## Reflection Models

**Previous lecture**

- **Phong model**
- **Microfacet models**
- **Gaussian height field on surface**
- **Self-shadowing**
- **Torrance-Sparrow Model**

**Today**

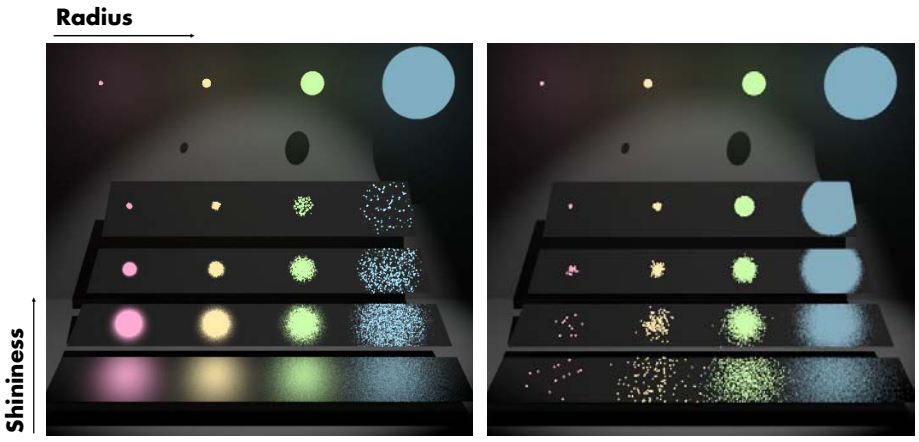
- **Multiple importance sampling**
- **Anisotropic reflection models**



# Multiple Importance Sampling

# Multiple Importance Sampling

**Reflection of a circular light source by a rough surface**




**Sampling the light source** **Sampling the BRDF**

$$\int f(x)g(x)\,dx$$



# Multiple Importance Sampling

## Two sampling techniques

$$X_{1,i} \sim p_1(x) \qquad X_{2,i} \sim p_2(x)$$

$$Y_{1,i} = \frac{f(X_{1,i})}{p_1(X_{1,i})} \qquad Y_{2,i} = \frac{f(X_{2,i})}{p_2(X_{2,i})}$$

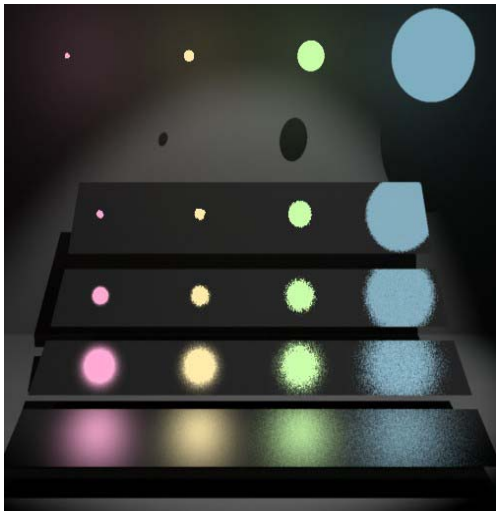
## Form weighted combination of samples

$$Y_i = w_1 Y_{1,i} + w_2 Y_{2,i}$$

## The balance heuristic

$$w_i(x) = \frac{p_i(x)}{p_1(x) + p_2(x)} \Rightarrow p(x) = w_1(x)p_1(x) + w_2(x)p_2(x)$$

