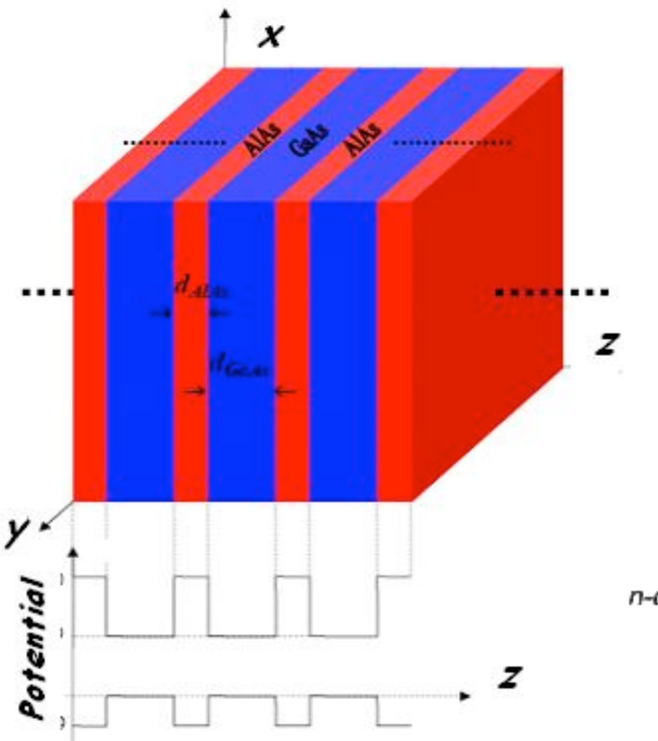
semiconductor junctions/superlattices



http://en.wikipedia.org/wiki/Superlattice

