



**DCGI**

**KATEDRA POČÍTAČOVÉ GRAFIKY A INTERAKCE**

# Photorealism

Jiří Bittner

# Outline

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- Introduction
- Photorealistic rendering

MPG 15.1-15.7

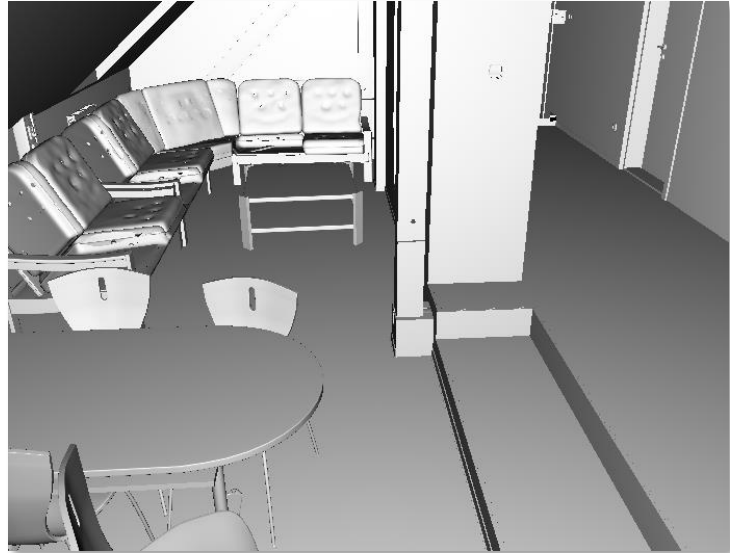
# Rendering - Introduction

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- 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)

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- 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

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



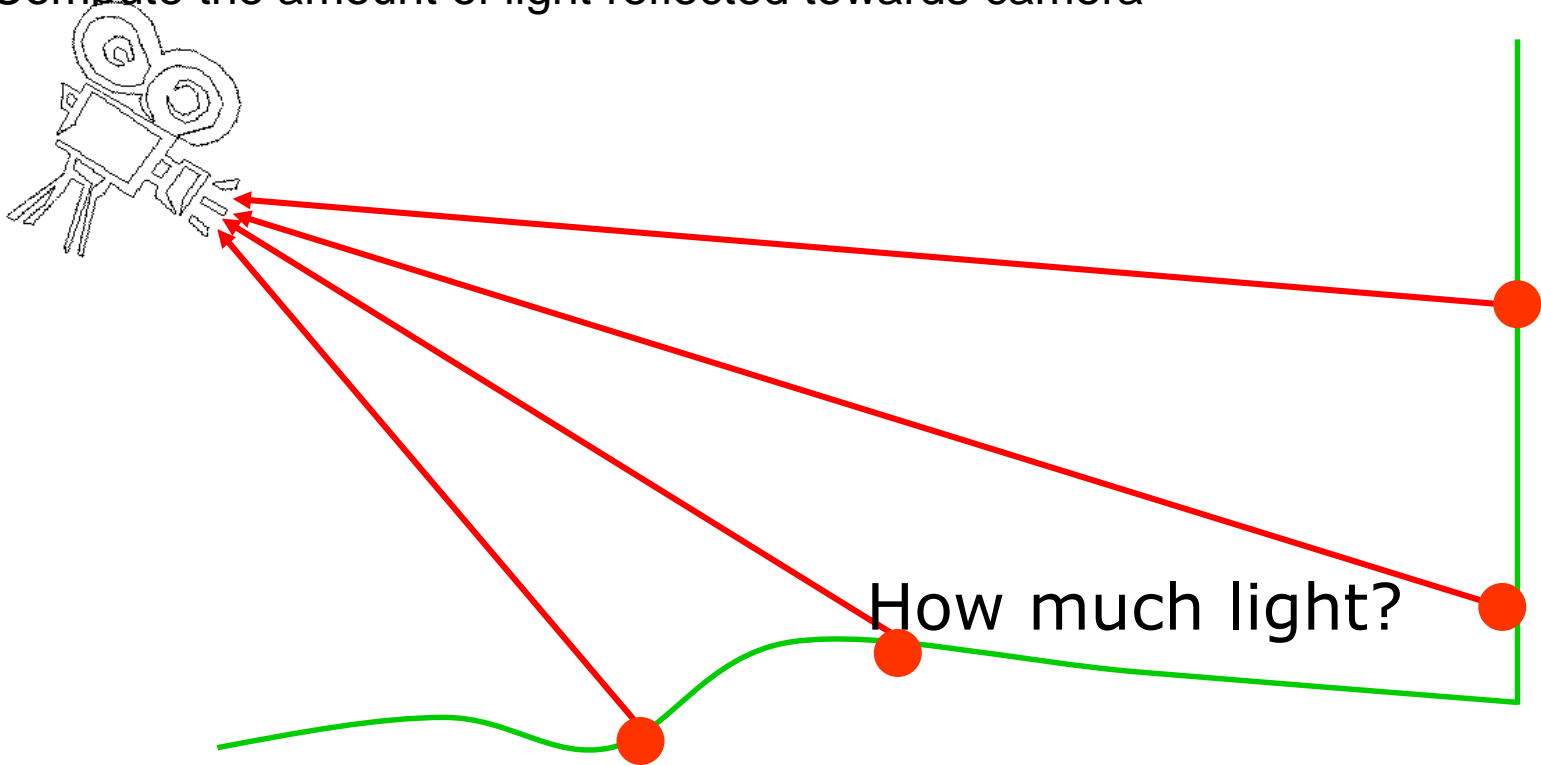
- *Photorealistic rendering*
  - *Goals: images match reality*
  - Simulation of light transport
  - **Our topic**