## Multiple Importance Sampling

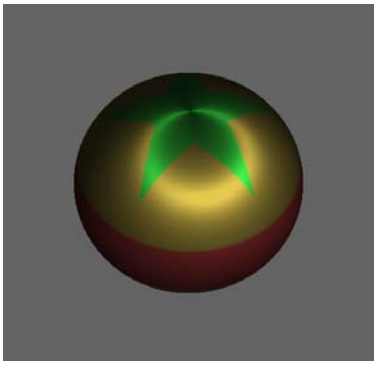


**Source: Veach and Guibas**



# Anisotropic Reflection Model

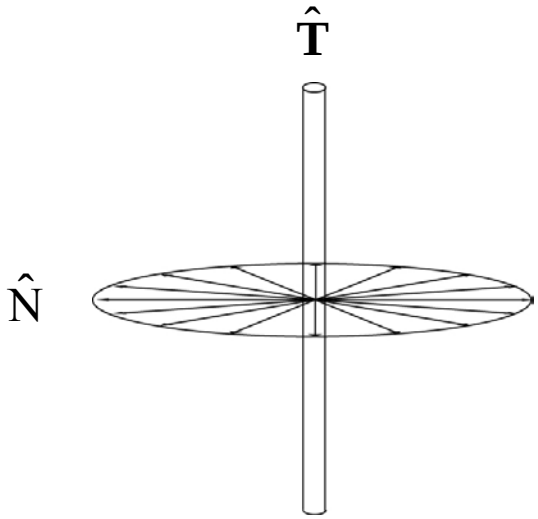
## Anisotropic Reflection





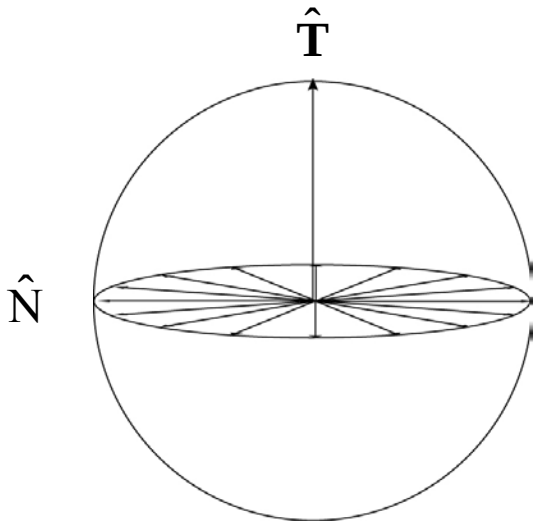

## Quarterhorse

## Reflection from a Cylinder

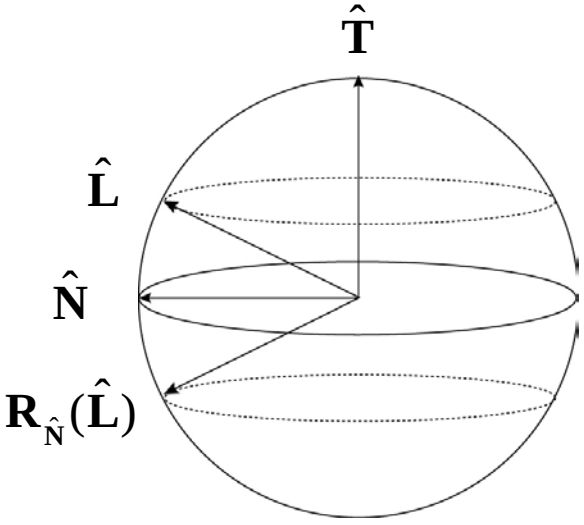





## Reflection from a Cylinder

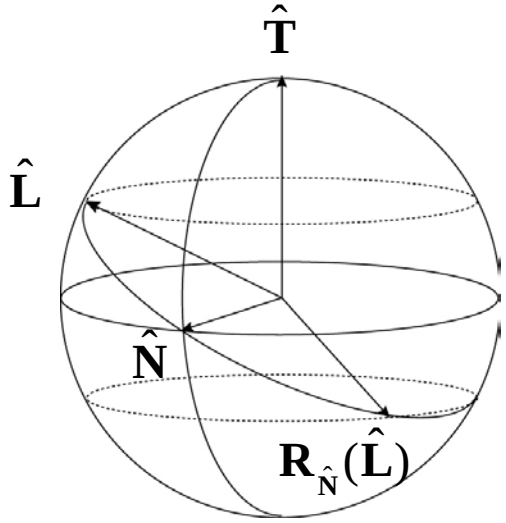


## Reflection from a Cylinder

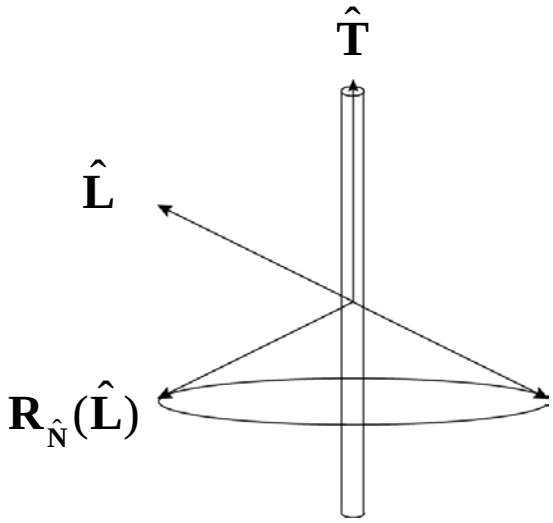





## Reflection from a Cylinder

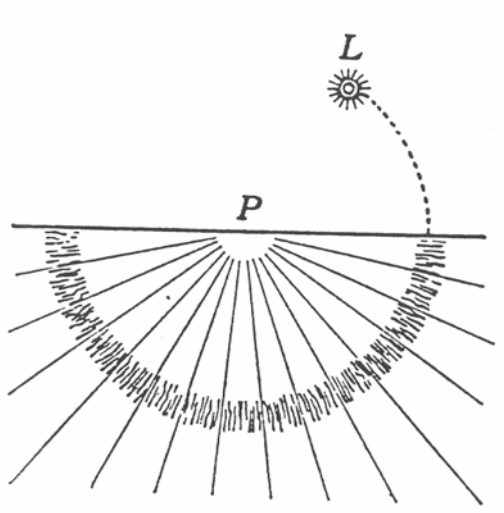


## Reflection from a Cylinder



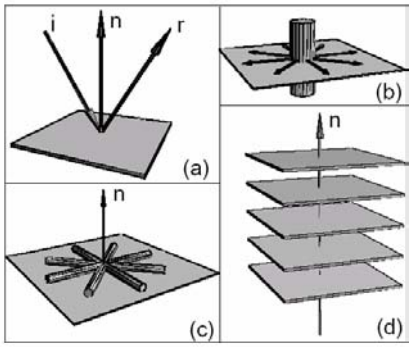



