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KATEDRA POČÍTAČOVÉ GRAFIKY A INTERAKCE

Photorealism

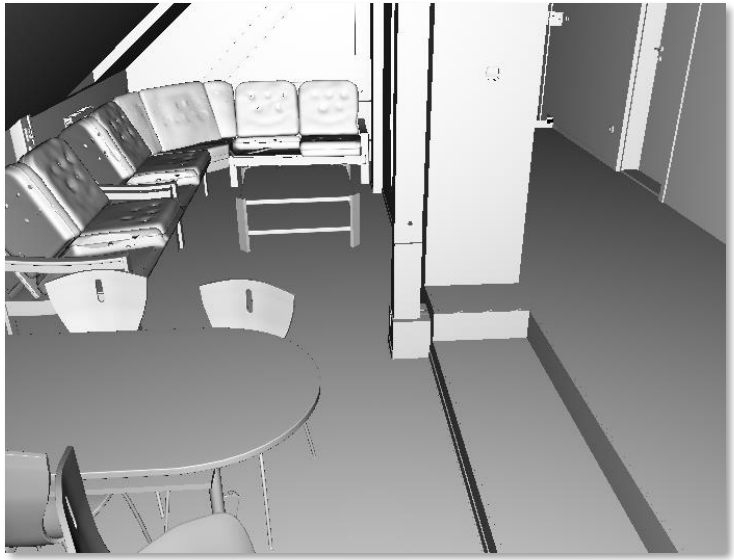
Jiří Bittner

Outline

- Introduction
- Photorealistic rendering MPG 15.1-15.7

Rendering - Introduction

- Compute image … from scene description



Photorealistic Rendering

(images from master thesis of R. Hub, ČVUT FEL 2014)

https://area.autodesk.com/fakeorfoto/

Scene Description (Review)

- Geometry
  - Objects & positions
  - Commonly a B-rep
- Surface materials
  - Color, reflectivity, ...
- Light sources
  - Position, direction, size
  - Directional and spatial distribution, color
- Camera
  - Perspective, parallel, spherical …

