

# Schlieren Imaging

**A quasi-rigiorous overview**

# Refraction

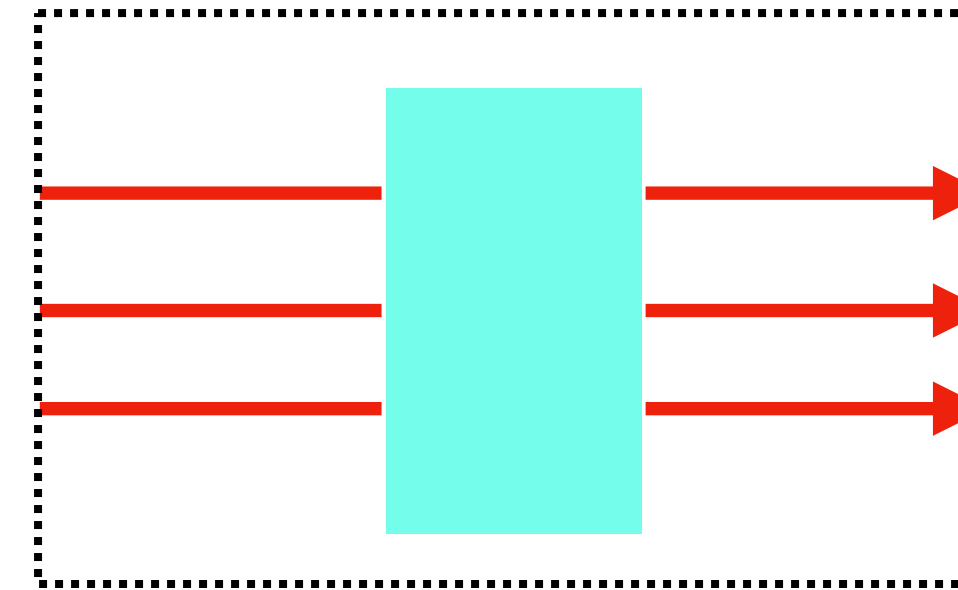
[In the convention where  $z$  is along the optical axis]

A collimated beam travels through a test region with non-uniform index of refraction. Suppose the index of refraction does not depend on  $x$ , so  $n(y, z)$ . Then, from Fermat's principle and Euler-Lagrange equations,

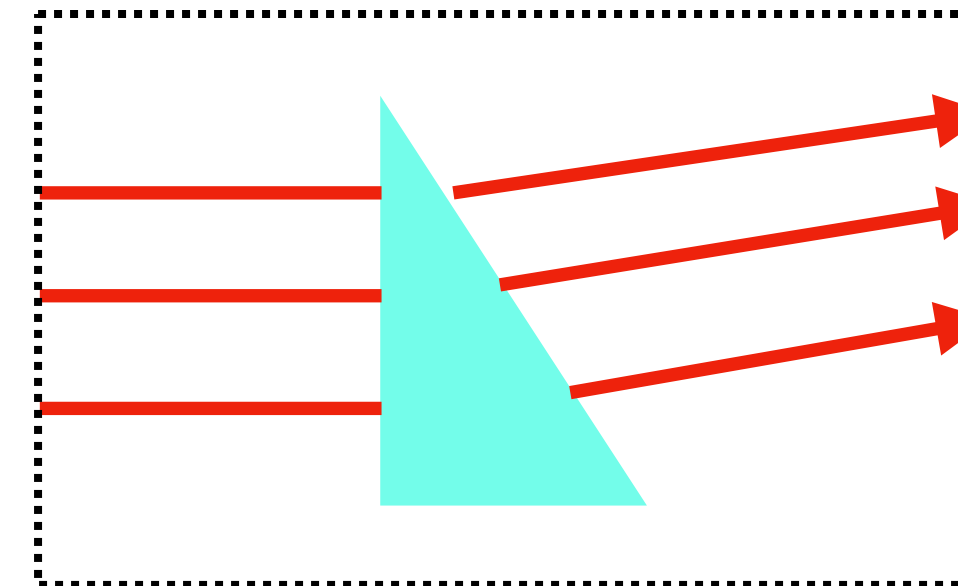
$$\frac{\partial^2 y}{\partial z^2} = \frac{1}{n} \frac{\partial n}{\partial y}$$

