# CS451
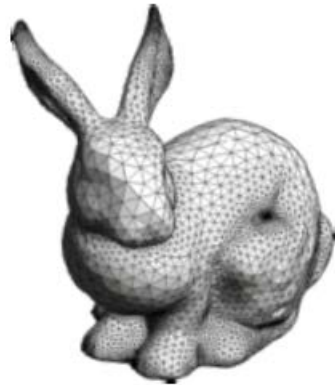# Ray Casting

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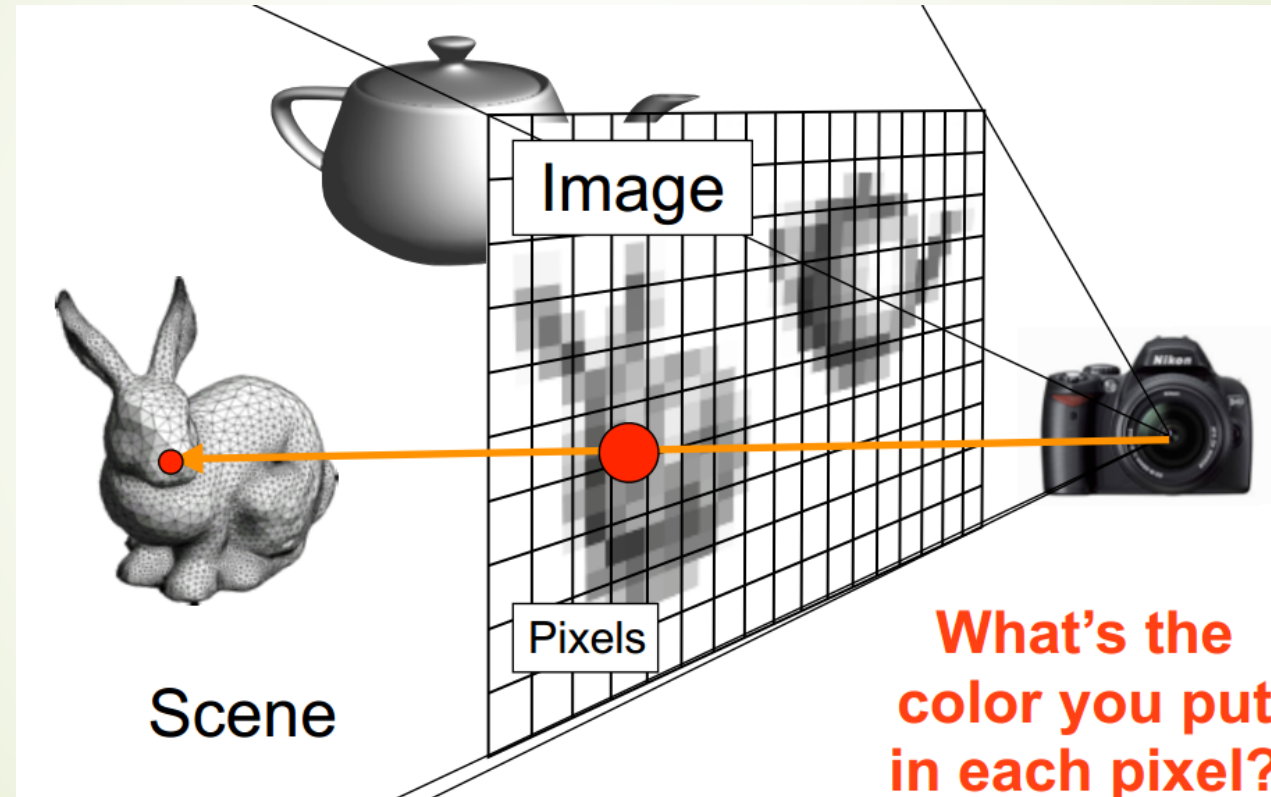# Rendering Review
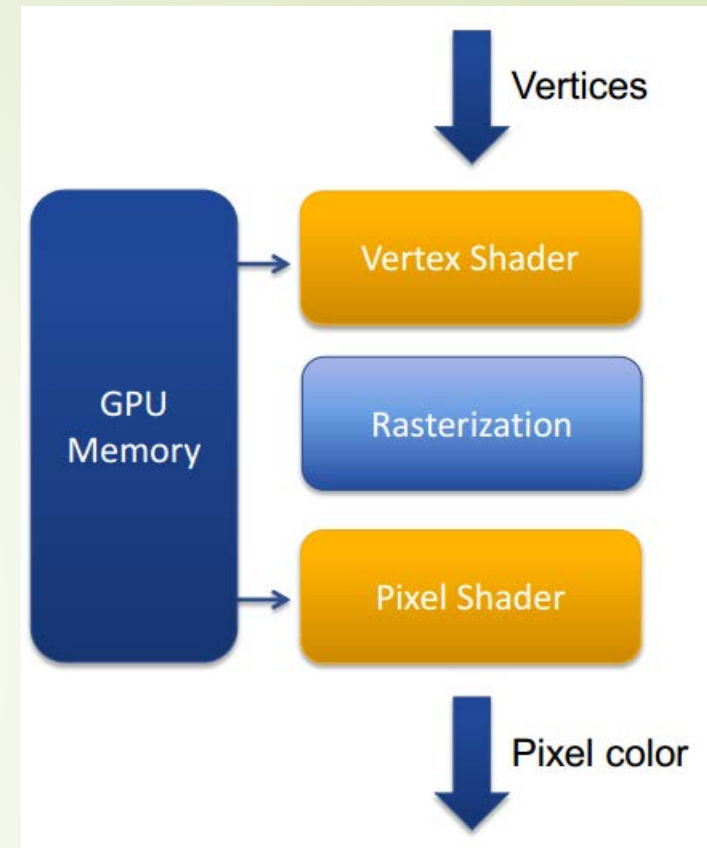
# Rendering Review

# Projection-Based Rendering

- Projection-based Rendering
  - Lights: directional, point, spot
    - Interact with vertices
  - Shading
    - determine pixel's colors
    - Ex: GLSL fragment shaders
  - Programmable pipeline opens up many possibilities
    - relief mapping, deferred rendering, non-photo realistic rendering (e.g. toon shading, cel shading), etc

