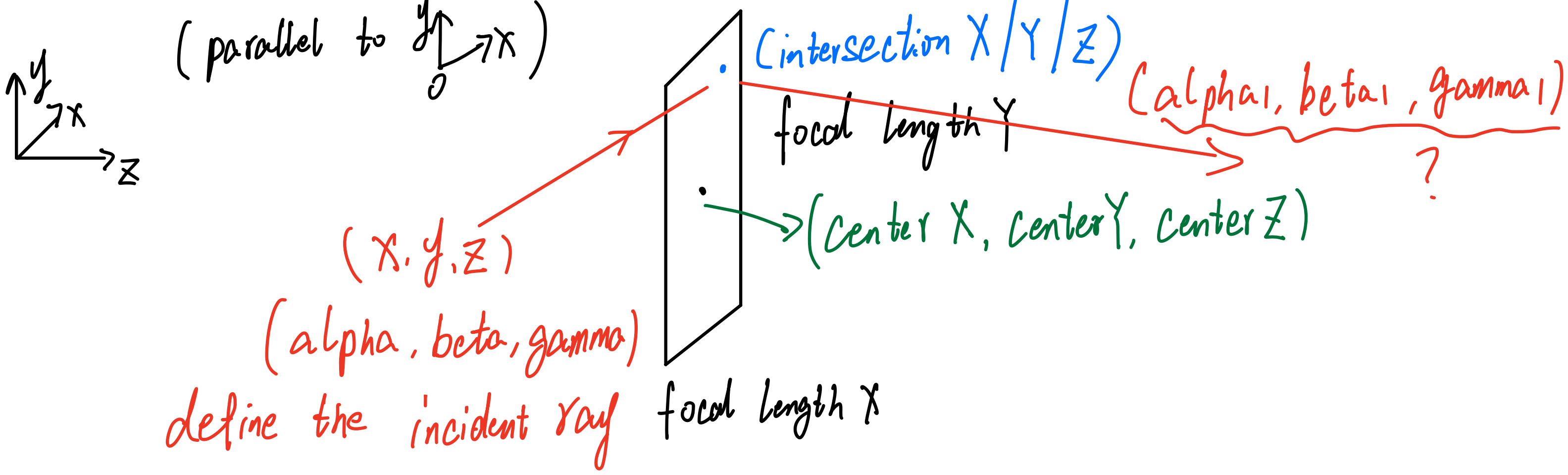
paraxial lens calculation

(parallel to y, x)



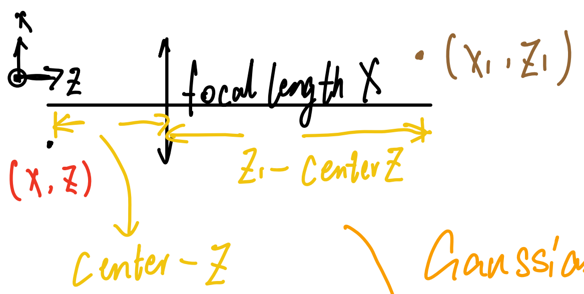
① intersection X = $x + \text{alpha}/\text{gamma} \cdot (\text{center}Z - z)$

intersection Y = $y + \text{beta}/\text{gamma}\,(\text{center}Z - z)$

intersection Z = center Z.

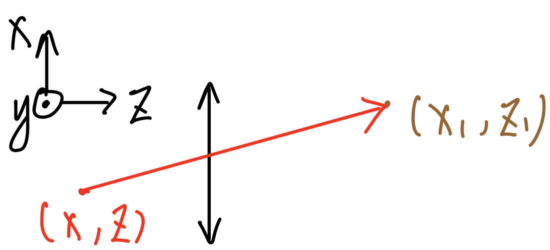
② calculate the image of $(x, y, z) \longrightarrow$ $(x_1, ?, z_1)$, $(?, y_2, z_2)$

the output ray will pass through $(x_1, ?, z_1)$ and $(?, y_2, z_2)$



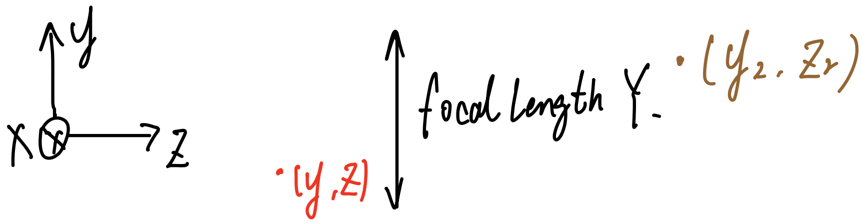
Gaussian formula

$$z_1 = \frac{1}{\dfrac{1}{\text{focallength}X} - \dfrac{1}{\text{center}Z - z}} + \text{center}Z$$



optical center.

$$x_1 = \text{center}X + \frac{\text{center}X - x}{\text{center}Z - z} \cdot (z_1 - \text{center}Z)$$



$$z_2 = \frac{1}{\frac{1}{\text{focalLengthY}} - \frac{1}{\text{centerZ} - z}} + \text{centerZ}$$

$$y_2 = \text{centerY} + \frac{\text{centerY} - y}{\text{centerZ} - z} \cdot (z_2 - \text{centerZ})$$

(intersectionX, intersectionY, intersectionZ) $(x_1, ?, z_1)$ $(?, y_2, z_2)$

on the output ray

$(?, y_2, z_2) \rightarrow (x_2, y_2, z_2)$

$$x_2 = \frac{x_1 - \text{intersectionX}}{z_1 - \text{intersectionZ}} \cdot (z_2 - \text{intersectionZ}) + \text{intersectionX}$$

$$\text{distance} = \sqrt{(x_2 - \text{intersectionX})^2 + (y_2 - \text{intersectionY})^2 + (z_2 - \text{intersectionZ})^2}$$

$$\text{alpha1} = \frac{x_2 - \text{intersectionX}}{\text{distance}}$$

$$\text{beta1} = \frac{y_2 - \text{intersectionY}}{\text{distance}}$$

$$\text{gamma} = \frac{z_2 - \text{intersectionZ}}{\text{distance}}$$

$\frac{\text{"positive"}}{\text{direction}} \rightarrow$ if gamma1 < 0

$\downarrow$

alpha1 = -alpha1

beta1 = -beta1

gamma1 = abs(gamma1)