Section 5 - Exercise #1 and 7

McLean seminar
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Section 5 – Exercise #1

1.1 Describe a basic photoelectric photometer.

➔ An instrument for measuring the brightness of a star by means of the electric current produced when its light falls on a light-sensitive surface (the photoelectric effect).

1.2 What precautions would you take to ensure that the signal remained constant even if the star drifted off-center in the aperture?

➔ Using photoelectric photometer with Fabry lens.
This prevents movement of the illuminated image on detector which might occur due to drifting of the star image across the diaphragm due to poor tracking.
(Refer: section 5.1.1 and figure 5.1)

Section 5 – Exercise #1

1.3 How would your design change if this were an “imaging” system?

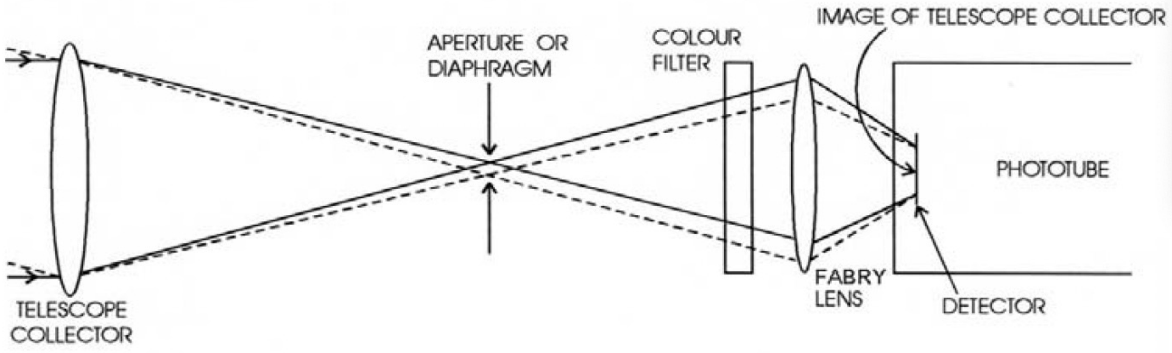

Figure 5.1. The basic layout of a photometer. Note that the image of the star is not focused onto the detector. By imaging the telescope’s collecting aperture on the detector the signal strength is independent of the position of the star within the diaphragm.

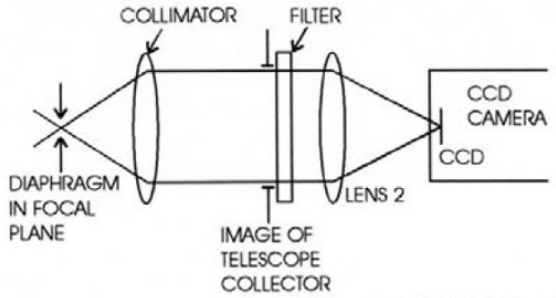

Figure 5.2. The basic layout of a camera system in which optics are used to collimate the diverging beam from the telescope focus and re-image the field at a different magnification. Filters can be placed in the collimated beam.

1.4 How would you extract a measurement of the magnitude of the star in this case?

➔ An annulus around the summed region is used to construct an estimate of the sky flux contained in the summed aperture. Thus, no separate measurement of the sky is required. Because the star image is spread over many pixels, and as different pixels are used for the sky image, it is essential to have a good procedure to normalize al the pixels to the same sensitivity or gain.

Section 5 – Exercise #7

7-1. Describe the design of a Fabry-Perot interferometer.
-> The Fabry-Perot interferometer is an imaging spectrometer which is formed by placing a device called an "etalon" in the collimated beam of a typical camera system.

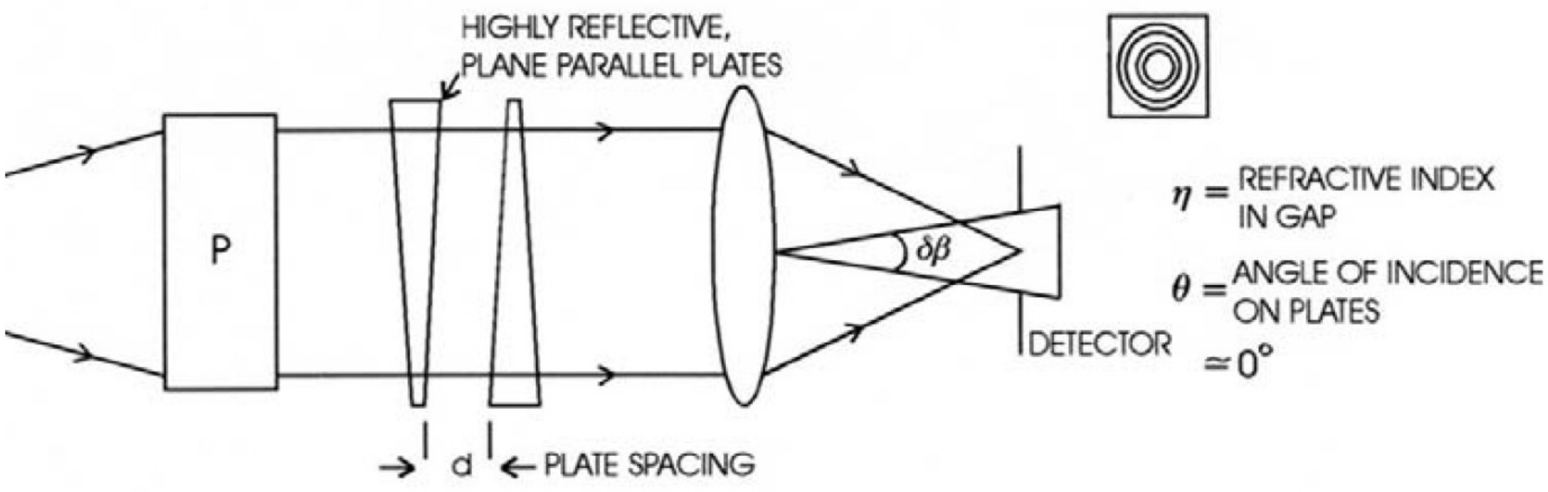

Figure 5.11. A typical arrangement for a Fabry–Perot interferometer. The device *P* is used to narrow the range of wavelengths fed to the etalon.

Section 5 – Exercise #7

7-2. For a resolving power of R=20,000 at λ = 0.5 micrometer with an air-spaced etalon of Finesse 40, what is the gap d and the free spectral range $\Delta\lambda_{FSP}$

$$2nd = \frac{R\lambda}{F} \longrightarrow d = \frac{R\lambda}{2nF} = \frac{(20{,}000)(0.5\ \mu m)}{2\ (1)\ (40)} = 125\ \mu m$$

Assuming that the refractive index of the medium in the gap is usually n=1

$$\Delta\lambda_{FSP} = \frac{\lambda^2}{2nd} = \frac{\lambda^2}{(\frac{R\lambda}{F})} = \frac{\lambda F}{R} = \frac{(0.5\ \mu m)(40)}{20{,}000} = 0.001\ \mu m$$