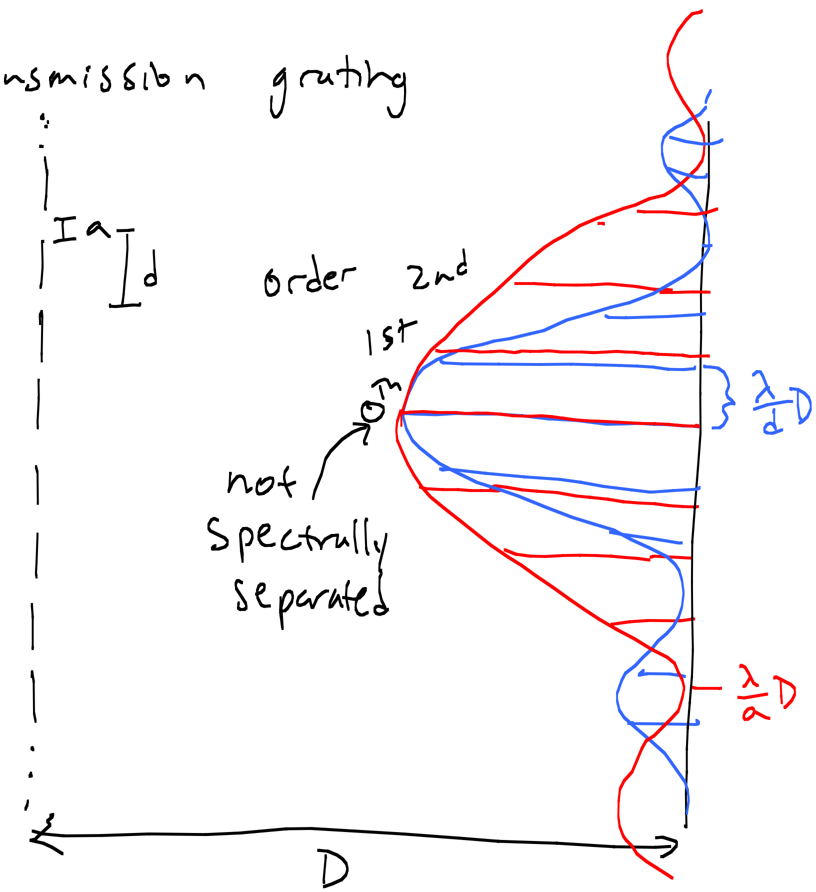
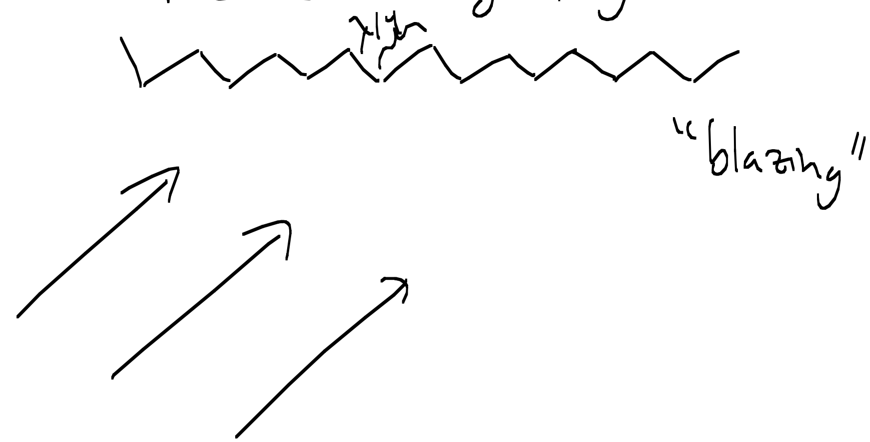
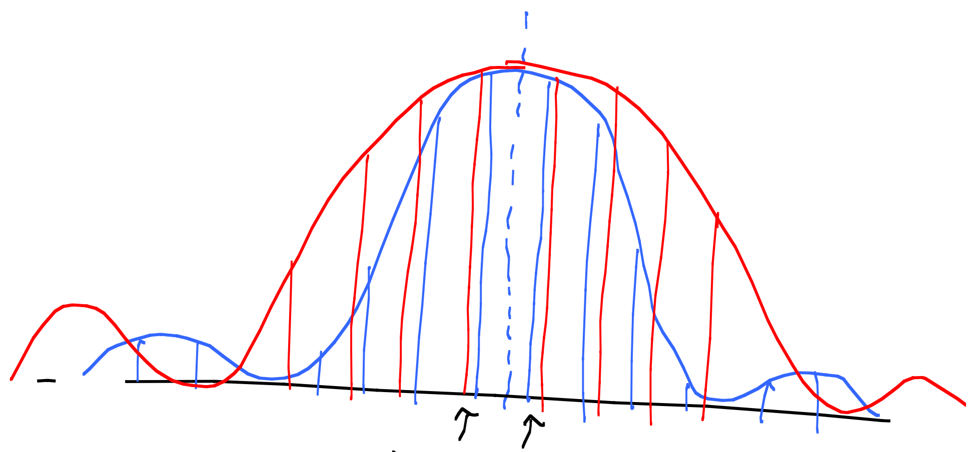
Diffraction: Spectroscopy

