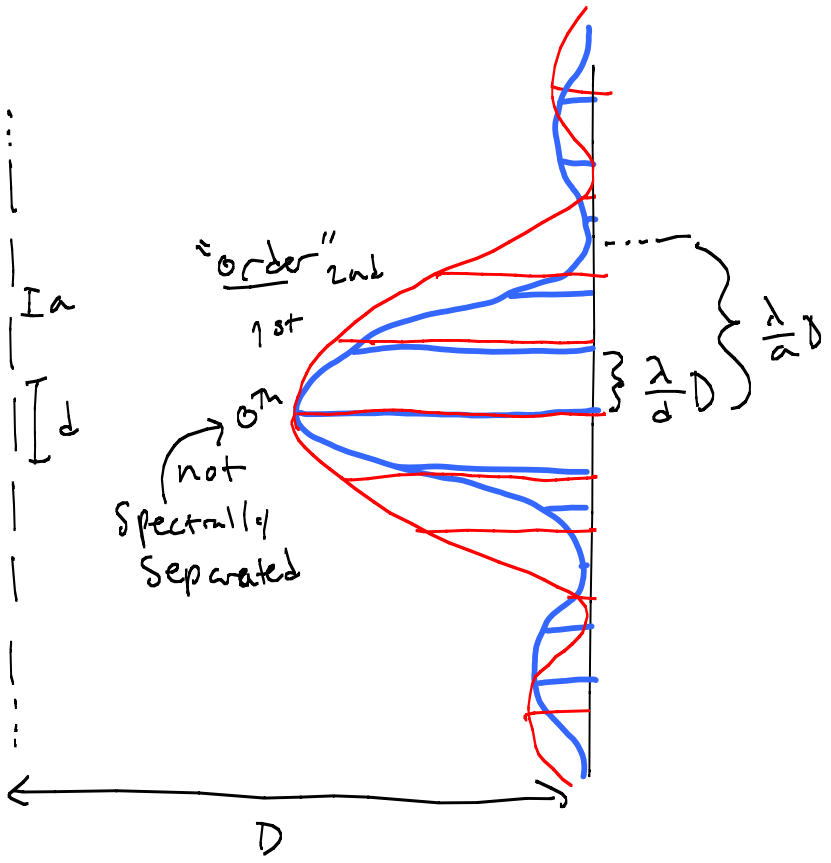
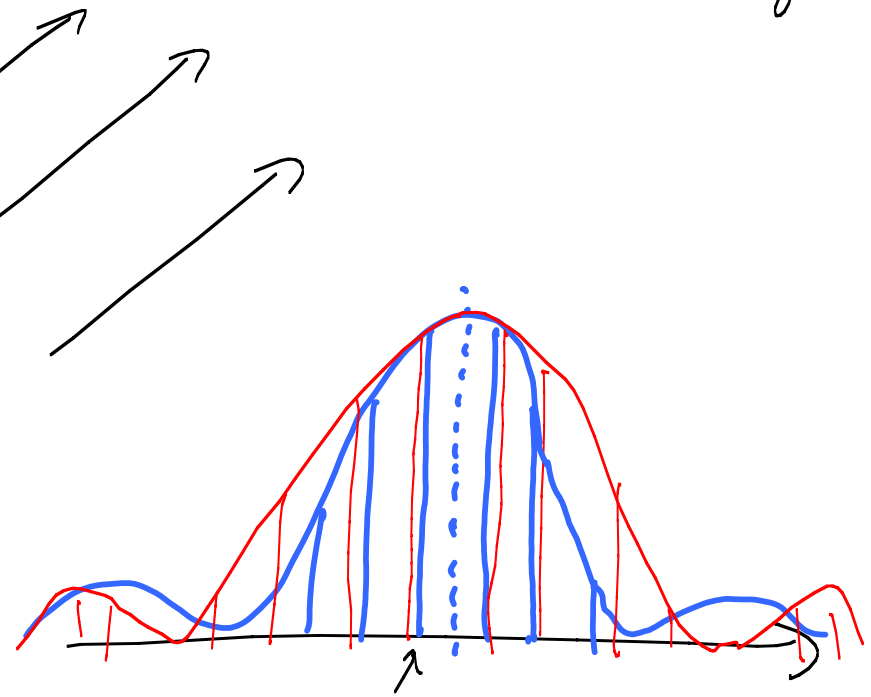
Diffraction: Spectroscopy

