Reflexions especulars

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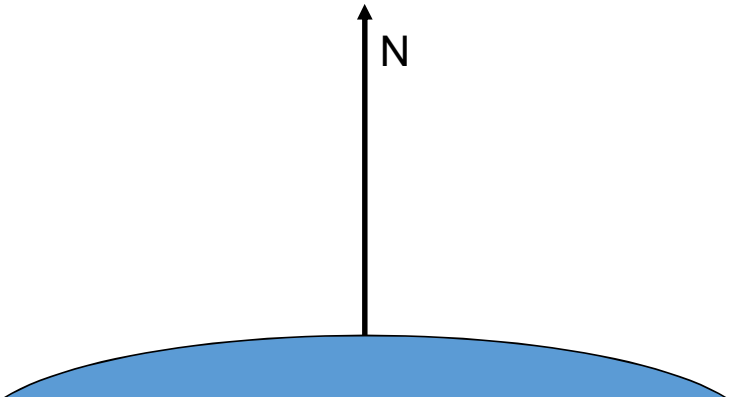
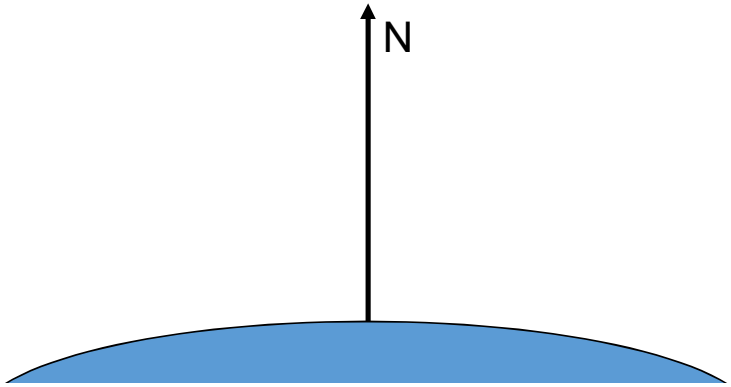
Introducció

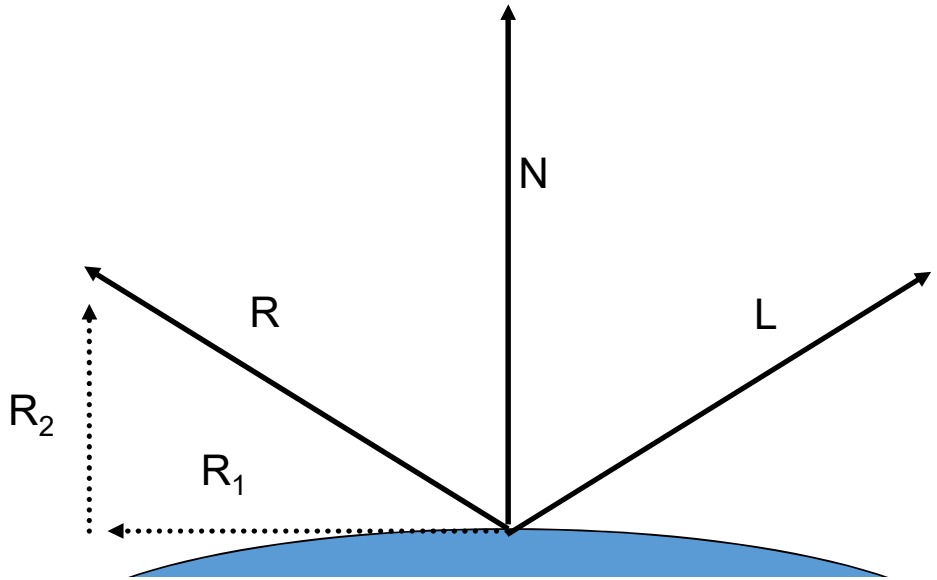
Reflexió difosa



Reflexió especular



Vector reflectit



Vector reflectit

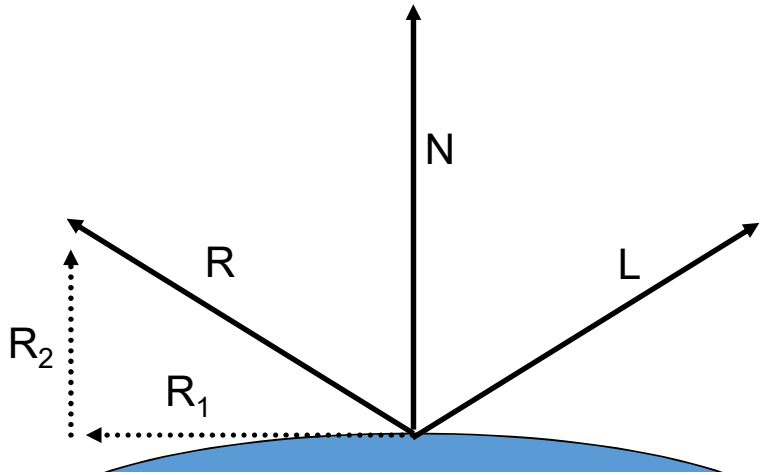
$R = R_1 + R_2$

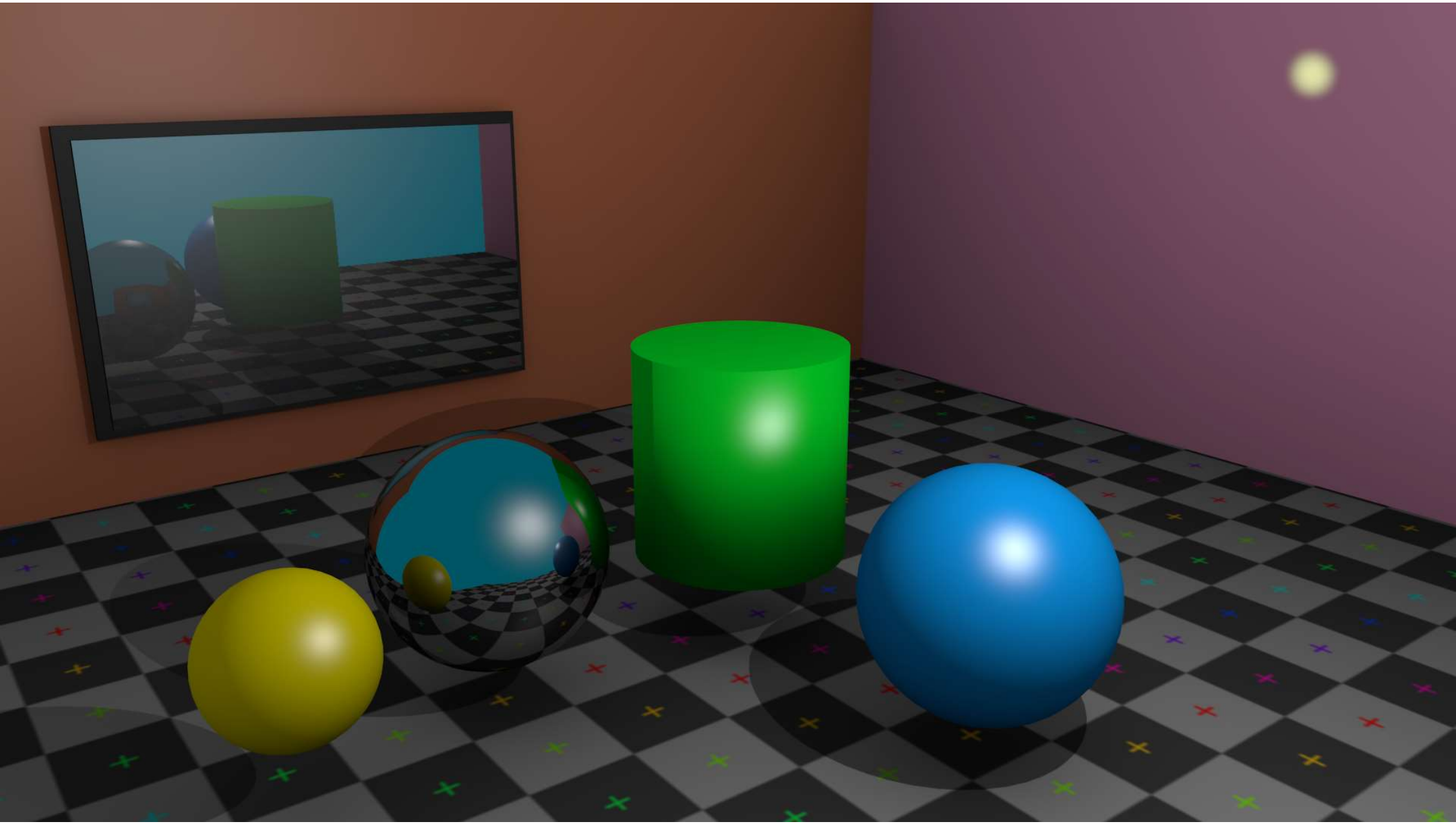
$R_1 = -L + R_2$

$R = 2R_2 - L$

$R_2 = (N \cdot L)N$

$R = 2\,(N \cdot L)N - L$





Mètodes

- Ray-tracing
- Reflexions basada en **objectes virtuals**
  - Modelats
  - Reflectits (sense stencil test)
  - Reflectits (amb stencil test)
  - Textures dinàmiques
- **Environment mapping**
  - Sphere mapping
  - Cube mapping