Transmission grating



reflection grating

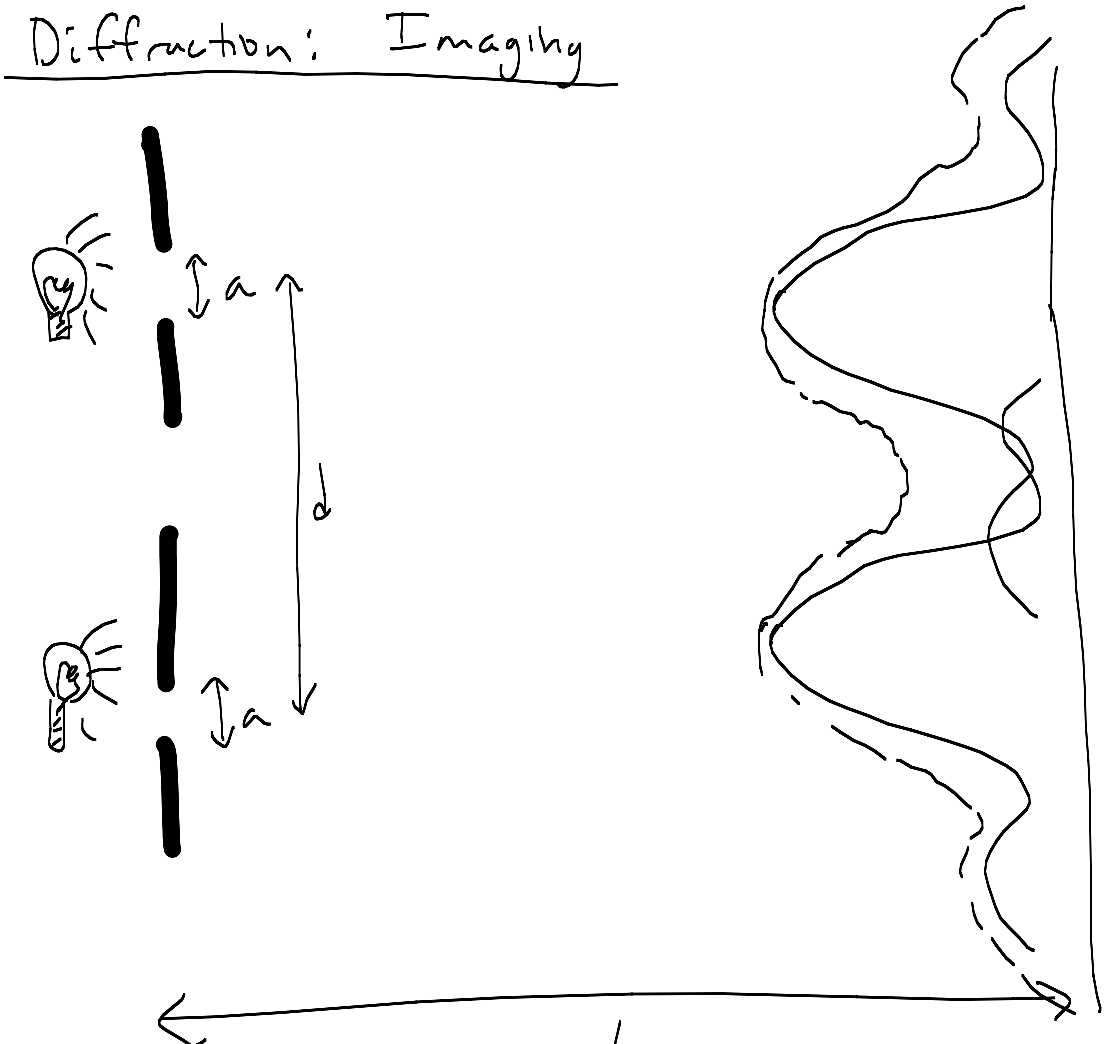




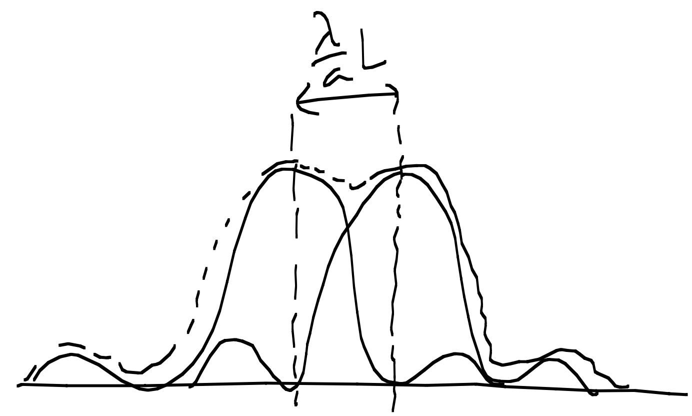
Now, the highest intensity peak is spectrally separated

