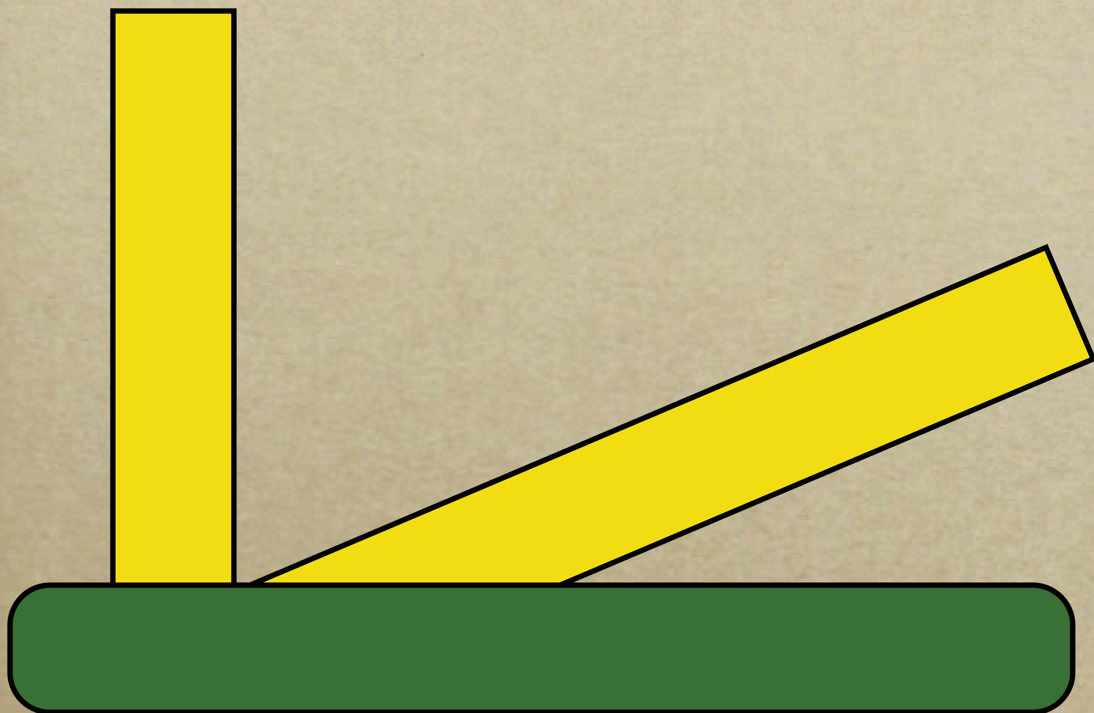
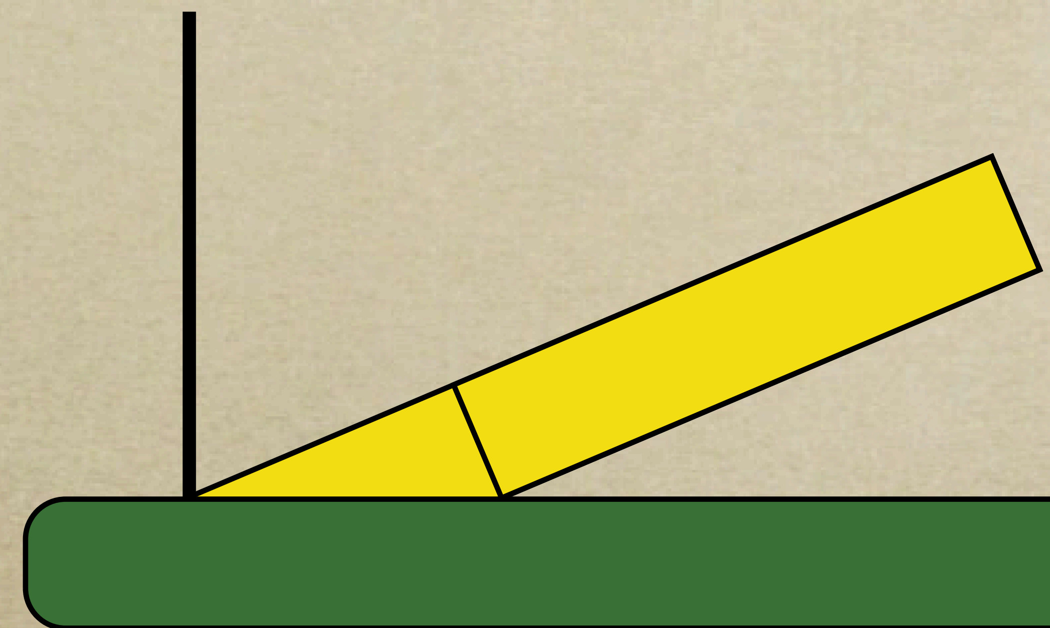
Yet more ray tracing...

Illumination models

Light: where from and where to?

Lambertian/Diffuse Illumination

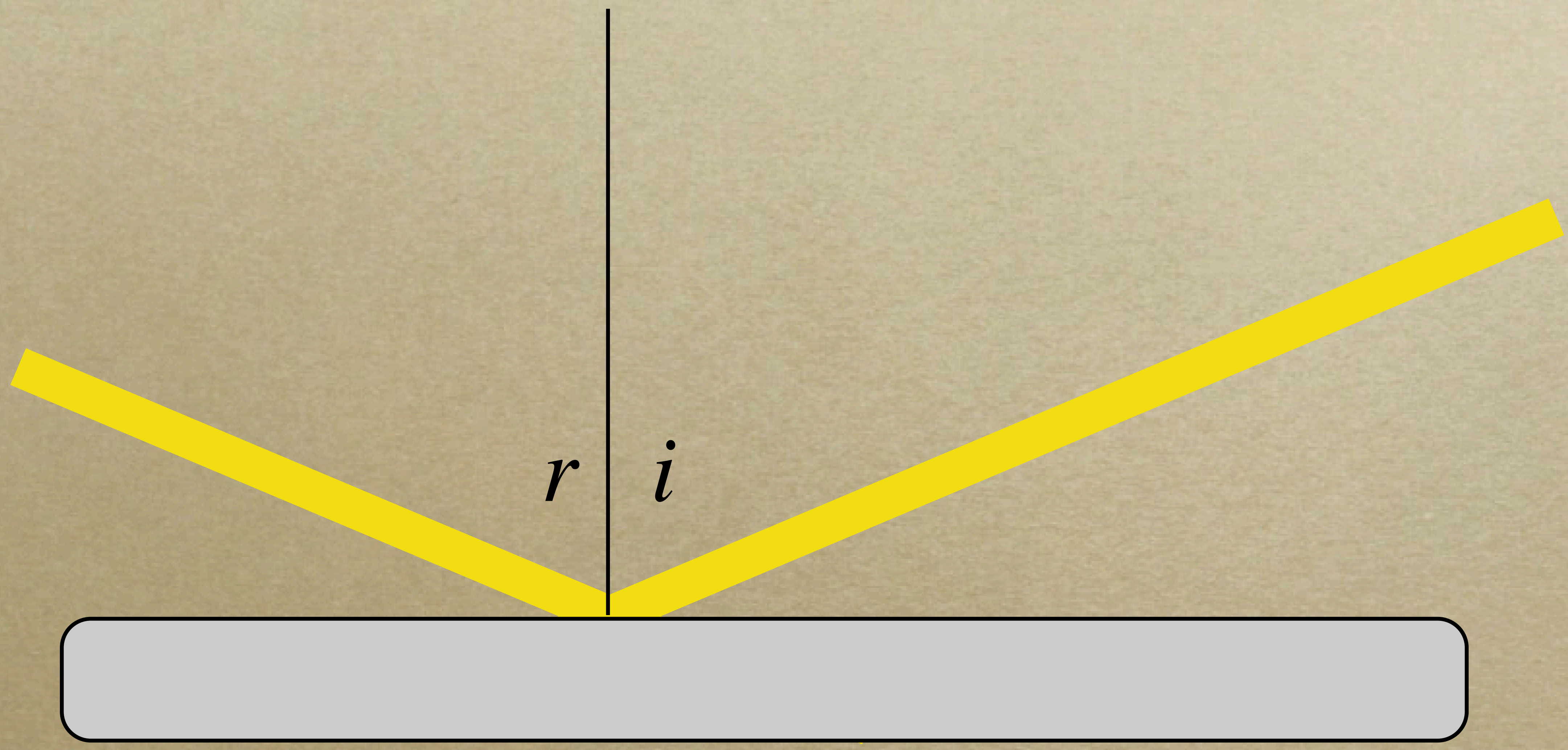




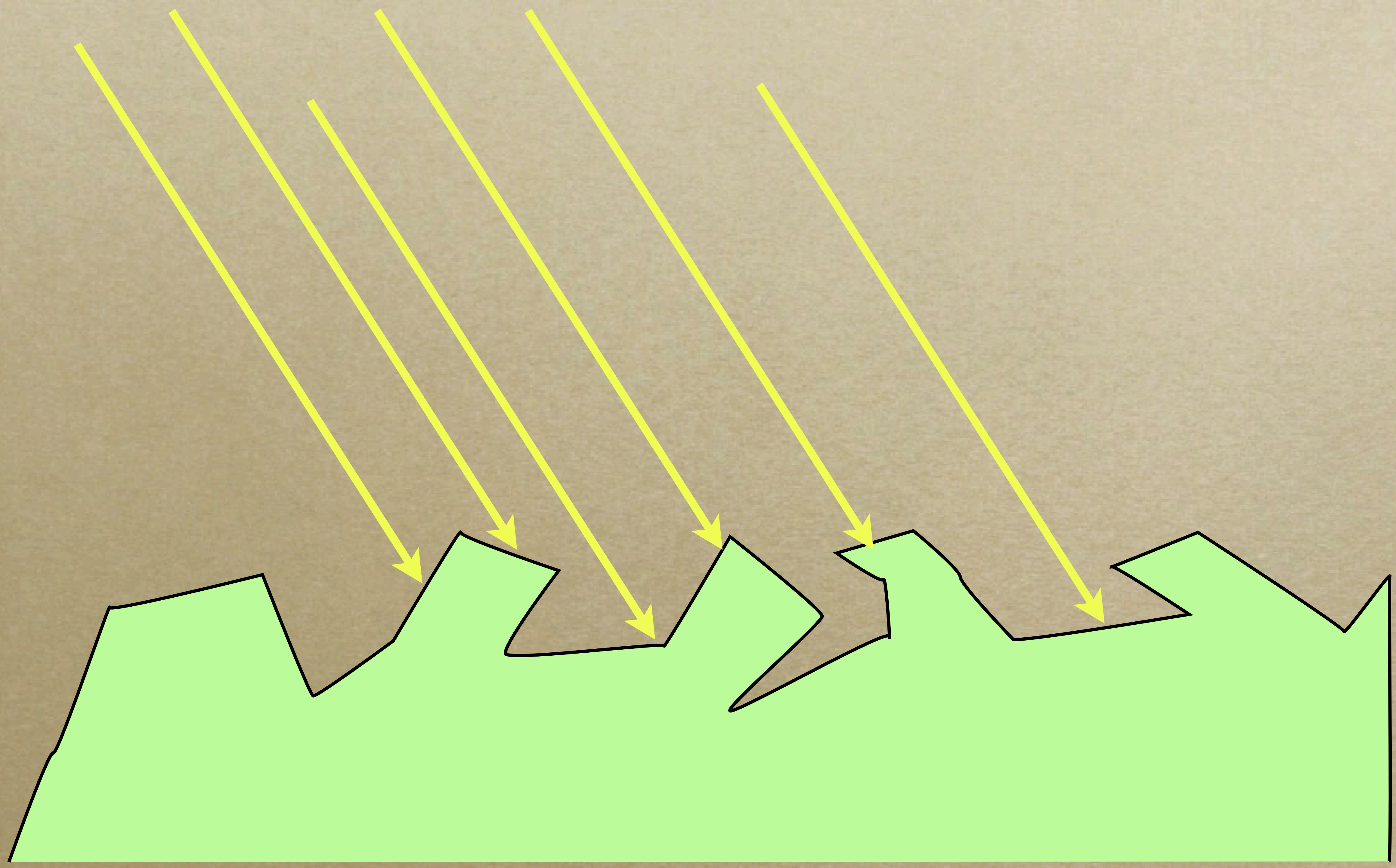
$$I_d = k_d I \hat{\mathbf{n}} \cdot \hat{\boldsymbol{\ell}}$$

