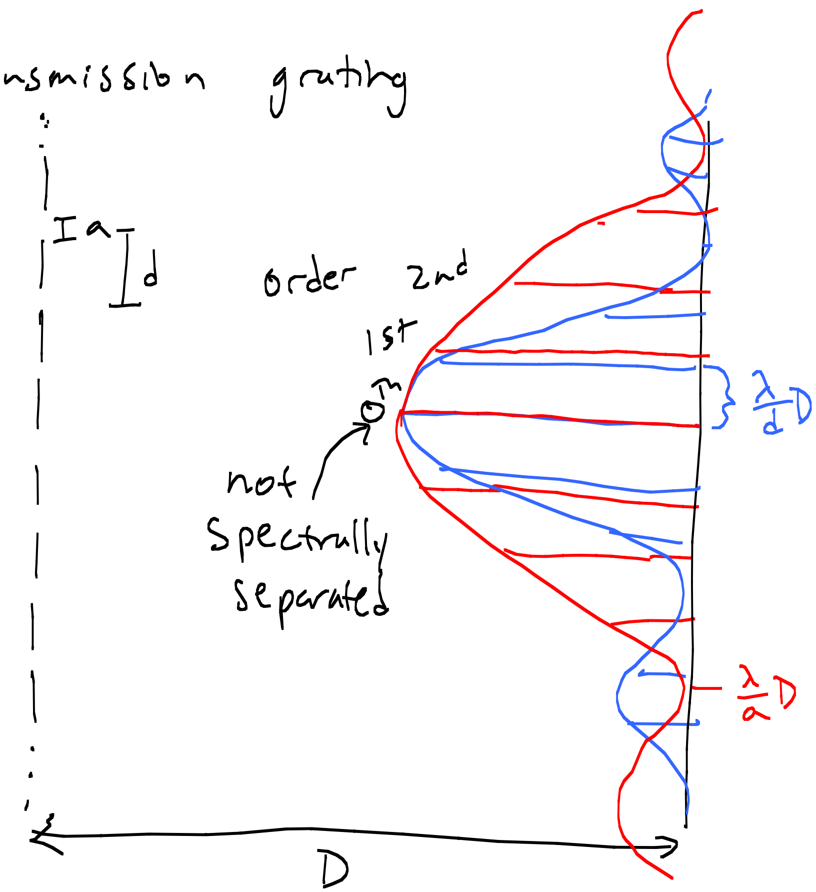
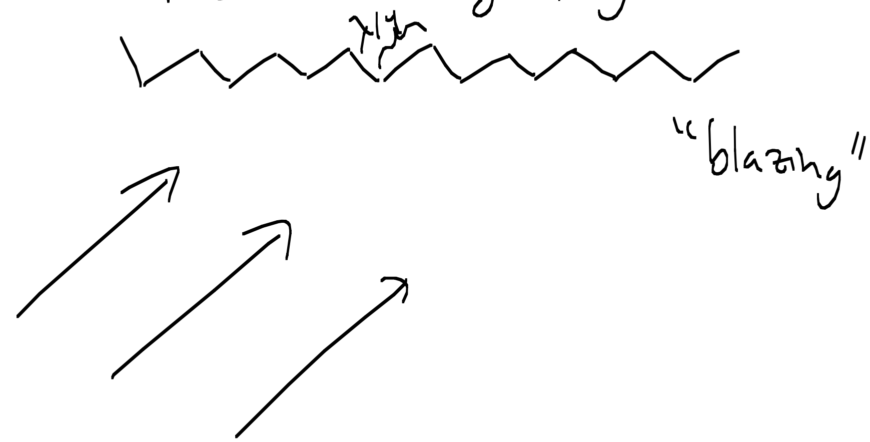
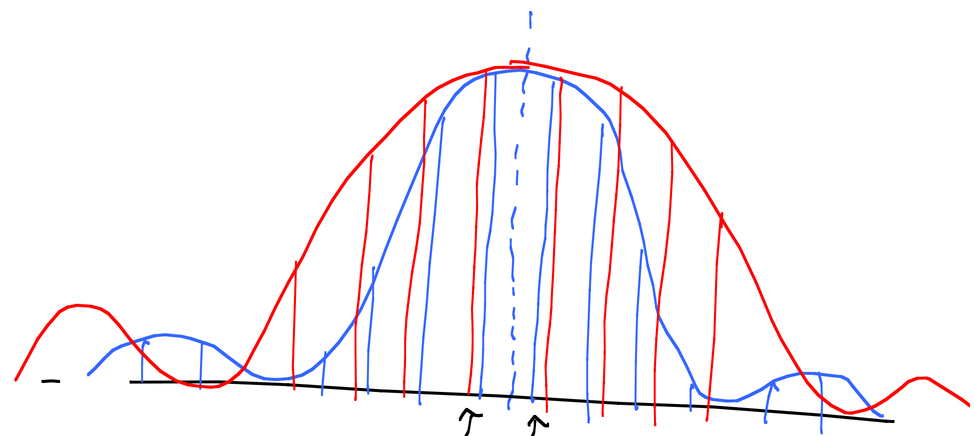
Diffraction: Spectroscopy

