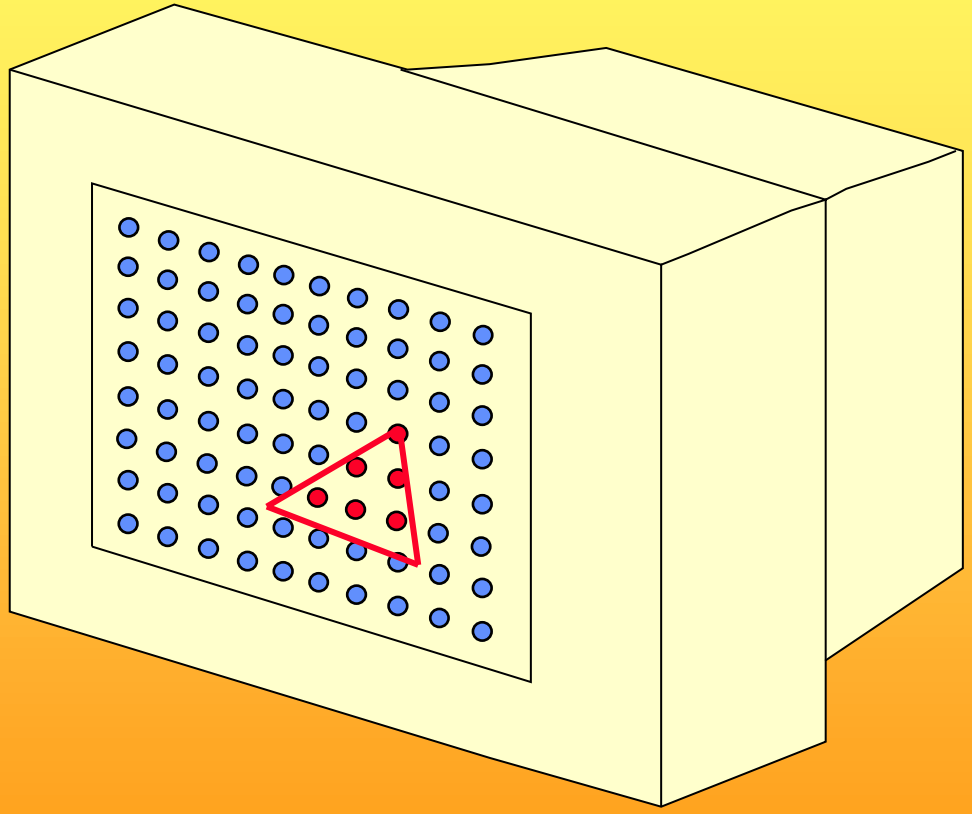
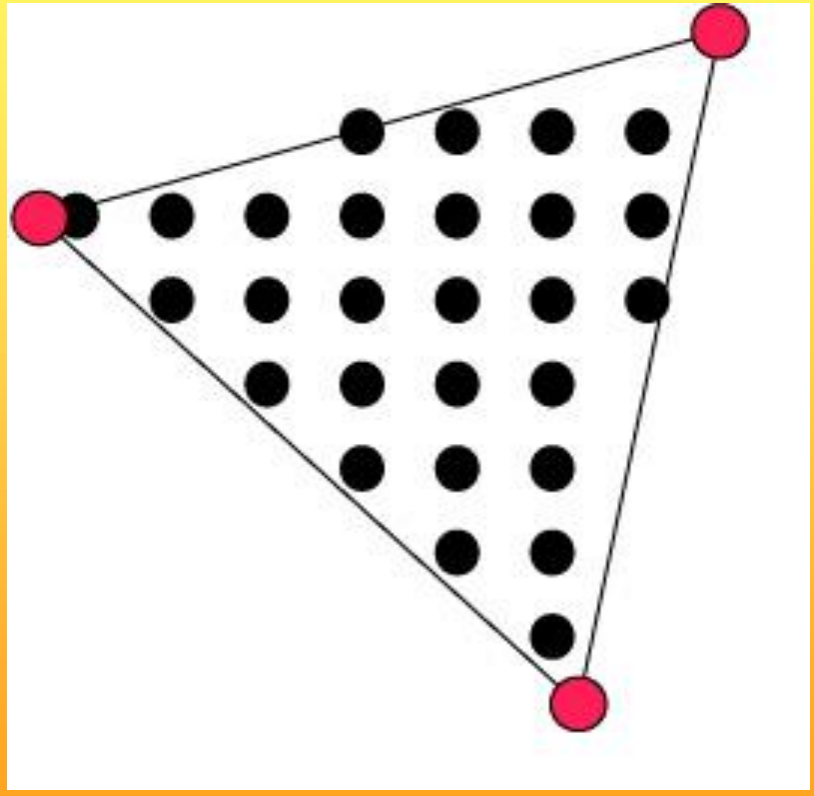
CHALMERS