# Non-Photo Realistic Rendering
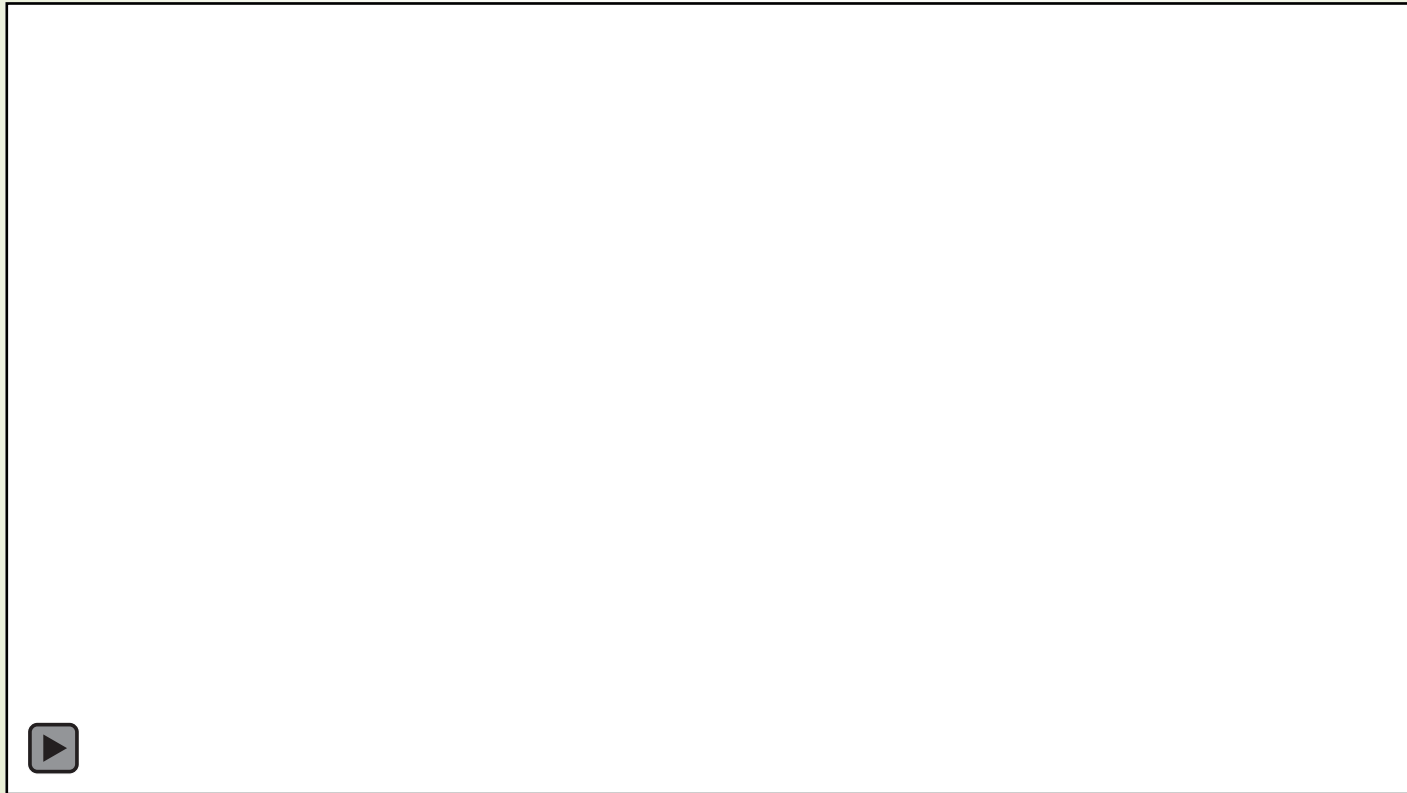
# Projection-Based Rendering

- More on programmable pipeline
- Input Assembler
  - Before Vertex Shader
  - Assembles data:
    - Vertex Buffer
    - Index Buffer
    - PrimitiveType
- Output Merger
  - After Pixel Shader
  - Z-buffer testing
  - Blending
  - Write to render target
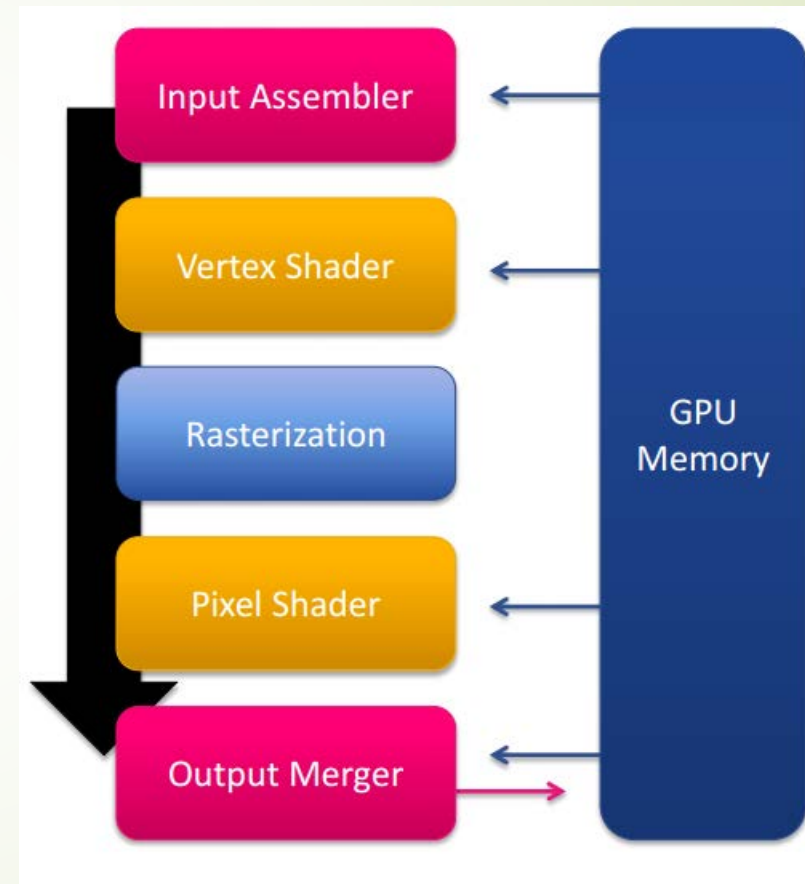
# Ray Casting

