

April 6, 2005

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➤ Think about:

Monday or Tuesday Review Session for Exam #3

➤ **Problem Set #4 Solutions** - coming soon!

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# Spectroscopy:

## Raman Spectroscopy

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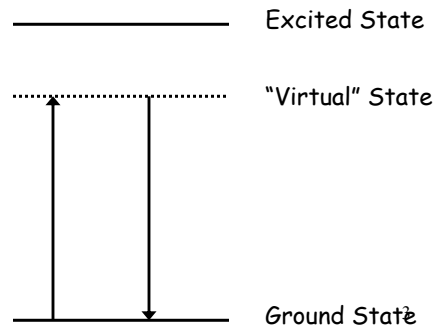
Chem 221  
**Instrumental Analysis**  
Spring 2005

# Raman Scattering

- Discovered in 1928 by C.V. Raman (received Nobel Prize in 1930)

First, let's look at Elastic (Rayleigh) scattering (no change in energy of light):

EMR induces oscillating electric field in electron cloud around molecule - which is then re-emitted as a photon



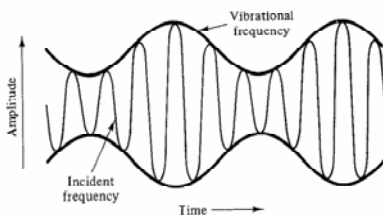
# Inelastic Scattering

- If there is a *vibration* which results in a **change in the net polarizability** of the electron cloud:

Scattered photon will be at an energy either greater than or lower than the original energy by an amount equal to the energy of the vibration:

## *Inelastic Scattering*

(Only about 1 molecule in  $10^8 - 10^9$  will inelastically scatter photons)

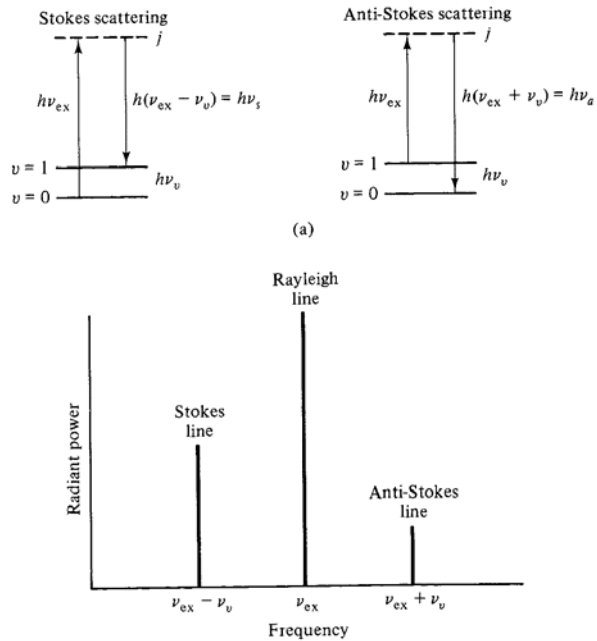


# Quantum View

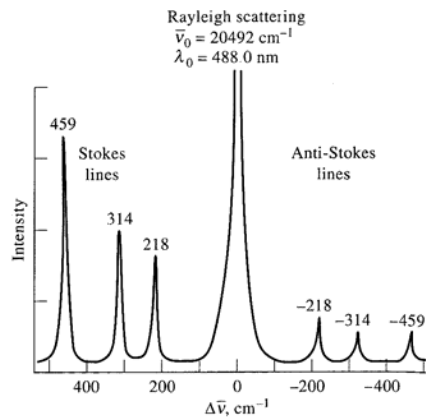
**Stokes Lines:**  
longer wavelength  
(more intense)

**Anti-Stokes Lines:**  
shorter wavelength

$$\Delta\nu = \nu_{\text{Raman}}$$



# Sample Spectrum: CCl4

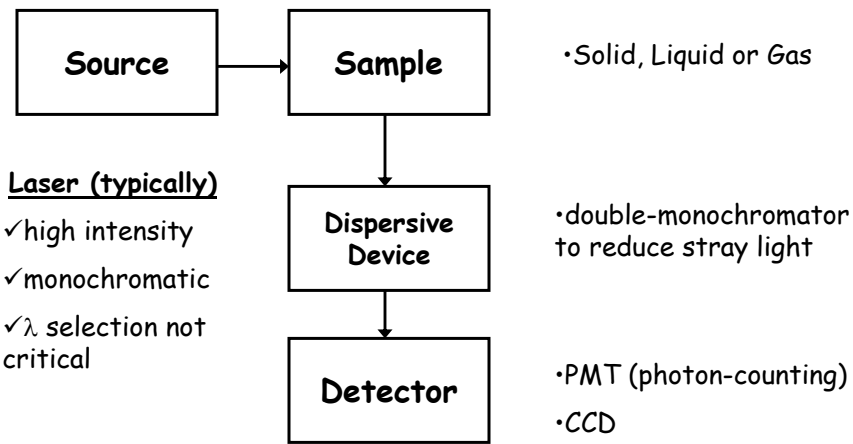


# Factors Affecting Raman Scatter Intensity

- **Concentration**
  - directly proportional
- **Source Intensity**
  - directly proportional
- **Source Wavelength**
  - $1/\lambda^4$  dependence

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# Instrumentation



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# Resolution?

Not straightforward - varies with source wavelength . . . why?

- $\Delta\lambda_{\text{eff}}$  is  $\lambda$ -independent, but  $\Delta\bar{\nu}_{\text{eff}}$  varies with  $\lambda$

For a 1-m monochromator, 1200 g/mm grating, and 100- $\mu\text{m}$  slits:  $\Delta\lambda_{\text{eff}} = 8 \text{ \AA}/\text{mm} \times 0.100 \text{ mm} = 0.8 \text{ \AA}$

So:

$$\lambda_{\text{source}} = 300 \text{ nm}; \text{ gives } \Delta\bar{\nu} = 8.9 \text{ cm}^{-1}$$

$$\lambda_{\text{source}} = 500 \text{ nm}; \text{ gives } \Delta\bar{\nu} = 3.2 \text{ cm}^{-1}$$