

Computer Graphics

Illumination

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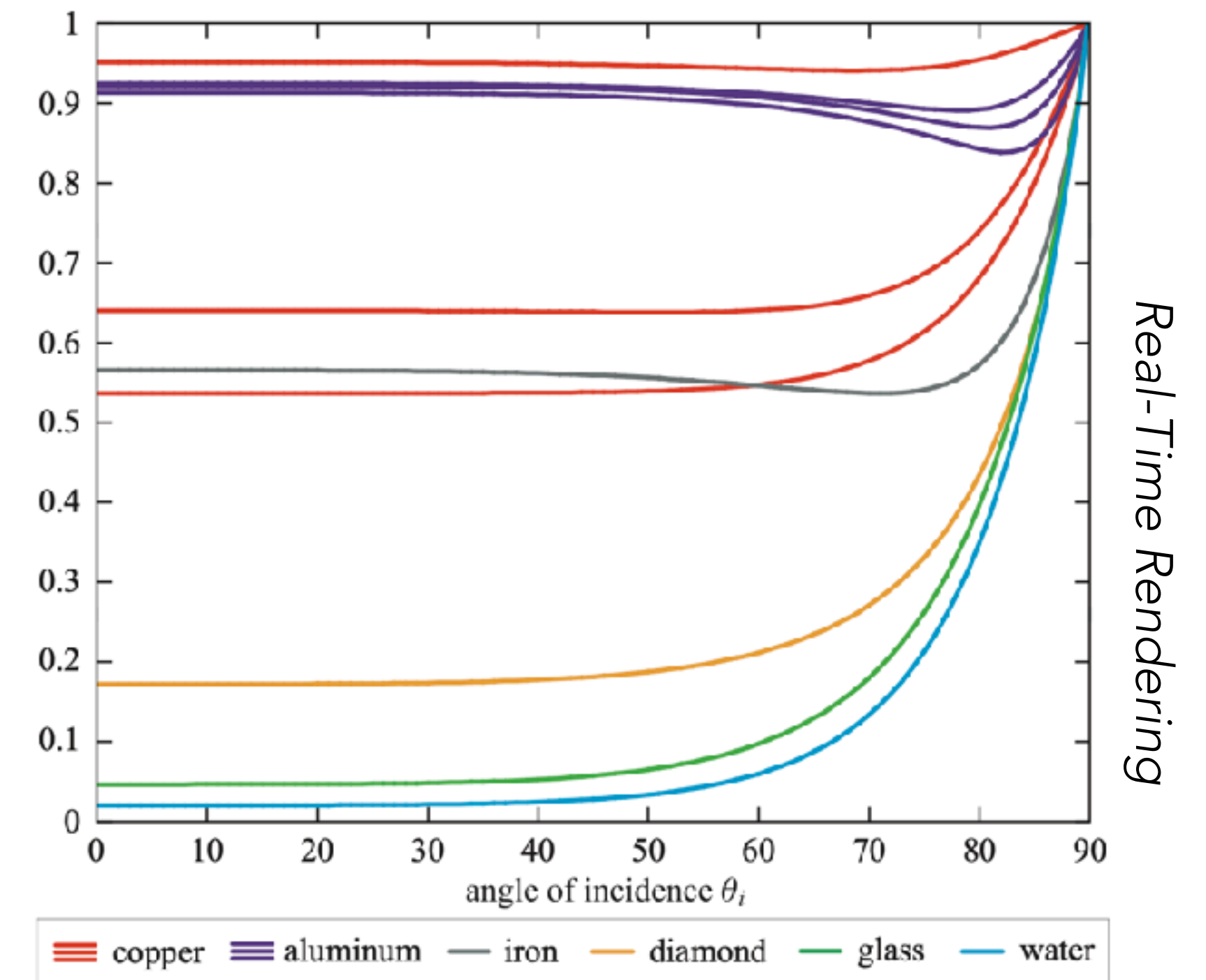
Fresnel Factor

- F is wavelength dependent
- Mirror-like at grazing angles

$$F = \frac{(g - c)^2}{2(g + c)^2} \left[1 + \frac{\{c(g + c) - 1\}^2}{\{c(g - c) - 1\}^2} \right]$$

$$c = v \cdot h \quad g^2 = \eta^2 + c^2 - 1$$

η : Refractive Index





F: Schlick Approximation

- Schlick [1994] approximation

- ➔ F_0 : Reflectance at normal incidence

- ➔ v : view vector

- ➔ h : half-vector

$$F_0 = \frac{(\eta - 1)^2}{(\eta + 1)^2} \quad \text{↪ } \eta \text{ varies with } \lambda$$