Transmission grating



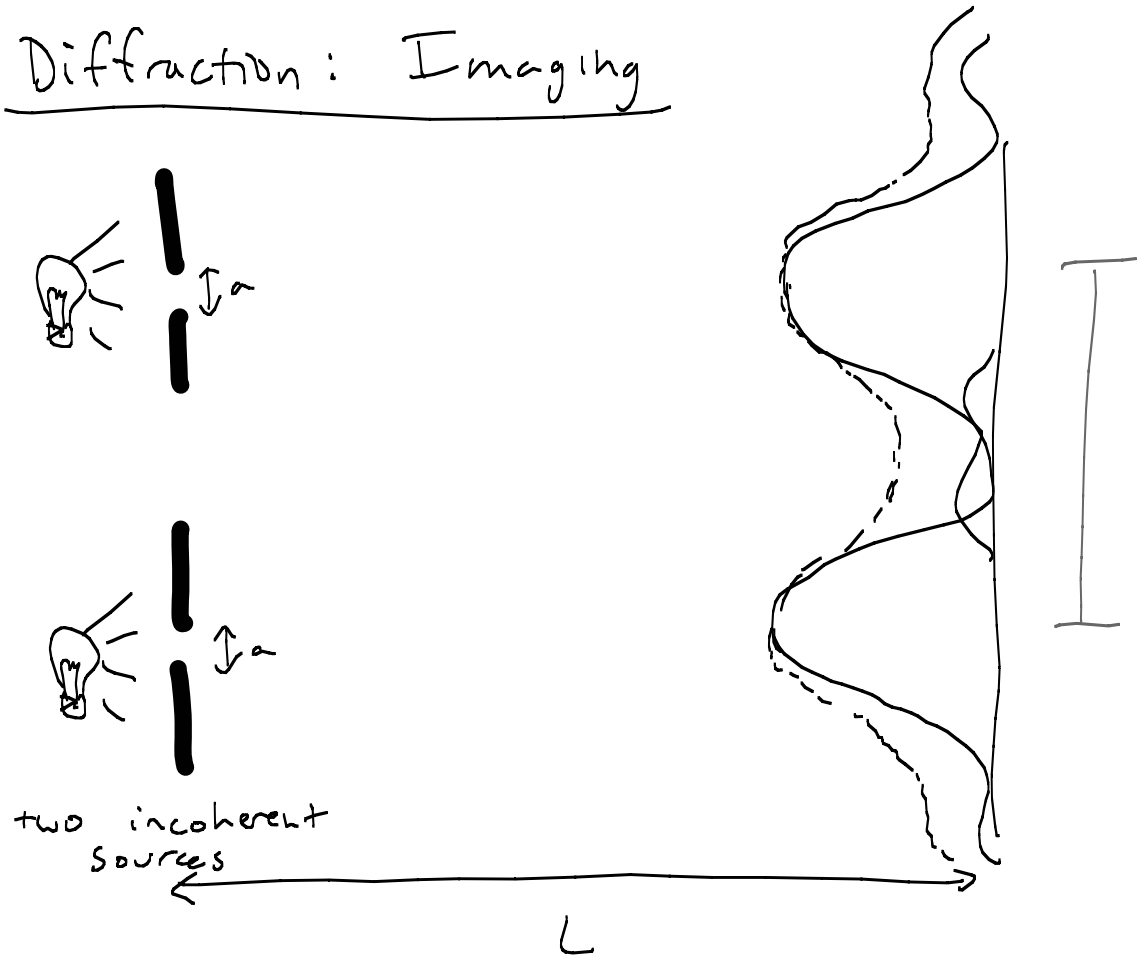
reflection grating

"blazing"

