

FETs at the Frontier

Physics, Limits, and Options

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1. Introduction
2. The Ballistic MOSFET
3. Scattering Theory of the MOSFET
4. Design of 10 nm MOSFETs
5. Beyond the Si MOSFET
6. Summary

Acknowledgements

Professor Supriyo Datta

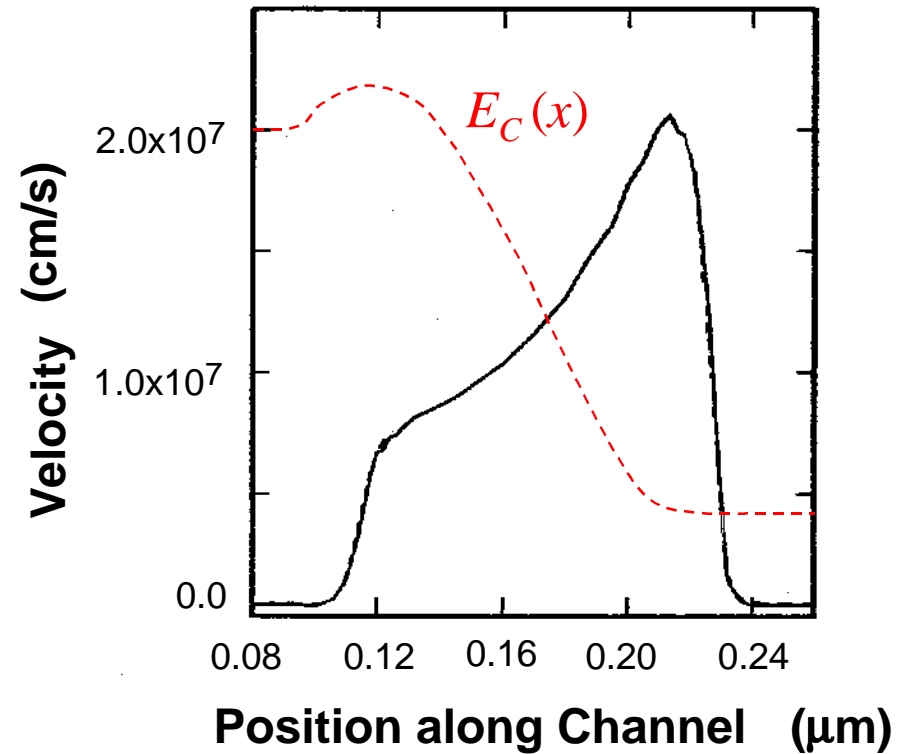
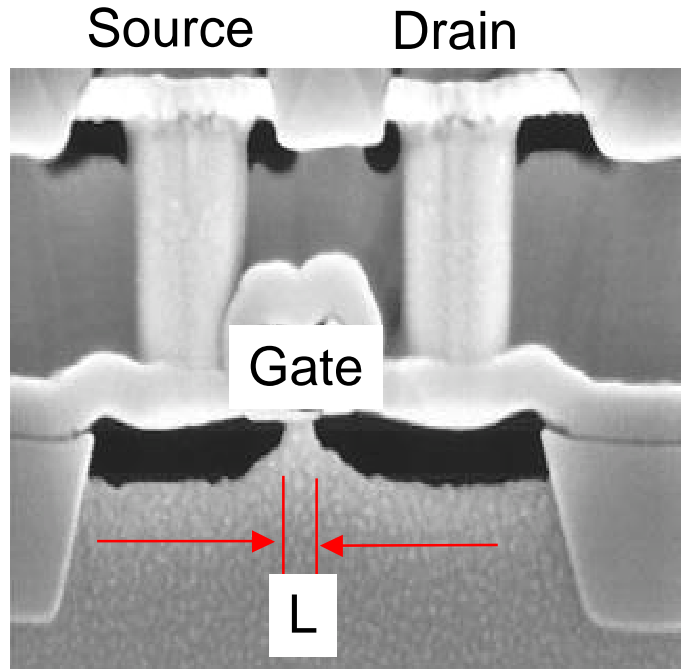
students:

Jing Guo, Sayed Hasan, Zhibin Ren, Jung-Hoon Rhew,
Anisur Rahman, Dave Rumsey, Ramesh Venugopal, Jing Wang