$$F = F_0 + (1 - F_0)(1 - v \cdot h)^5$$

For dielectric material

Lafortune et al. 1997

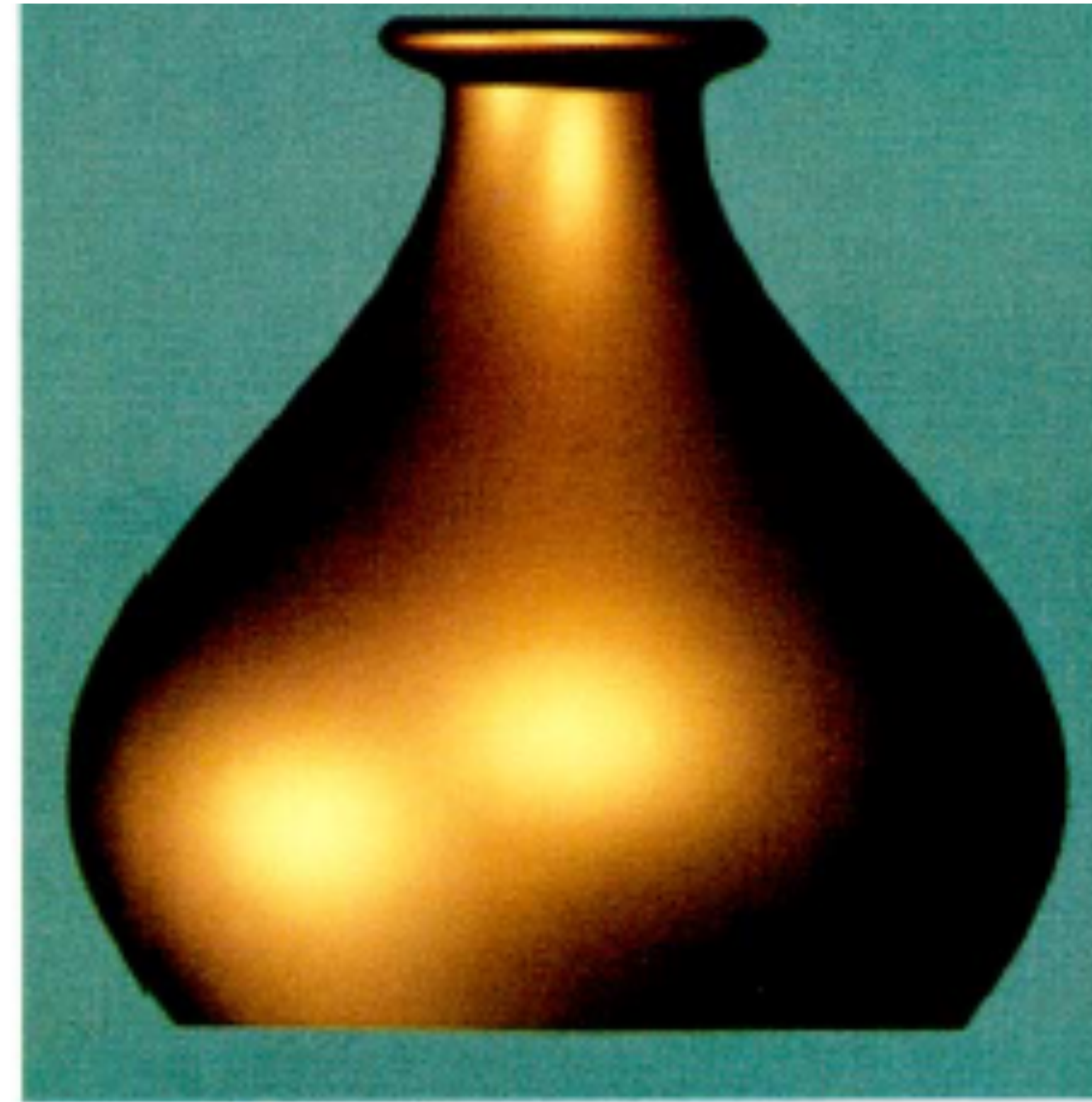


Results of Cook-Torrance

Copper colored plastic

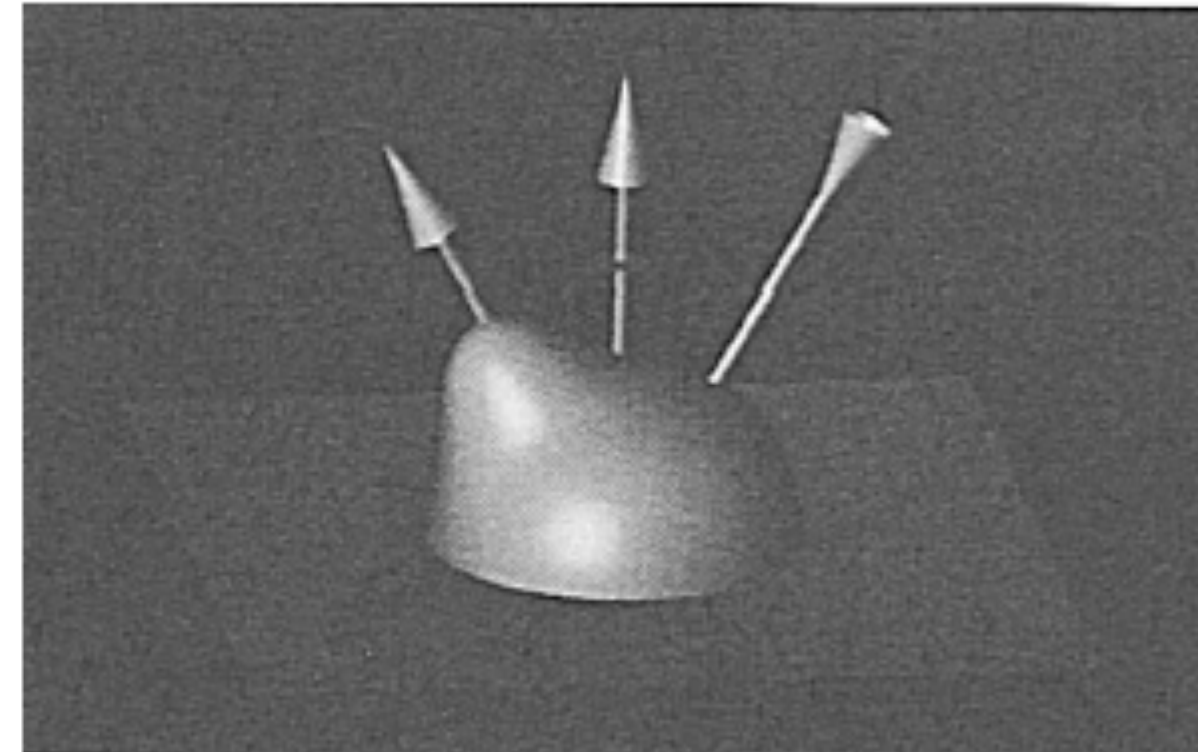
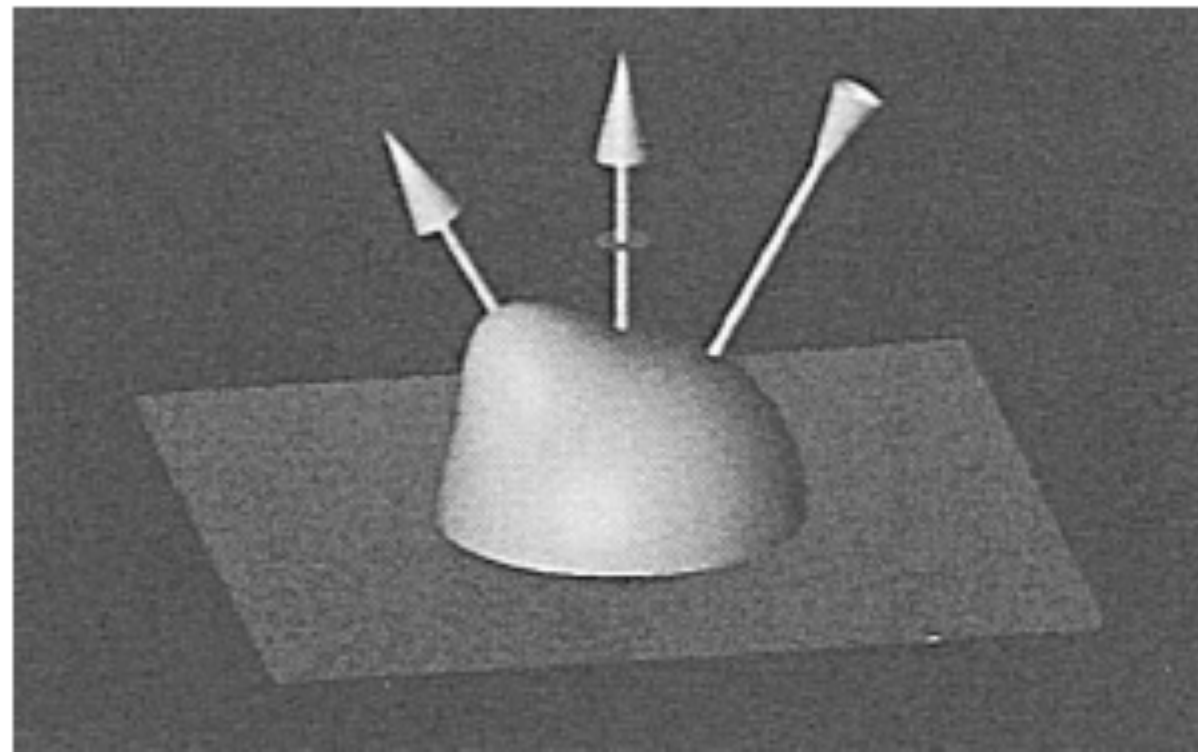


Copper Vase

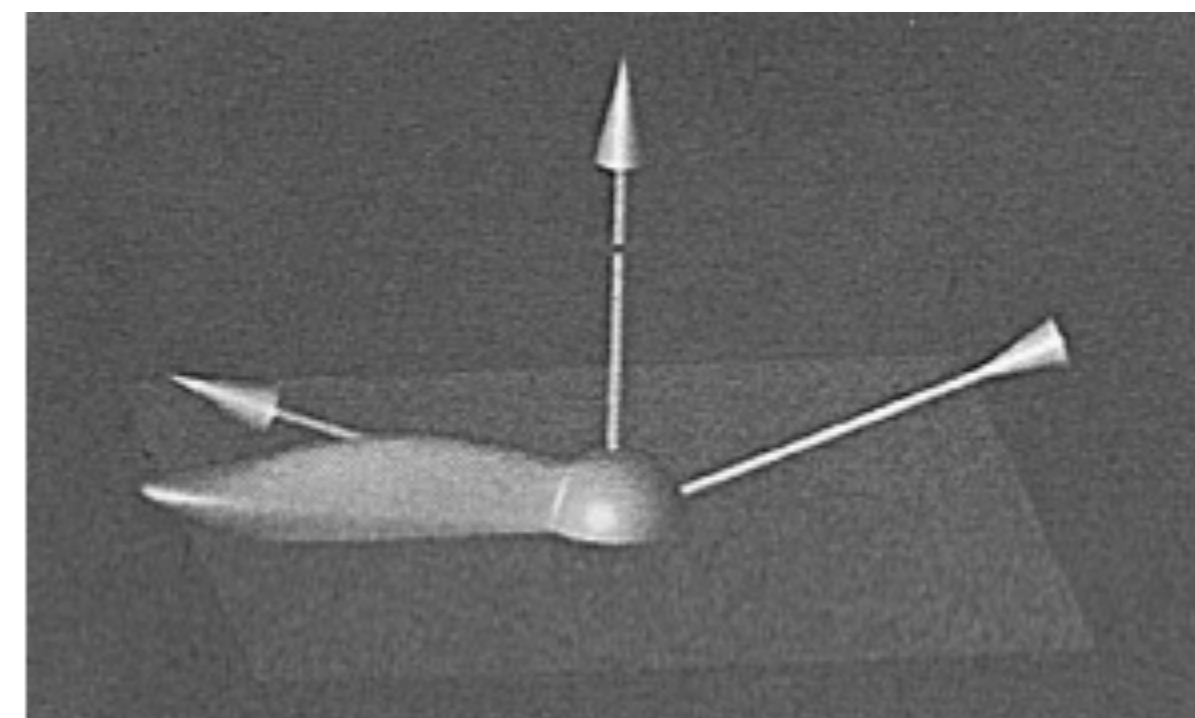
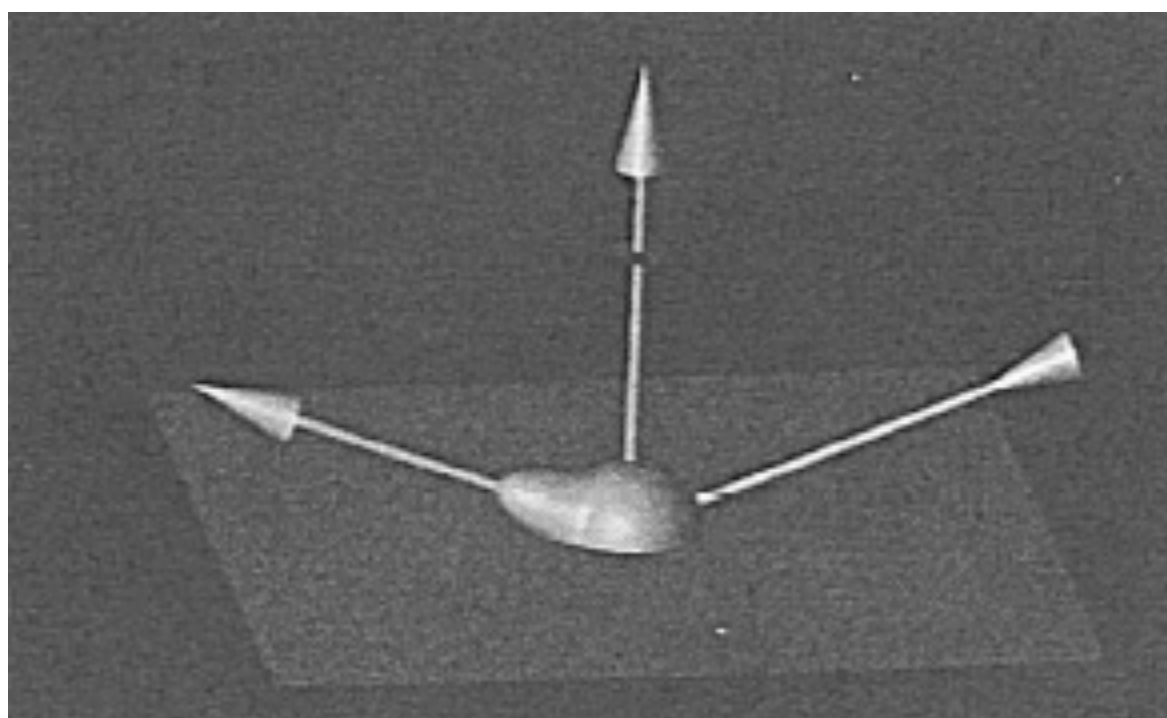


[Cook Torrance '82]