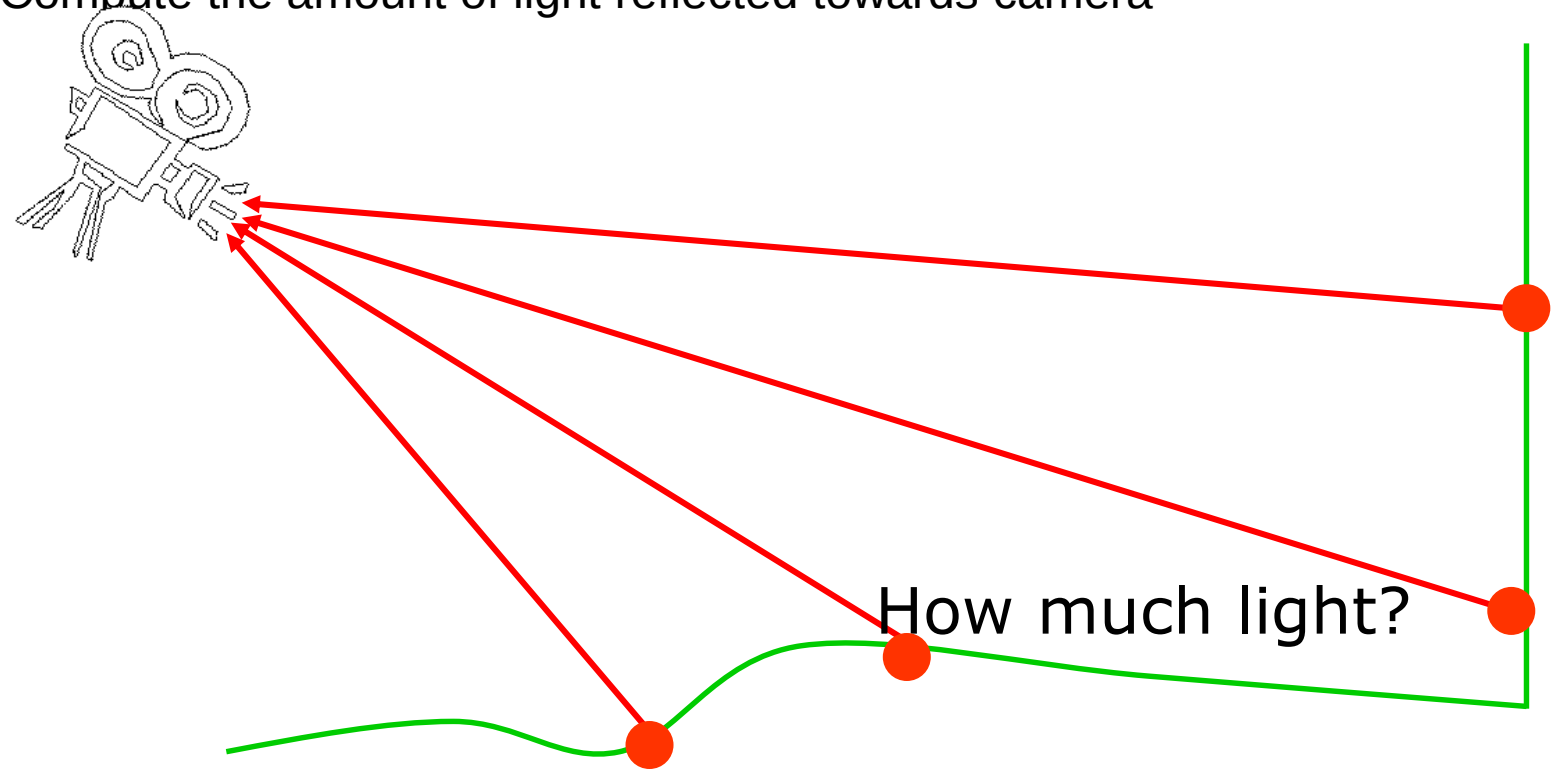
Different Approaches to Rendering

- *Non-photorealistic rendering*
  - Mimic artistic styles
  - Technical drawings
  - Emphasizing selected information

- *Photorealistic rendering*
  - *Goals: images match reality*
  - Simulation of light transport
  - **Our topic**

