

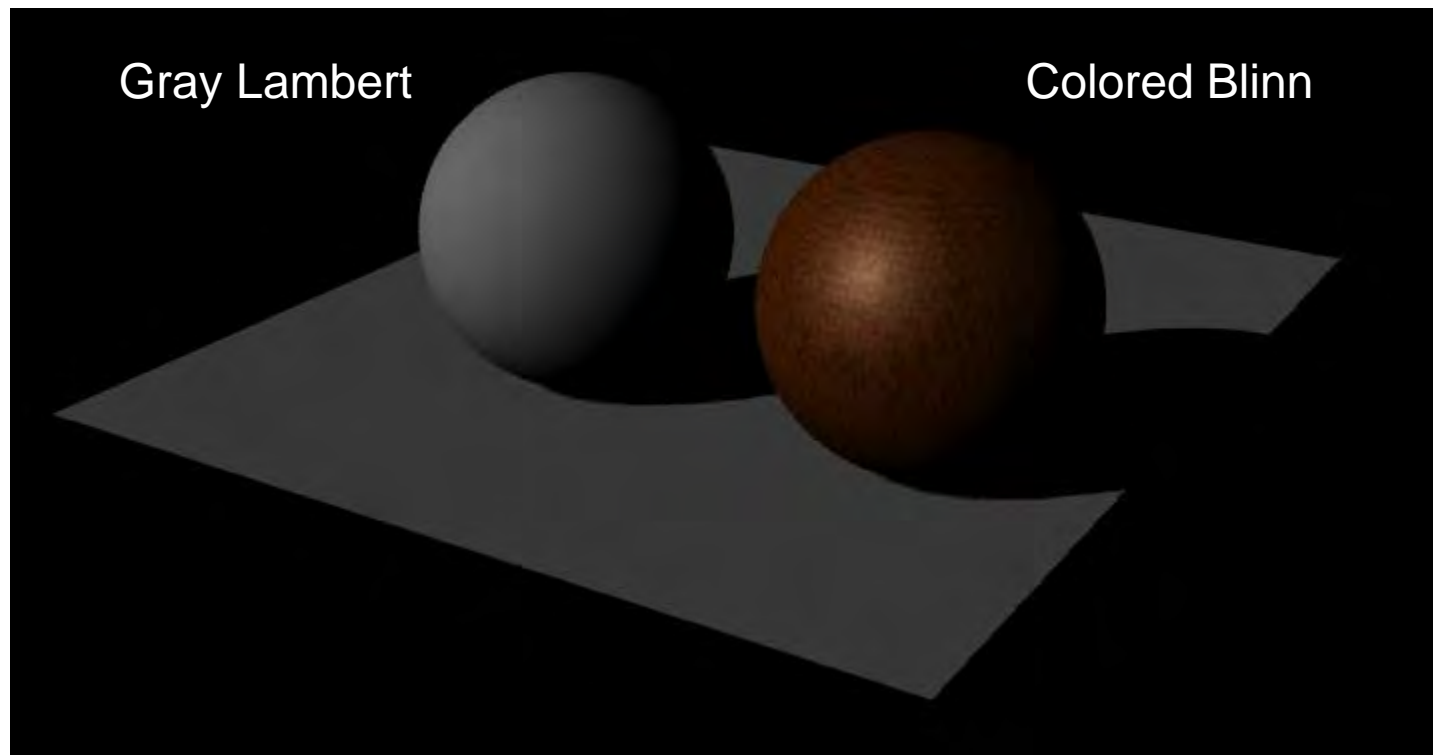
# Diffuse & Specular Reflection



National Science Foundation  
WHERE DISCOVERIES BEGIN

# Reflection & Surface Materials

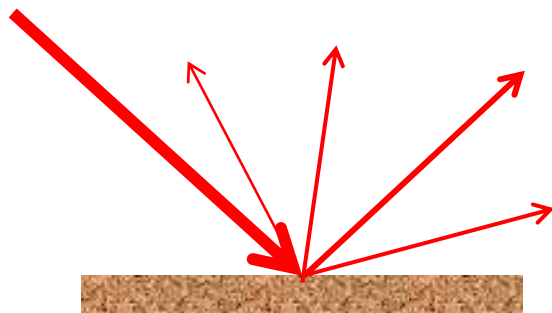
How light reflects off of surfaces depends on the surface materials, also known as shaders in CG.



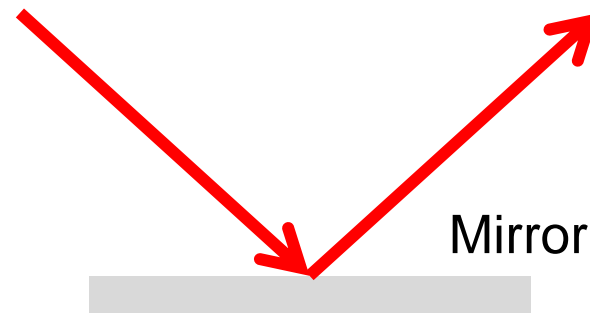
# Diffuse & Specular Reflection

Reflection from surfaces is mostly **diffuse**,  
with incoming light scattered in all directions.

Reflection from mirror surfaces is **specular**,  
with light reflecting in one direction.