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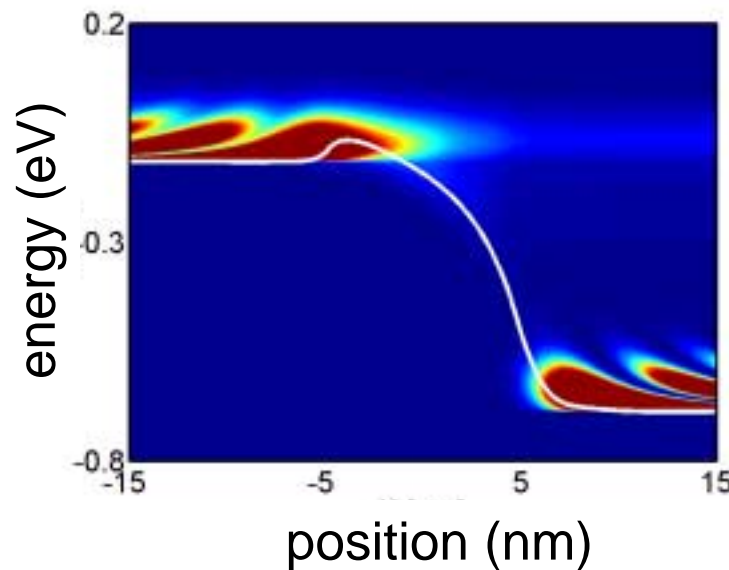
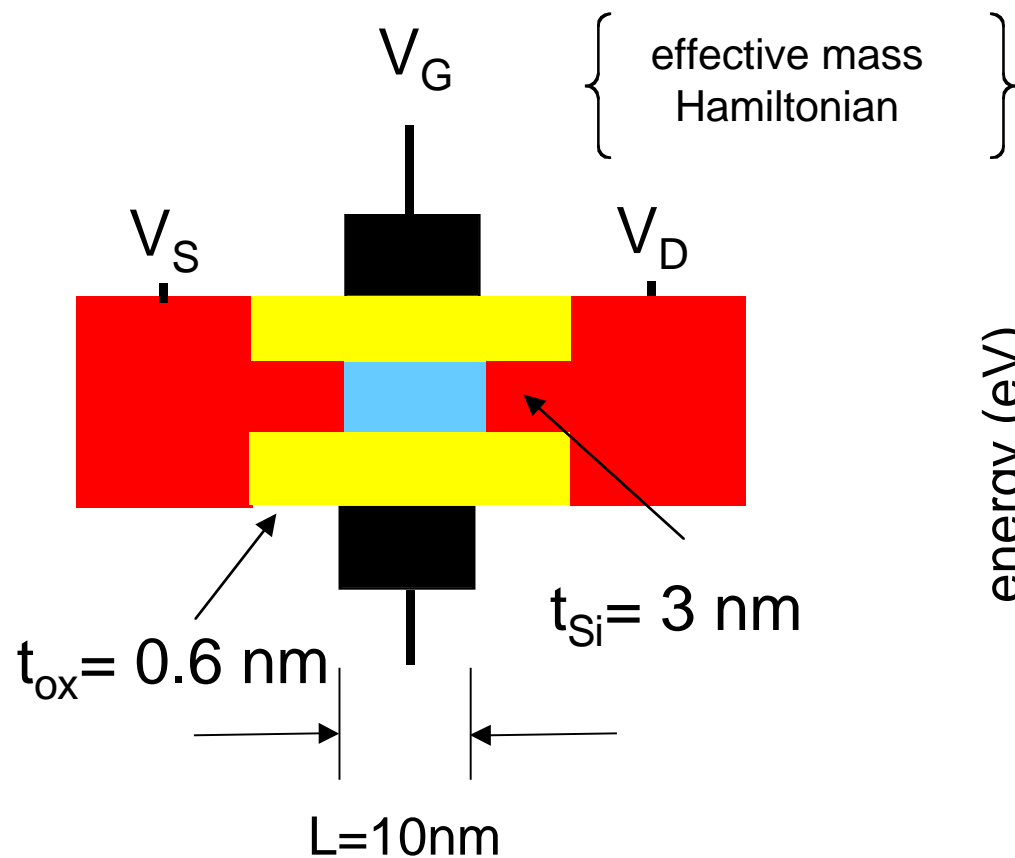
“Current is related to transmission”

Landauer (1959)

McKelvey (1961)

