angular equation

$$\hat{L}^2 Y(\theta,\phi) = \hbar^2 l(l+1) Y(\theta,\phi) \Rightarrow Y_l^m(\theta,\phi) = \text{spherical harmonics}$$

$l = 0, 1, 2, \ldots$

$m = -l, -l+1, \ldots, l-1, l$

radial equation

$$\left[\frac{\hat{p}_r^2}{2M} + V(r) + \frac{\hbar^2 l(l+1)}{2Mr^2}\right] R(r) = E\,R(r)$$

change of variables: $R(r) = \frac{u(r)}{r}$

$$\left[\frac{\hbar^2}{2M}\underbrace{\left(\frac{1}{r}\frac{d}{dr}r\right)\left(\frac{1}{r}\frac{d}{dr}r\right)}_{\frac{1}{r}\frac{d^2}{dr^2}r}\frac{u}{r} + V(r)\frac{u}{r} + \frac{\hbar^2 l(l+1)}{2Mr^2}\frac{u}{r}\right] = E\frac{u}{r}$$

$$\Downarrow$$

$$\left[-\frac{\hbar^2}{2M}\frac{d^2}{dr^2} + V(r) + \underbrace{\frac{\hbar^2 l(l+1)}{2Mr^2}}_{\text{centrifugal barrier}}\right] u(r) = E\,u(r)$$

$V_{eff}(r)$