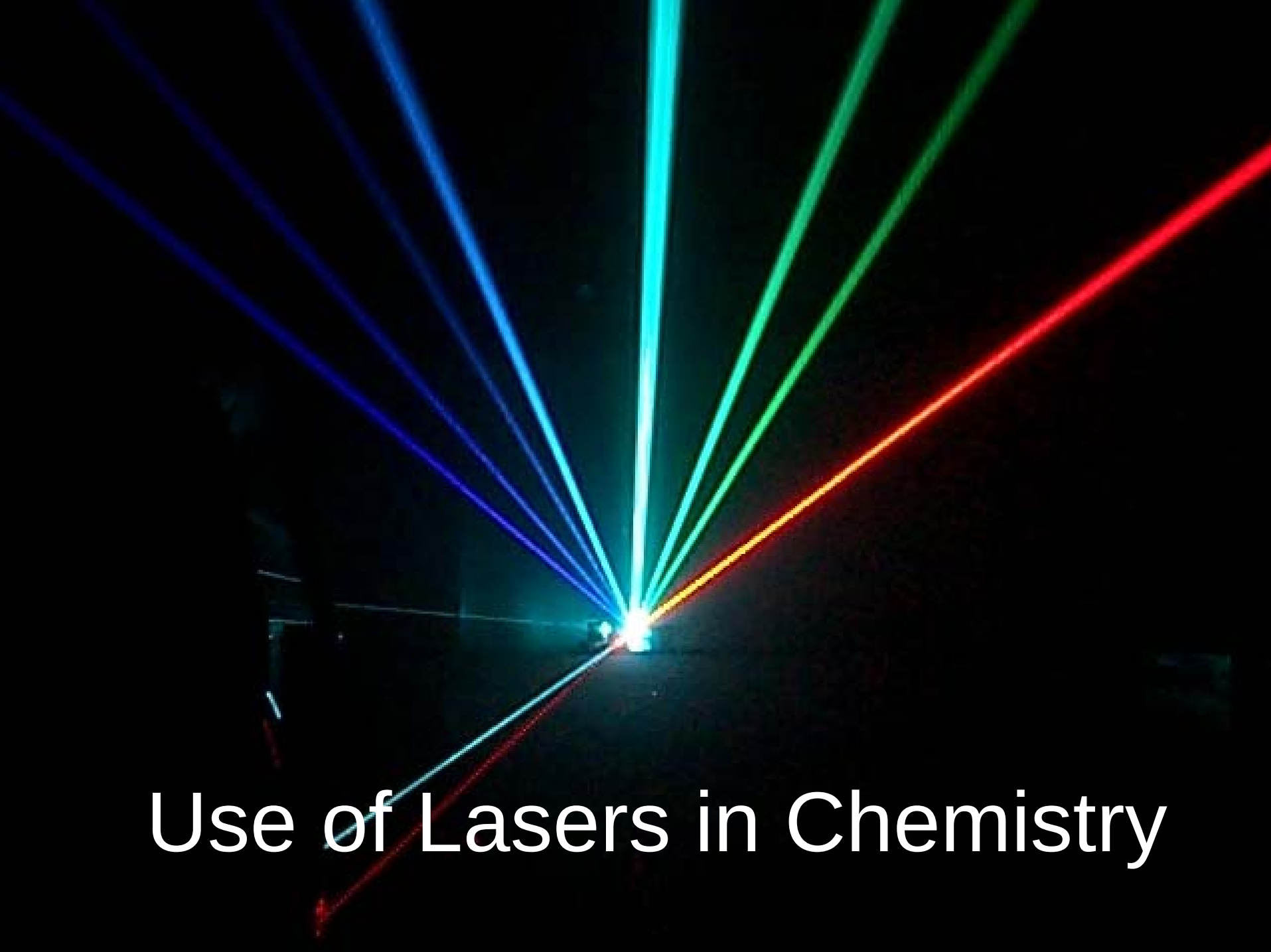
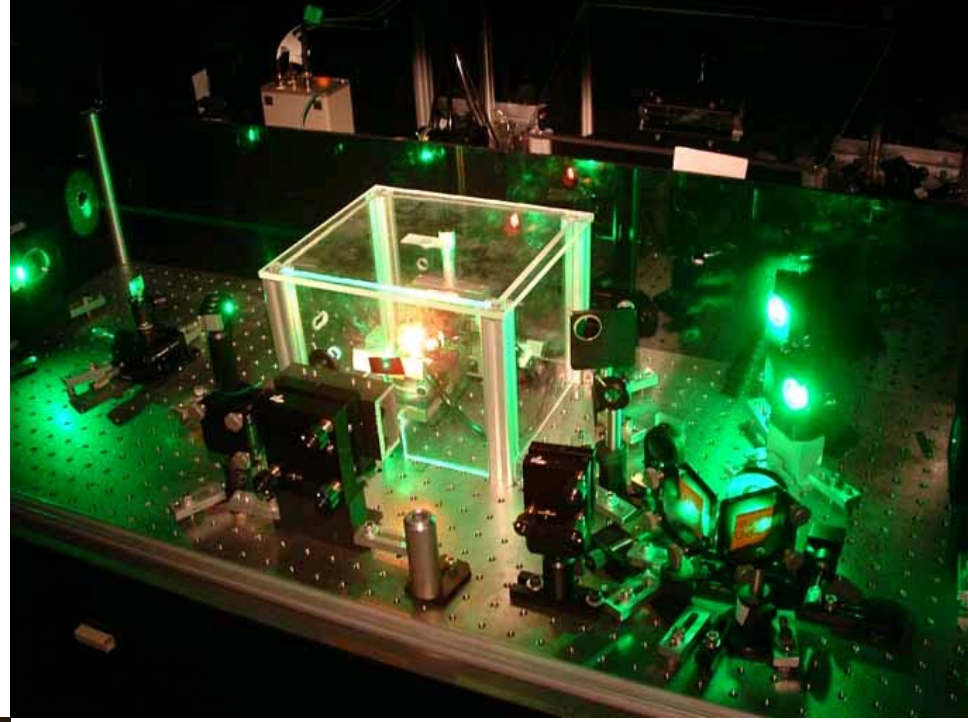