Mirror reflection

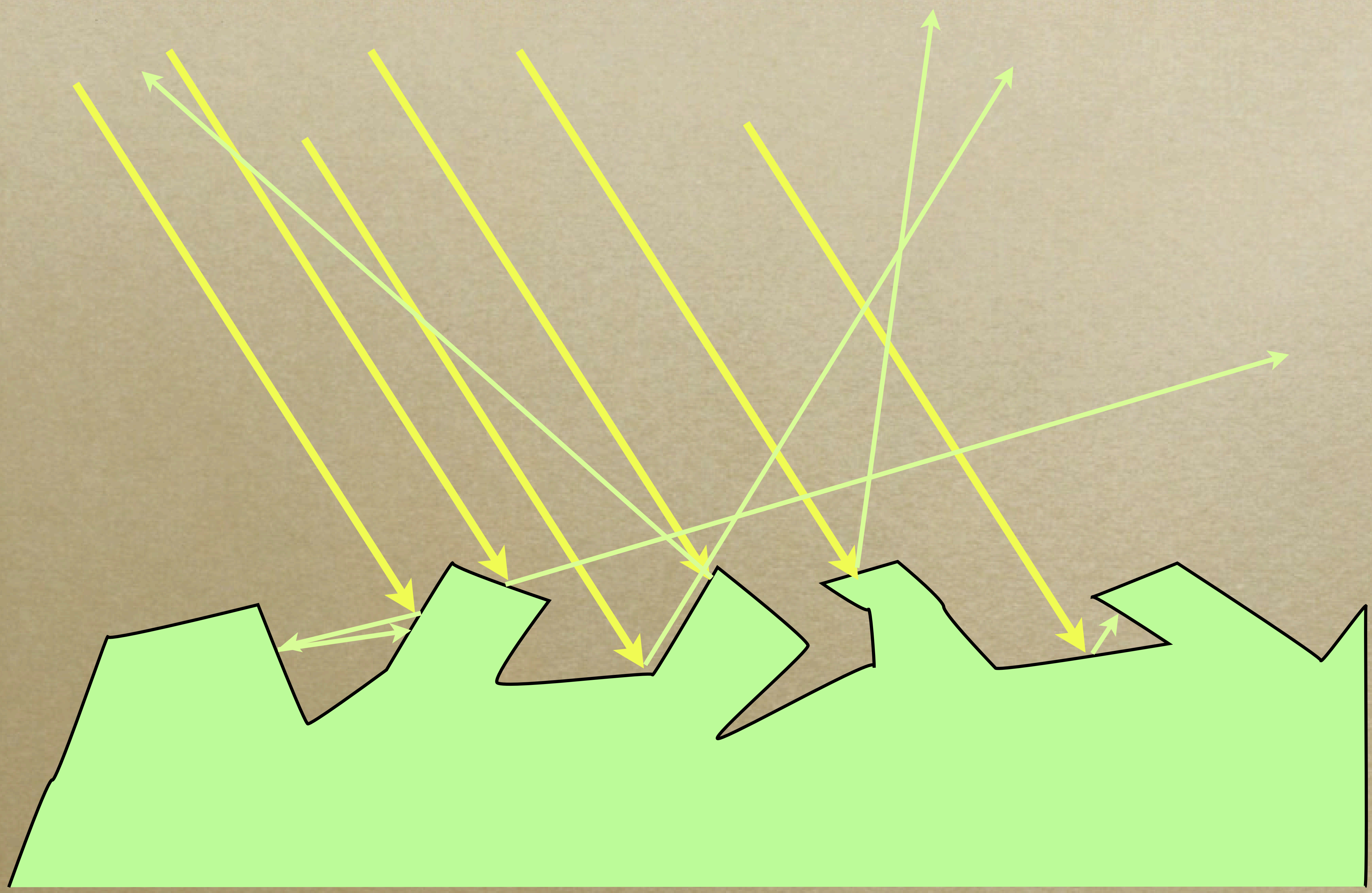
$$i = r$$



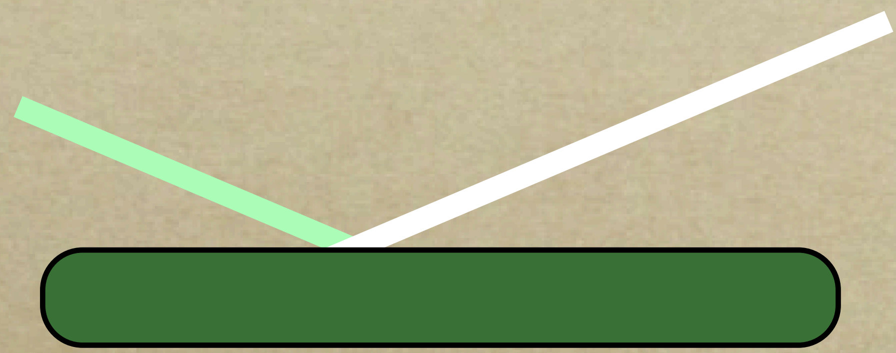
Real surfaces are complicated

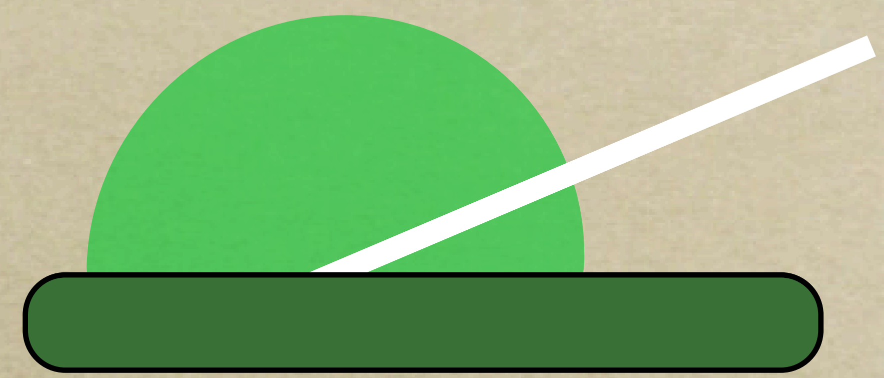


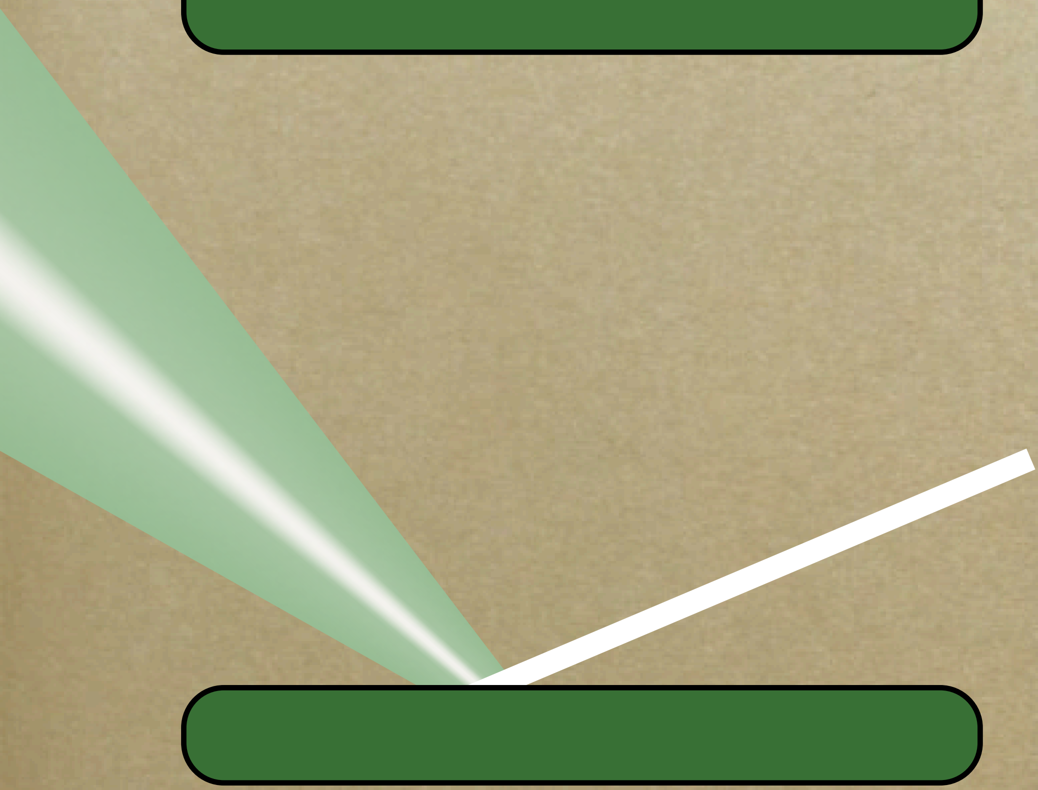
Real surfaces are complicated



Approximate behaviour



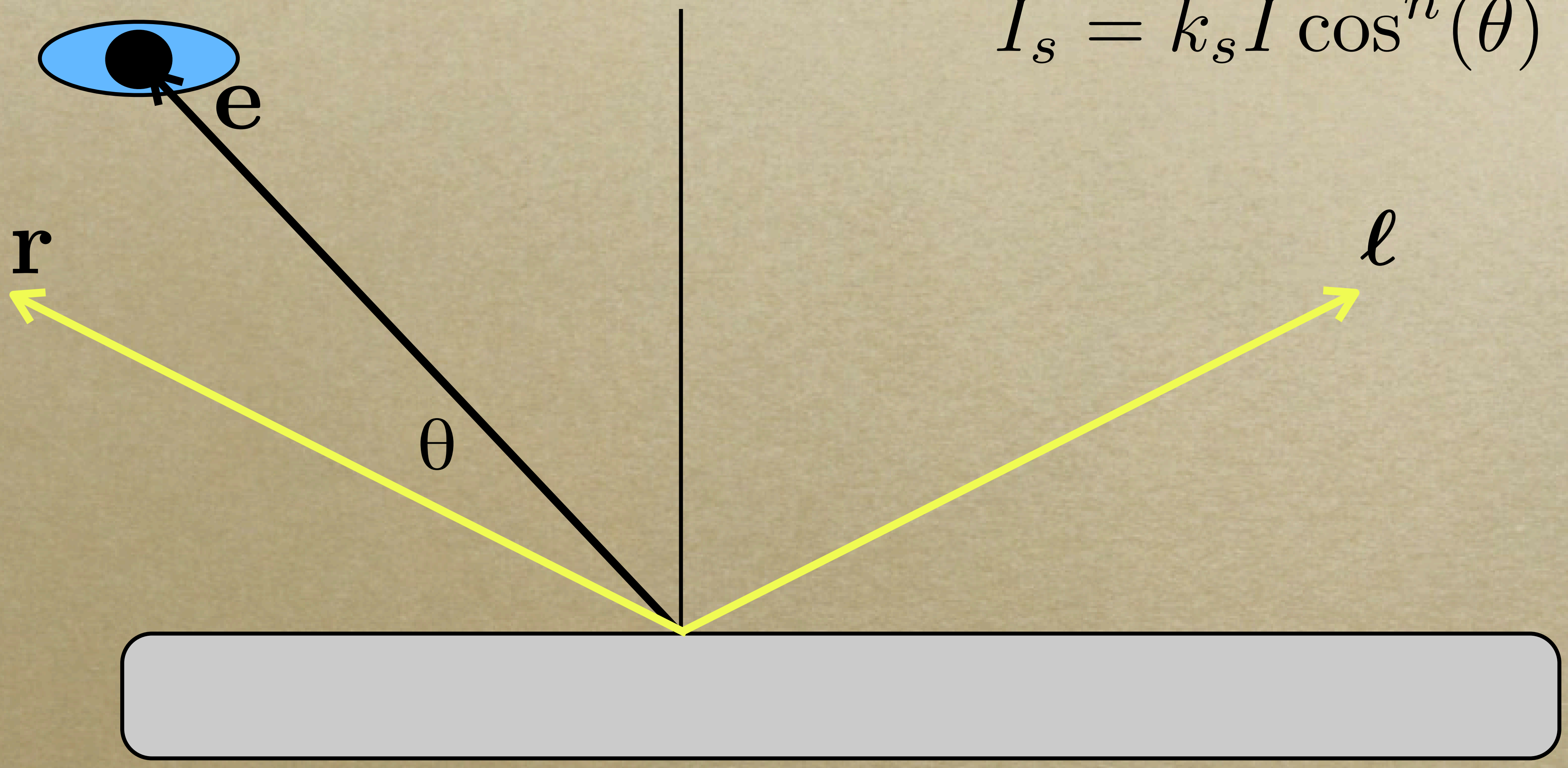




Some reflected
Some diffused
Some in-between

Phong's Model

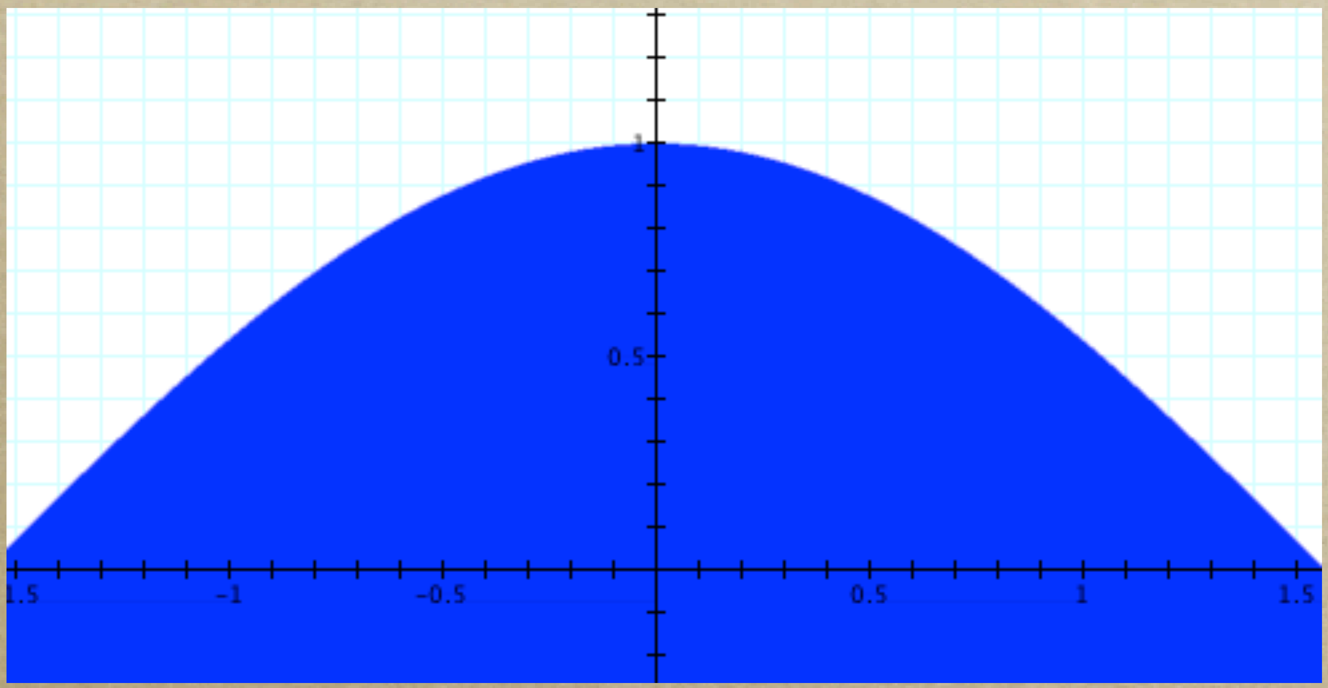
$$I_s = k_s I \cos^n(\theta)$$



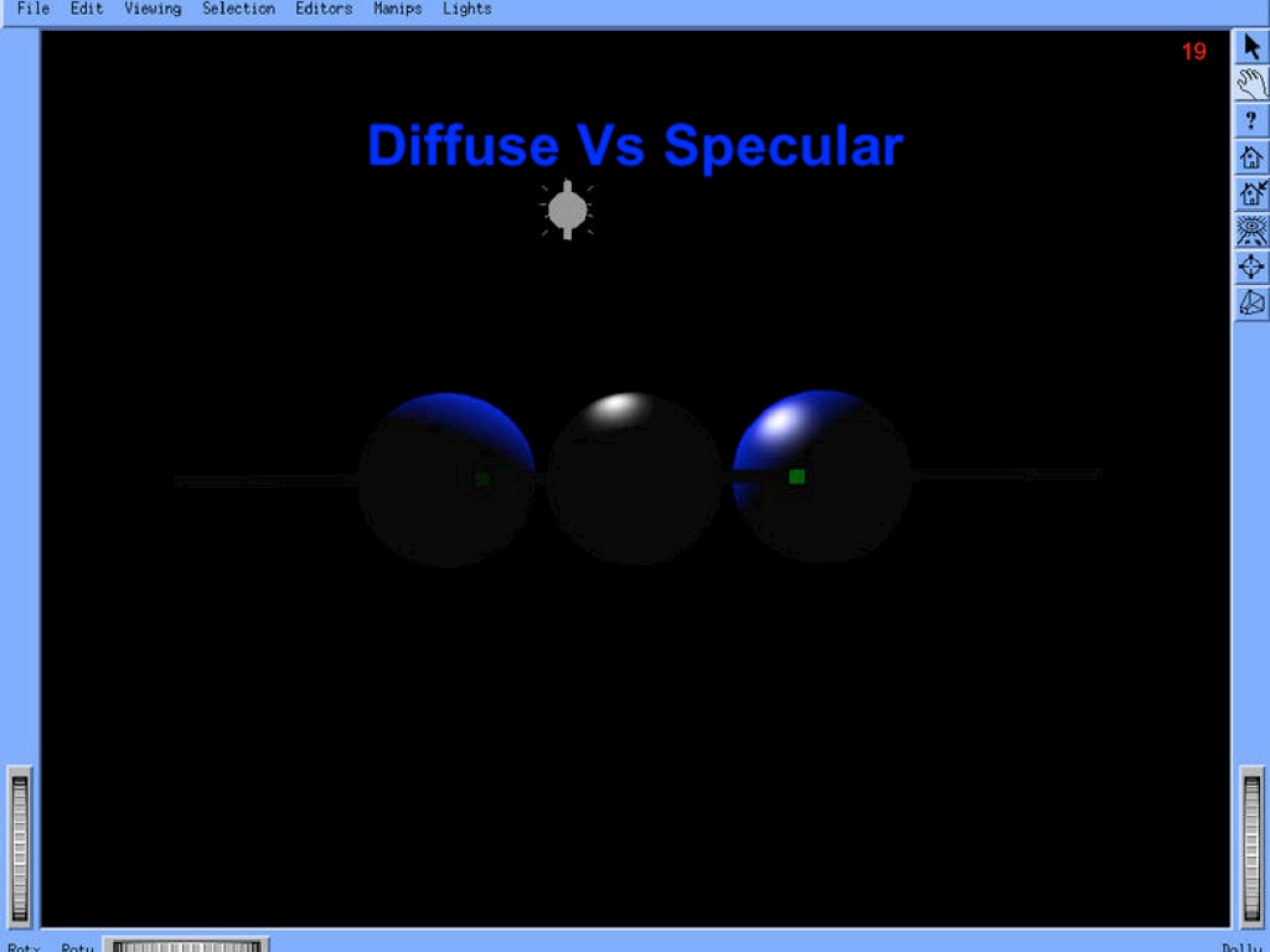
Why $\cos^n(\theta)$?

$n = 1..\ 6500$

Why $\cos^n(\theta)$?