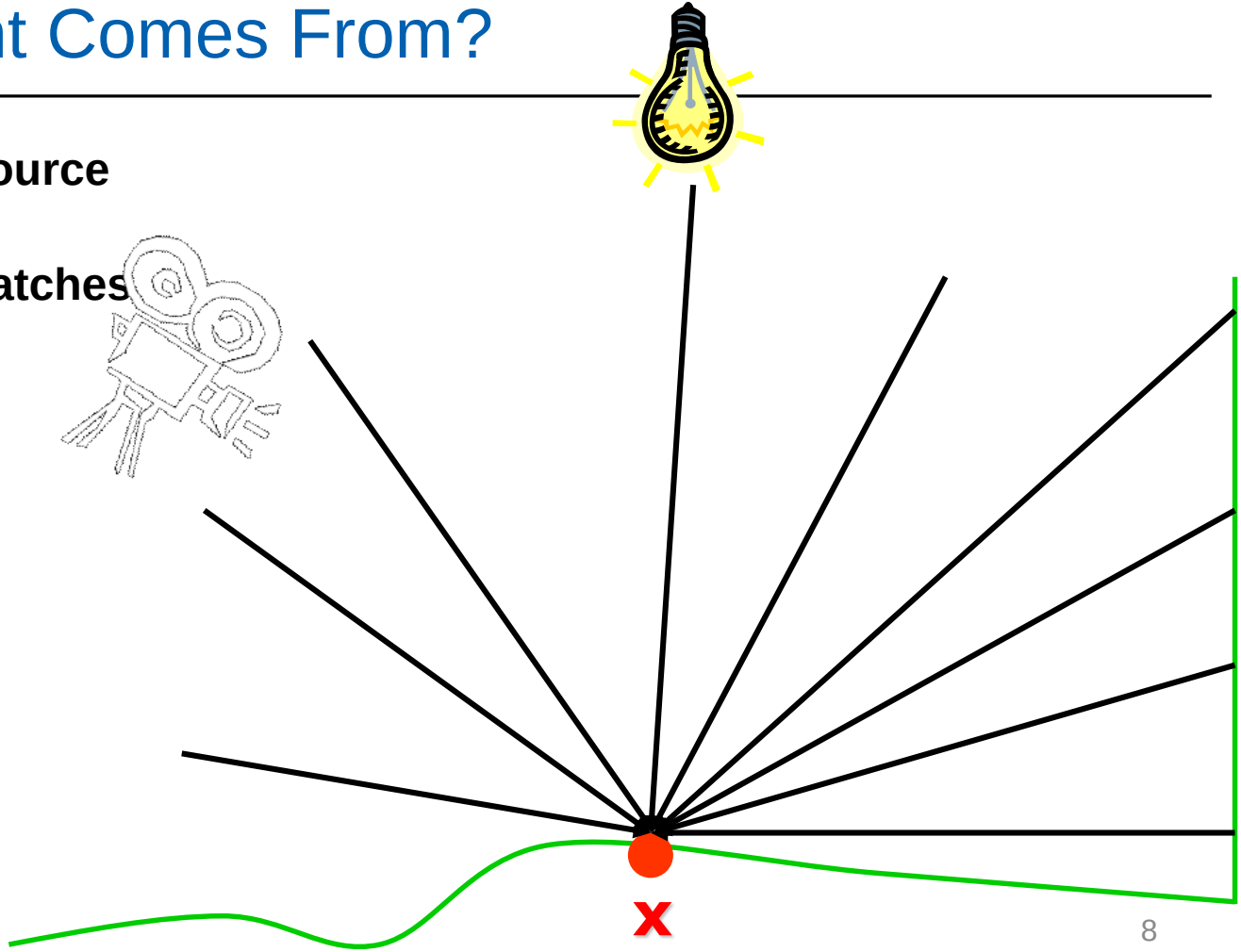
Photorealistic Rendering

- For every visible point **p** in the scene
  - Compute the amount of light reflected towards camera



Where the Light Comes From?

- Directly from **light source**
(direct illumination)
- From other **scene patches**
(indirect illumination)

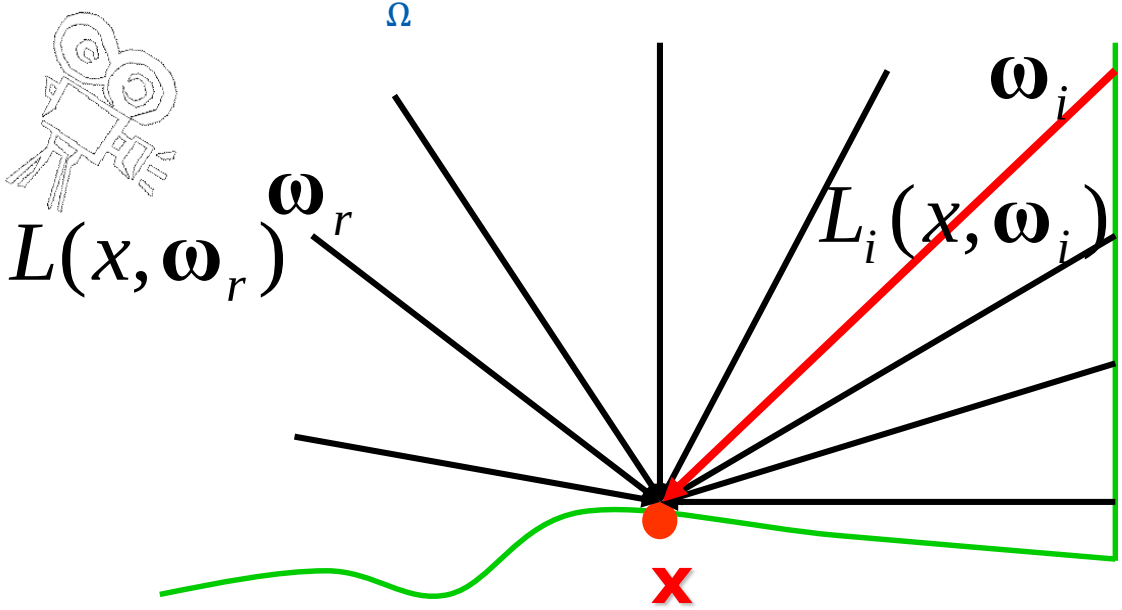


Rendering Equation

[Kajiya 86]