Reflexions amb objectes virtuals

Mètodes

- Ray-tracing
- Reflexions basada en **objectes virtuals**
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Objectes virtuals

Mètodes

- Ray-tracing
- Reflexions basada en **objectes virtuals**
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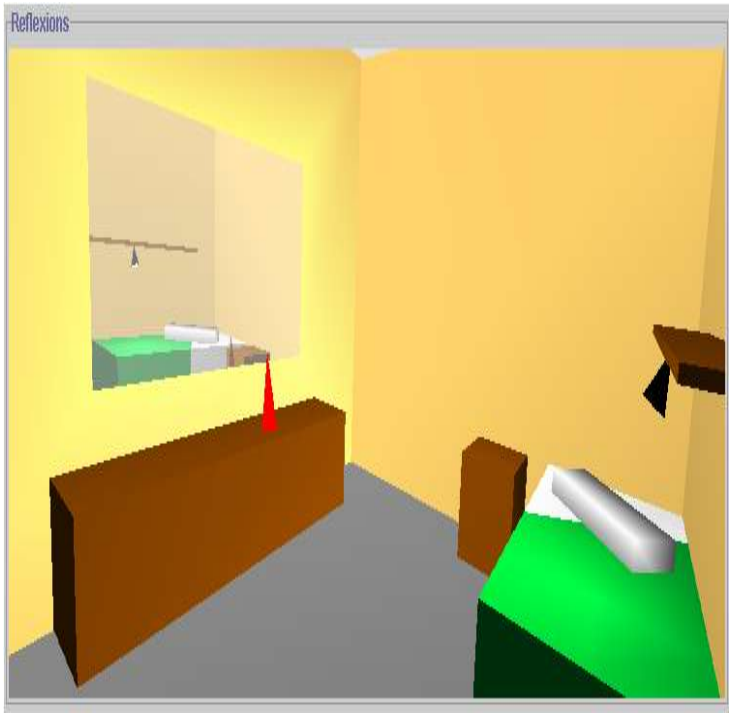
Objectes virtuals



Mètodes

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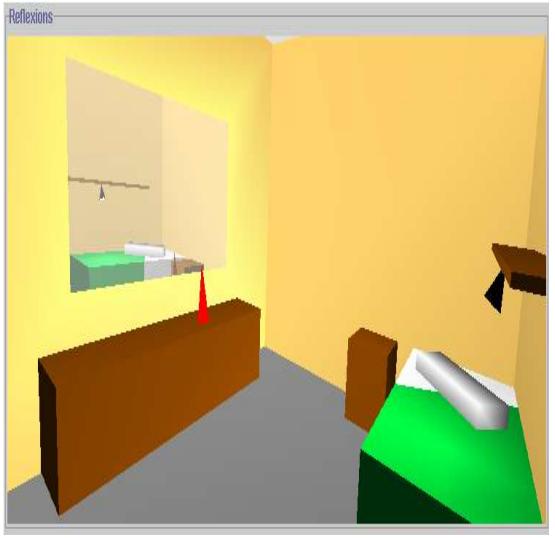
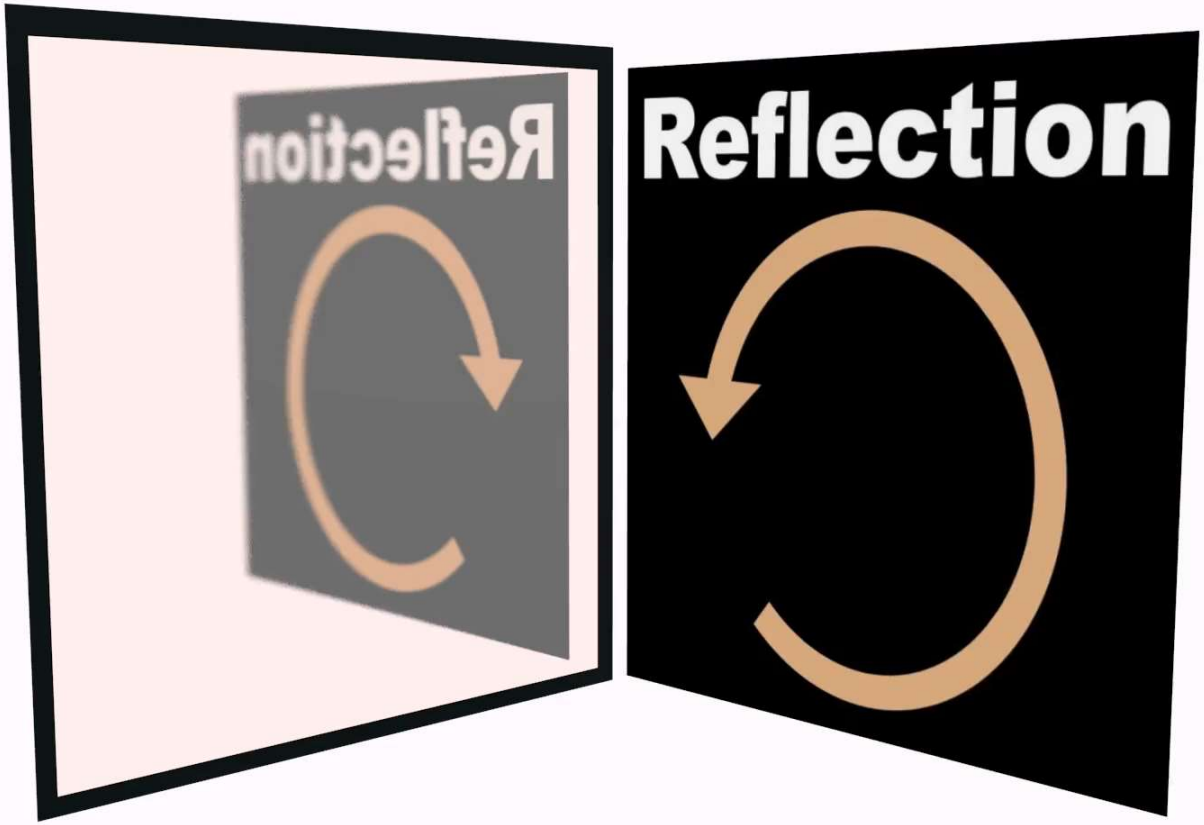
Algorisme (versió 1)

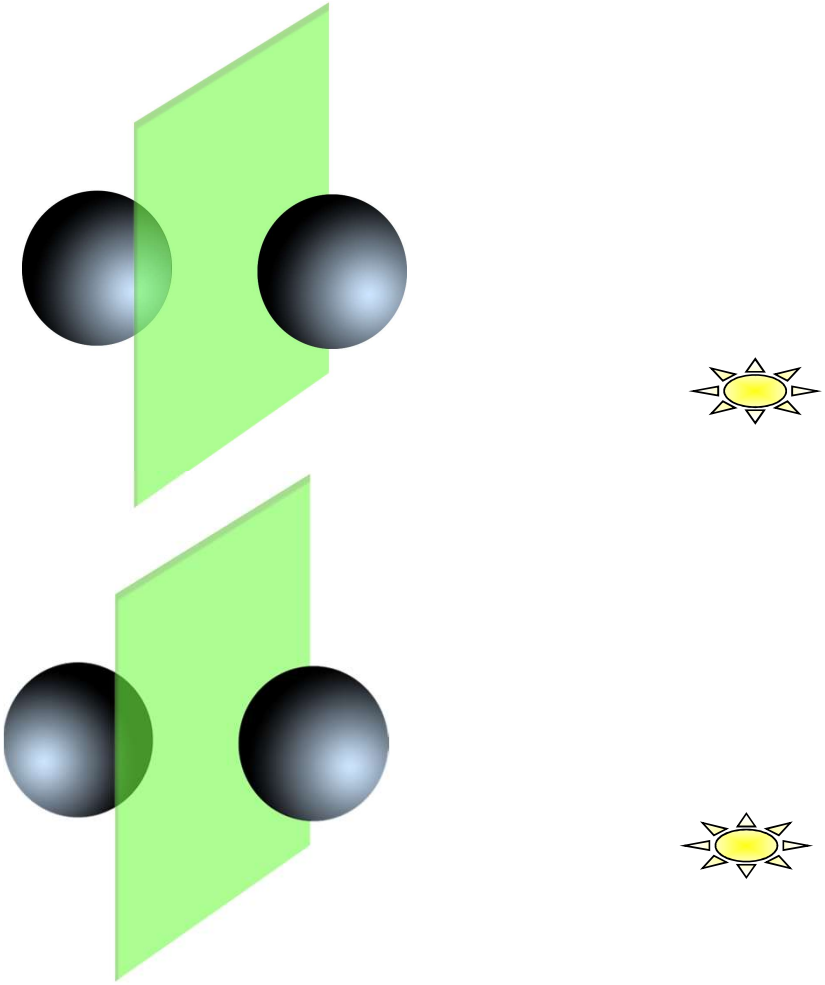
```
// 1. Dibuixar els objectes en posició virtual
glPushMatrix();
glMultMatrix(matriu_simetria)
glLightfv(GL_LIGHT0, GL_POSITION, pos);
glCullFace(GL_FRONT);
dibuixar(escena);
glPopMatrix();

// 2. Dibuixar el mirall semi-transparent
glLightfv(GL_LIGHT0, GL_POSITION, pos);
glCullFace(GL_BACK);
dibuixar(mirall);

// 3. Dibuixar els objects en posició real
dibuixar(escena);
```



