Problem Set 3

Prof. Beck–Observational Techniques

Due June 2

1 Problem 1

Doubly ionized oxygen has a strong and useful emission line at rest wavelength 5007 Å. You want to observe this line in an edge-on spiral galaxy that rotates with circular speed $360 km/sec$ and has rest velocity $450 km/sec$ with respect to the Sun.

a) Your first instrument is a normal-incidence grating, in first order. The grooves are spaced at $a = 2.0 \mu m$. At what angles (in degrees) will you see the extreme wavelengths of the [OIII] line from this galaxy ? At what angle should you blaze the grating for maximum efficiency?

b) You want the whole range of wavelengths from this galaxy to fall into 10 spectral resolution elements (FWHM). How many grating grooves need to be illuminated for this? What is the diameter of the beam that falls on the grating?

c) The light coming off the grating is collimated. You need to put a lens in the beam to focus the light onto the detector. Your detector is a CCD with pixels $10 \mu m$ in size, and you want the galaxy spectrum to cover 40 pixels. What focal length f does the lens need?

d) The second instrument you try is a scanning Fabry-Perot or etalon. At this wavelength, a good FP can have Q (finesse) of 30. To get the same spectral resolution (FWHM) as you got from the grating, in what order do you use the FP?

e How much do you have to change the spacing between the mirrors to get the same wavelength range? (Assume they are in vacuum).

2 Problem 2

What distance must the mirror in a Michelson Interferometer be driven in order to separate emission lines at 12.23μm and 12.28μm? (Real lines, in case you are wondering: the first is $Hu\alpha$ of HI and the second is $S(2)$ of H_2). What distance to separate the two NII lines at $\lambda\lambda 6584 \mathring{A}, 6548 \mathring{A}$?