Simple Illumination

Types

Ambient lighting

- indirect light hitting the object by reflecting off of other surfaces - color of surface reflecting it

Diffuse

light reflecting off the object by being absorbed by the surface (subsurface scattering) and reemitted equally in all directions

Specular

light reflecting immediately off the surface - directional and color of light source

Ambient

Radiosity - calculate amount of each surface visible from given point on object and propagate reflected light through environment

Approximation - use constant as amount of indirect Light hitting each surface and

- Add to diffuse light hitting object

Or

- Reflect portion of ambient light (OpenGL)

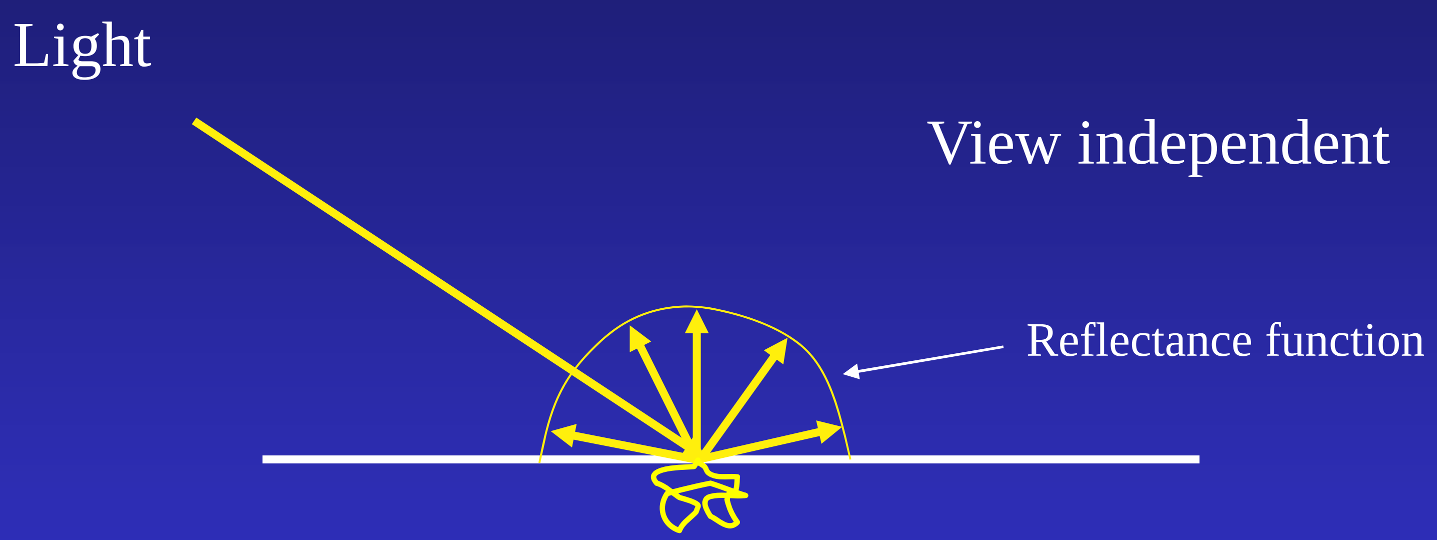
Diffuse

Light hitting surface direct from light source

Scatters equally in all direction (get absorbed in surface and emerges in random direction)

Because it is absorbed, the reflected light is the color of the object

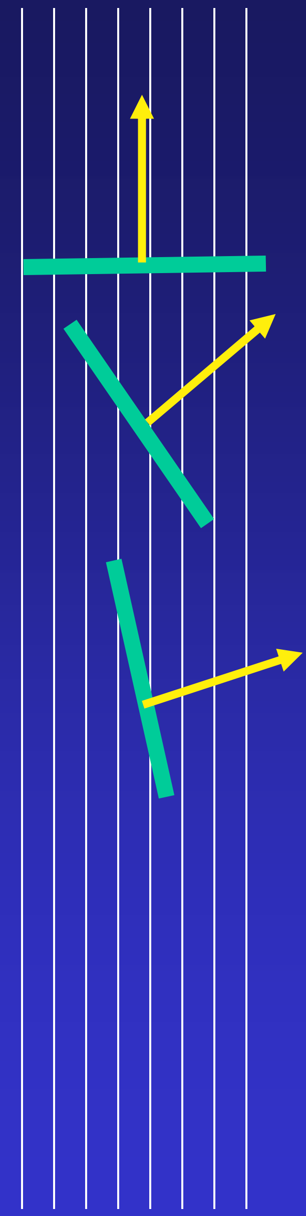
Diffuse



Amount of incoming light is function of incoming direction

Diffuse

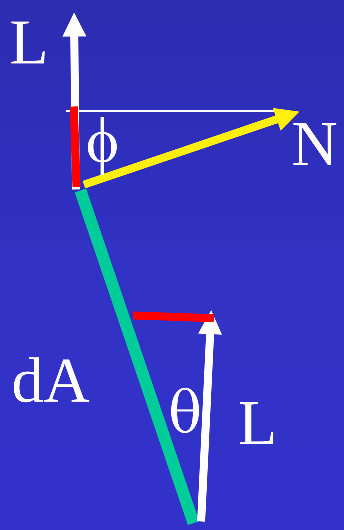
Calculate area of delta area projected onto plane perpendicular to direction of light rays



