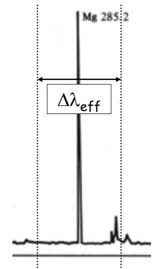
March 2, 2005

- **Reminder:** **Exam #2, 2 weeks from today ☺**

Resolution versus *Light Throughput*



Case I:

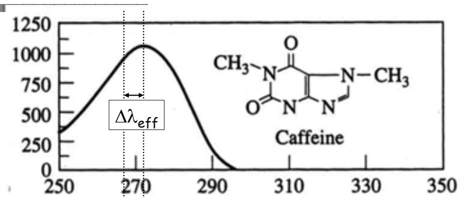
$\Delta\lambda_{\mathbf{eff}}$ >> *actual* linewidth

-slitwidth limited resolution

-common with *atomic* spectra

-*decreasing* $\Delta\lambda_{eff}$ will ***increase*** **L/B** (!)

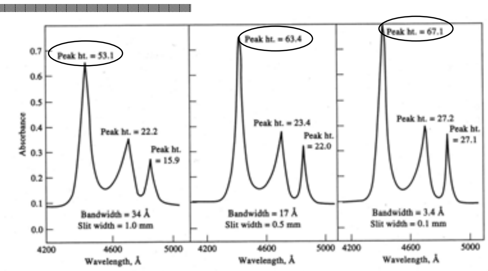
Resolution versus *Light Throughput:* **II**



Case II: $\Delta\lambda_{\mathbf{eff}}$ < *actual* bandwidth

-common with *molecular* spectra
-decreasing slitwidth, improves resolution, but *decreases* light throughput

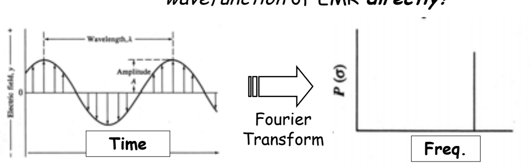
Effect of Slitwidth on *Absorbance*



Non-Dispersive Methods

- **Fourier-Transform Interferometry**

What if we could measure the *oscillating wavefunction* of EMR ***directly?***



Time Domain **Frequency Domain**

Direct Measurement: Feasible?

- Suppose we had EMR with λ = **10 μm**

Freq = $\nu = c/\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{10 \times 10^{-6} \text{ m}}$

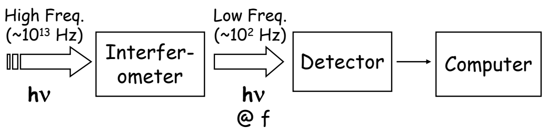
ν = ***3 x 10¹³ Hz***

That's 1 cycle every 33 x 10^{-15} secs (33 *femto*seconds!)

Upshot: we *can't* measure the oscillating EMR field *directly* for ***optical*** radiation

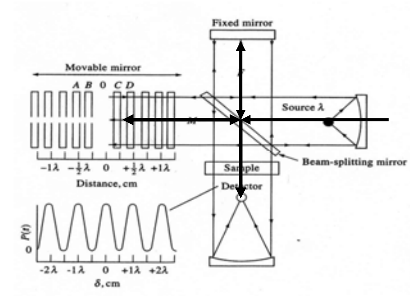
Enter Interferometry

- We need a signal that is *much* slower, so that it can be measured . . . How?



Michelson Interferometer

- EMR enters and hits *beamsplitter*
- Part goes to *fixed mirror*
- Part goes to *moveable mirror*
- Reflected beams recombine at *beamsplitter*

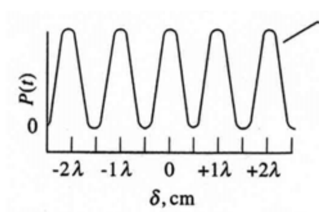


Resulting Interferogram

δ = *pathlength difference* (retardation)

$\delta = 2(M\text{-}F)$

<u>δ = **2x**</u> (mirror displacement)



So, we get *maxima* when $\delta = \mathbf{n}\lambda$ and *minima* when $\delta = \frac{1}{2}\mathbf{n}\lambda$ (recall that the actual mirror movement is $\frac{1}{2}\delta$)

Modulation Frequency

- *Moving Mirror* moves continuously at a <u>fixed velocity (V_M)</u>, so the signal at the detector will oscillate at a related <u>*frequency (f)*</u>:

$$f = 2V_M/\lambda$$

Or:

$$f = (2V_M/c)\nu$$

If V_M = 0.1 cm/sec, λ = 10 μm EMR will be modulated at: $f = 2(1.0 \times 10^{-3}\ \text{m/sec})/(10 \times 10^{-6}\ \text{m})$ = <u>***200 Hz***</u>