Hemispherical formulation

$$L_r(x,\omega_r) = L_e(x,\omega_r) + \int_{\Omega} f_r(x,\omega_i,\omega_r)\, L_i(x,\omega_i) \cos\theta_i \, d\omega_i$$

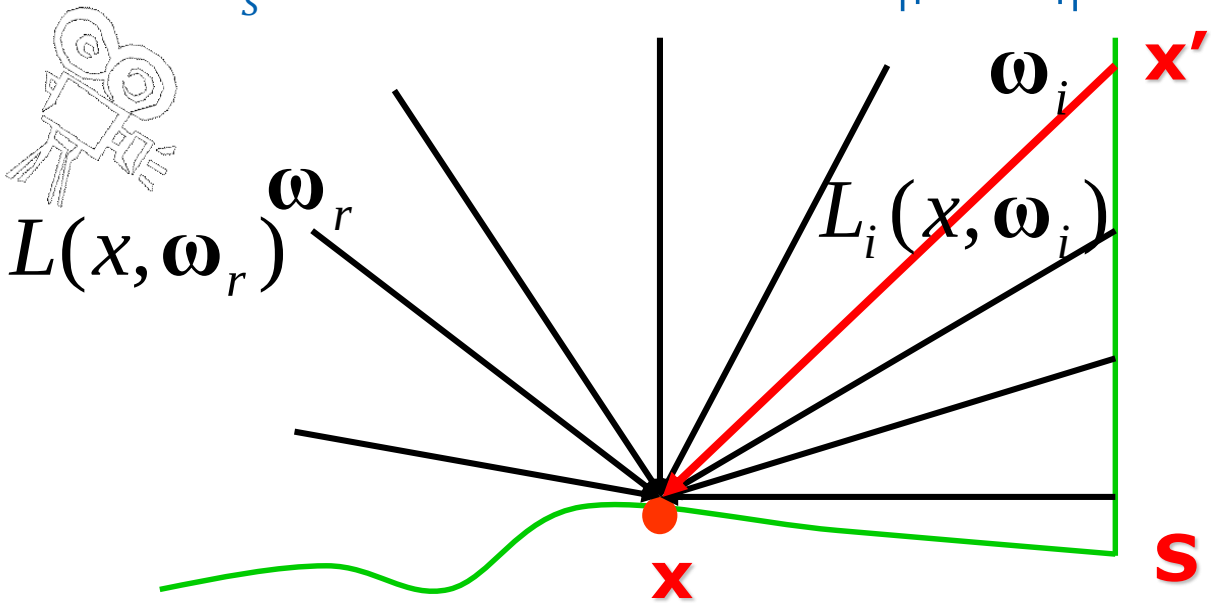


Rendering Equation

[Kajiya 86]

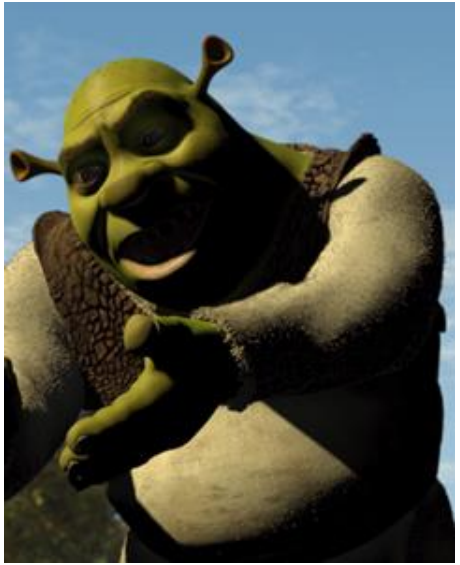
Area formulation

$$L_r(x,\omega_r) = L_e(x,\omega_r) + \int_S f_r(x,\omega_i,\omega_r)\, L_i(x,x' \to x)\, \frac{V(x,x')\cos\theta_i \cos\theta'}{\left|\left|x - x'\right|\right|^2}\, dA'$$

