Introduction to Ray Tracing

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Thank you to ACM SIGGRAPH!

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SIGGRAPH 2021

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Ray Tracing

Rajesh Sharma

Course Outline

-✔- Intro, Model, Sampling
-✔- Rays, Intersections
-✔- Scene, Recursion
-✔- Materials, BRDF
-- BRDF-2, Reflections (TODAY)
-- Systems View: Integrators, Accelerators
-- Wrap up, Learn more

Today

- Guest: No Guest
- Recap
- Reflection
- BRDF 2

Housekeeping

- Link to today's slides and shaderToys:
  - Log in to your google drive
  - Google drive folder: https://bit.ly/3viTHez
  - Code: https://www.shadertoy.com/user/xarmalarma
- Use the chat to ask questions, help others
- After the lecture: @xarmalarma, #siggraph2021

Simple Shading: Light anywhere

Lambert's Cosine Law

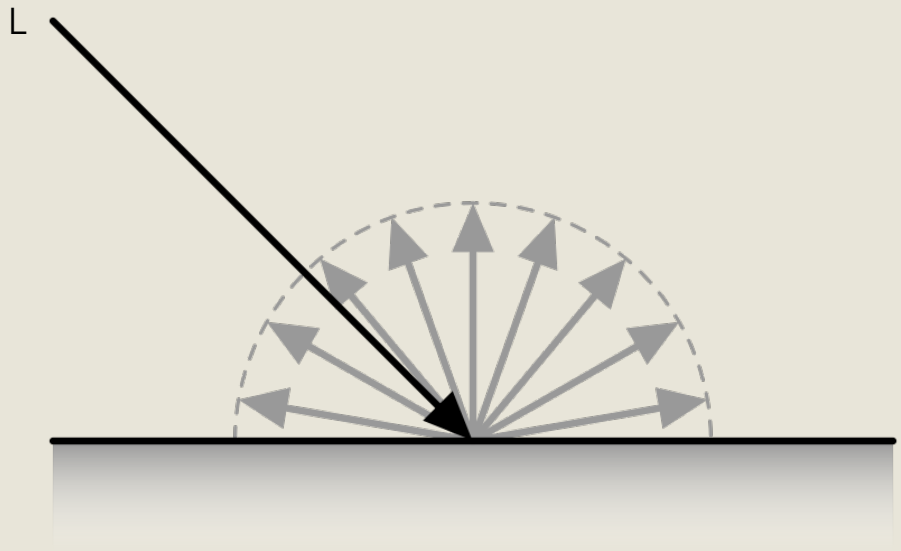
- Diffuse, Lambertian
- View Independent

Smaller the angle, more the intensity:

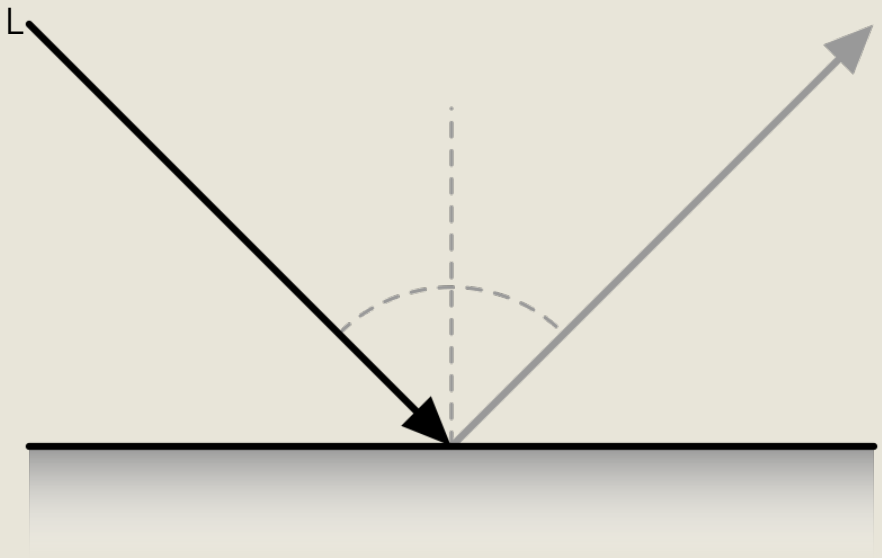
`dot(L^, N^) = cos(angle)`

Materials

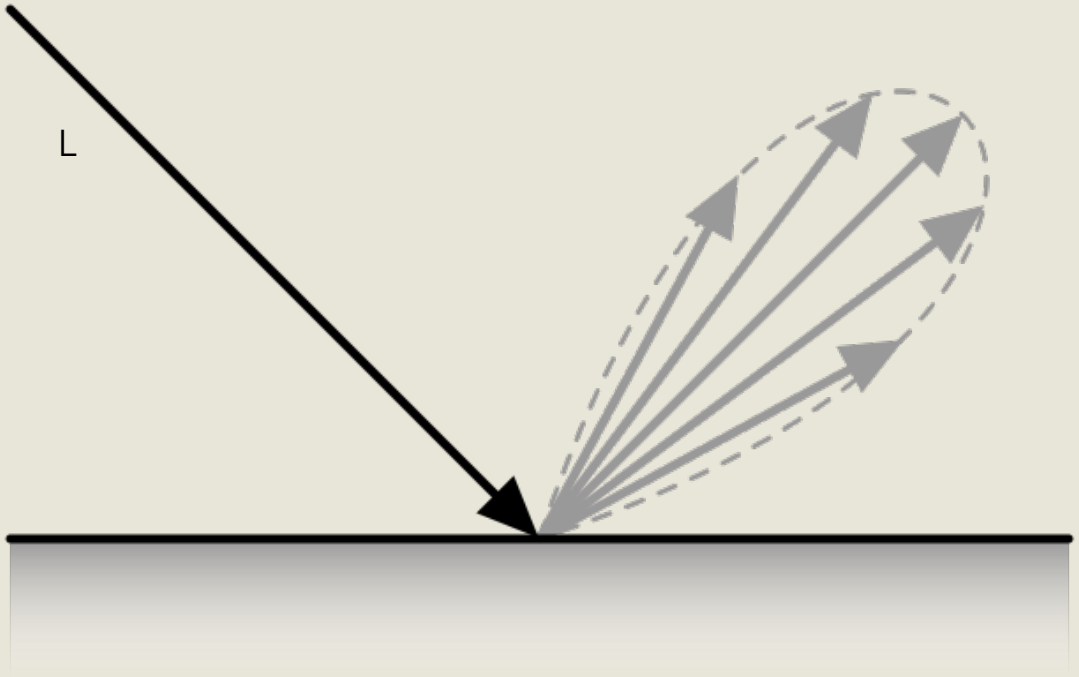
- So far our material is just a color and possibly a texture
- We have diffuse (Lambertian) surfaces