Inversió ordre

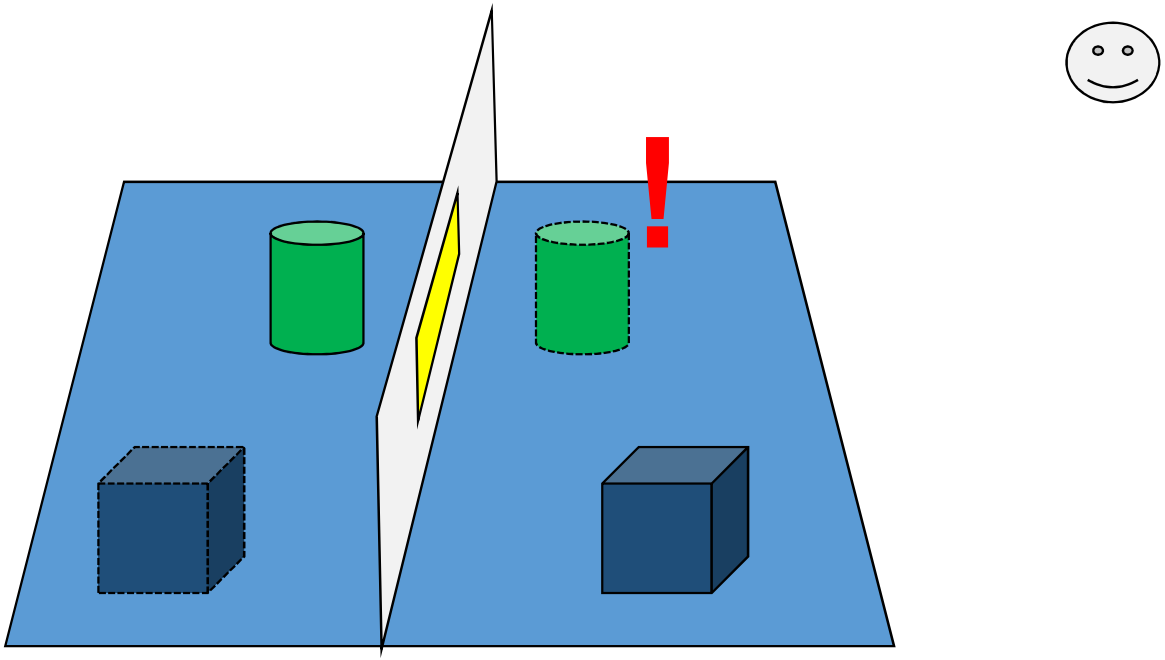


Reflexió de les fonts de llum



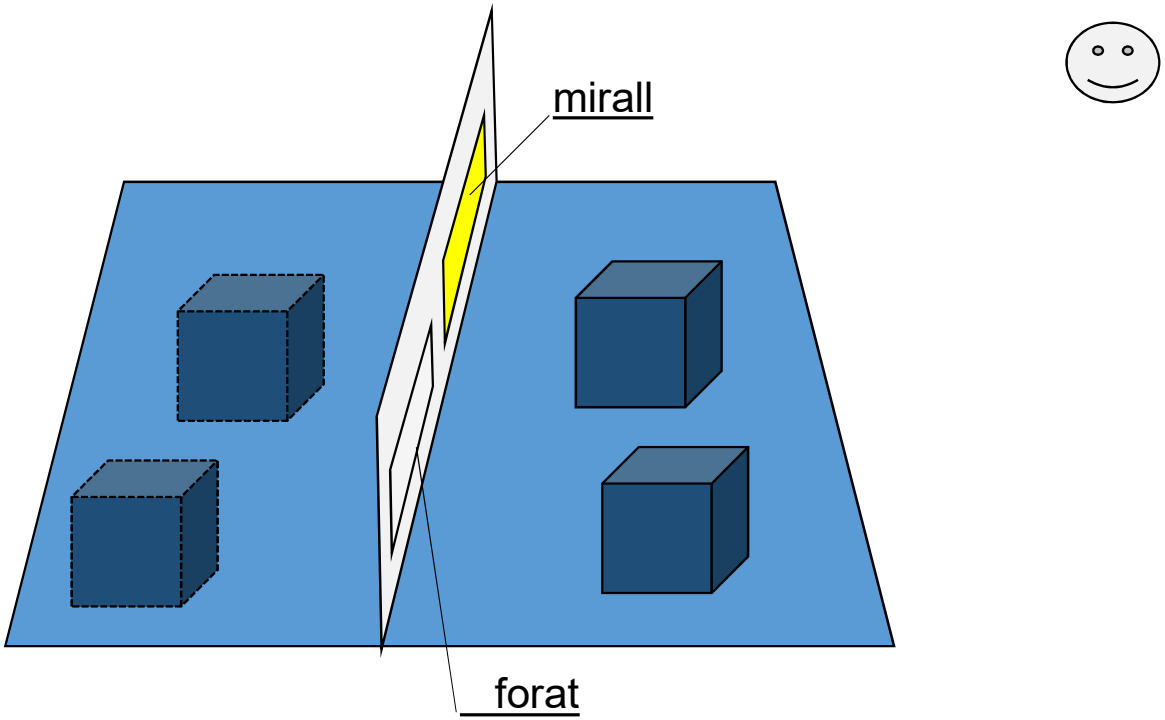
Limitacions

Assumeix que els objectes virtuals estan en el semiespai positiu del pla del mirall.



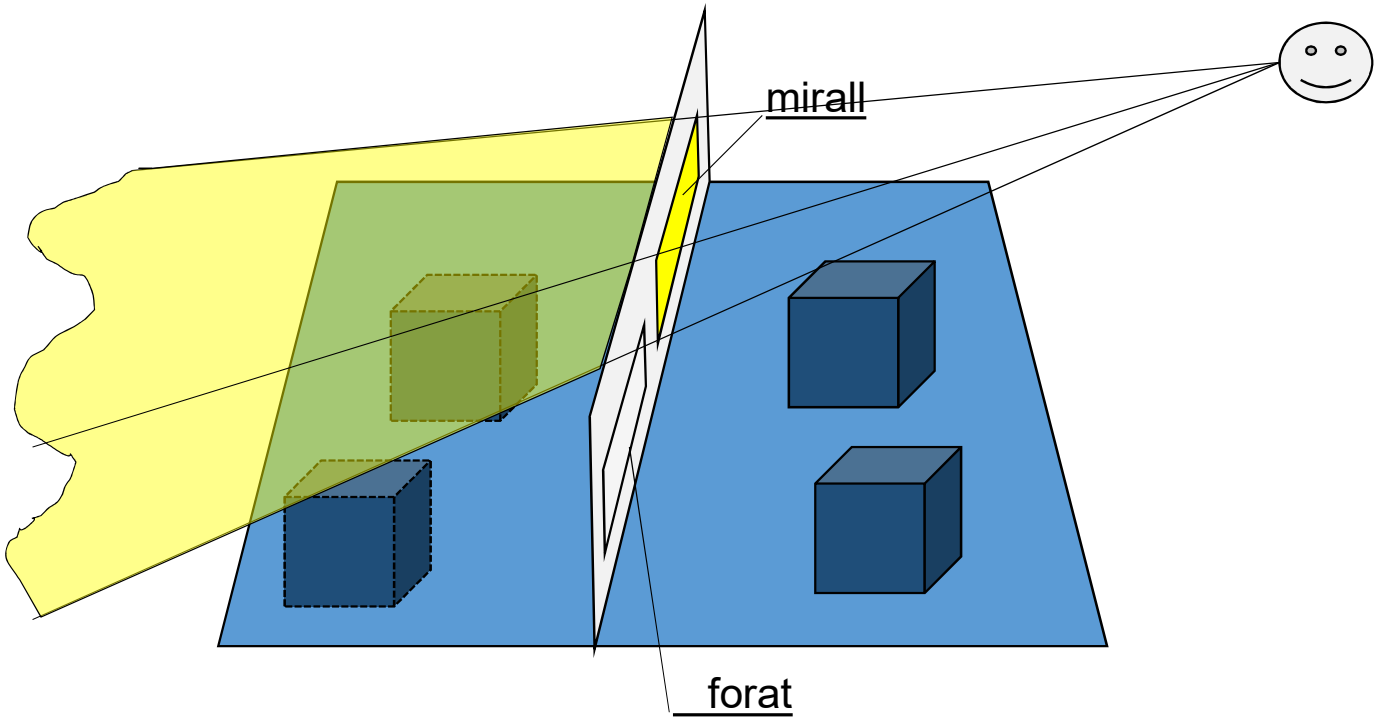
Limitacions

Assumeix que els objectes virtuals només es veuran a través del forat del mirall.