- For every pixel
    - Construct a ray from the eye
    - For every object in the scene
    - Find intersection with the ray
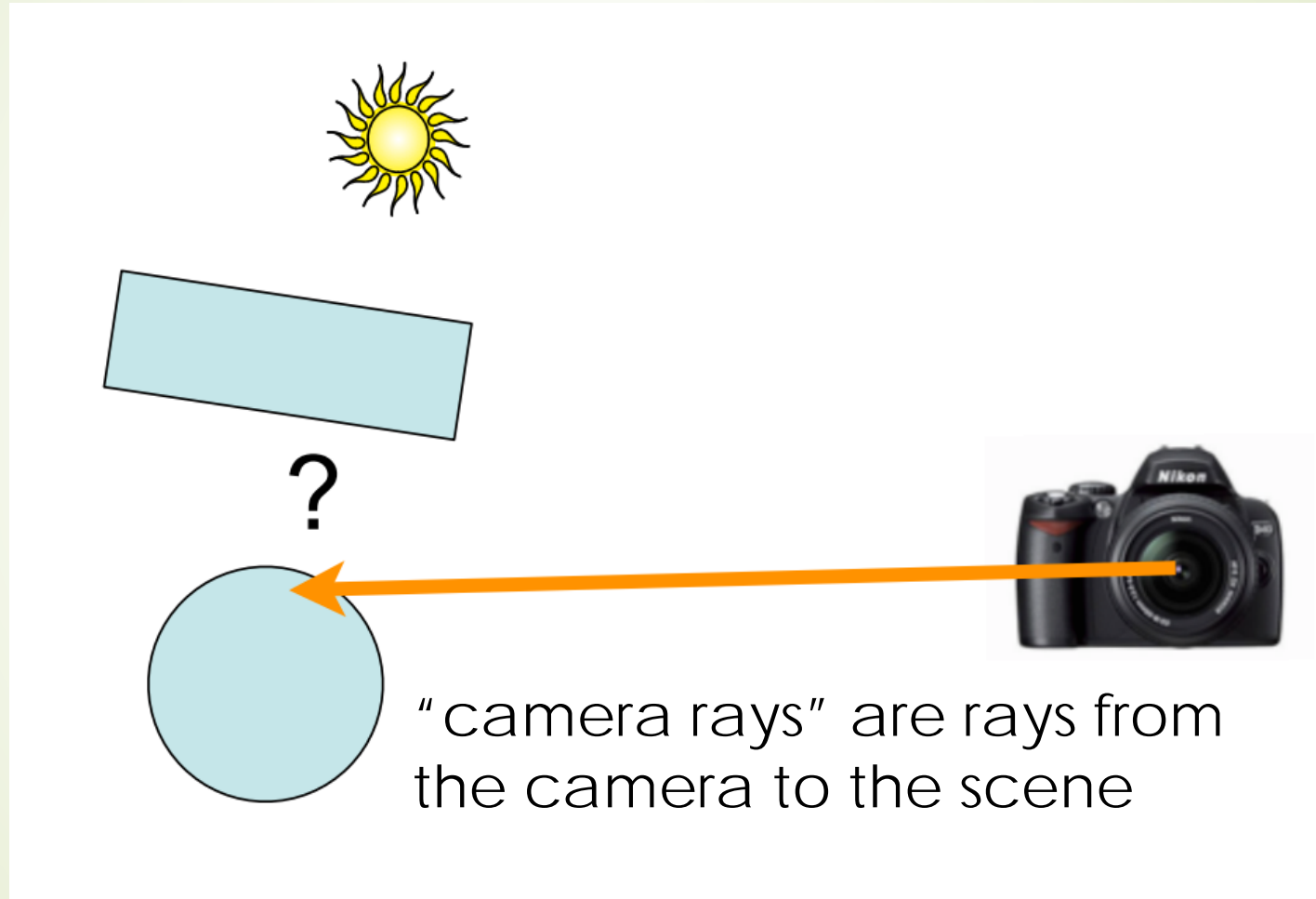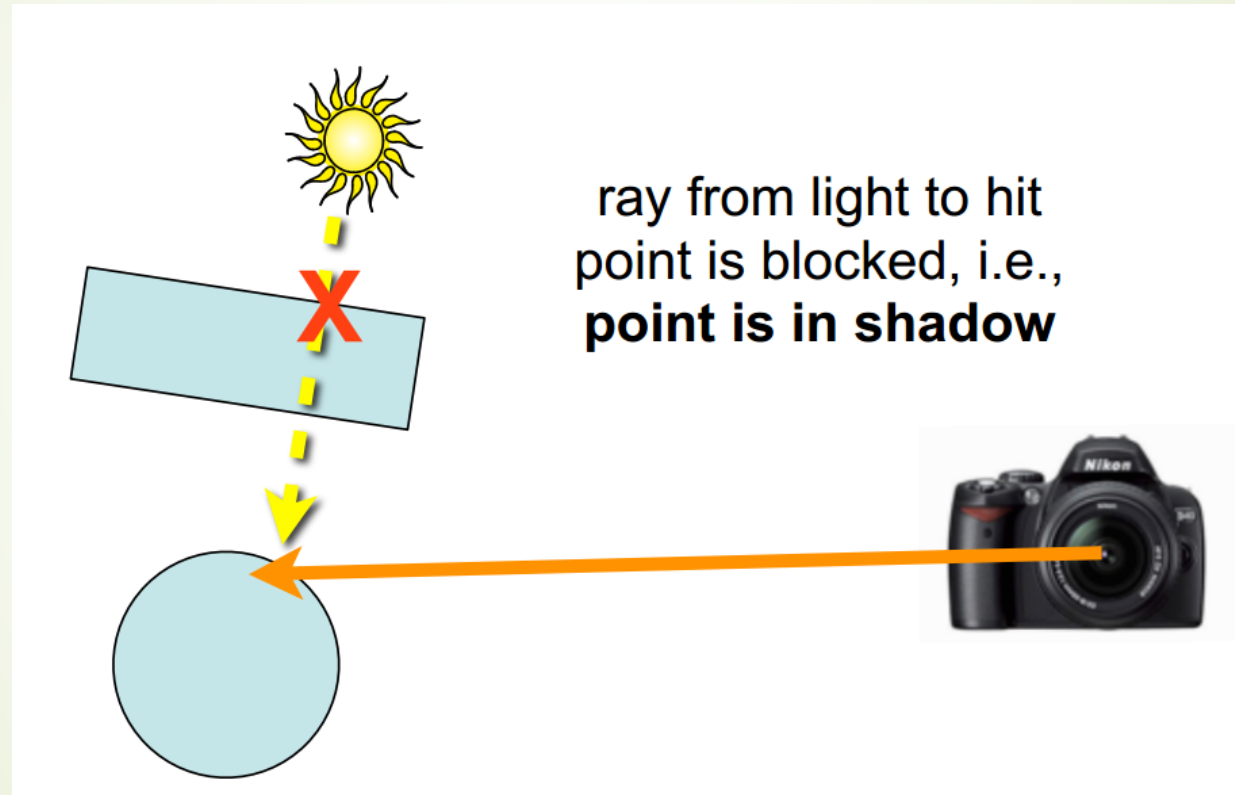    - Keep if closest
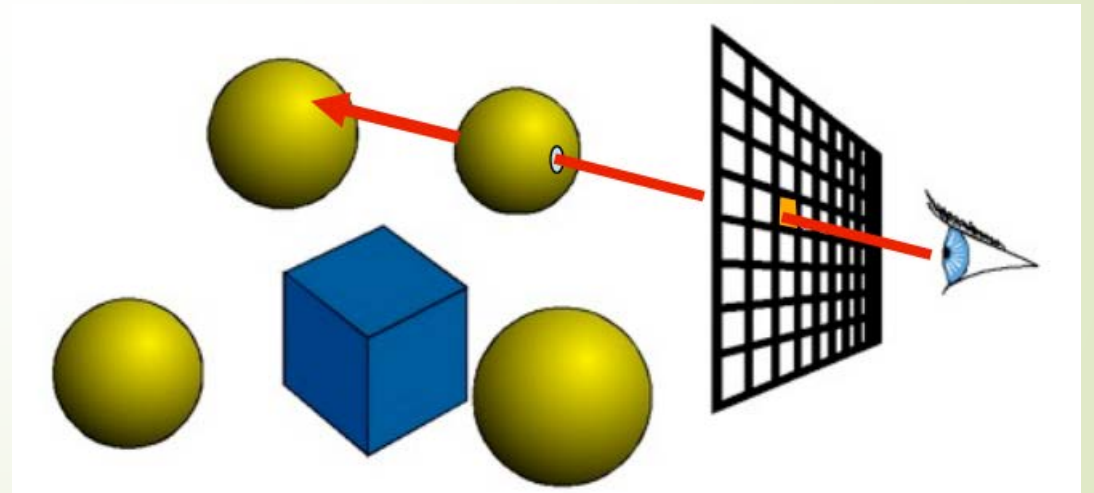
# Ray Casting Based Shading