3D Graphics in Games and Movies

Ulf Assarsson

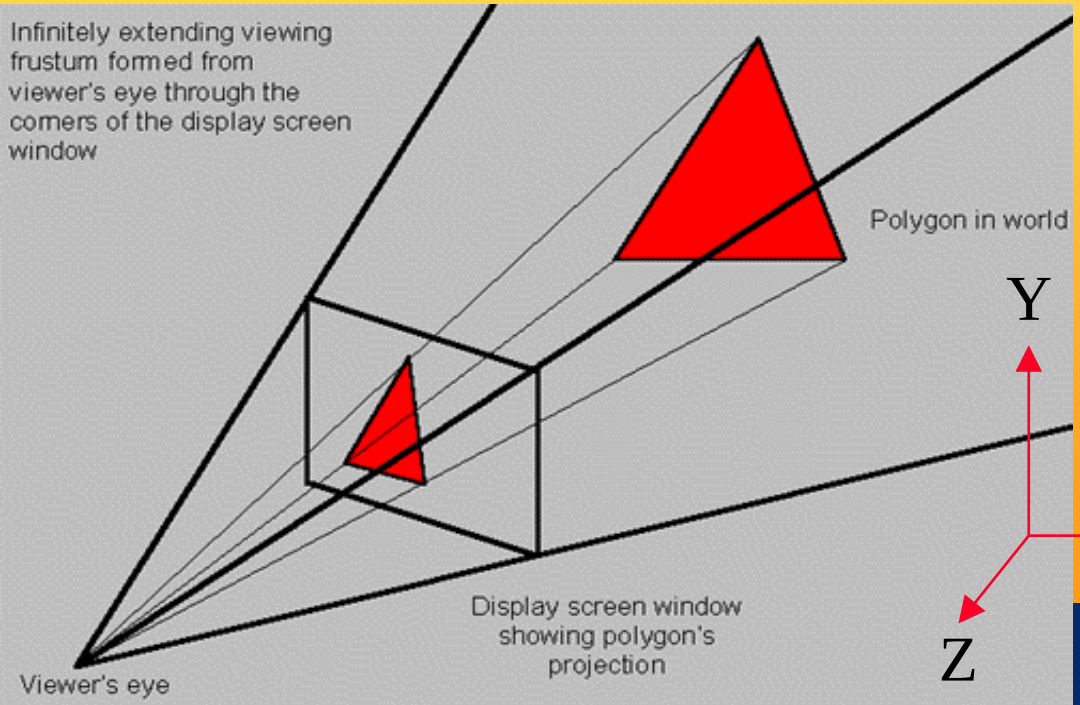
The screen consists of pixels

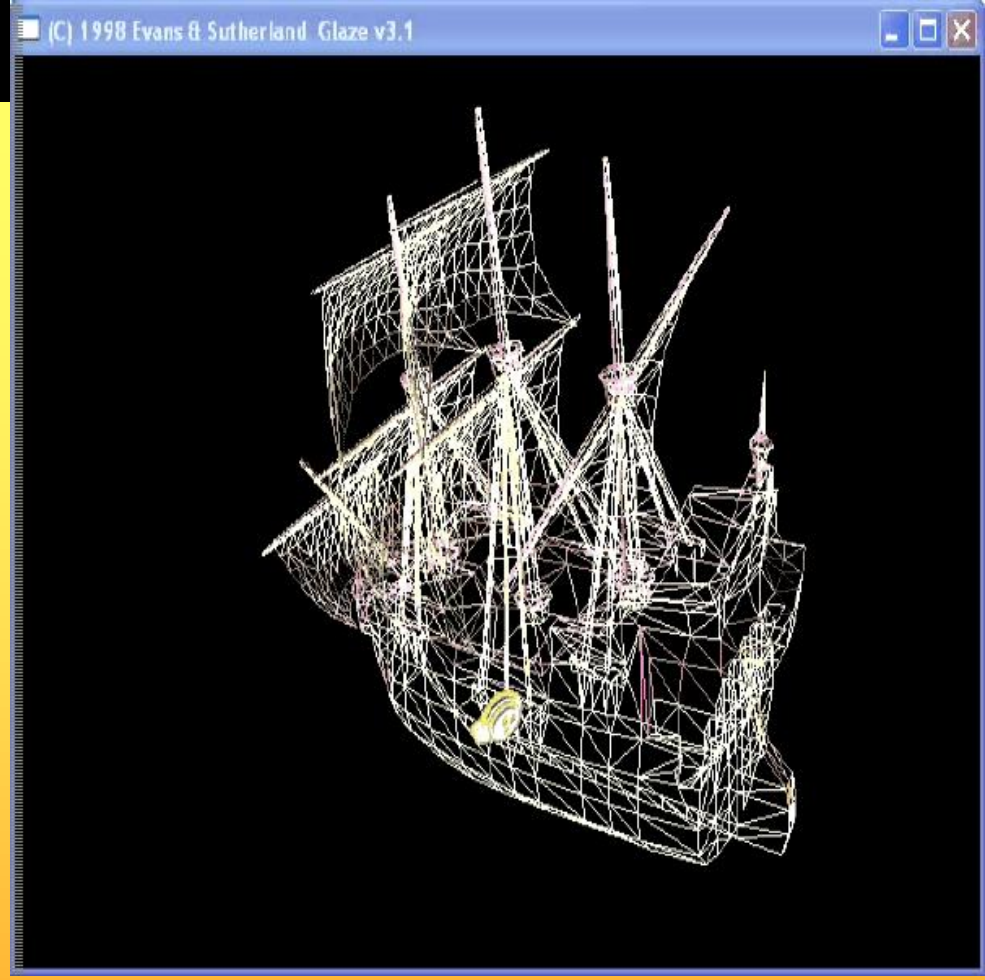




3D-Rendering

- Objects are often made of triangles
- x,y,z- coordinate for each vertex

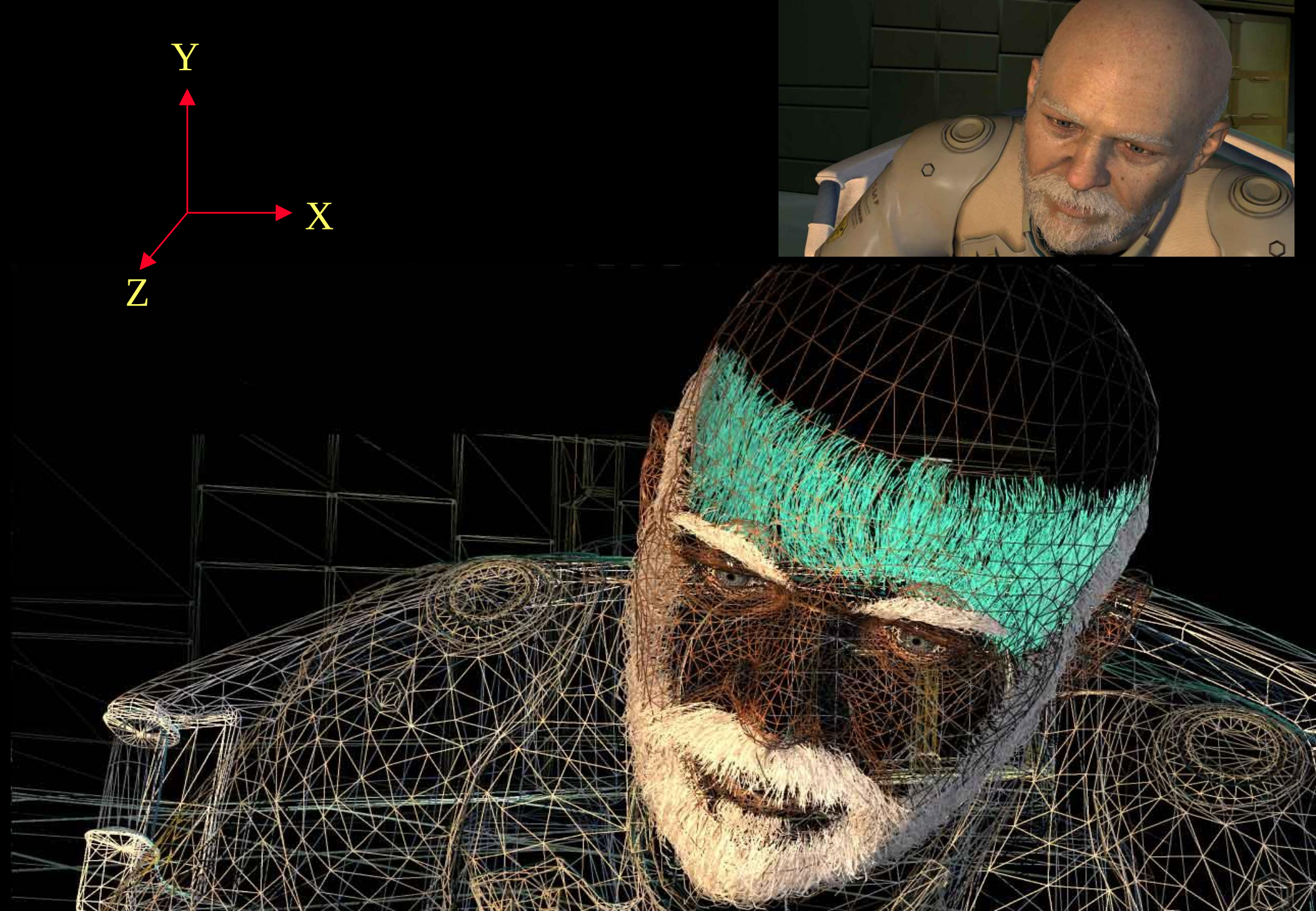




Why only triangles?

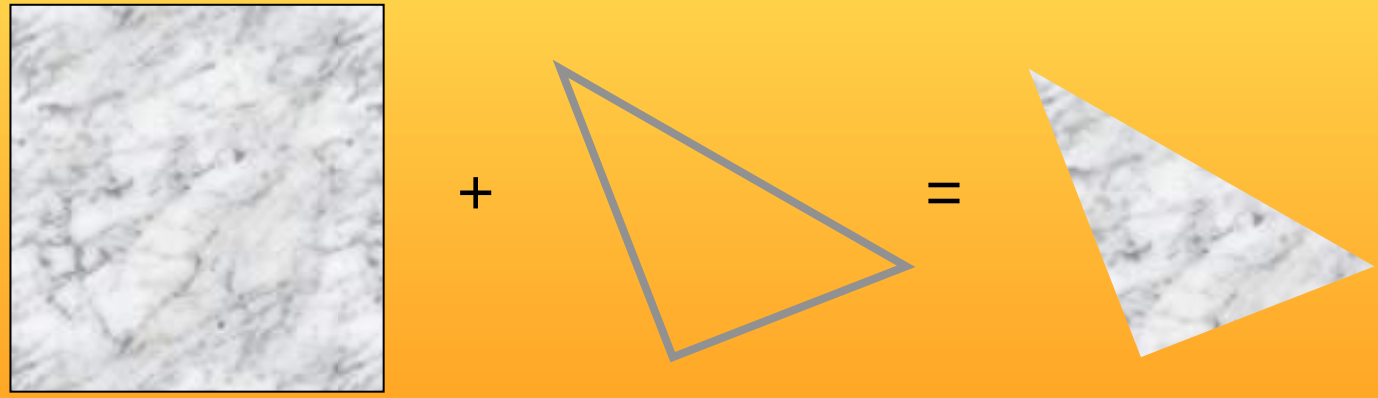
4D Matrix Multiplication

$$\begin{bmatrix} s_x & \bullet & \bullet & t_x \\ \bullet & s_y & \bullet & t_y \\ \bullet & \bullet & s_z & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$


Y
X
Z

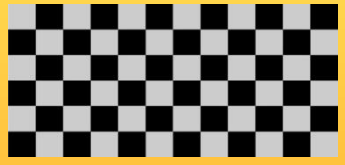
Textures

- One application of texturing is to ”glue” images onto geometrical object



Texturing: Glue images onto geometrical objects

- Purpose: more realism, and this is a cheap way to do it



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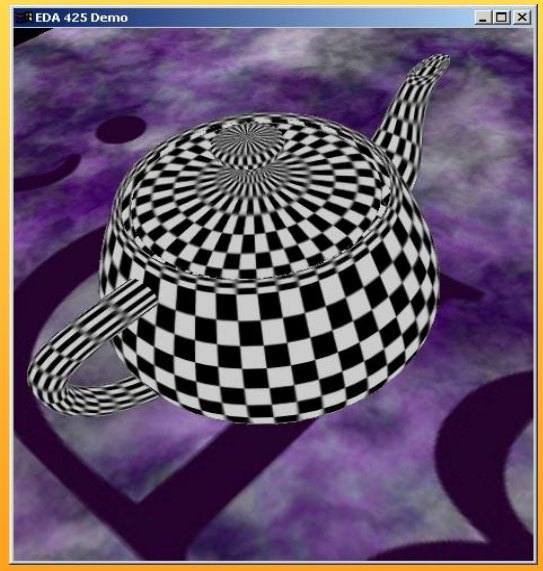
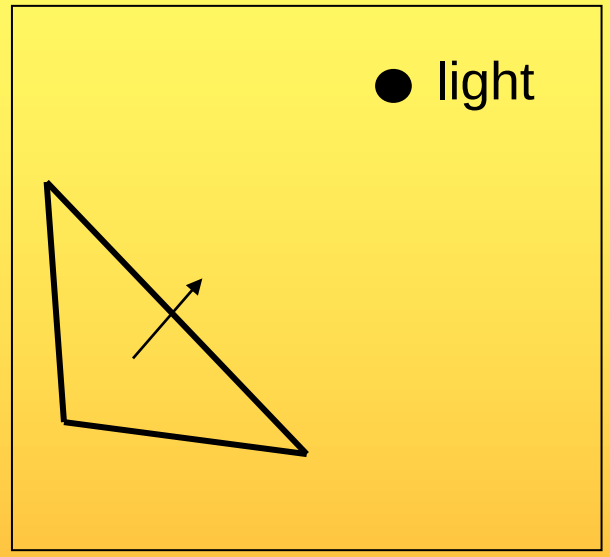
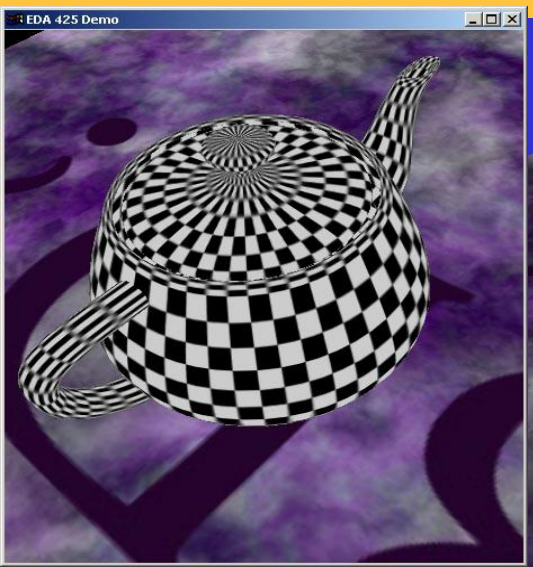
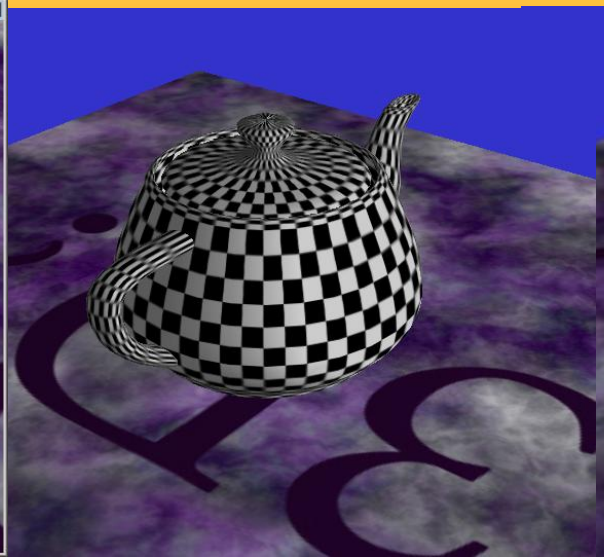
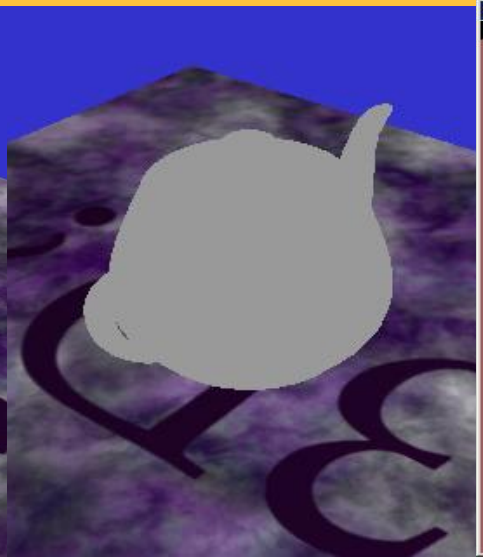