Solució 1

Dibuixar els objectes virtuals amb plans de retallat addicionals – glClipPlane()



Solució 2

Usar stencil per limitar els objectes virtuals a la regió ocupada pel mirall.

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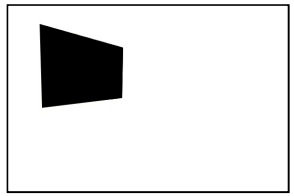
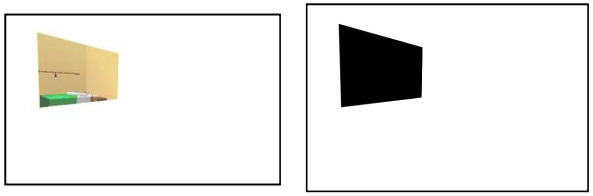
Algorisme (versió 2)

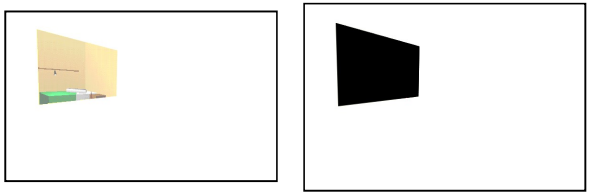
Pas 1. Dibuixar mirall al stencil buffer



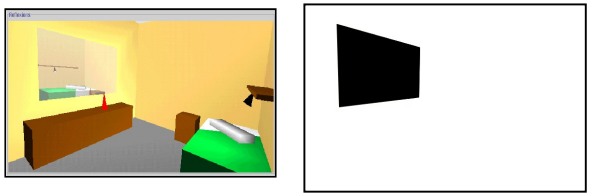
Pas 2. Dibuixar objectes en pos virtual



Pas 3. Dibuixar mirall semi-transparent



Pas 4. Dibuixar objectes en pos real



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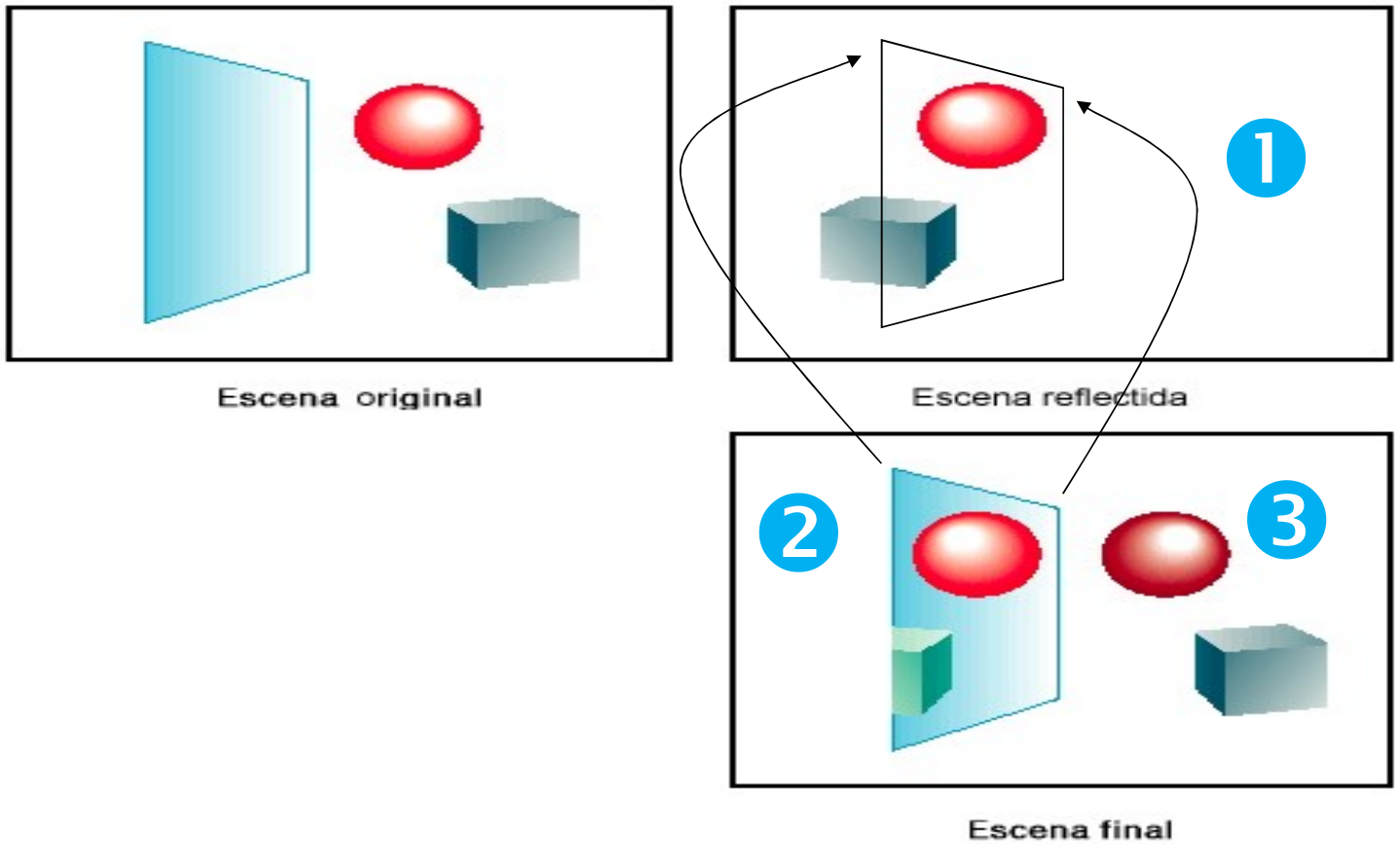
Textures dinàmiques



Matriu de reflexió

Matriu de reflexió

Matriu de reflexió respecte un pla (a,b,c,d):

$$\begin{bmatrix} 1-2a^2 & -2ba & -2ca & -2da \\ -2ba & 1-2b^2 & -2cb & -2db \\ -2ca & -2cb & 1-2c^2 & -2dc \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Environment mapping

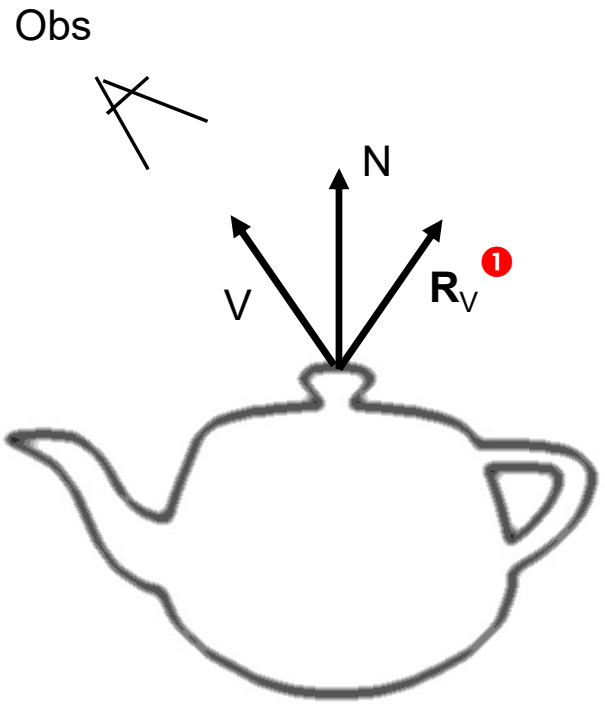
Environment map

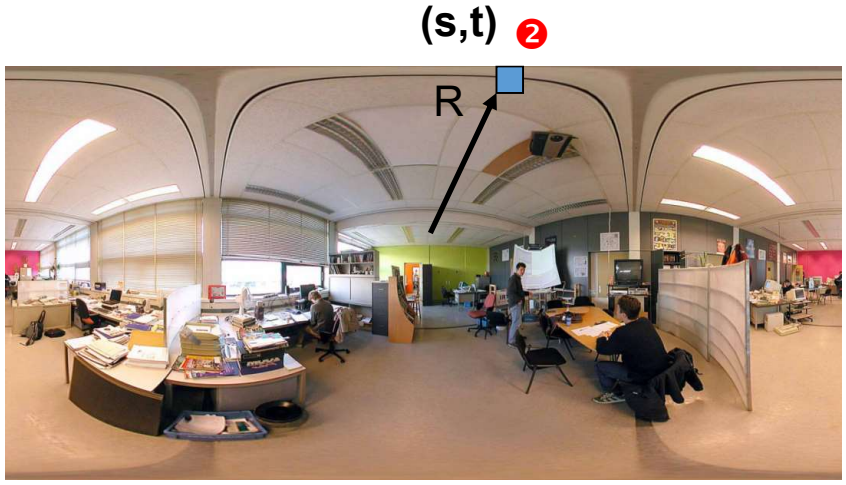
Donat una direcció arbitrària R, ens retorna el color de l'entorn en direcció R

color = environmentMap(R)