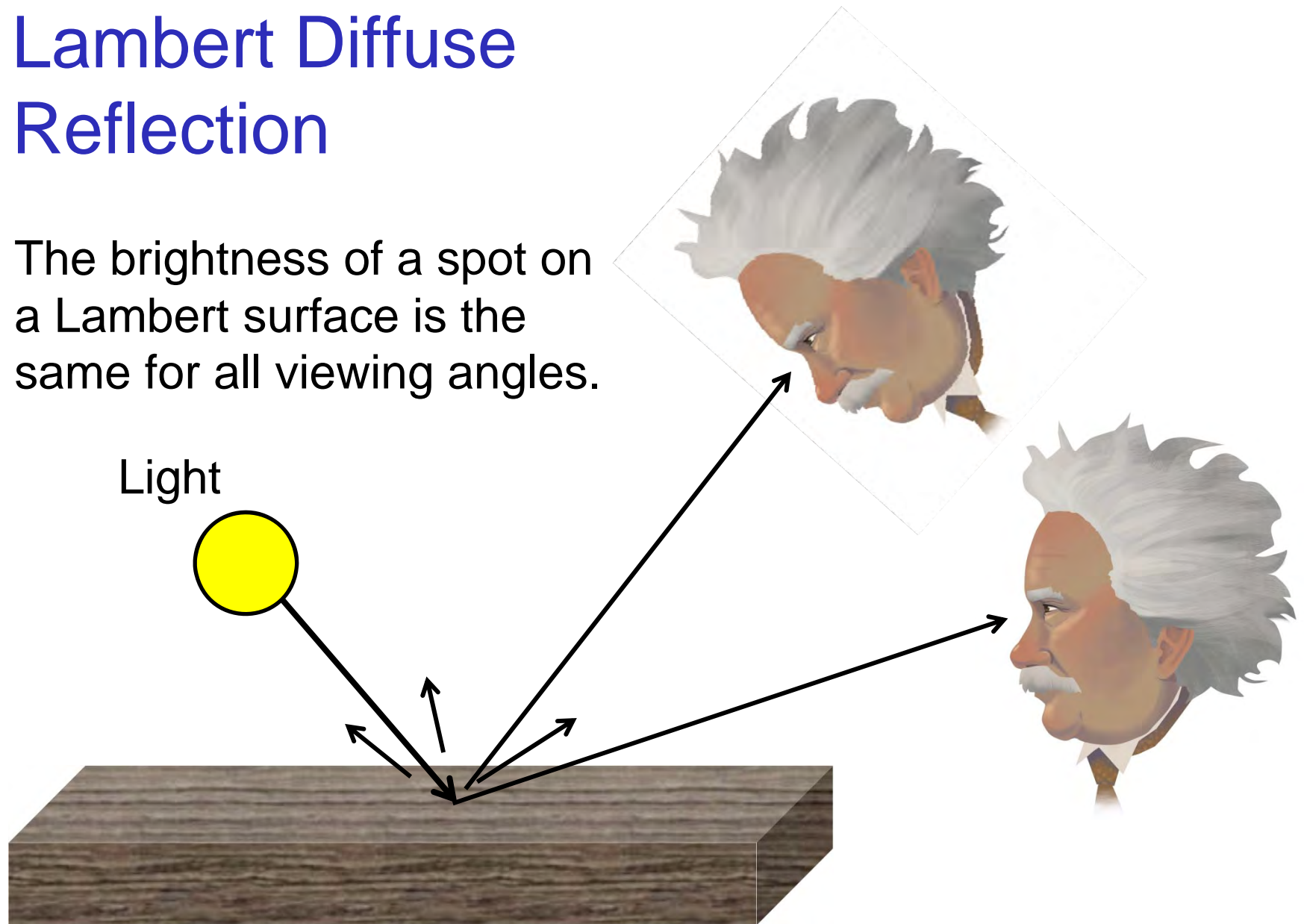
**Diffuse reflection**



**Specular reflection**

# Lambert Diffuse Reflection

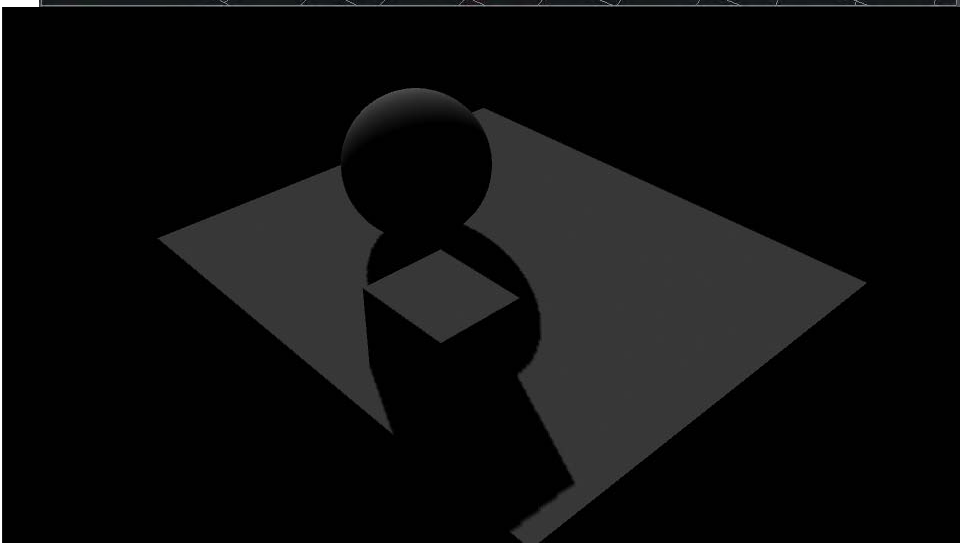
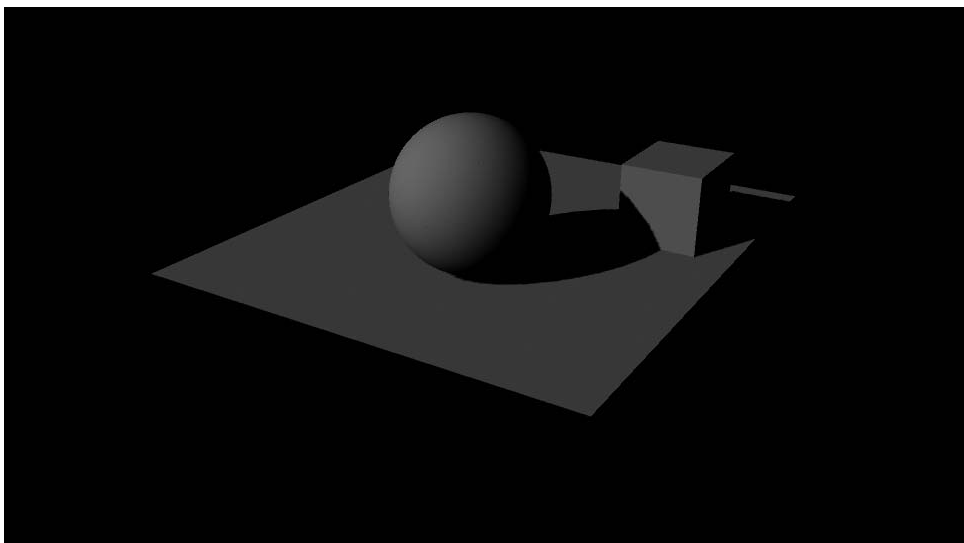
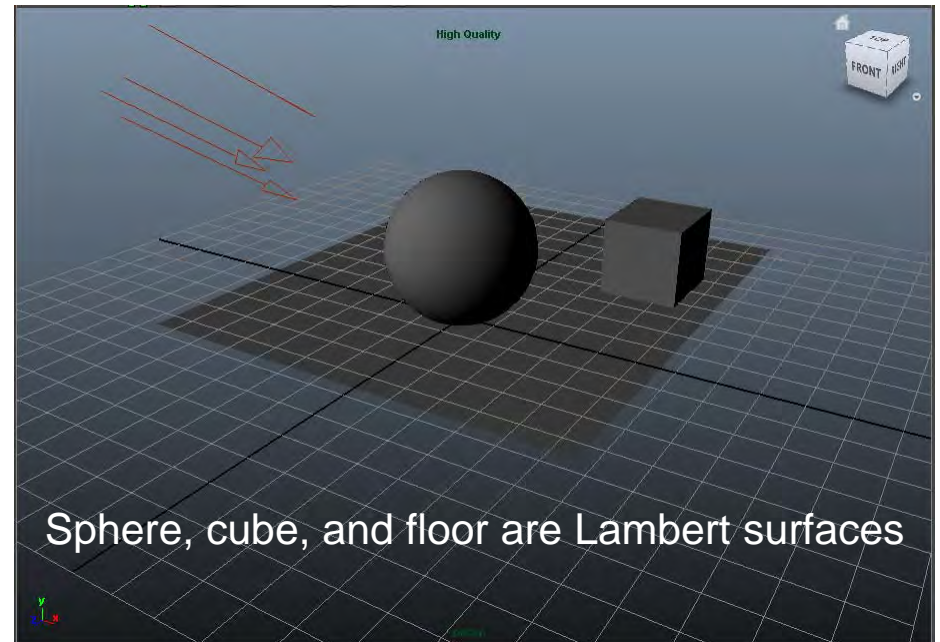
The brightness of a spot on a Lambert surface is the same for all viewing angles.



The surface brightness does change if we move the light.