Materials - Mirror

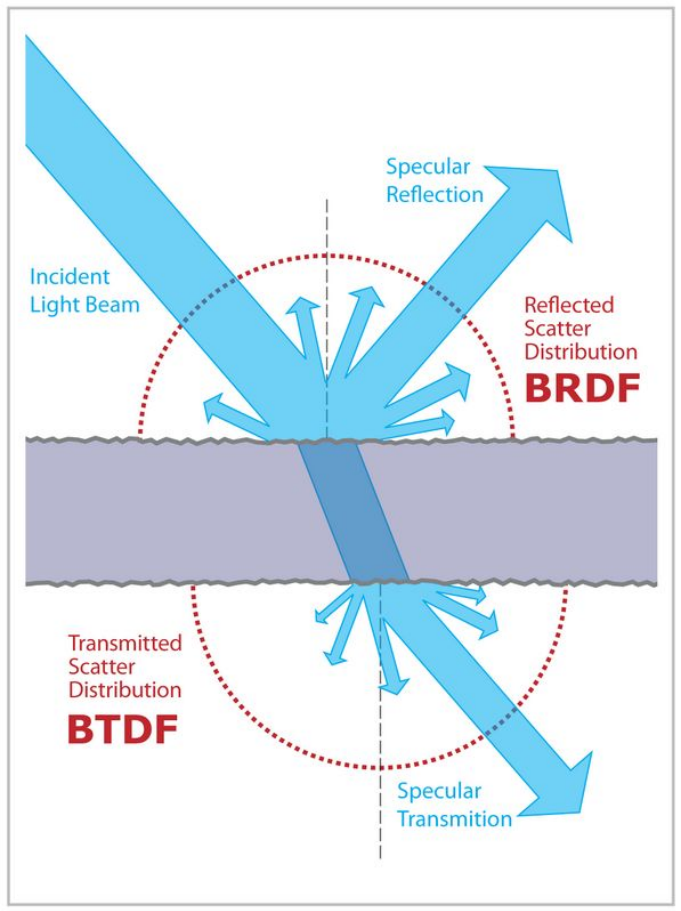


Materials - Glossy



Materials - Things can get complicated

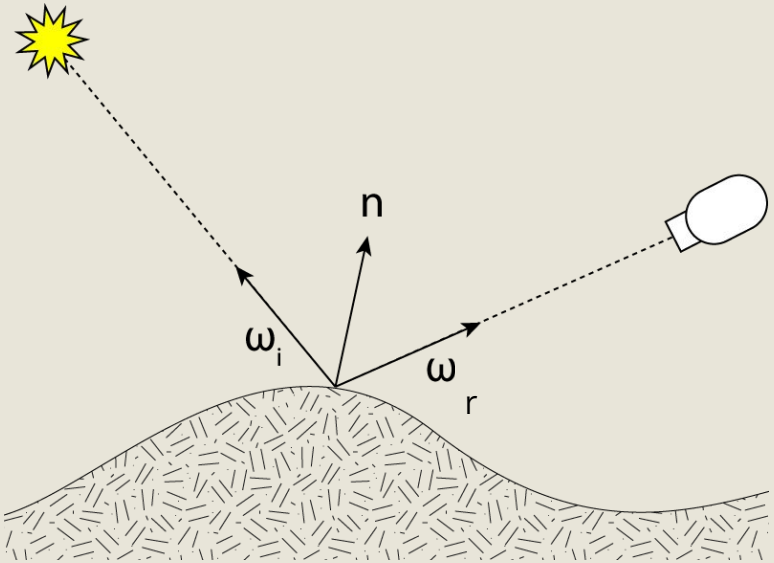
L



Mirror - Specular
Metal - Glossy
Skin - Subsurface
Glass - Transparent
Plaster, Paper - Diffuse

Materials - Simplify

$$f_r(\omega_i, \omega_r) = \frac{\mathrm{d}\, L_r(\omega_r)}{\mathrm{d}\, E_i(\omega_i)} = \frac{\mathrm{d}\, L_r(\omega_r)}{L_i(\omega_i) \cos\theta_i \; \mathrm{d}\, \omega_i}$$

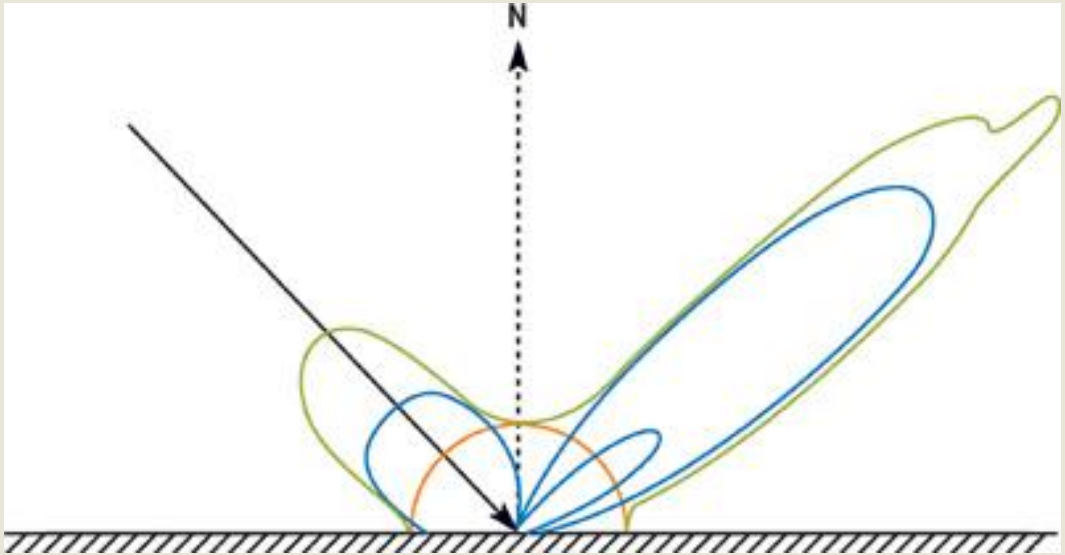


For Diffuse of Lambertian: ω_r doesn't matter

So, the BRDF in that case is simply the reciprocal of the dot product of normal and incident direction.