Projected area = $\sin(\theta)$

$= \cos(\phi)$

$= N \cdot L$



$$(N \cdot L)color_{object}$$

Specular

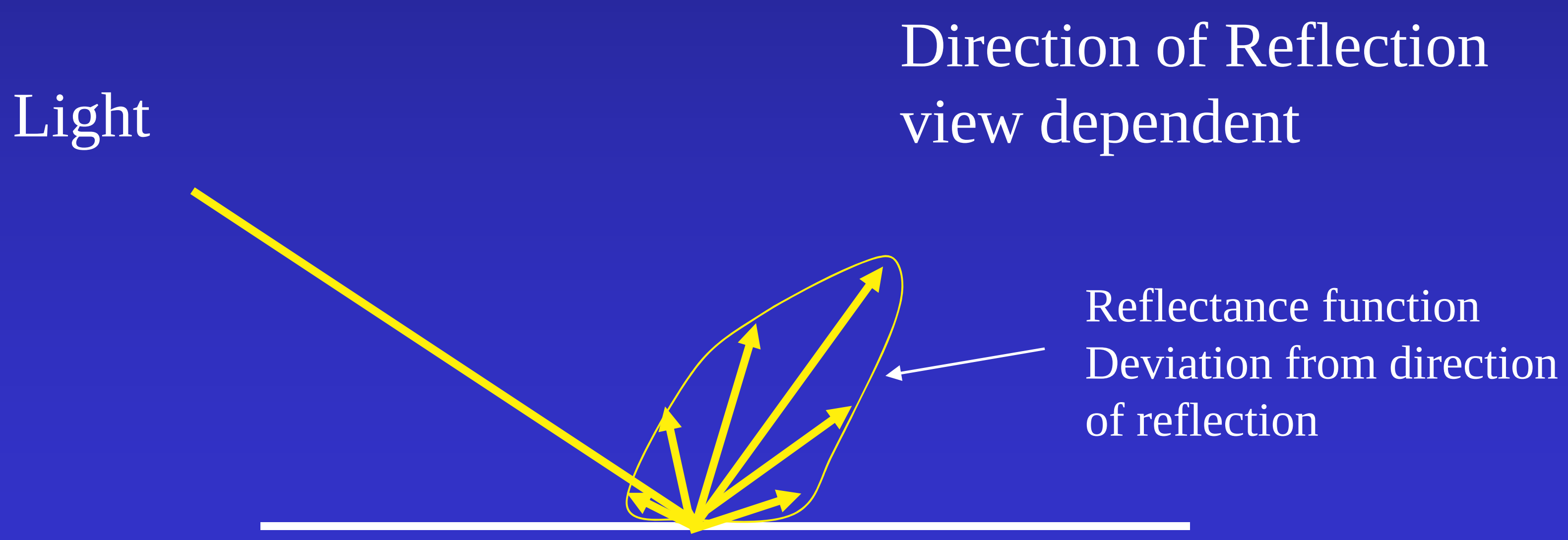
Light hitting surface direct from light source

It reflects directly off of surface of object and is reflected primarily at angle from normal equal to angle coming in (incident angle)

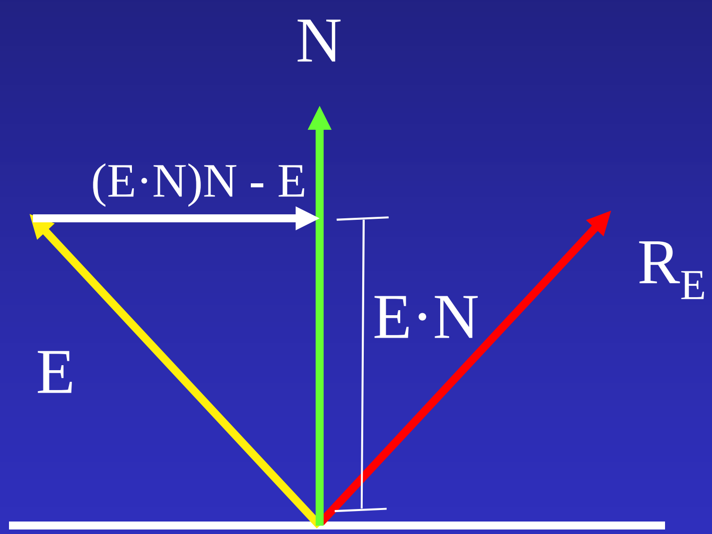
Because it is not absorbed, the reflected light is the color of the light source

Specular

Phong Model for Specular Reflection: Calculate direction of reglection and use cosine falloff as view deviates from that direction