# Photorealistic Rendering

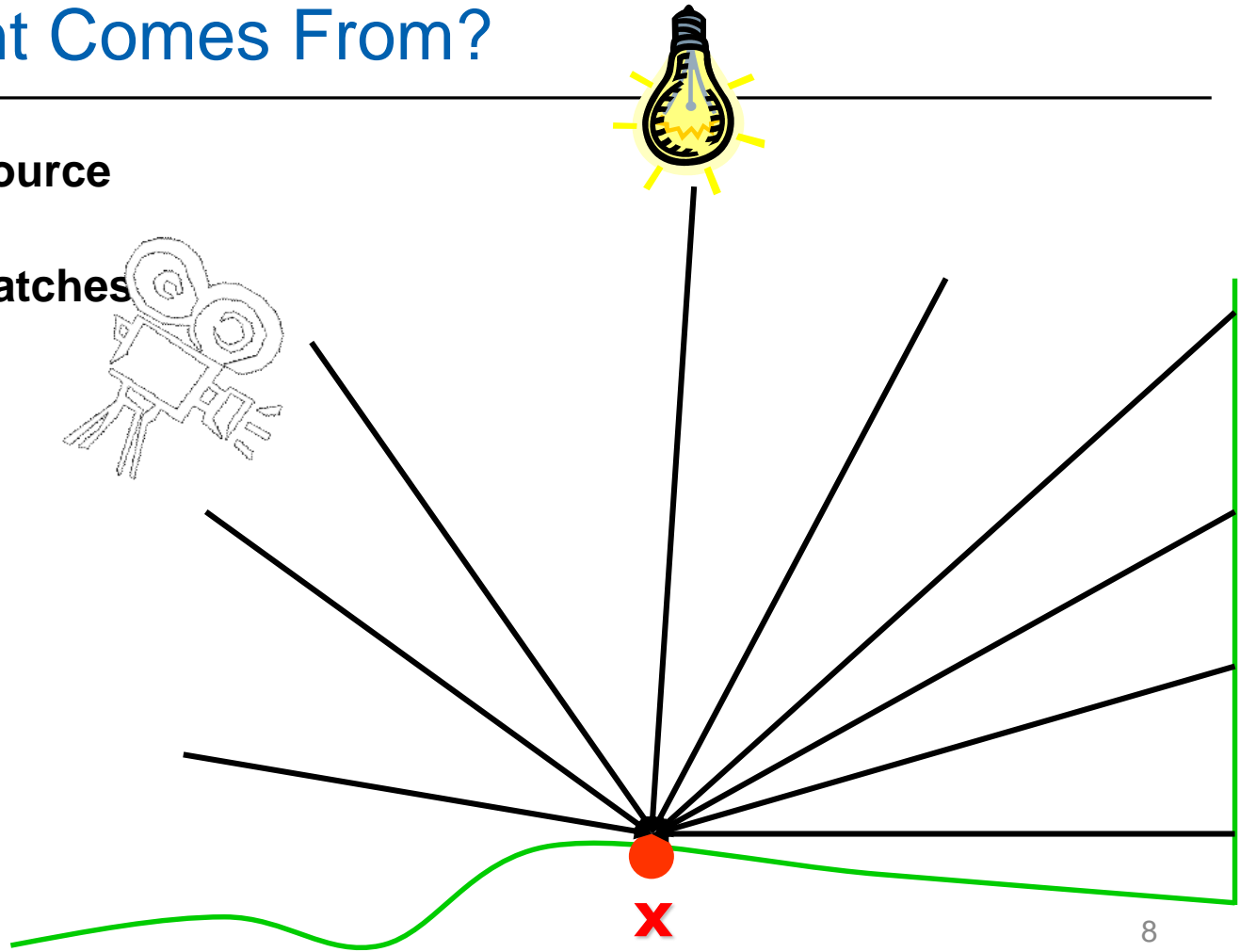
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- For every visible point  $\mathbf{p}$  in the scene
  - Compute the amount of light reflected towards camera



