Pre-Report (Diffraction)

(1) Derive the equation (10.56)

(2) Derive the equation (10.57) from the equation (10.56).

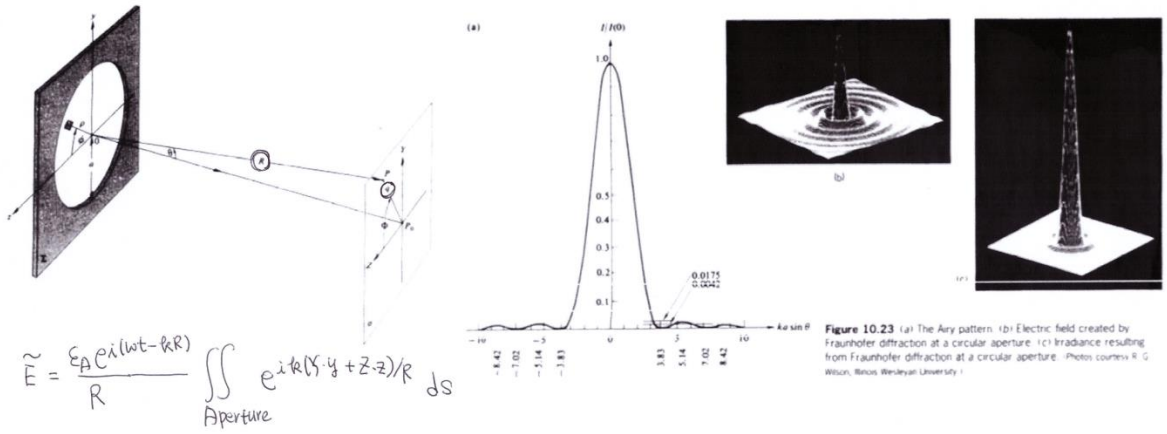

Figure 10.23 (a) The Airy pattern. (b) Electric field created by Fraunhofer diffraction at a circular aperture. (c) Irradiance resulting from Fraunhofer diffraction at a circular aperture. (Photos courtesy R. G. Wilson, Illinois Wesleyan University.)

$$\tilde{E} = \frac{\xi_A e^{i(\omega t - kR)}}{R} \iint_{\text{Aperture}} e^{ik(X\cdot y + Z\cdot z)/R}\, ds$$

$$I(\theta) = I(0)\cdot\left[\frac{2J_1(ka\cdot\sin\theta)}{k\cdot a\cdot\sin\theta}\right]^2 \quad (10.56) \longrightarrow$$

The towering central maximum corresponds to a high irradiance circular spot known as the Airy disk.

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$J_1(u) = 0$ at $u = 3.83$ from Table 10.1.

Then, $k\cdot a\cdot(\theta/R) = 3.83 \longrightarrow \theta_1 = 1.22\cdot\frac{R\lambda}{2a}$ (10.57)

(3) If the distance between a hole with a diameter 0.1 mm and a screen is 1 m with a laser having a wavelength of 633 nm, how much is a radius of an Airy disk?

(4) Describe the diffraction pattern caused by a knife edge.

(END)