blue laser diode

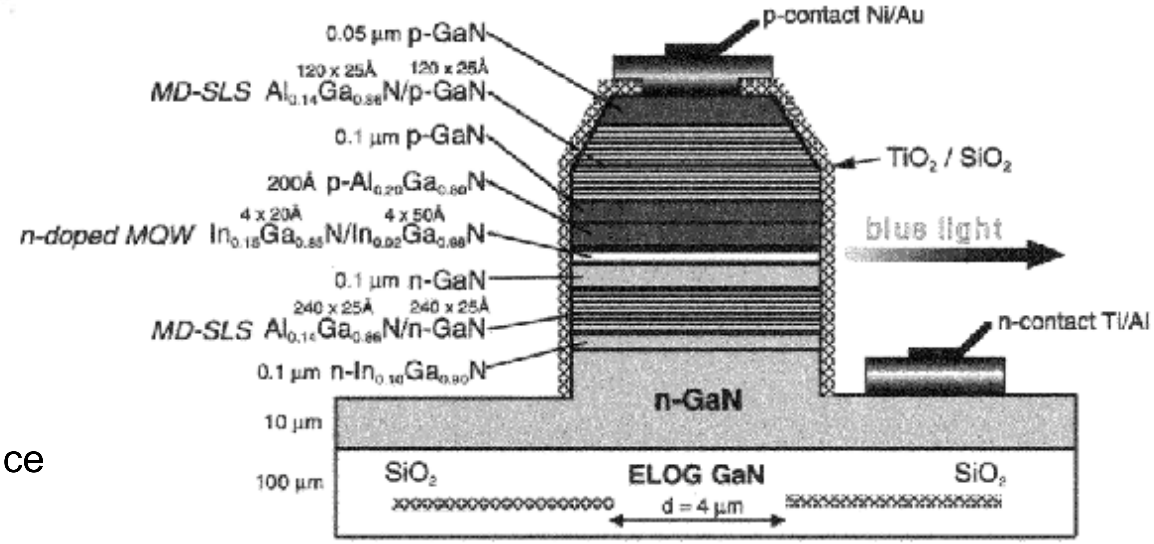
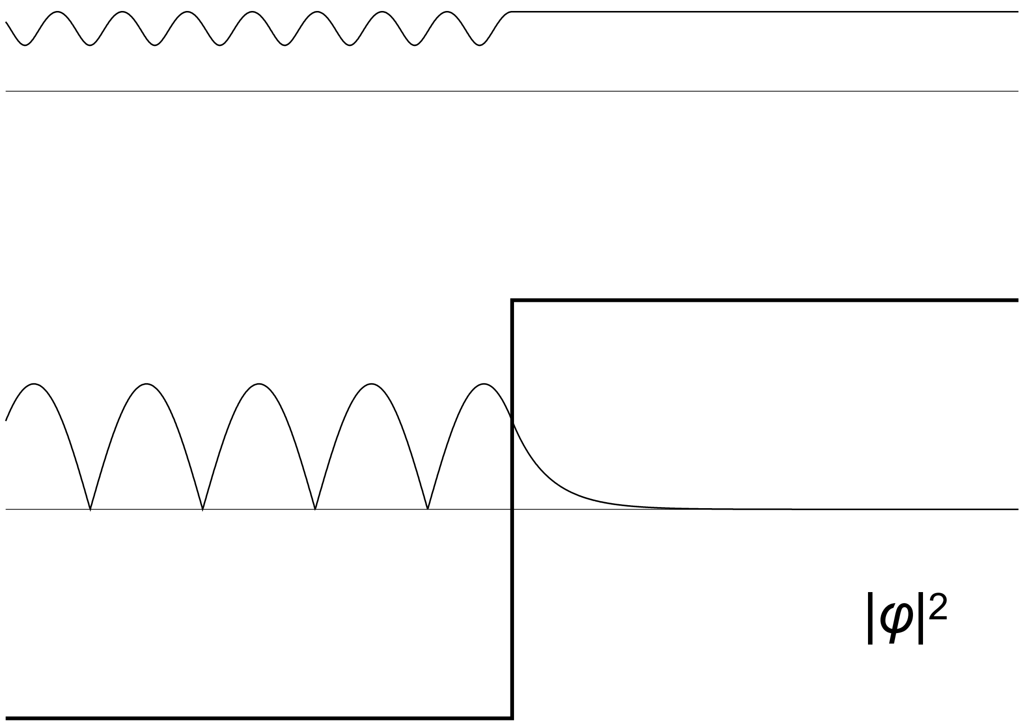