Light computation per triangle

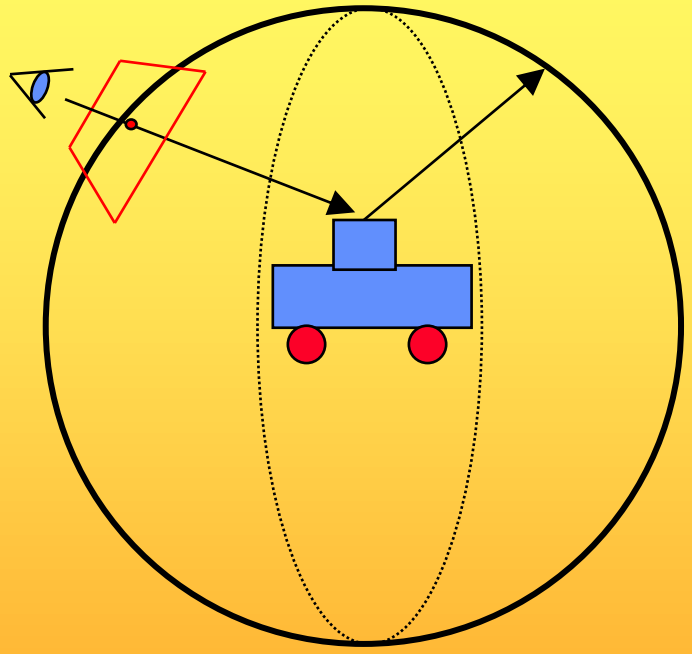


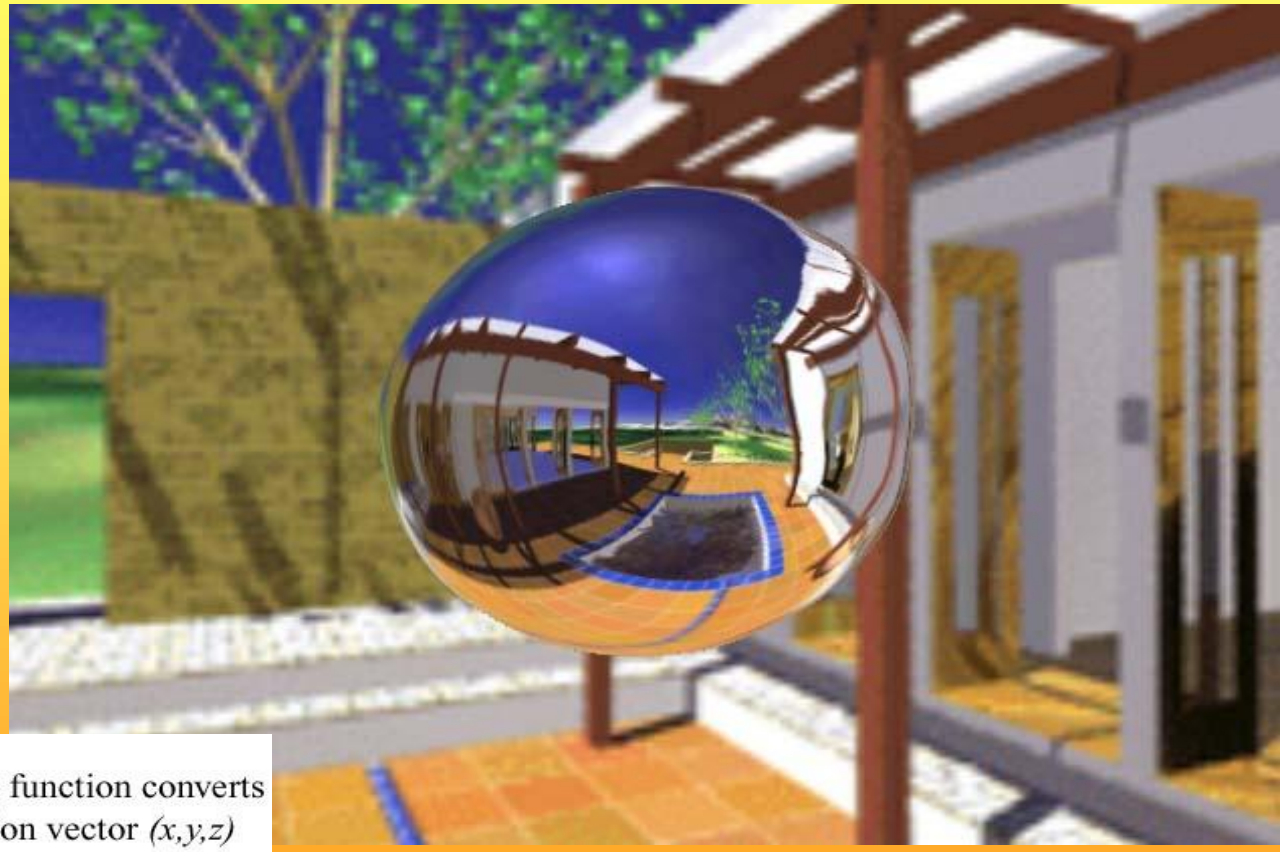


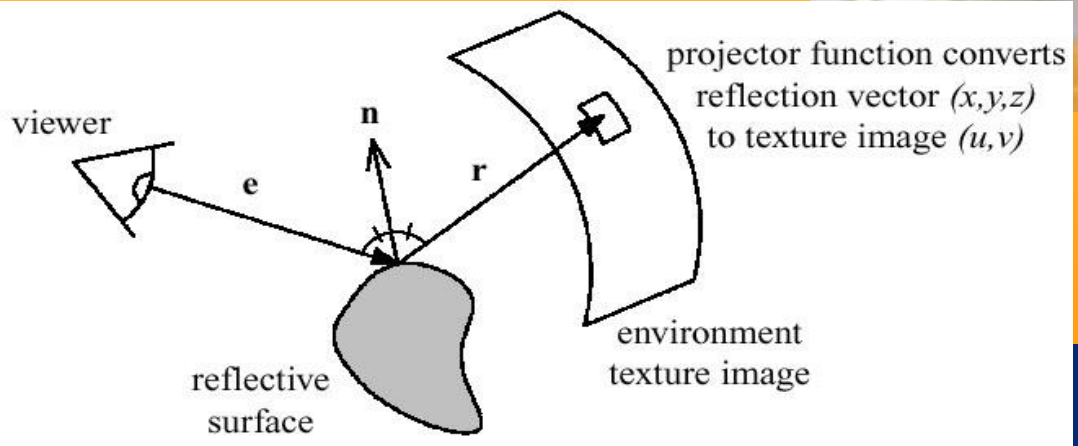




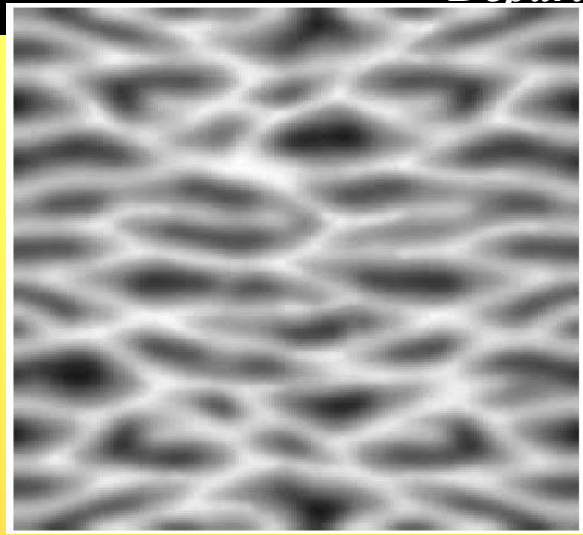
Environment mapping

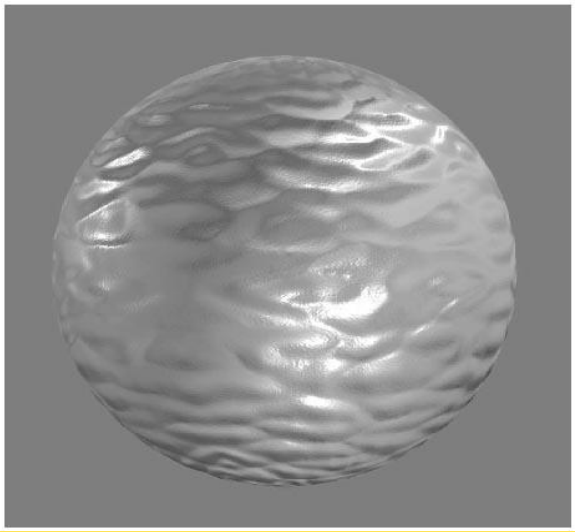




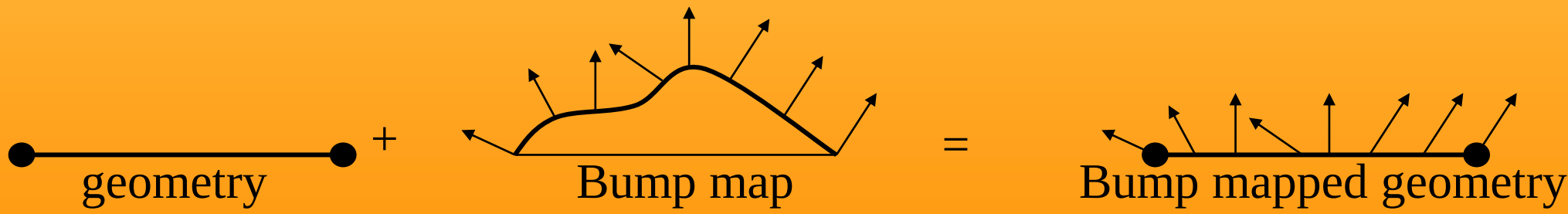


Bump mapping



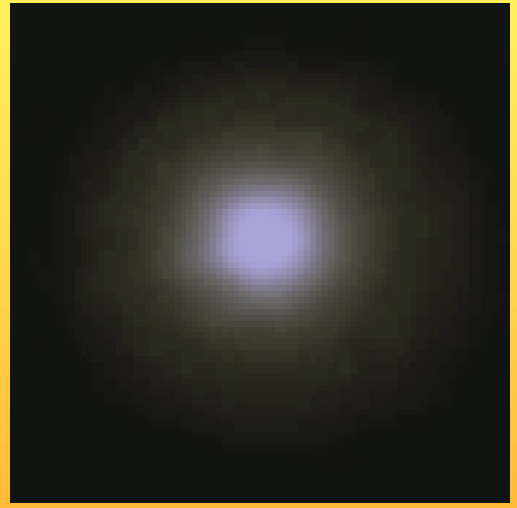


