Harmonic Oscillator

\[ F = -kx \]
\[ m \cdot \frac{d^2x}{dt^2} = -kx \]

The harmonic oscillator reasonably describes the motion of two atoms in a bond.

\[ \psi(x) = e^{ix} \]
\[ \psi(x) = A \cos \omega t + \sin \omega t \]
\[ \psi(x) = \sin \omega x \]

Since energy at the atomic level is quantized (only comes in discreet packets), there are only specific vibrational energy levels available to a bond.

Modes of vibration

- Scissoring
- Symmetric Stretch
- Asymmetric Stretch

Rotational Energy Levels

Rotational motion is also quantized. H + Cl C & the atomic level, so only specific rotational energy levels can exist for a system.
\[ \text{Excitonic} \quad E \quad \rightarrow \quad E' \quad \text{vibrational states match} \]

Fluorescence → ISC - inter-system crossing - a spin-forbidden transition enabled due to vibrational states.

\[ \text{Chemiluminescence} - \quad \text{A phenomenon caused by a chemical reaction that in which the reaction itself causes the formation of an excited state intermediate that then can decay relax to the ground state radiatively (by releasing light).} \]
The diagram shows a chemical reaction involving the conversion of a compound labeled 'DMSO' to another compound labeled '1ummol'. The reaction is catalyzed by oxygen ('O₂') and involves a step marked by the letter 'δ'.