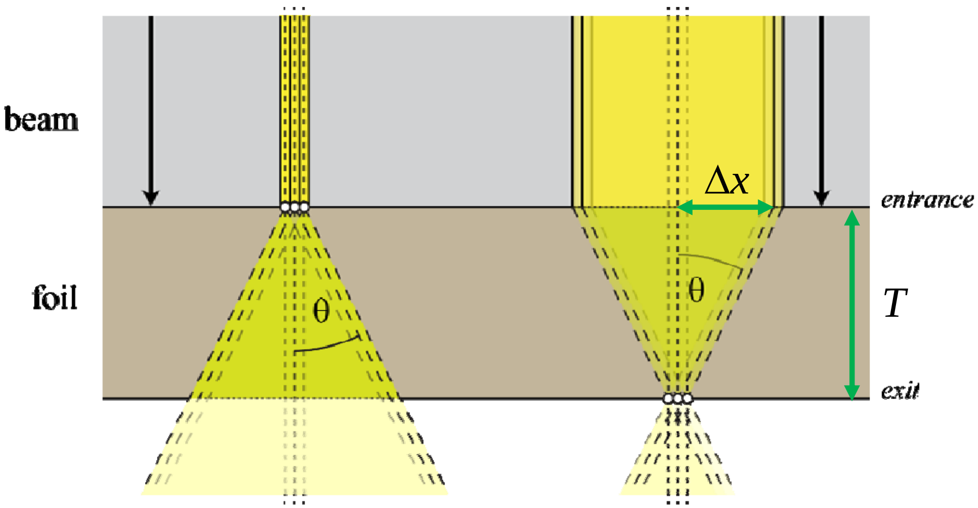
Column approximation



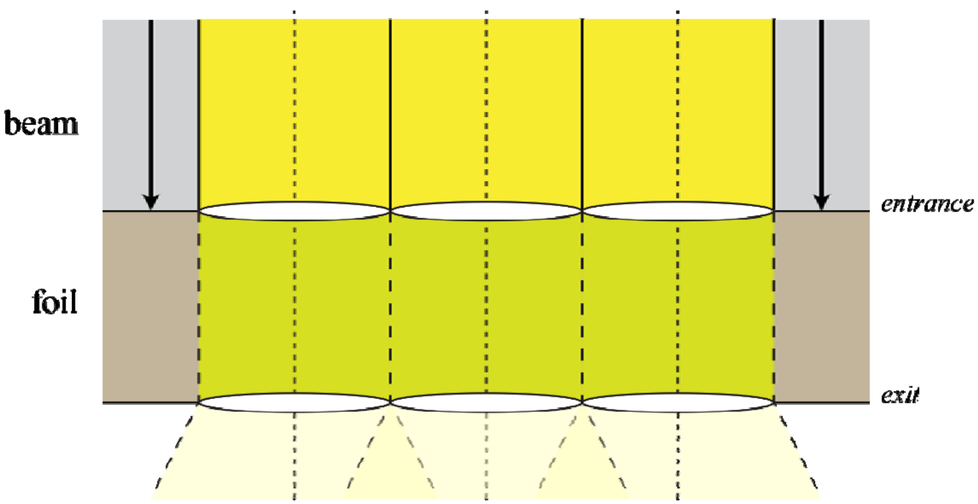
Scattering from an inverted cone of material contributes to the wave amplitude at a point on the exit surface of a thin foil

$$\Delta x = T \cdot \theta$$

$$T = 100 \text{ nm}$$

$$\theta = 10 \text{ mrad}$$

$$\rightarrow \Delta x = 1 \text{ nm}$$



The *column approx.* assumes scattering arises from a narrow cylinder extending vertically through an area on the exit surface.

Spatial variations in the sample must be sufficiently long range for the approx. to be valid.