Compared to Phong



30° Incidence

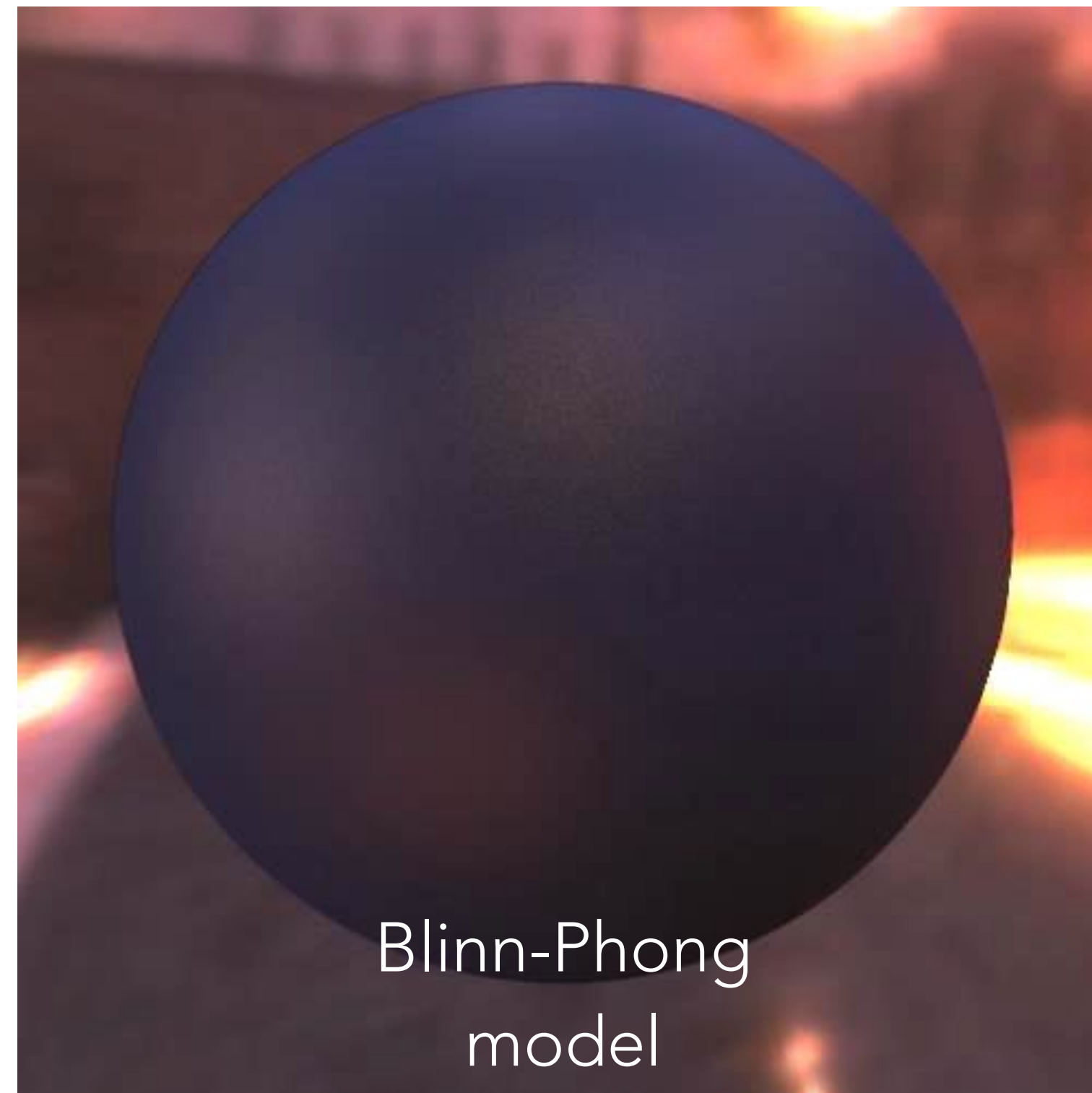
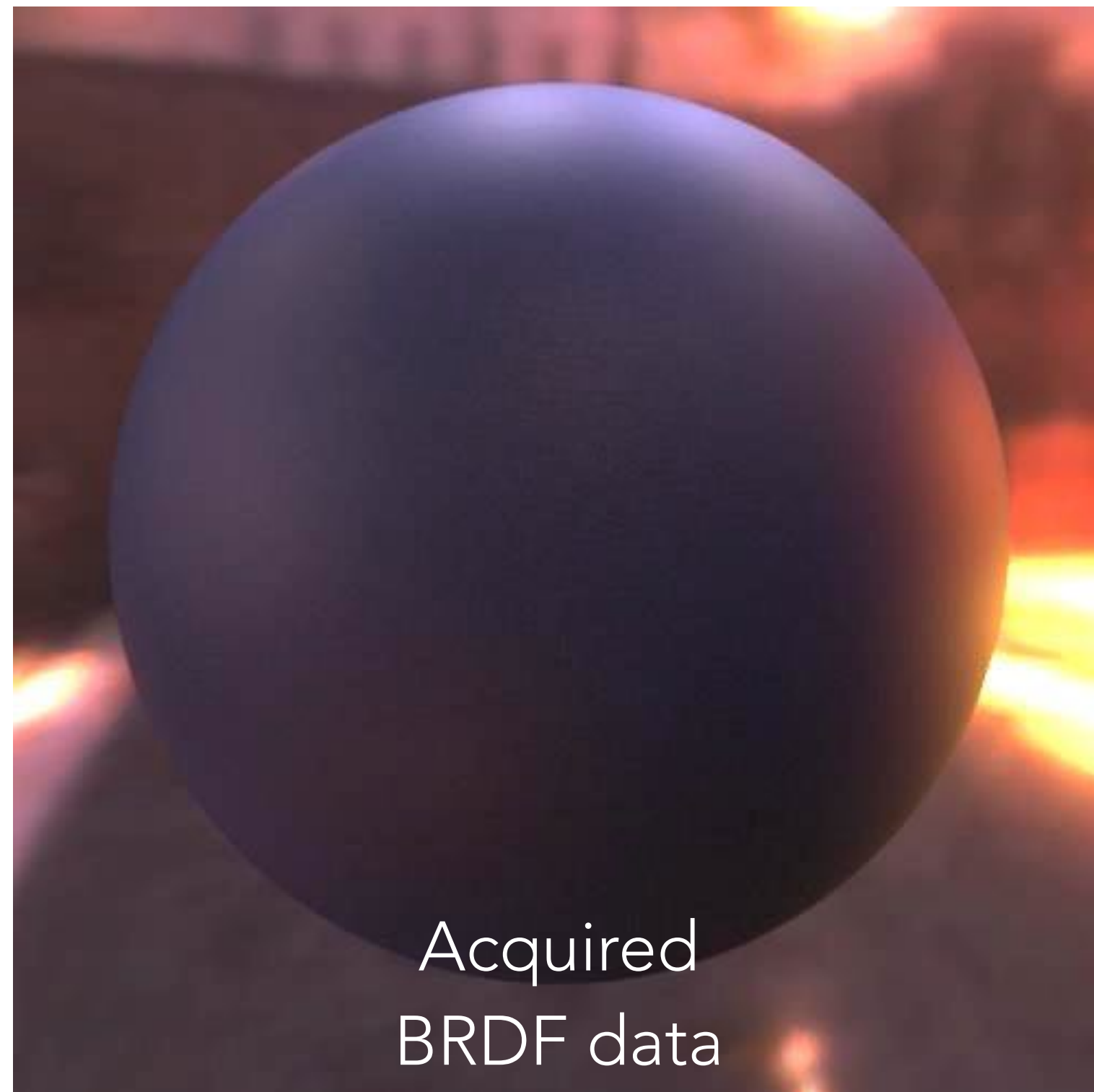


70° Incidence

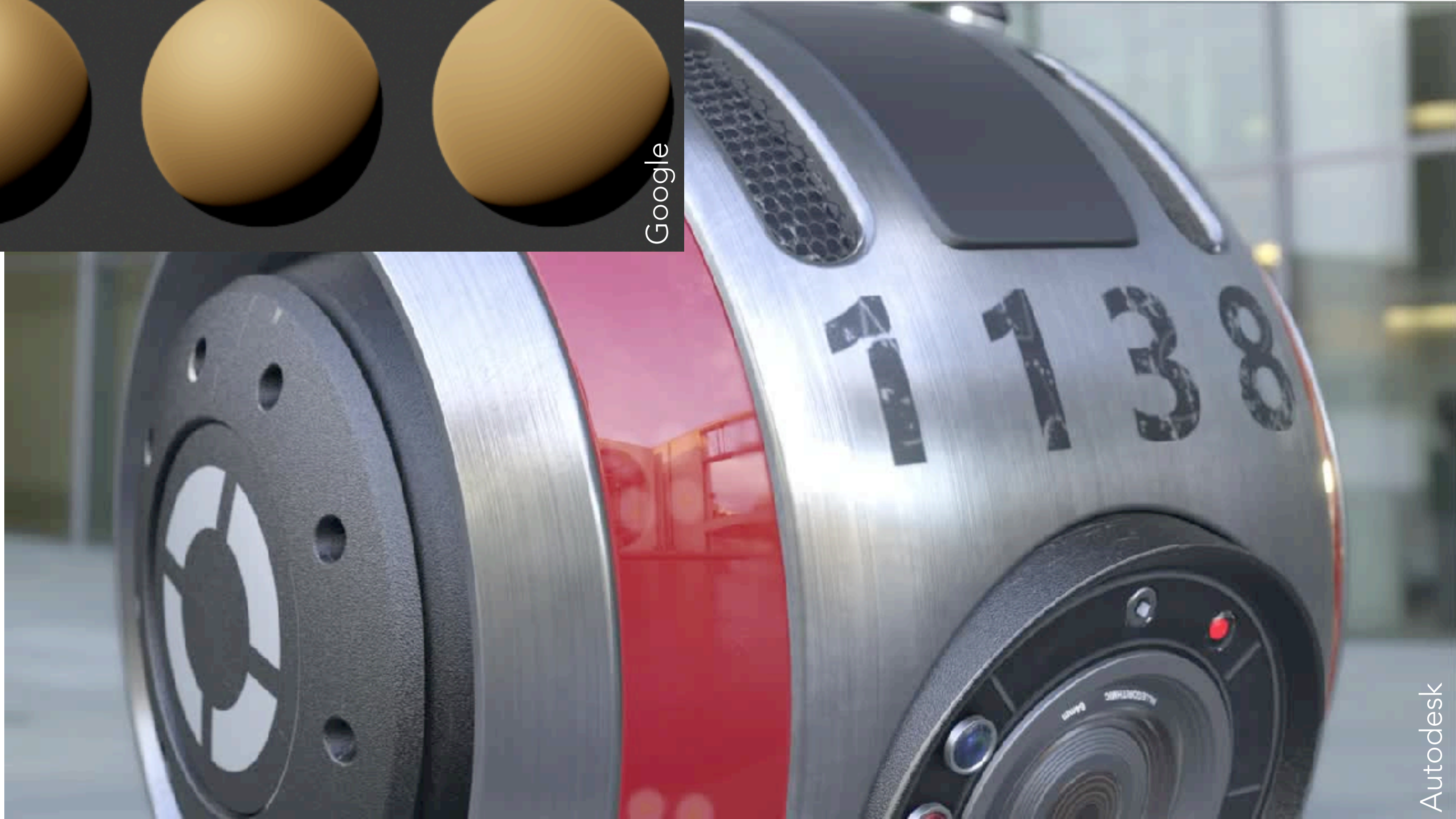
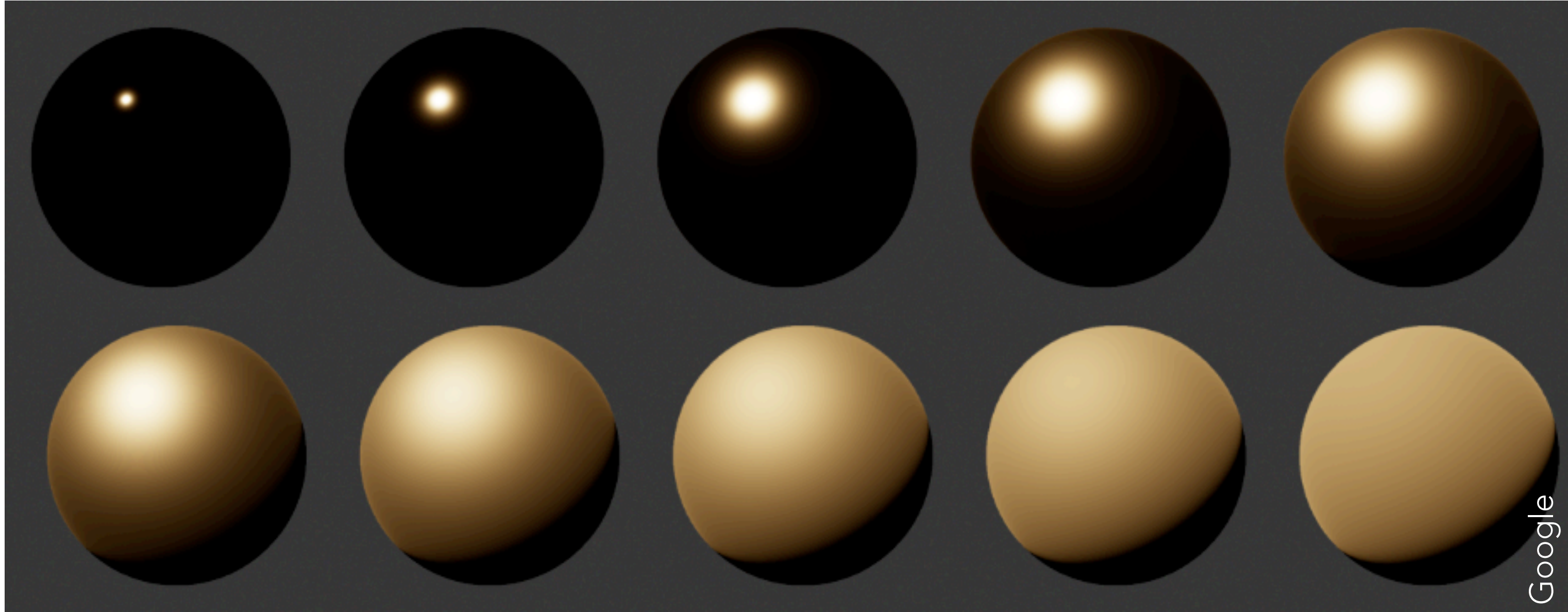
Phong

Torrance et al.