1. Introduction

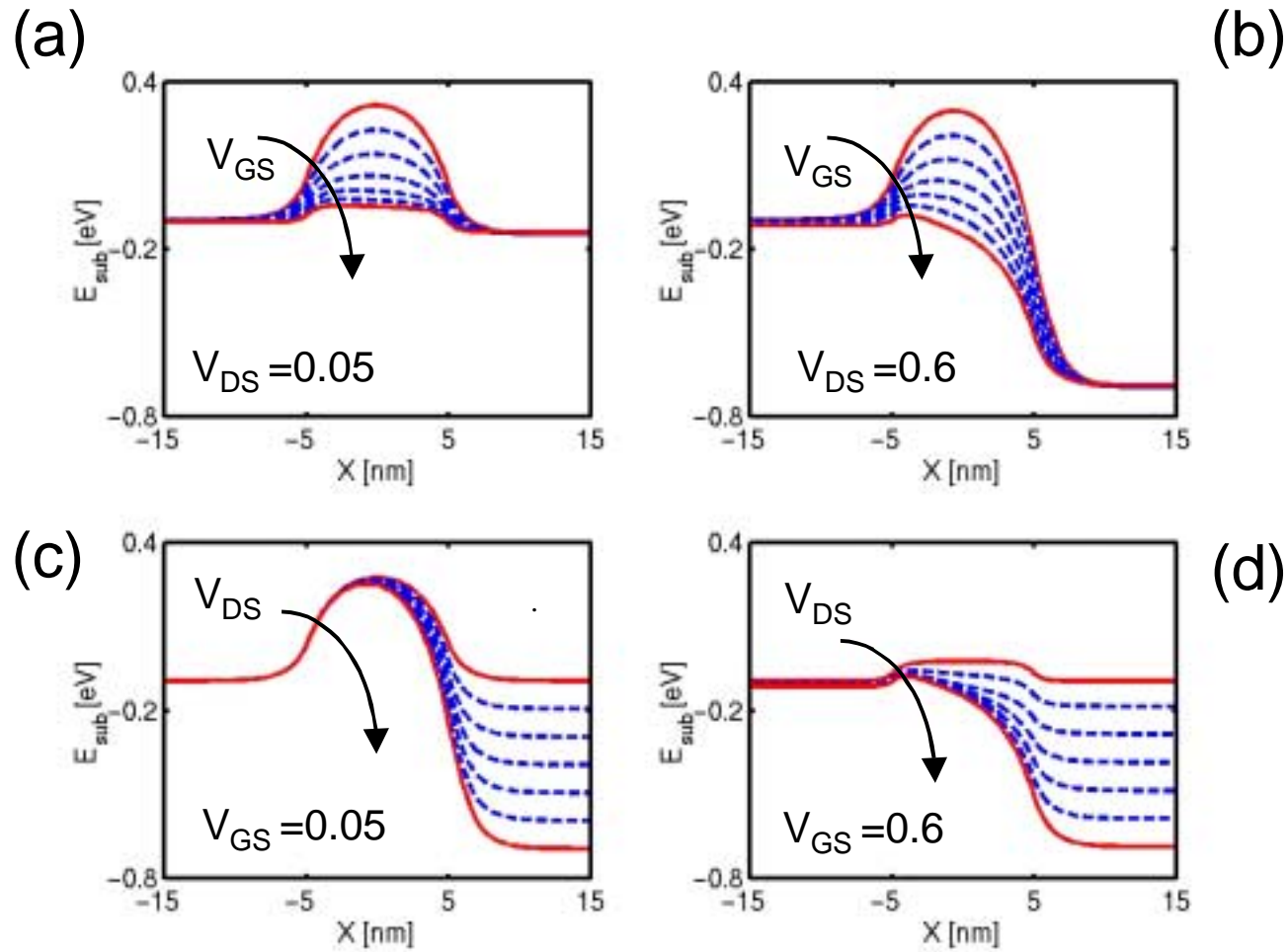
NEGF Simulations



Z. Ren, R. Venugopal, S. Datta, and