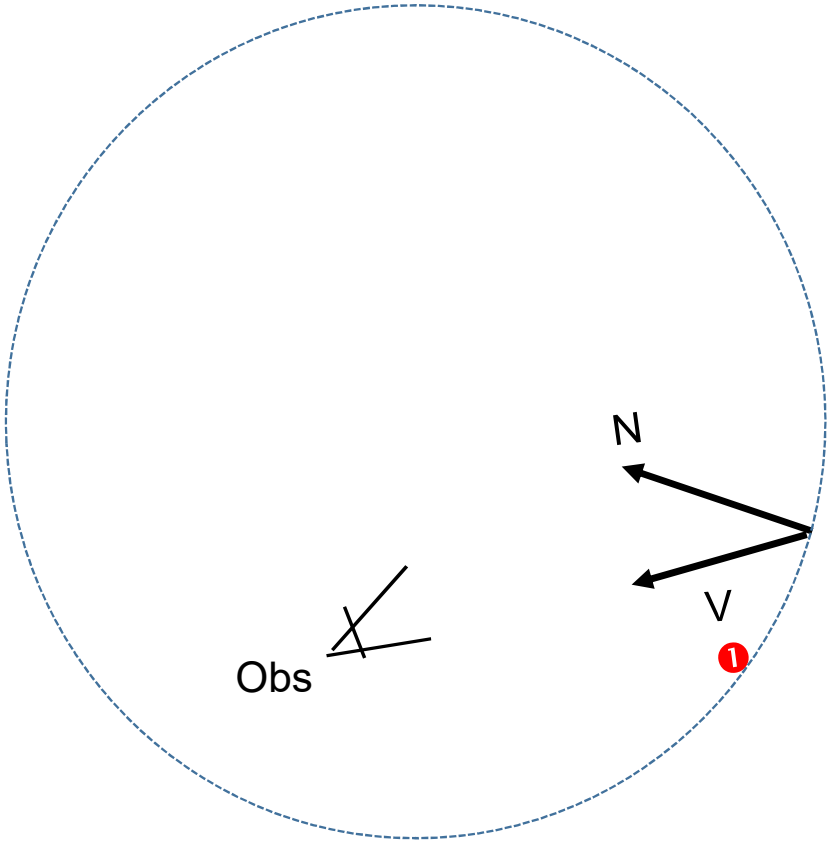
Representació com a textura

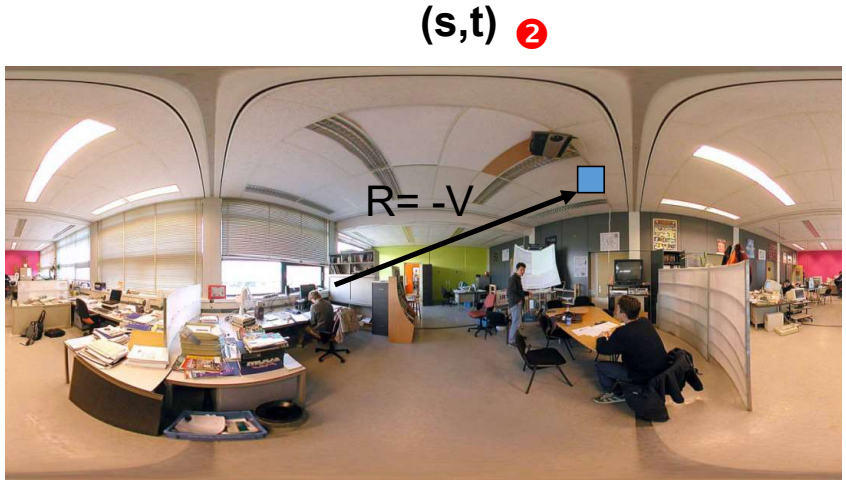
Ús per reflexions especulars





Ús com a entorn (background)





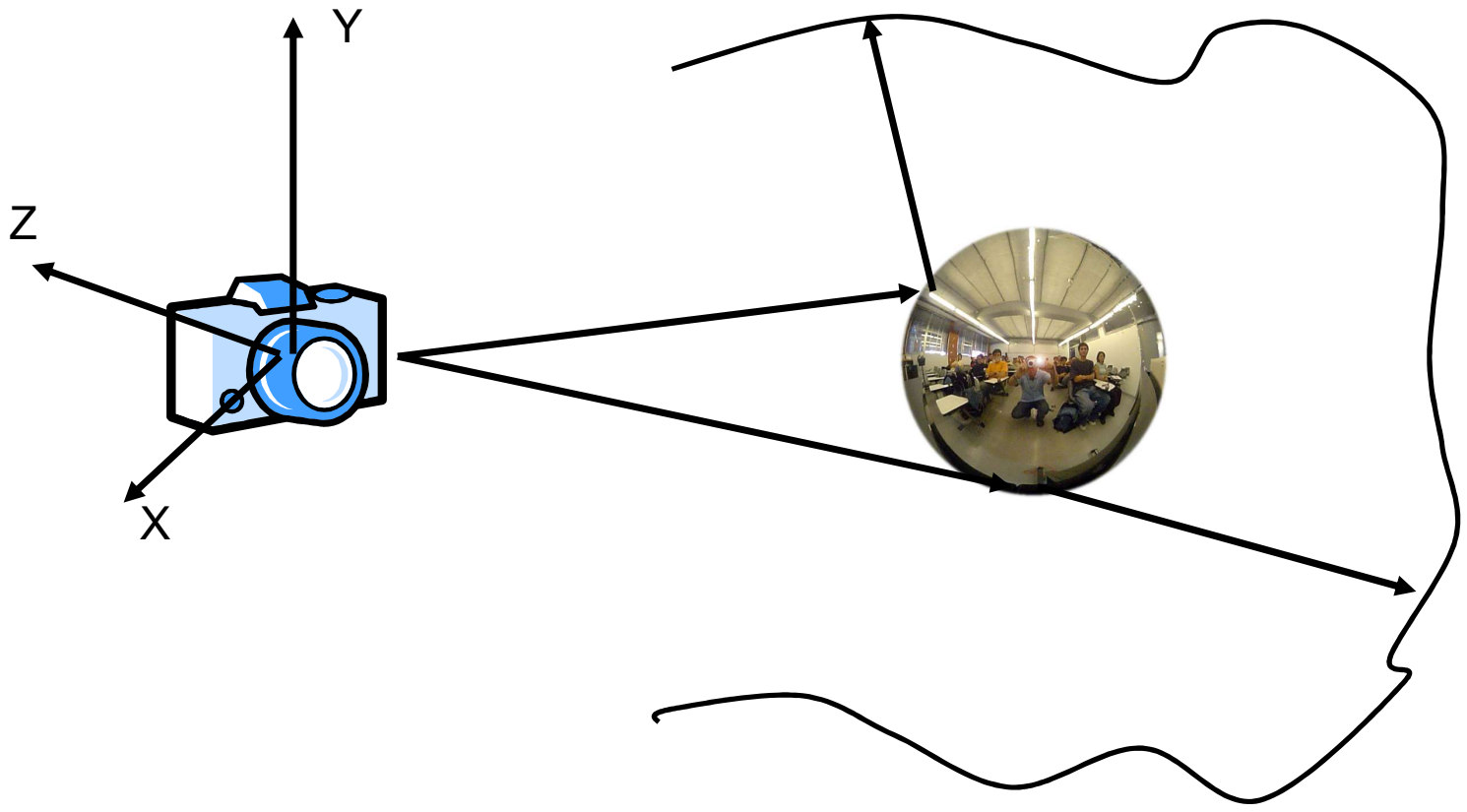
Sphere mapping

Sphere map

Sphere map

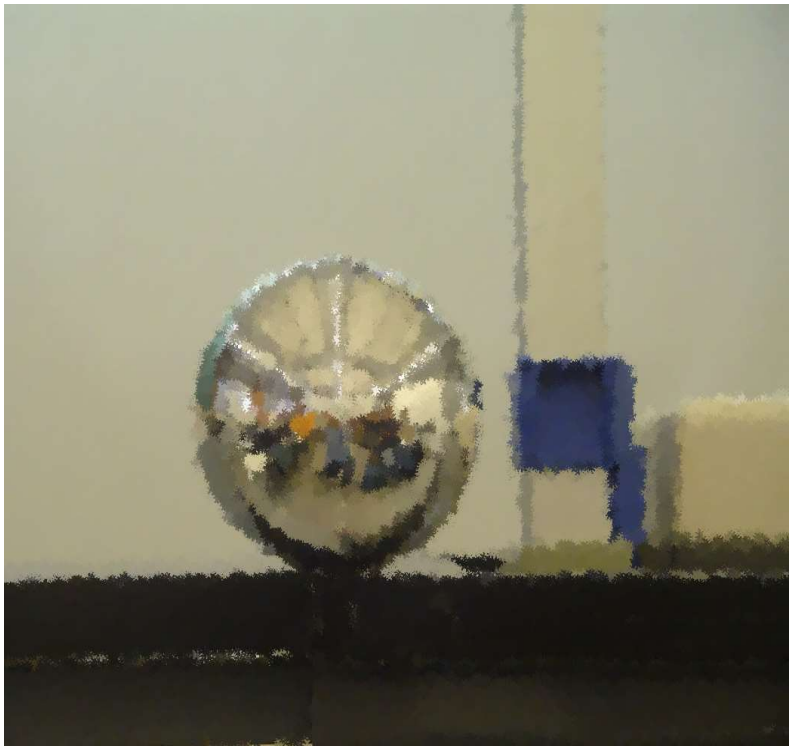
Hand with Reflecting Sphere by **M. C. Escher.**
Lithograph, 1935.
Official M.C. Escher website.