# Where the Light Comes From?

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



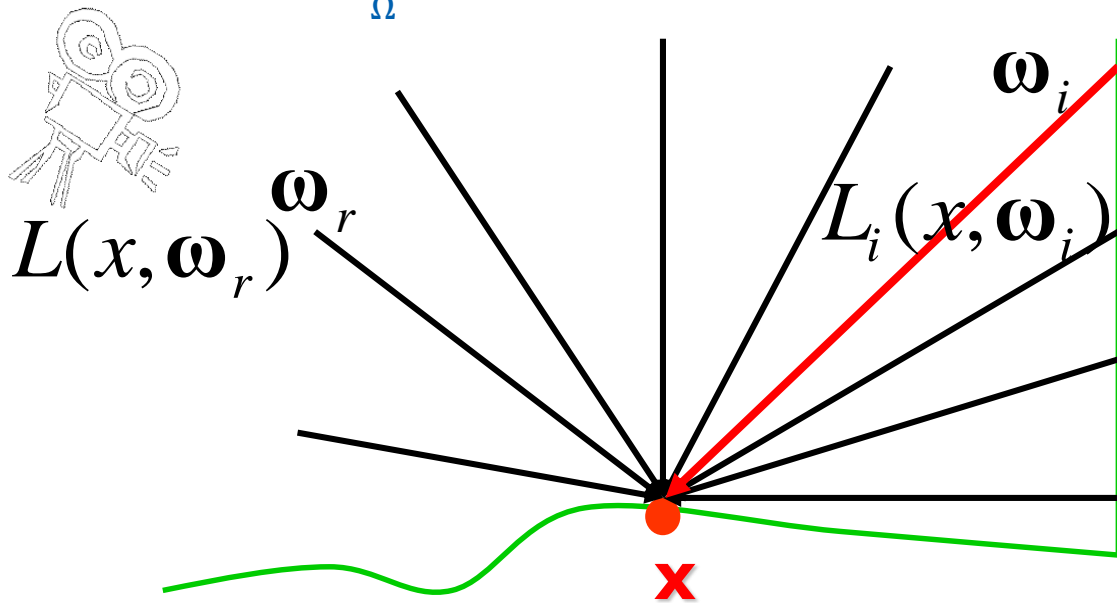


# Rendering Equation

[Kajiya 86]