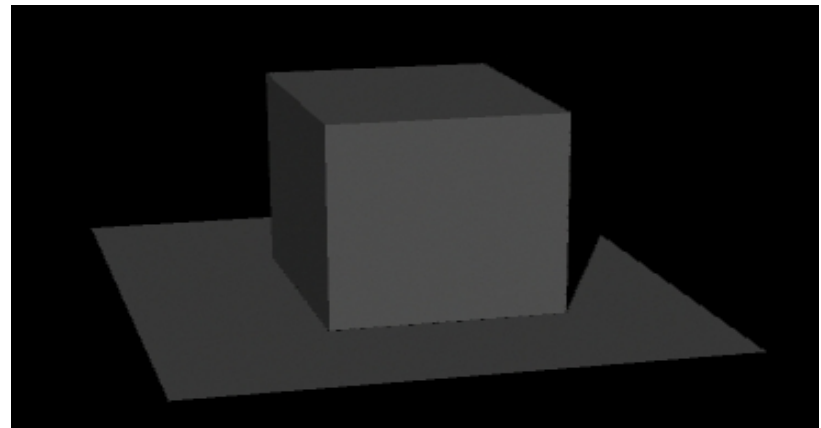
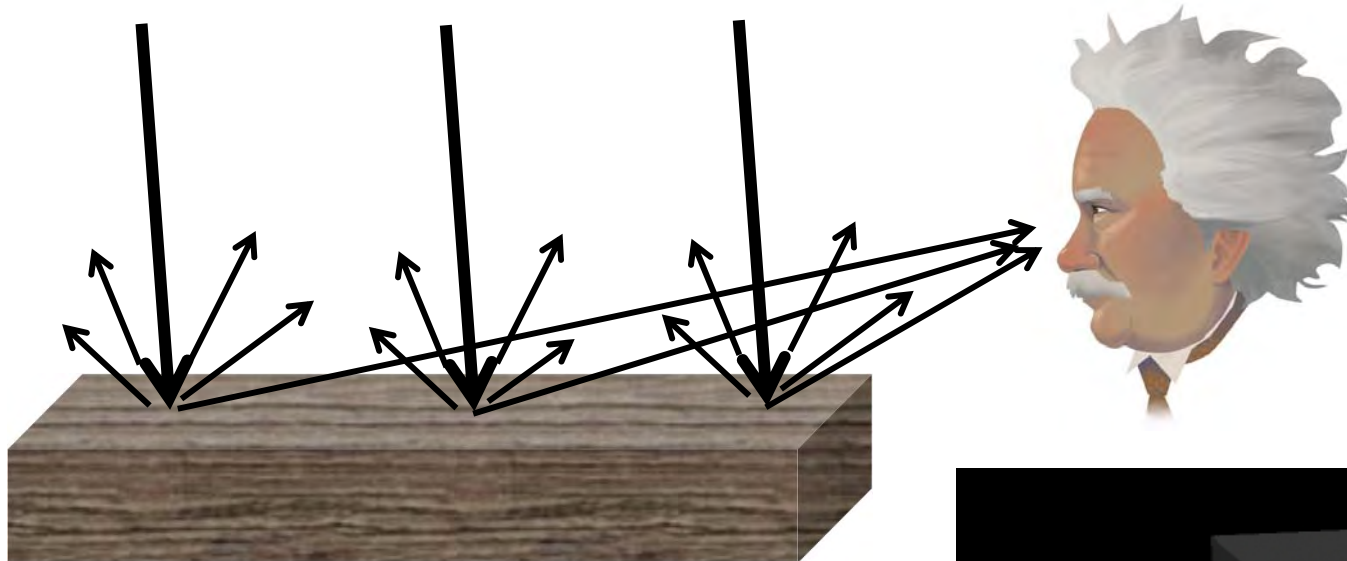
# Lambert Diffuse Reflection

All points on a Lambert surface look the same from any camera angle.



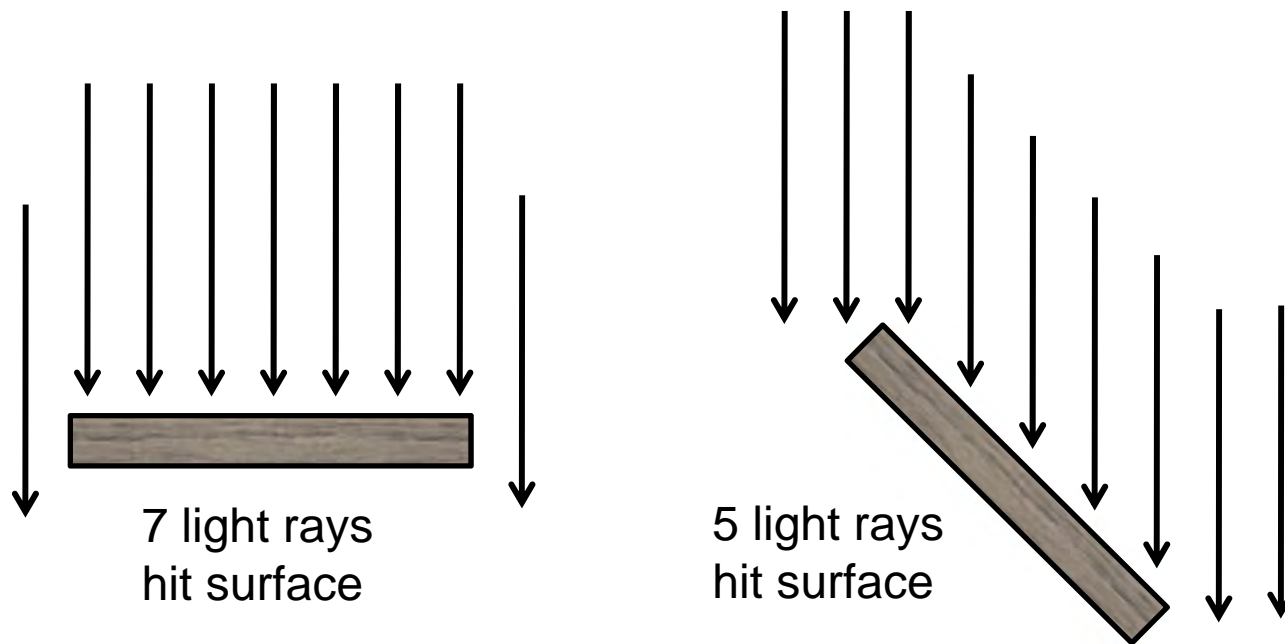
# Directional Light & Lambert Surface

All points on a flat Lambert diffuse surface look equally bright under directional light.