- For every pixel
  - Construct a ray from the eye
  - For every object in the scene
  - Find intersection with the ray
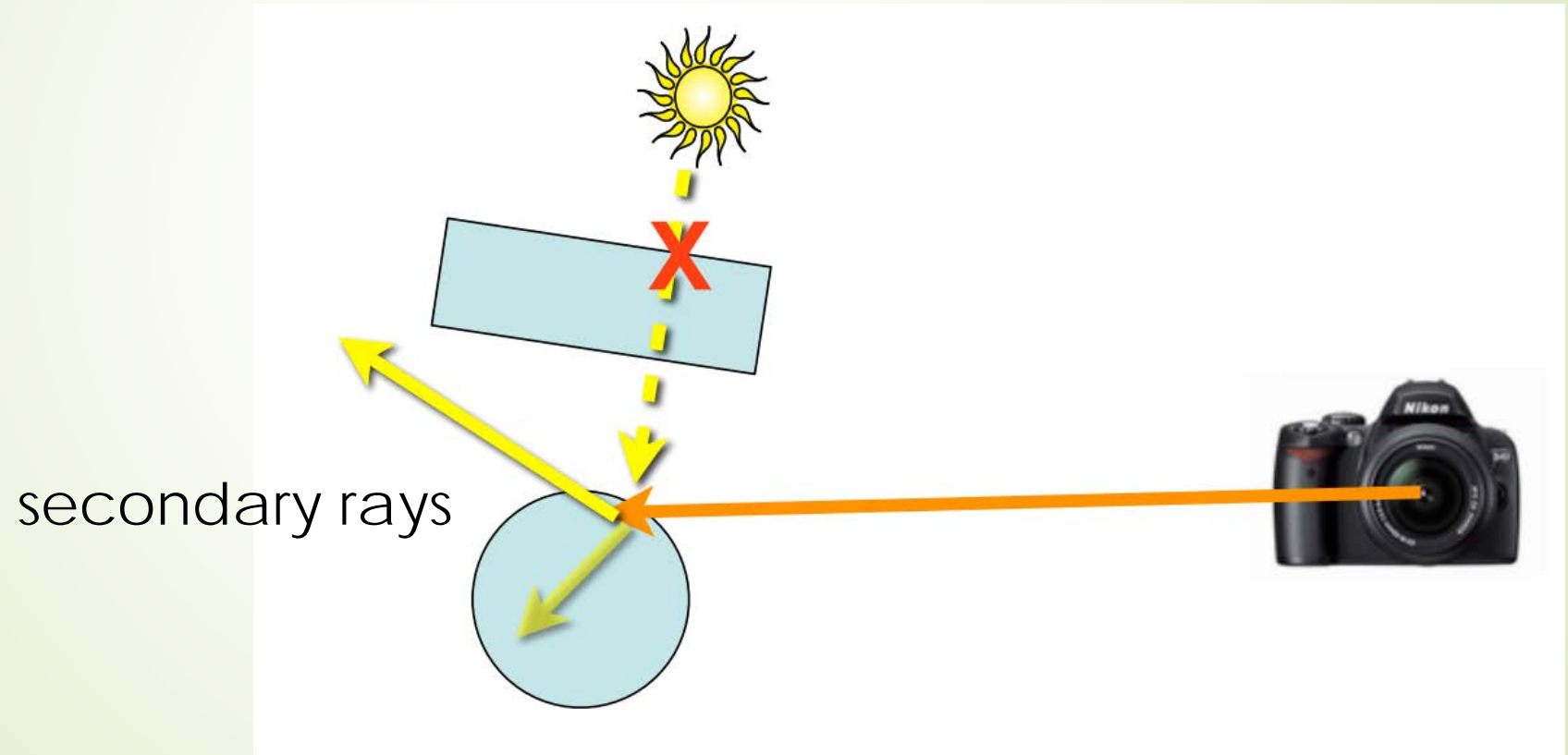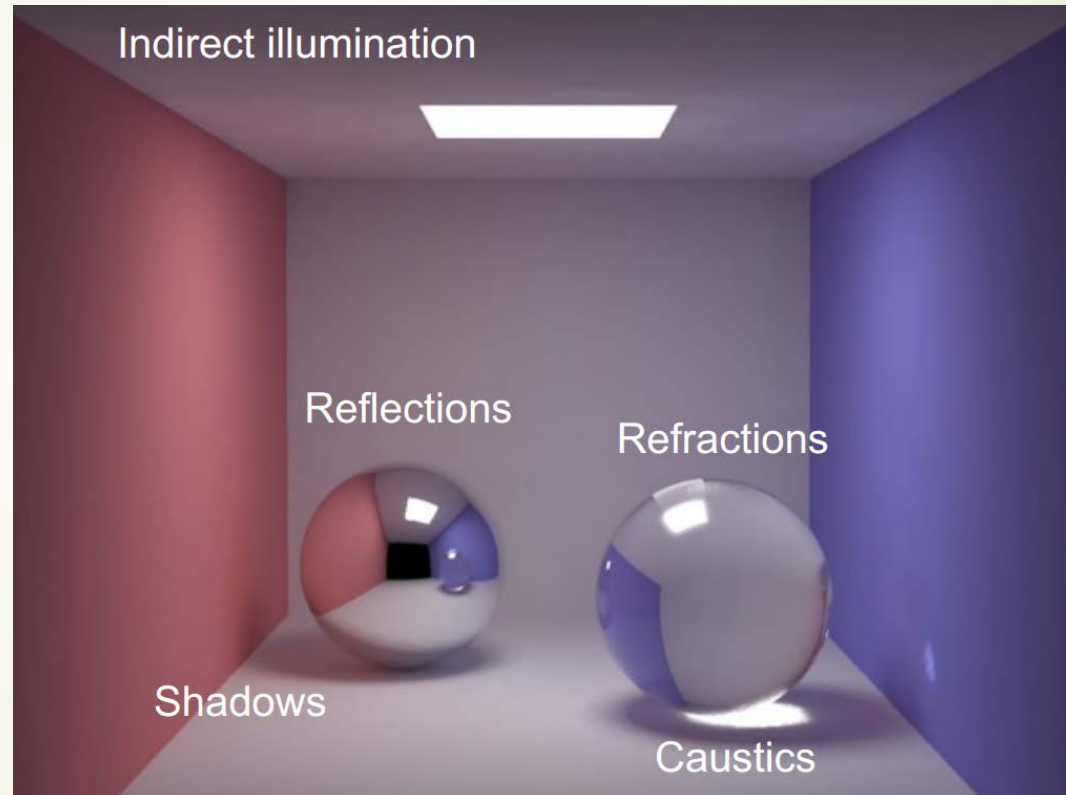  - Keep if closest
  - Shade

