Class 1-24: Spectrometers and gratings and light oh my

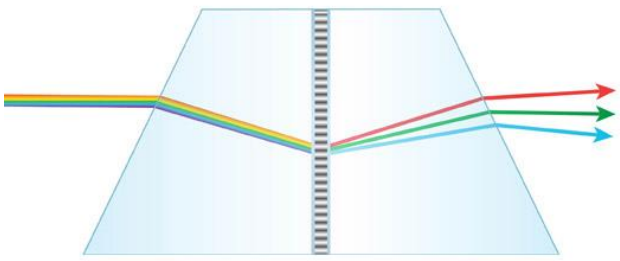
Any questions from the last class or things you've googled?

How do we separate light by its wavelength?

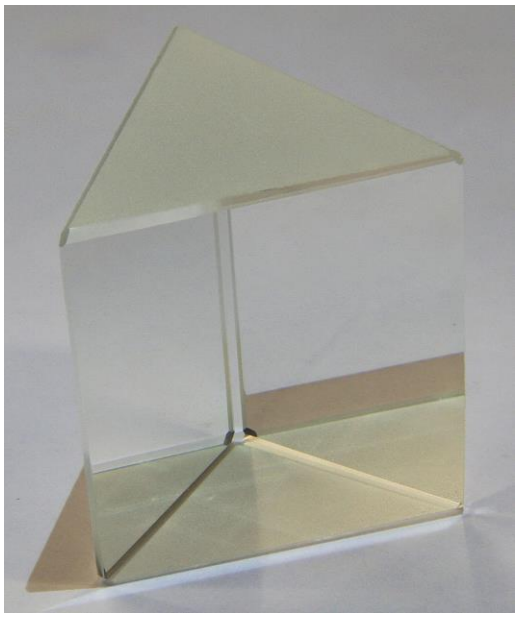
Dispersion!

Periodic Structures

The variation of the structure causes different wavelengths to destructively and constructively interfere



Material Properties



The different indices of refraction of the element causes different wavelengths to bend at different angles

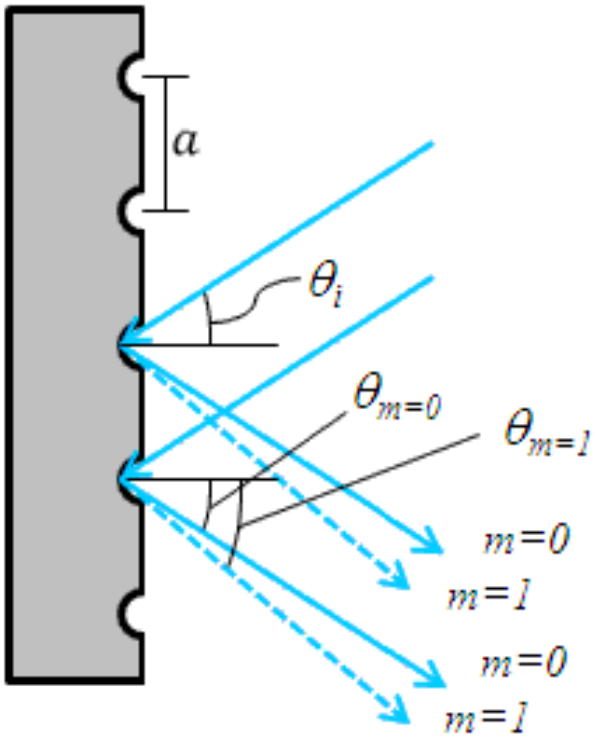
Wait…do lenses focus to the same spot if the index of refraction is different?