Figure 10: *A schematic illustration of a blue light emitting laser, where the active layer is a multilayer quantum well structure based on InGaN. AlGaN/GaN modulation-doped strained-layer superlattices (MD-SLSs) are used instead of bulk AlGaN cladding layers to confine the photons. The thicknesses of many of the 743 layers of the device have to be carefully controlled.*

http://www.nobelprize.org/nobel_prizes/physics/laureates/2000/advanced.html

potential step



$$\varphi_<(x) = e^{ikx} + re^{-ikx} \qquad \varphi_>(x) = te^{i\tilde{k}x} \qquad k_i = \sqrt{\frac{2m(E-V_i)}{\hbar^2}}$$

matching at x=0

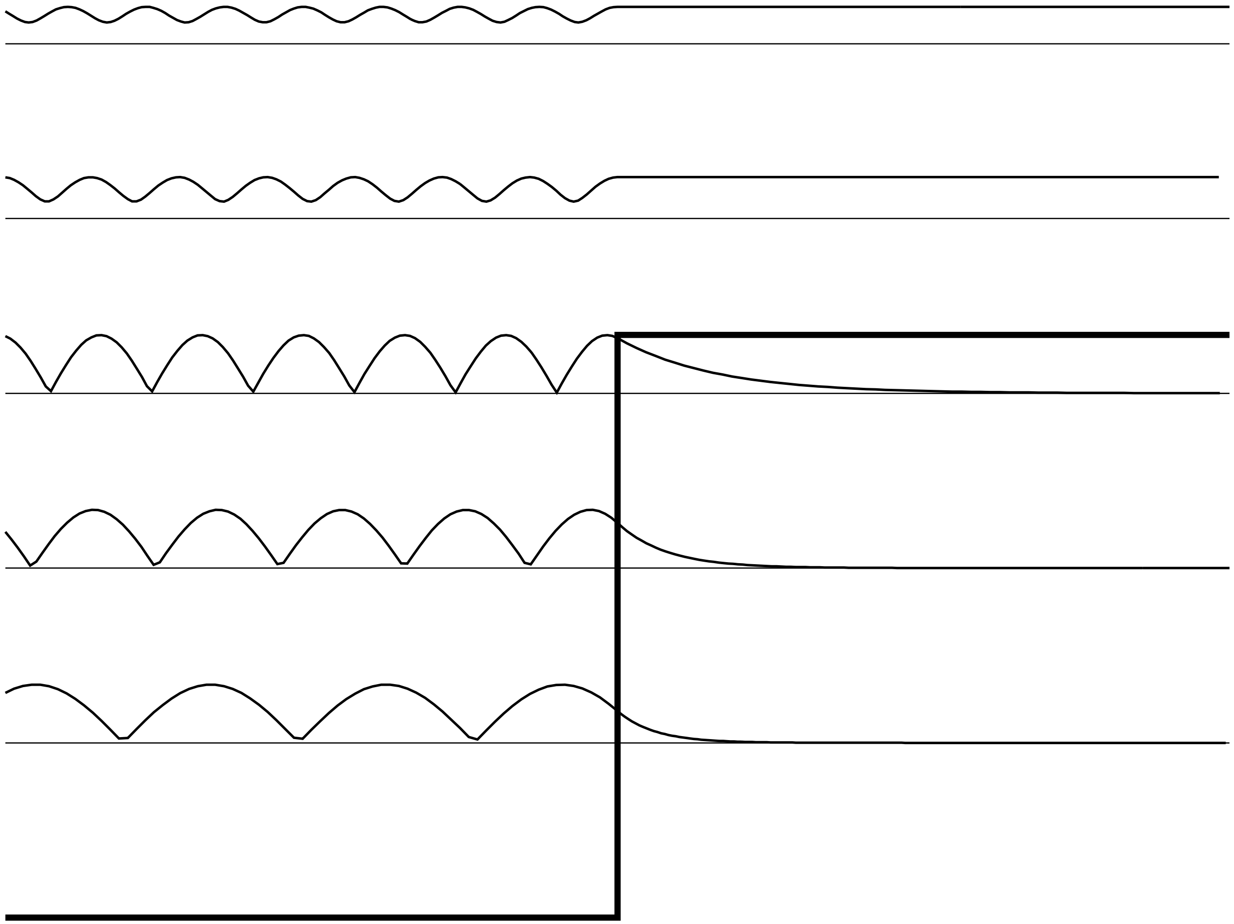
$$\begin{aligned} 1 + r &= t \\ ik(1-r) &= i\tilde{k}t \end{aligned}$$

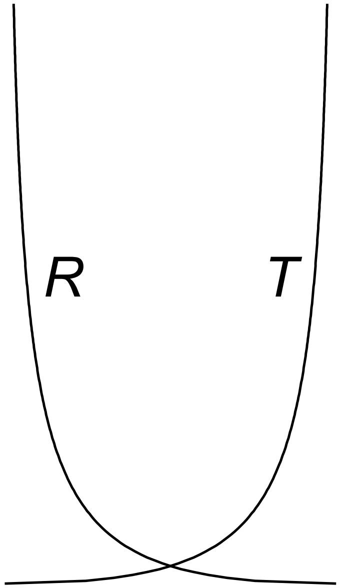
$$\begin{aligned} t &= \frac{2k}{k+\tilde{k}} \\ r &= \frac{k-\tilde{k}}{k+\tilde{k}} \end{aligned}$$