Transmission grating



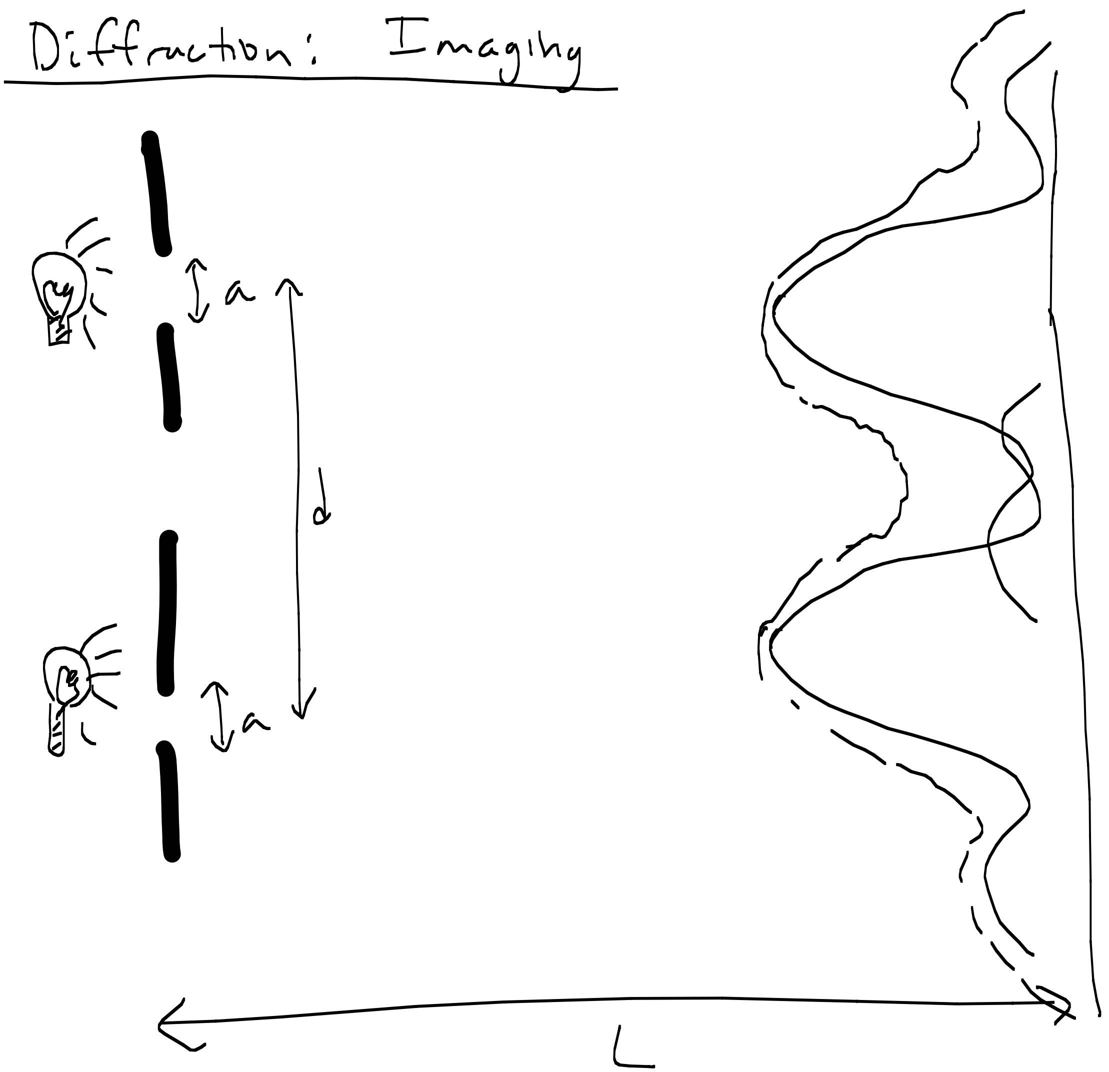
reflection grating



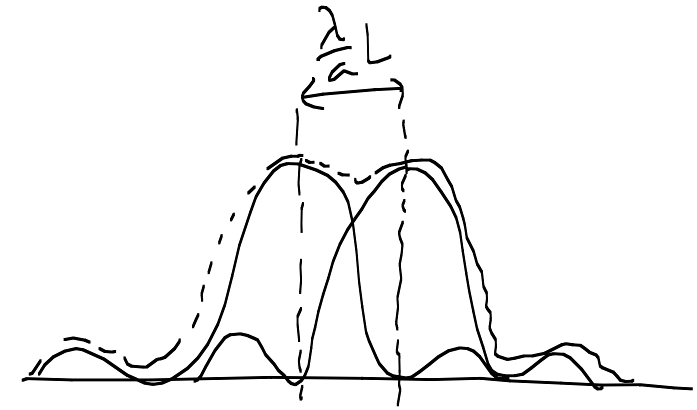


Now, the highest intensity peak is spectrally separated
→ higher efficiency

