



# Methods for Designing Quantum Cascade Lasers

[Nadia Bolis](#), [Claire F. Gmachl](#)

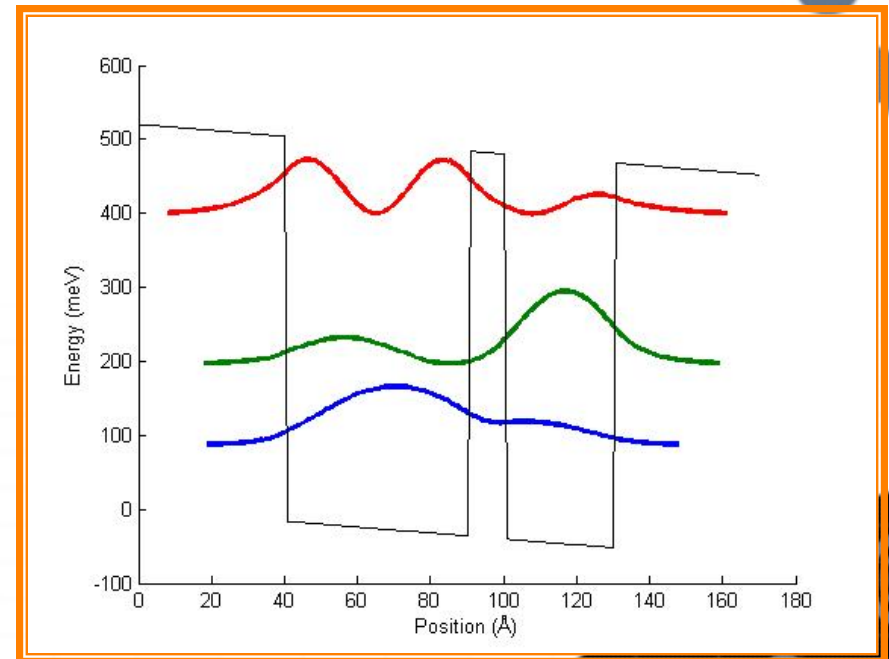


Department of Electrical Engineering  
Princeton University

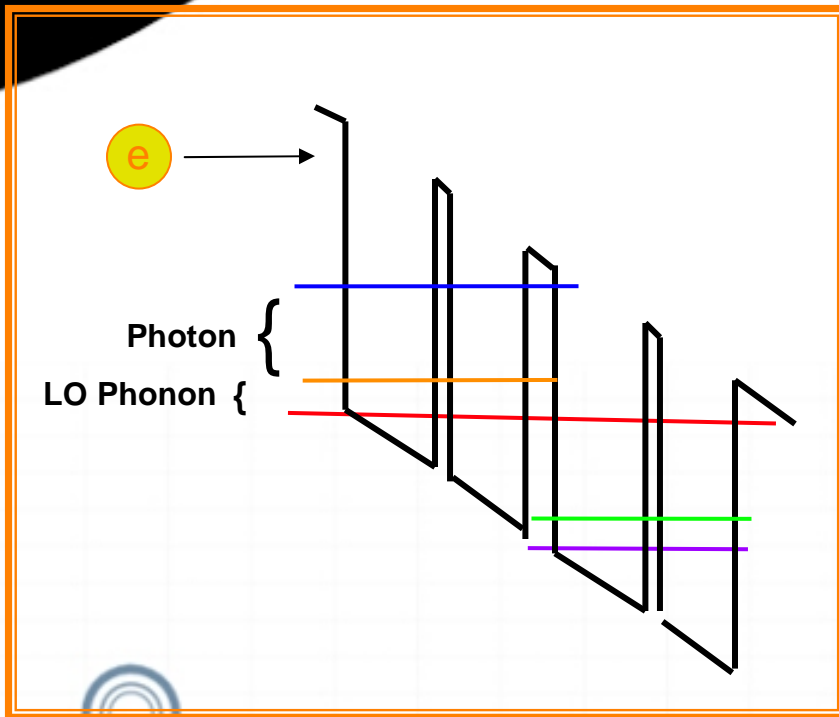
**PCCM**

# QCL Physics

- Layered structure of laser's wafer creates potential wells
- When voltage is applied across the laser, electrons will relax from higher to lower energy levels emitting either light or LO phonon
- Widths of wells determine spacing between energy levels and therefore the frequency of light emitted



# Laser Model



- I Considered various methods of finding desired difference between energy levels ( $\Delta E$ )
  - I took a simple model to test: a double square well with no injector region

# Attempted Methods

- Methods:
  - Computer Program ErwinJr: numerically solves for Energy levels and wave functions when widths of wells and barriers are given
  - Analytically: determine an equation for the Energy as a function of the widths of a set of wells. Subsequently solve for the widths using the known desired energy differences
  - Additional Program: automatically change the size of the wells and barrier by  $\pm \Delta\varepsilon$  and determine the corresponding energy for each variation. Select the set of  $\Delta\varepsilon$  that provides the  $\Delta E$  closest to the desired energy level and iterate till convergence.