

Methods for Designing Quantum Cascade Lasers



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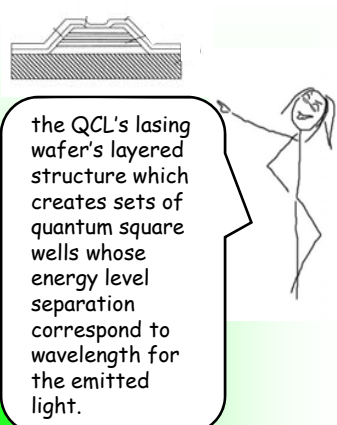
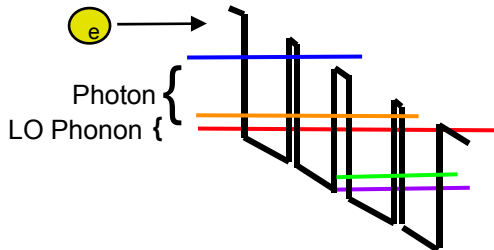
Quantum Cascade Lasers can be designed to emit light out of a wide range of frequencies making them a convenient tool to trace gas sensor systems as well as body tissue gas sensing.

What allows the wide range of possible Lasing wavelengths is...

By putting a voltage across the wafer, electrons flow through the layers relaxing.

from the higher energy levels to the lower ones,

emitting photons or Longitudinal Optical (LO) phonons as they do so

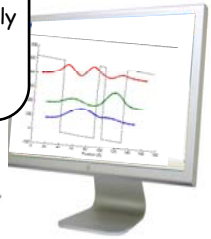


the QCL's lasing wafer's layered structure which creates sets of quantum square wells whose energy level separation correspond to wavelength for the emitted light.

Here, we aim at designing a 17μm laser, with no injector region and with each active region being composed of a double well. The width of the wells and barrier of the double wells determine the frequency of the emitted light

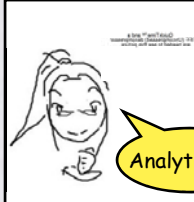
Models of the well potentials are tested using a Schrödinger solver program which calculates numerically wave functions and energy levels for specifically sized wells

This method is based mostly on trial and error



Then...

I wonder if there is a more efficient method to determine the right well sizes..



Analytically!

However...

Unfortunately, the expressions for the energy could not be solved explicitly, so...



Programming!

To accomplish this, an expression relating the energy of the double wells and the lengths of the wells and barriers has to be determined, and given The desired energies the widths could be solved for.

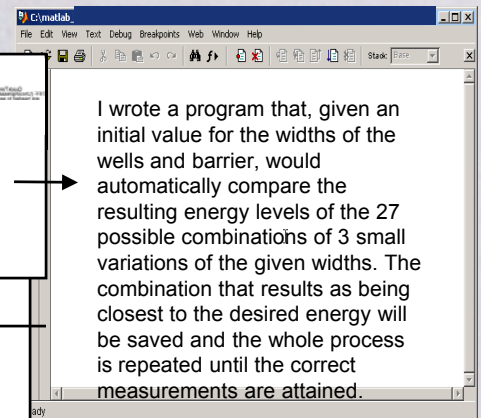
$$i\hbar \frac{\partial}{\partial t} \psi = -\frac{\hbar^2}{2m} \nabla^2 \psi + V(x, y, z) \psi$$

E(widths of wells)

$$DE_1 = e_1, DE_2 = e_2$$

$e_1, e_2 = \text{desired energy difference}$

Solve for widths



I managed to Successfully run t his program on a test function. Regrettably, however, due to lack of time I was not able to test it with the original program.