$n = 1..\ 6500$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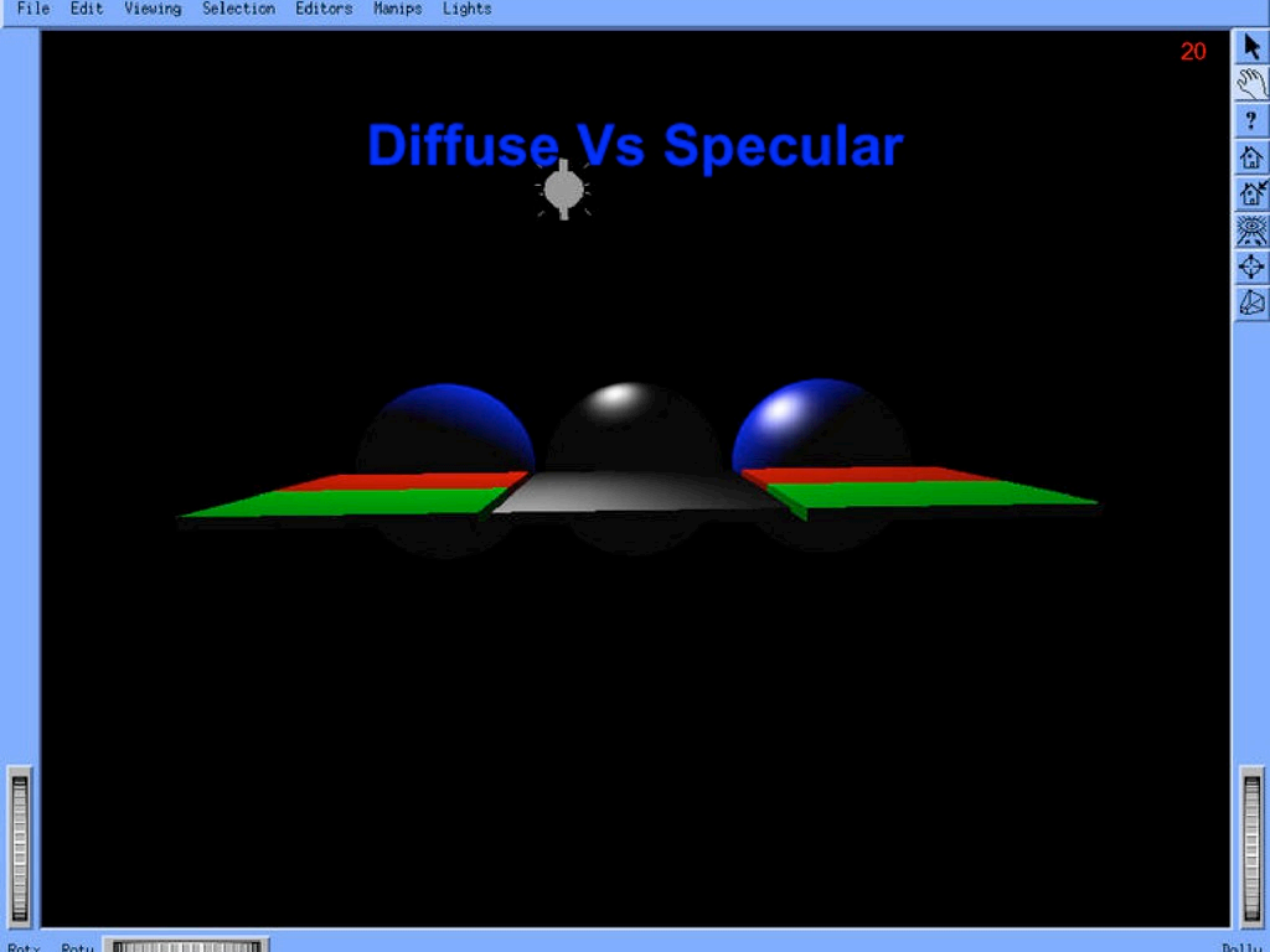
Diffuse Vs Specular
Rotx Roty
Dolly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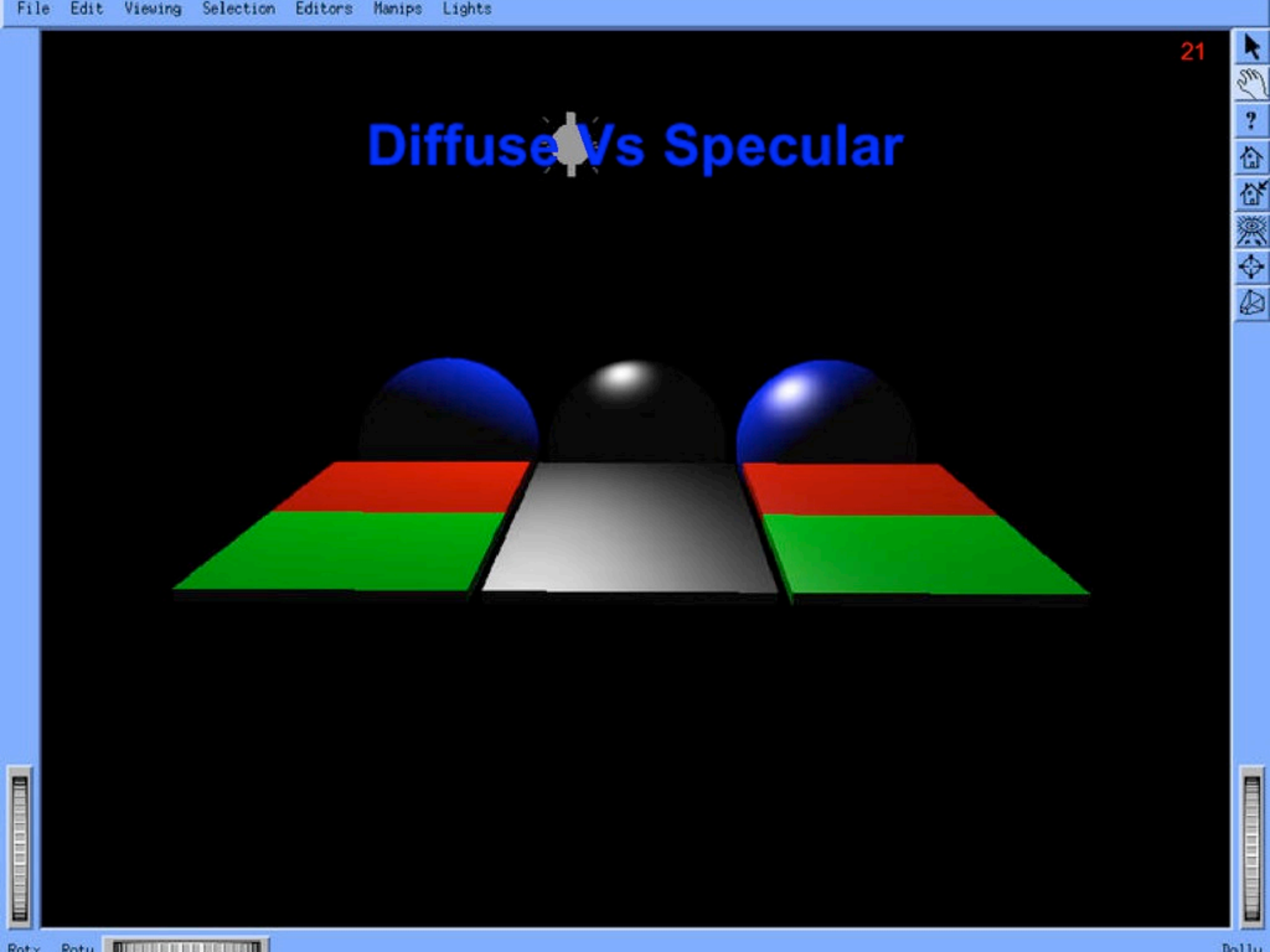
Diffuse Vs Specular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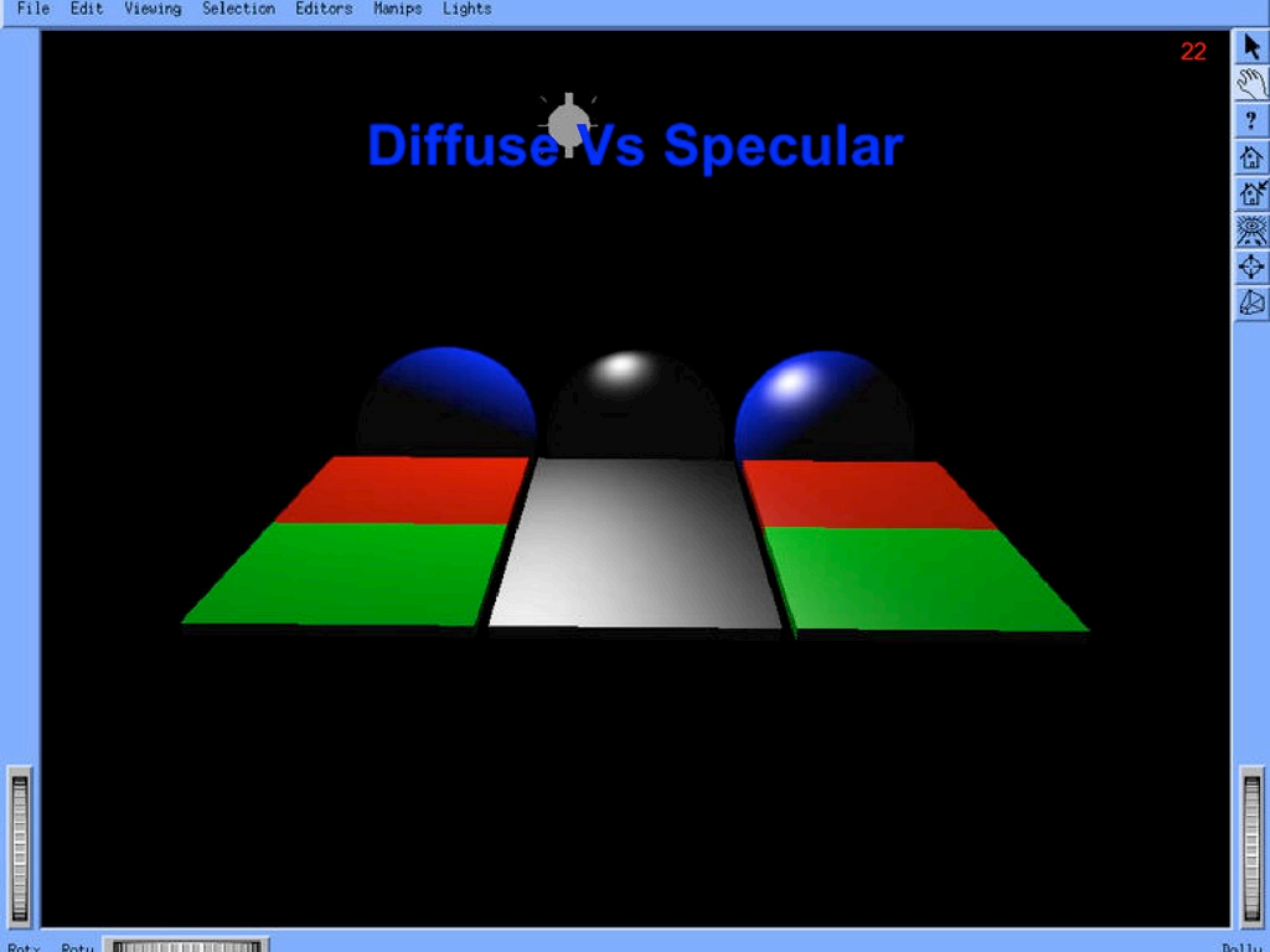
Diffuse Vs Specular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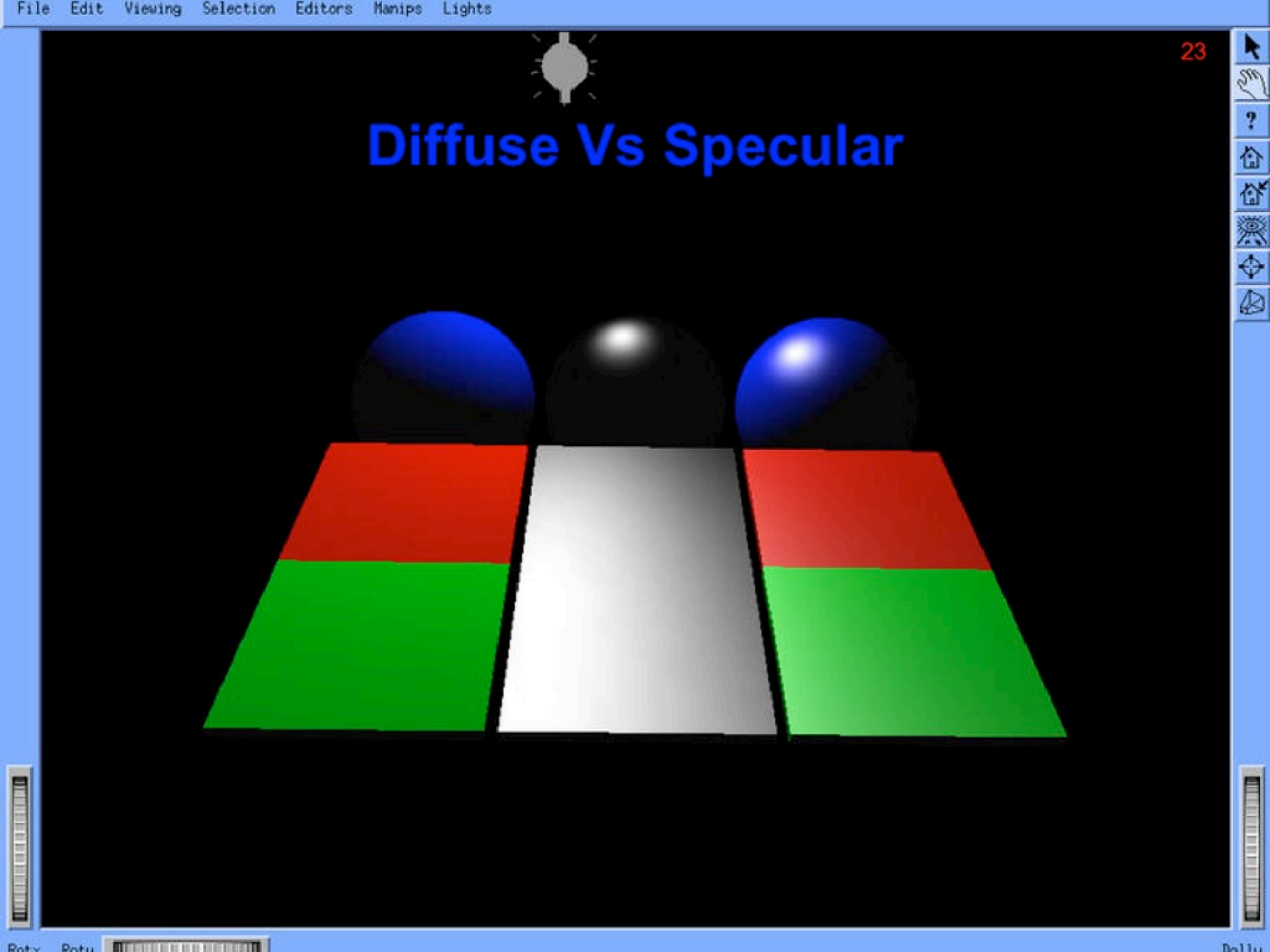
