Spectroscopy

What is a (power) spectrum? What can we learn?

from A. Gonzalez’s lectures & http://burro/astr.cwru.edu
Basic spectrograph layout

slit: defines spectrograph image profile, limits sky

collimator: converts diverging beam to parallel

grating/prism: dispersive element

camera: refocuses light to make image of the slit
Characterizing a spectrograph:

dispersion: by how much are different wavelength spread out (determined by dispersive element)

angstroms/mm, angstroms/pixel

resolution: how well can you measure wavelength differences? Determined by slit, camera, detector, and dispersive element

angstroms, relative to wavelength (R values)
Dispersive elements

prisms: limited by range of index of refraction

diffraction gratings: much more flexibility
\[ \frac{d\lambda}{dx} = \frac{Ld \cos \theta}{n} \]  

how can you affect resolution?
typical numbers:

gratings range from few hundred to 1200 lines/mm

typically observing in first order

( other orders blocked or off CCD)

blaze angles are usually low

resolutions are usually few to tens of Angstroms

useful range of an order $\sim \frac{\lambda(\text{blaze})}{n}$
Typical Efficiency Curves for Ruled Gratings
Optimized (Blaze) Wavelengths from 250-400 nm

- 300 grooves/mm @ 300 nm
- 600 grooves/mm @ 300 nm
- 600 grooves/mm @ 400 nm
- 1200 grooves/mm @ 250 nm
- 1200 grooves/mm @ 400 nm

Notes:
1) All curves are for Avg. polarization
2) All curves are for Aluminum (Al) coating
3) All gratings measured in Littrow mounting configuration

www.edmundsoptics.com
single wavelength source

slit

single wavelength source plus star

image

spatial

wavelength

spatial
single wavelength source

rotating galaxy with emission lines

slit

image

wavelength

spatial

spatial
multiple objects

slit

spatial

image

wavelength
planetary nebula spectrum

http://www.chara.gsu.edu/~cantrell/ml46.htm
3600-4800 Angstroms

(not the same spectrum as previous slide)
Multiobject Spectrographs

(These don’t correspond, just done for example)
hectospec (at MMT)
High-resolution Spectroscopy

special Echelle gratings

high blaze angles, observe in very high order
typically cross disperse to get more coverage
an example of a cross-dispersed spectrograph

ESI at Keck