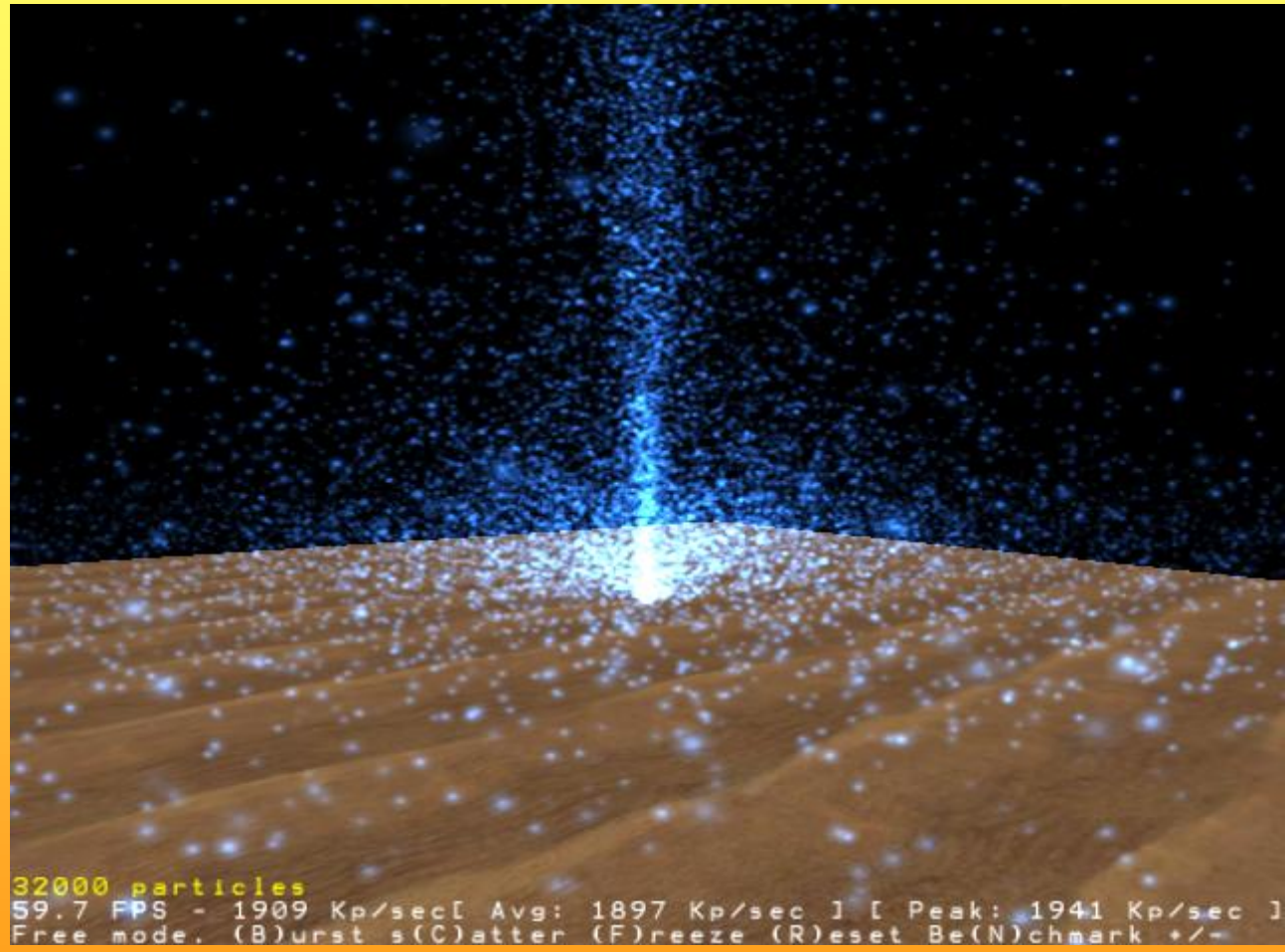
- by Blinn in 1978
- Inexpensive way of simulating wrinkles and bumps on geometry
  - Too expensive to model these geometrically



Stores heights: can derive normals

Particle System





Particles

Shadows

- More realism and atmosphere

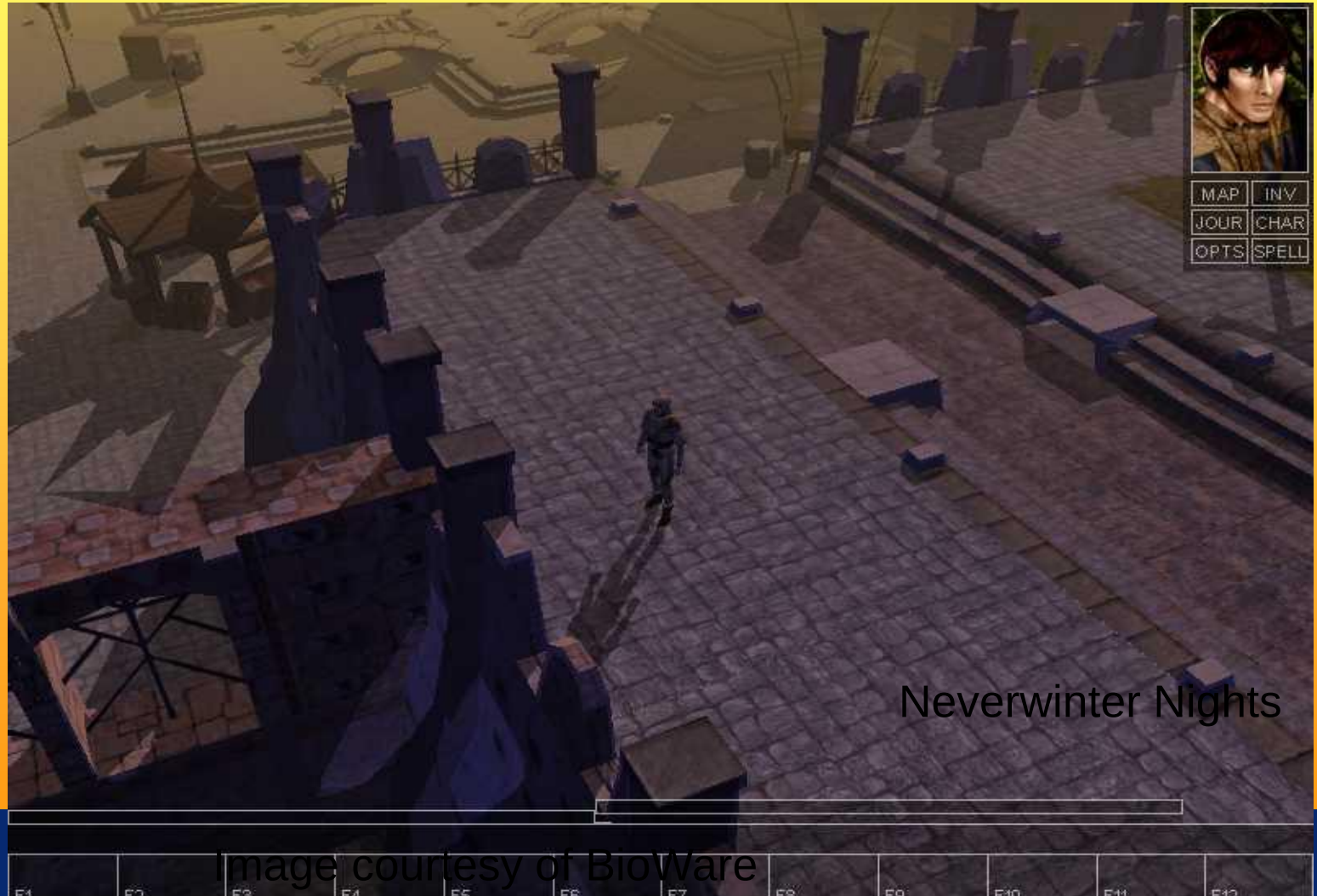
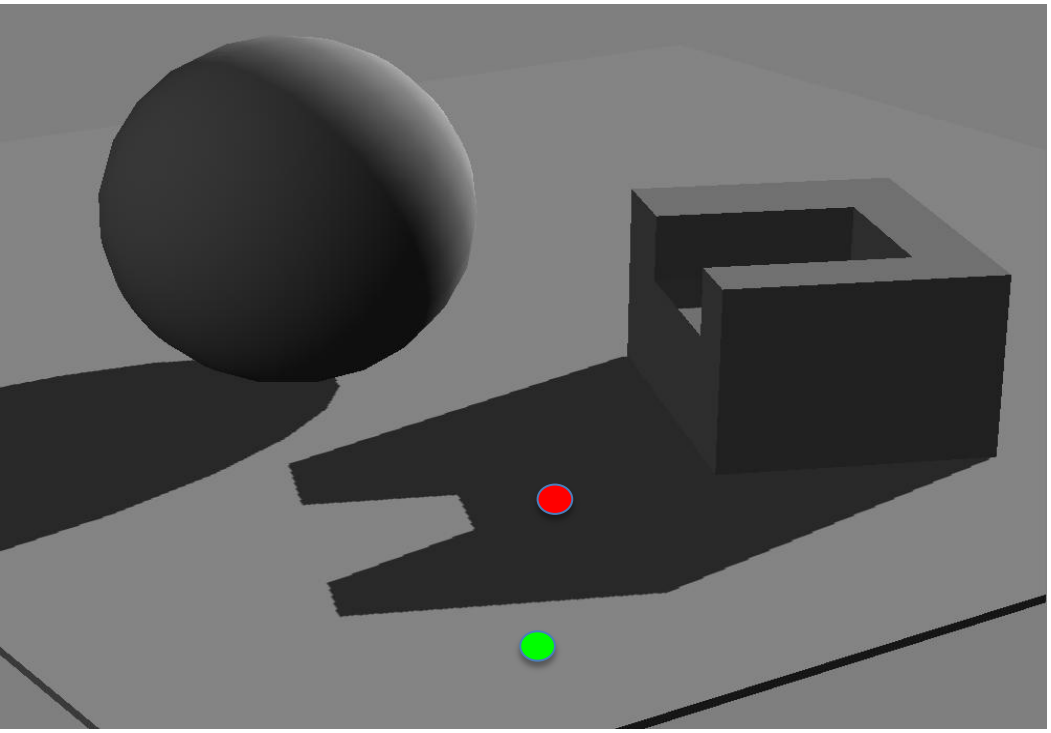