# Ray Casting



"camera rays" are rays from the camera to the scene

# Ray Casting Shadow
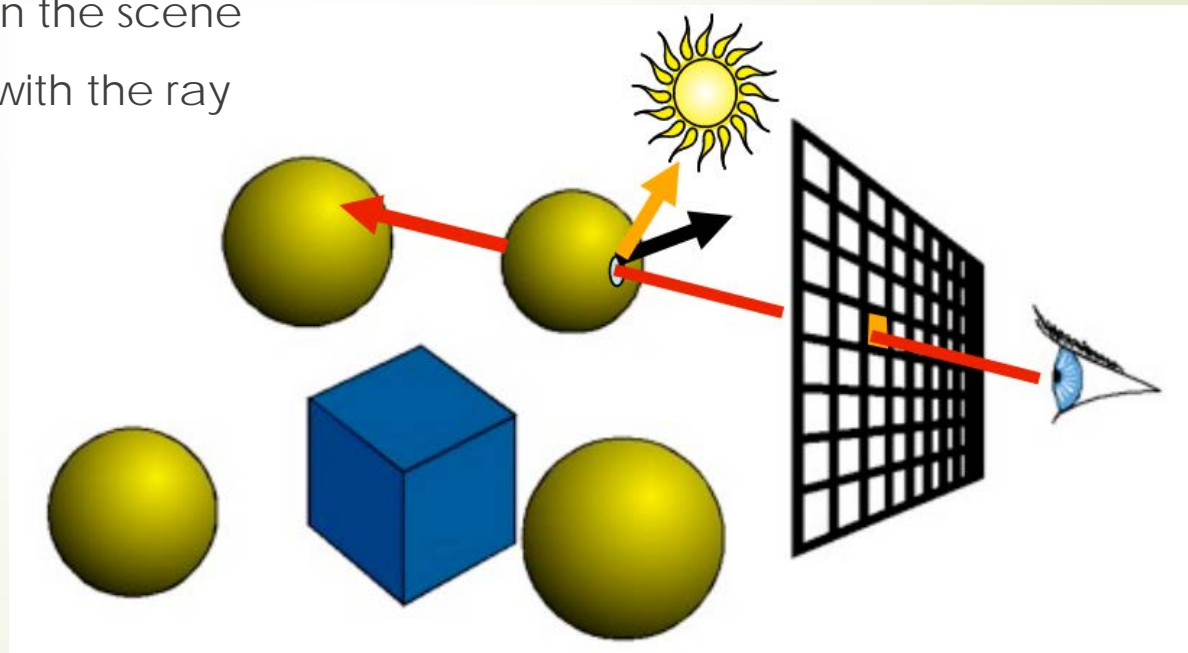


ray from light to hit point is blocked, i.e., **point is in shadow**

# Ray Tracing

- Ray casting = eye rays only
- Ray tracing = include secondary rays

secondary rays

# Questions?



Indirect illumination

Reflections
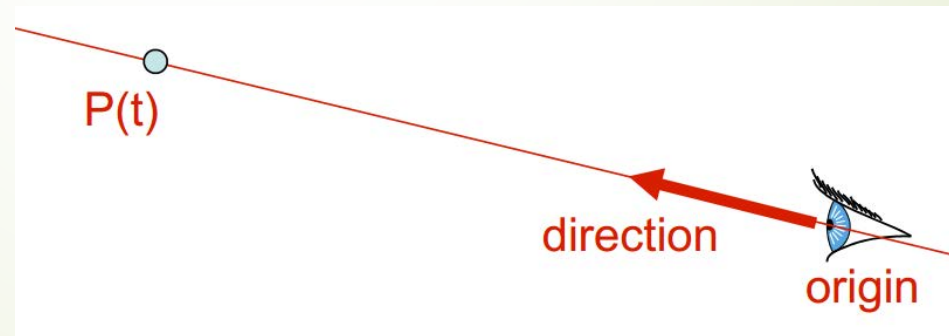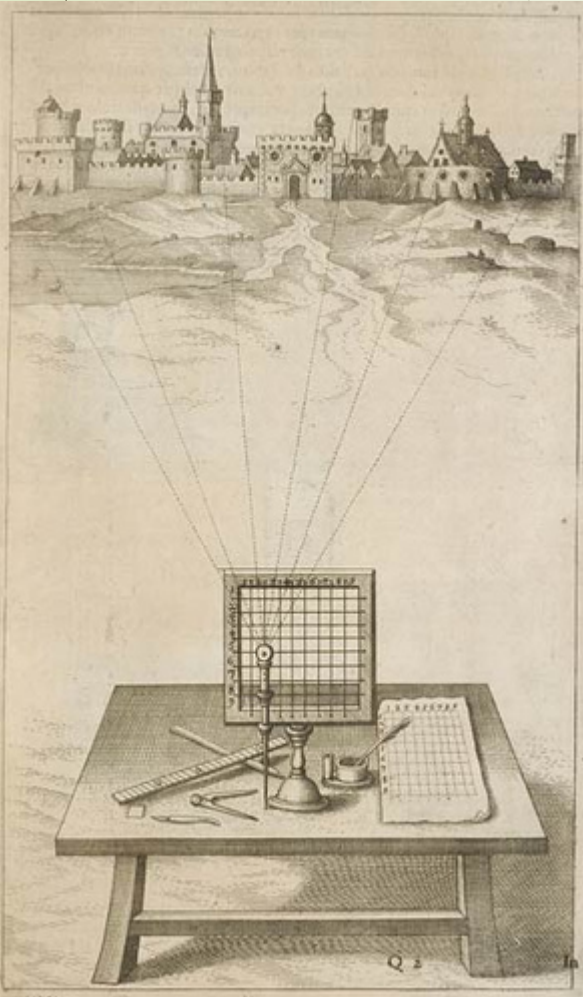
Refractions