Gratings

- A periodically grooved surface causes light to diffract at different angles and into different orders

$$a(\sin(\theta_m) + \sin(\theta_i)) = m\lambda$$

a = groove separation
m = diffraction order
Θi = incident angle of light
Θm = angle of the reflection at order m



Prisms

- Shamelessly borrowed from Thorlabs' spectrometer kit documentation

$$n = \frac{\sin\left(\frac{\gamma + 60°}{2}\right)}{\sin 30°}$$

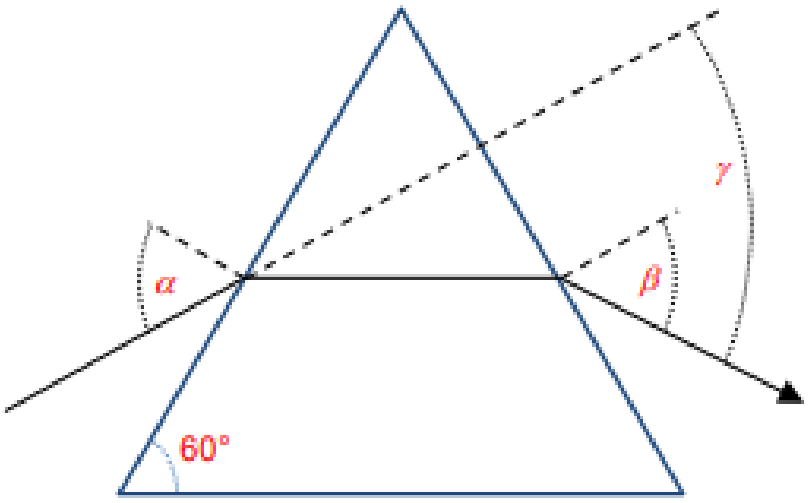


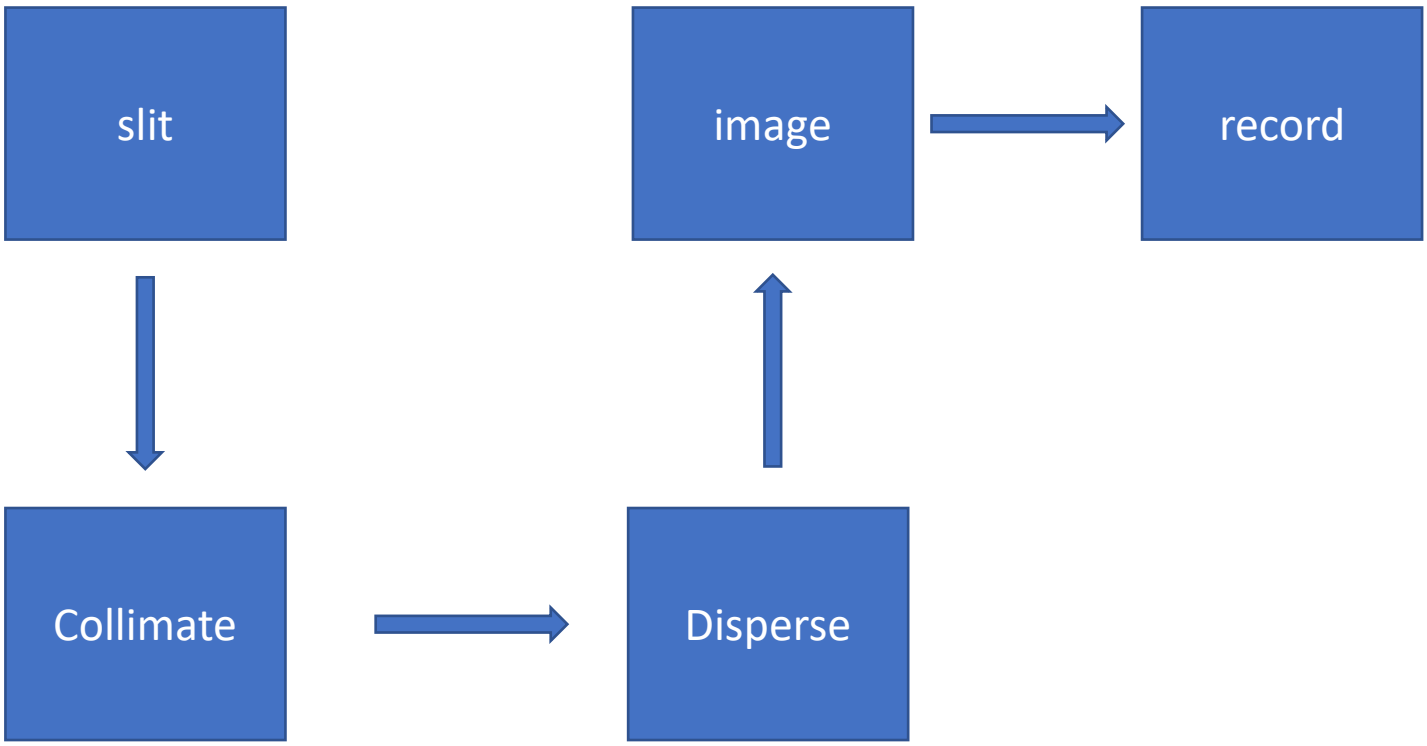
Figure 3: Angle of Minimum Deviation in an Equilateral Prism

