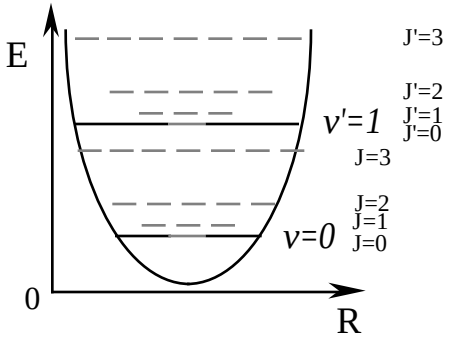
Vibration- Rotation Spectroscopy



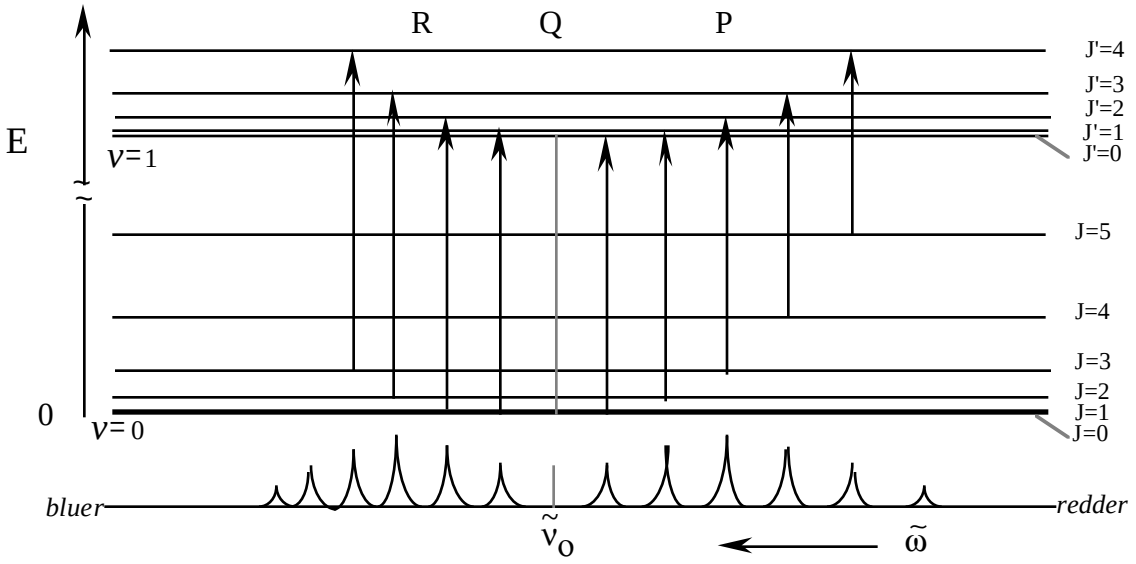
$E_\upsilon = h\nu_o \left(\upsilon + {}^1/_2 \right)$

$E_J = \tilde{B} hc\, J(J+1)$

$g_J = 2J+1$

$\upsilon', J' \leftarrow \upsilon, J$

upper <– lower



$\tilde{\nu}_o$ $\tilde{\omega}$

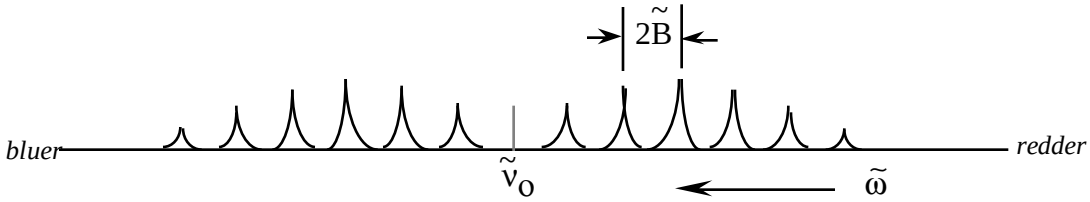
$\Delta E_{\upsilon',J' \leftarrow \upsilon,J} = E_{\upsilon',J'} - E_{\upsilon,J} = h\nu_o \left(\upsilon' - \upsilon \right) + \tilde{B}' hc\, J'(J'+1) - \tilde{B} hc\, J(J+1)$

$\Delta J = J' - J = +1$	R branch (higher energy, bluer)
$\Delta J = J' - J = -1$	P branch (lower energy, redder)
$\Delta J = J' - J = 0$	Q branch (not allowed in diatomics, specific selection rule)
$\Delta \upsilon = 1$	for harmonic potential

if $\tilde{B}' = \tilde{B}$ then $\Delta E_{\upsilon',J' \leftarrow \upsilon,J} = h\nu_o \pm 2\tilde{B} hc\, J$ for J = lower level

and the spacing between adjacent lines is

$\Delta E_{\upsilon',J' \leftarrow \upsilon,J+1} - \Delta E_{\upsilon',J' \leftarrow \upsilon,J} = 2\tilde{B} hc\,(J+1) - 2\tilde{B} hc\, J = 2\tilde{B} hc$



$\tilde{\nu}_o$ $\tilde{\omega}$