M. Lundstrom, IEDM, 2001

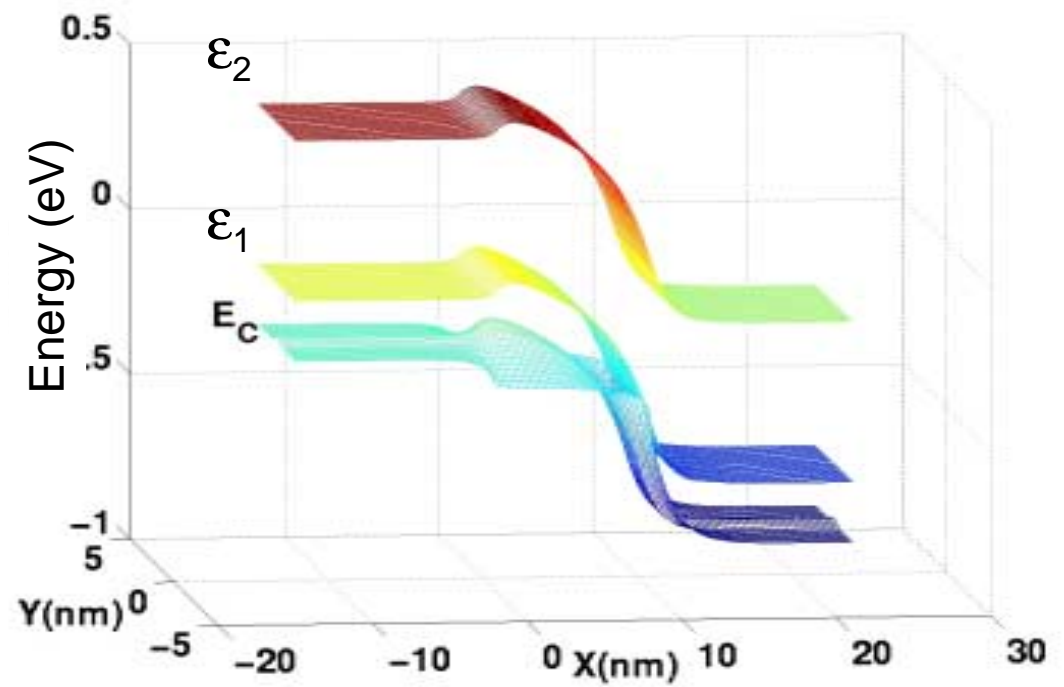
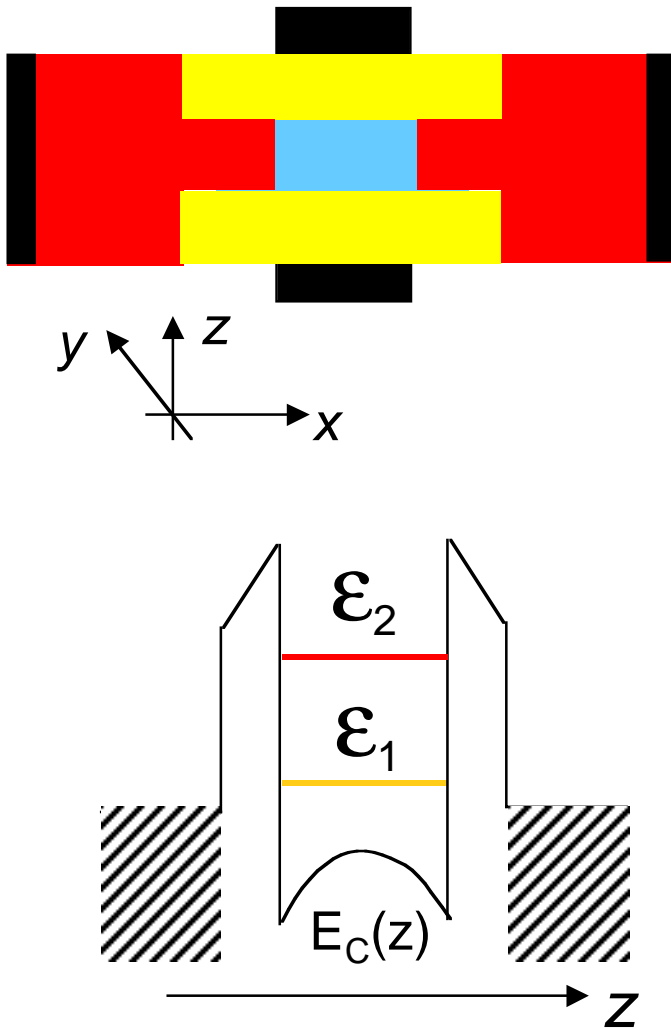
1. Introduction

