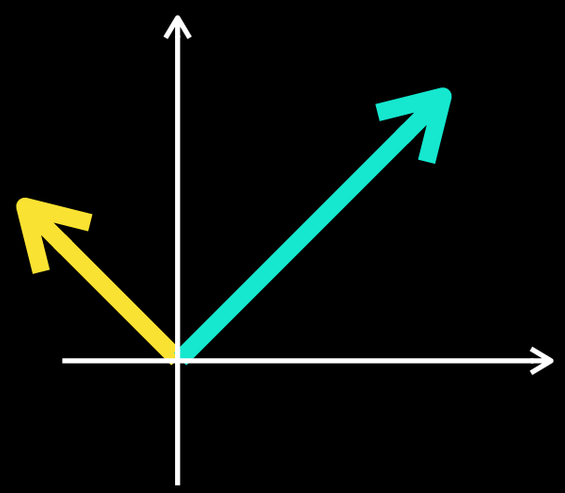
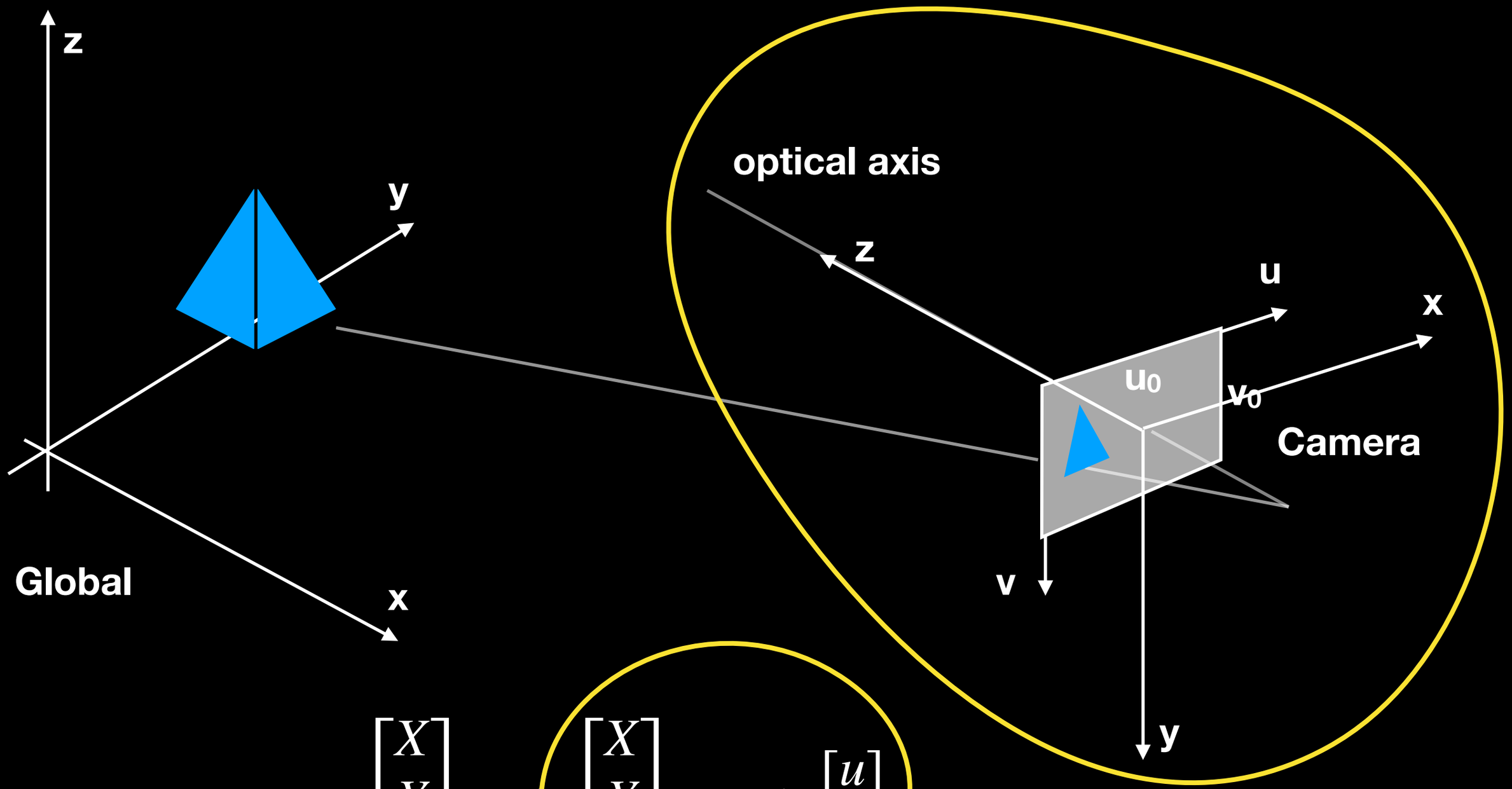
3D / 2D projection