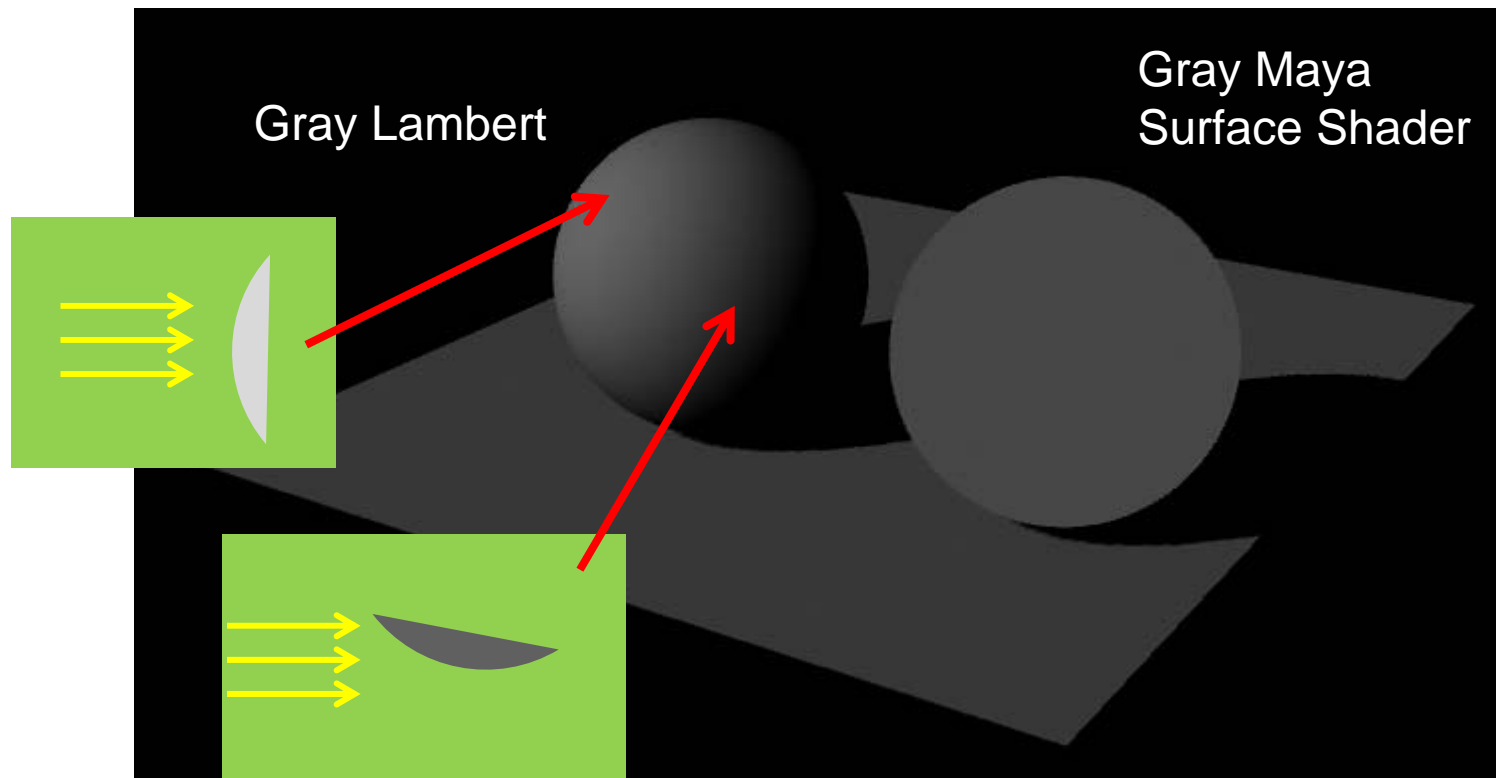
# Light Intensity & Angle

When the surface is tilted, the intensity of the light on the surface decreases because the rays are spread over a larger area.



# Form Shadows

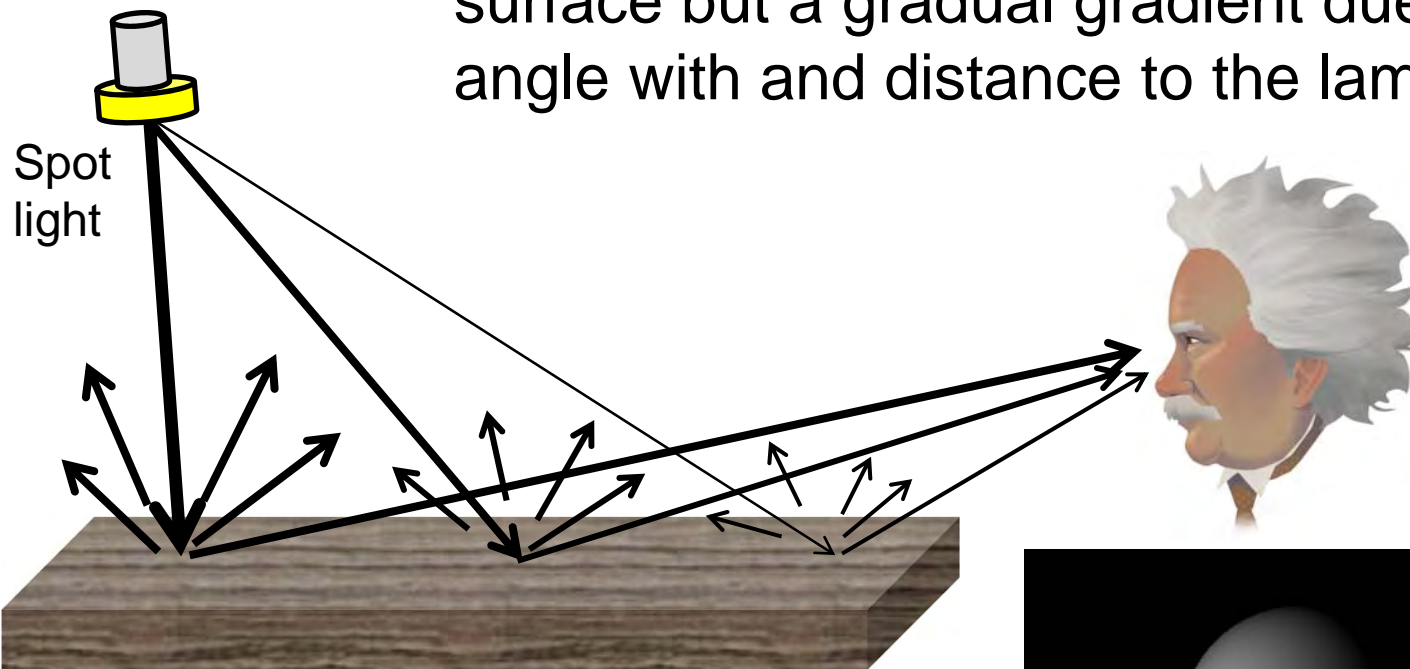
A Lambert surface is brightest when it faces the incoming light rays and has a form shadow as the surface turns away from the light source.



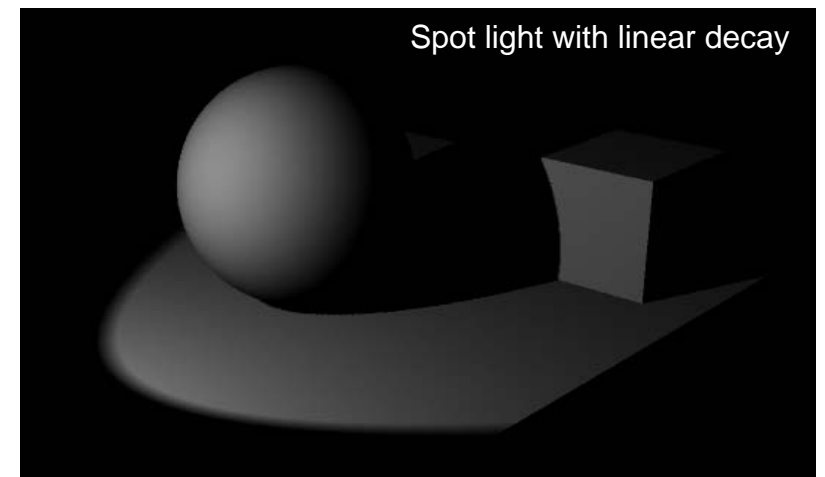


# Spot Light on Diffuse Surface

No highlight on a Lambert diffuse surface but a gradual gradient due to angle with and distance to the lamp.