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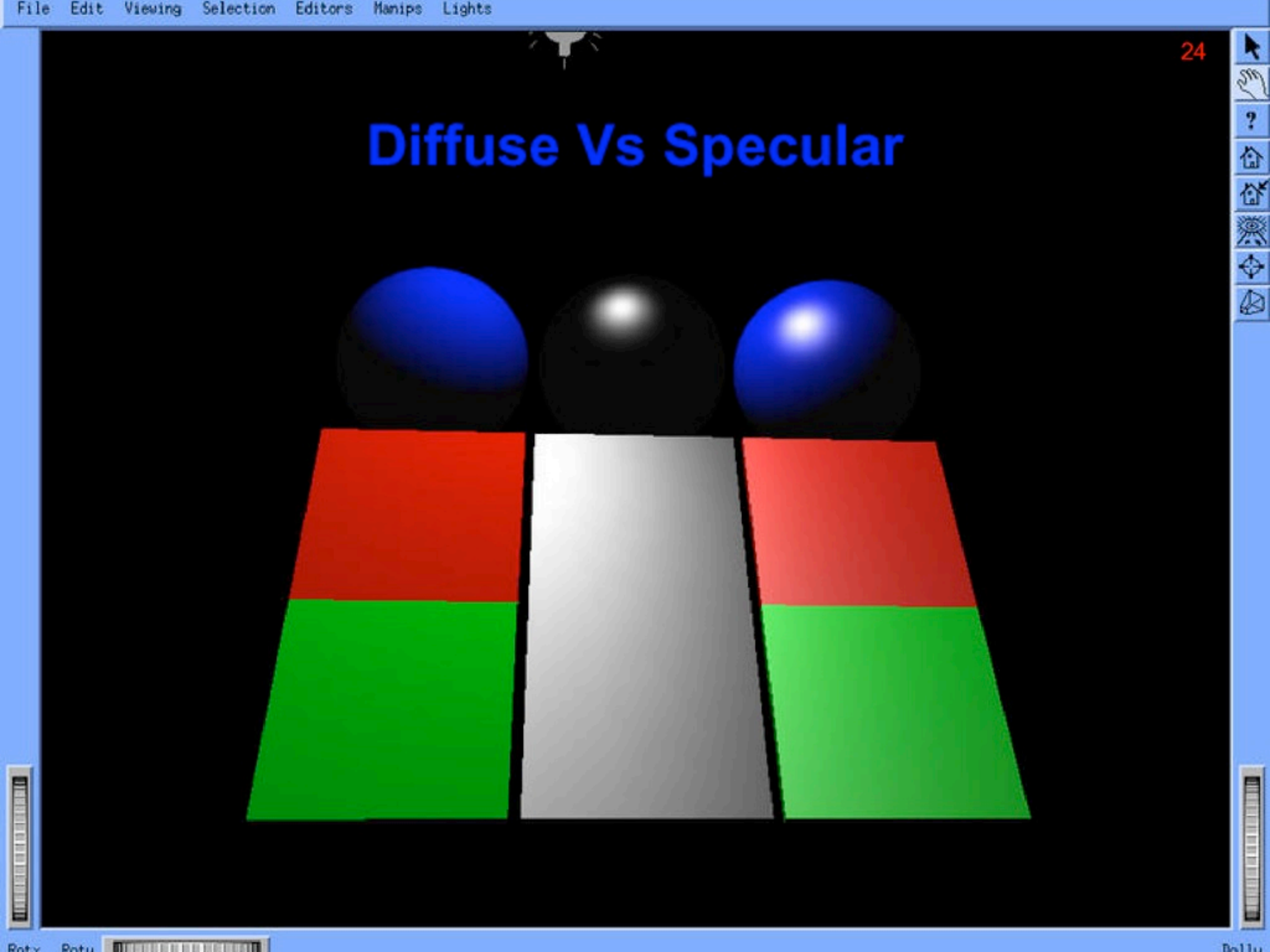
Diffuse Vs Specular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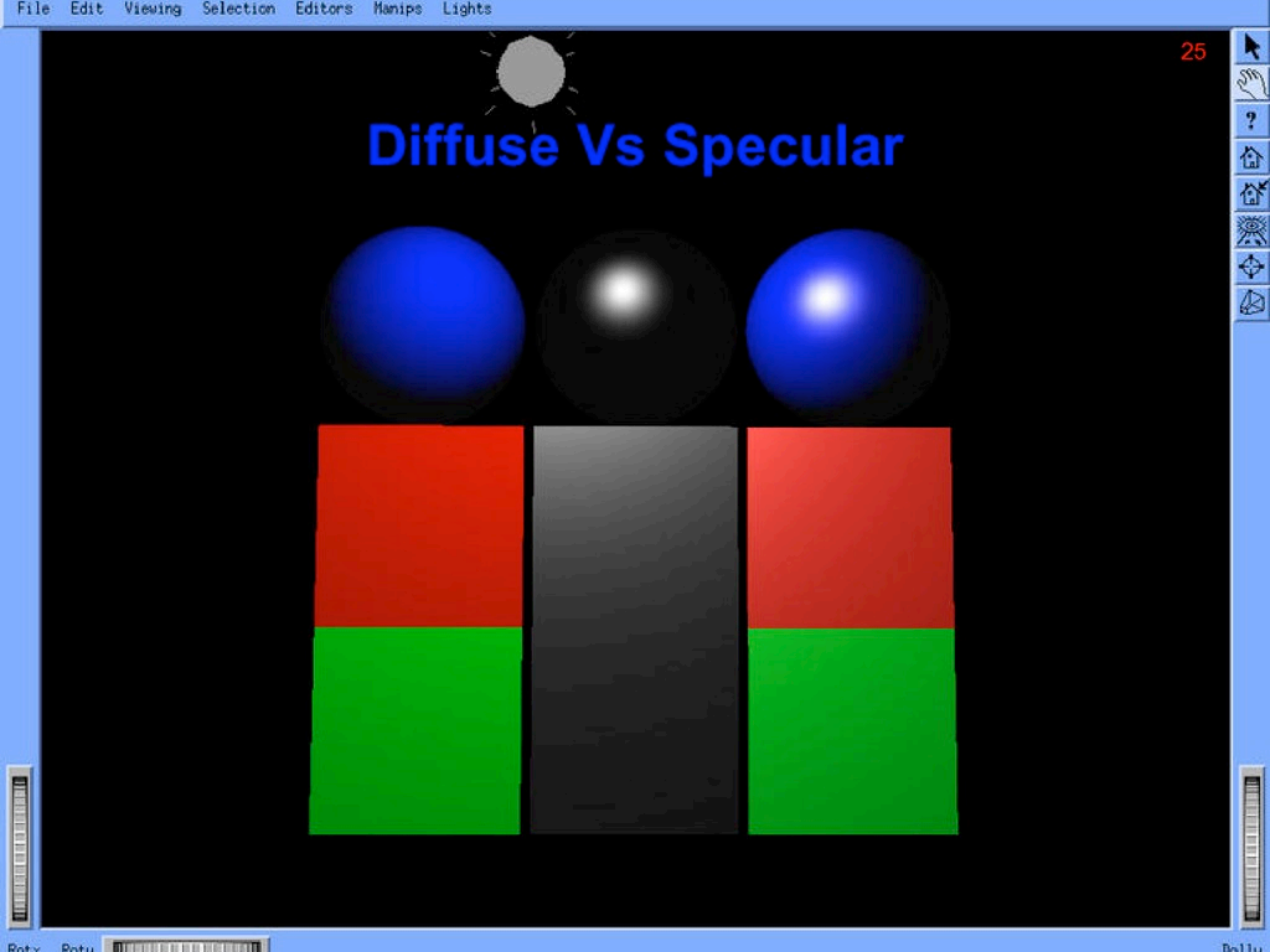
Diffuse Vs Specular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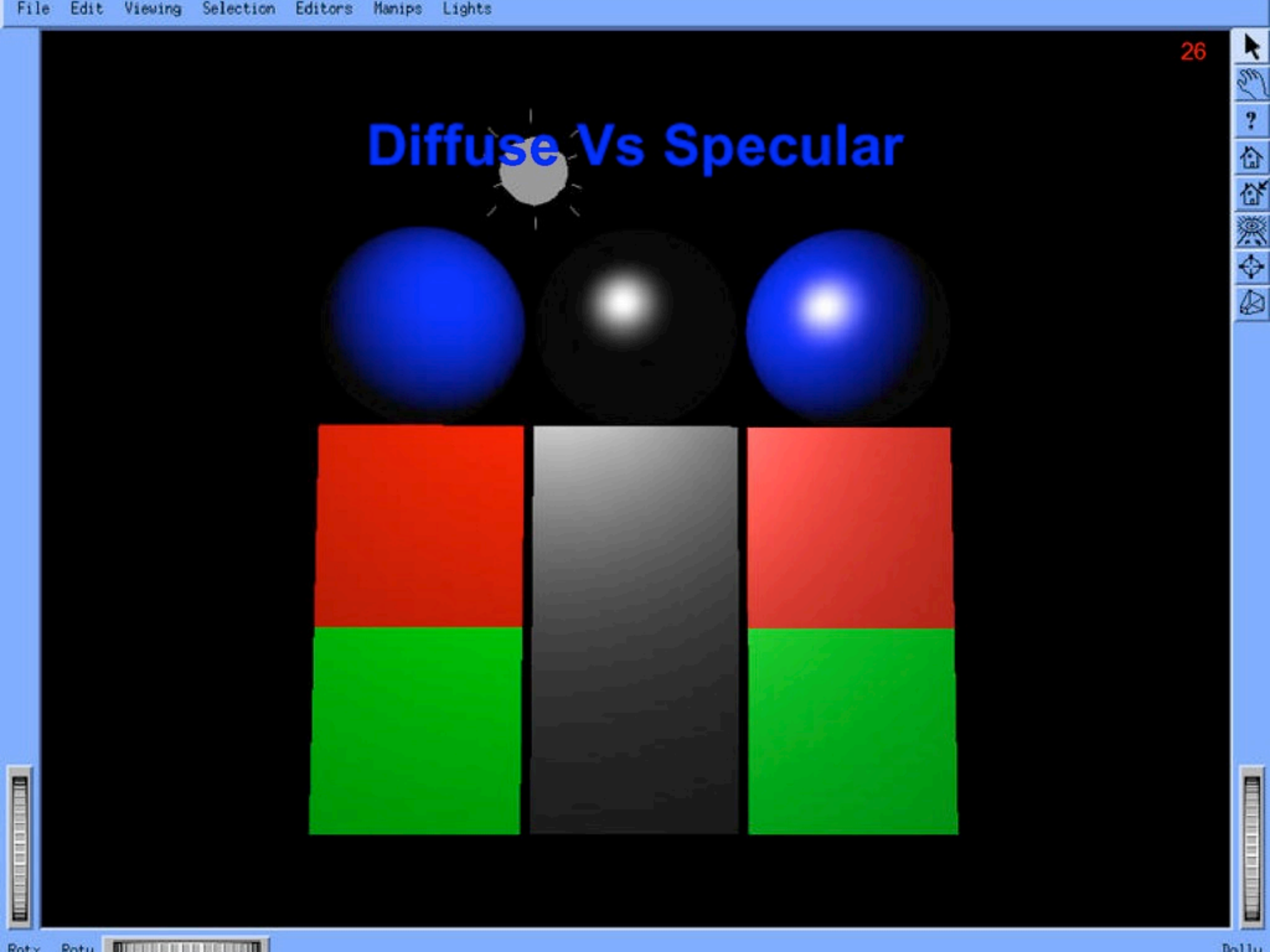
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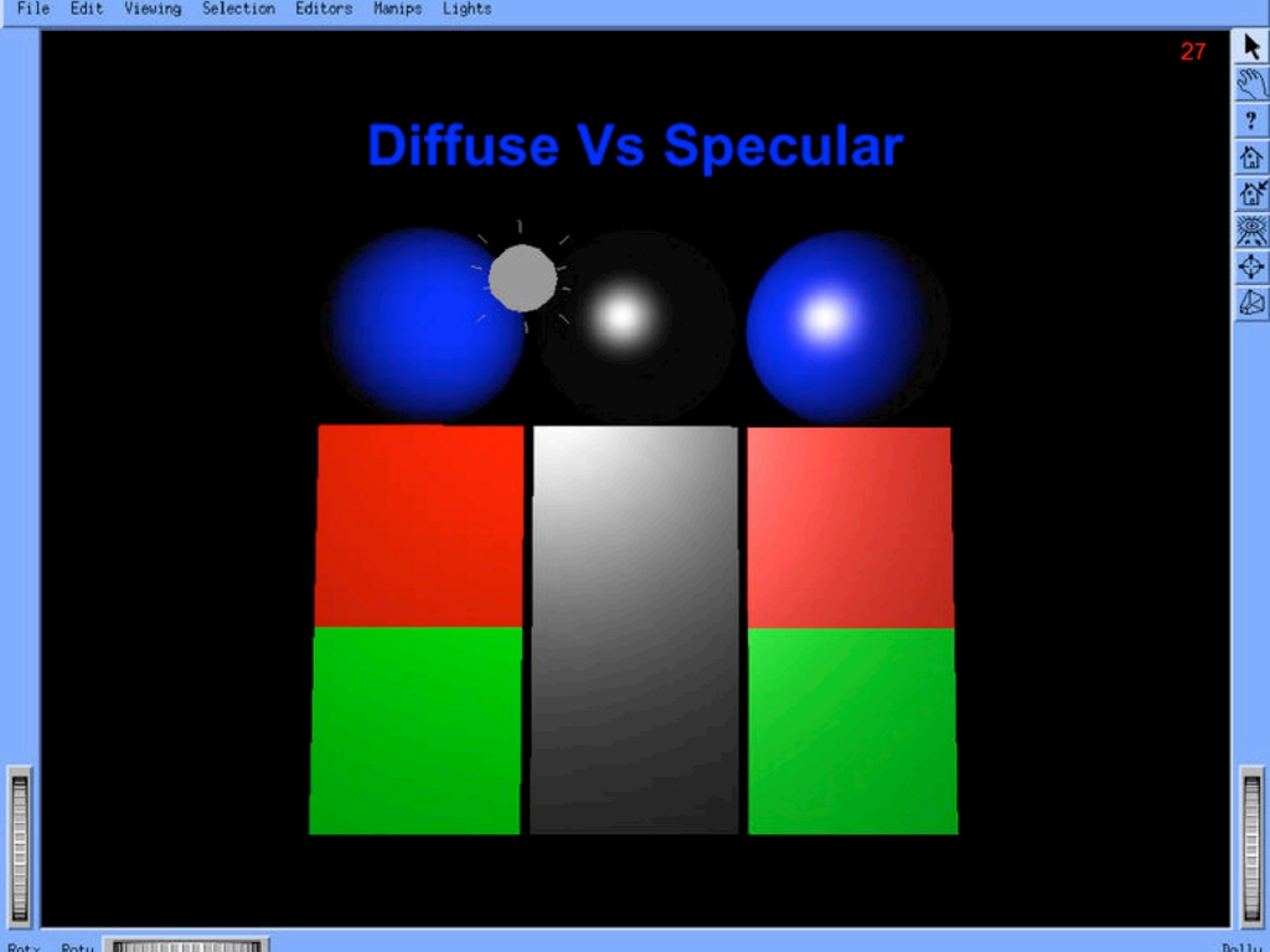