Shadows

Caustics

# Ray

- Representation
  - Origin (Point)
  - Direction (Vector)
- Parametric line
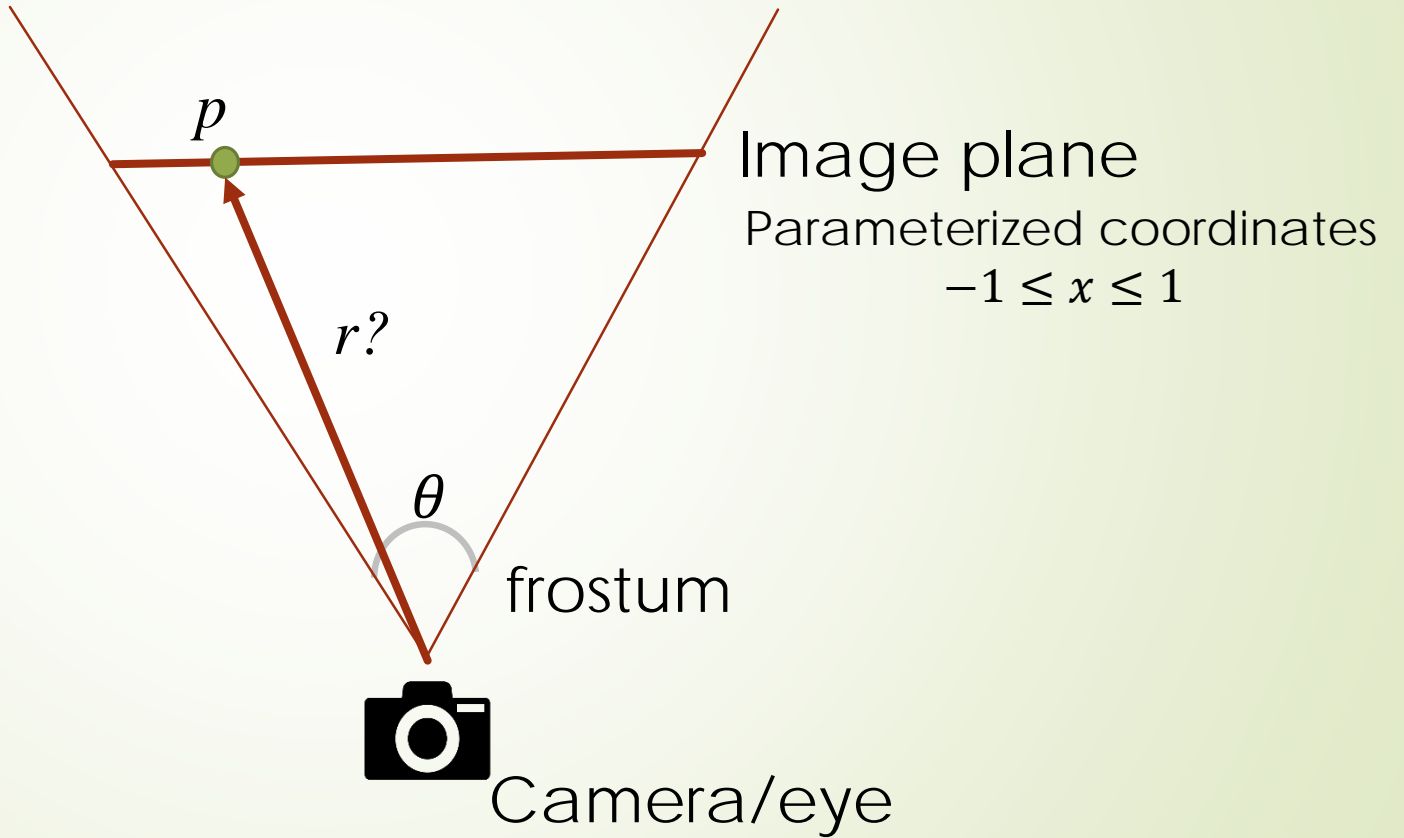  - $P(t) = O + tV, \forall t > 0$

# Albrecht Durer's Ray Casting



- Dürer demonstrates the device Alberti called a 'veil'.
  - The screen and corresponding grid on the artist's drawing paper are repeated for the viewer in the pattern of windows looking over a landscape.