Diffraction: Imaging

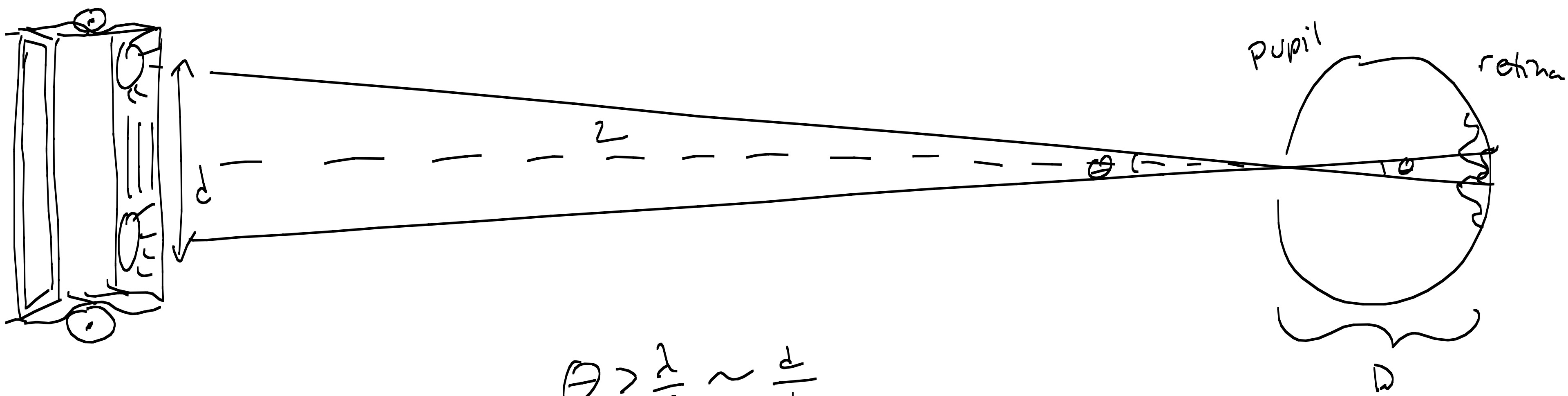


If distance between sources $d < \frac{\lambda}{a} L$, can't distinguish 2 sources from 1



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 (λ ~ μm)