Image courtesy of BioWare

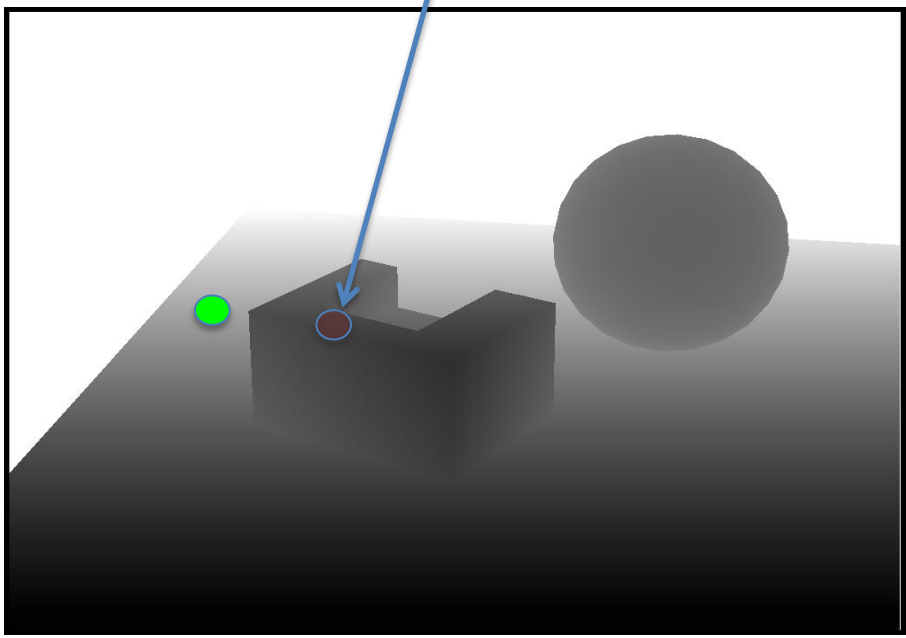
Shadows play an important role for realism

Shadow Maps



Camera's view

Point not represented in shadow map (point is behind box)



Light's view
(Shadow Map)

State of the art (realtime)

A few hundred textured polygons

Half a million individual line segments

Real time hair rendering

ain challenges

adowing

ard shadowing techniques fail

ow Maps => aliasing at sillhouette edges

ow Volumes => overdraw proportional to the number of uette edges

s **ALL** sillhouette edges

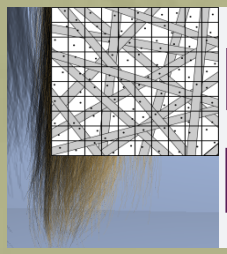
r technique handles transparency

rency

trand should contribute very little to a pixel (~1%)

ands are actually refractive and at least some rency effect is required

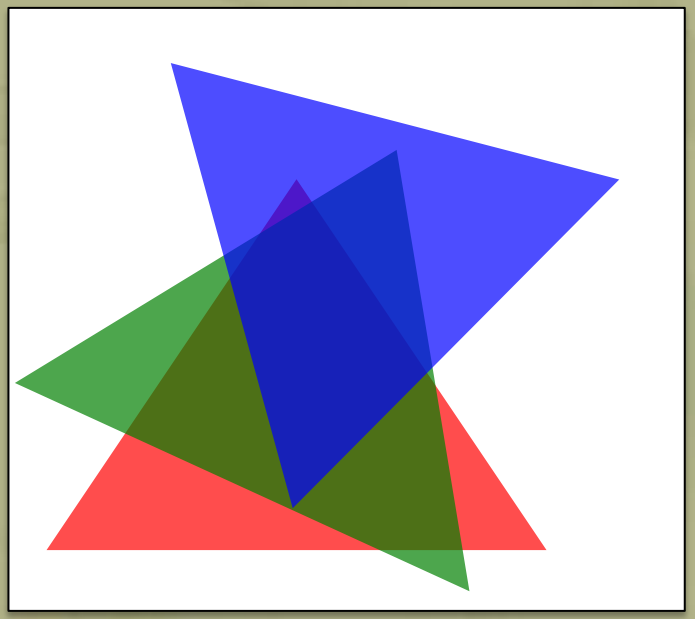
lending works very well to handle this

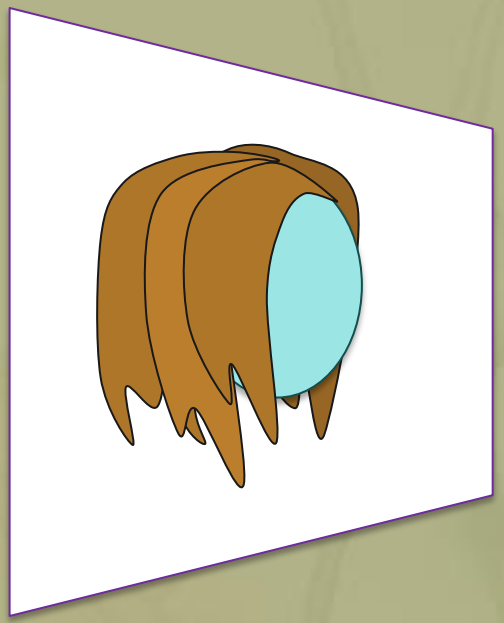


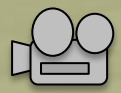
Draw transparent objects back-to-front

Painter's algorithm:
sort transparent primitives and render back-to-front.

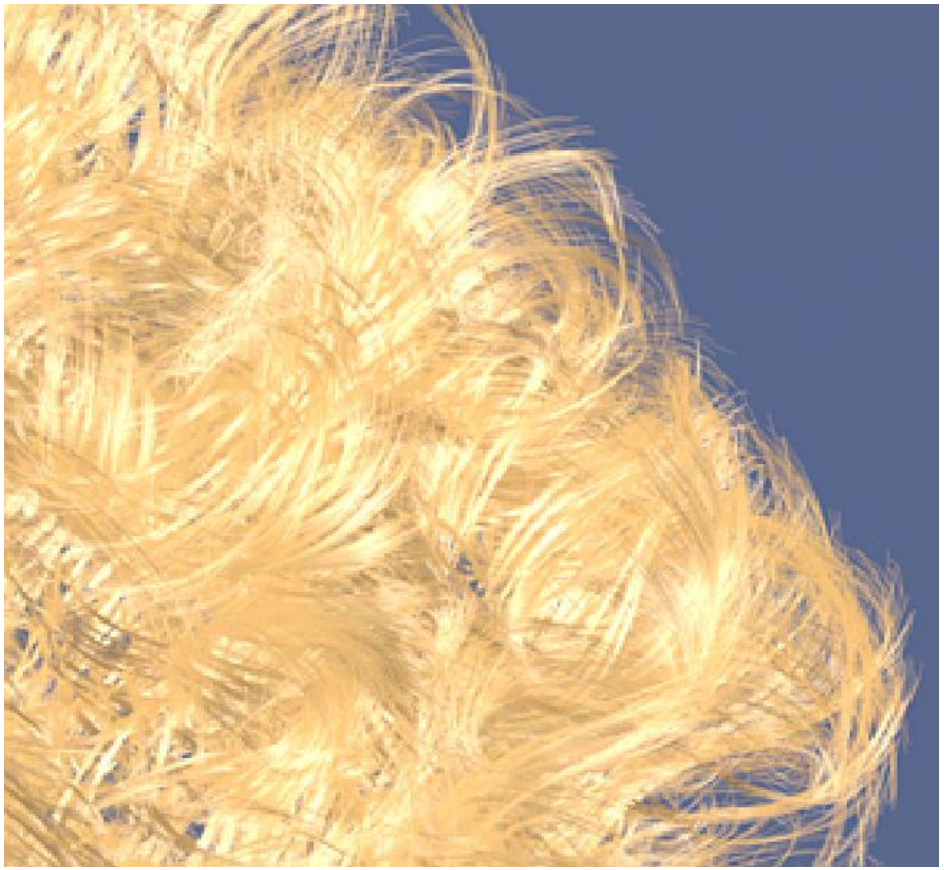
E.g. 30% transparency means objects behind show through by 30%.