[Blinn '77]



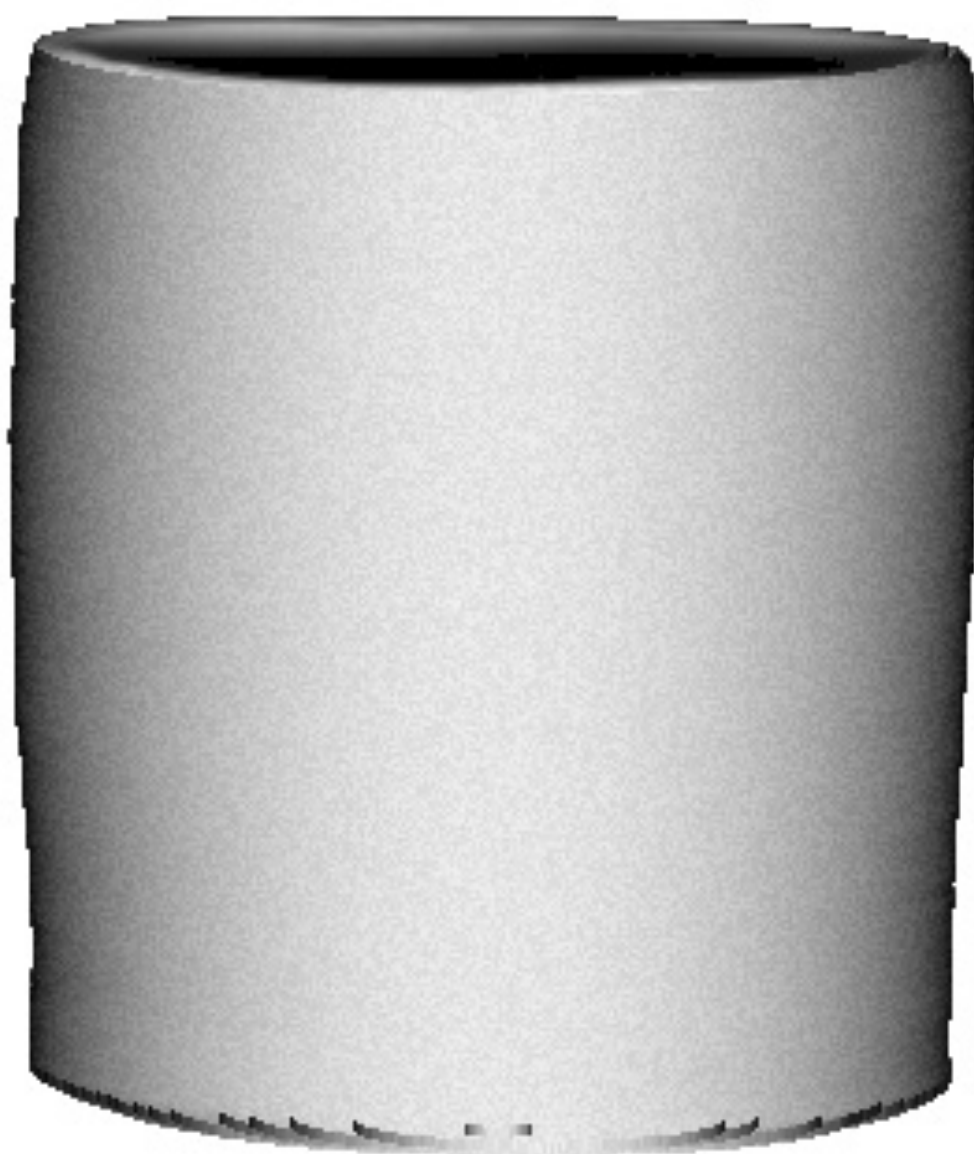
Wojciech Matusik



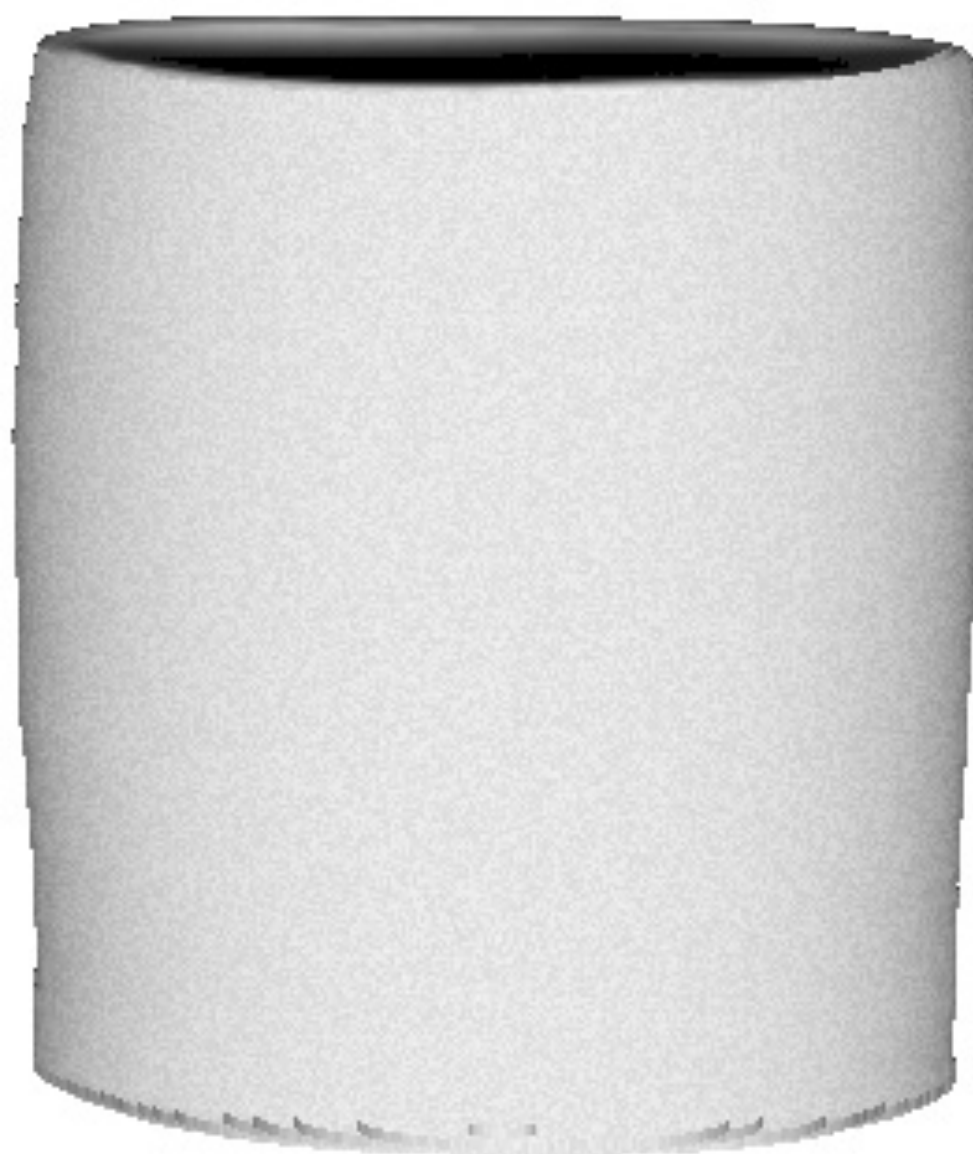
Oren-Nayar Diffuse BRDF Model



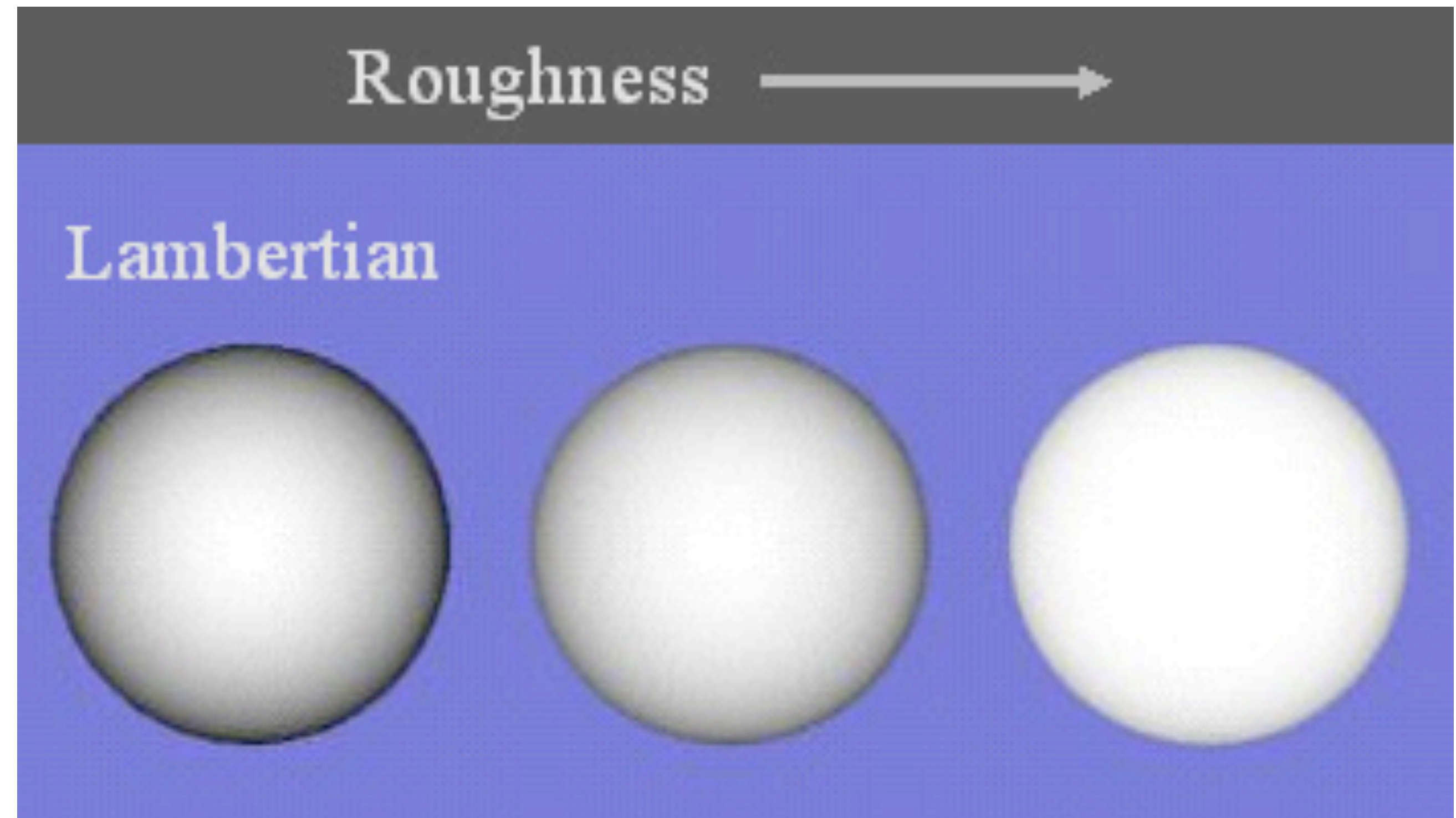
- Assumes Diffuse microfacets instead of mirror-like?