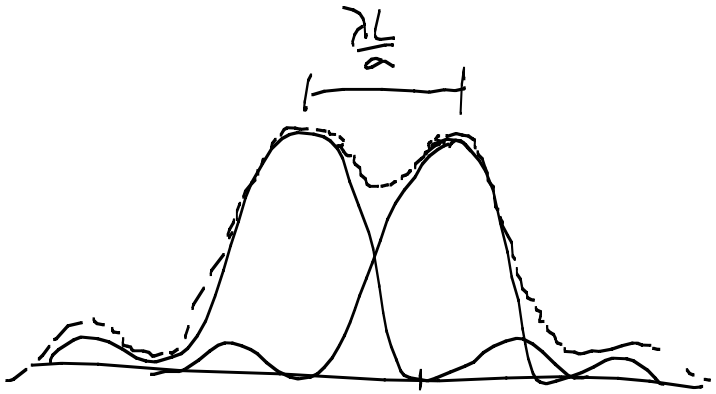


now, the highest intensity peak is spectrally separated
→ higher efficiency!

Diffraction: Imaging

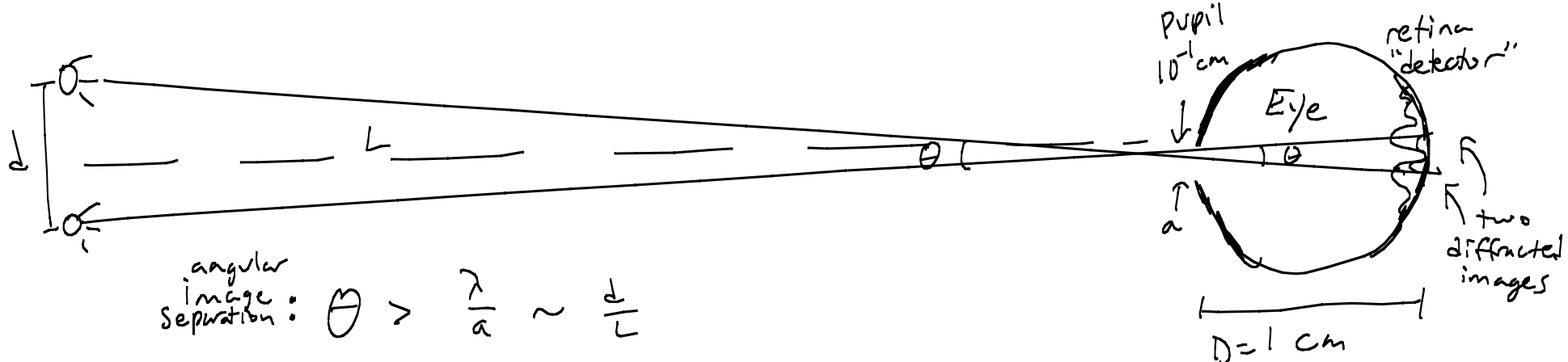


If distance between diffracted images $> \frac{\lambda L}{a}$, it is difficult to distinguish 2 sources from 1



So, diffraction puts a <u>fundamental</u> limit on resolution of imaging systems: even electron microscopes!