http://aauerbach.info/research/theory/theoretical_eye.html
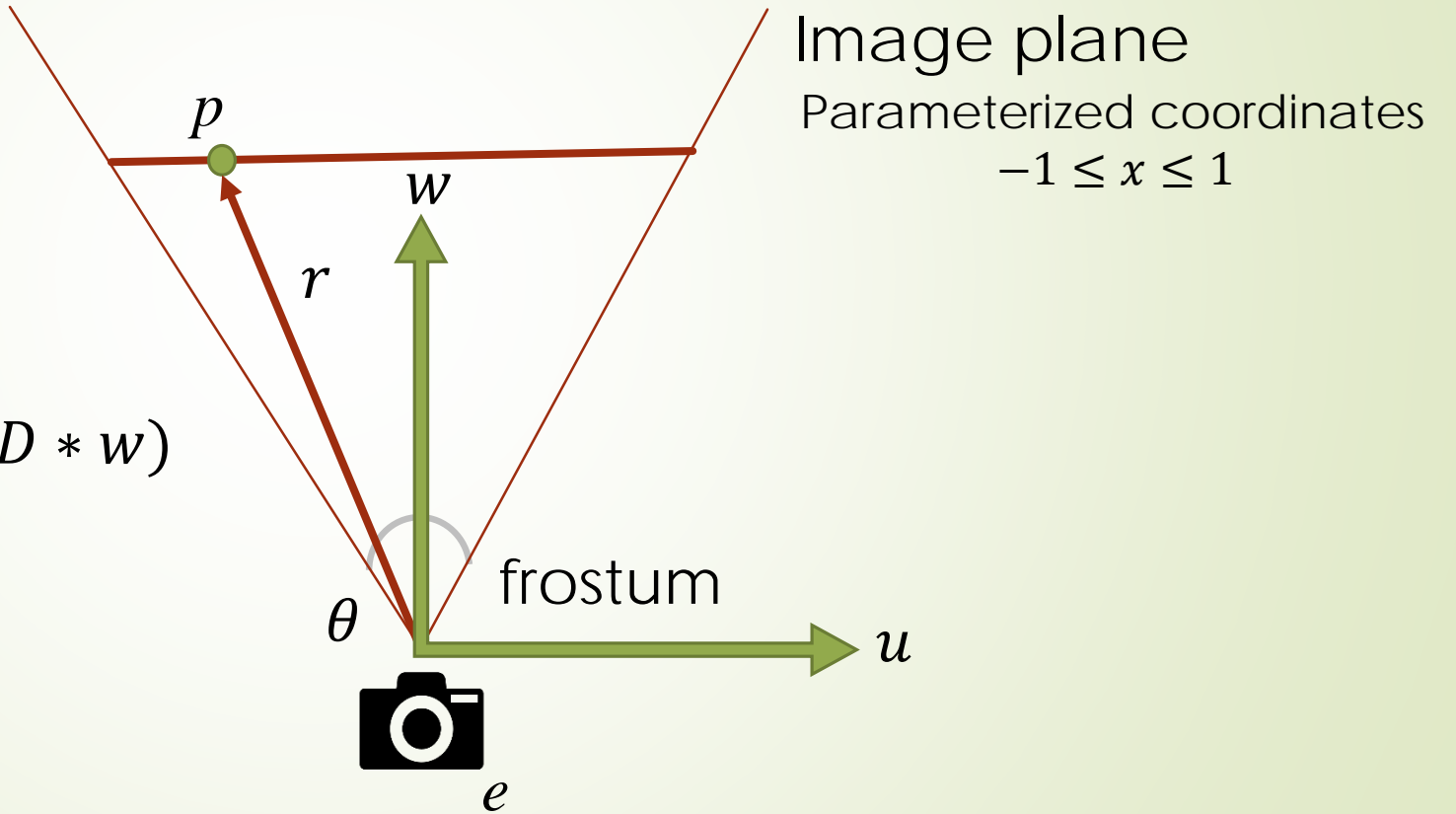
# Ray Generation

- In 2D

$p$

Image plane
Parameterized coordinates
$-1 \leq x \leq 1$

$r?$

$\theta$

frostum

Camera/eye

# Ray Generation



- In 2D

Image plane
Parameterized coordinates
$-1 \leq x \leq 1$

$$r = p - e = (x * u, D * w)$$

$$D = \frac{1}{\tan(\theta/2)}$$

frostum

# Ray Generation

- In 3D

**Image plane**
Parameterized coordinates
$$-1 \leq x \leq 1$$
$$-1 \leq y \leq 1$$

$p$

$w$

$r$

$$r = (x * u, A * y * v, D * w)$$

$A$ is the aspect ration

$$D = \frac{1}{\tan(\theta/2)}$$
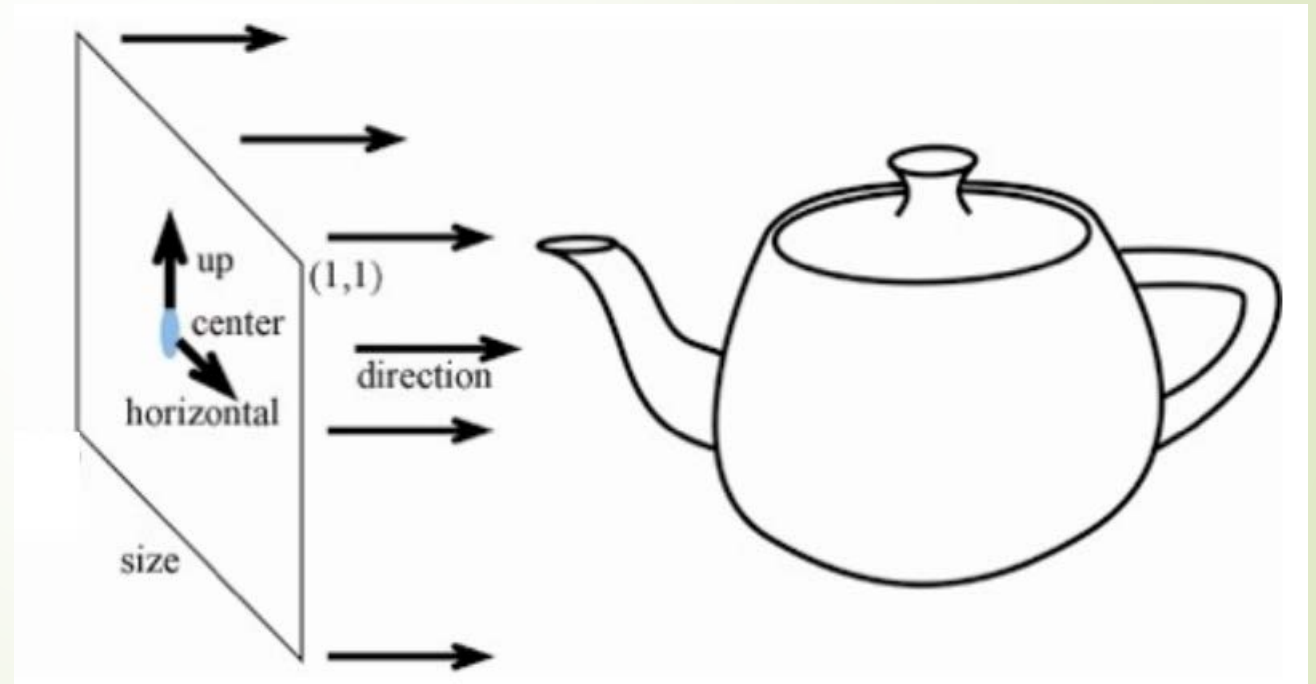
$\theta$