Diffuse Vs Specular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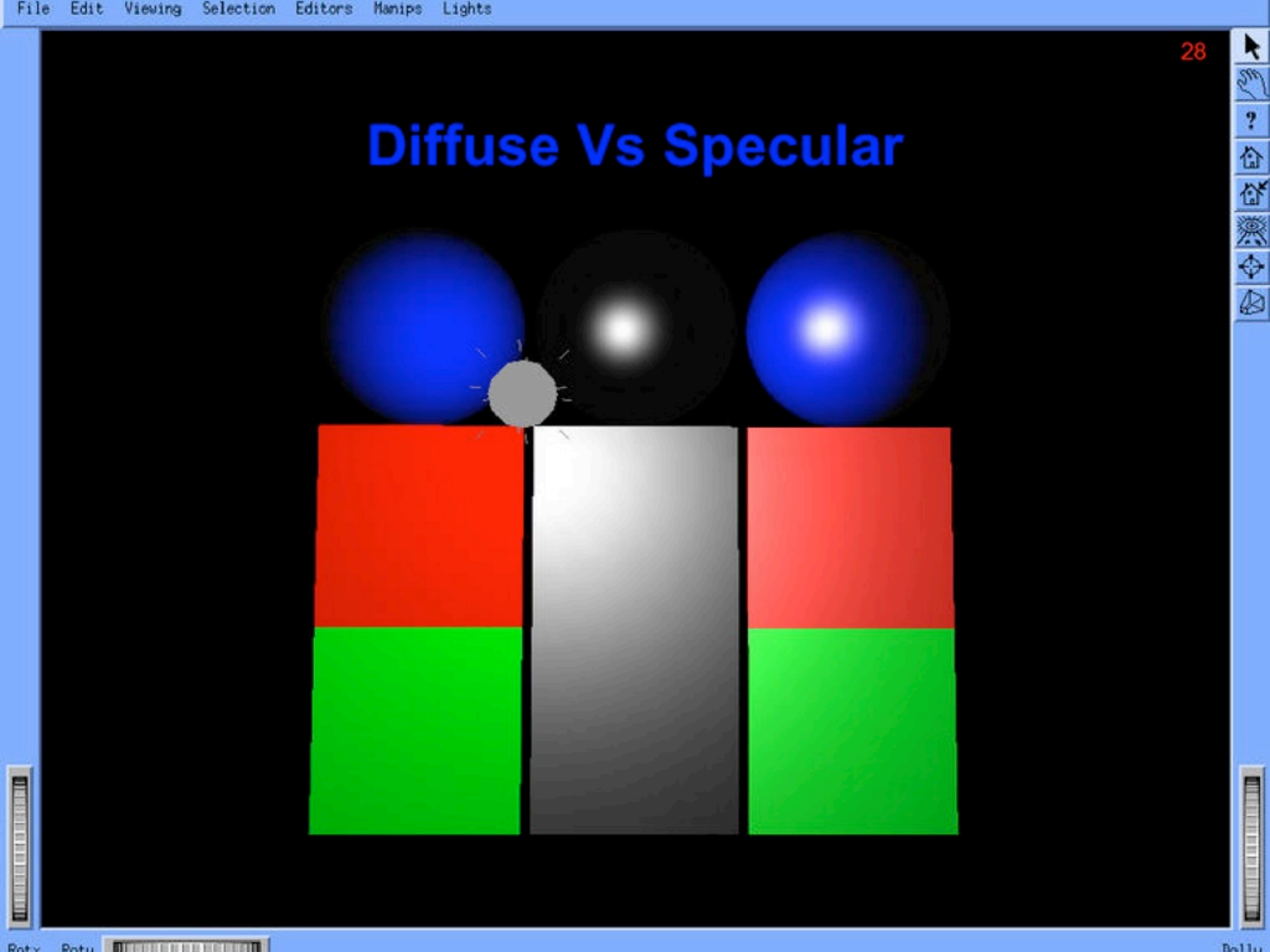
Diffuse Vs Specular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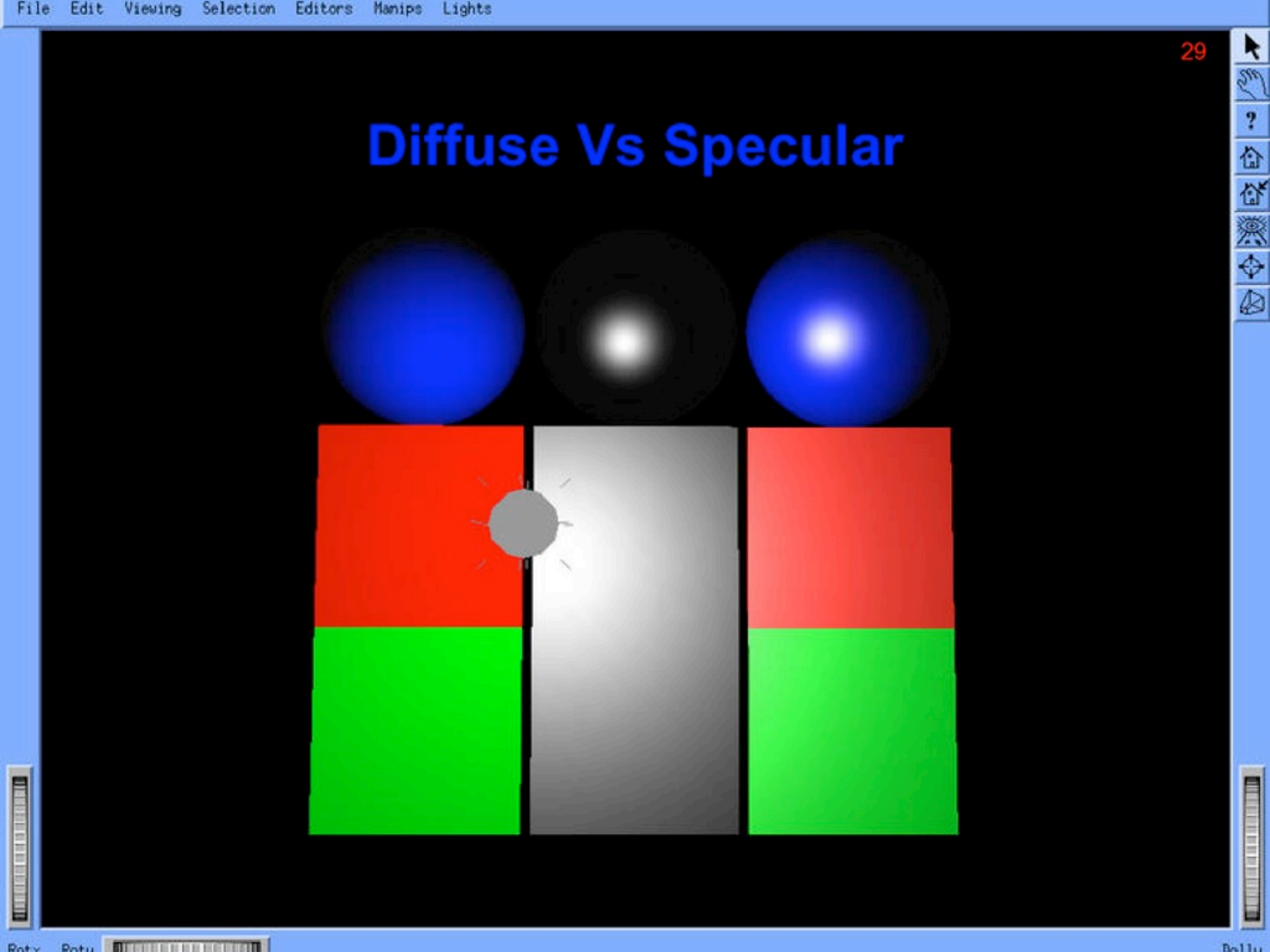
Diffuse Vs Specular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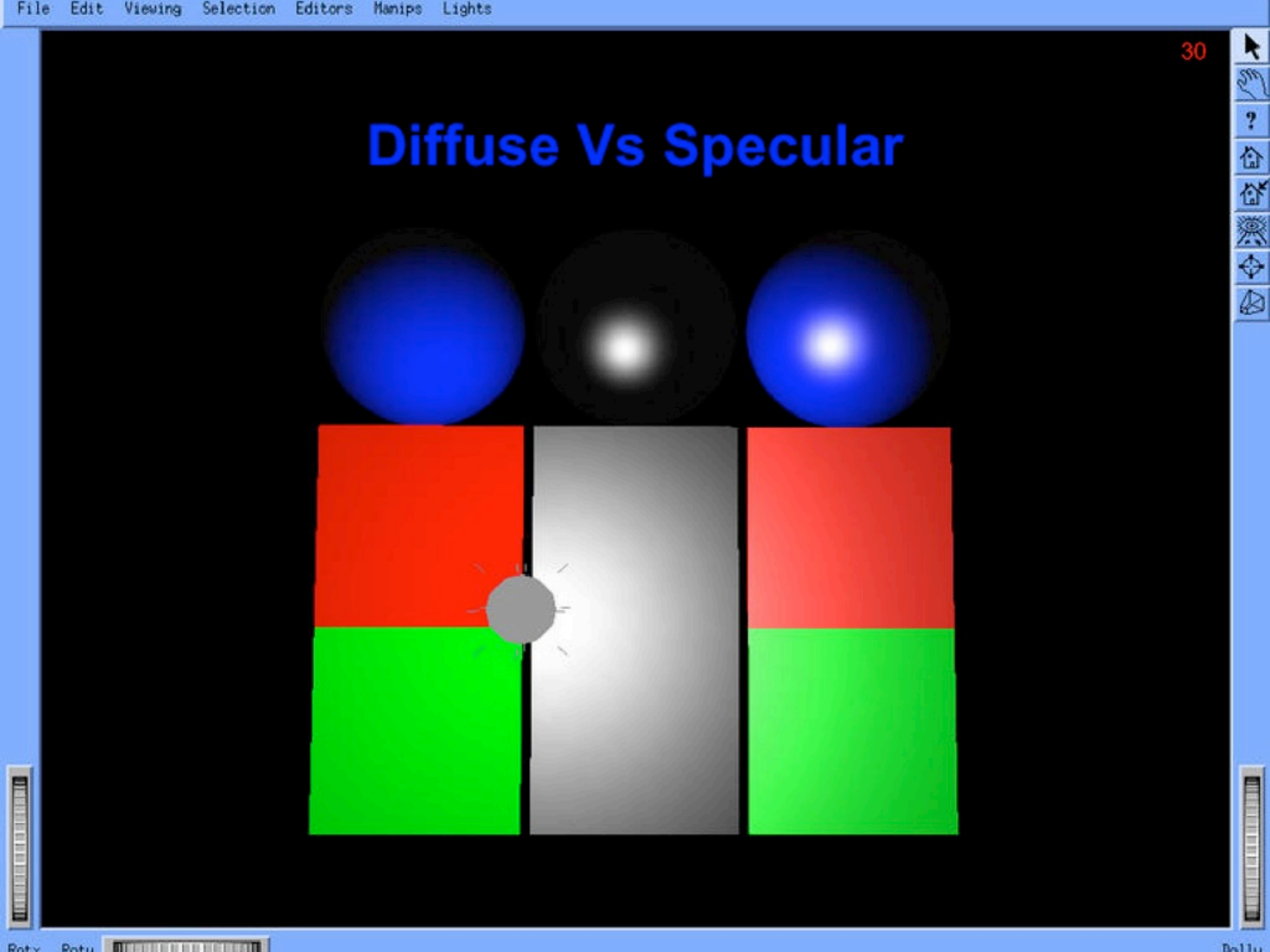
Diffuse Vs Specular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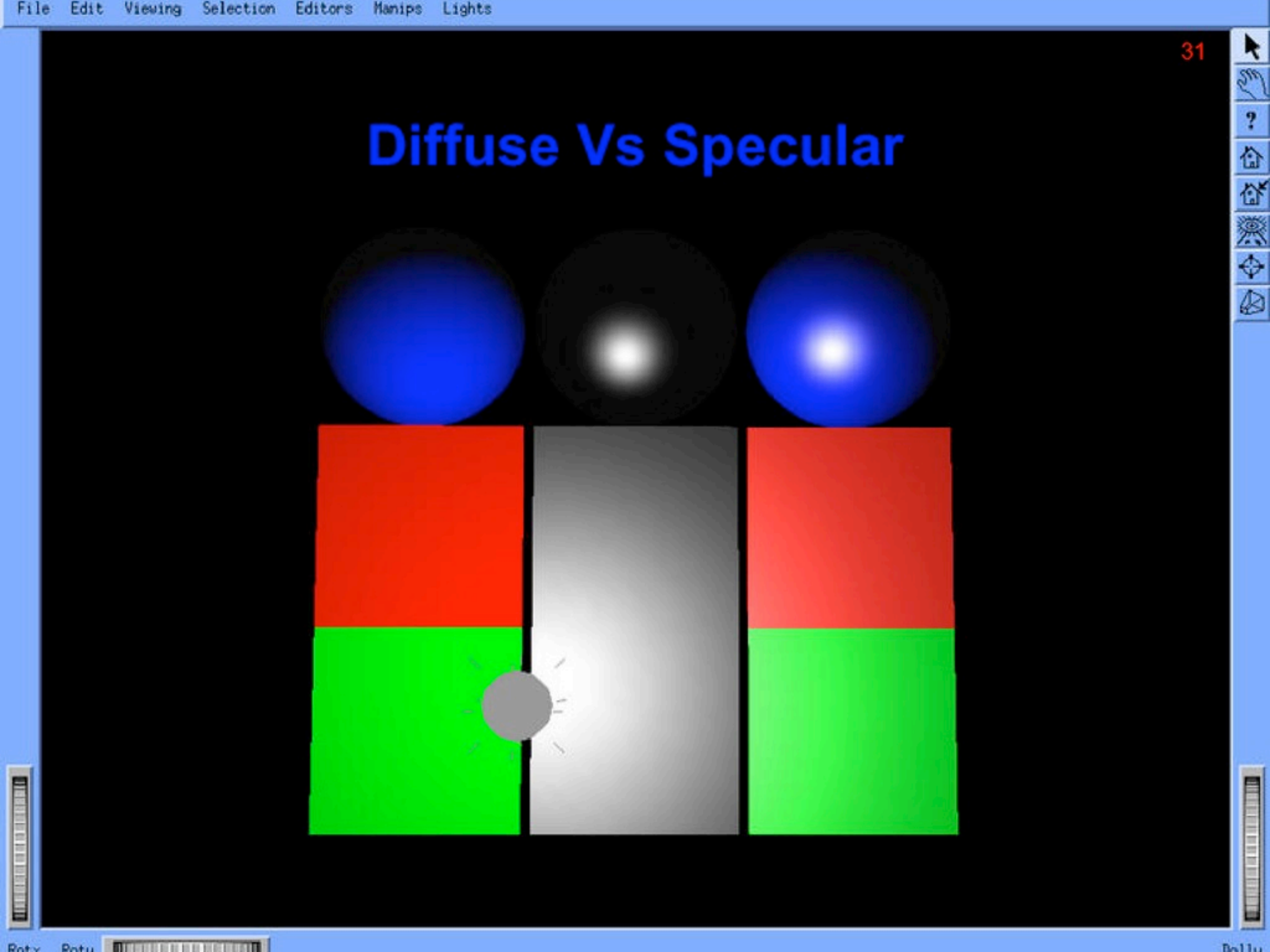
Diffuse Vs Specular