→ higher efficiency

Diffraction: Imaging

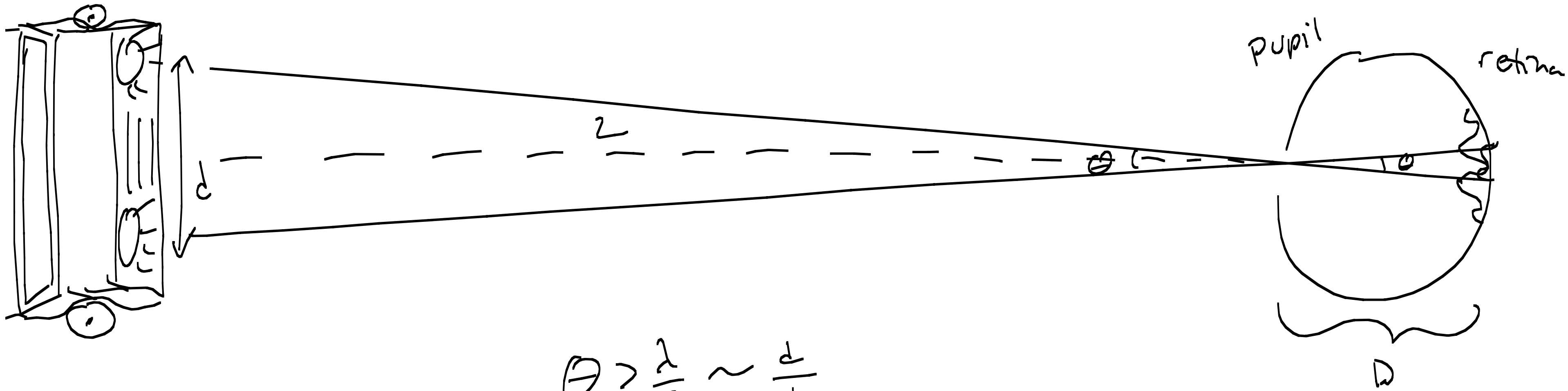


If distance between sources $d < \frac{\lambda}{a}L$, can't distinguish 2 sources from 1



