

## 13.1 A simple shading model for Ray Tracing



Jaakko Lehtinen  
with lots of material from Frédo Durand

# In This Video

- A simple shading model for a simple ray tracer
  - Point-light illumination
  - Shadows
  - Reflections
  - Refractions



# Today – Ray Tracing

(Indirect illumination)

Reflections

Refractions

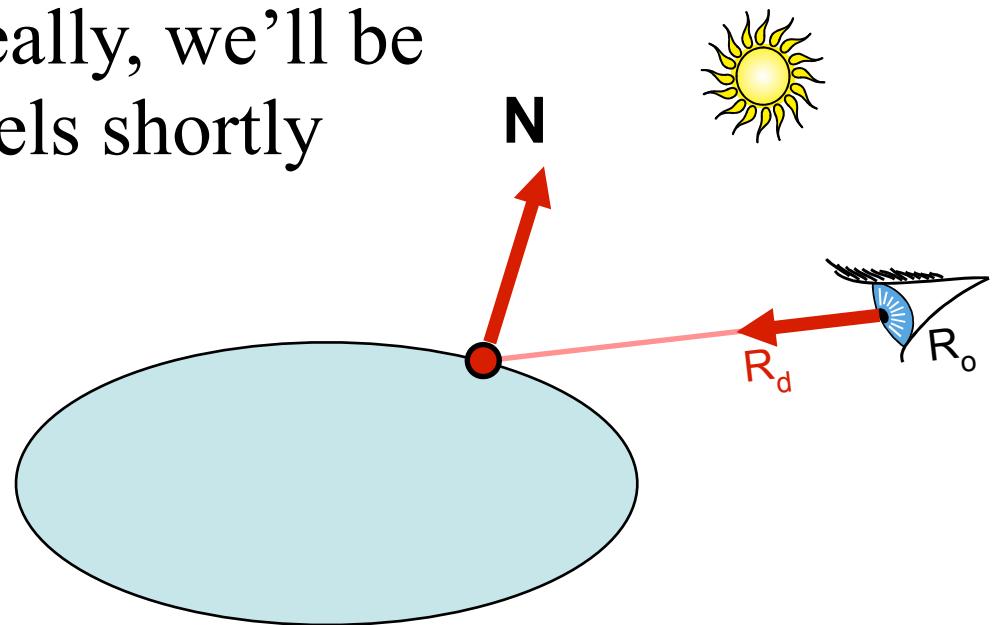
Shadows

(Caustics)

# A Very Simple Shading Model

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- A subset of “Whitted ray tracing”
  - Turner Whitted, An Improved Illumination Model for Shaded Display, Comm. ACM, 1980
- Just for illustration really, we’ll be looking at other models shortly



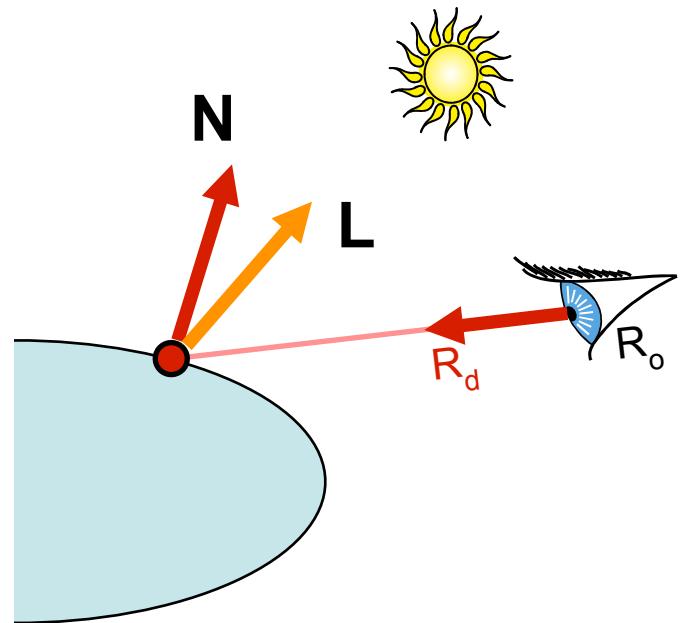
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- Light towards the eye  $I$  is...