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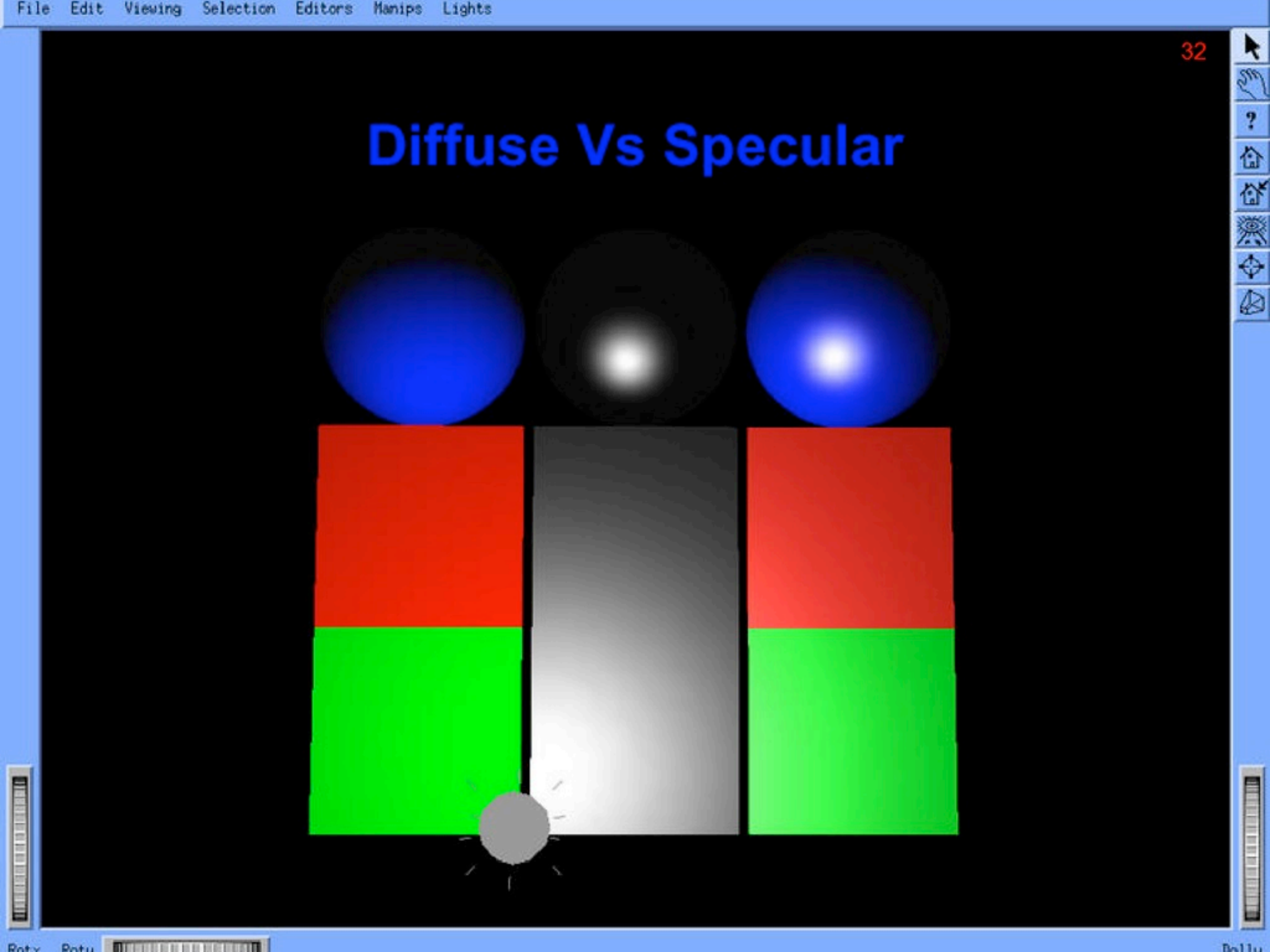
Diffuse Vs Specular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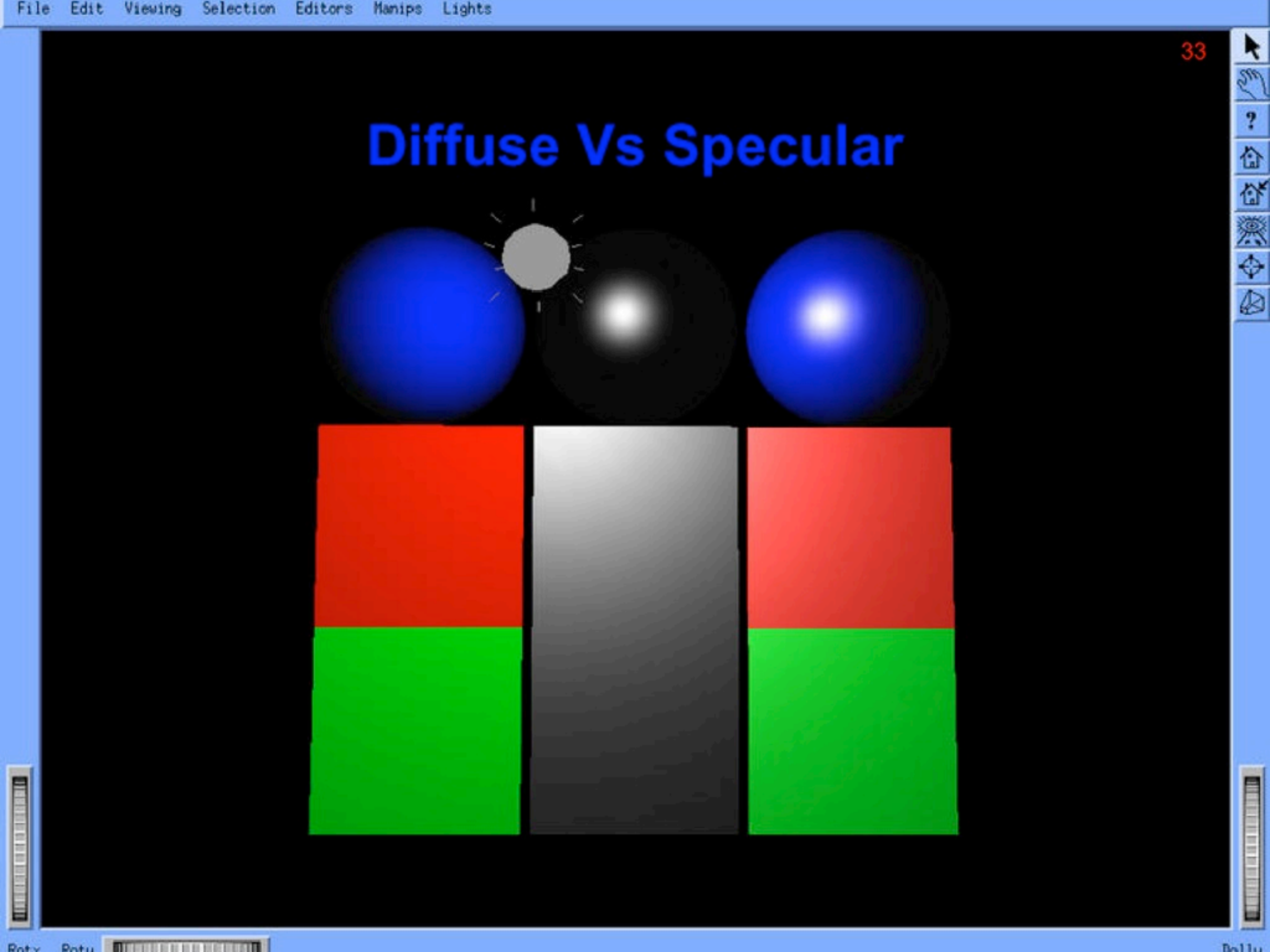
Diffuse Vs Specular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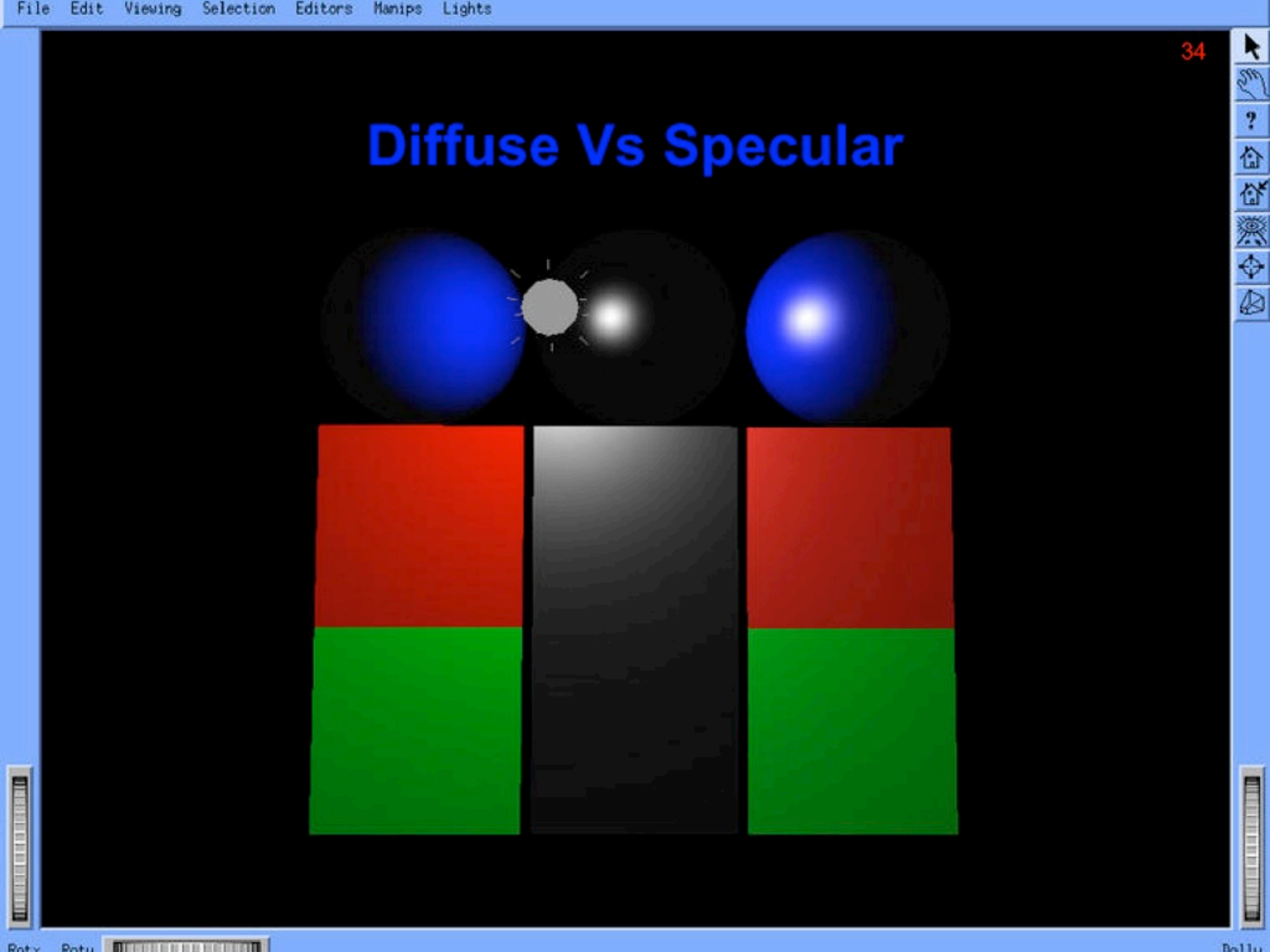
Lights
33
Diffuse Vs Specular
Rotx
Roty
Dolly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Diffuse Vs Specular