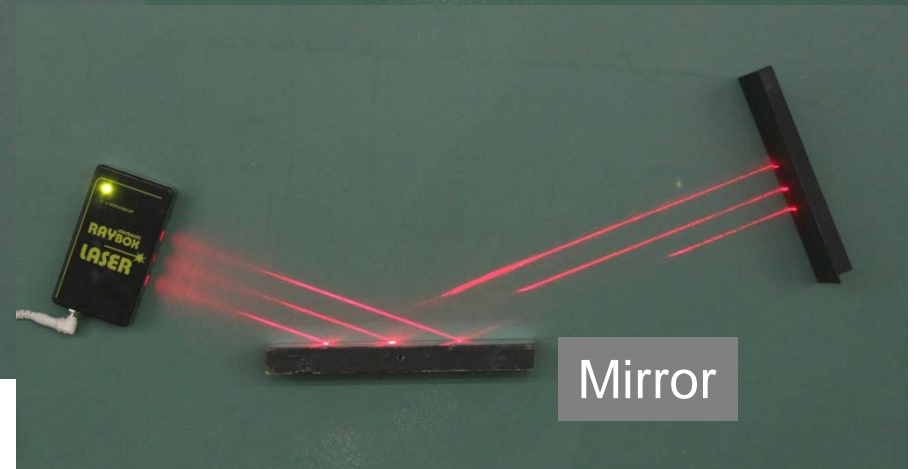
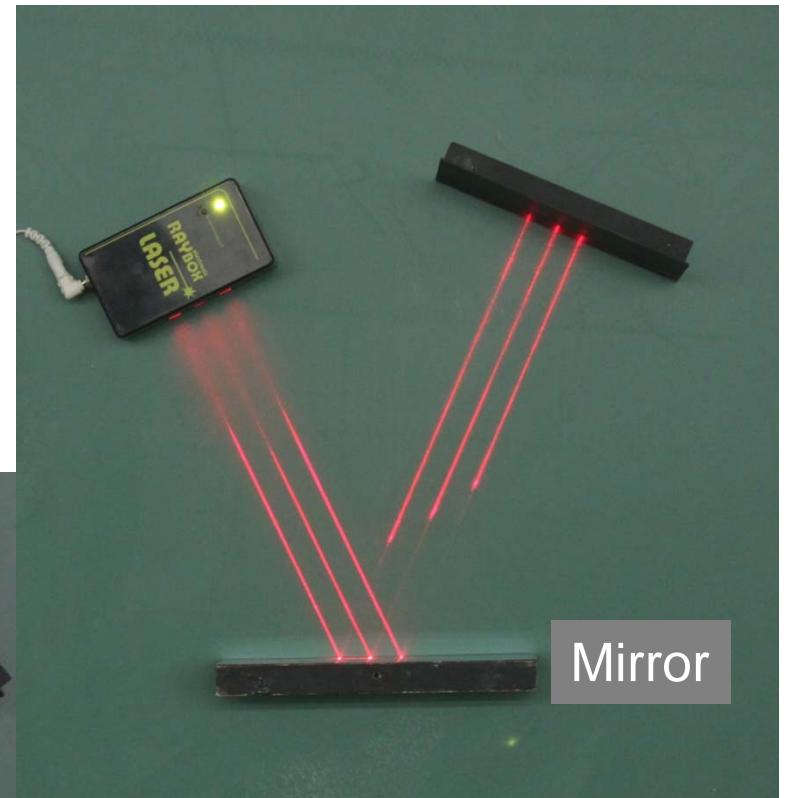
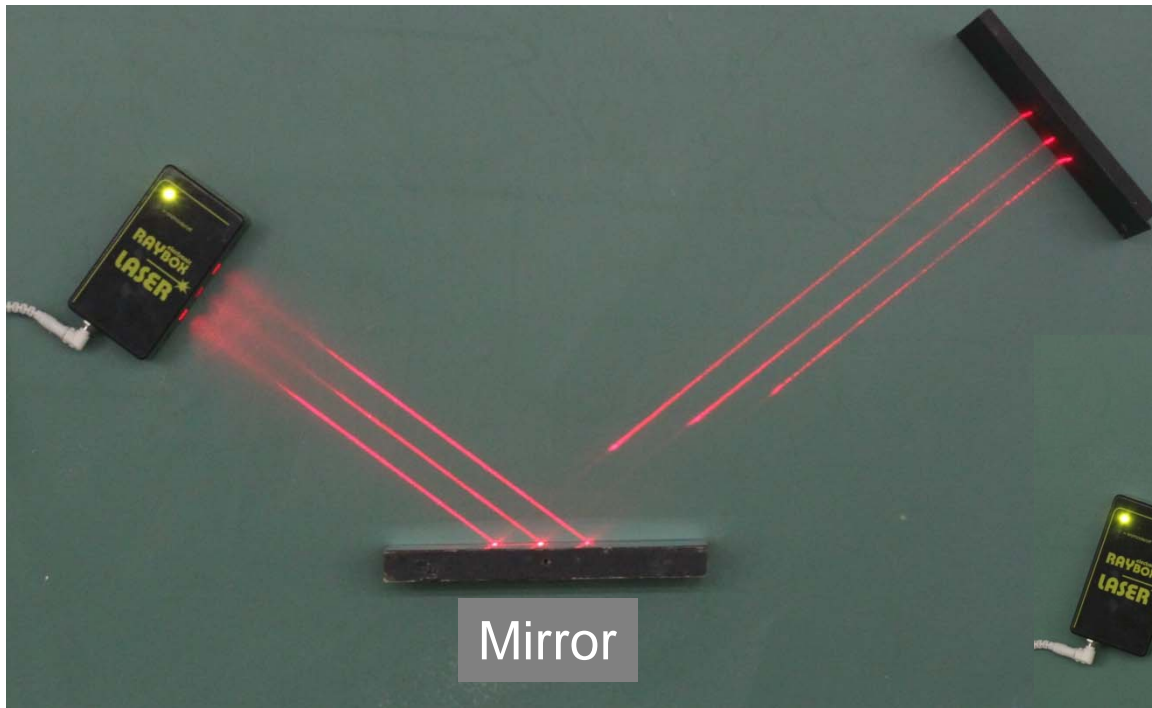


This end is brighter since it's closer to the lamp and because the surface faces head-on.



# Specular Reflection

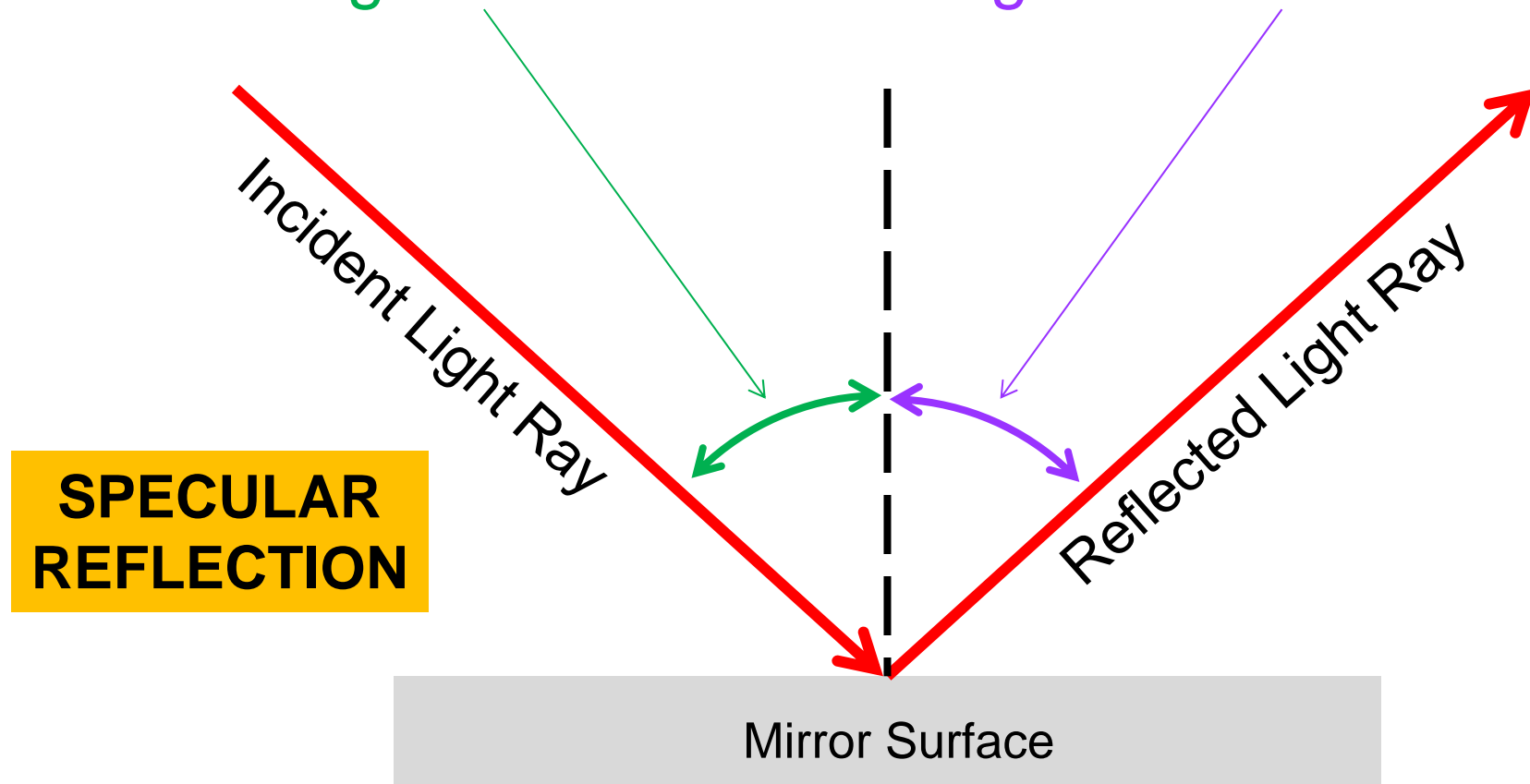
In specular reflection each light ray is mirror reflected.