Materials - BRDFs for different materials

$$f_r(\omega_i, \omega_r) = \frac{\mathrm{d}\, L_r(\omega_r)}{\mathrm{d}\, E_i(\omega_i)} = \frac{\mathrm{d}\, L_r(\omega_r)}{L_i(\omega_i) \cos\theta_i \;\mathrm{d}\,\omega_i}$$

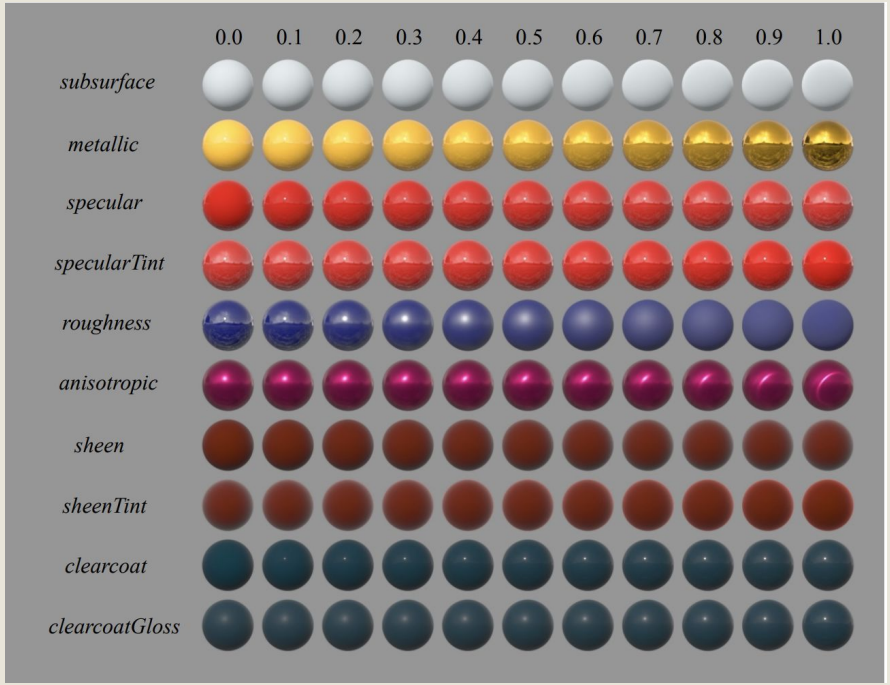


Multiple lobes

https://developer.nvidia.com/sites/all/modules/custom/gpugems/books/GPUGems/elementLinks/fig18-02.jpg

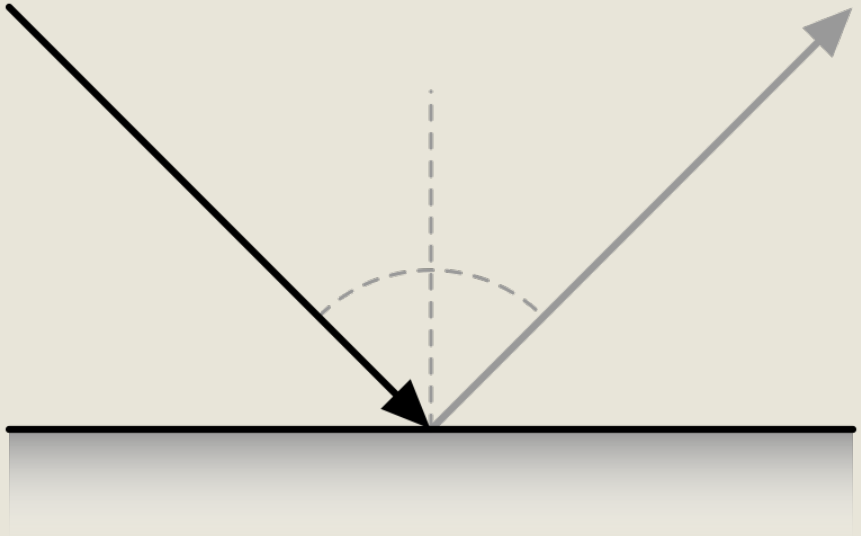
Materials - BRDFs for different materials

