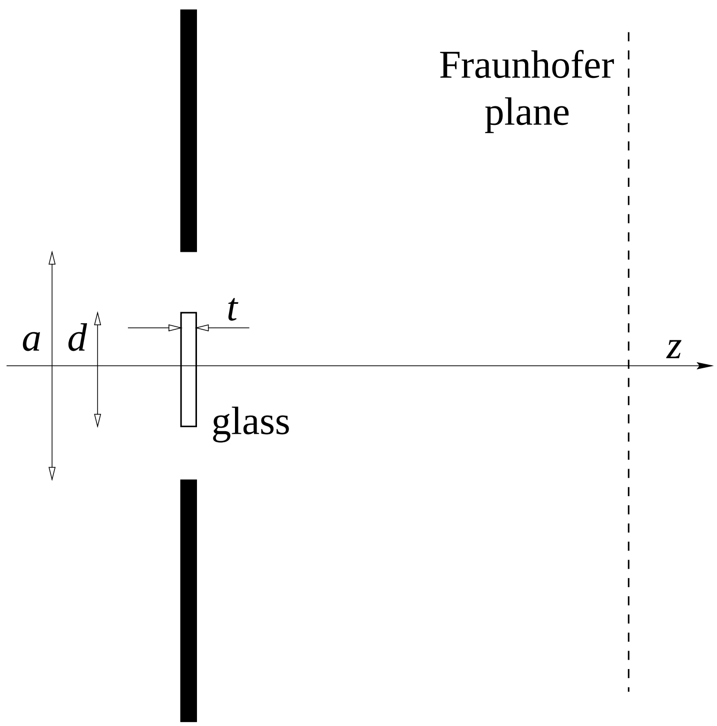
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

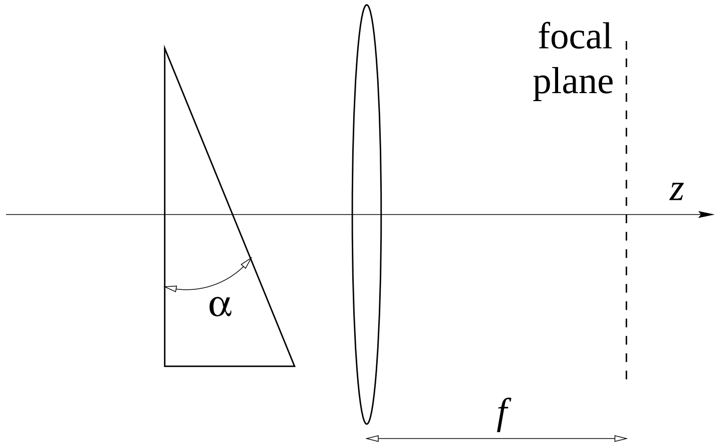
2.71/2.710 Optics **Fall '01**

Problem Set #8 Posted Nov. 14, 2001 — Due Wednesday Nov. 21, 2001

1. **Glass plate.** A glass (refractive index n) plate of width d and thickness t is centered relative to a slit of width $a > d$ as shown in the schematic below. The slit and glass plate are both assumed to be infinite in the direction perpendicular to the page. Derive the Fraunhofer diffraction pattern and plot it for the case $a = 2\text{cm}$, $d = 1\text{cm}$, $t = 1.00025\text{mm}$, and $n = 1.5$. (*Hint:* model the glass plate as a phase delay relative to the surrounding air.)



2. **Prism and lens.** A prism of apex angle $\alpha \ll 1$ is placed in front of a lens of focal length f (see schematic on the next page). The configuration is illuminated by a monochromatic plane wave (wavelength λ) incident parallel to the $\hat{\boldsymbol{z}}$ axis. Calculate the diffraction pattern at the focal plane of the lens, ignoring the effect of the finite lens aperture (see the next problem for a calculation that takes the finite size into account).



3. **Finite lens.** The lens shown below is illuminated by a plane wave at angle $\theta \ll 1$ with respect to the $\hat{\boldsymbol{z}}$ axis. Model the lens as a thin transparency with quadratic phase transmission function bounded by a rectangular aperture of size a, *i.e.* as

$$\exp\left\{-i\frac{x^2+y^2}{\lambda f}\right\} \operatorname{rect}\left(\frac{x}{a}\right) \operatorname{rect}\left(\frac{y}{a}\right),$$

where f is the focal length and (x, y) the coordinates at the lens plane. Calculate and sketch the diffraction pattern at the focal plane. (*Hint:* use the convolution theorem).