Importance of Shadows



Images from: Tom Lokovic and Erich Veach, "*Deep Shadow Maps", pp 385-392, Siggraph 2000.*

Importance of Transparency

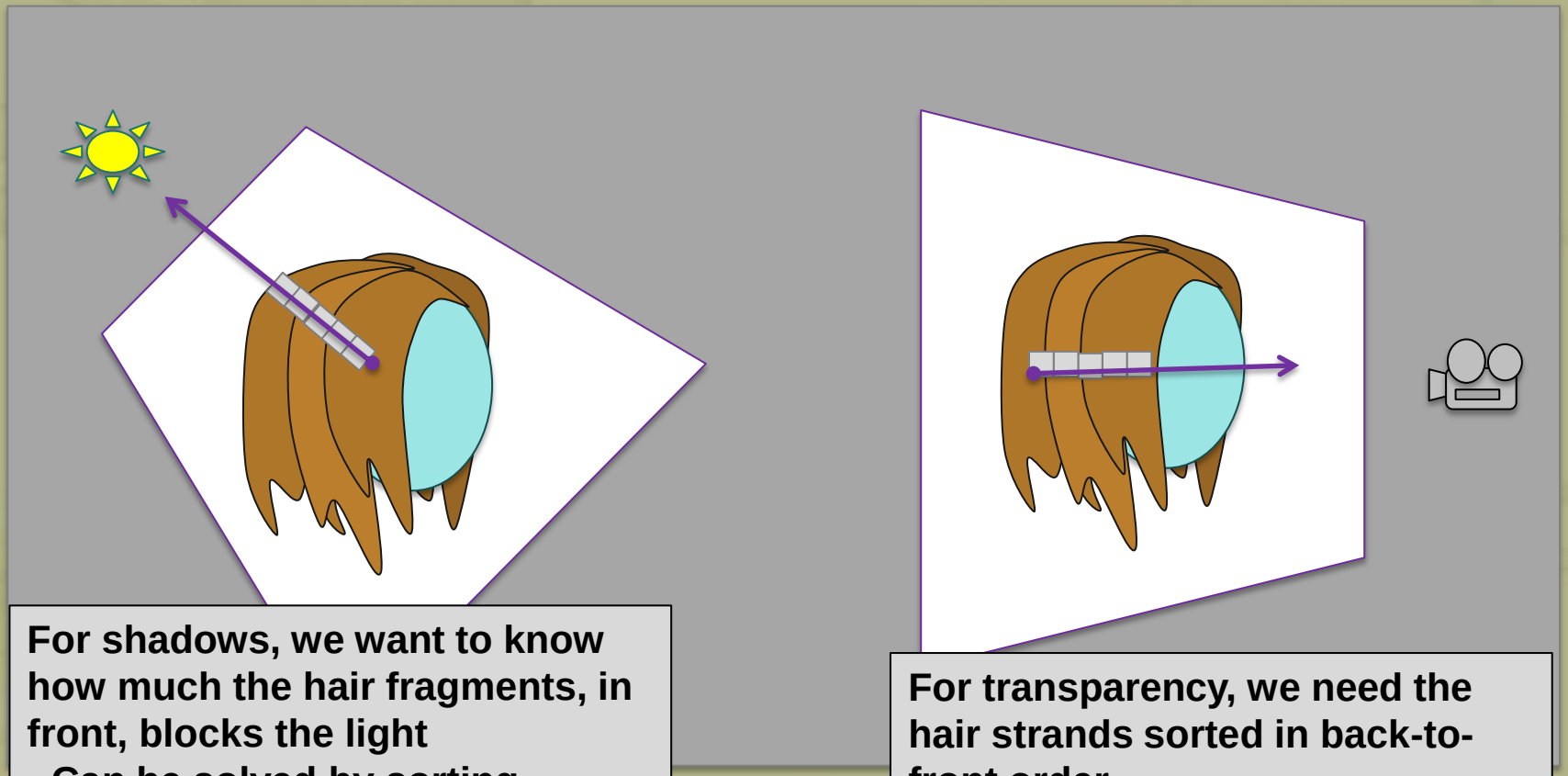
- Hair is sub-pixel sized and transparent, alpha blending is absolutely necessary

Without alpha blending

With alpha blending

Real time hair rendering

The two problems are quite similar



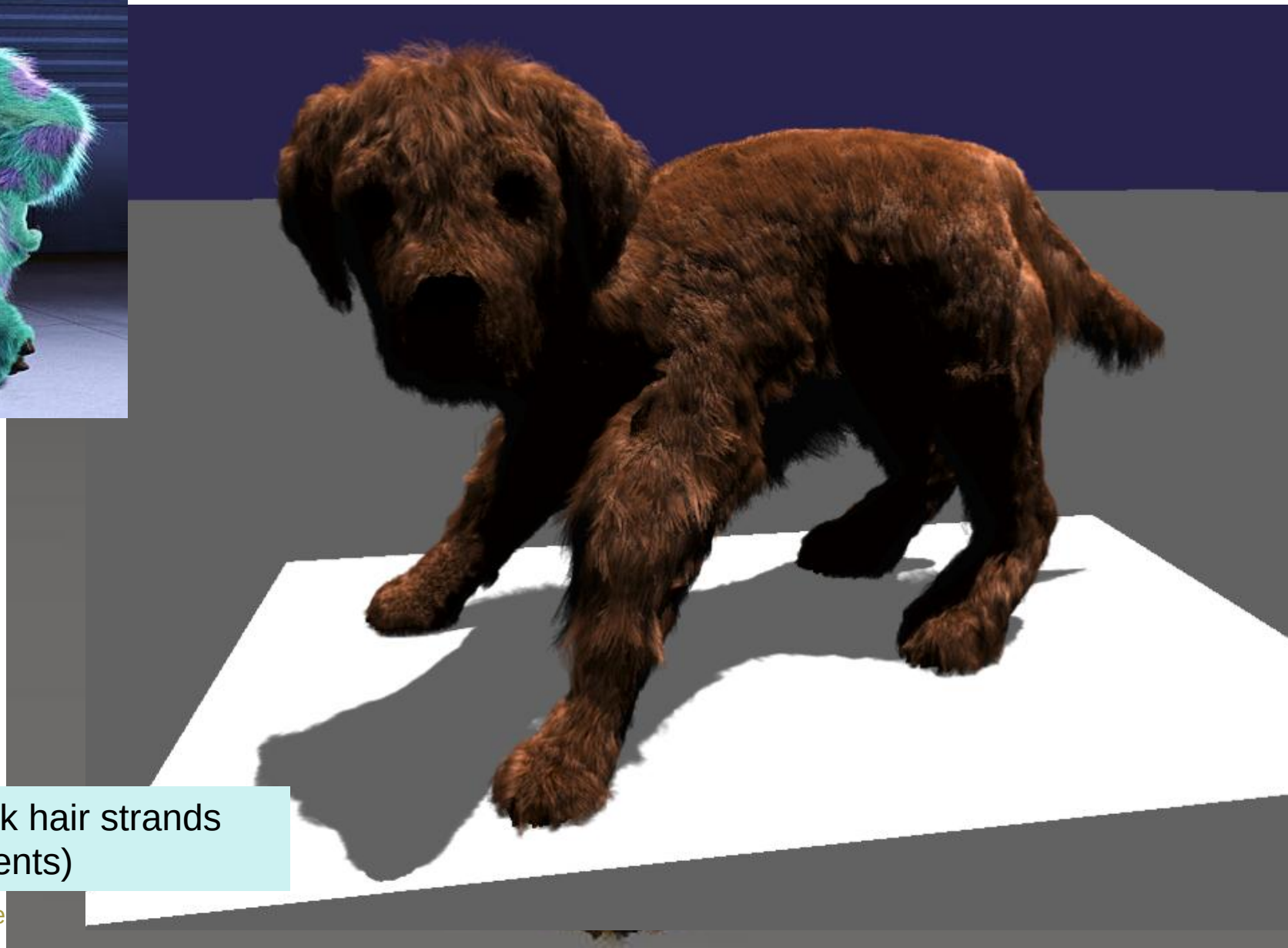
For shadows, we want to know how much the hair fragments, in front, blocks the light
- Can be solved by sorting

For transparency, we need the hair strands sorted in back-to-front order

Results

About half a million line segments rendered with 256 Opacity Map slices and approximate alpha sorting at 70 fps (GTX480)

