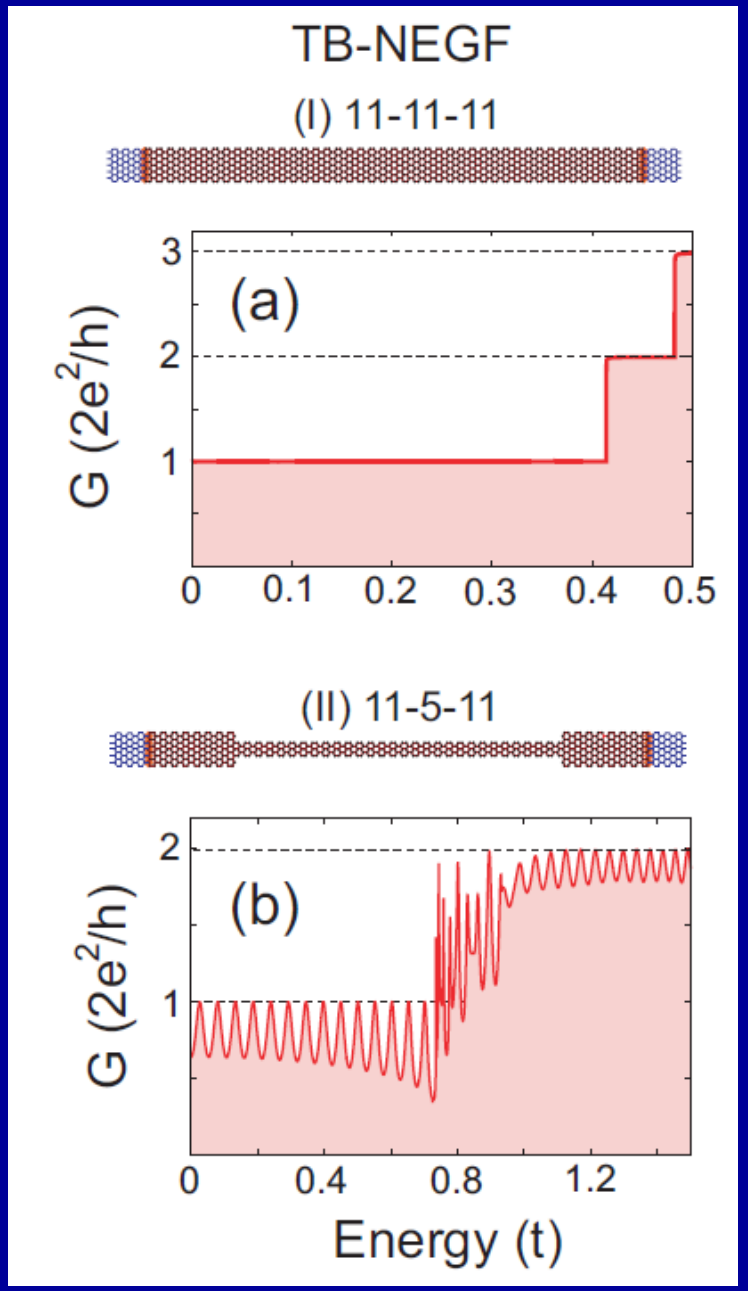
Uniform:

Conductance-quantization steps

Segmented:

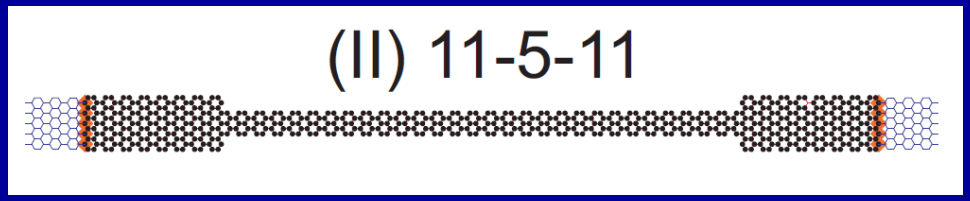
Oscillations, quasi-ballistic transport

Optical Fabry-Perot, zero mass like a photon, open system

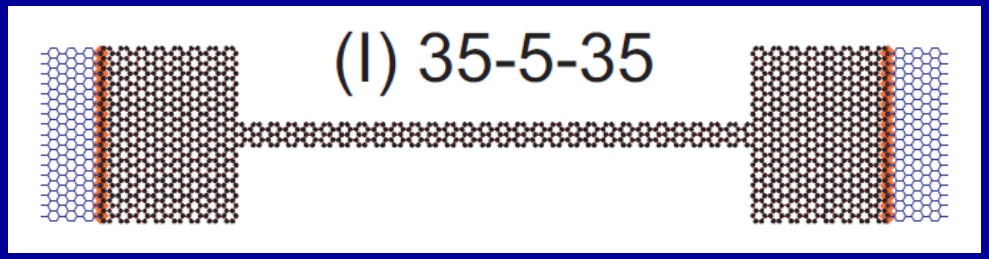


Width of the leads

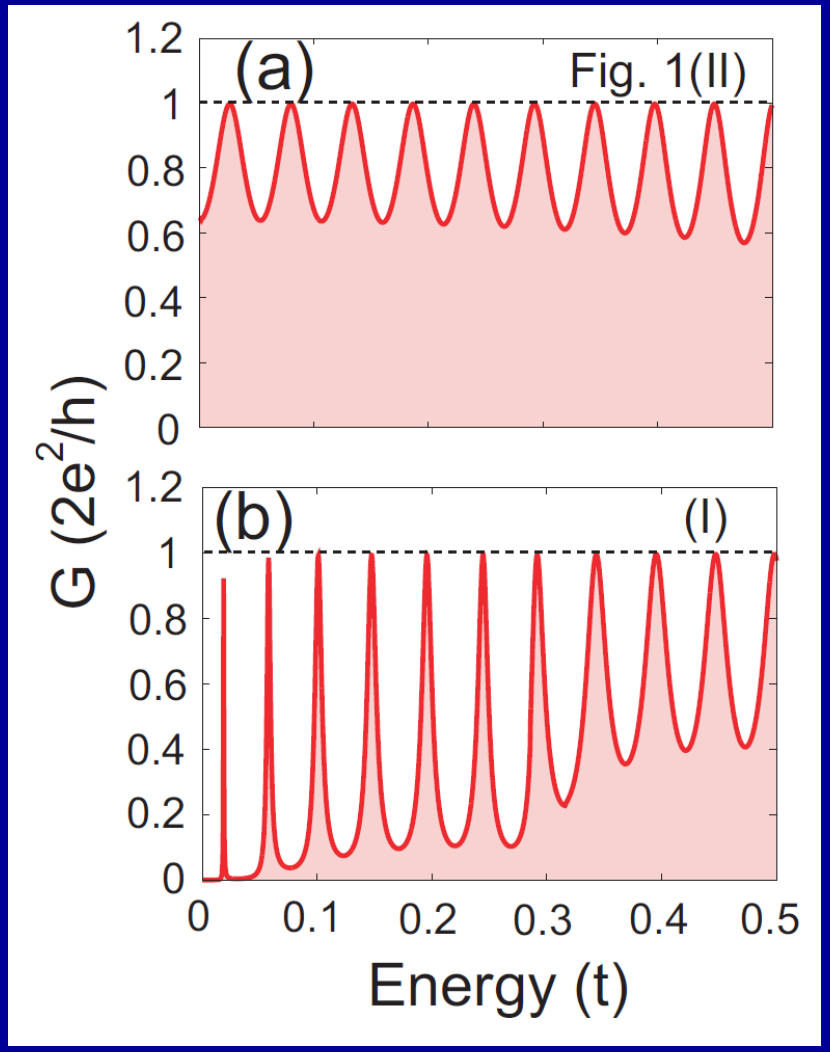
Open system, quasi-ballistic, strong coupling to the leads



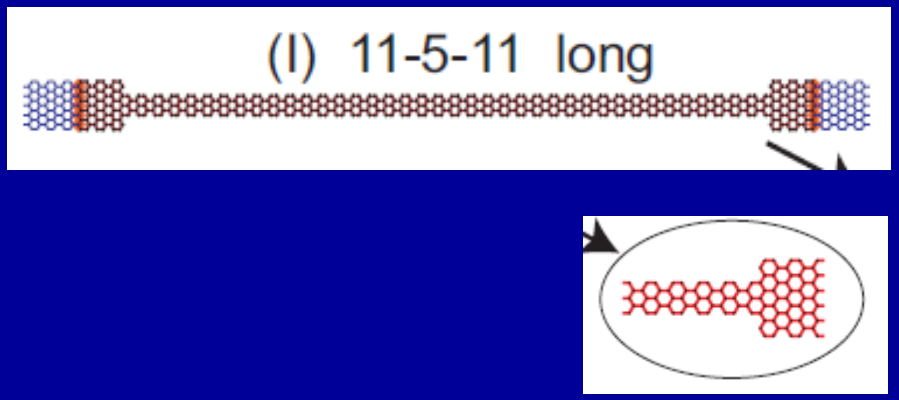
Sharp spikes, close system, weak coupling to leads, quantum dot