Lambertian



Oren-Nayar

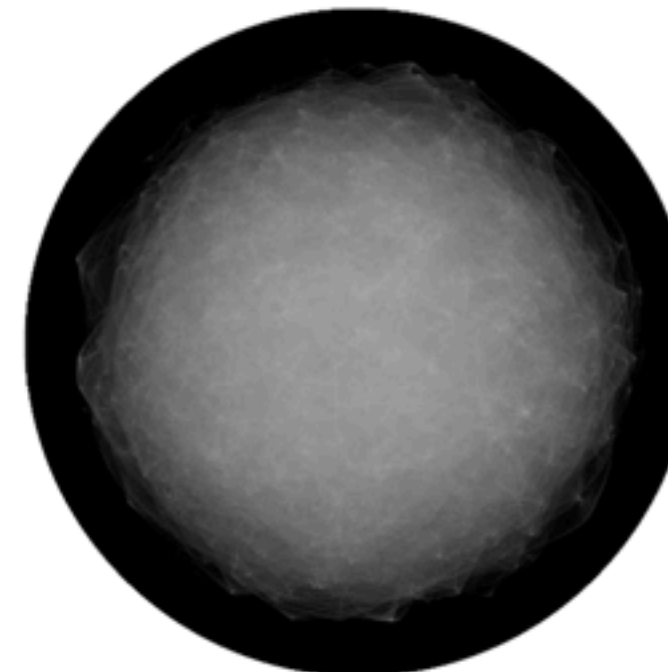
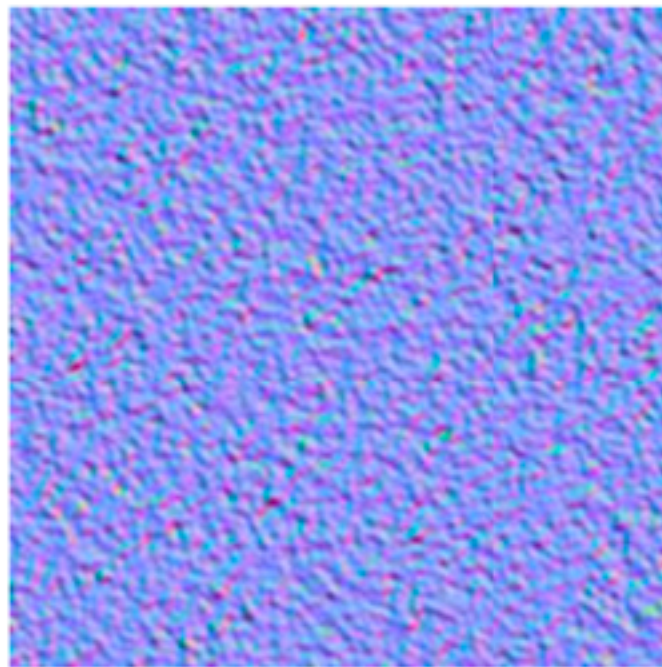


Anisotropic Roughness

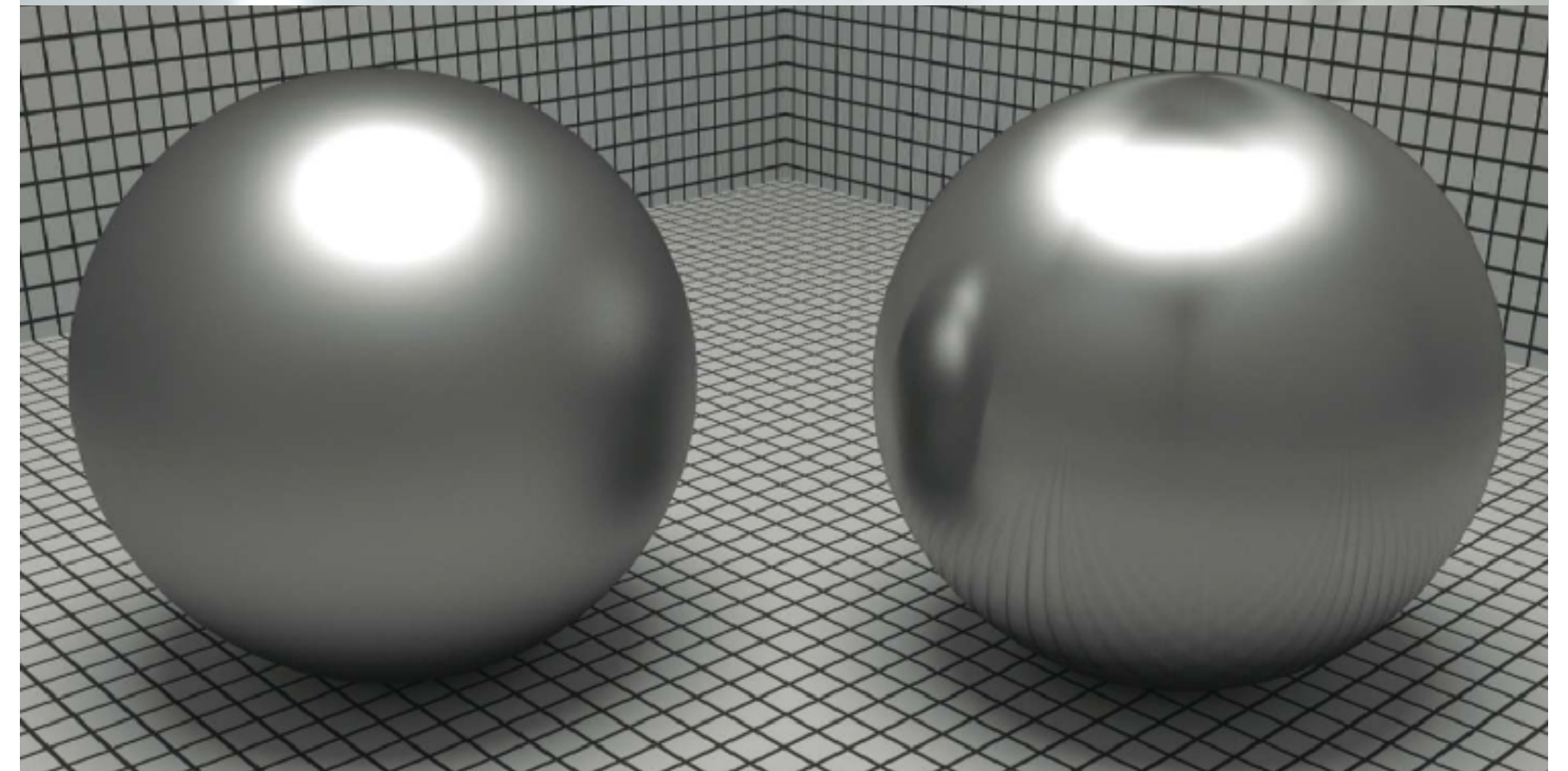
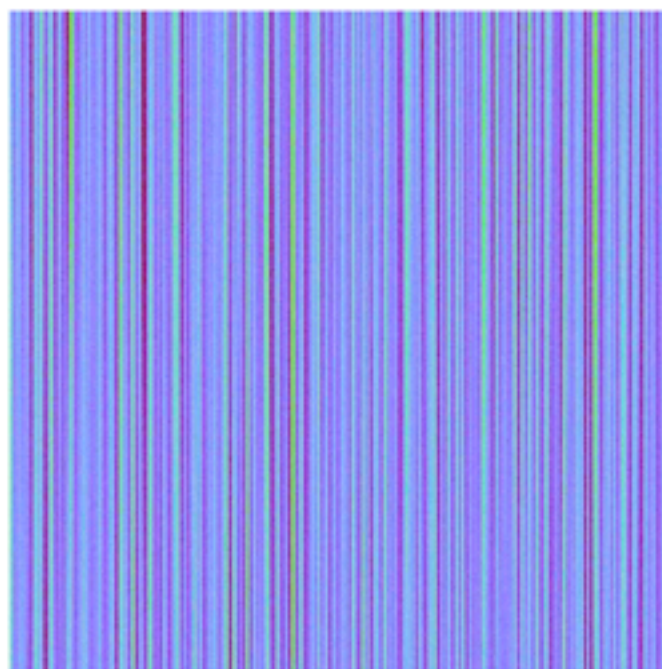


- Normal Distribution function is anisotropic (biased)