Construcció de sphere maps



Exemple sphere map

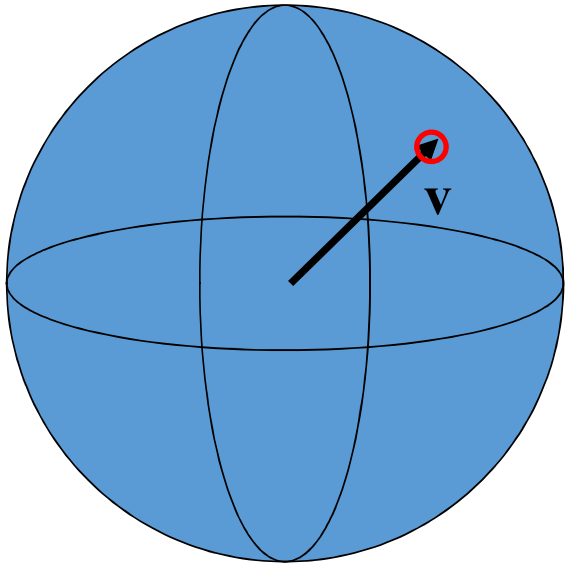
Sense retallar



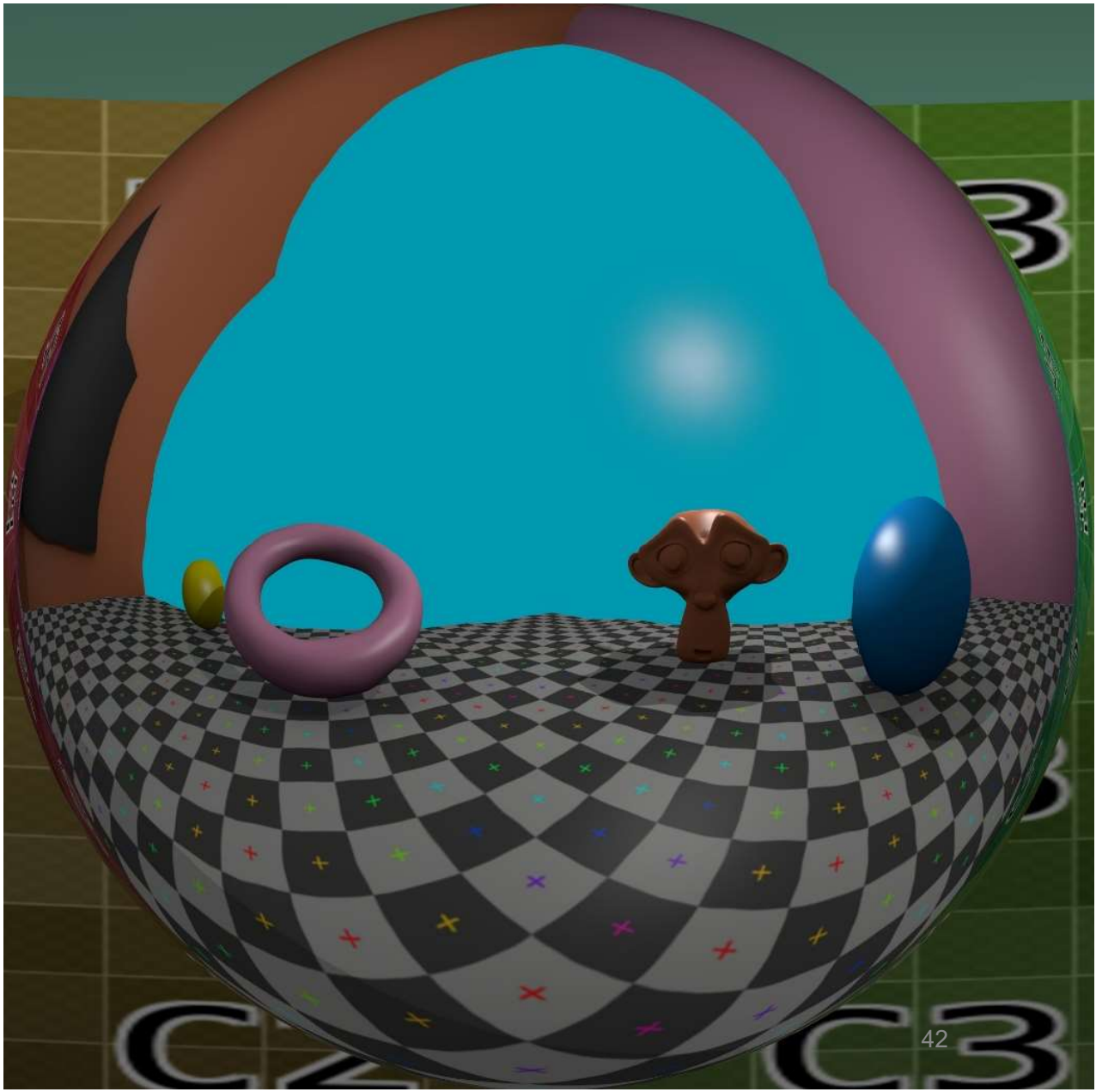
Retallat

Propietats

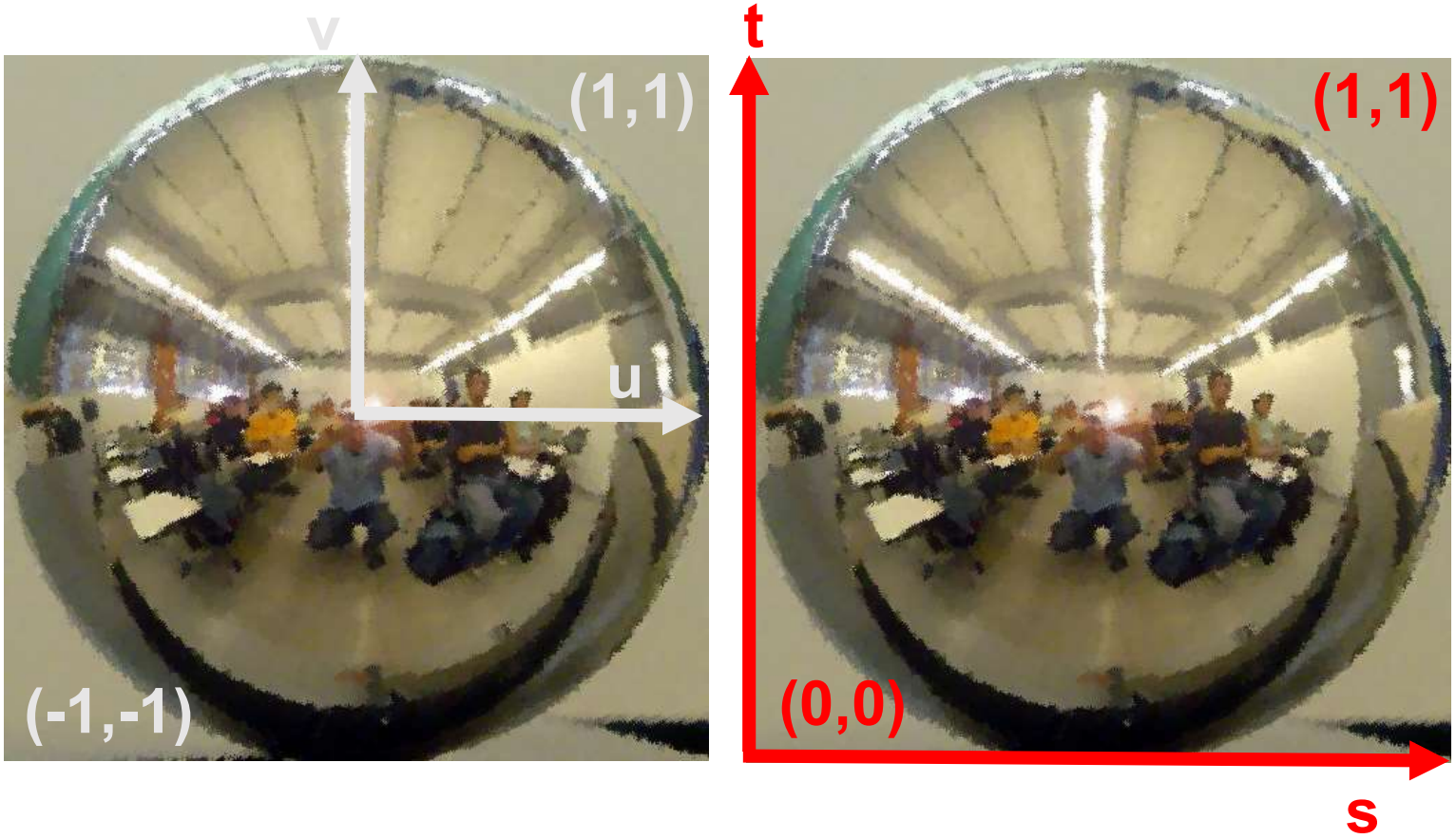
- De la textura només se n'aprofita el cercle inscrit
- Conté informació de aproximadament tot l'entorn (totes direccions)
- Distorsió considerable a prop de la vora del cercle