A gradient in the index of refraction along  $y$  (RHS) causes the light to change direction (LHS)

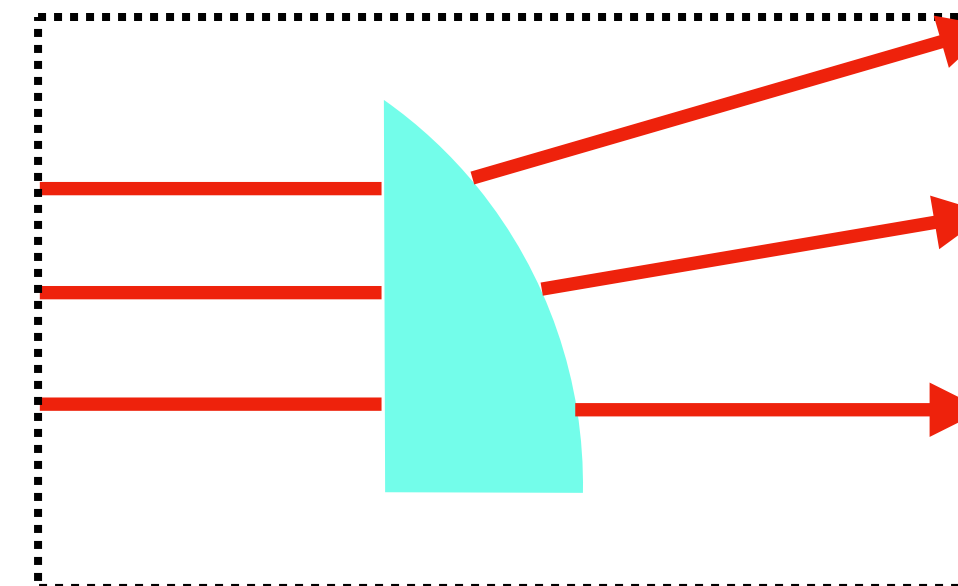
**We assume that  $\partial y / \partial z$  is negligible because the change in  $n$  is small**



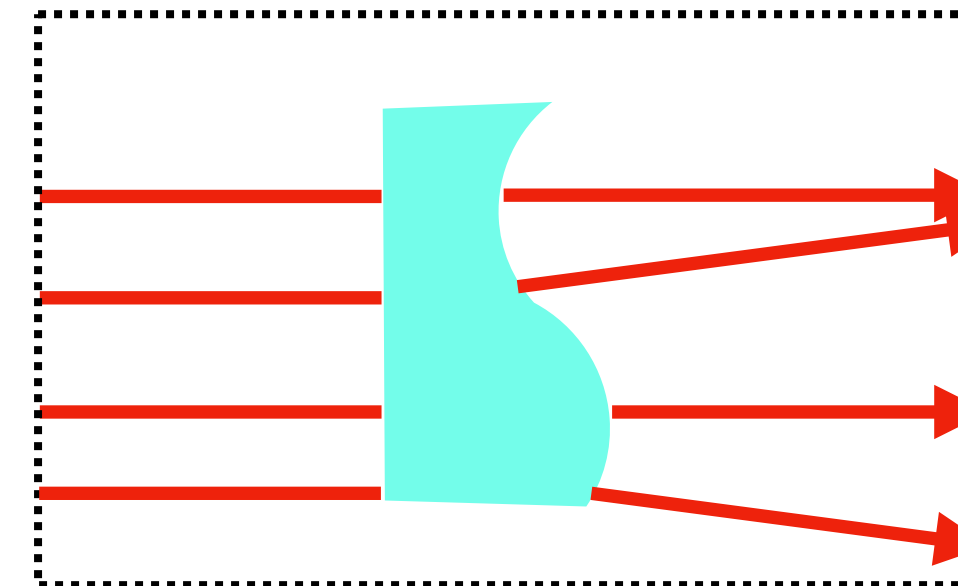
$$\frac{\partial n}{\partial y} = 0$$



$$\frac{\partial n}{\partial y} = \text{const.}$$



$$\frac{\partial^2 n}{\partial y^2} = \text{const.}$$



$$\frac{\partial^2 n}{\partial y^2} \neq \text{const.}$$