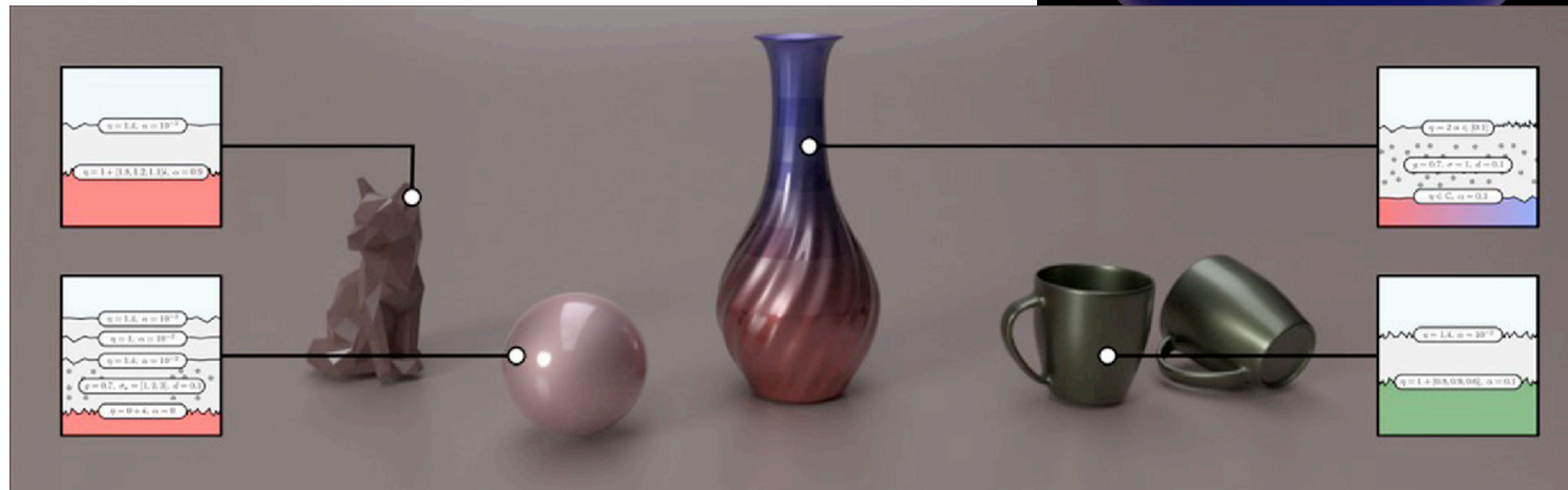
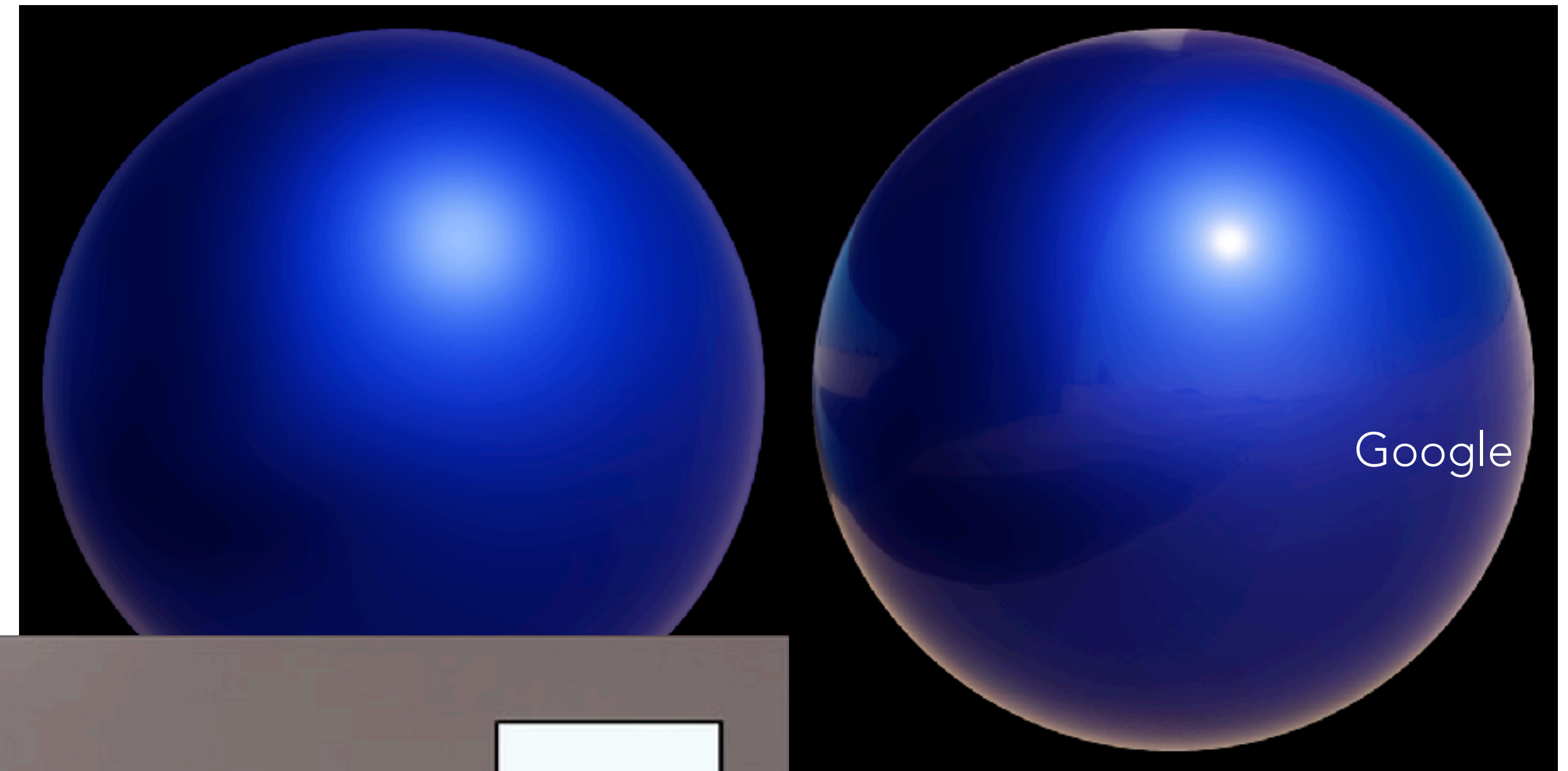
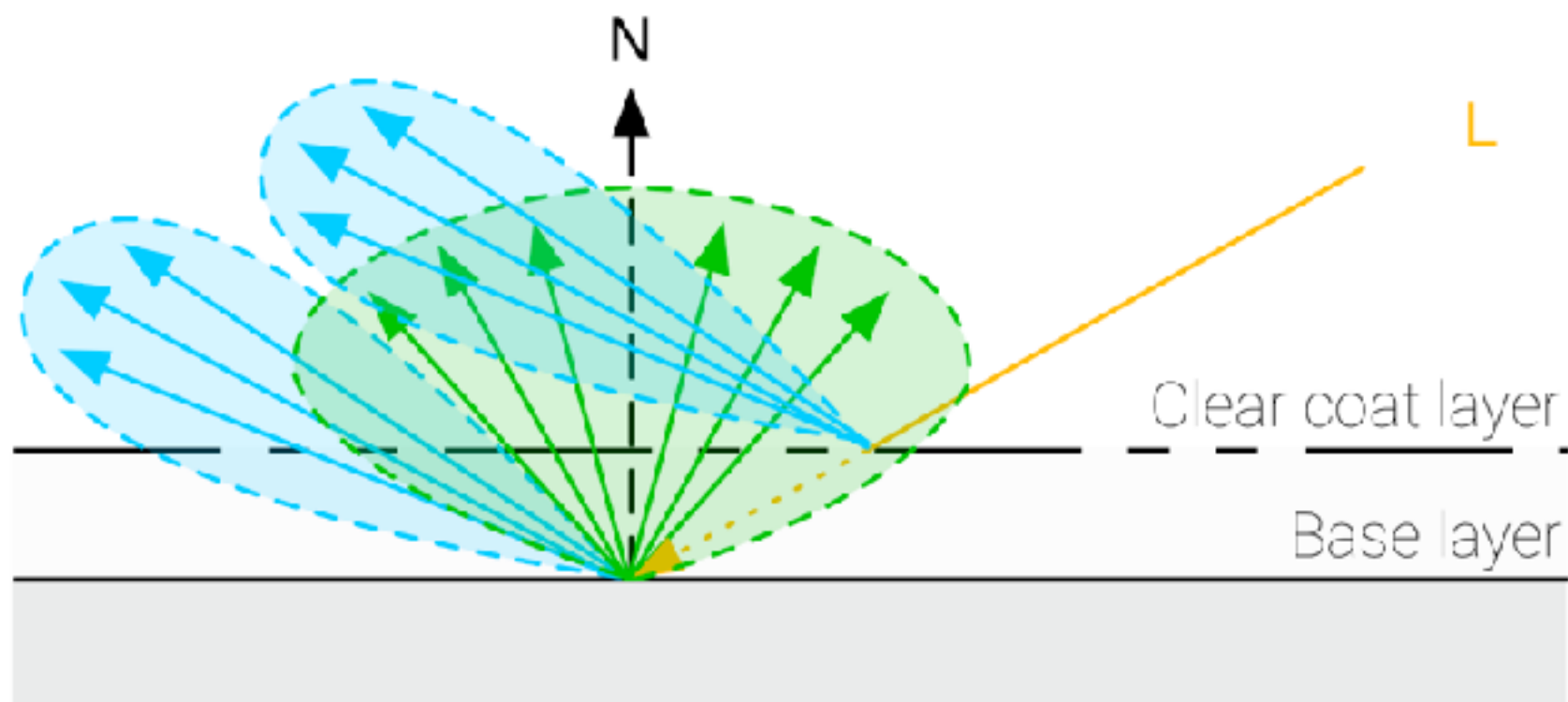
Isotropic



