EECS 598-05: Quantum Optoelectronics Prof. Mackillo Kira

Basic Info, Challenges and Approaches

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Regular Electronics

1. Simplified Apparatus
    - Super-densely Packed: Electrons are only few Åaway from one another
    - Strongly-interacted: Forces drive the motion of electrons and then give the constant current
2. Limitations
    - Voltage restriction

      Voltage must be low to avoid possible damage

      High voltage essentially cause large current, and each collision will the lattice which eventually causes irreversible damage

      Eg: 100KV over 1m = $10^5 V/m = 10^{-5} V/$Å(wimpy on atomic scale)
    - Coulomb & Phonon Interaction

      Scattering at the 100 femtosecond scale

      Many collisions will cause quantumness/ coherence lost
    - Voltage switching relatively slow

      Compared to the scattering rate, the 1 Ghz switching rate too slow to prevent the scattering (10^4 collisions in one switching period)

Quantum Optoelectronics

1. Using Optical & Terahertz Fields to :
    - Generate charge carriers
    - drive these carriers
2. Why it is useful?
    - With shorter period(100 fs), there will be no collisions

- No heading

  There used to be heating problems because if electron scatters with lattice vibrations, it will converts energy to the lattice
- High field strength becomes possible

  Collisions are no more problems
- Without all those, certain well-designed system

  can generate & control quantum coherences

  quantum information processing becomes possible

Generic Challenges

1. Excitation can easily involve over 1 million charged particles

   Short Distance and Strong Interaction(Quantum Many Body System)
2. Light-matter interaction involves quantum light

   Semiconductor Quantum Optics
3. Excitations quantum kinetics & Non-perturbative

   No Steady State, No Thermodynamics

Course Content

1. Realistic many-body/ quantum optics treatment/ understanding of semiconductor quantum optoelectronics
2. Foundations of optical/ quantum-optical responses
3. Quantum processing of quantum coherences & correlations
4. Connections to quantum computing & information