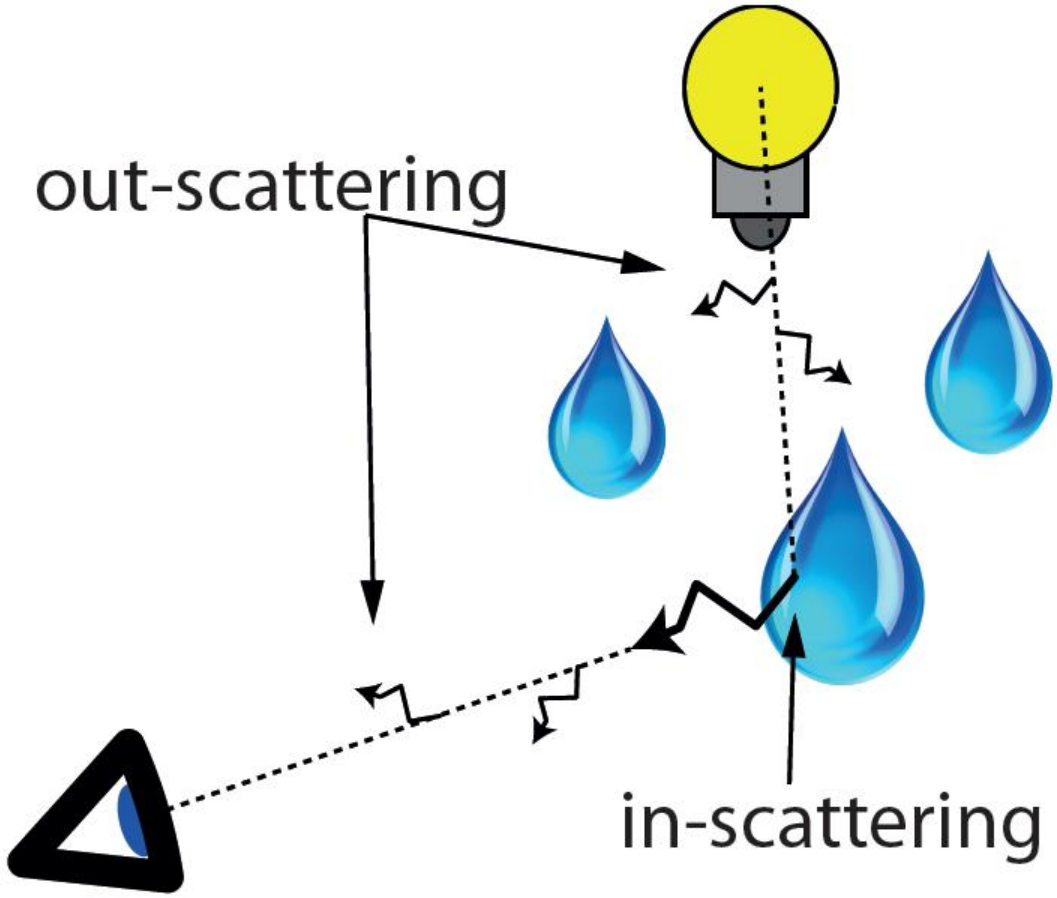
Results



46 fps using 400k hair strands
(1.8M line segments)

Volumetric Shadows

- Single Scattering in Participating Media

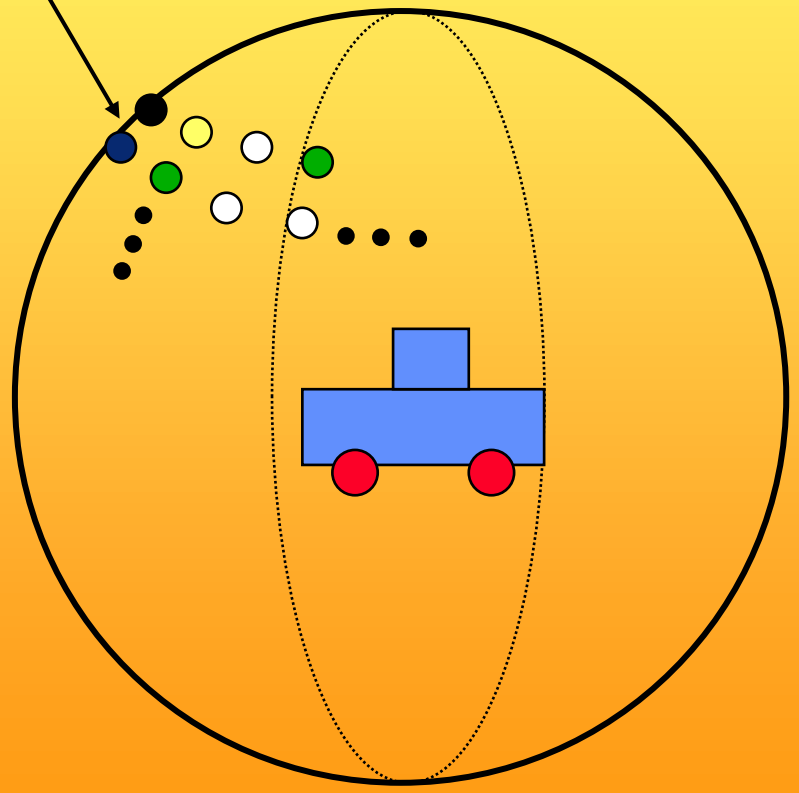


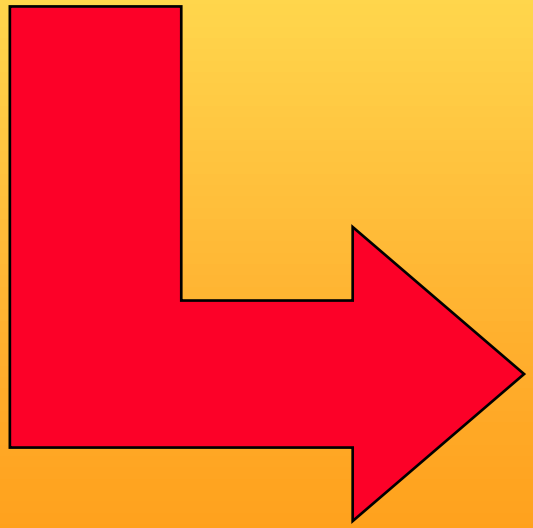
With courtesy of Illuminate Labs

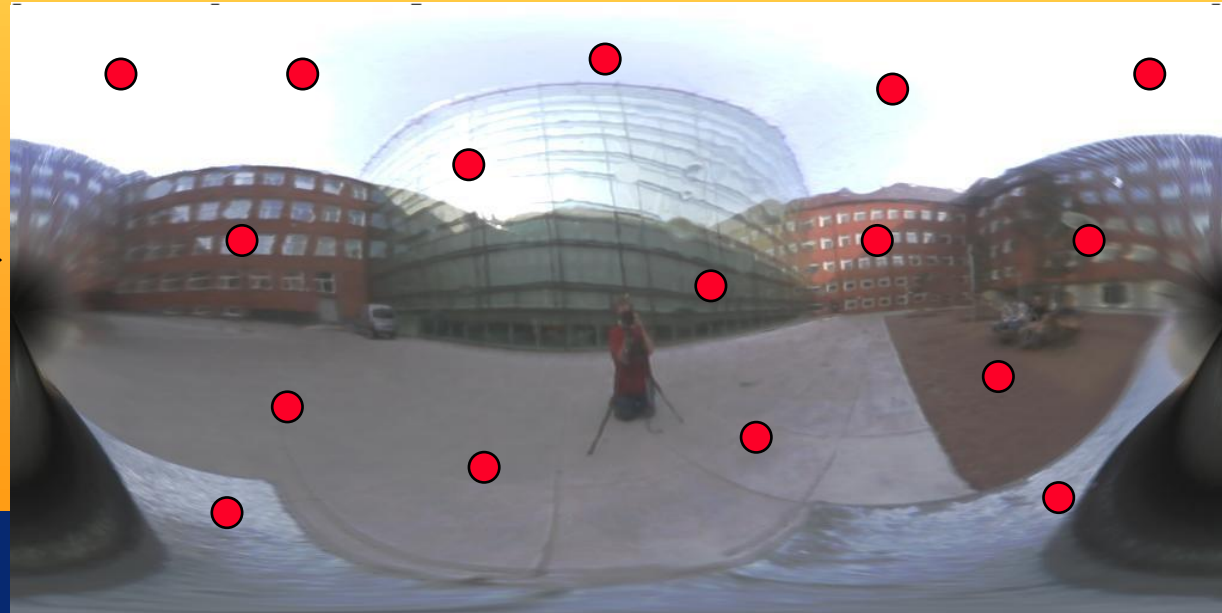
How making objects appear as belonging to a certain environment?