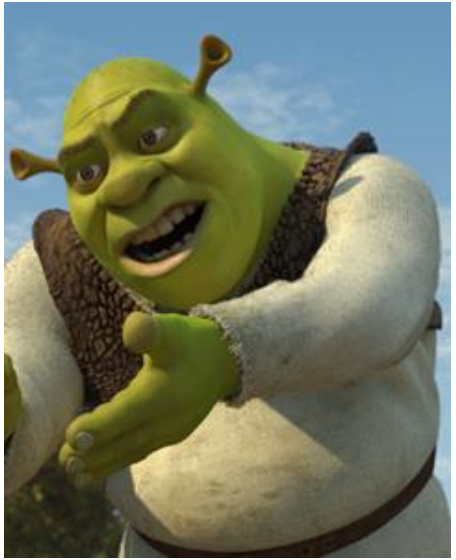


Global Illumination – GI

- ***Only direct illumination***
  - Light bounces ONCE on path from light source to camera



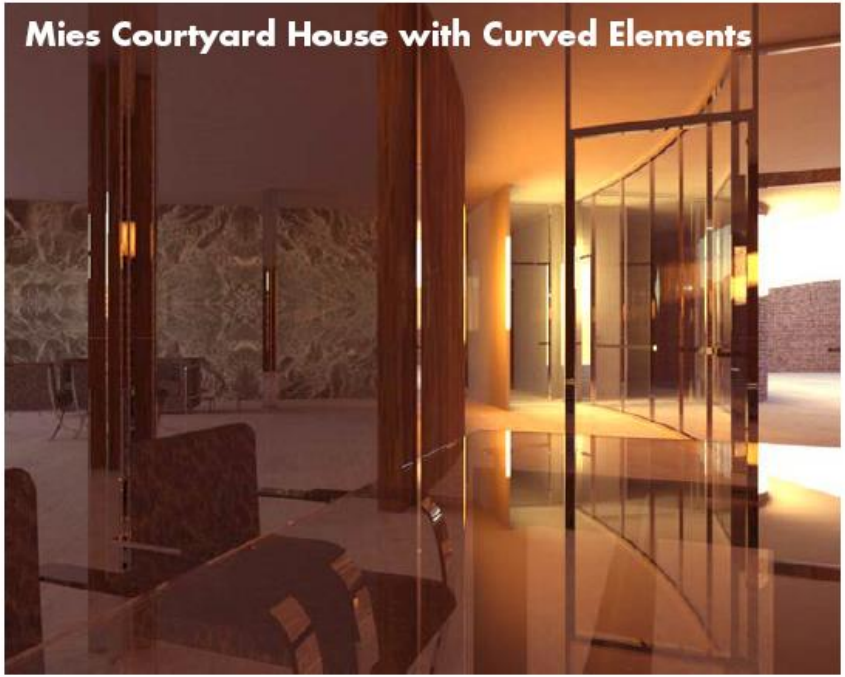
Images © PDI/Dreamworks



- ***Global illumination***
  - Global = Direct + Indirect
  - Light transport among scene patches
  - Many light bounces