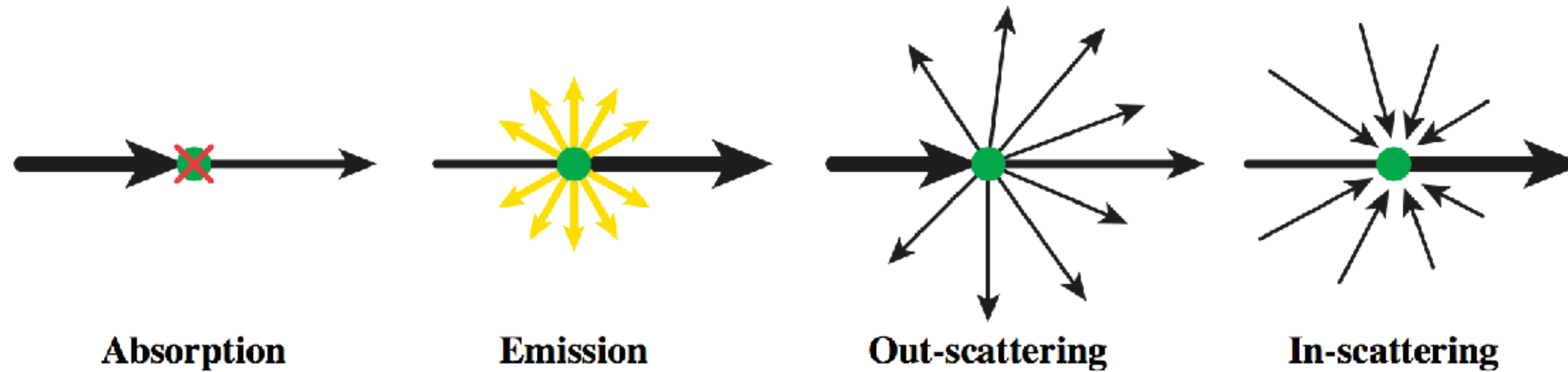
Anisotropic



Layered Materials



Participative Media

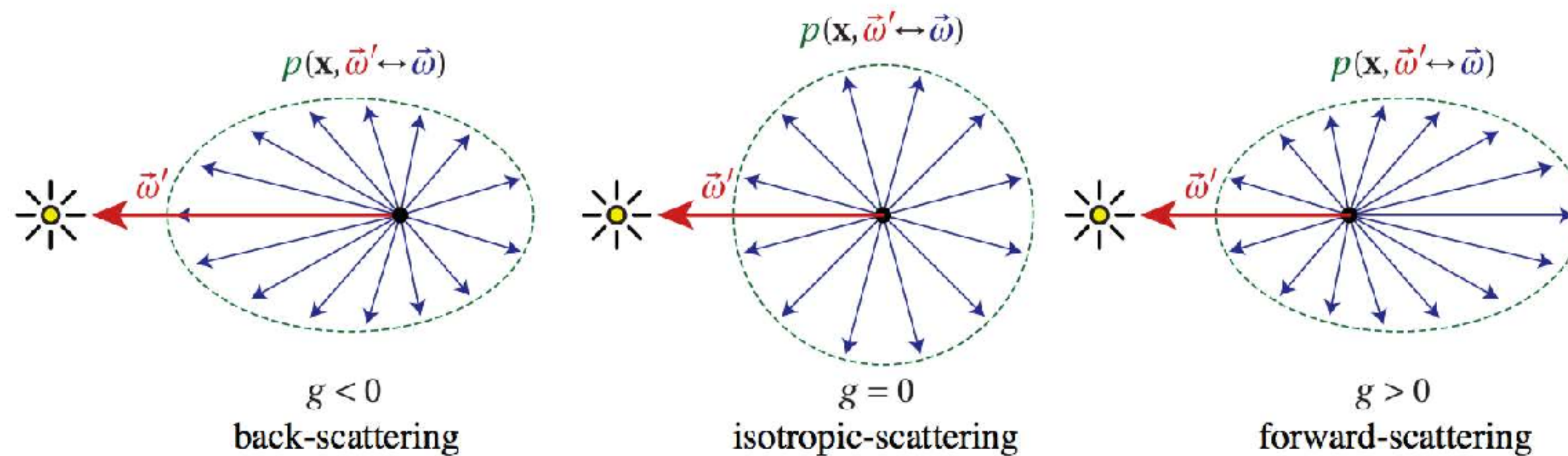


Wojciech Jarosz



Bitterli et al. 2018

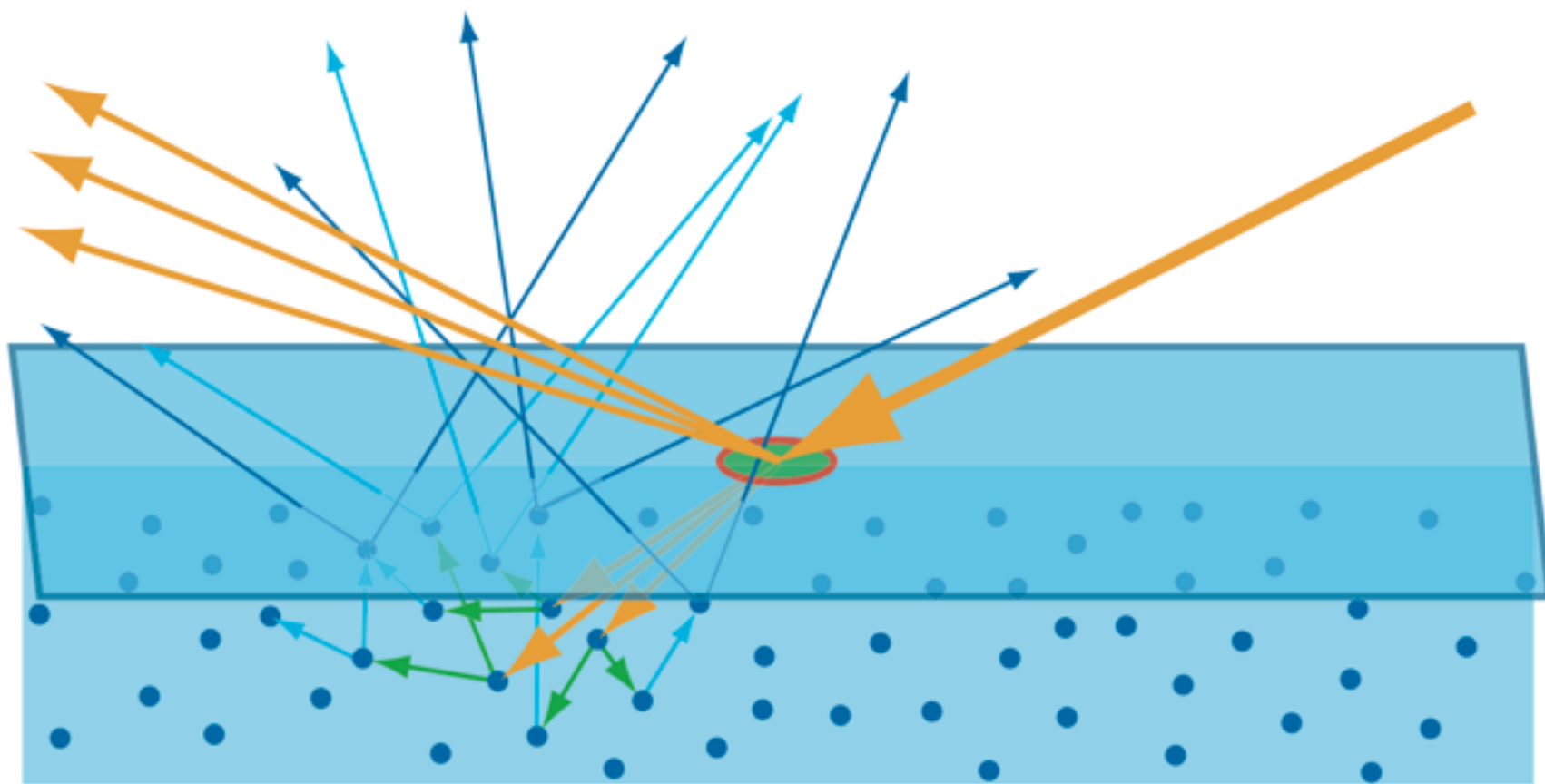
distribution of scattered ray directions



Wojciech Jarosz

Translucent materials

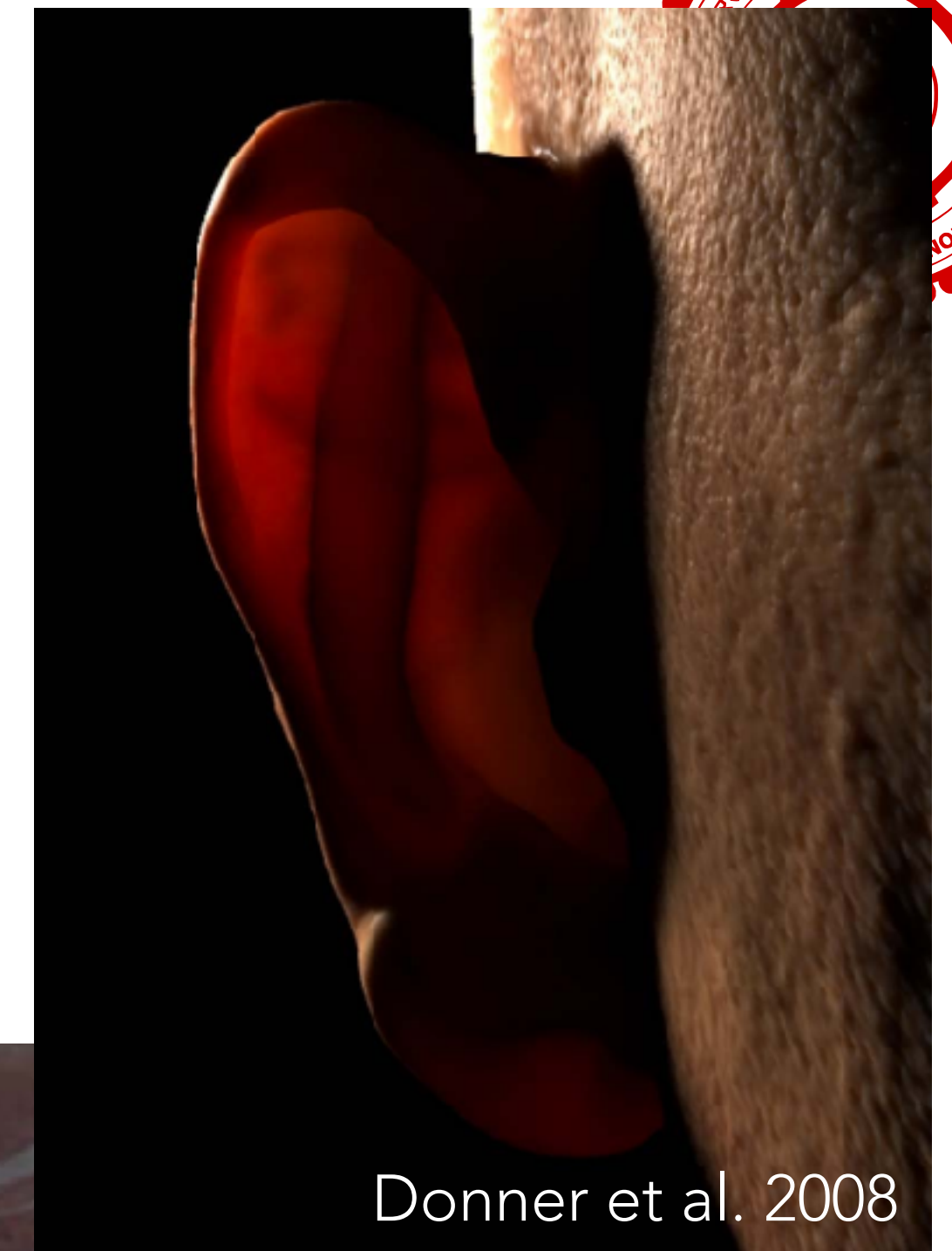
- Sub-surface scattering: light bounces around for a non-negligible distance in the material before emerging elsewhere
- Cannot be described by BRDF!