## Anisotropic Reflection



# Shape of Anisotropic Highlights

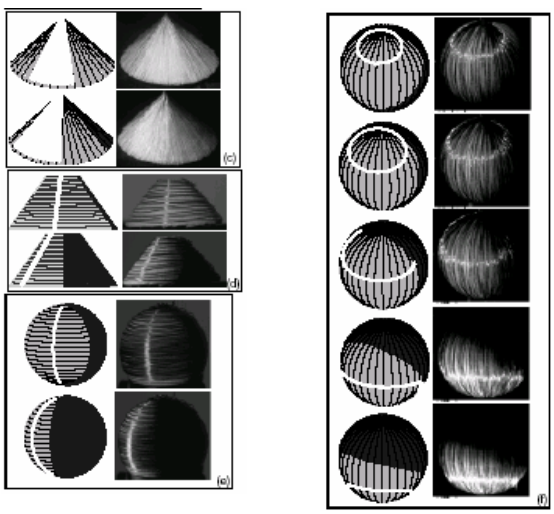
**Fibers tangent to the plane defined by the halfway vector reflect light**




**From Lu, Koenderink, Kappers**

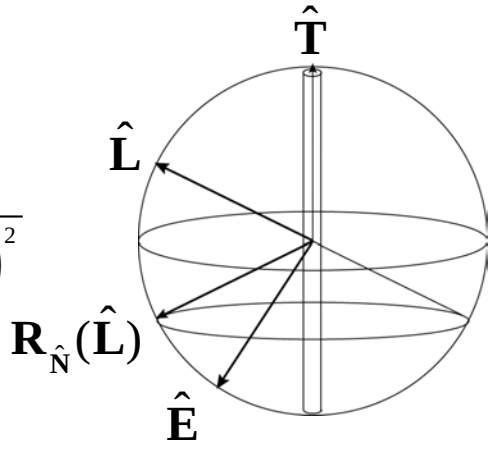


# Shape of Anisotropic Highlights



**From Lu, Koenderink, Kappers**

## Kajiya-Kay Model




**Diffuse**

$$\sin\theta_L = \sqrt{1-\left(\hat{\mathbf{T}}\bullet\hat{\mathbf{L}}\right)^2}$$

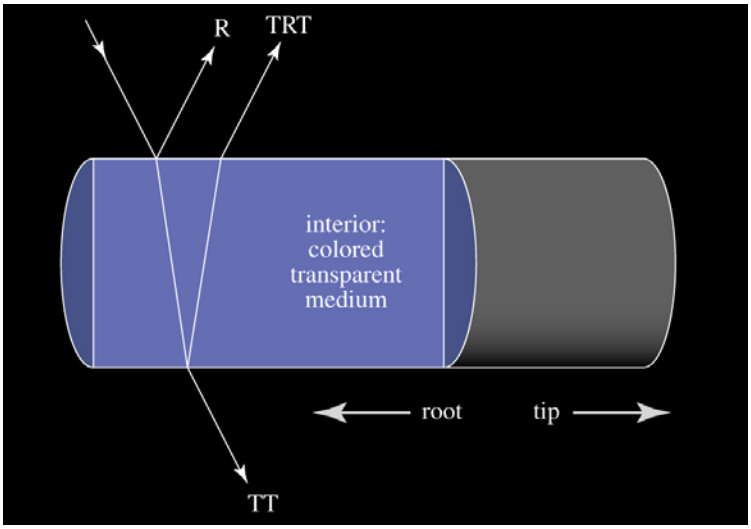
**Specular**

$$\cos^s\left(\theta_E-\theta_L\right)=\left(\cos\theta_E\cos\theta_L+\sin\theta_E\sin\theta_L\right)^s$$