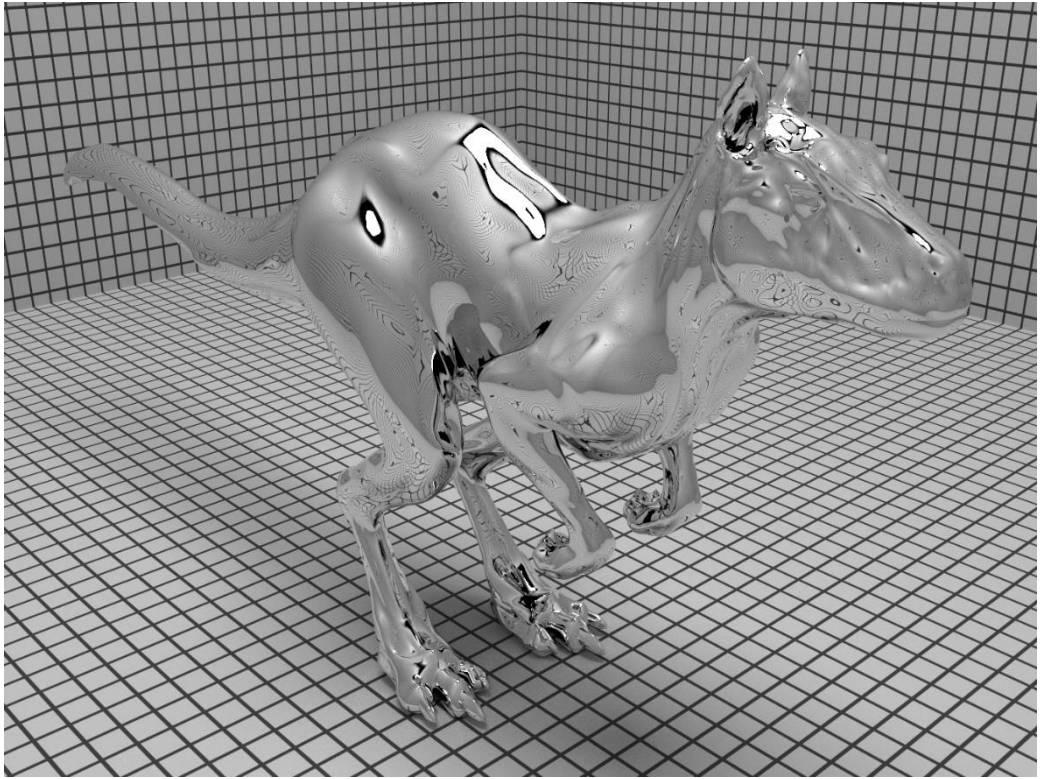
Global Illumination Effects

- Ideal reflection/refraction
- Color bleeding
- Caustics



Modeling: Stephen Duck; Rendering: Henrik Wann Jensen

Ideal Specular Reflection

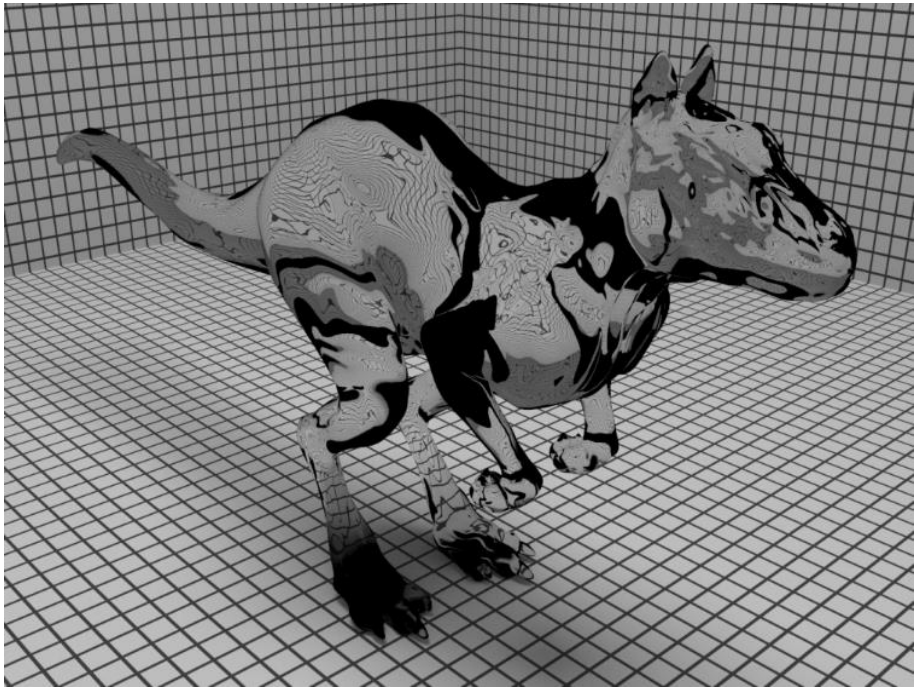


Reflection on Water Surface

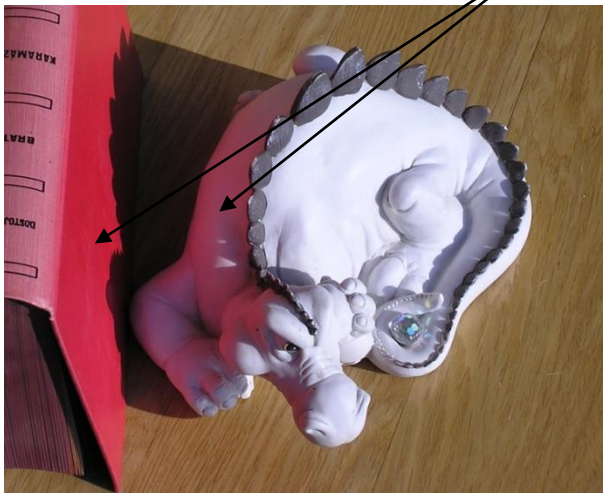
Smooth Water Surface

Wavy Water Surface

Ideal Specular Refraction



Color Bleeding



- From one diffuse surface to another
- Important in painting
  - subconscious understanding of spatial relationships

Caustics

1. Light concentration due to reflection/refraction