Example: Two-beam, dark-field image contrast

Dynamical diffracted intensity (two-beam):

$$I_{\mathbf{g}} = \left(\frac{\pi T}{\xi}\right)^2 \cdot \mathrm{sinc}^2\left(\pi s_{eff} T\right)$$

$$s_{eff} \doteq \sqrt{s^2 + \left(\frac{1}{\xi^2}\right)}$$

Assuming s, ξ, and T are slowly varying:

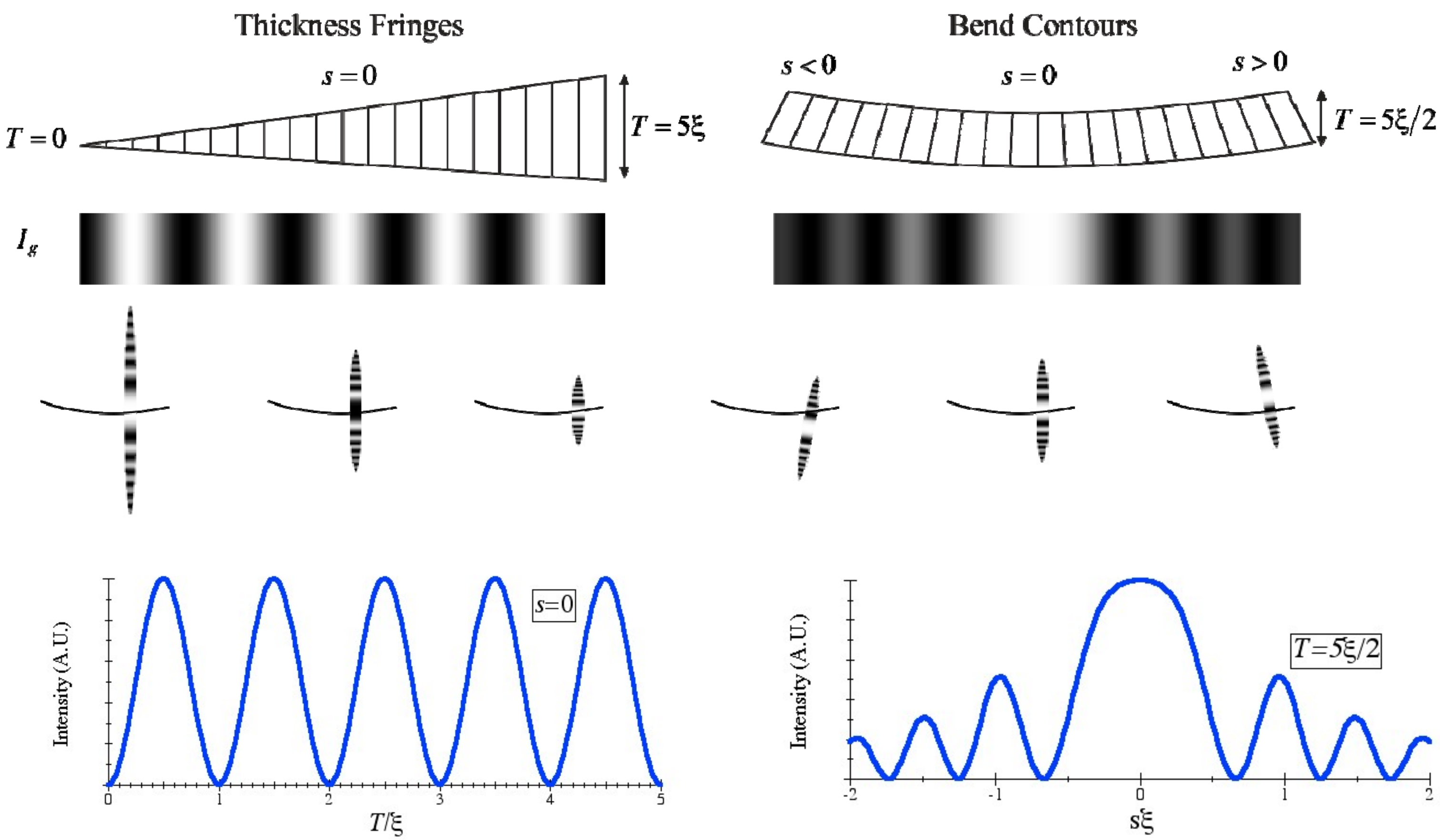
Apply the column approximation.

$$I_{\mathbf{g}}(x) \approx \left[\frac{\pi T(x)}{\xi(x)}\right]^2 \cdot \mathrm{sinc}^2\left[\pi s_{eff}(x) \cdot T(x)\right]$$

Thickness fringes & bend contours

Dark-field image intensity

ξ constant



Example: Si plan-view specimen

220 DF near an [001] zone