reflection and transmission

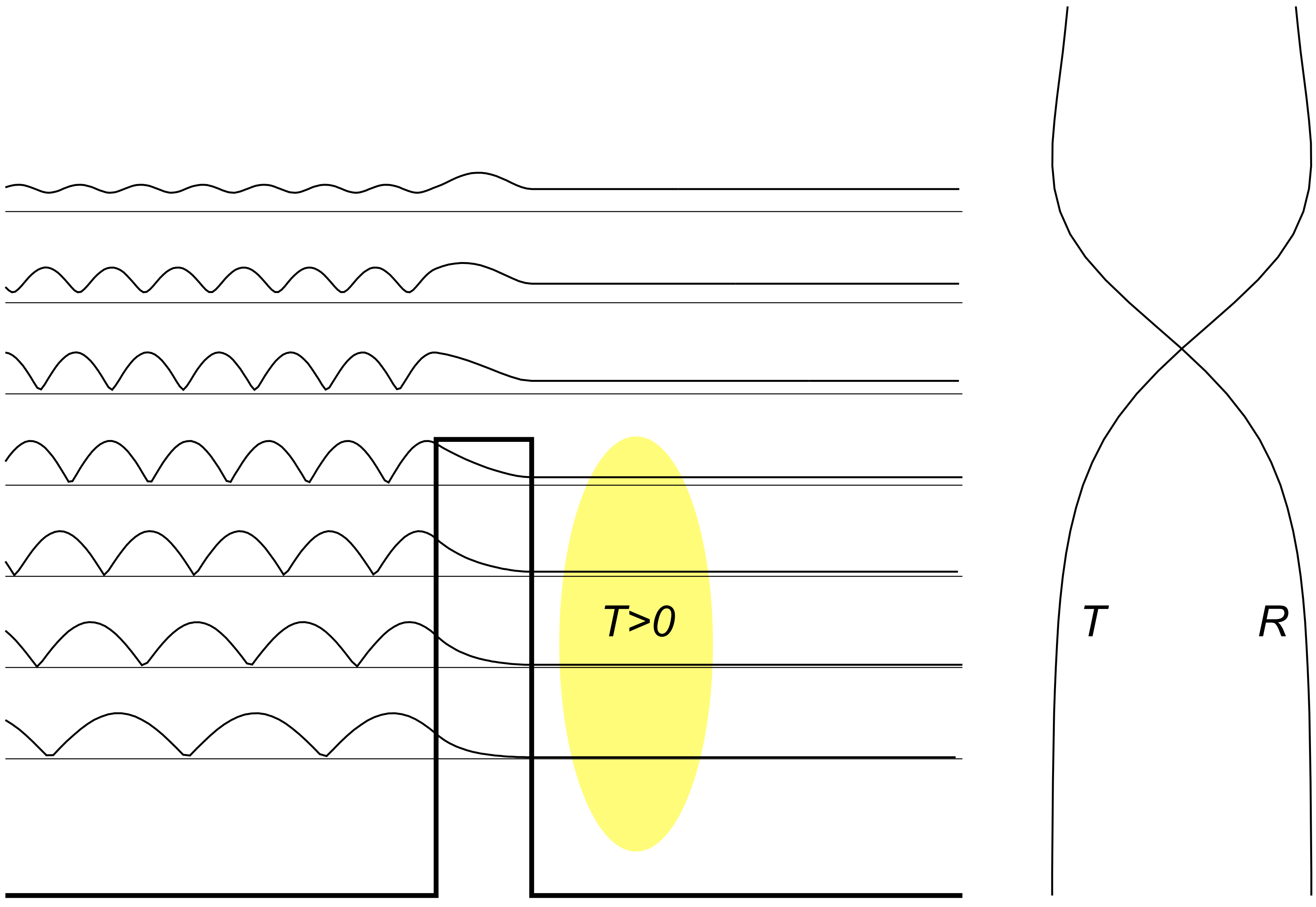
$$R = \left| \frac{k - \tilde{k}}{k + \tilde{k}} \right|^2$$

$$T = \frac{4k\tilde{k}}{(k+\tilde{k})^2} \text{ for } E > V_0, \text{ otherwise } = 0$$