energy band diagrams



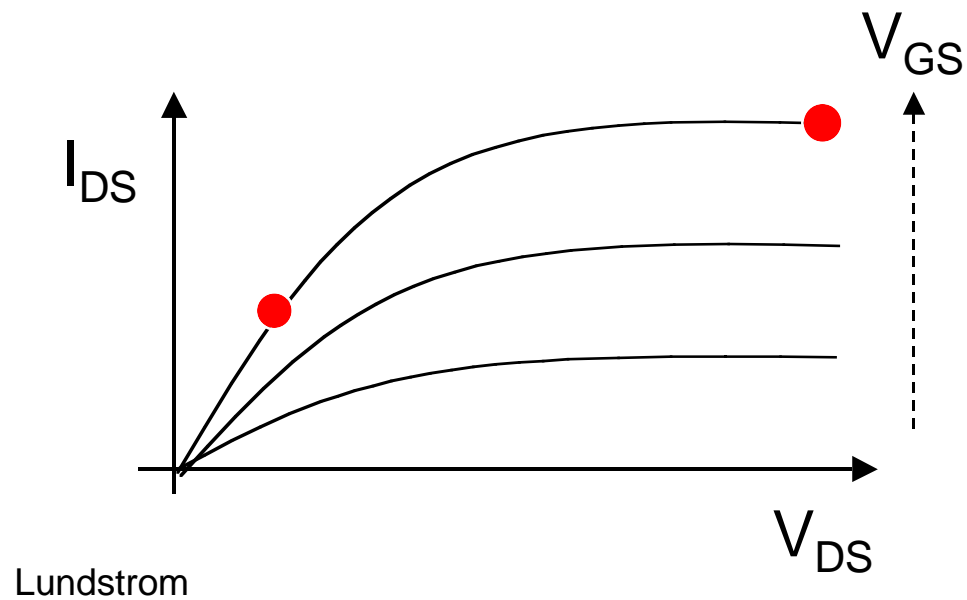
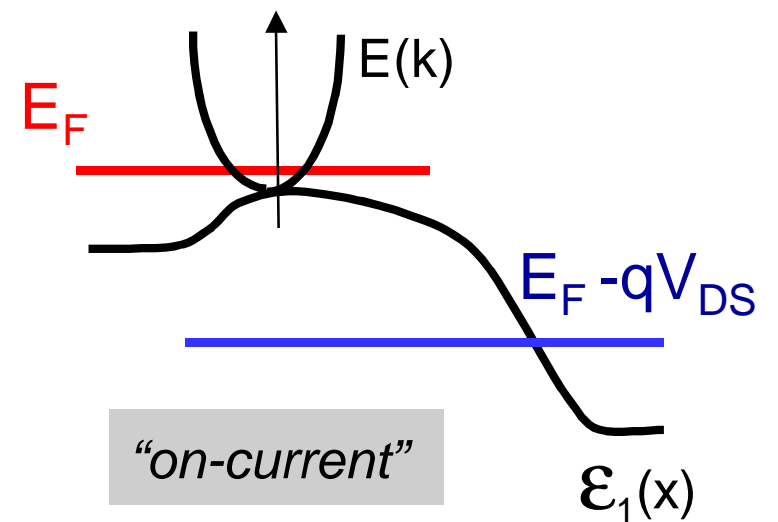
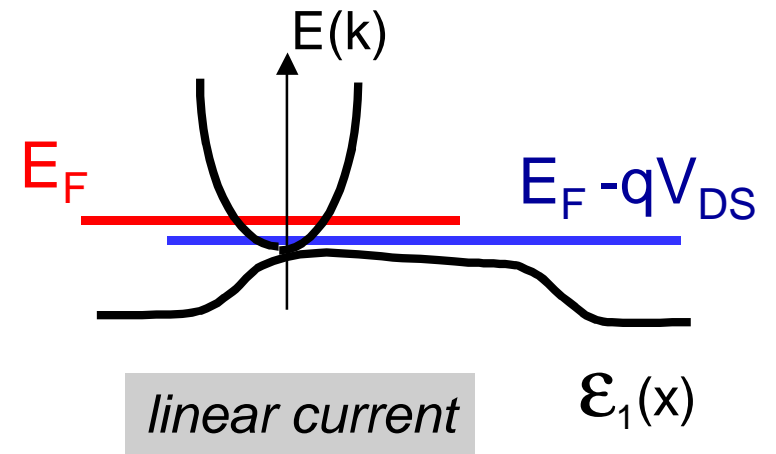
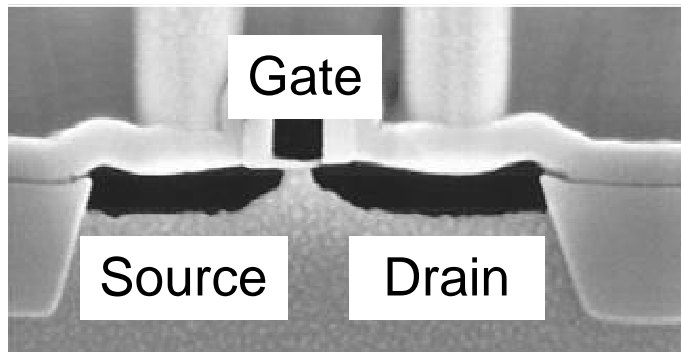
1. Introduction