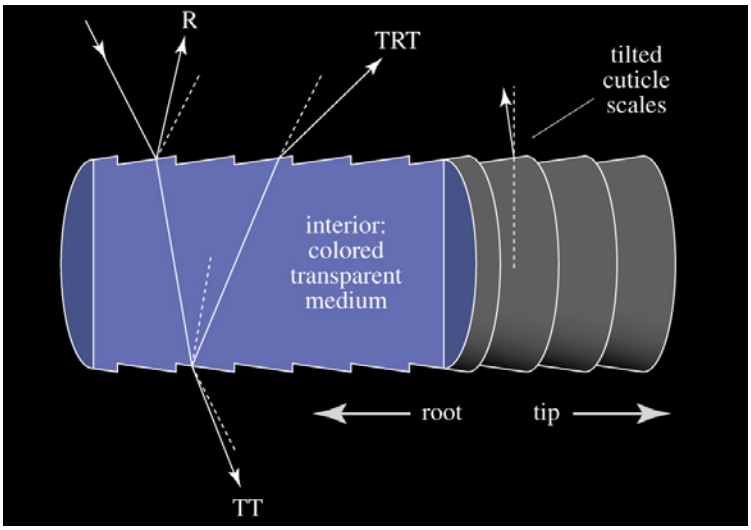
## Herbert

# Fiber Model

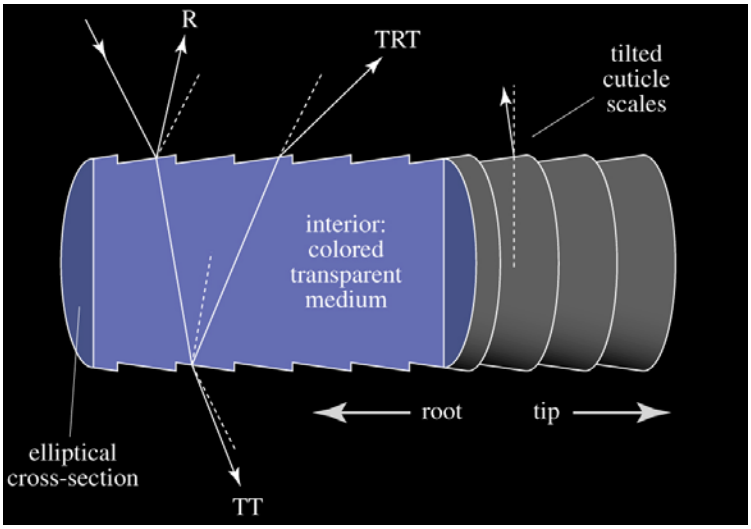





# Fiber Model

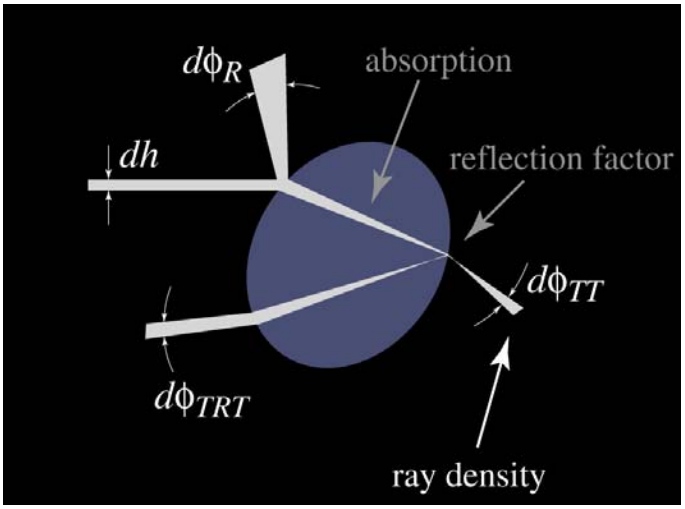


# Fiber Model






# Caustics



# Hair Appearance



# Hair Appearance