## Hemispherical formulation

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

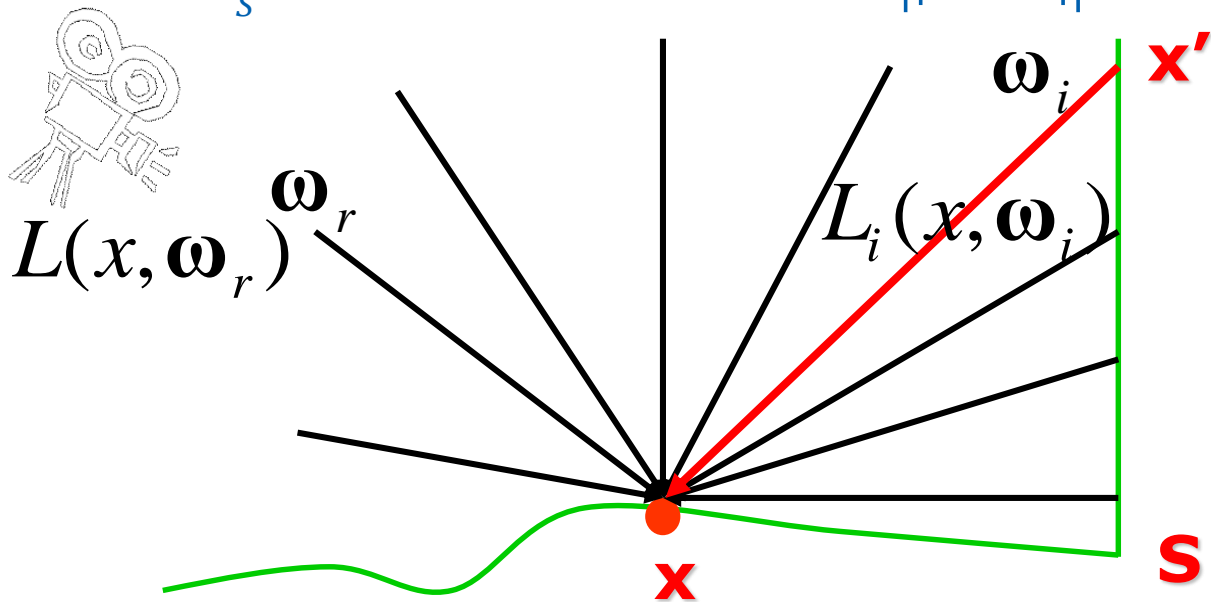


# Rendering Equation

[Kajiya 86]

## Area formulation

$$L_r(x, \omega_r) = L_e(x, \omega_r) + \int_S f_r(x, \omega_i, \omega_r) L_i(x, x' \rightarrow x) \frac{V(x, x') \cos \Phi_i \cos \Phi'}{\|x - x'\|^2} dA'$$

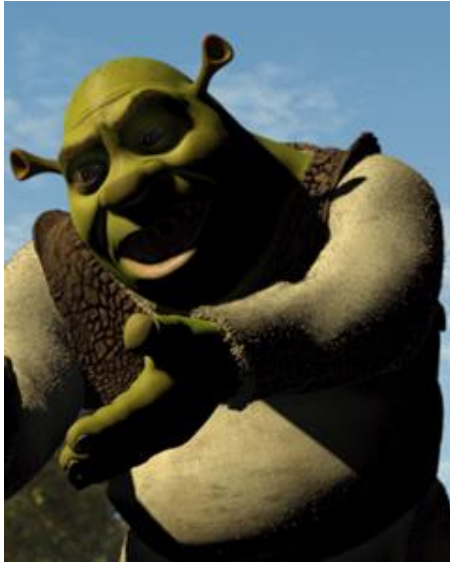


# Global Illumination – GI

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- **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

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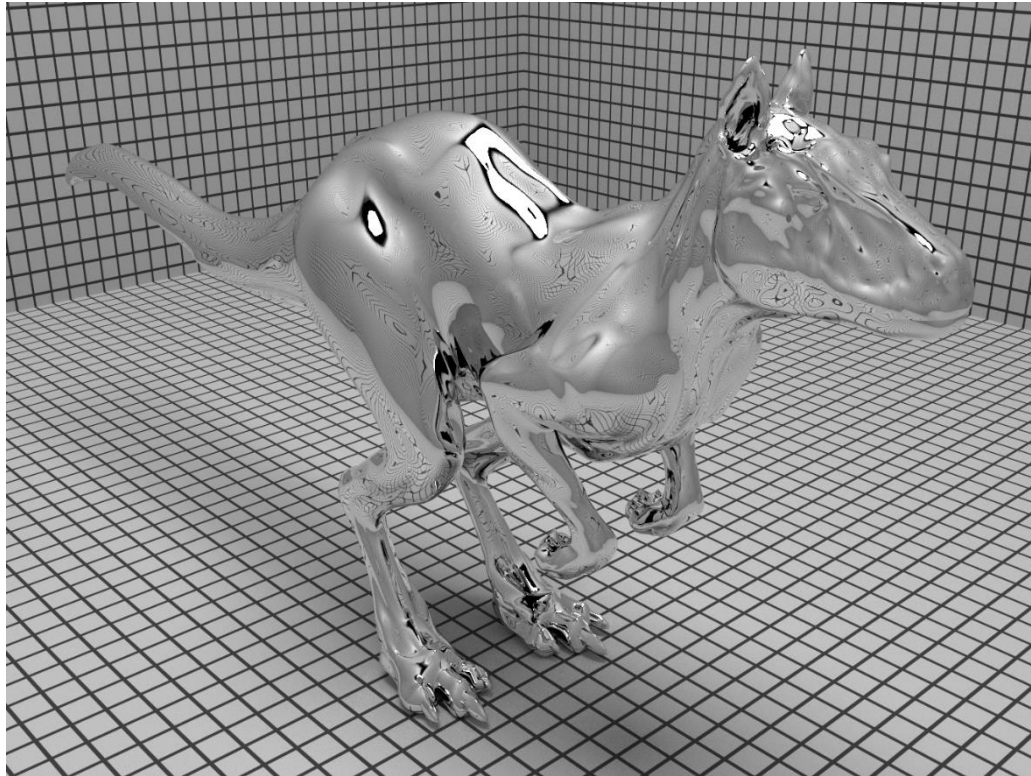
- Ideal reflection/refraction
- Color bleeding
- Caustics