$$I = k_d \max(0, \mathbf{L} \cdot \mathbf{N}) V(\mathbf{L})$$

direct lighting

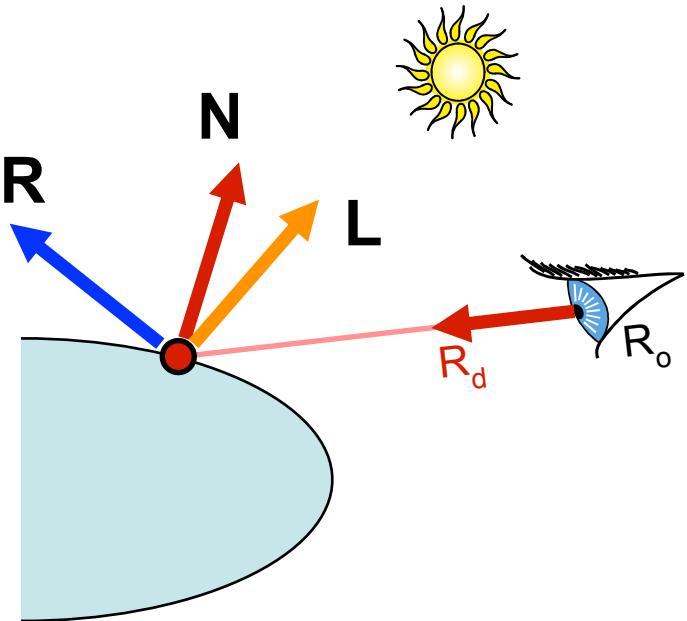


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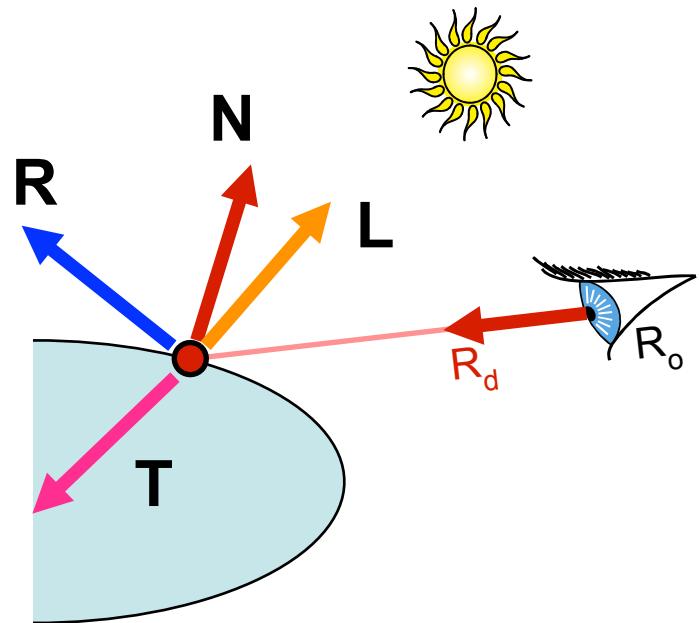
$$I = k_d \max(0, \mathbf{L} \cdot \mathbf{N})V(\mathbf{L}) \quad \text{direct lighting}$$
$$+ k_s I(\mathbf{R}) \quad \text{mirror reflection}$$



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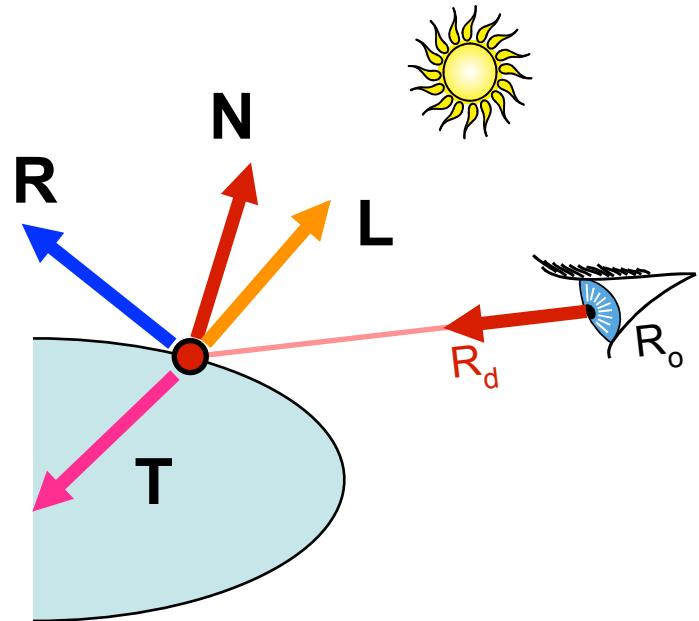
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$I(\mathbf{R})$  is light from mirror direction  $\mathbf{R}$