Example



angular image separation: $\theta > \frac{\lambda}{a} \sim \frac{d}{L}$

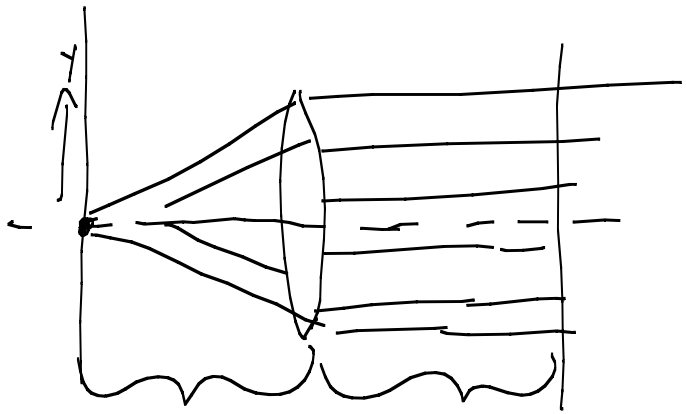
$$L < \frac{d\,a}{\lambda} \cong \frac{10^{2}\text{ cm}\ 10^{-1}\text{ cm}}{5\times10^{-5}\text{ cm}} = 2\times10^{5}\text{ cm} \sim \underline{2\text{ Km}}$$

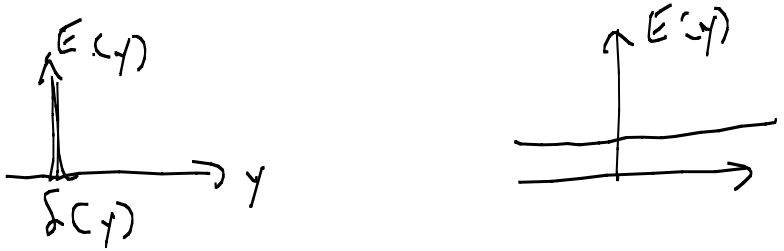
Spatial separation on retina: $D\frac{\lambda}{a} = 1\text{ cm}\ \frac{5\times10^{-5}\text{ cm}}{10^{-1}\text{ cm}} = 5\times10^{-4}\text{ cm}\ (5\,\mu\text{m})$

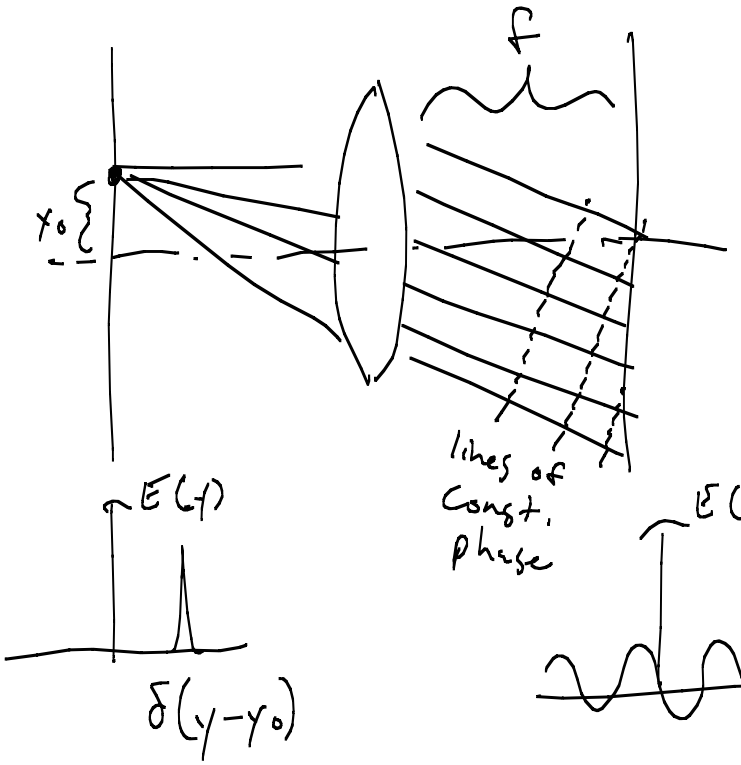
C.f. cone dia.: Biology "knows" about diffraction!

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

Lenses act as Fourier Transform, too:







Object consists of many δ's along y which interfere in image to produce Fourier Transform.