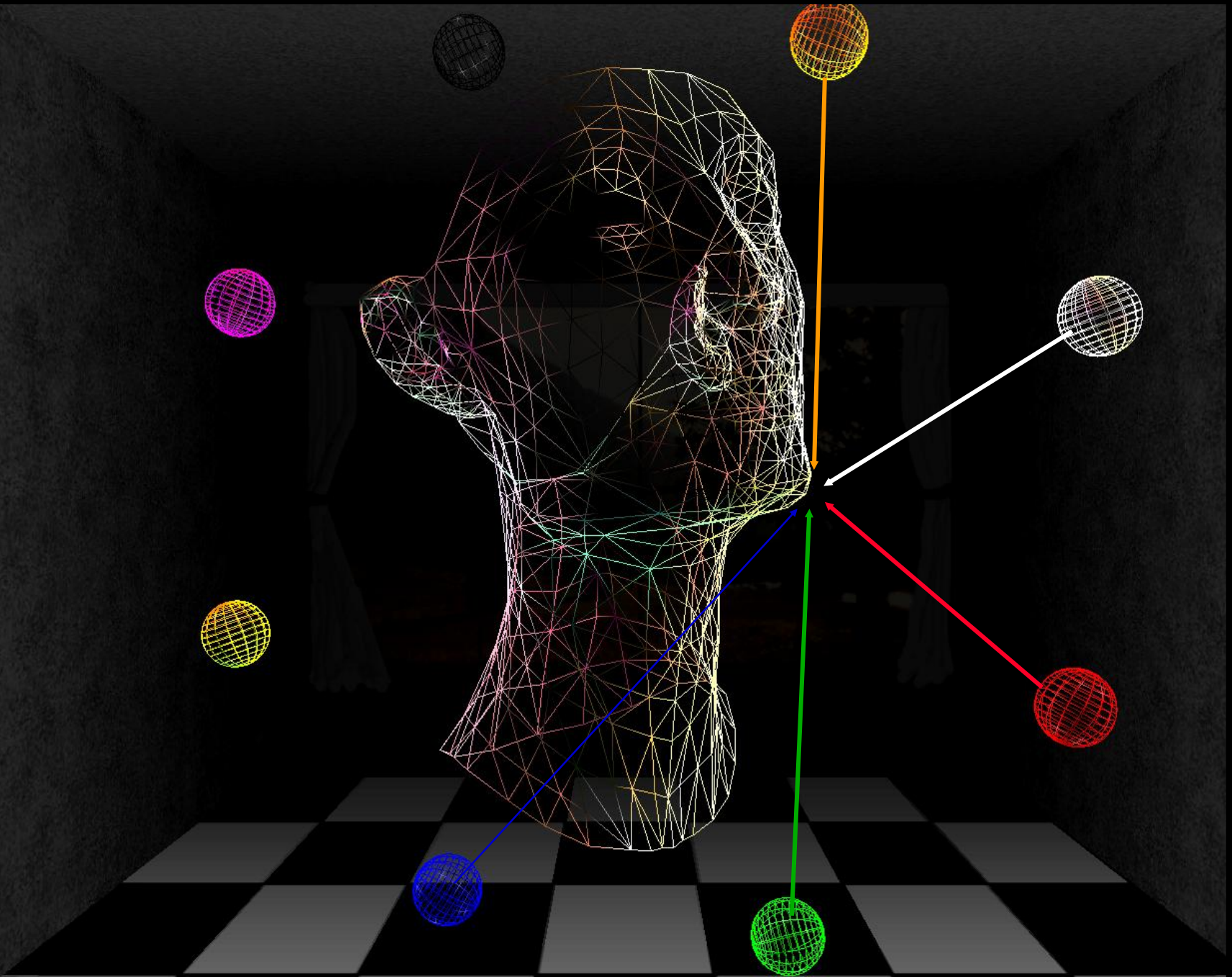
Photograph of full environment

Lamps illuminating our object

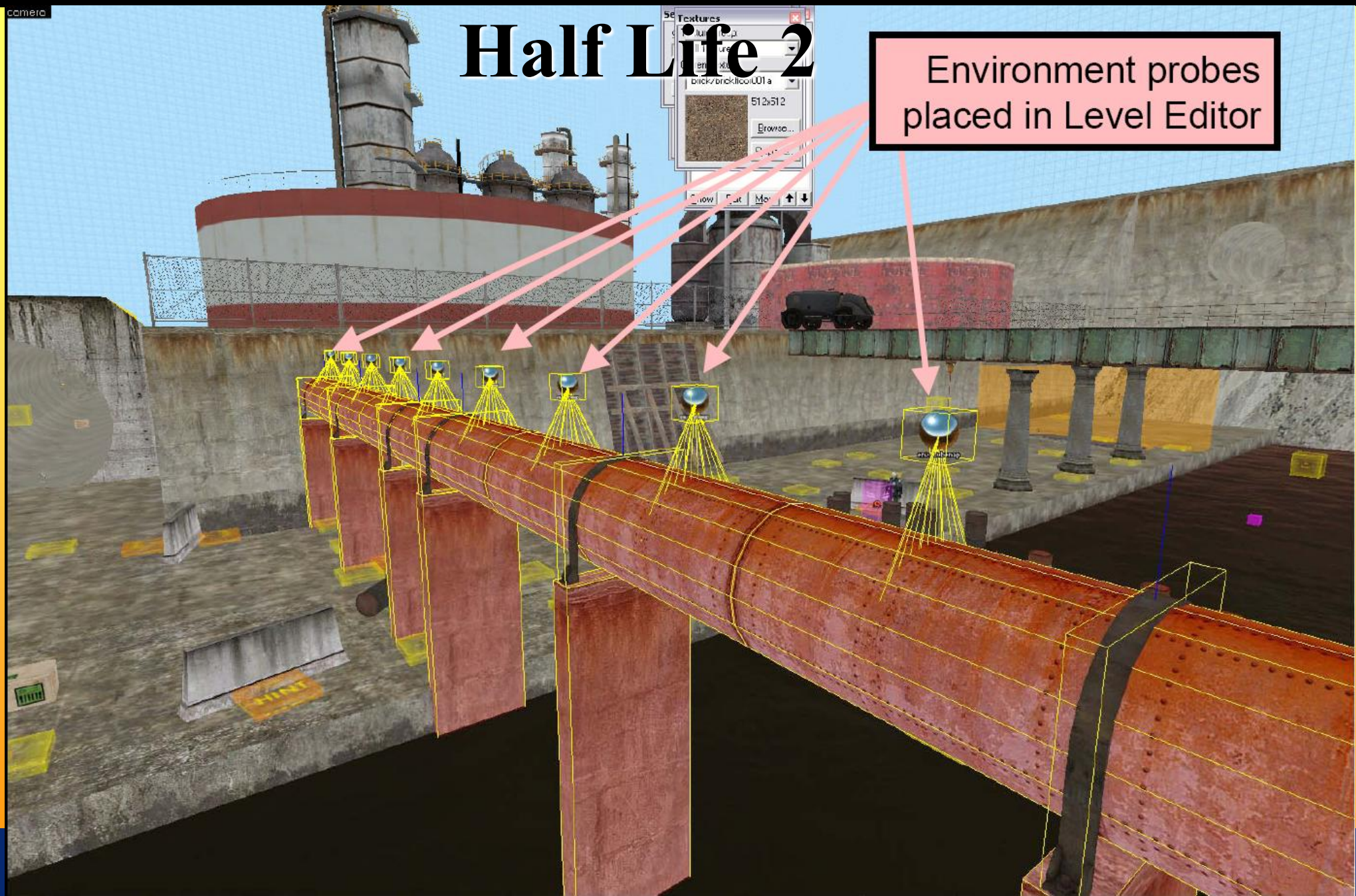






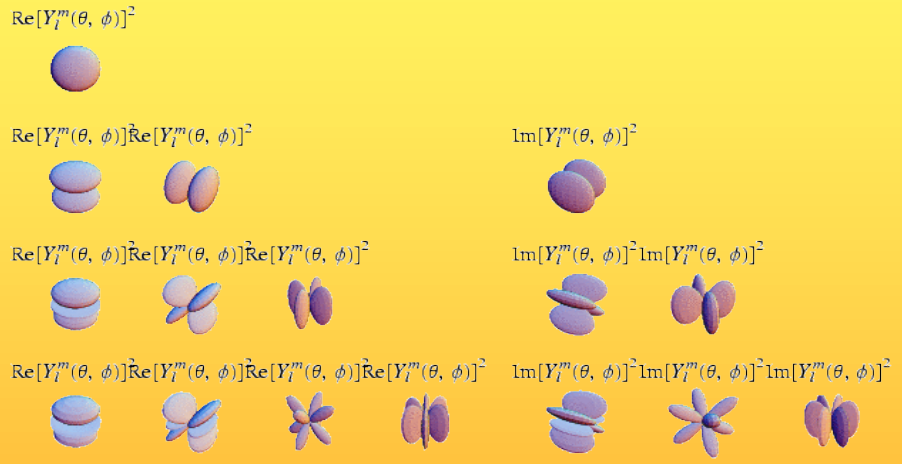


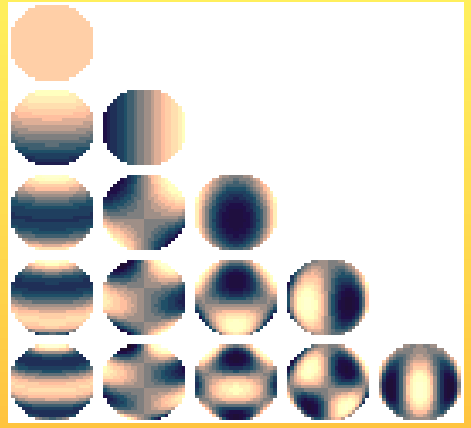
With courtesy of Dorna Sports: Moto GP2

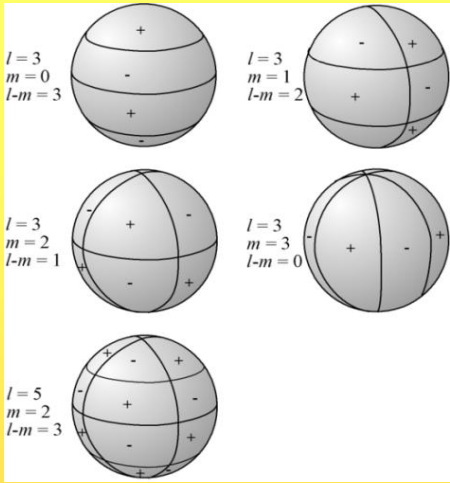

camera
Half Life 2
Environment probes
placed in Level Editor
Textures
512x512
Browse...

Spherical Harmonics

$$f(r,\theta,\varphi) = \sum_{\ell=0}^{\infty} \sum_{m=-\ell}^{\ell} r^{-1-\ell} f_\ell^m Y_\ell^m(\theta,\varphi) + \sum_{\ell=0}^{\infty} \sum_{m=-\ell}^{\ell} r^{\ell} f_\ell^{m'} Y_\ell^m(\theta,\varphi),$$







$$Y_l^{ms}(\theta,\phi) \equiv \sqrt{\frac{2l+1}{4\pi}\frac{(l-m)!}{(l+m)!}}\, P_l^m(\cos\theta)\sin(m\phi)$$

$$P_\ell^{(m)}(x) = \frac{(-1)^m}{2^\ell \ell!}(1-x^2)^{m/2}\frac{d^{\ell+m}}{dx^{\ell+m}}(x^2-1)^\ell.$$

- The general solution to Laplace's equation is a linear combination of the spherical harmonic functions multiplied by the coefficients.

Subsurface Scattering

- Photons go into the surface, and bounce around

Standard way

Subsurface scattering

NVIDIA Skin

CHALMERS

Vill du veta mer?

Välkommen till TDA361 Computer Graphics

Lp2, 2012