2019 NSF STC Virtual Site Visit
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Theme 1: Nano-electronics

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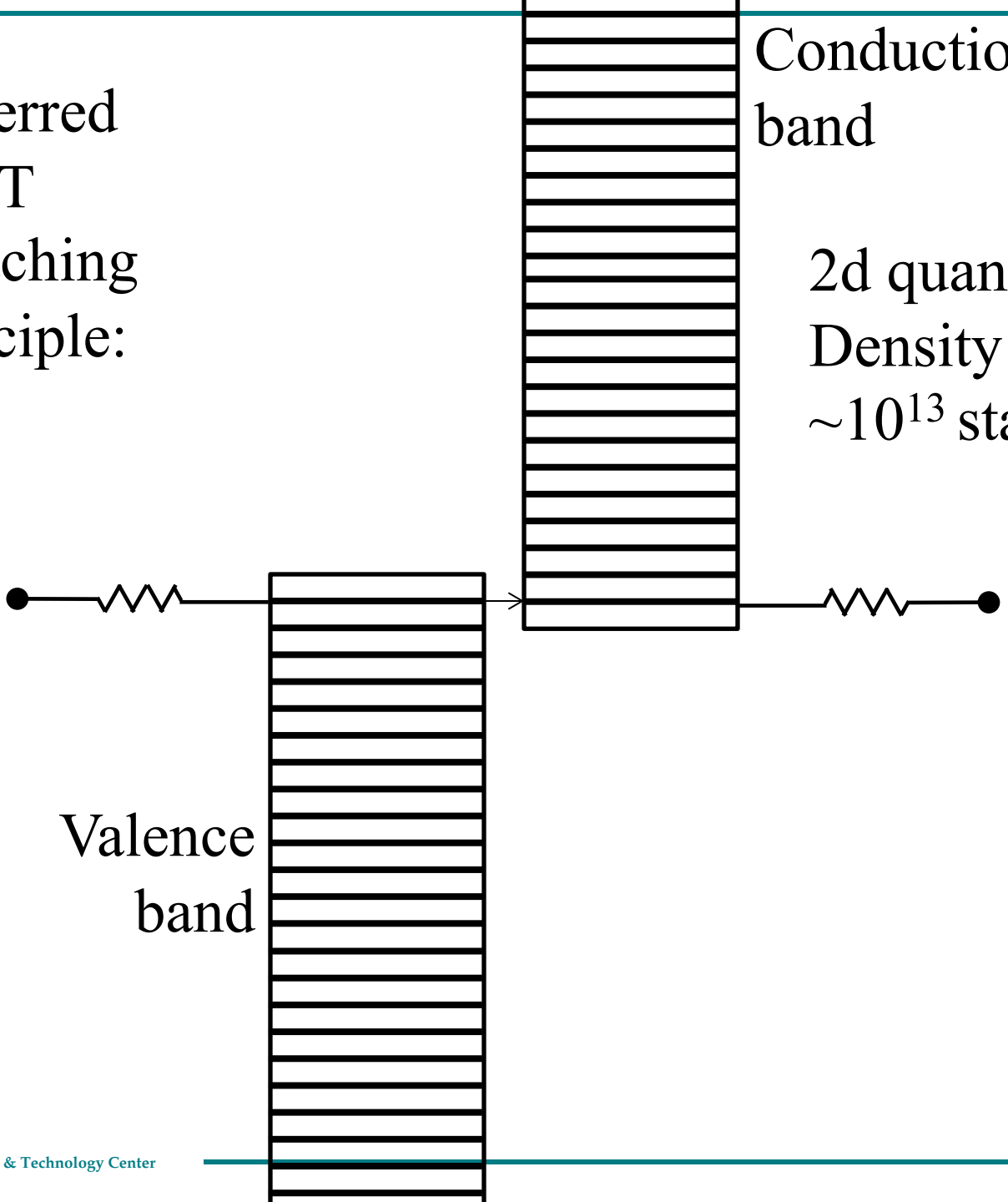
THE UNIVERSITY OF TEXAS AT EL PASO
FLORIDA INTERNATIONAL UNIVERSITY
CALIFORNIA COMMUNITY COLLEGES CHANCELLOR'S OFFICE