Linear Algebra Essentials

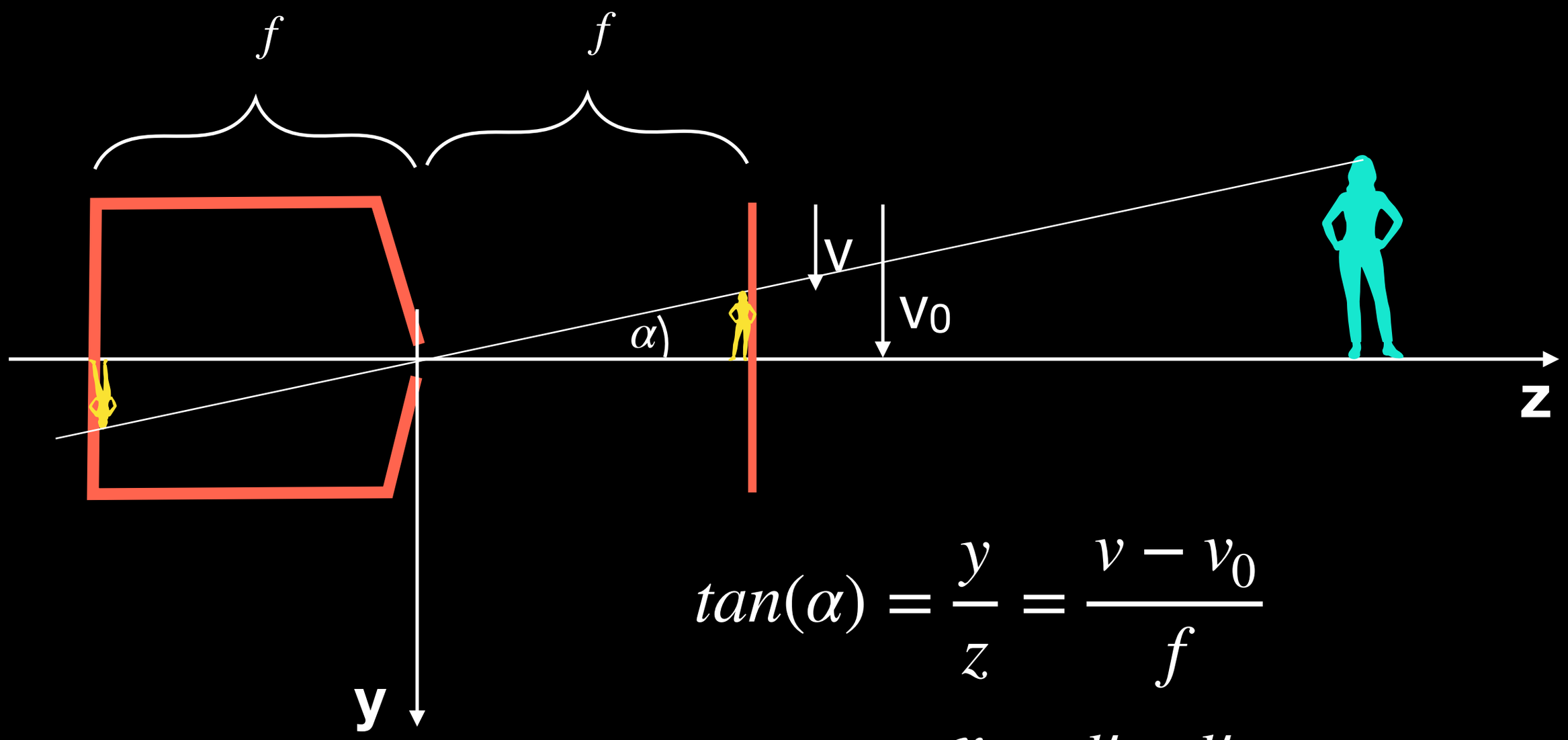


3D - 2D projection



$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_G \rightarrow \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{cam} \rightarrow \begin{bmatrix} u \\ v \end{bmatrix}$$