frostum
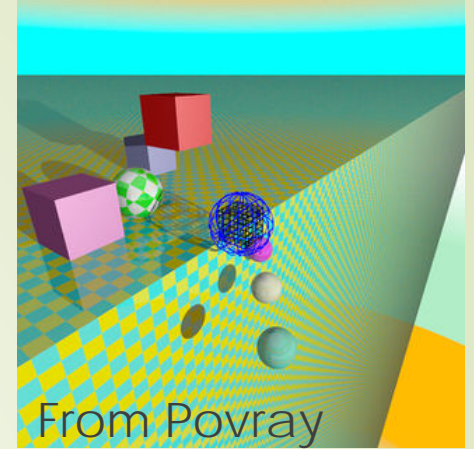
$u$

$v$

$e$
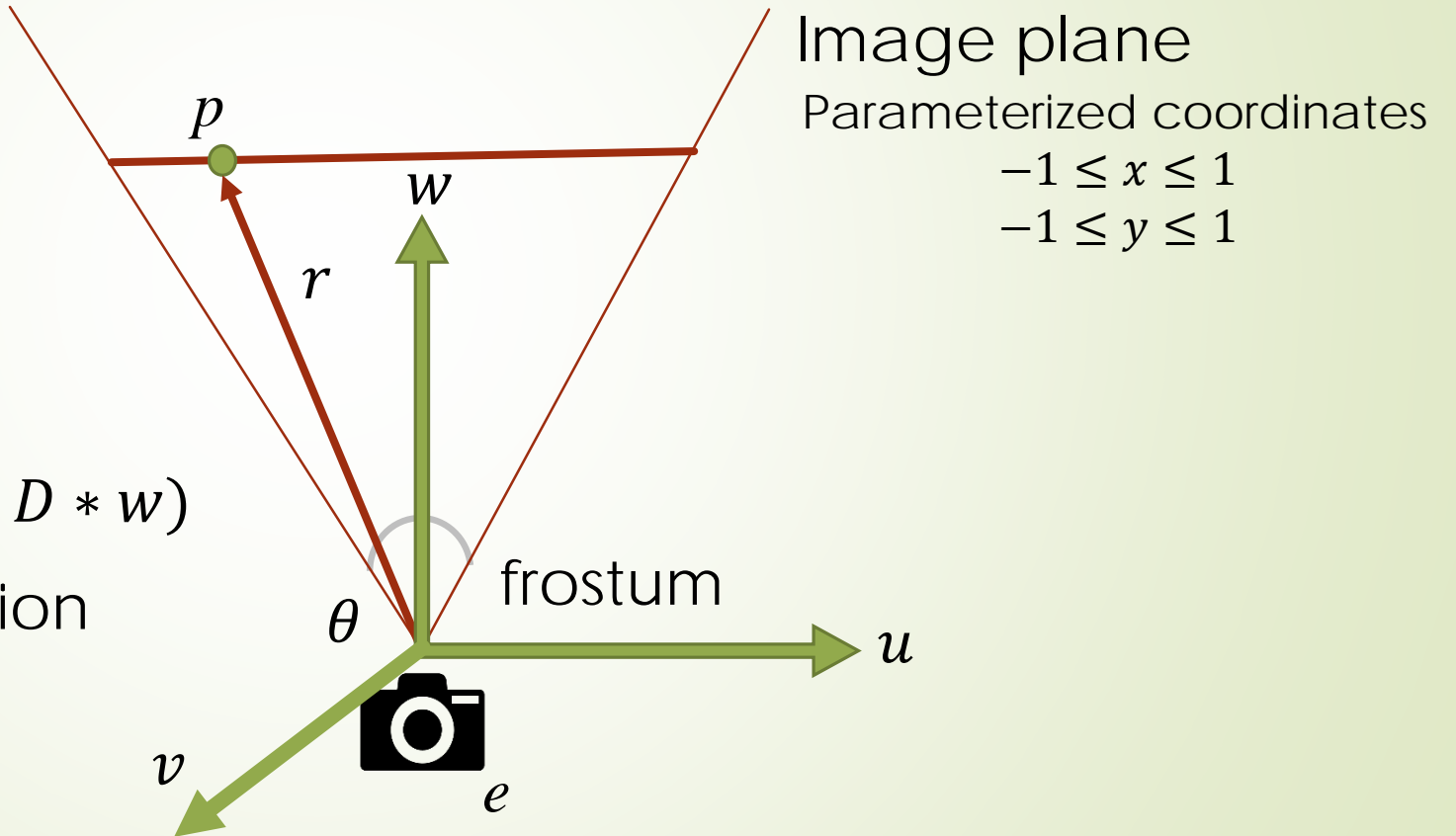
# Ray Generation for Orthographic Camera

- Orthographic Camera
  - Origin =
  - Direction =

# Other Types of Cameras


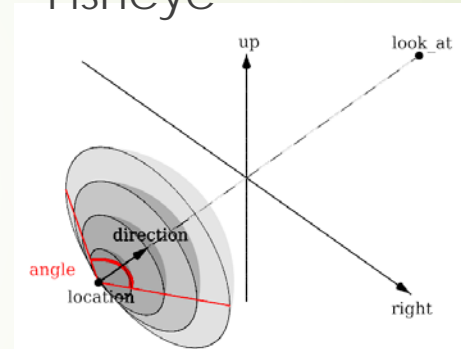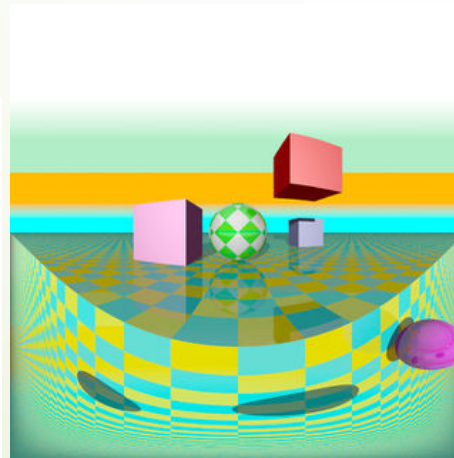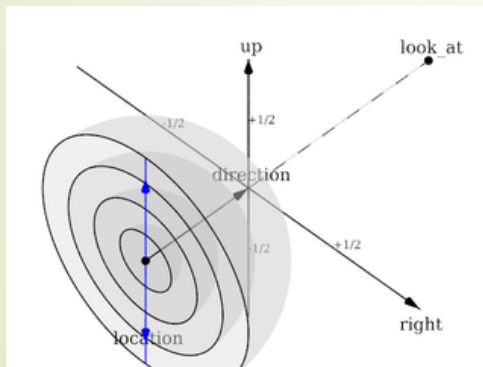From Povray

- Fisheye (spherical projection)
- Omnimax (Imax dome)
- Panoramic camera
- …

Fisheye


Panoramic


Omnimax