$I(\mathbf{T})$  is refracted light from direction  $\mathbf{T}$

$k_d$ ,  $k_s$ , and  $k_t$  are diffuse, specular and refraction coefficients

# Our Placeholder Model

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$$I = k_d \max(0, \mathbf{L} \cdot \mathbf{N}) V(\mathbf{L}) \quad k_d = \text{diffuse coefficient ("color")}$$
$$+ k_s I(\mathbf{R}) \quad k_s = \text{specular coefficient ("color")}$$
$$+ k_t I(\mathbf{T}) \quad k_t \text{ mirror refraction coefficient}$$
$$+ k_d k_a \quad \text{ambient lighting}$$

- $V(\mathbf{L})$  is visibility of light source (0 or 1)
- $k_d, k_s, k_t$  are material properties
  - $k_a$  global constant,  $k_l$  is light color
- We are ignoring (e.g.)
  - Specular reflection from the light (only diffuse N.L)
  - Distance falloff (only angle of normal and L)

# Where Do These Come From?

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- “Light incident from reflected direction”
- “Light incident from refracted direction”

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- “Light incident from reflected direction”
- “Light incident from refracted direction”
- Light going towards the camera

# Where Do These Come From?

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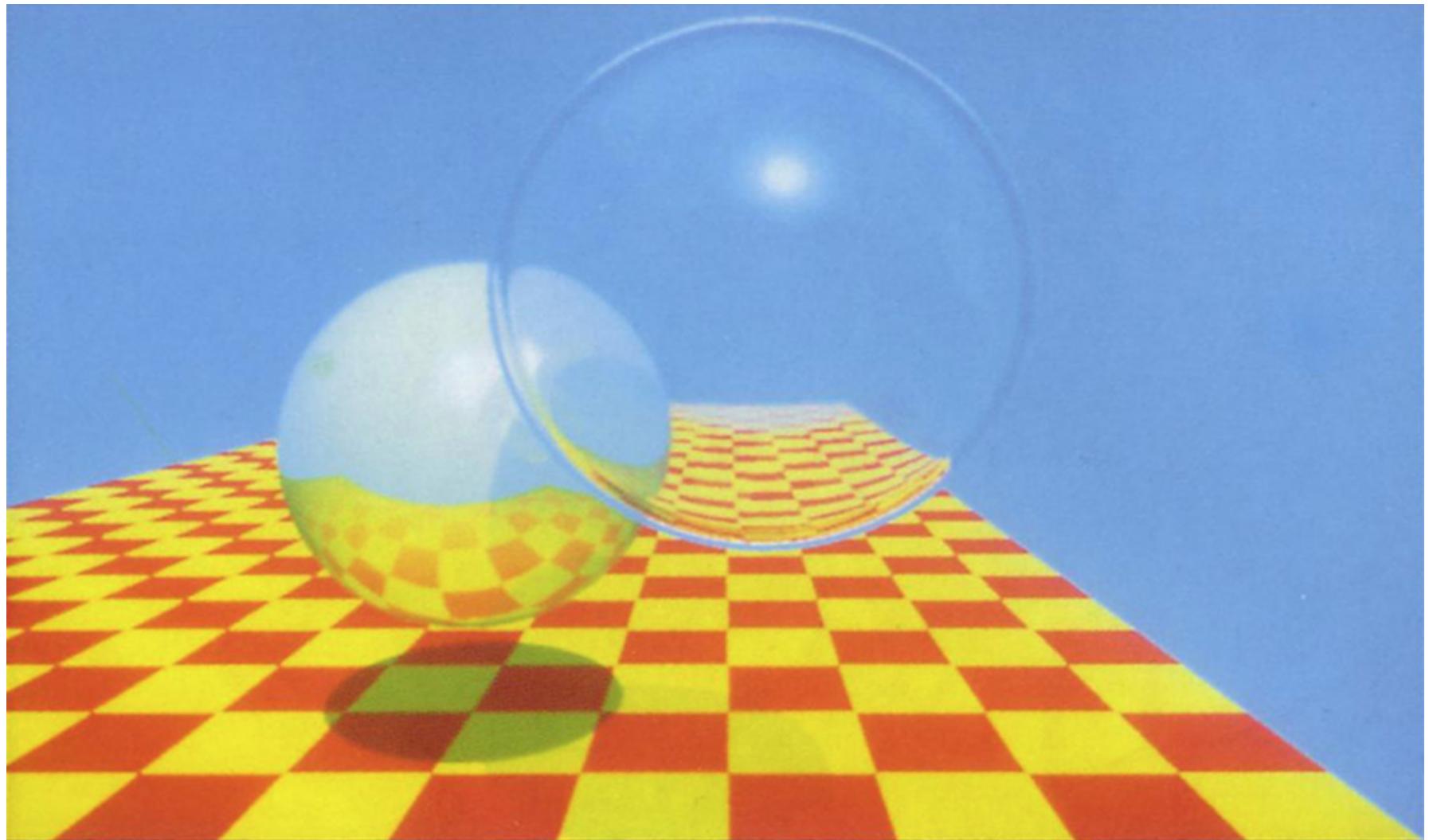
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- “Light incident from reflected direction”
- “Light incident from refracted direction”
- Light going towards the camera
- We’ll recurse and use the same function again

