Physics II

Circular Apertures

(And the limits of resolution)

Limit of resolution:

$\theta = \sin^{-1}\left(1.22\frac{\lambda}{D}\right)$, where D is the diameter of the aperture.

Problem 1.- The Hubble space telescope has a diameter of D=2.4 meters.

(a) Calculate the maximum angular resolution.
Take the wavelength of visible light as $\lambda = 550nm$

(b) Knowing the angular resolution estimate the minimum separation between two light sources that can be distinguished with the telescope 1 mile away [1 mile is 1609 m]

Problem 2.- A paparazzo camera has an objective lens 12cm in diameter.

a) Calculate the minimum angle between two points that will still be distinguished in the picture. Consider that the wavelength is $\lambda = 533nm$

b) Knowing the minimum angle and knowing that the distance from the two points to the camera is 150m, how close can the points be and still be distinguished?

Problem 3.- A 10-inch telescope is advertised as having "diffraction limited optics" which means that the only limitation to the image sharpness comes from diffraction. Assuming the ad is accurate; determine the minimum angle of separation between double stars that can be resolved with the instrument. Take the wavelength of light as 600 nm.
[1 inch = 0.0254 m]

Problem 4.- Why do we see a bright spot in the middle of circular shadows?

Problem 5.- Calculate the minimum diameter of a telescope that you need to resolve the separation between Pluto and its moon Charon if the angular separation is 0.000153º as seen from Earth during the observation.
Assume perfect conditions for seeing, diffraction limited optics and wavelength of the light 600nm.