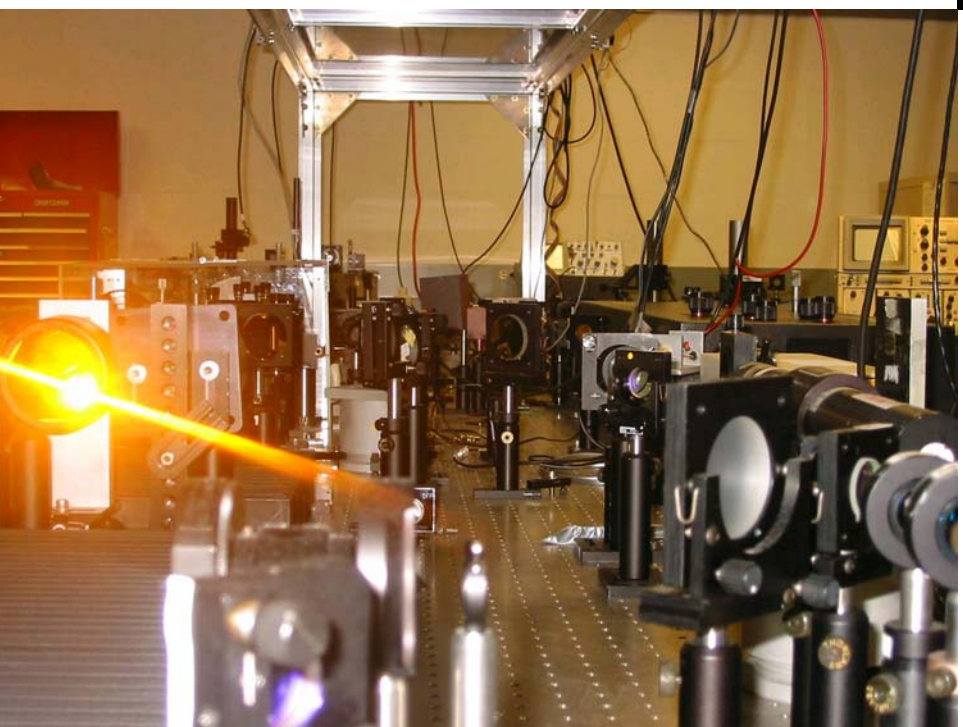
Use of Lasers in Chemistry

Spectroscopy

Examining the structure of matter

- IR
- Raman
- Ultrafast (Time Resolved)
- More…

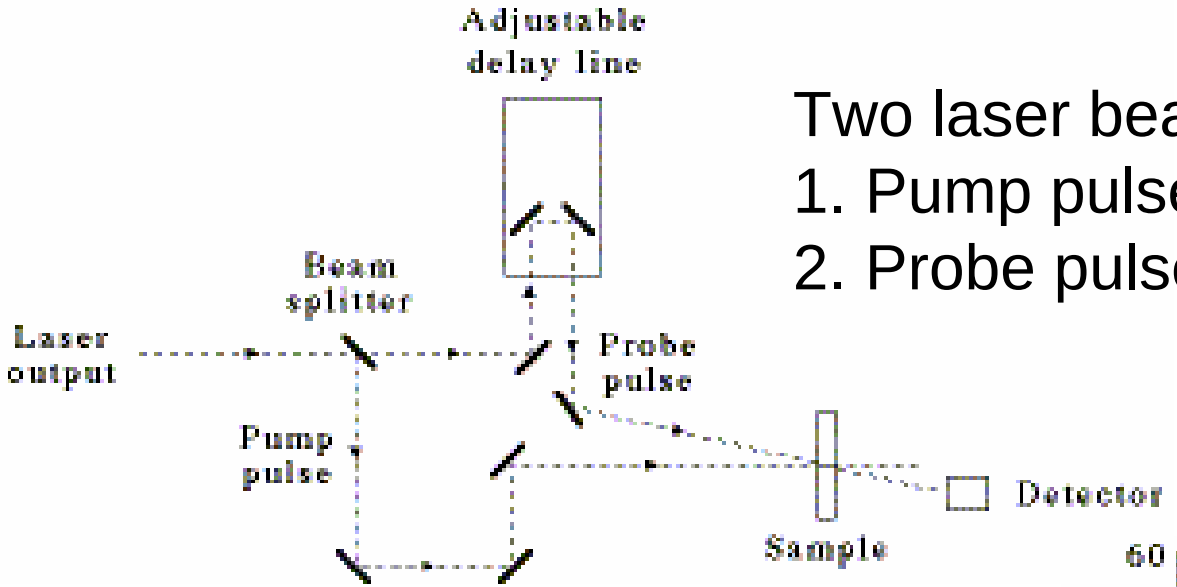




