February 25, 2005

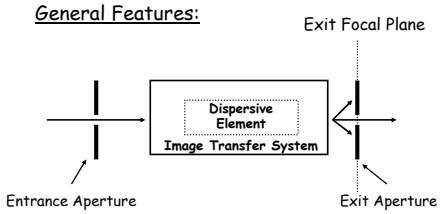
- Today's Office Hour: ***Cancelled*** ☹
  - See/email me to make an appointment

Wavelength Selectors

- Dispersive Devices

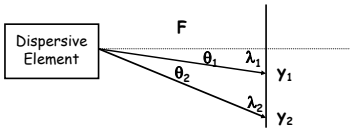
  -separates EMR into individual λ-components

General Features:



Dispersion (Terminology)

- How do we quantify the spatial separation of wavelengths on the exit focal plane?



Angular Dispersion: $D_a = d\theta/d\lambda$ (property of dispersive element)

Linear Dispersion: $D = dy/d\lambda$ (property of dispersive *device*)

More Dispersive Terminology

- If $d\theta$ is small, it can be shown that:

$$D = F \times D_a$$

- More commonly, we will use:

Reciprocal Linear Dispersion (D^{-1}) = 1/D

-example: typically around *0.1 - 20 Å/mm* in UV/Vis

Effective Bandwidth:

$$\Delta\lambda_{eff} = D^{-1} \times w$$

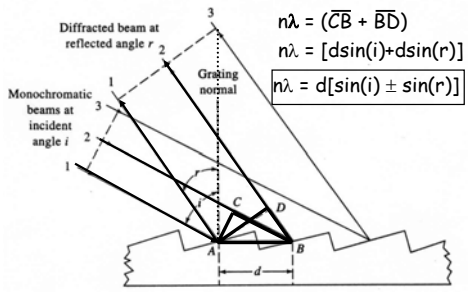
slitwidth

D^{-1} = 16 Å/mm
w = 100 μm
$\Delta\lambda_{eff}$ = 1.6 Å

Diffraction Gratings

- Typically, a series of closely spaced *facets* ruled onto a *reflecting surface*
  - Spacing of facets must be comparable to λ of EMR
  - Parallel EMR rays striking adjacent facets will travel different distances
  - *Constructive interference* occurs if the **difference** in the distance travelled by the two rays is an **integer multiple of λs**
  - *Constructive interference* will be a function of the ***angles*** (incident and reflection) and the ***wavelength***

Let's see how it works!



$n\lambda = (\overline{CB} + \overline{BD})$

$n\lambda = [d\sin(i) + d\sin(r)]$

$n\lambda = d[\sin(i) \pm \sin(r)]$

Spectral Order

$$n\lambda = d[\sin(i) \pm \sin(r)]$$

spectral order

For *fixed* values of ***i and r***, $n\lambda$ is constant.

Example: $n\lambda$ = 6000 Å

n:	1	2	3	4
λ:	6000	3000	2000	1500

Special Case:

$n\lambda$=0 (*zeroth order*)

ALL λs reflected!

Dispersion for a Grating

- For a fixed angle of *incidence (i):*

$$n d\lambda = d\cos(r) d(r)$$

So: $\dfrac{d(r)}{d\lambda} = \dfrac{n}{d\cos(r)}$

D_α

If the angle *r* is kept small (<5°):

$\dfrac{d(r)}{d\lambda} \approx \dfrac{n}{d}$ — **wavelength independent**

Spectral Resolution/Resolving Power

- We define *Resolution* (or *Resolving Power):*

$$R = \lambda_{avg}/\Delta\lambda$$

R is the resolving power needed to ***just resolve*** two spectral features: **Rayleigh Criterion**