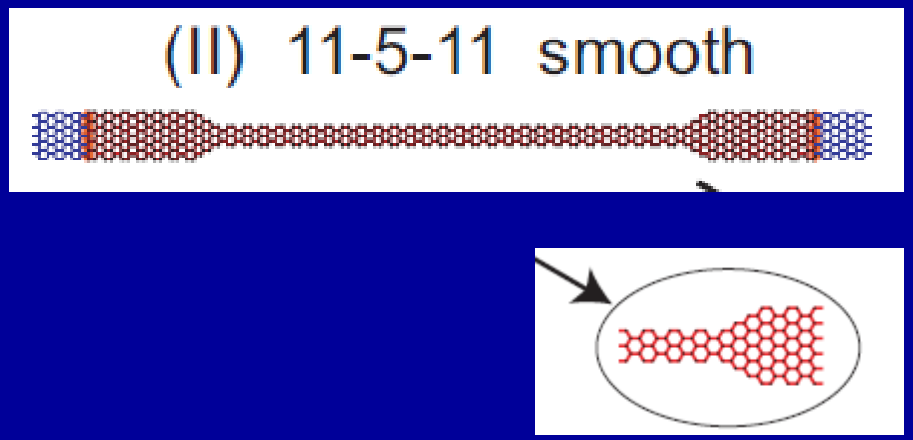
TB-NEGF

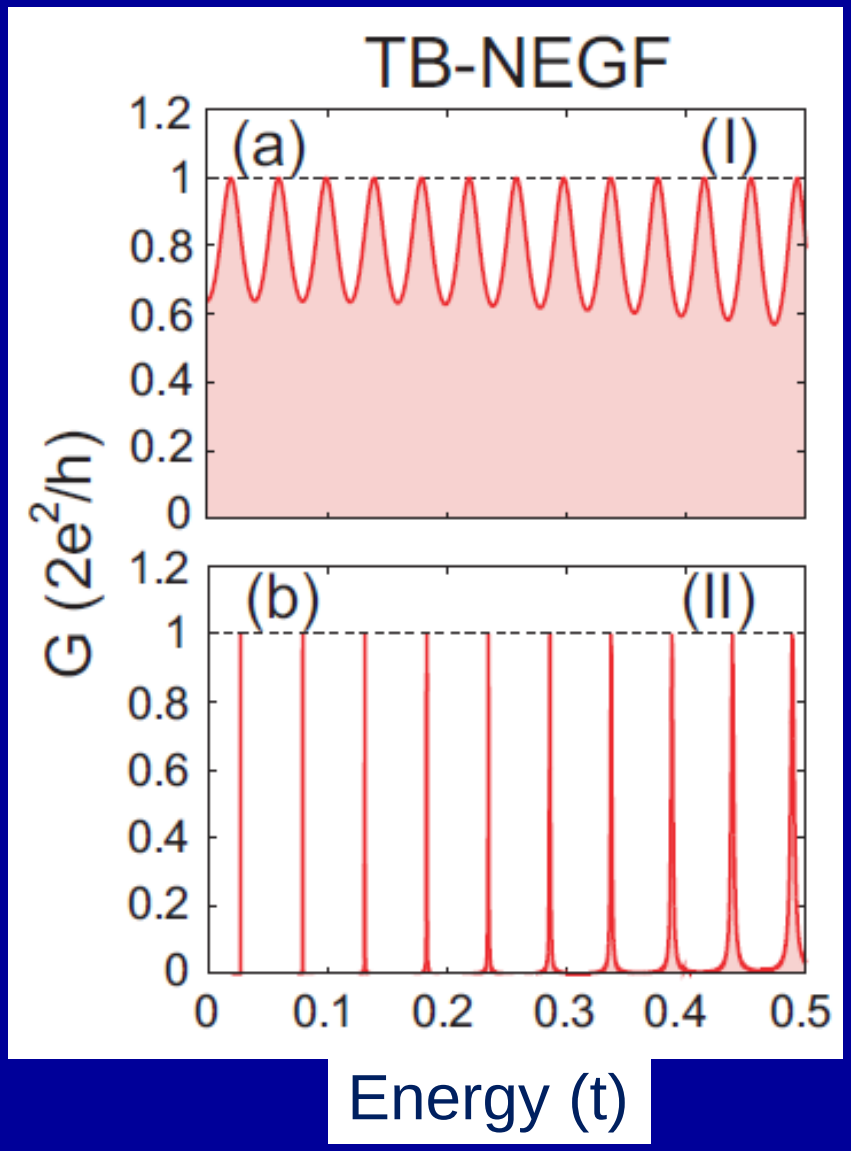


Length and smoothness



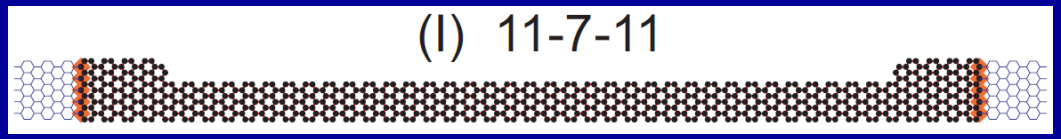
Larger No. of oscillations
Fabry-Perot quasiballistic