**Modeling: Stephen Duck; Rendering: Henrik Wann Jensen**

# Ideal Specular Reflection

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# Reflection on Water Surface

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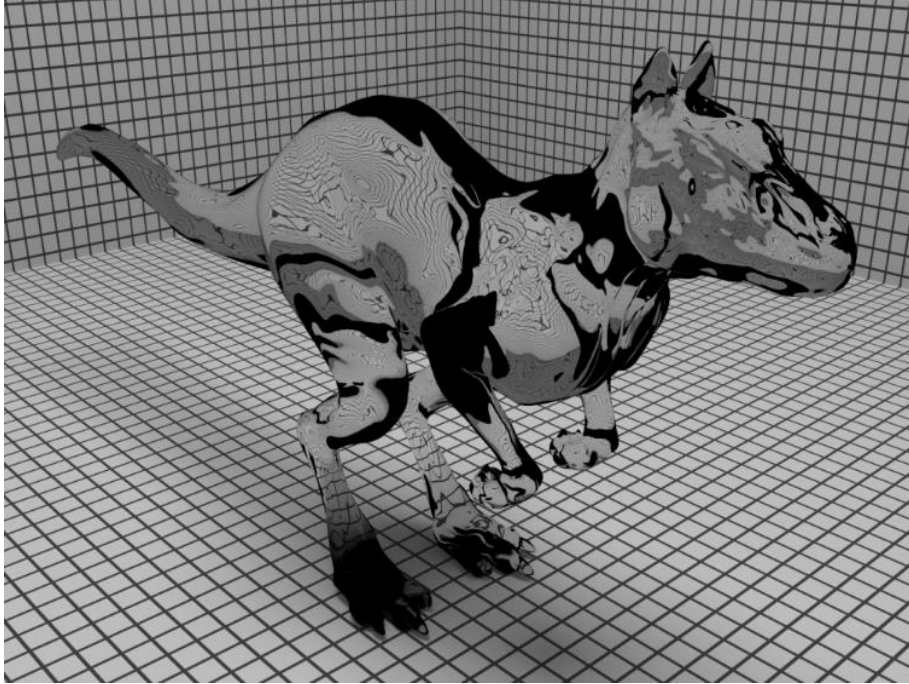
**Smooth Water Surface**