Wait

By The cover art can be obtained from Harvest / Capitol., Fair use, https://en.wikipedia.org/w/index.php?curid=18421376

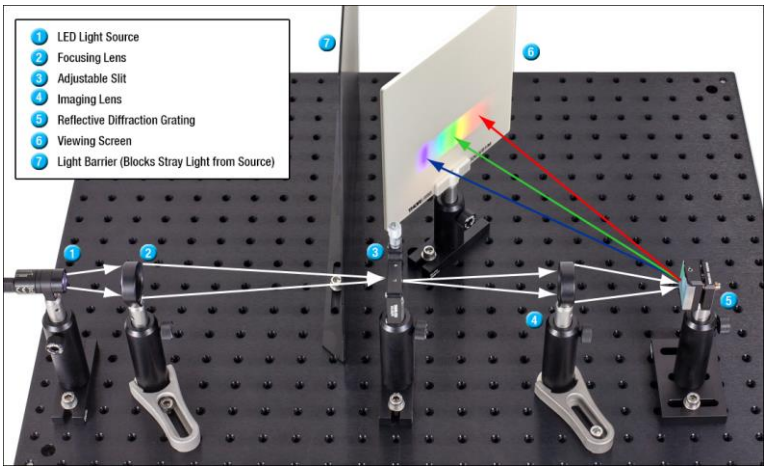
Basic idea of a spectrometer/monochromator

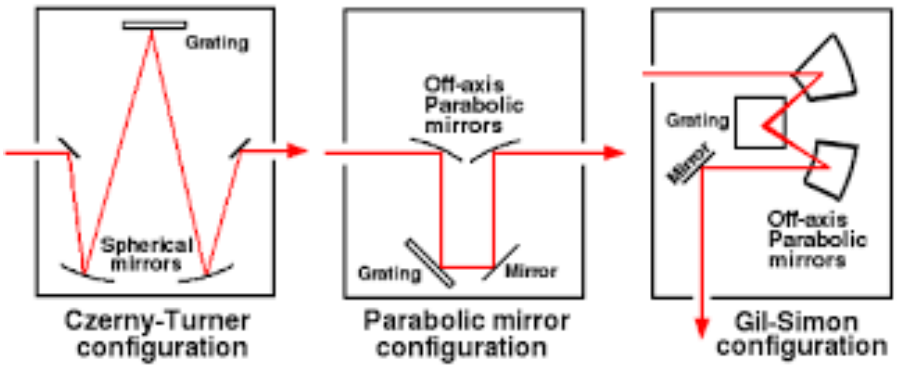
- The basic idea is that we image a thin line of light that has been spread out in frequency



Theres a couple common designs or ideas

- Use mirrors to image and/or collimate
- Use lenses to image and/or collimate
- Use a grating to disperse the light
- Use a prism to disperse the light
- Record one frequency with a photodiode (or photomultipler tube)
- Record multiple frequencies with a camera





Activity

- Go through monochromator I found in the trash
- Build a spectrometer/monchomator
  - We have lenses, gratings, Off axis parabolic mirrors, prisms, spherical mirrors etc

Activity

- If we have a nice uniform emitter that's expanded, and then clip the beam, in the far field smaller clipping apertures should have a larger spot and bigger apertures should have a smaller spot