# Law of Specular Reflection

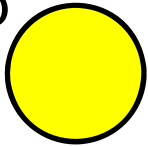
Law of specular reflection says:

“Angle of Incidence = Angle of Reflection”



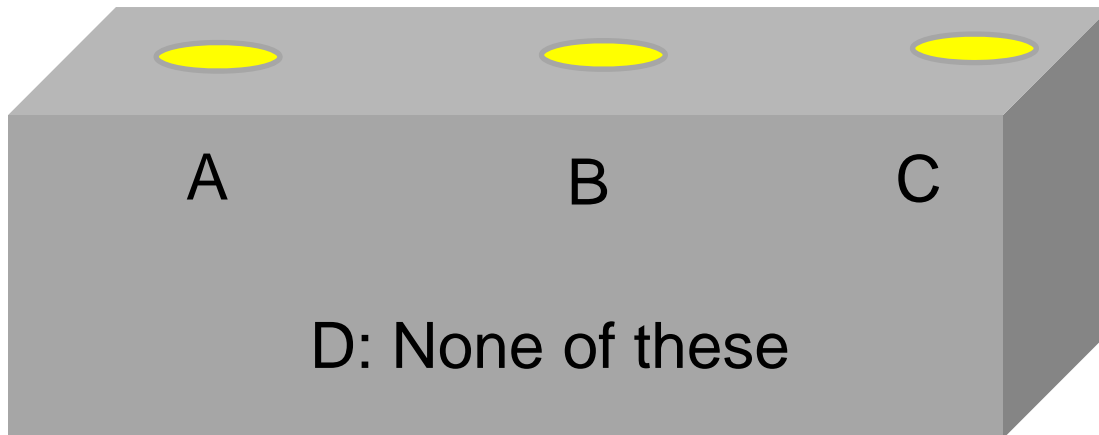
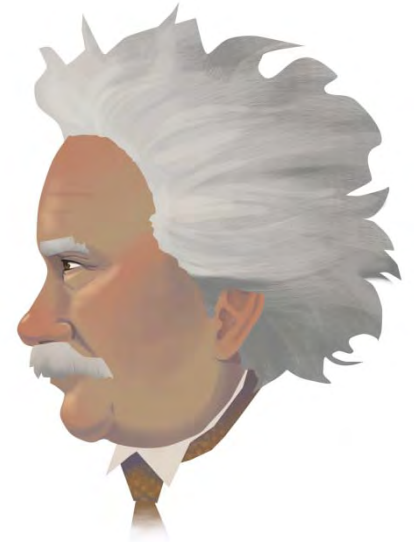
# Finding the Highlight

Lamp

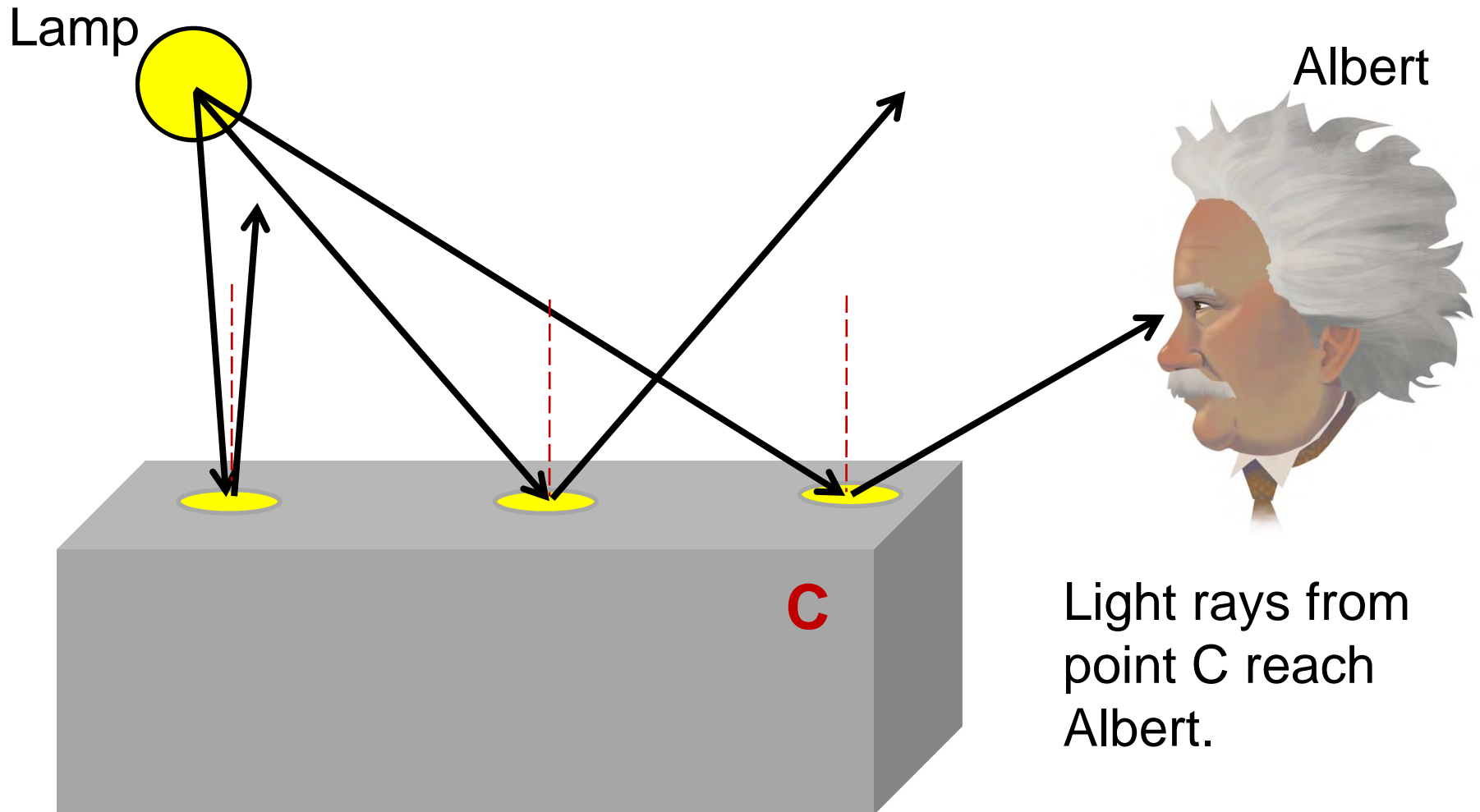


Where does Albert see the highlight reflected off this metal block?