Preferred TFET Switching Principle:



2d quantum Density of States ~10^{13} states/cm^2eV

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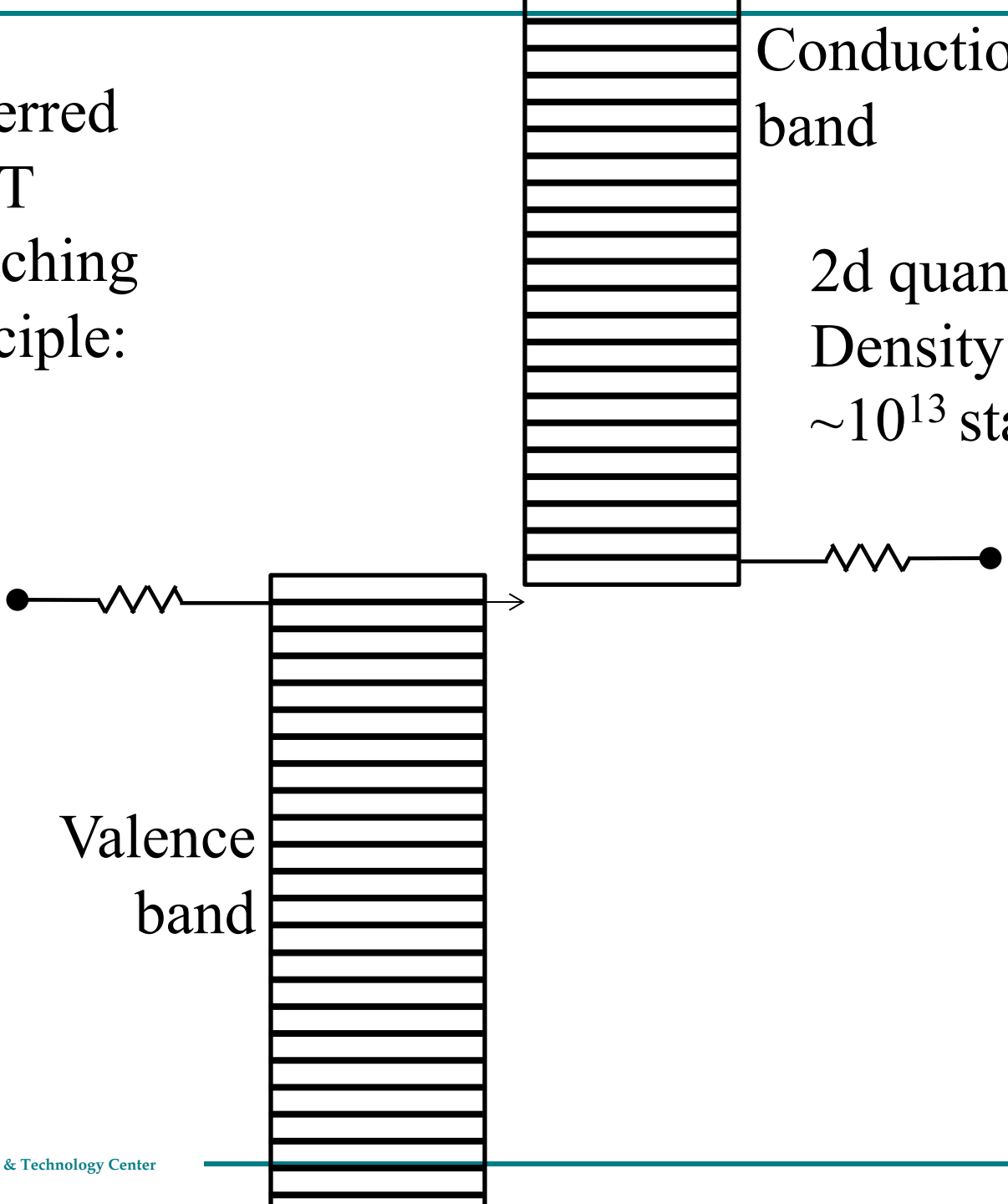
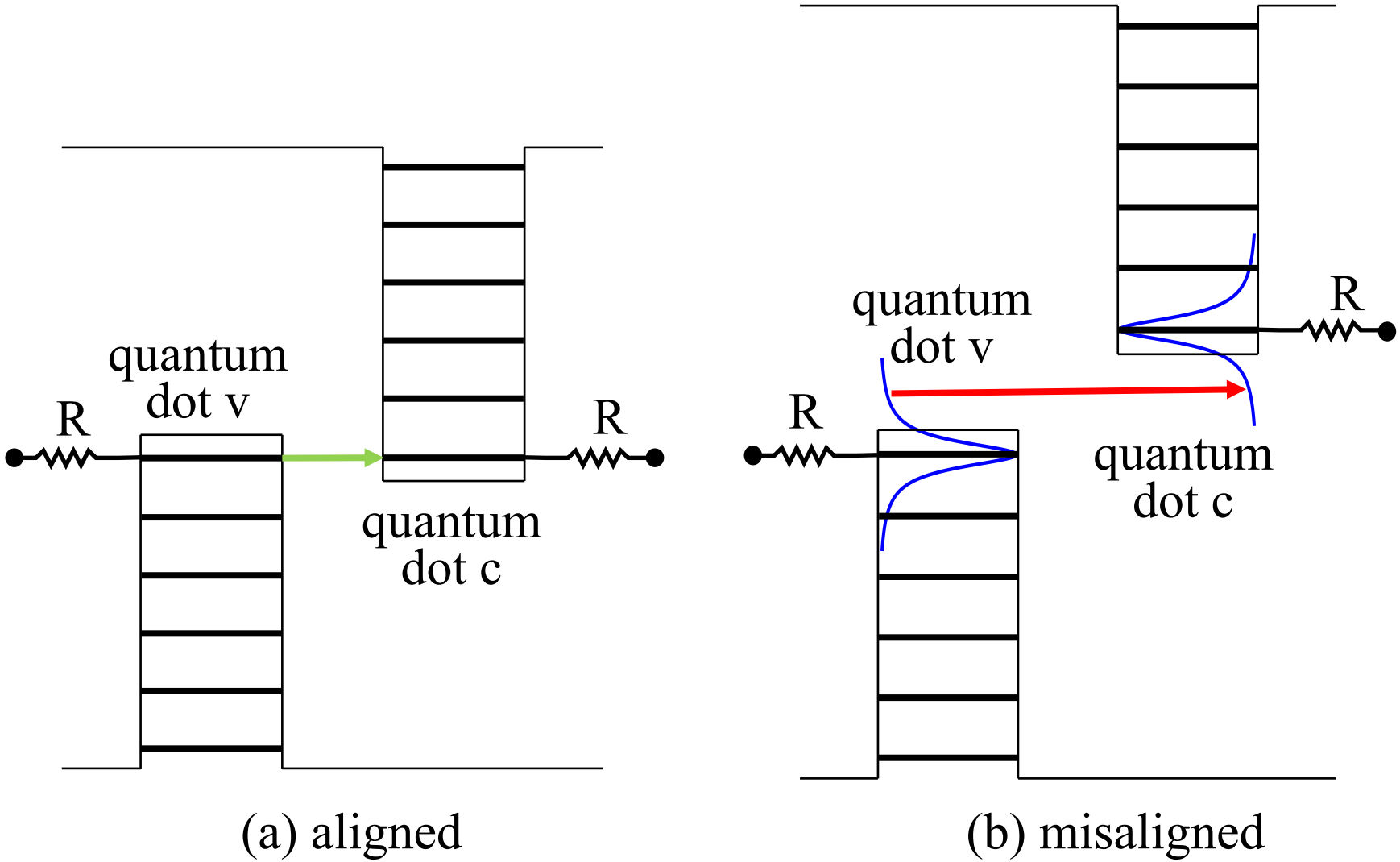
Principle:



2d quantum
Density of States
~10^{13} states/cm^2eV

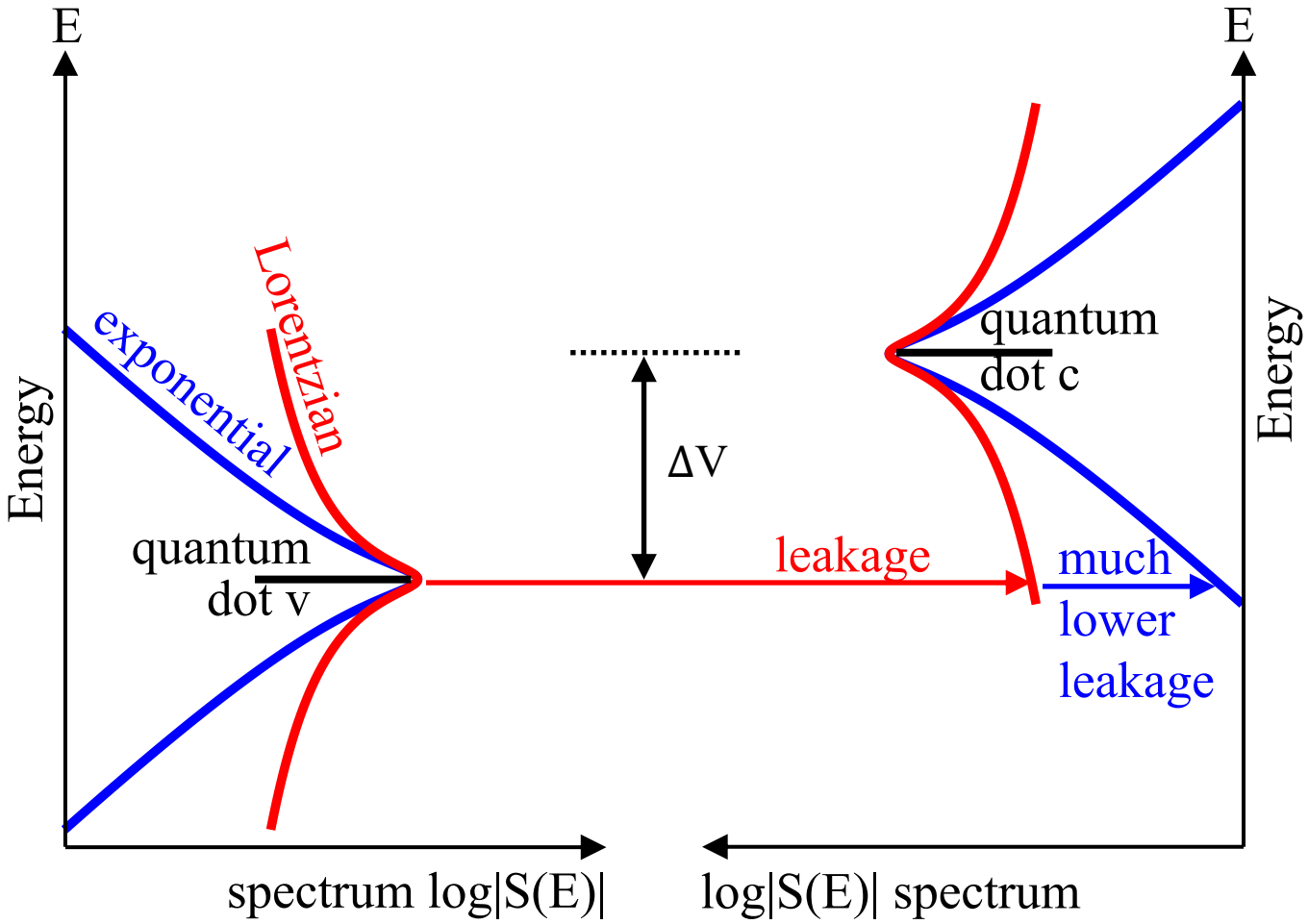
Challenges to the Ideal "Energy-Filtering" t-FET:

1. Conductance becomes Intrinsically Handicapped at V_{sd}<100mVolts, and it's really harmful.
2. D_{it} is a severe problem, not because of the gate efficiency, but because of On/Off ratio.
3. Coulomb Blockade demands greater contact linewidth broadening, penalizing voltage.
4. Phonon broadening.
5. Phonon-assisted tunneling.
6. Dopants create an extrinsic bandtail.
7. There is further harm to the On/Off ratio caused by "Inverse Auger", or "Impact Ionization" leakage.
8. D_{it} is a severe problem, not because of the gate efficiency, but because of On/Off ratio.