Pinhole camera model



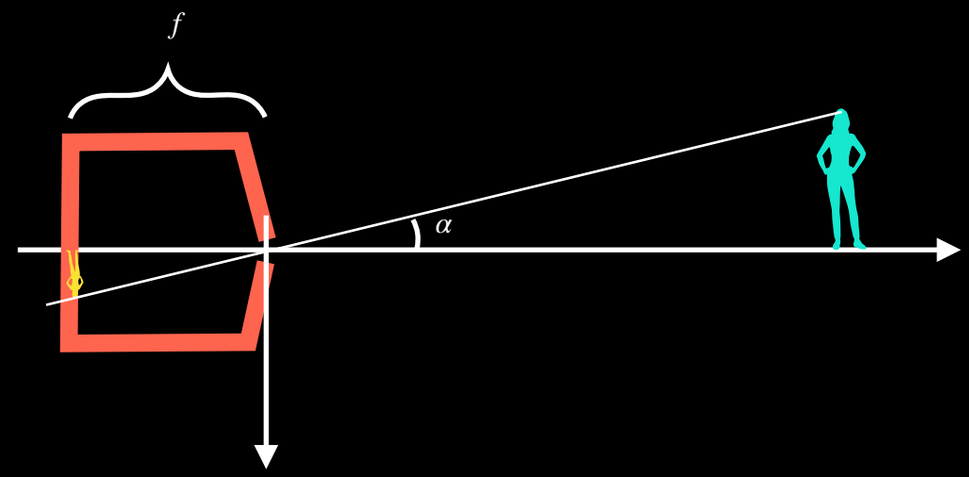
$$tan(\alpha) = \frac{y}{z} = \frac{v - v_0}{f}$$

$$\frac{x}{z} = \frac{u - u_0}{f}$$

Pinhole camera model

$$\frac{1}{z} fx + u_0 = u$$

$$\frac{1}{z} fy + v_0 = v$$



$$\frac{1}{z} \begin{bmatrix} f & 0 & u_0 \\ 0 & f & v_0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

intrinsic matrix

$$\begin{bmatrix} f & 0 & u_0 \\ 0 & f & v_0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \end{bmatrix} = z \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