Albert

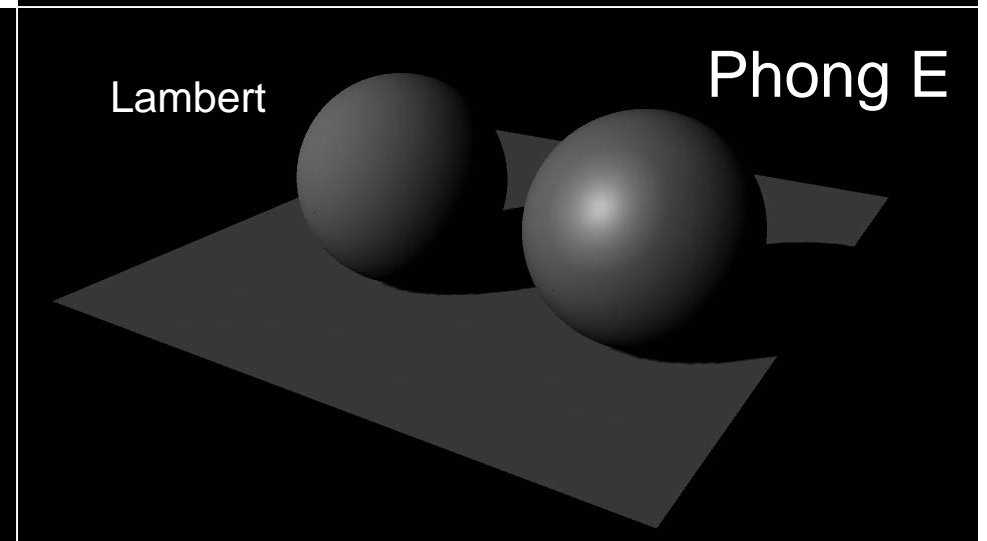
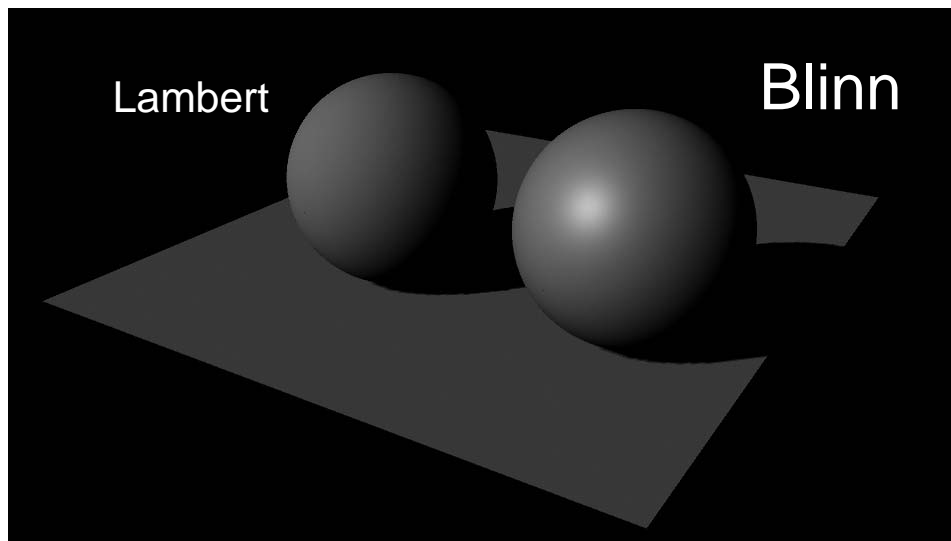
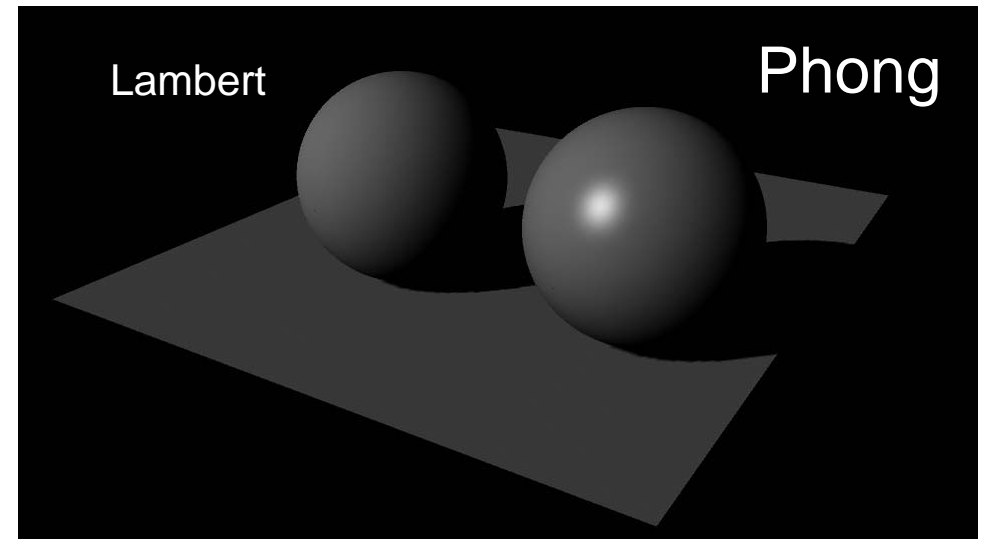