So, diffraction puts a <u>fundamental</u> limit on resolution of imaging systems. This is why electron microscopes w/ $\lambda = \frac{p}{h}$ (typically ~Å) have much greater resolution than optical ($\lambda \sim \mu m$)

Example



$$\theta > \frac{\lambda}{a} \sim \frac{d}{L}$$

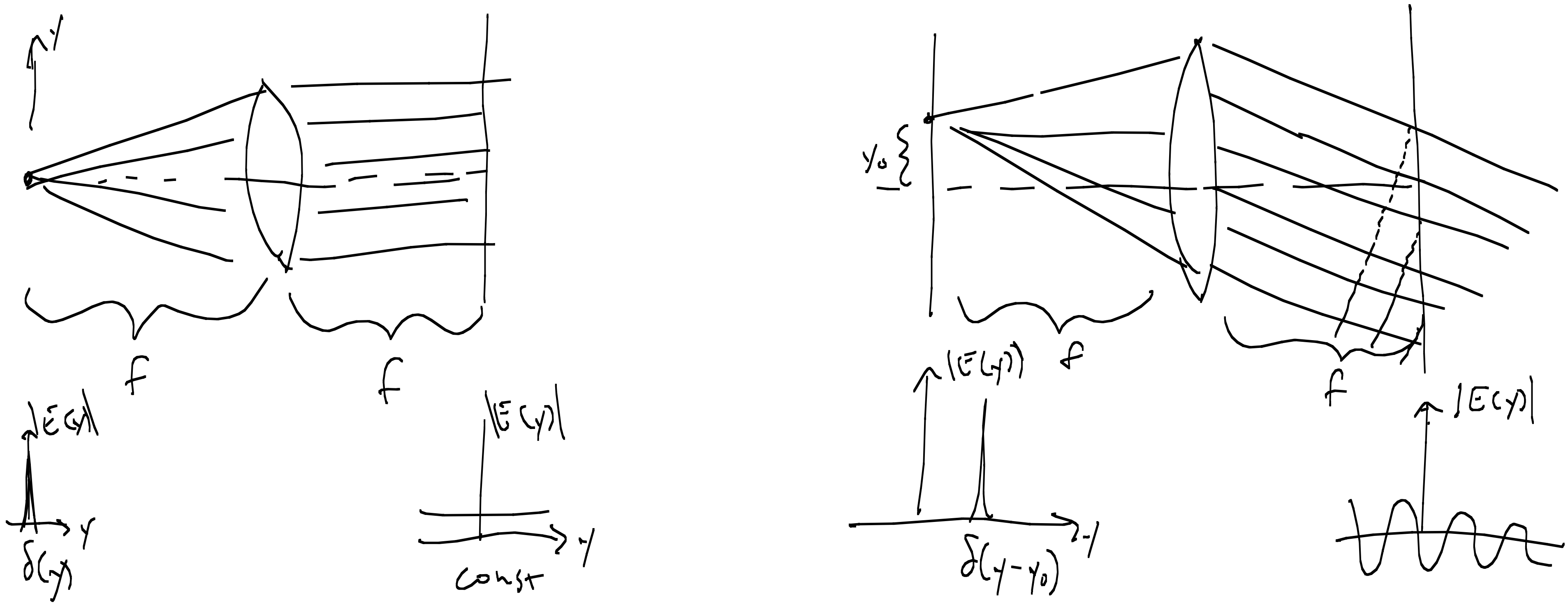
$$L < \frac{da}{\lambda} \cong \frac{10^2 \text{cm} \cdot 10^{-1} \text{cm}}{5\times10^{-5} \text{cm}} = 2\times10^5 \text{cm} \quad (2 \text{Km})$$

$$\text{spatial separation on retina} > \frac{\lambda}{a}\cdot D = \frac{5\times10^{-5}\text{cm}}{10^{-1}\text{cm}} 1\text{cm} = 5\times10^{-4}\text{cm} \quad (5\mu\text{m})$$

c.f. "cone" size on retina: $5\mu m$!

For higher resolution, need larger apertures: telescopes, synthetic aperture (radar)

Lenses act as Fourier Transform, too!



An arbitrary object consists of many δ's distributed along y which interfere coherently to produce Fourier Transform.