Exemple



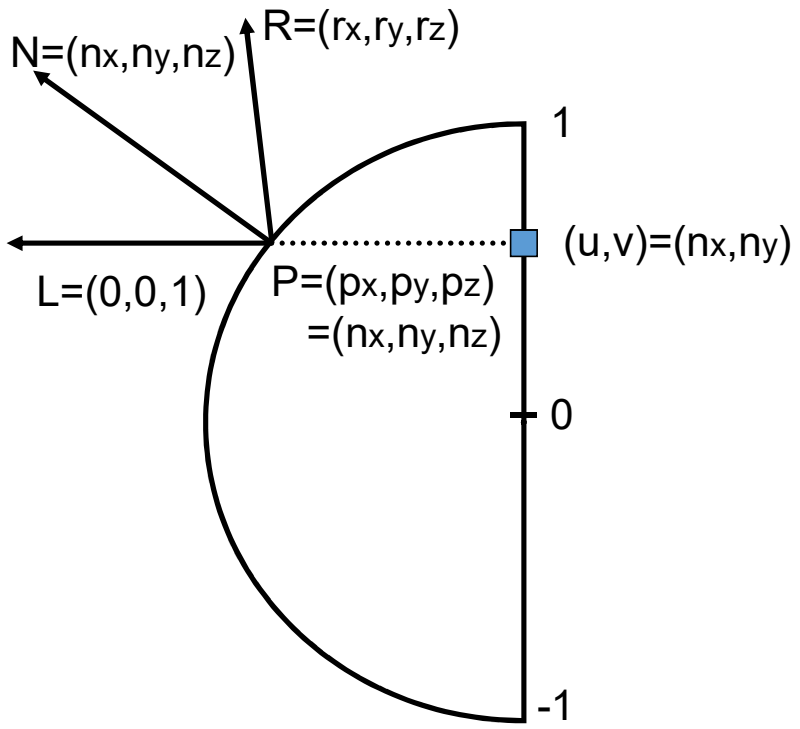
Coordenades (u,v) ←→(s,t)



Relació entre vector R i (u,v)

Relació entre vector R i (u,v)

$R=(2n_zn_x, 2n_zn_y, 2n_z^2-1)$



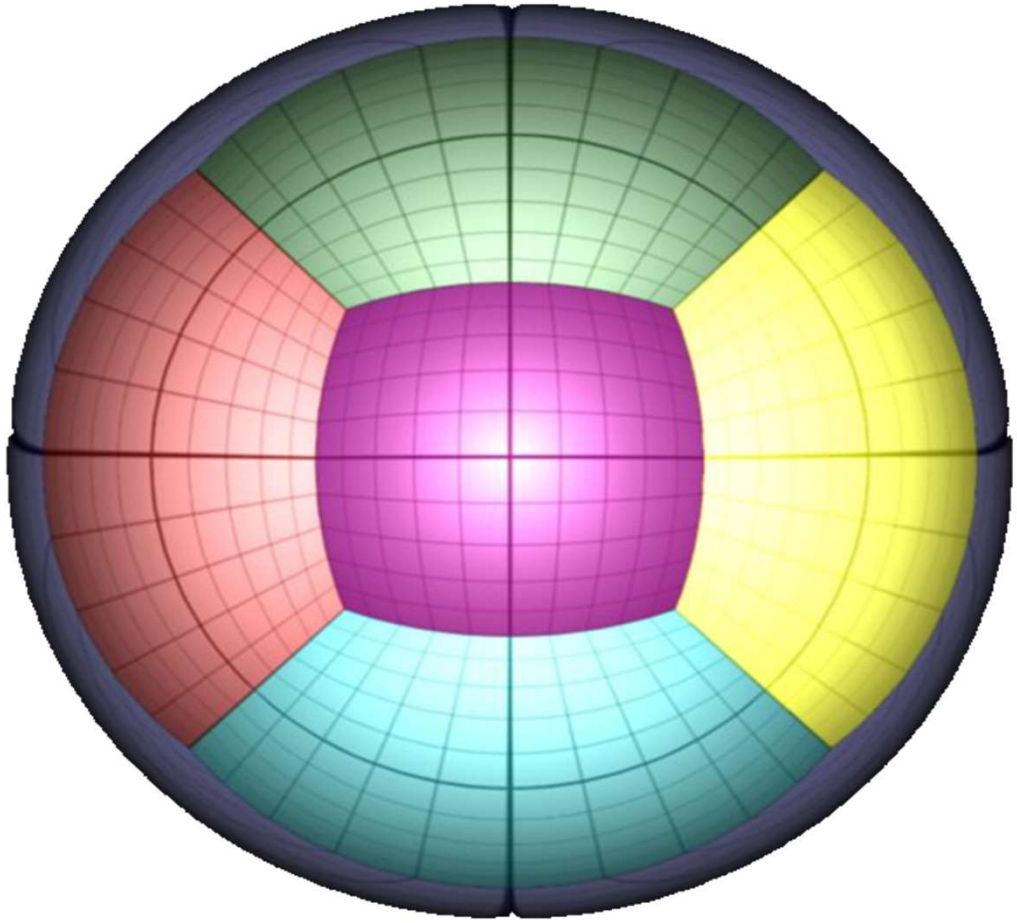
Càlcul del color donat R

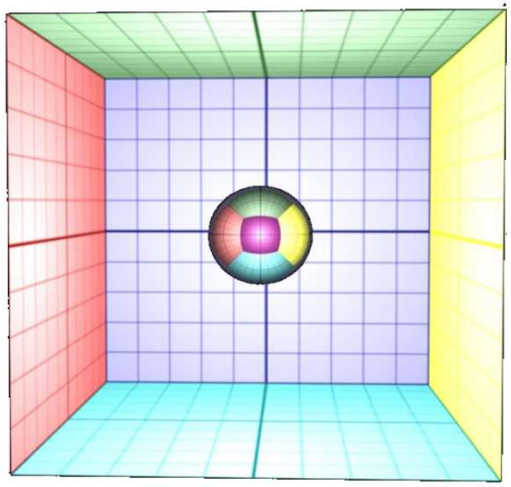
```
vec4 sampleSphereMap(sampler2D sampler, vec3 R)
{
   float z = sqrt((R.z+1.0)/2.0);
   vec2 st=vec2((R.x/(2.0*z)+1.0)/2.0,(R.y/(2.0*z)+1.0)/2.0);
   return texture(sampler, st);
}
```