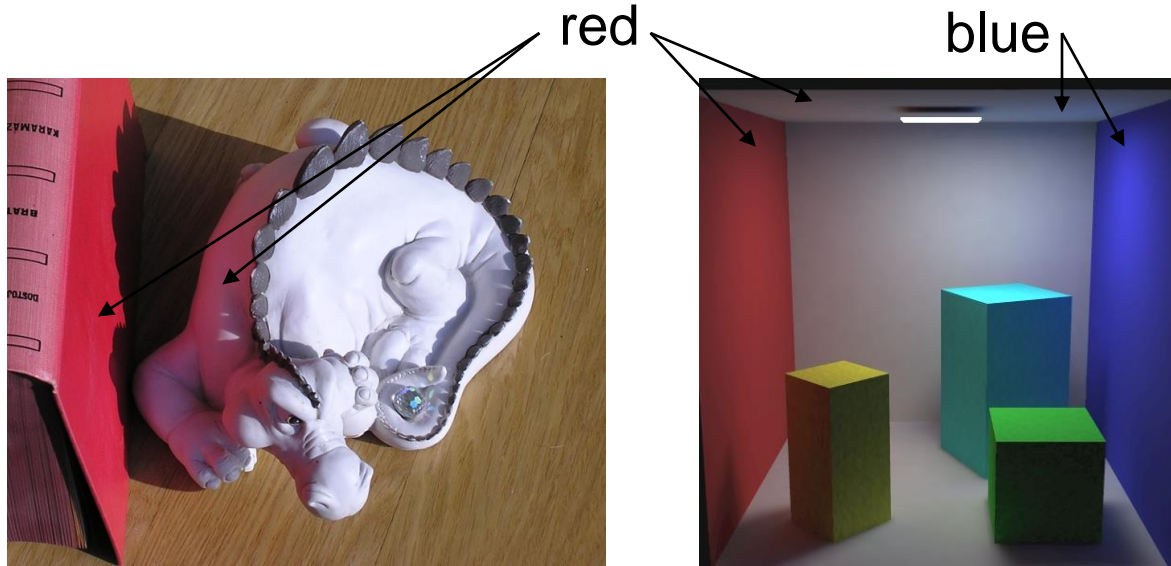
**Wavy Water Surface**

# Ideal Specular Refraction

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# Color Bleeding



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



# Caustics

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



reality



simulation

# Rendering Water

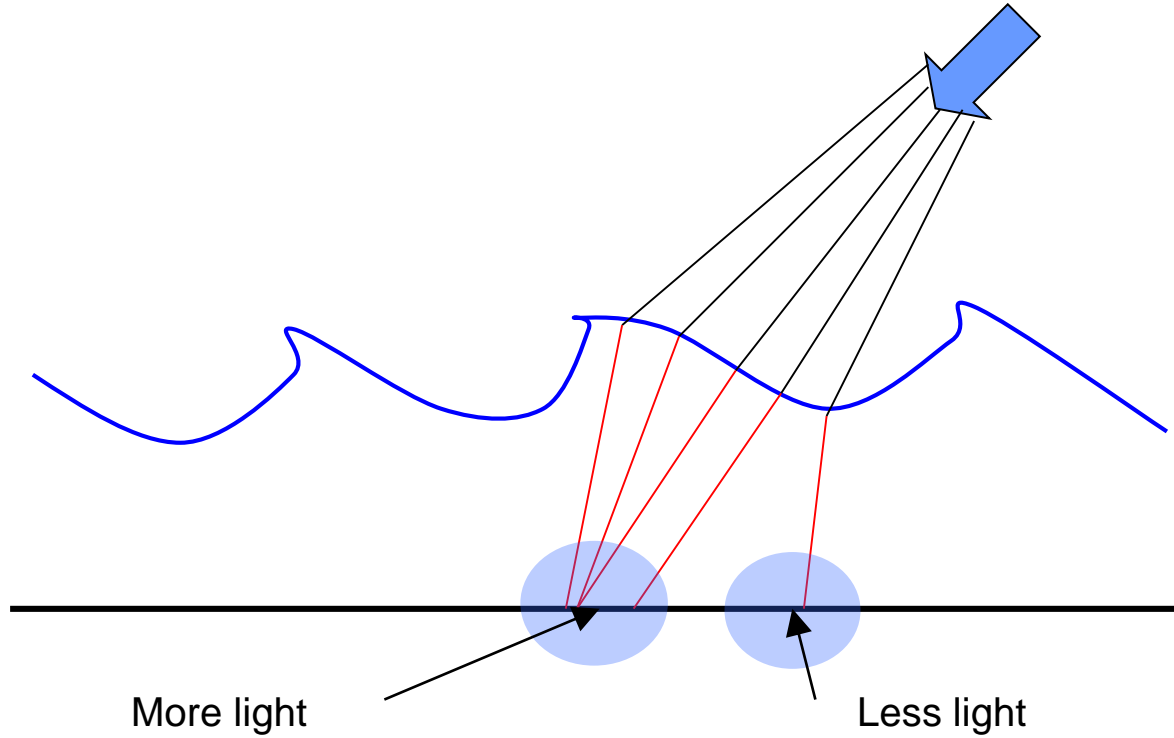
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- Reflection/refraction on water surface
- Caustics on the pool bottom



# Underwater Caustics

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# Global Illumination Simulation

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- 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?