Hetero-junction laser diode

Insert thin region (0.1 \(\mu m\)) of pGaAs between nGaAs and pAlGaAs:

- current confined to thin pGaAs region
- pAlGaAs region has different index of refraction that can be used to help guide photons out of diode
Quantum wells

\[ V(z) = \begin{cases} 
0 & \text{if } 0 < z < L_z \\
\infty & \text{if } z < 0, z > L_z 
\end{cases} \]

\[ \psi(z) = A \sin(k_z z) \]

\[ E_n = \frac{n^2 \pi^2 \hbar^2}{2mL_z^2} \]

Density of states

New density of states (after some effort):

\[ \rho(E)dE = \frac{m}{\hbar^2 \pi L_z} dE \]
Narrower active region means:

- Laser gain can occur
- Total resistance/heat goes down
- Threshold current goes down
- But: total active volume goes down so laser power goes down

Ternary compounds, e.g. $Al_xGa_{1-x}As$  
$E_g$ ranges from 2.15 eV ($\lambda = 576\text{nm}$) for $x=1$ to 1.55 eV ($\lambda = 800\text{nm}$) for $x=0$