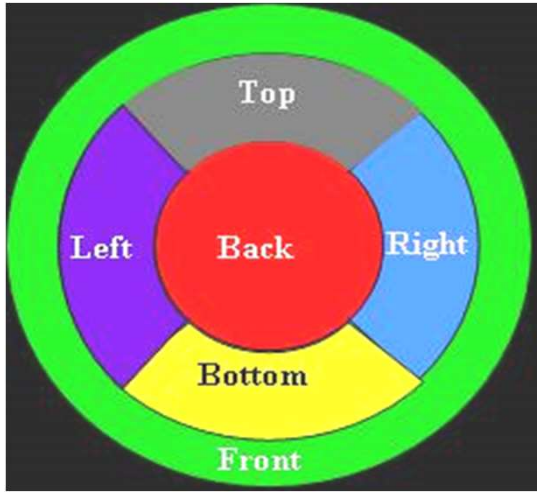
Eye/world coordinates

Eye/world coordinates

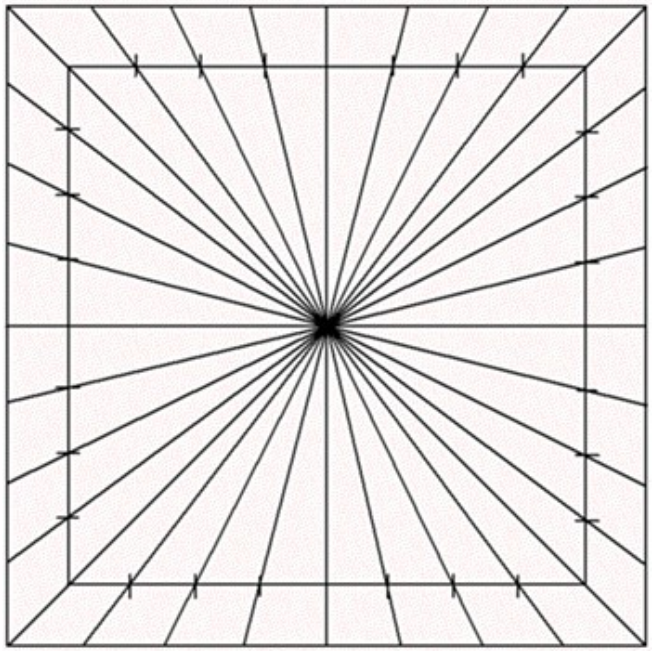
Sphere mapping: distorsió

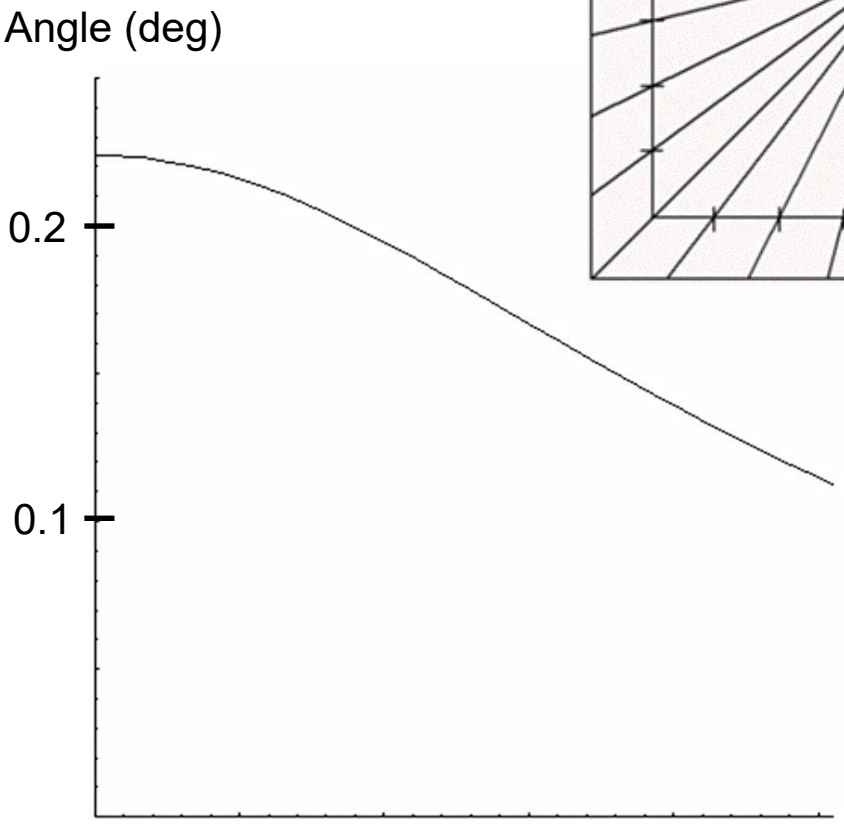




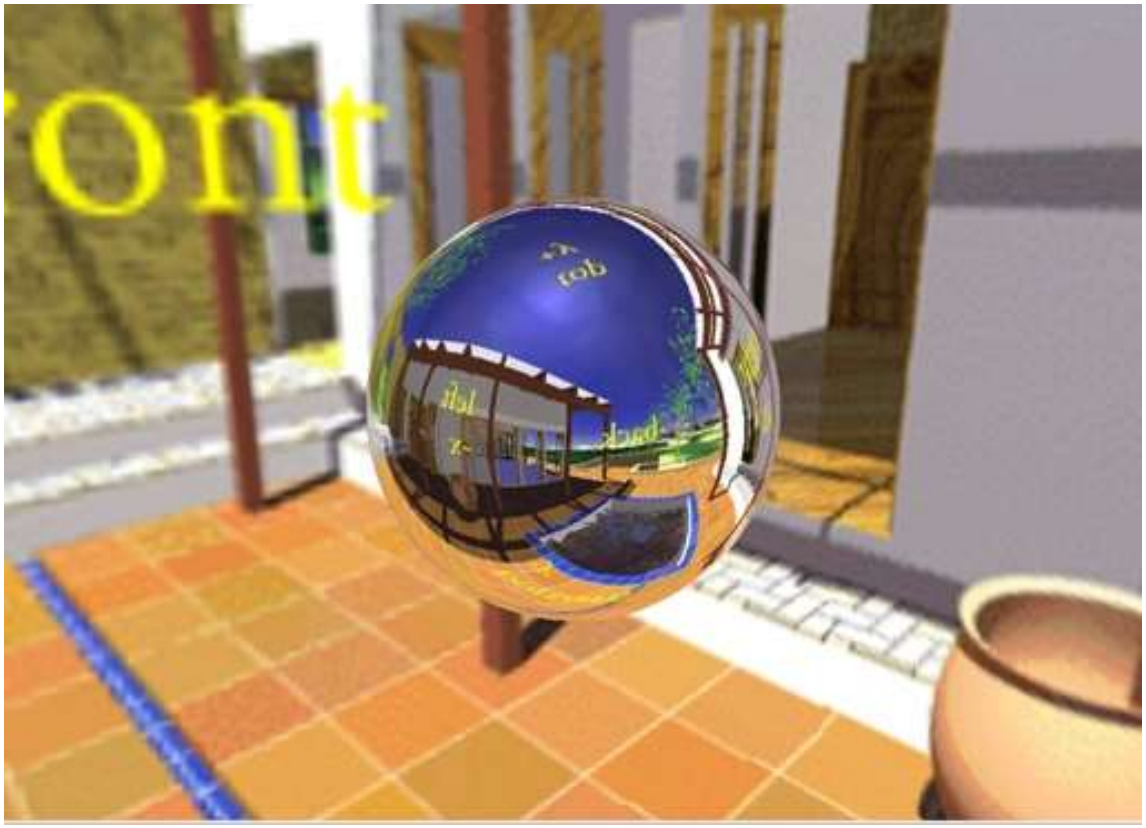


CUBE MAPPING




Angle (deg)
0.2
0.1
Dist (px)

Cube mapping: exemple



Cube mapping: exemple

```
// 1. Creació de les sis textures
glTexImage2D(GL_TEXTURE_CUBE_MAP_POSITIVE_X_EXT, …);
glTexImage2D(GL_TEXTURE_CUBE_MAP_NEGATIVE_X_EXT, …);
glTexImage2D(GL_TEXTURE_CUBE_MAP_POSITIVE_Y_EXT, …);
glTexImage2D(GL_TEXTURE_CUBE_MAP_NEGATIVE_Y_EXT, …);
glTexImage2D(GL_TEXTURE_CUBE_MAP_POSITIVE_Z_EXT, …);
glTexImage2D(GL_TEXTURE_CUBE_MAP_NEGATIVE_Z_EXT, …);
```

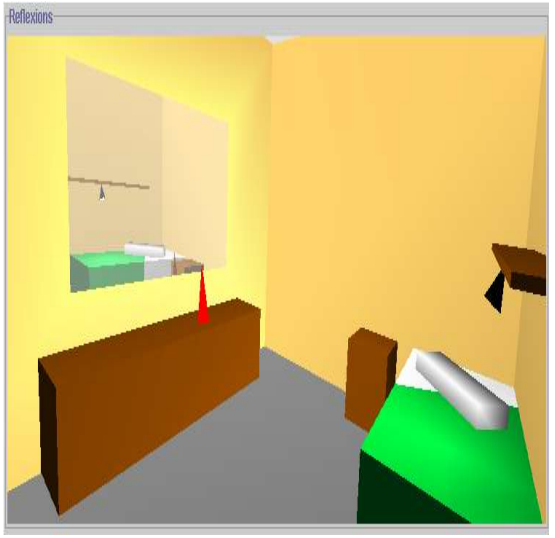
Cube mapping: GLSL

```
uniform sampler2D sampler;
…
fragColor = texture(sampler, vtexCoord);
```

```
uniform samplerCube samplerC;
…
vec3 R;
…
fragColor = textureCube(samplerC, R);
```

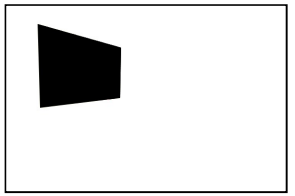
Algorisme (versió 1)

```
// 1. Dibuixar els objectes en posició virtual
glPushMatrix();
glMultMatrix(matriu_simetria)
glLightfv(GL_LIGHT0, GL_POSITION, pos);
glCullFace(GL_FRONT);
dibuixar(escena);
glPopMatrix();

// 2. Dibuixar el mirall semi-transparent
glLightfv(GL_LIGHT0, GL_POSITION, pos);
glCullFace(GL_BACK);
dibuixar(mirall);

// 3. Dibuixar els objects en posició real
dibuixar(escena);
```

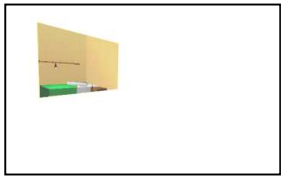


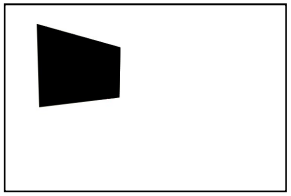
Algorisme (versió 2)

Pas 1. Dibuixar mirall al stencil buffer

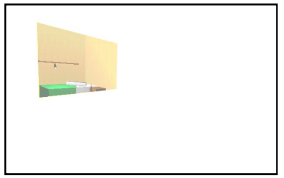


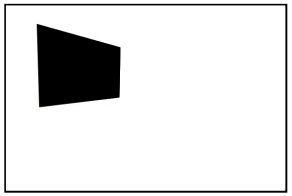
Pas 2. Dibuixar objectes en pos virtual





Pas 3. Dibuixar mirall semi-transparent





Pas 4. Dibuixar objectes en pos real