energy band diagrams



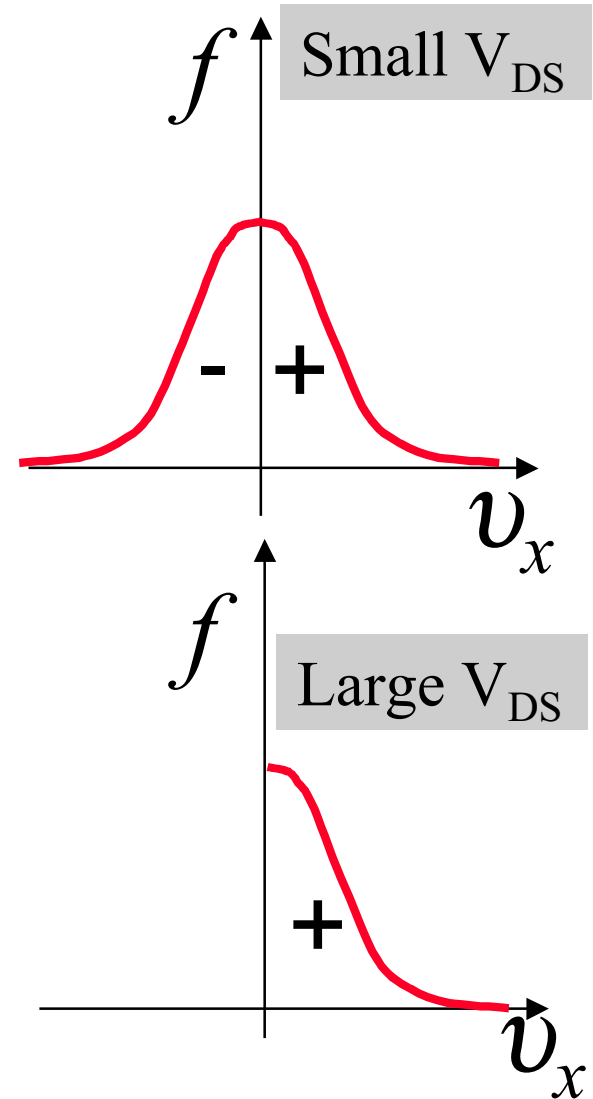
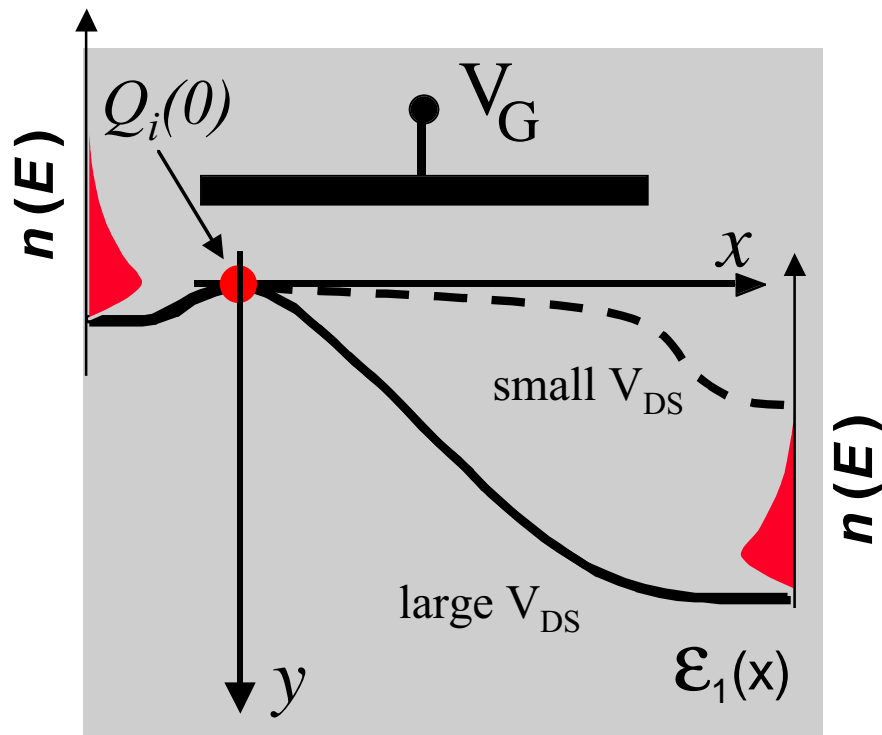
2. The Ballistic MOSFET