Specular



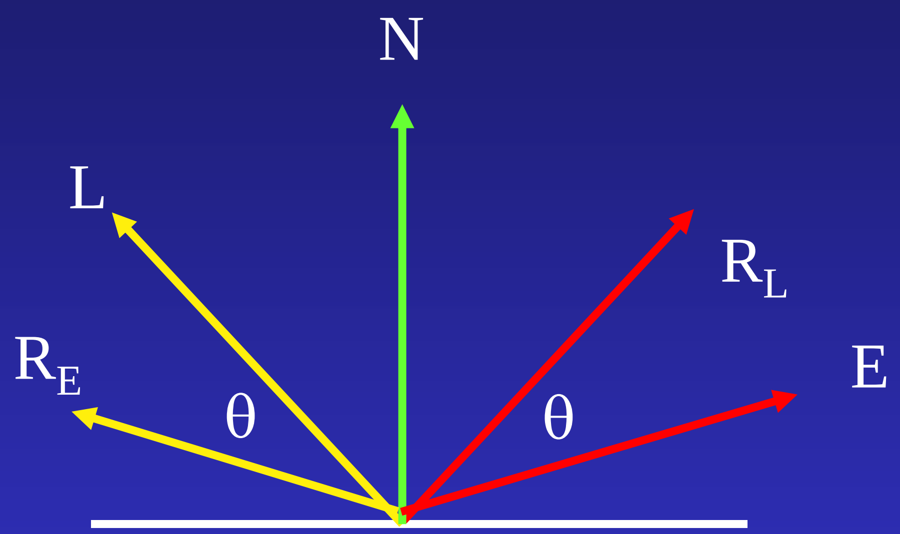
$(E \cdot N)\, N$

$(E \cdot N)N - E$

$(E \cdot N)N + (E \cdot N)N - E$

$2(E \cdot N)N - E = R_E$

Specular



R_E – refection vector of E

R_L – refection vector of L

$\mathrm{Cos}(\theta) = E \cdot R_L = L \cdot R_E$

Raise it to a power (material property) to control how fast the specular component falls off. Multiply by color of light.

$$(E \cdot R_L)^f \, color_{light}$$

OR

$$(L \cdot R_E)^f \, color_{light}$$

Illumination Model

$$C = K_d(a + I(N \cdot L))c_{obj} + K_s(R_E \cdot L)^f I(1,1,1)$$

Assume single, white light source

Add coefficient of reflectivity for diffuse, K_d , and specular light, K_s

Add intensity of light, I

Assume ambient term is incoming light to be diffusely reflected

Multiple Light Sources

$$C = K_d(a + \sum_i [\delta_i I_i (N \cdot L_i)])c_{obj} + K_s \sum_i [\delta_i I_i (R_E \cdot L_i)^f c_i]$$

Add in the effects of a light source if and only if
the face is a FRONT FACE with respect to the light based on sign of $N \cdot L$
δ_i = 0 if light is behind face
= 1 if light is in front of face

Assume multiple colored light sources

Diffuse - color of object (c_{obj})
Specular - color of light source (c_i)
Use $L \cdot R_E$ to avoid recomputing reflection vector

Some of the Options

Ambient term wavelength dependent

Each light contributes to ambient light: $ambient_i$

Light has different diffuse and specular intensities

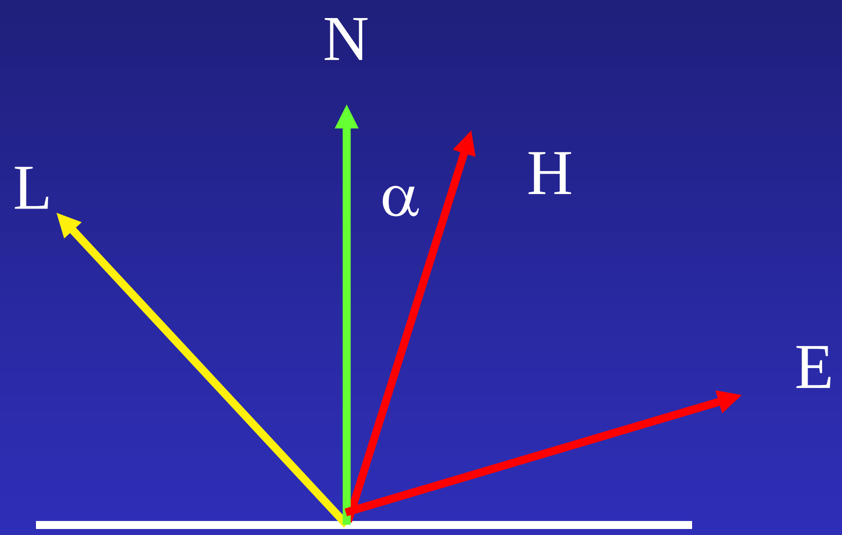
Calculate Light reflection vector instead of Eye reflection vector

Use bisecting vector between L and E, compare to N for specular (see next slide)

Reflection coefficients wavelength dependent (separate r, g, b values)

Light color affects diffuse color

Specular



Alternative specular calculation

H - bisects angle made by L and E

Compare H to N (cosine of angle)

$\theta/2 = \alpha$

H = (E+L)/|E+L|

$$(H \cdot N)^f \, color_{light}$$