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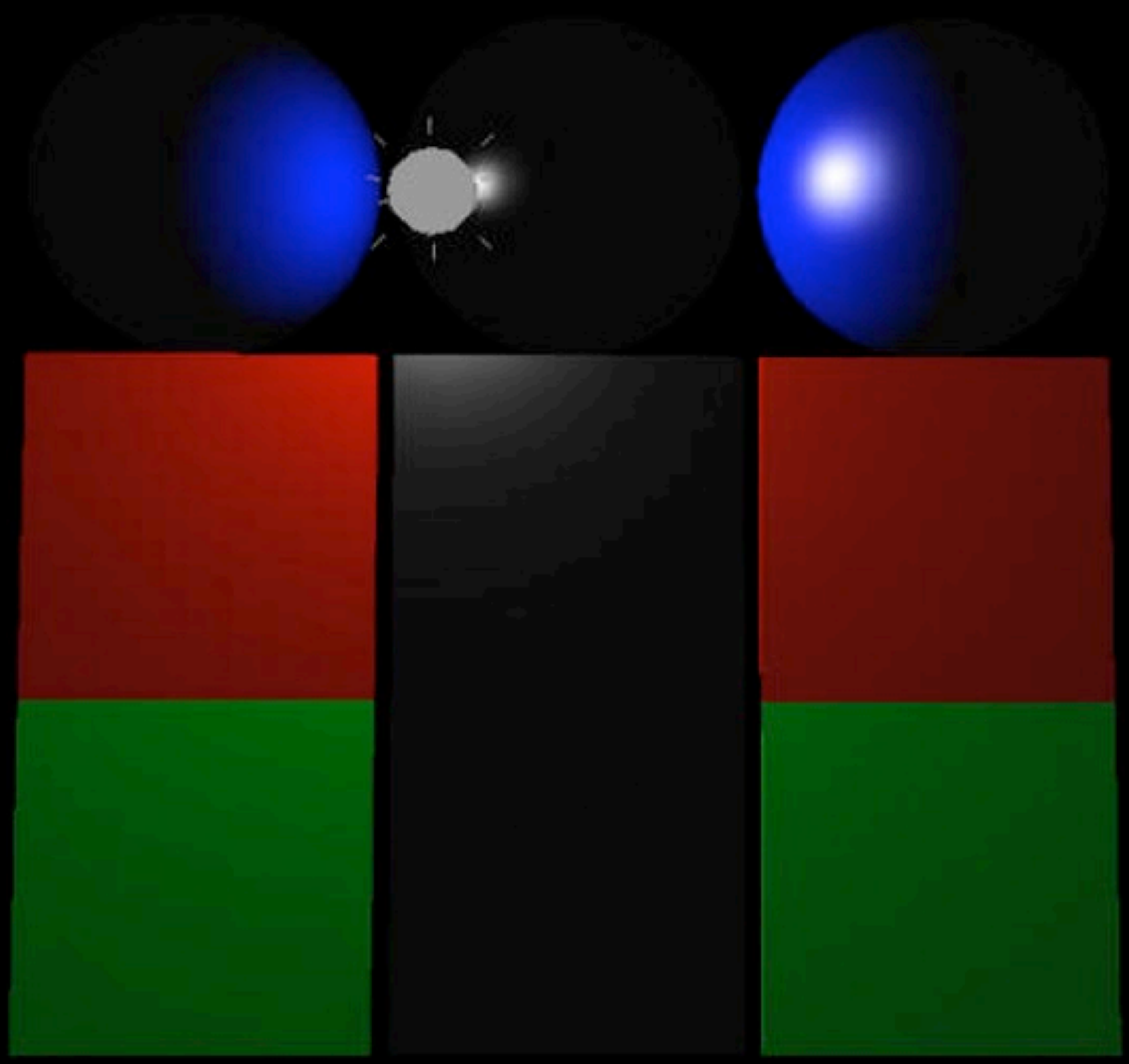
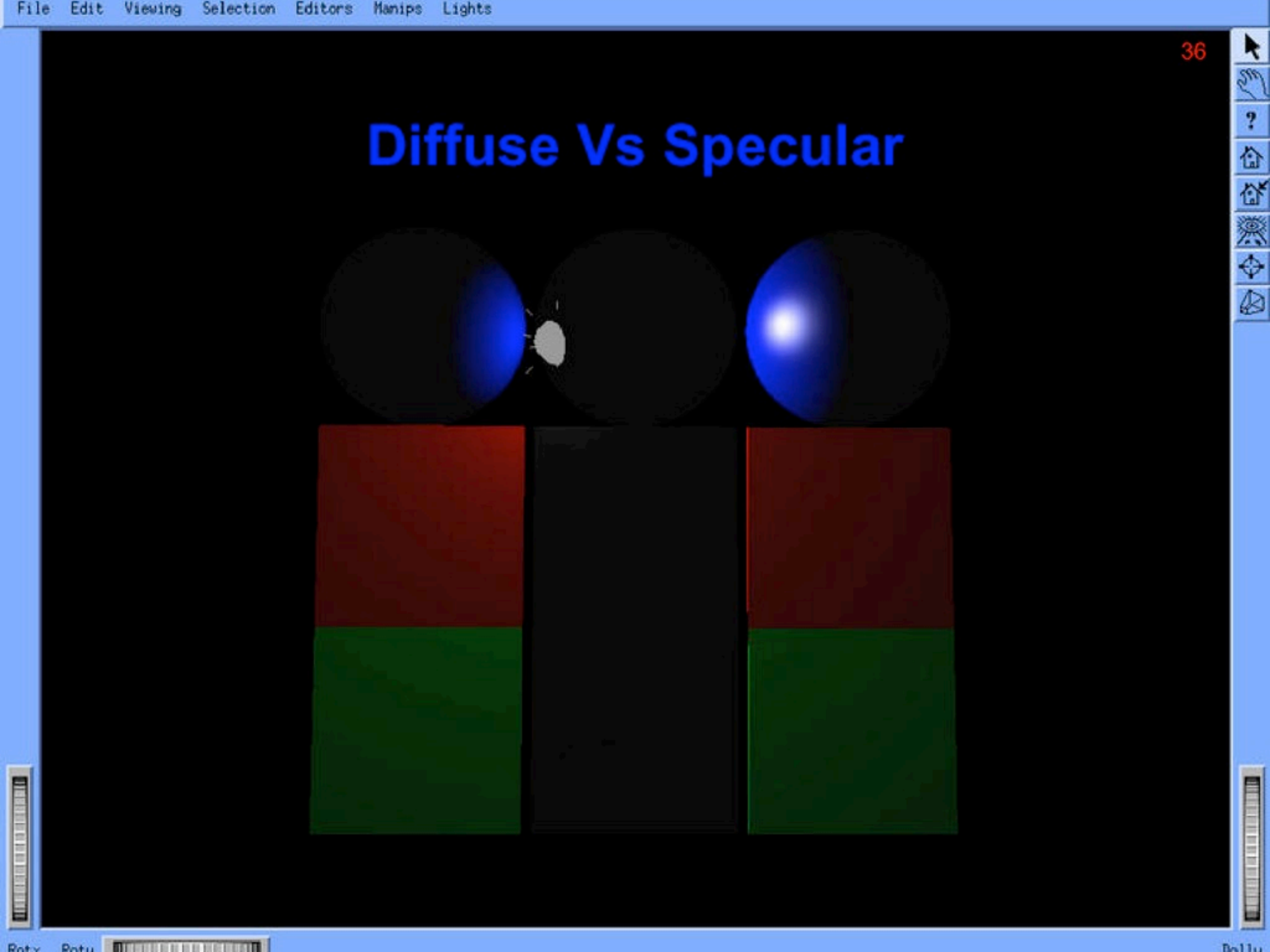
Diffuse Vs Specular