Natori's theory



2. The Ballistic MOSFET.....

thermionic emission

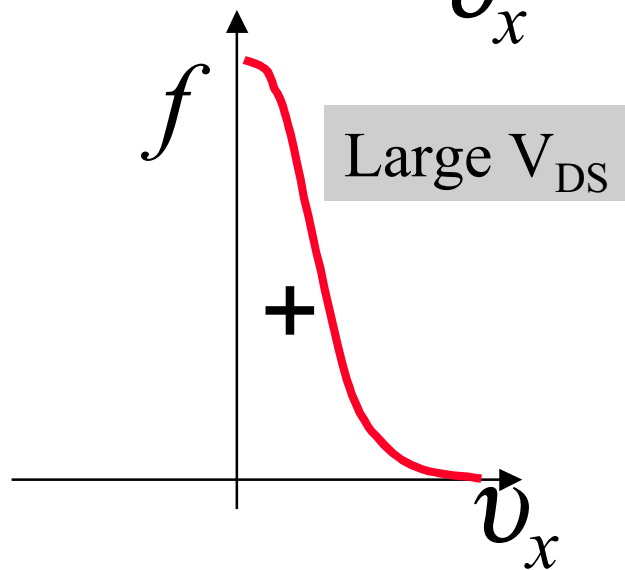
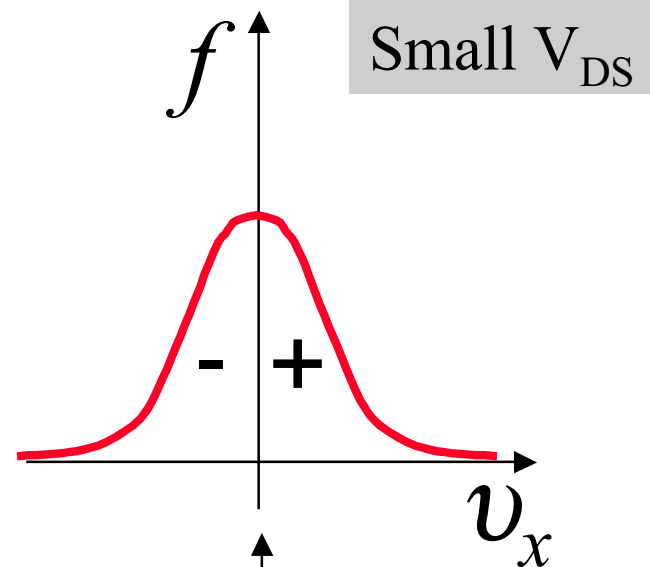
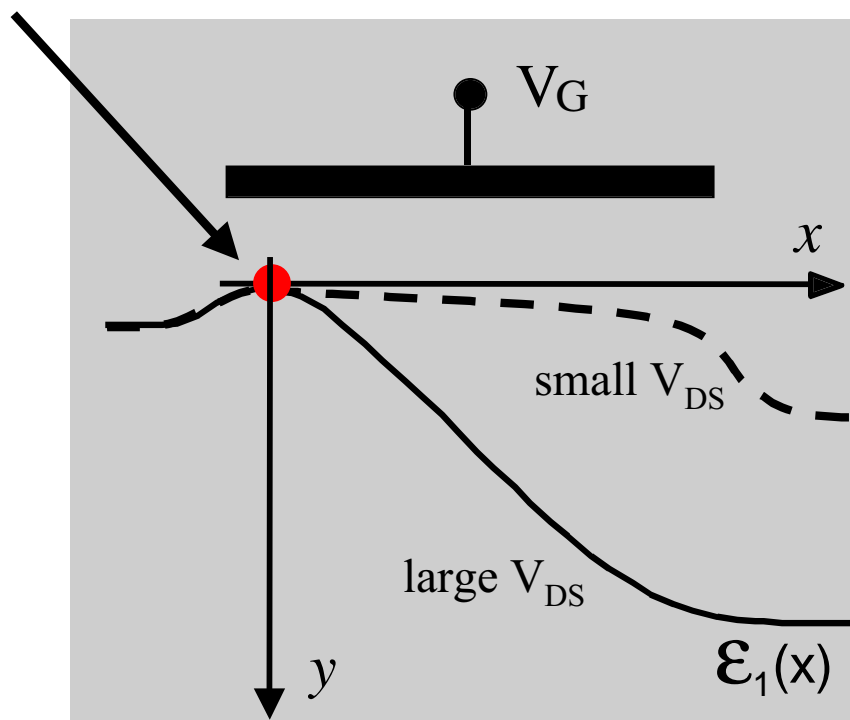