# Finding the Highlight



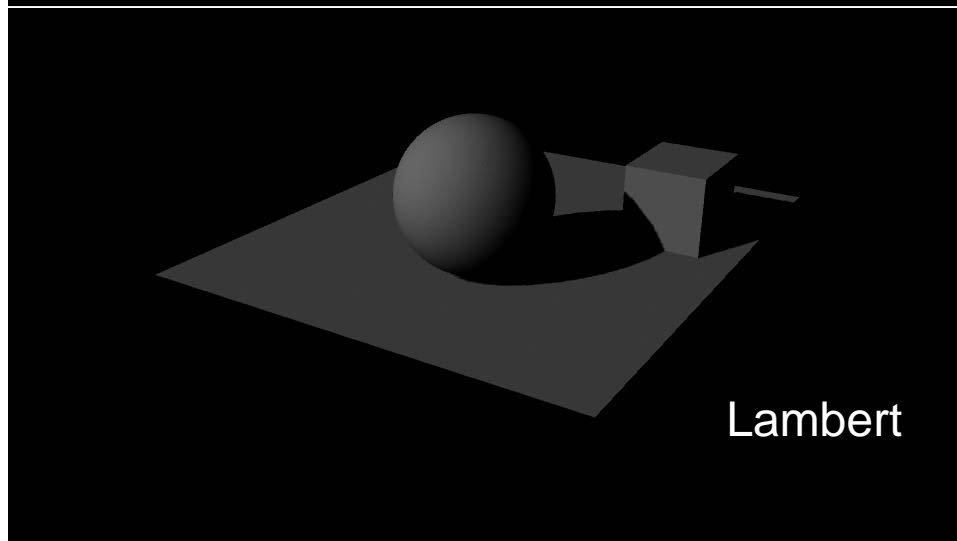
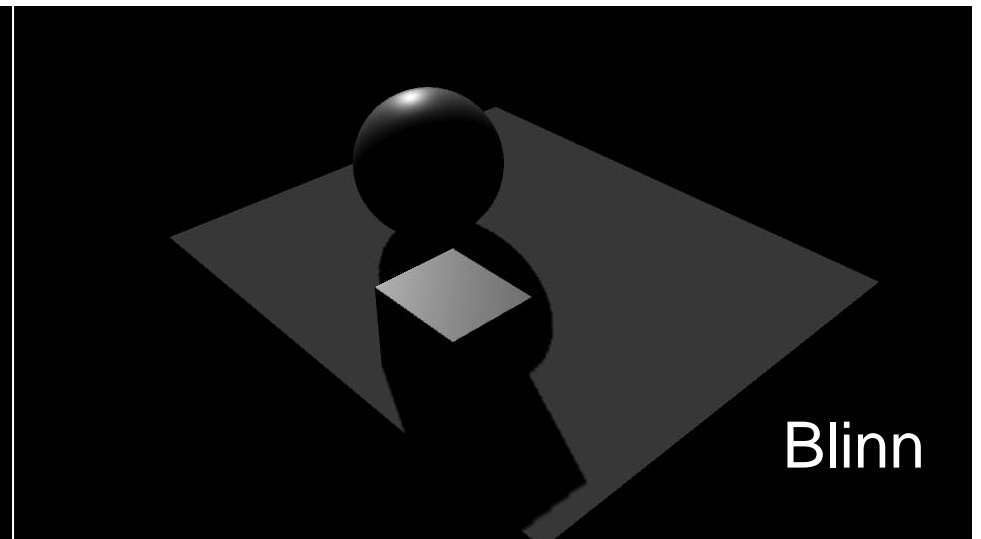
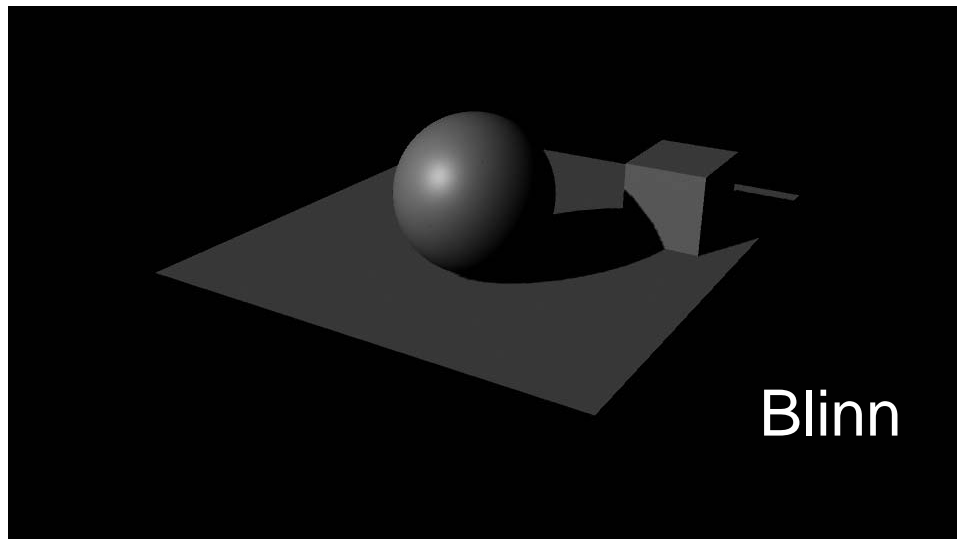
# Partially Specular Material Surfaces

Various models for partially specular material surfaces.



# Blinn Surface

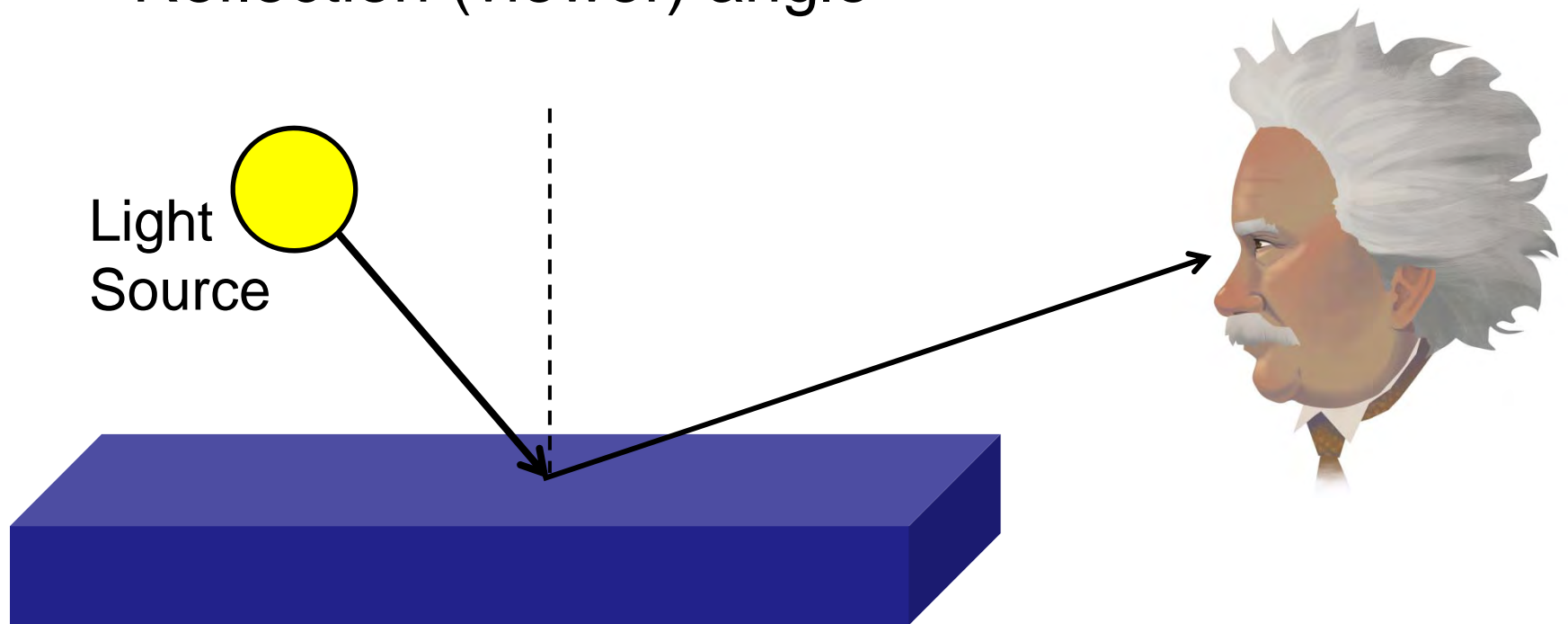
Note the highlight on the sphere and the brightness of the cube.



# Bi-directional reflectance distribution function (BRDF)

BRDF specifies the amount of light reflected by a surface depending on:

- Incident (light source) angle
- Reflection (viewer) angle





# Summary

- Diffuse surfaces reflect light in all directions.
- Brightness of a Lambert diffuse surface is the same from any viewer angle.
- Brightness of a surface varies with the angle and distance to the light source.
- Specular surfaces mirror reflect light rays.
- Law of specular reflection say “Angle of incidence equals angle of reflection.”
- Surface material models, such as Blinn and Phong, are both diffuse and specular.