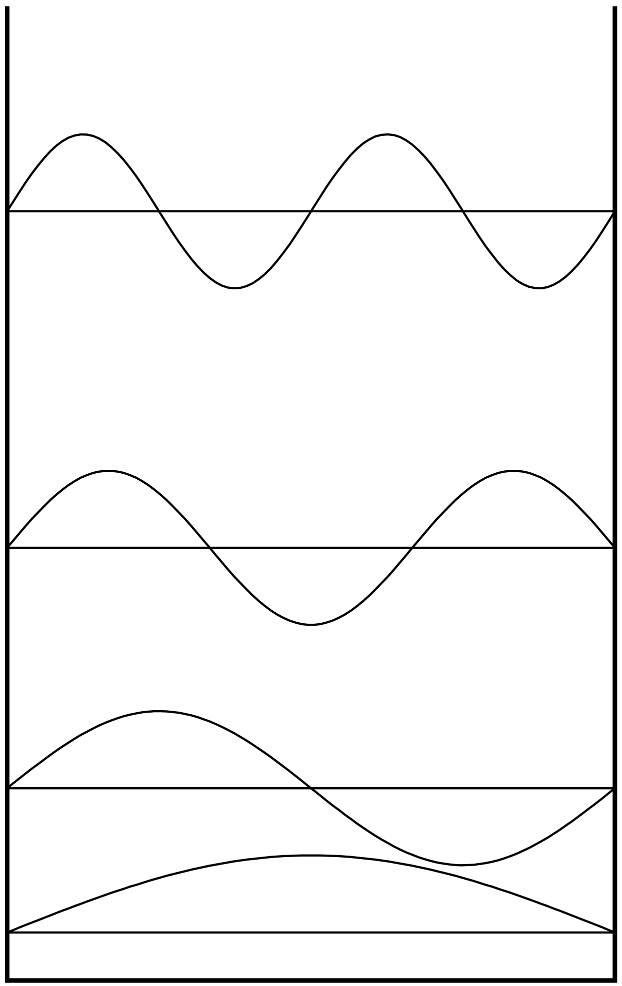




tunneling



particle in a box



boundary conditions ⇒ **quantization**

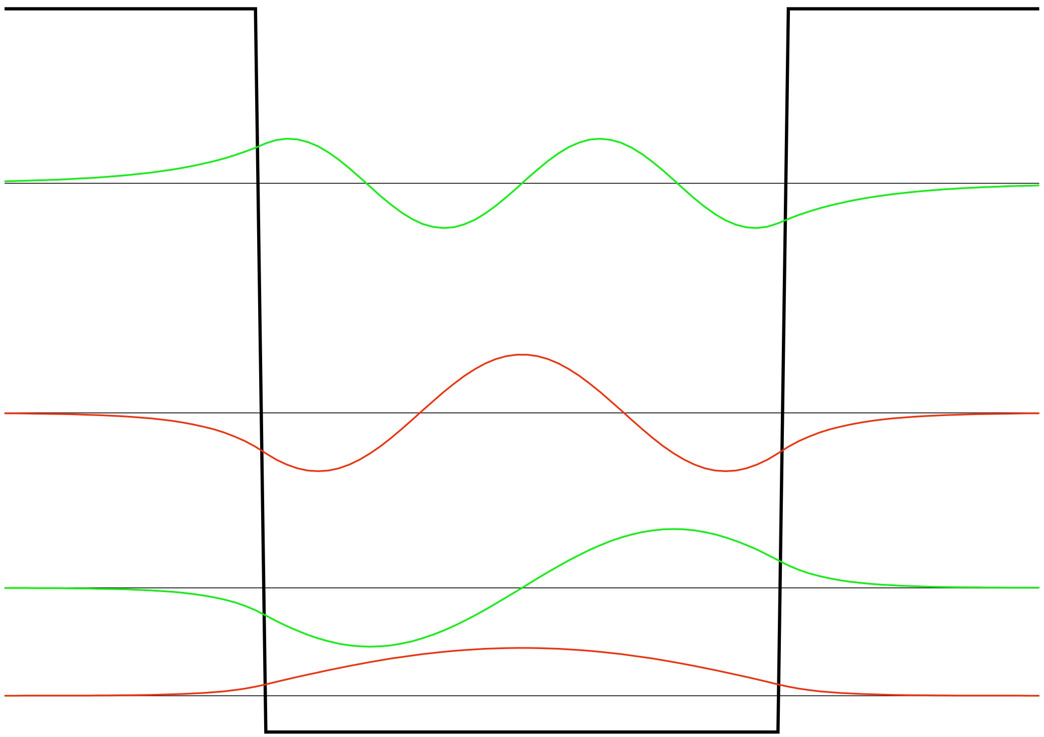
$$E_n = \frac{\hbar^2}{2m}\left(\frac{n\pi}{L}\right)^2$$

$$\varphi_n(x) = \sqrt{\frac{2}{L}}\sin\left(\frac{n\pi\, x}{L}\right)$$

discrete energies
zero-point energy
increasing number of nodes

symmetry of potential
symmetry of solutions (density)
even/odd eigenfunctions

finite potential well



$B\,e^{+\kappa x}$ $\quad A\cos\,kx \quad +B\,e^{-\kappa x}$

$B\,e^{+\kappa x}$ $\quad A\sin\,kx \quad -B\,e^{-\kappa x}$

matching

$$\begin{aligned} A\cos\,kL/2 &= Be^{-\kappa L/2} \\ -kA\sin\,kL/2 &= -\kappa Be^{-\kappa L/2} \end{aligned}$$

$$\begin{aligned} A\sin\,kL/2 &= -Be^{-\kappa L/2} \\ kA\cos\,kL/2 &= \kappa Be^{-\kappa L/2} \end{aligned}$$

matching without poles!