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Diffuse Vs Specular

Light in the shadows

Ambient light

- *To avoid complete blackness where there is no direct light, we add a small amount of constant, directionless light.*
- *This is called ambient light or ambient illumination as it approximates the light all around us.*

Simple light model

$$I_{total} = I_a k_a + I_j \left(k_d(\hat{\boldsymbol{\ell}}_j \cdot \hat{\mathbf{n}}) + k_s(\hat{\mathbf{e}} \cdot \hat{\mathbf{r}}_j)^n \right)$$

where I_a *is the intensity of ambient light,*

I_j *is the intensity of the light source*

and, k_a, k_d, k_s, *and* n *are constants.*

More than one light?

$$I_{total} = I_a k_a + \sum_{j \in visible\ lights} I_j \Big(k_d (\hat{\boldsymbol{\ell}}_j \cdot \hat{\mathbf{n}}) + k_s (\hat{\mathbf{e}} \cdot \hat{\mathbf{r}}_j)^n \Big)$$

Shadows

A light source illuminates a surface only if there is nothing in between.

So before we add in $I_j\Big(k_d(\hat{\boldsymbol{\ell}}_j \cdot \hat{\mathbf{n}}) + k_s(\hat{\mathbf{e}} \cdot \hat{\mathbf{r}}_j)^n\Big)$ *for a particular* j*, we need to see if the surface at that point is in shadow from light source,* j*.*

Shadow rays

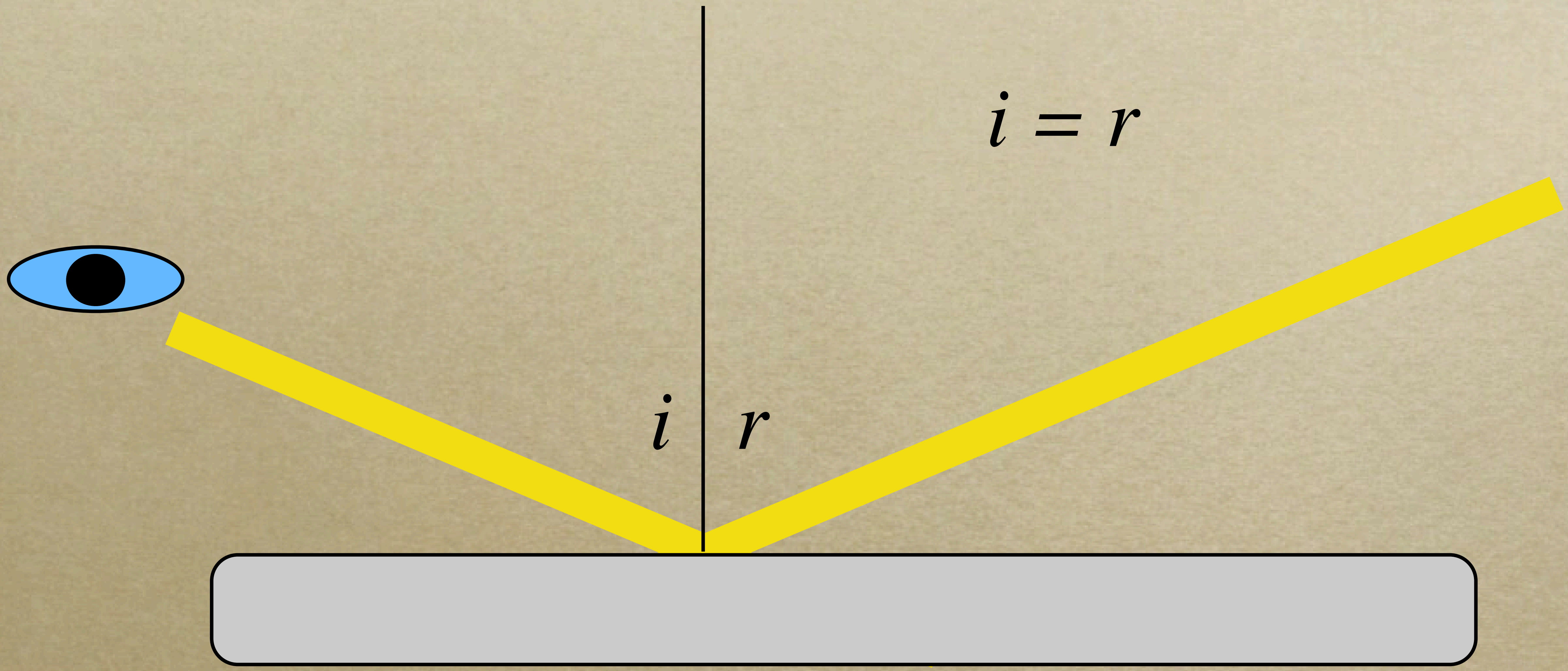
Cast a ray from the hit point, $\mathbf{p}_{\mathrm{h}}$*, to each light source's position,* $\mathbf{p}_{\ell}$

This is the ray $\mathbf{p} = \mathbf{p}_{\mathrm{h}} + (\mathbf{p}_{\ell} - \mathbf{p}_{\mathrm{h}})\mathrm{t}$

Notice that when $\mathrm{t} = 1$, $\mathbf{p} = \mathbf{p}_{\ell}$

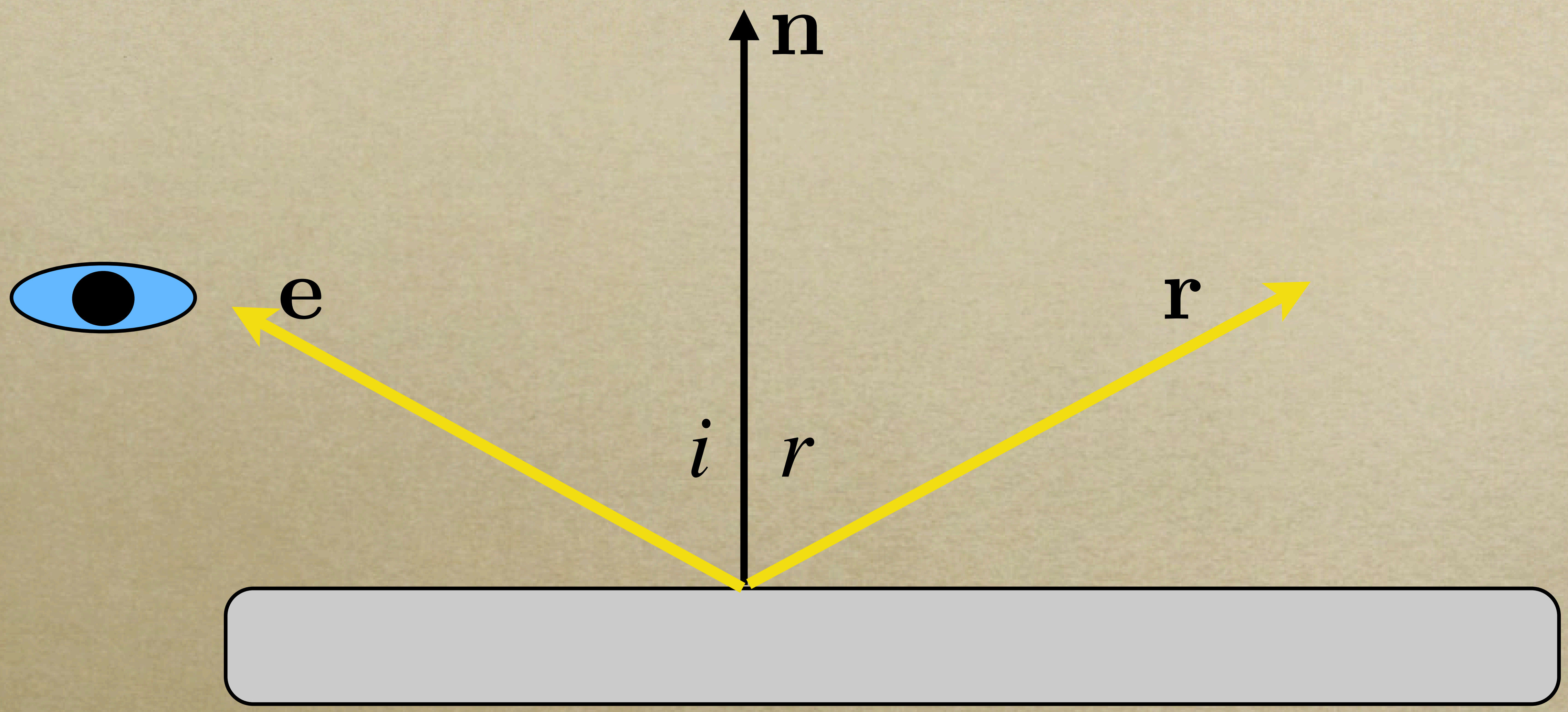
So we test this ray to see if there is an intersection with $\mathrm{t} < 1$

Mirror reflections



There is also light from the reflected ray.

Reflections



$$\mathbf{r} = 2\mathbf{n}(\mathbf{e} \cdot \mathbf{n}) - \mathbf{e}$$

(Assumes **n** *is a unit vector.)*

Truly recursive

- *So we trace a new ray in the direction* **r**
- *Whatever we see along that line is multiplied by a reflection coefficient* k_r*, and added to the illumination of the hit point.*
- *This reflection ray can generate its own shadow and reflection rays.*

Next Lecture...

Refraction