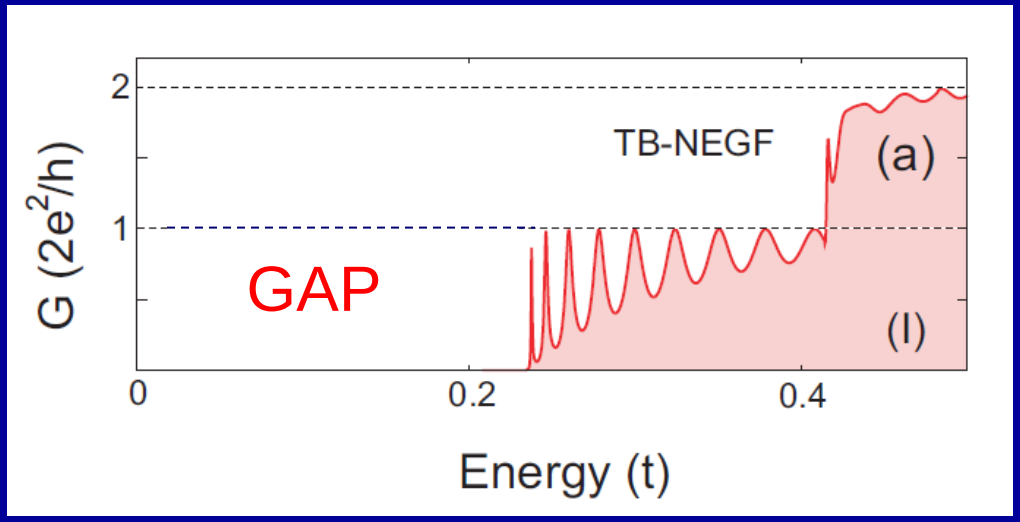




Smothness leads to enhanced confinement and resonant tunneling – quantum dot

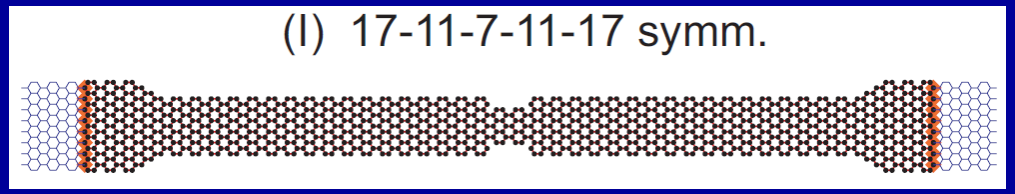
Semiconducting middle segment

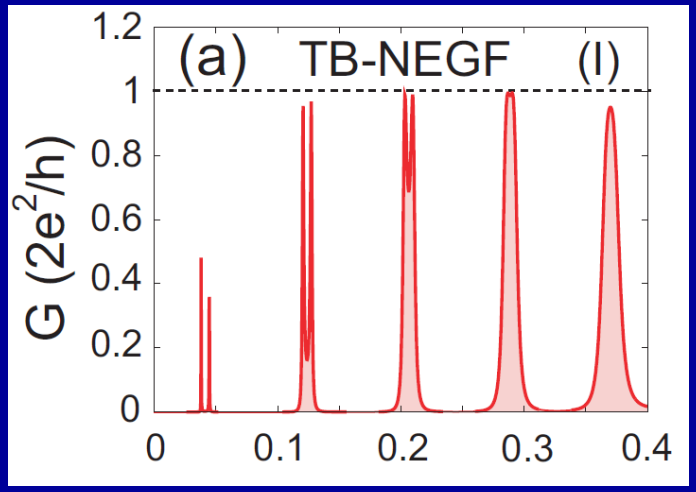




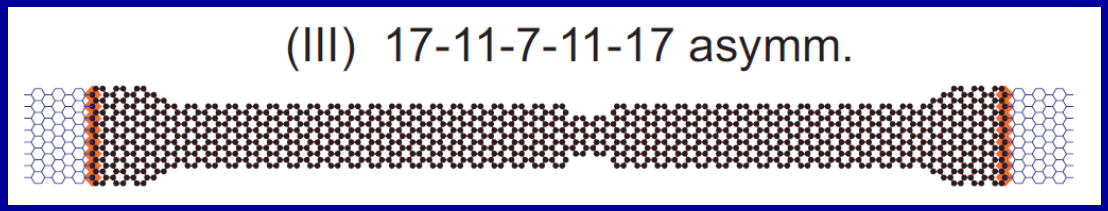
Finite-mass Fabry-Perot,
relativistic fermion with finite mass,
unlike optical FP

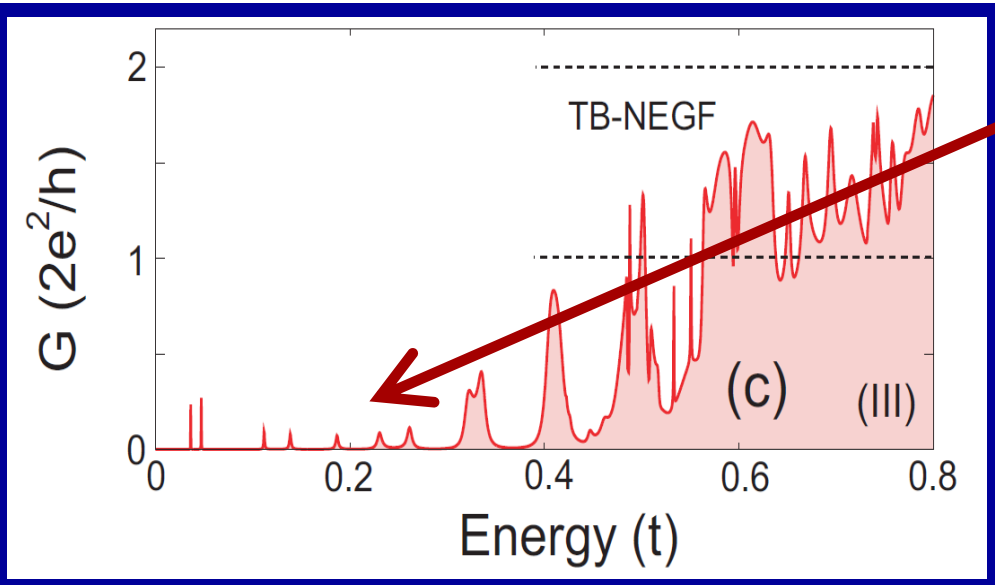
Double quantum dot





Doubling





Spikes with heights << 1

Quasi-ballistic behavior is destroyed; Connection to CB

Summary

1) We have addressed the intrinsic transport properties of graphene's honeycomb lattice in the context of atomically precise segmented armchair nanoribbons

2) The intrinsic transport properties reflect the relativistic nature of massless and massive Dirac electrons

3) The interfaces between the segments act as reflectors:
   a) for open configurations: Fabry-Perot-type oscillations and quasi-ballistic conductance
   b) for closed configurations: sharp conductance spikes reflecting quantum dot (QD) formation
   c) for asymmetric double-dot configurations: quasi-ballistic behavior is suppressed/ some resemblance with imperfect (not atomically precise) nanoribbons