2. Local increase of light intensity
3. Incidence with diffuse surface

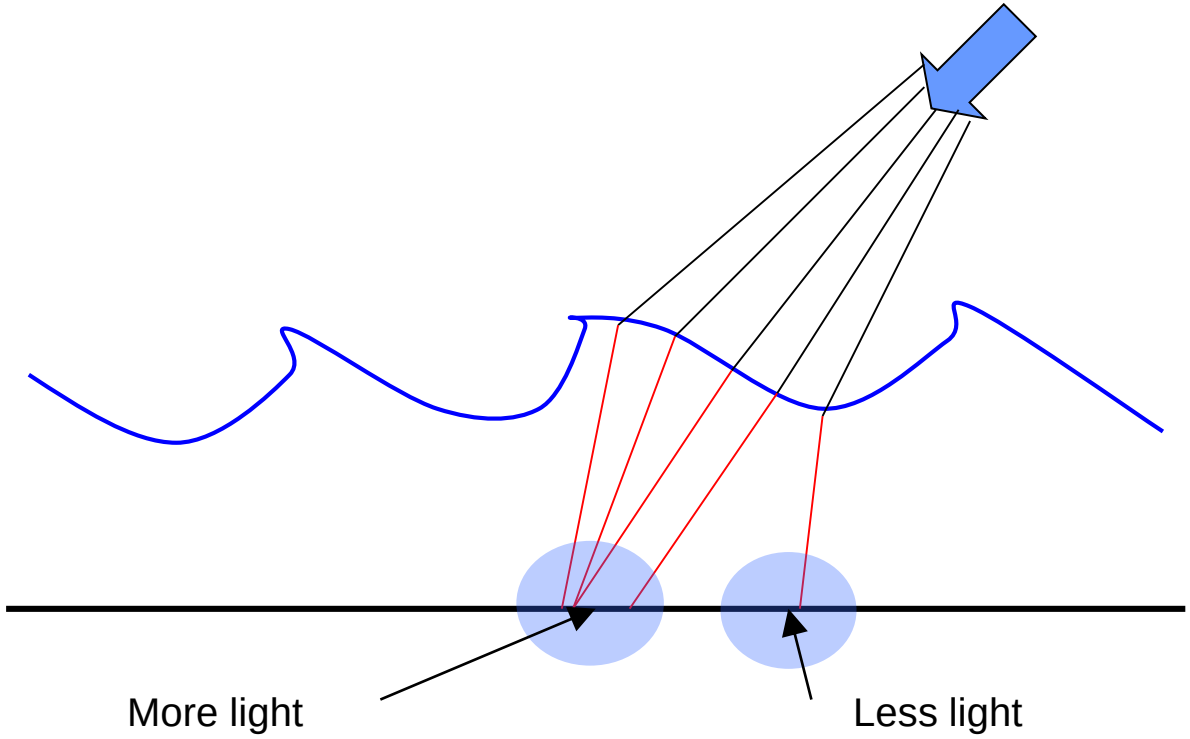
reality

simulation

Rendering Water

- Reflection/refraction on water surface
- Caustics on the pool bottom

Underwater Caustics



Global Illumination Simulation

- We need
  - Description of “amount of light” in space – *radiometry*
  - Description of light reflection on surface – *BRDF*
  - Description of stationary light distribution – *rendering equation*
  - Efficient algorithms!
- Details in Realistic Image Synthesis (A4M39RSO)

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Questions?