Real-Time Rendering

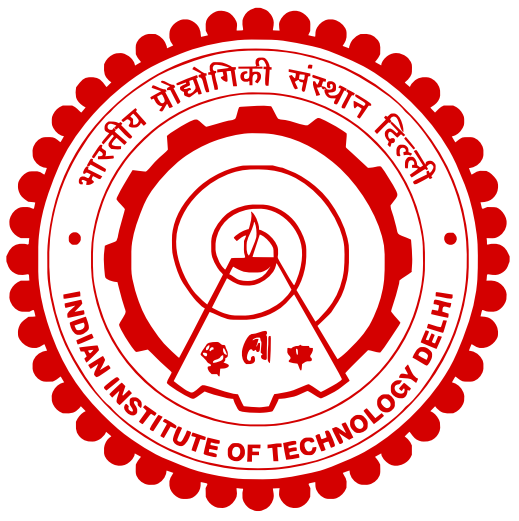


Jensen et al. 2001



Donner et al. 2008

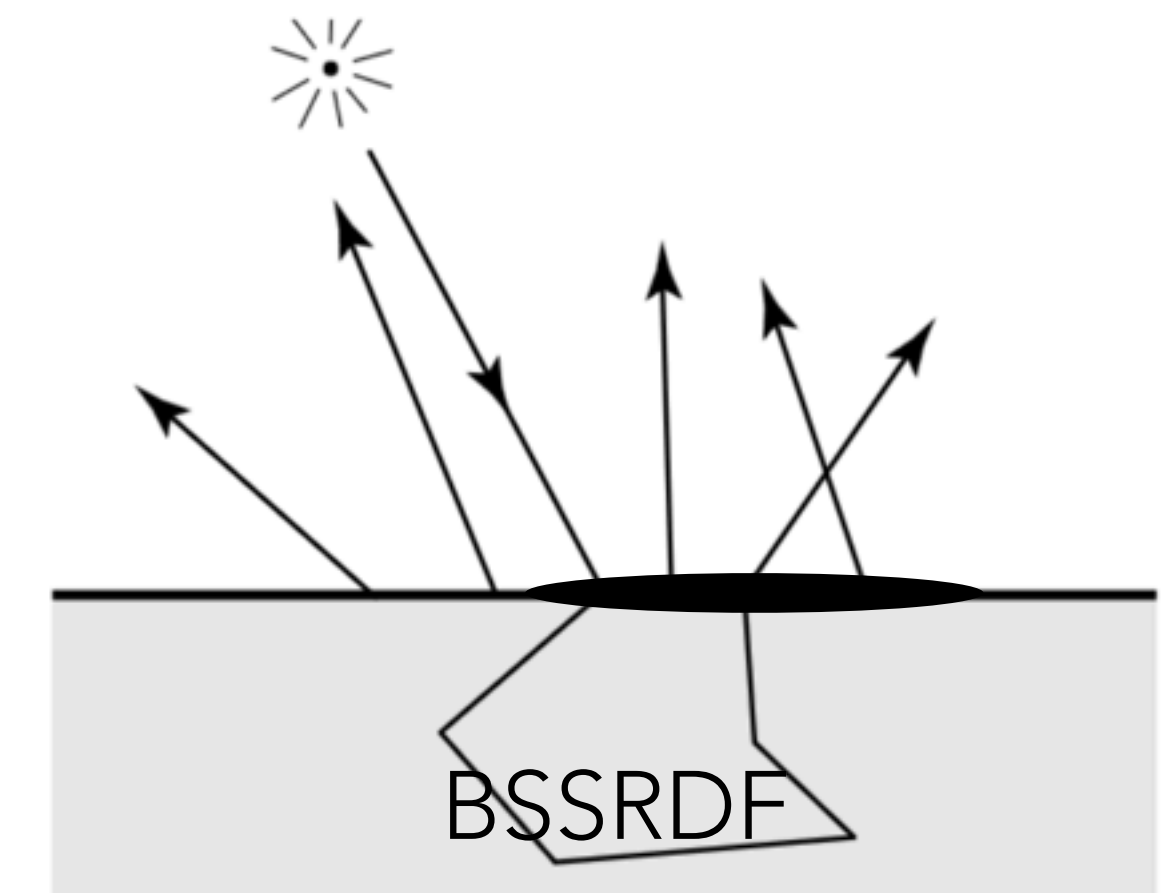
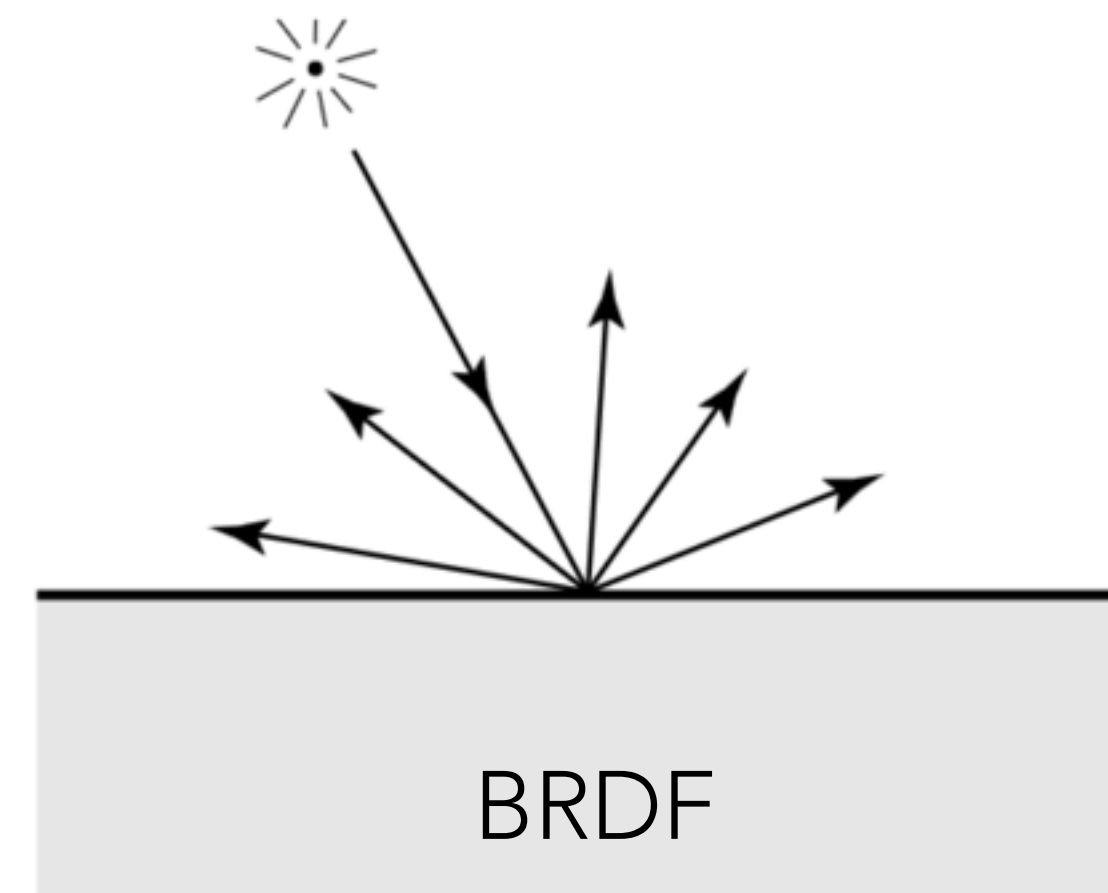




BSSRDF

- BRDF: $\rho(\omega_i, \omega_o)$
- Bi-directional Sub-surface Reflectance Distribution function $S(\mathbf{x}_i, \omega_i, \mathbf{x}_o, \omega_o)$
- Exitant radiance is

$$L_o(\mathbf{x}_o, \omega_o) = \int_A \int_{\Omega} S(\mathbf{x}_i, \omega_i, \mathbf{x}_o, \omega_o) L_i(\mathbf{x}_i, \omega_i) \cos(\theta_i) d\omega_i dA$$



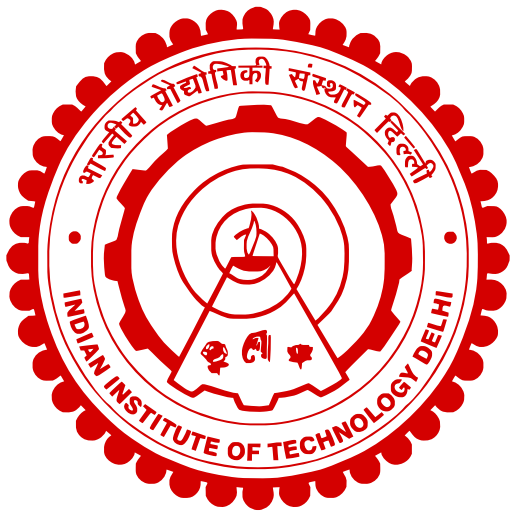


BRDF



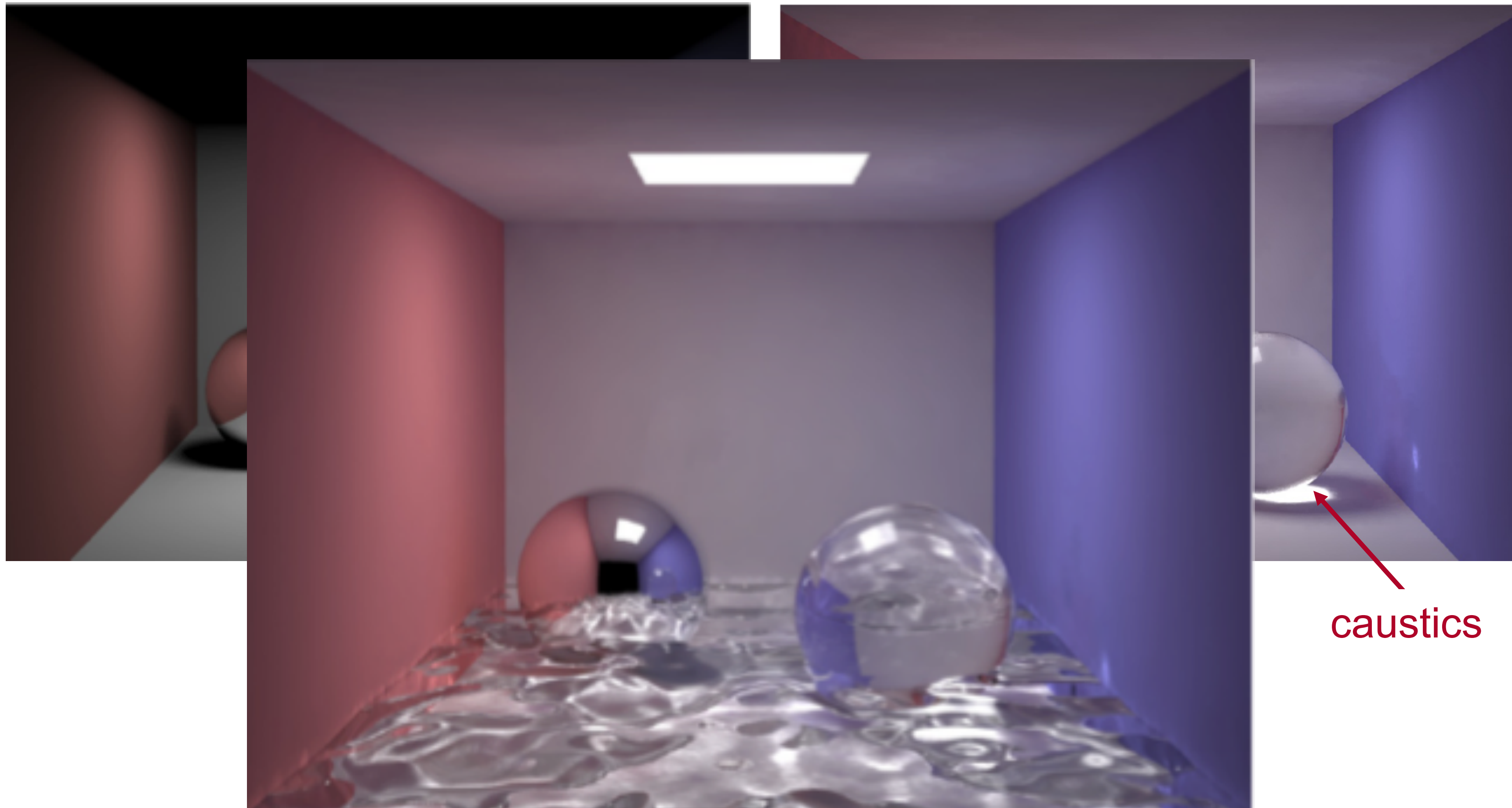
BSSDF

Global Illumination



- Radiosity Computation
- Monte-Carlo Ray tracing
- Photon Mapping

Ray Tracing vs Photon Mapping



Trace forward rays from the light source and backward rays from the camera