Intrinsic matrix

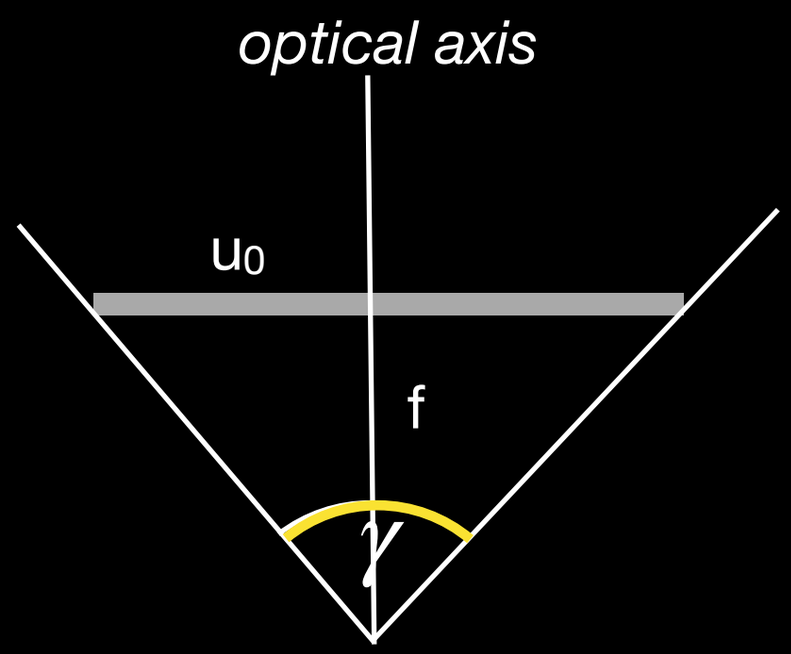
focal length

optical axis

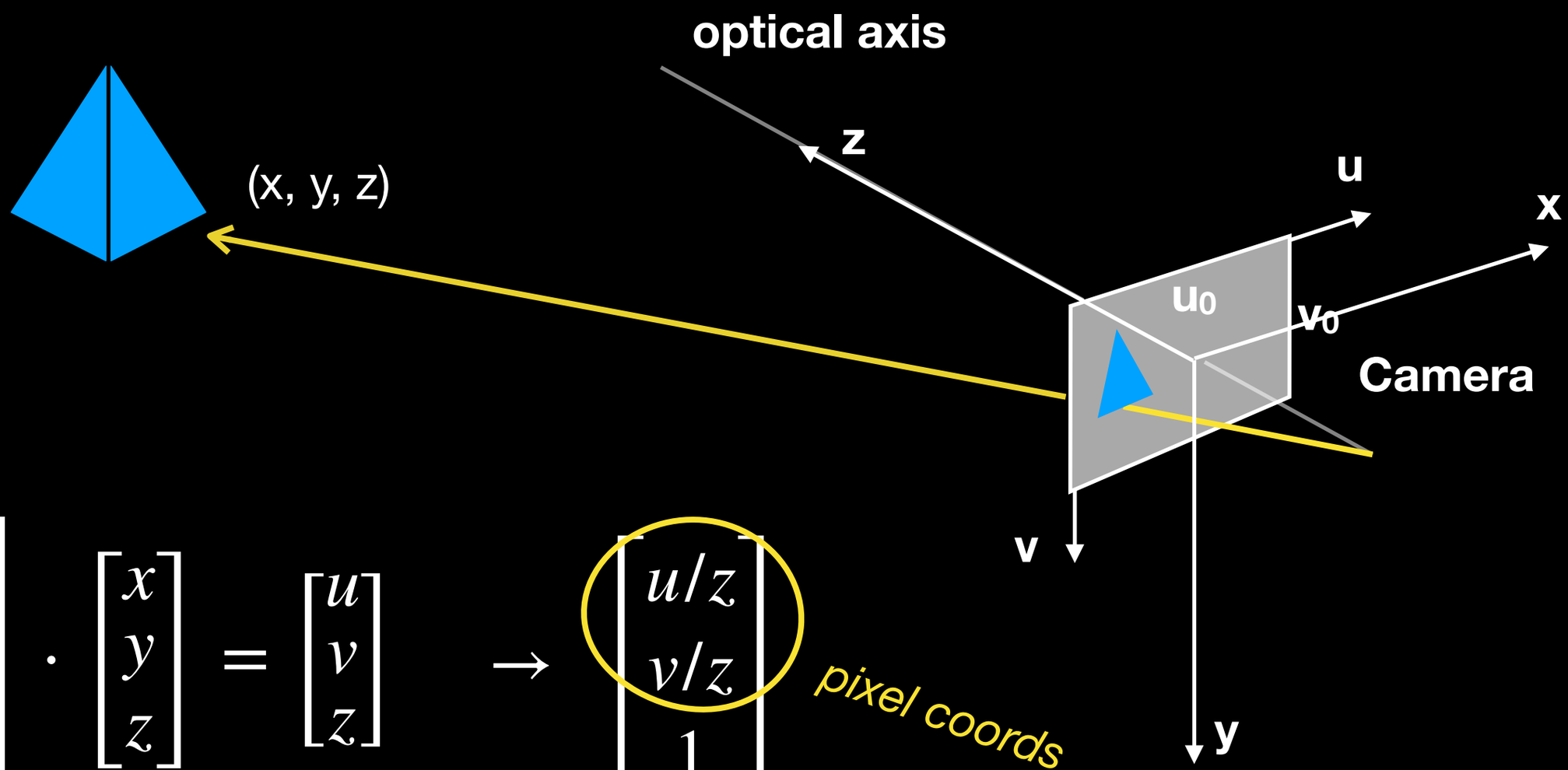
$$\begin{bmatrix} f & 0 & u_0 \\ 0 & f & v_0 \\ 0 & 0 & 1 \end{bmatrix}$$

Field of view (FoV)

$$\gamma = 2 \cdot arctan(\frac{u_0}{f})$$



3D - 2D projection



$$\begin{bmatrix} f & 0 & u_0 \\ 0 & f & v_0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} u \\ v \\ z \end{bmatrix} \rightarrow \begin{bmatrix} u/z \\ v/z \\ 1 \end{bmatrix}$$

pixel coords