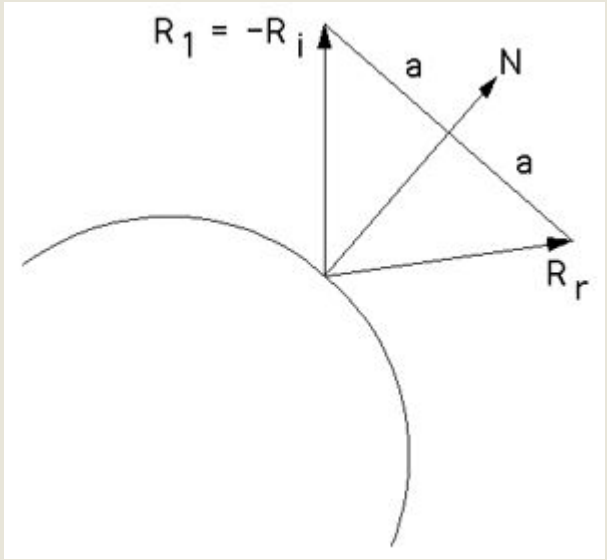
$$f_r(\omega_i, \omega_r) = \frac{\mathrm{d}\, L_r(\omega_r)}{\mathrm{d}\, E_i(\omega_i)} = \frac{\mathrm{d}\, L_r(\omega_r)}{L_i(\omega_i) \cos\theta_i \, \mathrm{d}\, \omega_i}$$



https://www.disneyanimation.com/publications/physically-based-shading-at-disney/

Materials - Mirror



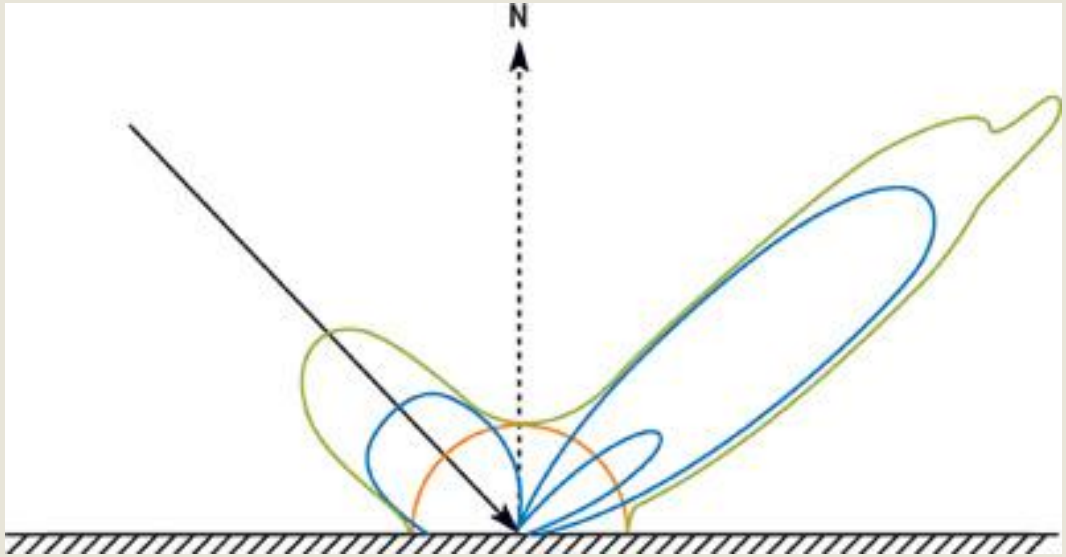


$$R_r = R_i - 2\,N\,(R_i \cdot N)$$

Materials - Mirror

Hands on: Shadertoy: Reflections

Materials - Generalizing



Materials - Generalizing

- Properties:
  - Base Color
  - Metallic
  - Roughness
  - Specularity
  - Clearcoat
  - Sheen
  - Anisotropic

Materials - Mirror

Hands on: Shadertoy: BRDF

Hands-on

- ★ Log in to your google drive
- ★ Make a shortcut to: https://bit.ly/3viTHez
- ★ Create an account on shadertoy.com
- ★ Fork a copy of:
  - ○ https://www.shadertoy.com/view/7ts3WN

Next Class

- Continue building BRDF
- Unifying everything, optimize
- Homework:
  - Try surface varying materials, textures
  - Try animating the light
  - @xarmalarma, #siggraph2021

QUESTIONS?

- Chat
- #xarmalarma