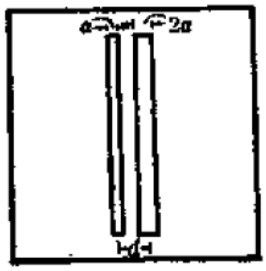
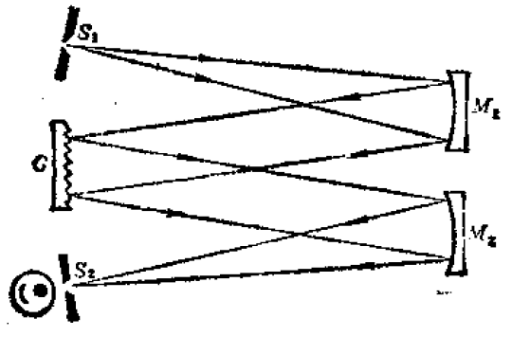
Homework for General physics II Set3

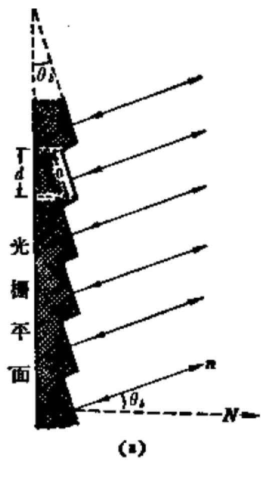
1. Hecht's 10.2 (Deriving the interference term of Multi-slits by phasor method)
2. A 3-slit grating consists of three parallel slits on a plane, each slit has width of *a*, and separated by *d* (center to center). Place a transparent plate to cover the middle slit so that it alters the phase of light passing through it by π.. A plane wave of wavelength λ shines the grating plane perpendicularly, observe the Fraunhoffer diffraction pattern on the back focal-plane of a lens. (1) what is the irradiance distribution of the diffraction pattern. (2) what is the condition for the principle maxima (due to interference among slits), what is the condition for zero-irradiance?
3. （Zhao's problem 6 on pg. 17 of Vol. 2）



For a diffraction screen with two slits with different width, slit has width a, slit 2 has width 2a, their center are separated by d=3a; what is the Fraunhoffer diffraction intensity pattern?

4. Hecht's 10.33
5. Hecht's 10.38
6. Hecht's Problem 10.40
7. Refer to Fig.2-5, pg 26(Zhao's book, vol.2), or Fig.10-32, Hecht's. Basically a reflected blazed grating for Fraunhoffer diffraction with input and output focusing mirrors （M1，M2）. The grating is **1000 lines/mm**, and **100mm**-long, with blaze angle θ_b; the focal length of the mirror is **1 meter**. The illumination is taken as pictured in fig2-3 (a), pg 24, i.e. the incoming light is a plane wave along the direction of the facet's normal.





a) Let's first consider a case with a flat grating. In its first order, the <u>maximum dispersible wavelength</u> will be 1000nm (that is the limiting case for a flat reflection grating, i.e.θ_b=0), then what is the minimum wavelength in the first order without introducing confusion due to mixing of order, and what is the free spectral range (in wavelength)? For the second-order of this grating working for the maximum wavelength of 500nm, answer the same questions for the second order.

b) Now we use a blazed grating to analyze the spectrum of the 1^{st} order in last question, i.e. the wavelength is within the free-spectral-range you calculated above(A blazed type has the advantage over the flat one in concentrating energy into the useful dispersive order) If we want the center wavelength (middle-point) in the free spectral range has the highest irradiance modulation due to diffraction by single element, what is the blazed angle of the grating then? (estimate for the 1^{st} order in the last question)

c) At such blazed angle in (2), what are the angles corresponding to the maximum and minimum wavelengths for 1^{st} order in question (1) (the angles are measured with respect to 'N', the normal to the base of the grating)

d) Due to irradiance modulation by single element diffraction, the irradiance of the maximum and minimum wavelengths will be less than that of the center wavelength, what are the ratios of irradiance between the maximum and minimum wavelengths with respect to that of the center wavelength.

e) For light at about 600 nm region, what is the minimum resolvable wavelength, and for two wavelengths in this region separated by minimum resolvable wavelength, what is their linear separation at the outlet slit S_2.(The outlet is on a plane at the back focal plane of the mirror with focal length 1m)

f) To use the full power of chromatic resolution of the spectrometer, the outlet slit should be less than the value you estimated in (5). However, in real experiment, people usually use wider slit to collect more light. If the outlet slit is taken as 1mm, then what is the spread of wavelength $\delta\lambda$ that can pass the slit and collected by detector?