Photochemistry

Study of the dynamics of chemical reactions initiated by the absorption of light

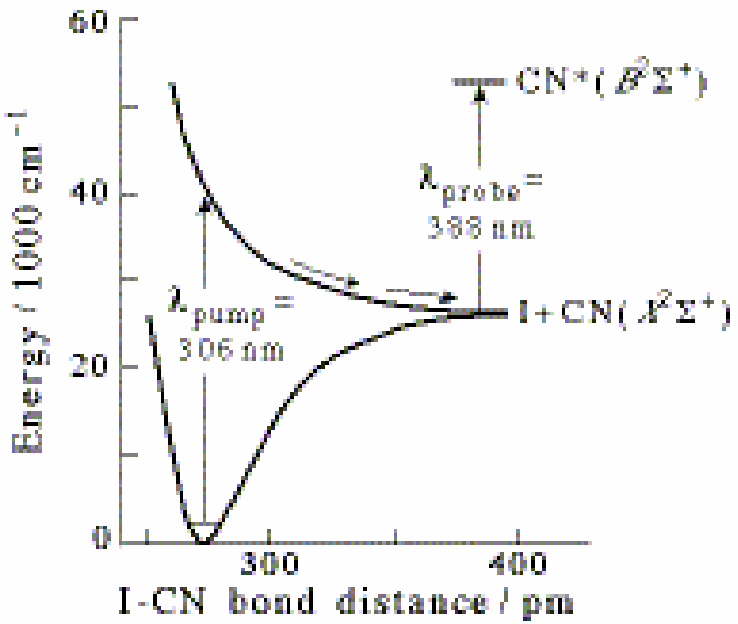
Time-Resolved Spectroscopy



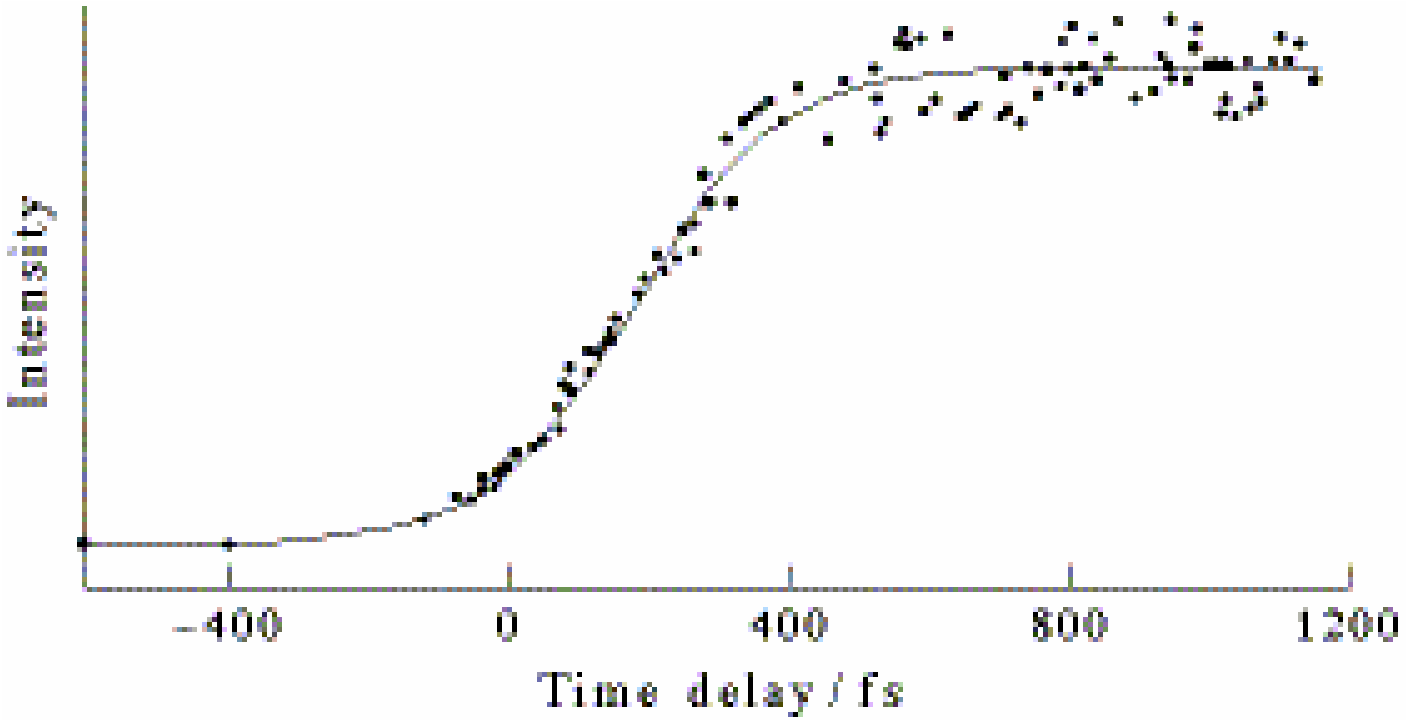
Two laser beams:

1. Pump pulse – Initiates Reaction
2. Probe pulse – Records Changes

$ICN_{(g)} + h\nu \rightarrow I_{(g)} + CN_{(g)}$

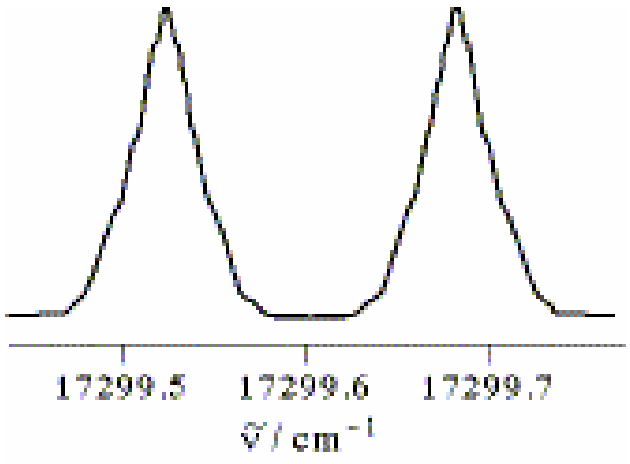


Results…

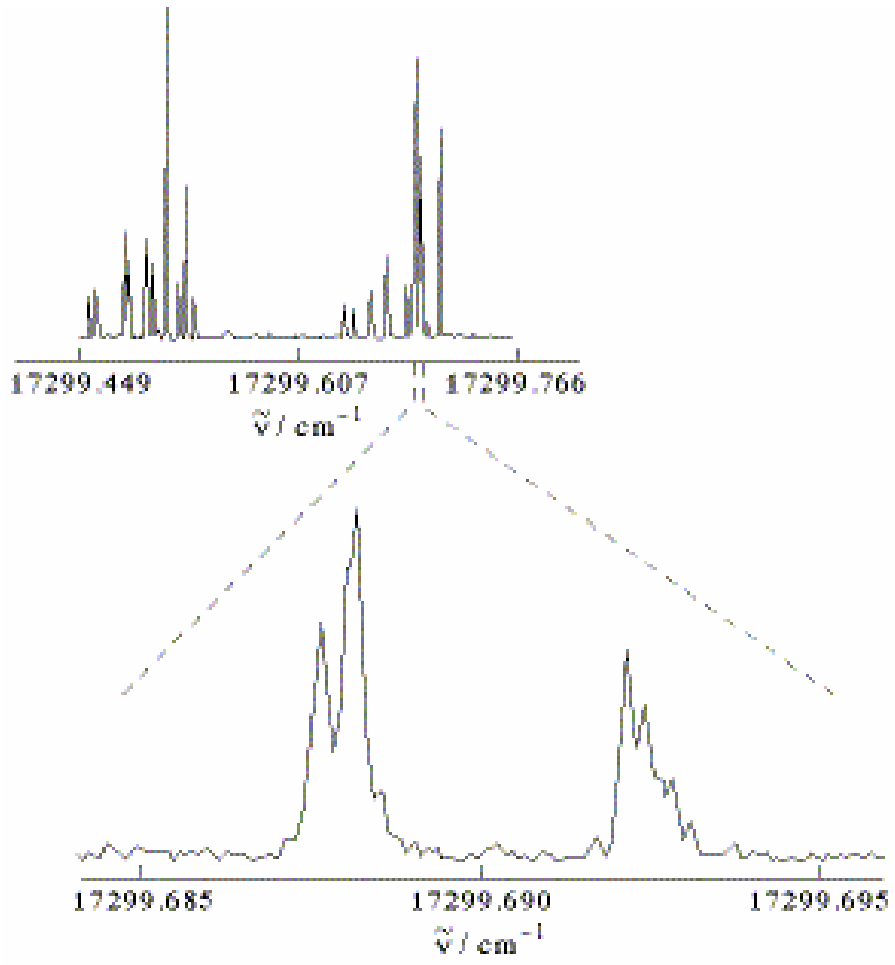


- The intensity increases as the concentration of CN radicals increases.
- No additional CN is formed after ~600 fs.
- Solid line has form 1-exp(-t/τ); τ is the reaction half-life.
- For this reaction, t = 205 ± 30 fs.

High Resolution Spectroscopy



Lamp based Spectrometer



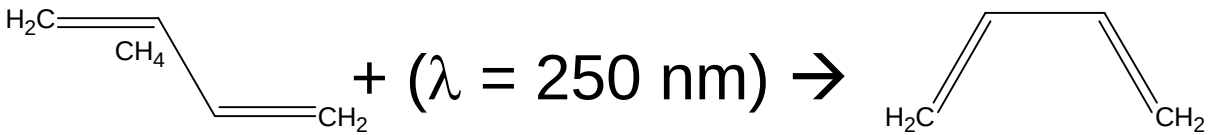
Laser based Spectrometer

Why would the laser spectrometer have higher resolution?

Types of Photochemical Reactions

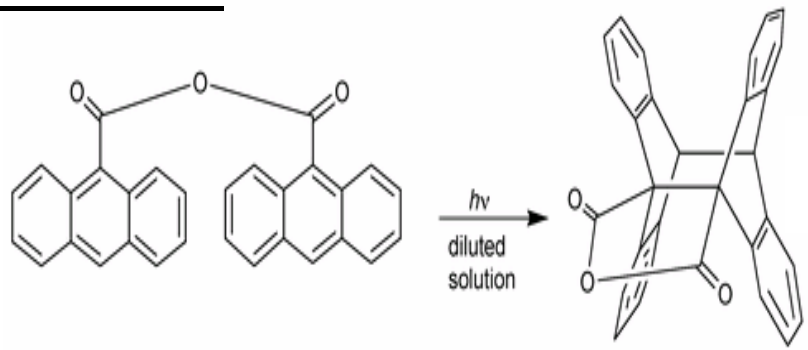
a. Photodissociation: $O_3 + (\lambda = 300\ nm) \rightarrow O_2 + O$

b. Photoisomerization:



(*trans*-butadiene + (λ = 250 nm) → *cis*-butadiene)

c. Photodimerization:



Quantum Yield

$$\Phi = \frac{\text{Number of molecules that undergo reaction}}{\text{Number of photons absorbed}}$$

Upon absorption of 313 nm light, acetone photodissociates according to the chemical equation:

$$(CH_3)CO_{(g)} + (\lambda = 313\ nm) \rightarrow C_2H_{6(g)} + CO_{(g)}$$

Exposure of a gaseous sample of acetone to a radiant power of 1.71×10^{-2} W (recall: 1W = 1J/s) at 313 nm for a period of 1.15×10^{4} s results in the photodissociation of 8.68×10^{-5} mol of acetone. Determine the quantum yield for this photodissociation (assume 100% absorption of light).

A: 0.17