(a) aligned

(b) misaligned

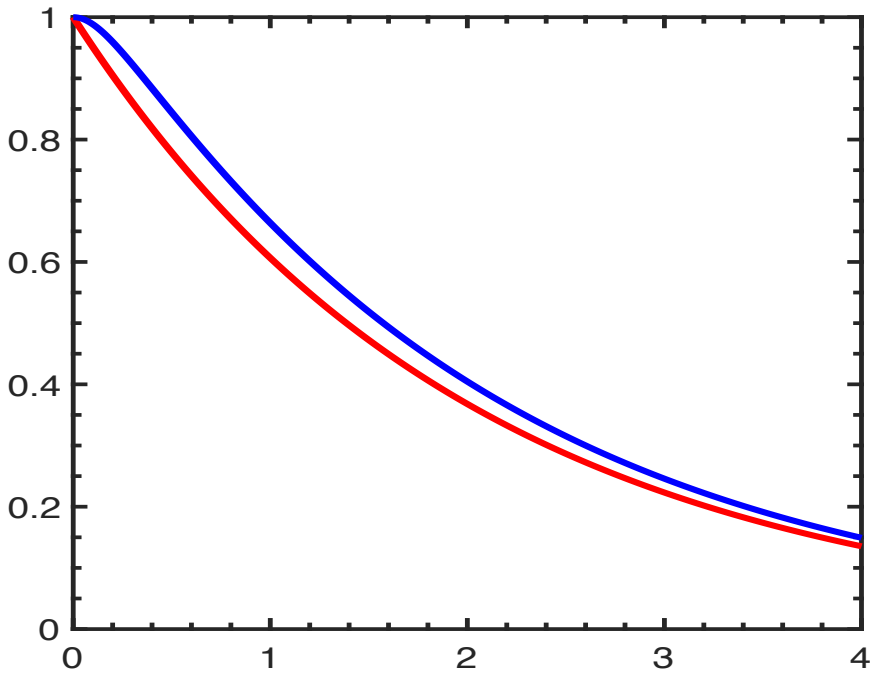


(b)

