Modern Physics Cheat Sheet

10.1 Molecular Bonding and Spectra

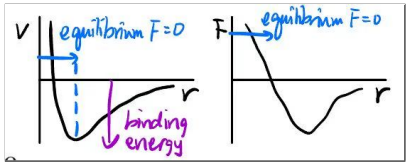
Potential of a molecule is

$$V = \frac{A}{r^n} - \frac{B}{r^m}$$

where $n > m$ and

$$F = -\frac{dV}{dr} = \frac{mB}{r^{m+1}} - \frac{nA}{r^{n+1}}$$

The **binding energy** is the energy to seperate two atoms.
The **equilibrium radius** is when $F = 0$.



Rotational States

By $E_{\text{rot}} = \frac{L^2}{2I}$ and $L = \sqrt{l(l+1)}\hbar$, we have quantized **rotational energy**

$$E_{\text{rot}} = \frac{\hbar^2 l(l+1)}{2I}$$

take note that

$$I = \int \rho r^2 dV = mr^2$$

Vibrational States

Vibrational kinetic energy is by QM Oscillator,

$$E_{\text{vibr}} = (n + \frac{1}{2})\hbar\omega$$

$$\omega = \sqrt{\kappa/\mu}$$

by $\kappa = \frac{dF}{dr}$,

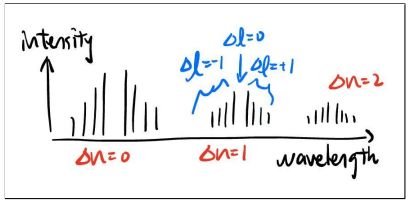
$$\omega = \sqrt{\frac{e^2}{2\pi\epsilon_0 \mu r^3}}$$

Vibration and Rotation Combined

Consider the energy of photon emitted due to excitation.

$$E_{\text{ph}} = E_{\text{rot}} + E_{\text{vibr}}$$

Recall selection rules $\Delta n = \mathbb{Z}, \Delta l = \pm 1$. Gives spectral pattern



The missing central peak has

$$f = \frac{1}{2\pi}\sqrt{\frac{\kappa}{\mu}}$$

a

b

c