# What Does It Look Like?

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Turner Whitted



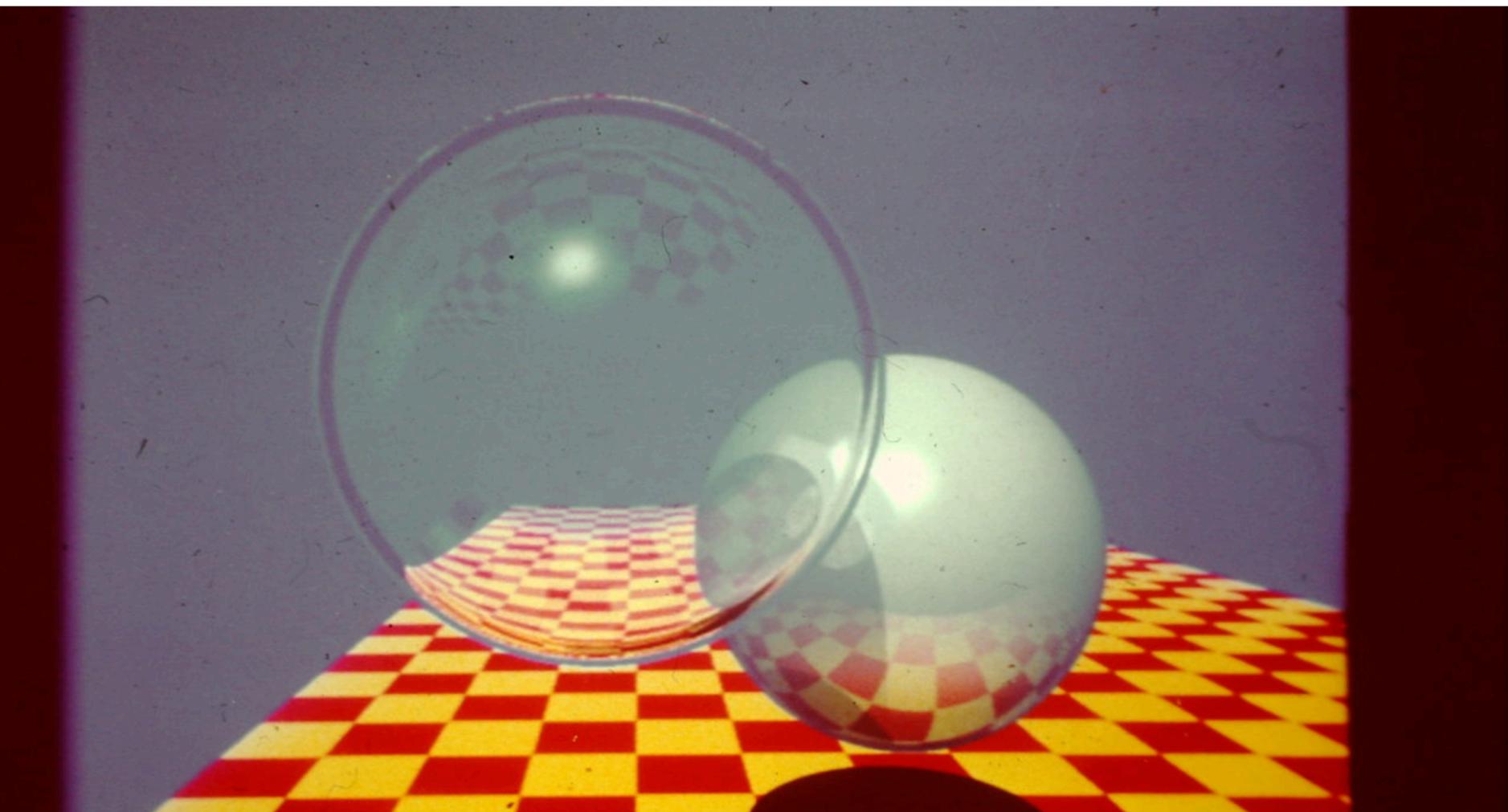
# Good Read!

Turner Whitted thinks back to the days of his discovery

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## A Ray-Tracing Pioneer Explains How He Stumbled into Global Illumination

August 1, 2018 by [J. TURNER WHITTED](#)



# What Does It Look Like?

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Simple NVIDIA Optix sample