For Lorentzian spectral tails,

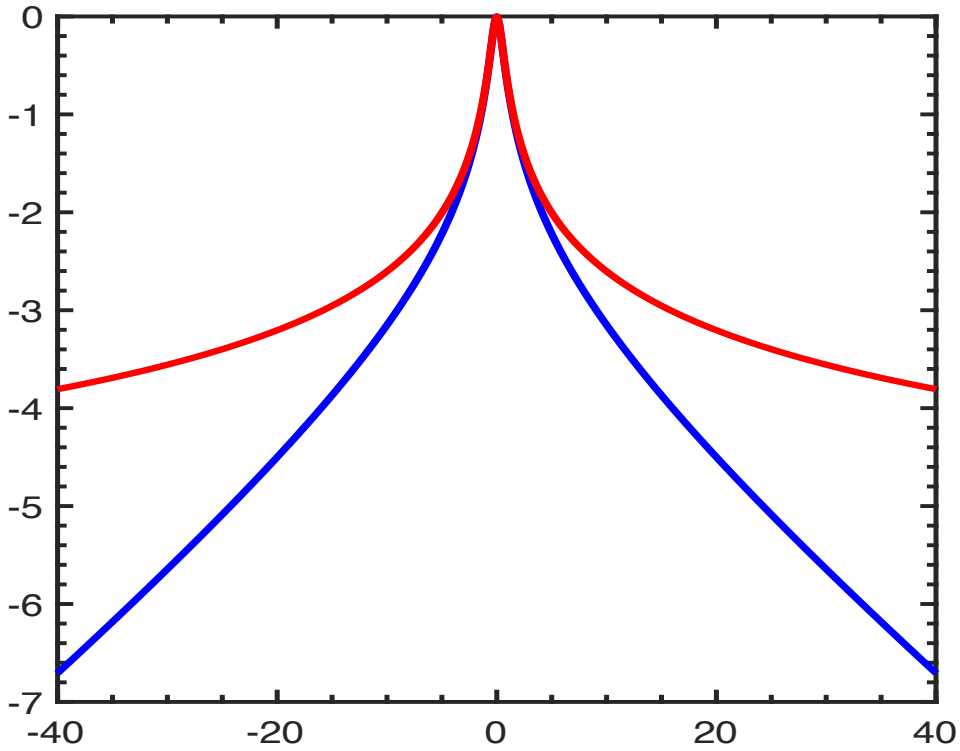
you can never turn off the tunnel-FET

What happens in reality is not exponential decay:

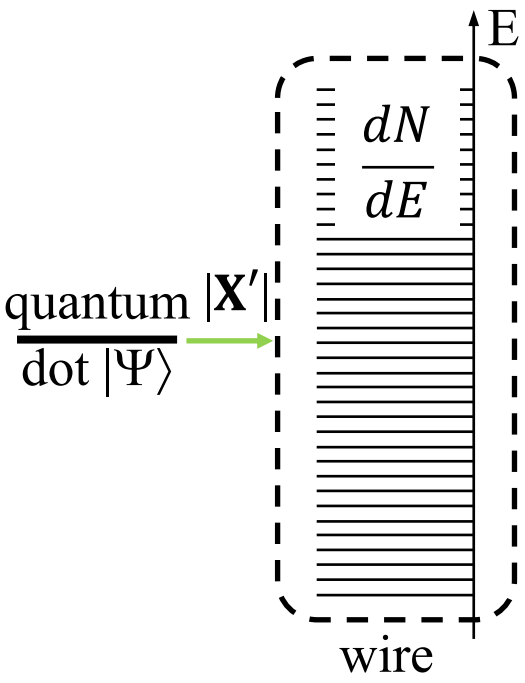


There is an initial parabolic period of time $2\tau_p$!

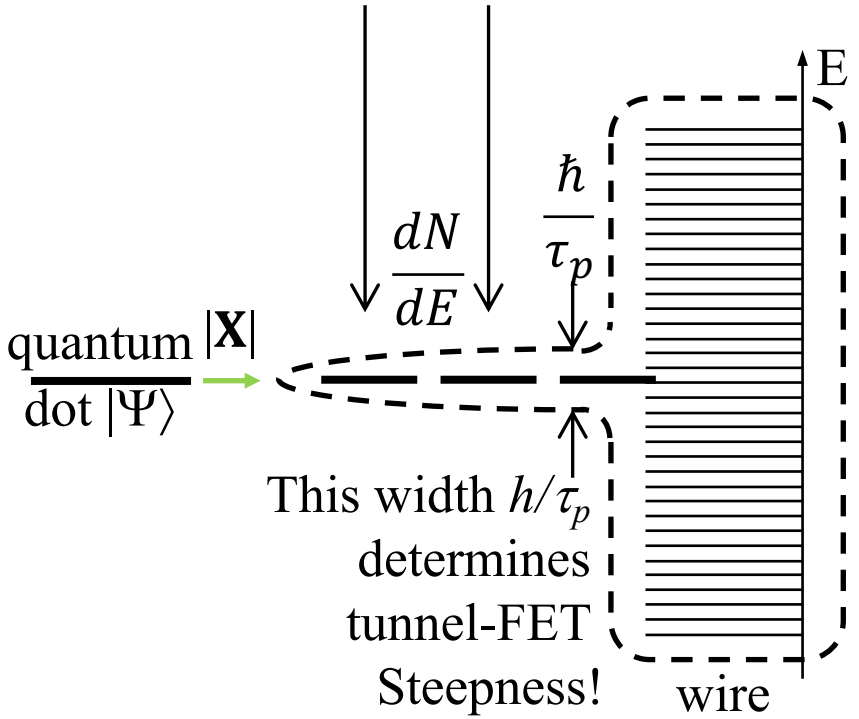
The initial parabolic decay rescues the tFET concept:



We are setting forth, for the first time, the requirement: that the wires connecting to a tunnel FET should consist of 1-d conductors of heavy effective mass, a narrow band metal that can only be achieved by a metallic, graphene nano-ribbon

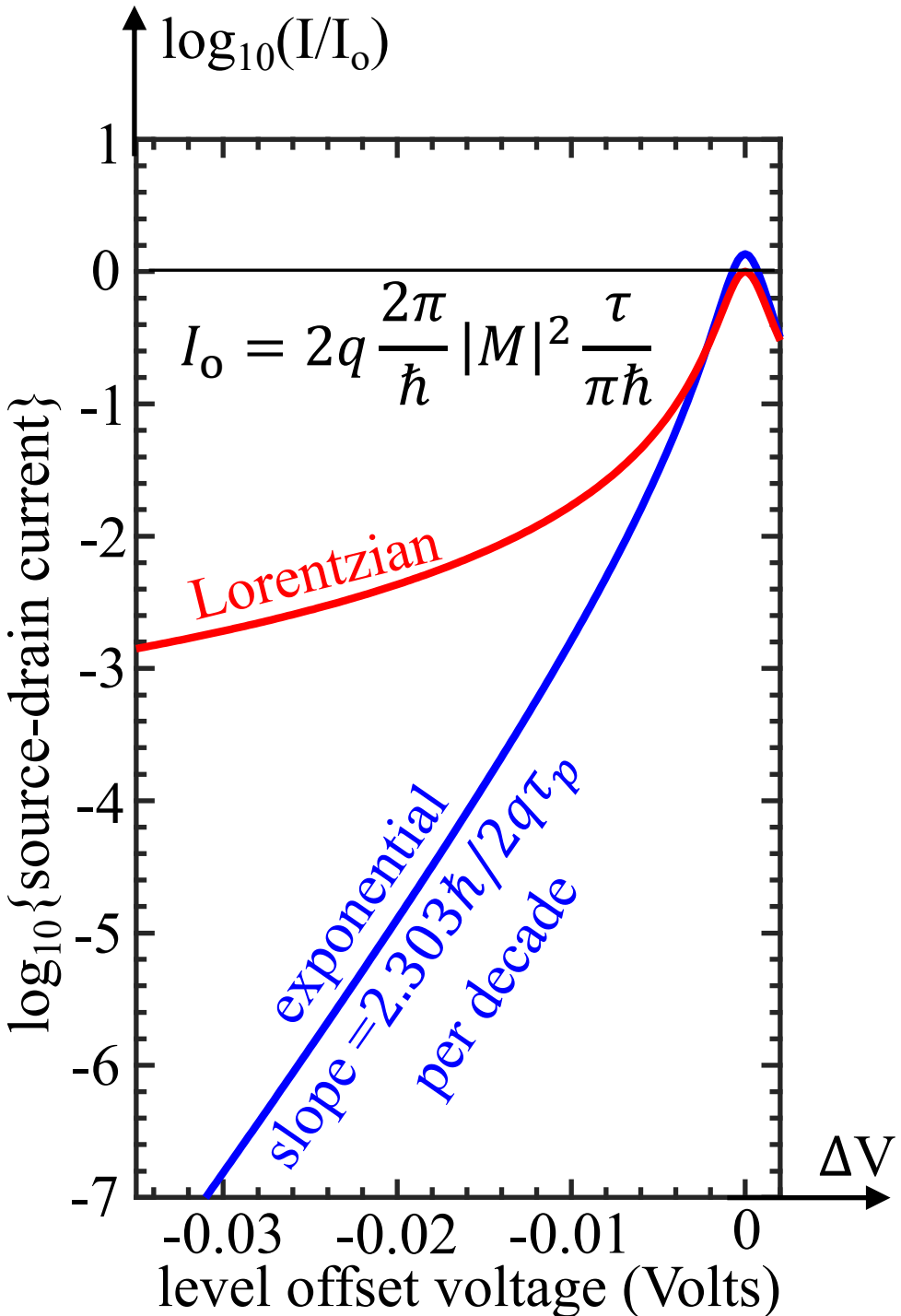


Lorentzian straight Fermi's Golden Rule

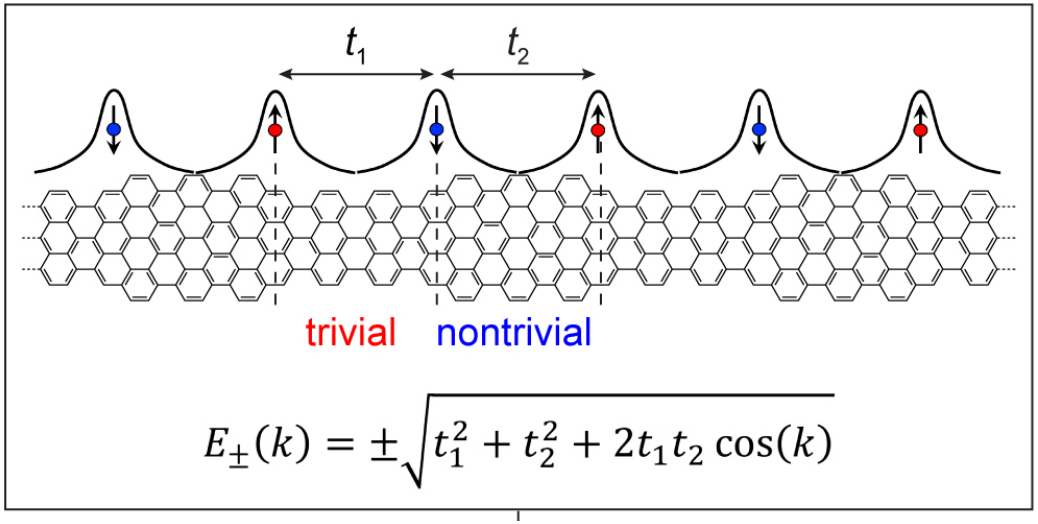


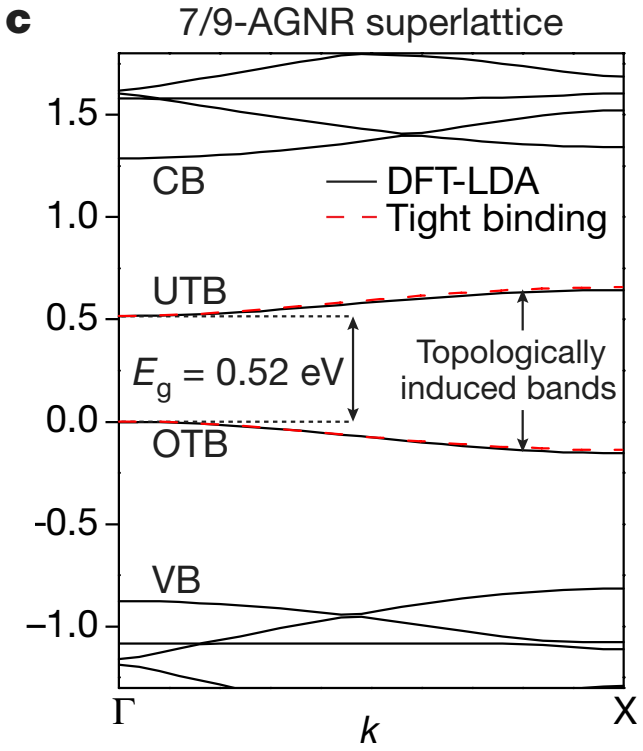
initial parabolic decay for a time τ_p

The predicted tFET I-V curves.



Engineering Metallic GNRs from Topological Superlattices





$E_g = 2\,|t_1 - t_2|$

Semiconductor Band Structure for: $t_1 \neq t_2$; $E_g > 0$

Metallic Band Structure for: $t_1 = t_2$; $E_g = 0$

(Fischer and Louie groups)

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New Requirement:

8. Prevent the Lorentzian lineshape by requiring narrow-band, heavy-effective-mass connecting leads to the tunneling device. This has implications for other areas of scientific spectroscopy.