$$f_0 = e^{-E/k_B T} \sim e^{-m^* v_x^2 / 2k_B T}$$

2. The Ballistic MOSFET....

charge control in a well-tempered MOSFET

$$Q_i(0) \approx C_{ox} (V_{GS} - V_T)$$

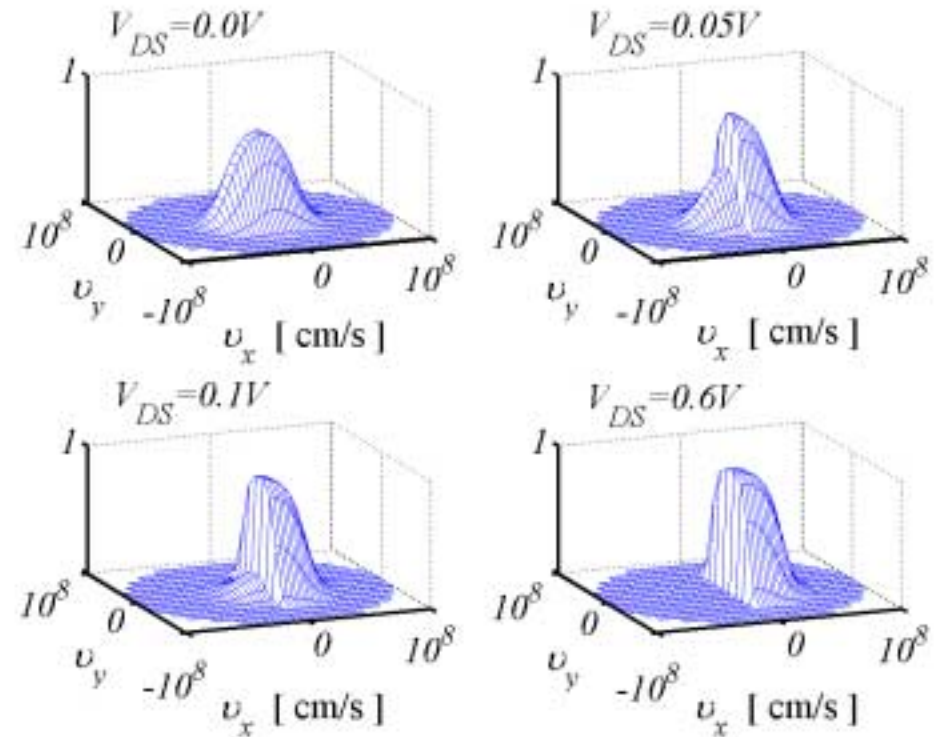
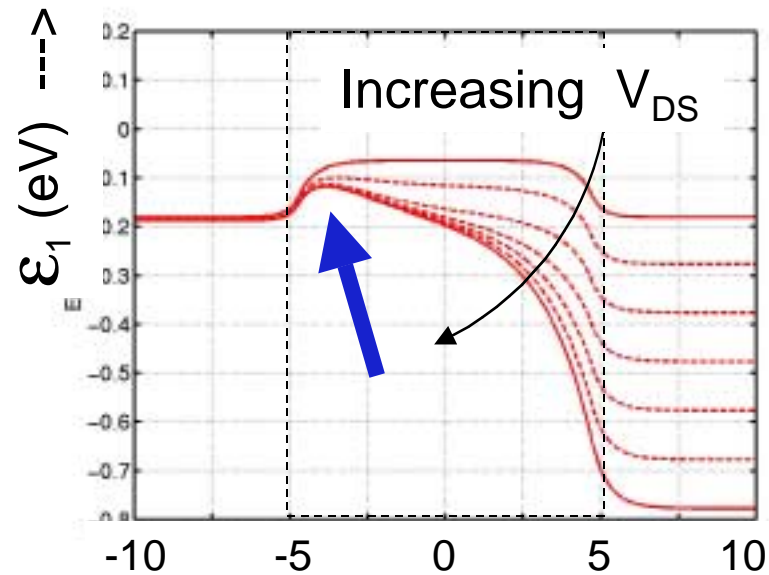


2. The Ballistic MOSFET.....

numerical solution of the ballistic BTE

ϵ_1 vs. x for $V_{GS} = 0.5V$

$f(k_x, k_y)$



J.-H. Rhew, Purdue University