Example



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

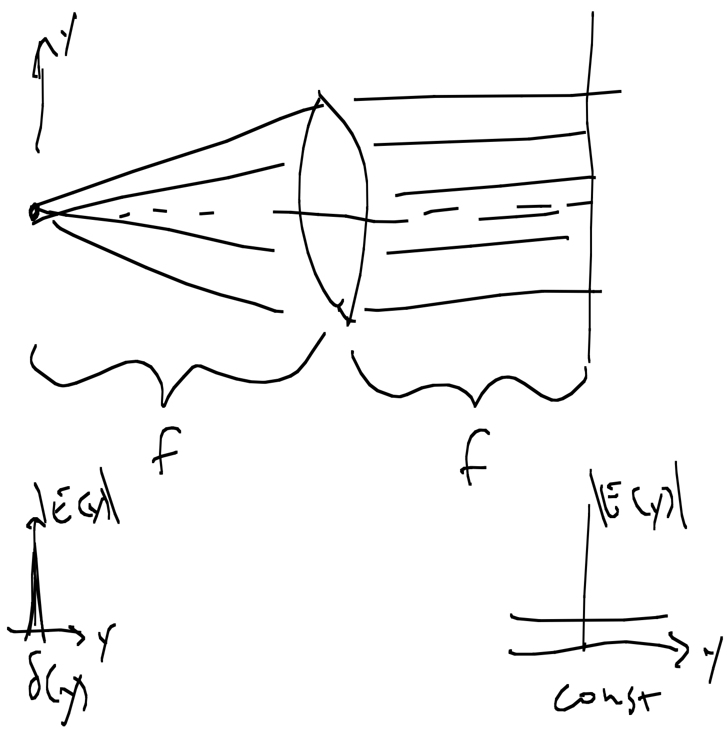
$$L < \frac{da}{\lambda} \cong \frac{10^2\,cm \cdot 10^{-1}\,cm}{5\times10^{-5}\,cm} = 2\times10^5\,cm \quad (2\,Km)$$

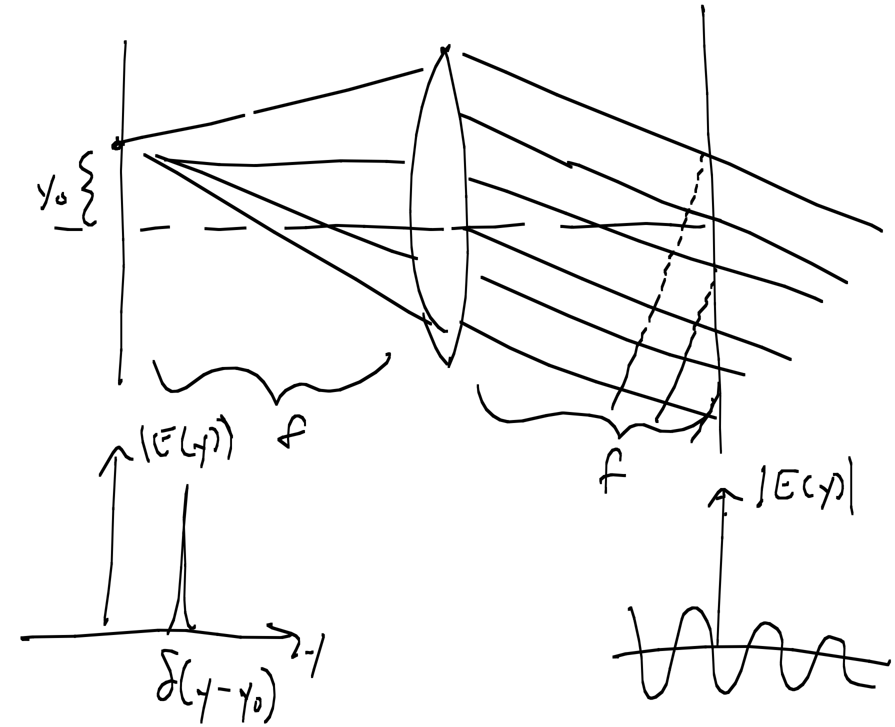
spatial separation on retina $> \frac{\lambda}{a} \cdot D = \frac{5\times10^{-5}\,cm}{10^{-1}\,cm}\,1\,cm = 5\times10^{-4}\,cm \quad (5\,\mu m)$

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.