

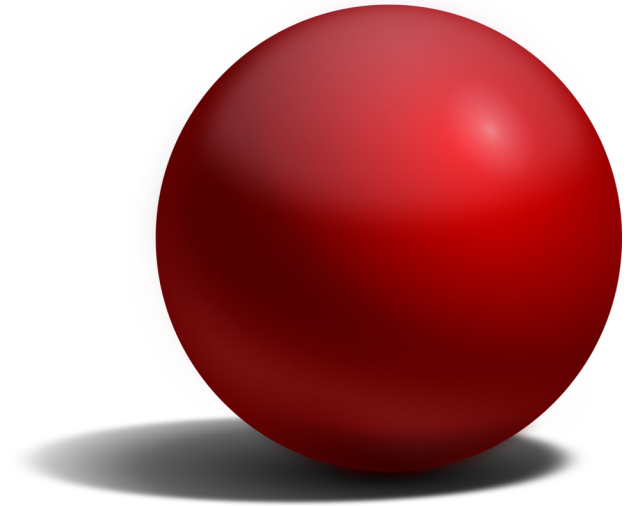
A scenic landscape featuring a river flowing through a valley, with mountains in the background under a sunset sky. The sun is low on the right side, casting a warm glow over the scene. The foreground shows a rocky riverbed with some water pools.

# Ray Tracing

Autor: Tin Švigelj

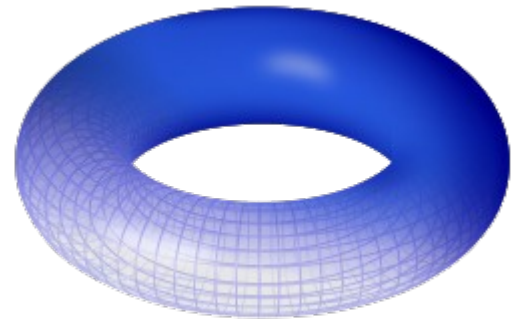
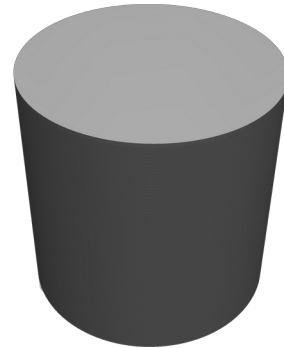
# Temelji

- P. W. Ford - 1959. - New Ray Tracing Scheme
  - Aksijalno simetrična leća
  - Sferični predmeti
  - Izračun u polarnom koordinatnom sustavu
  - 0.5s po zraci



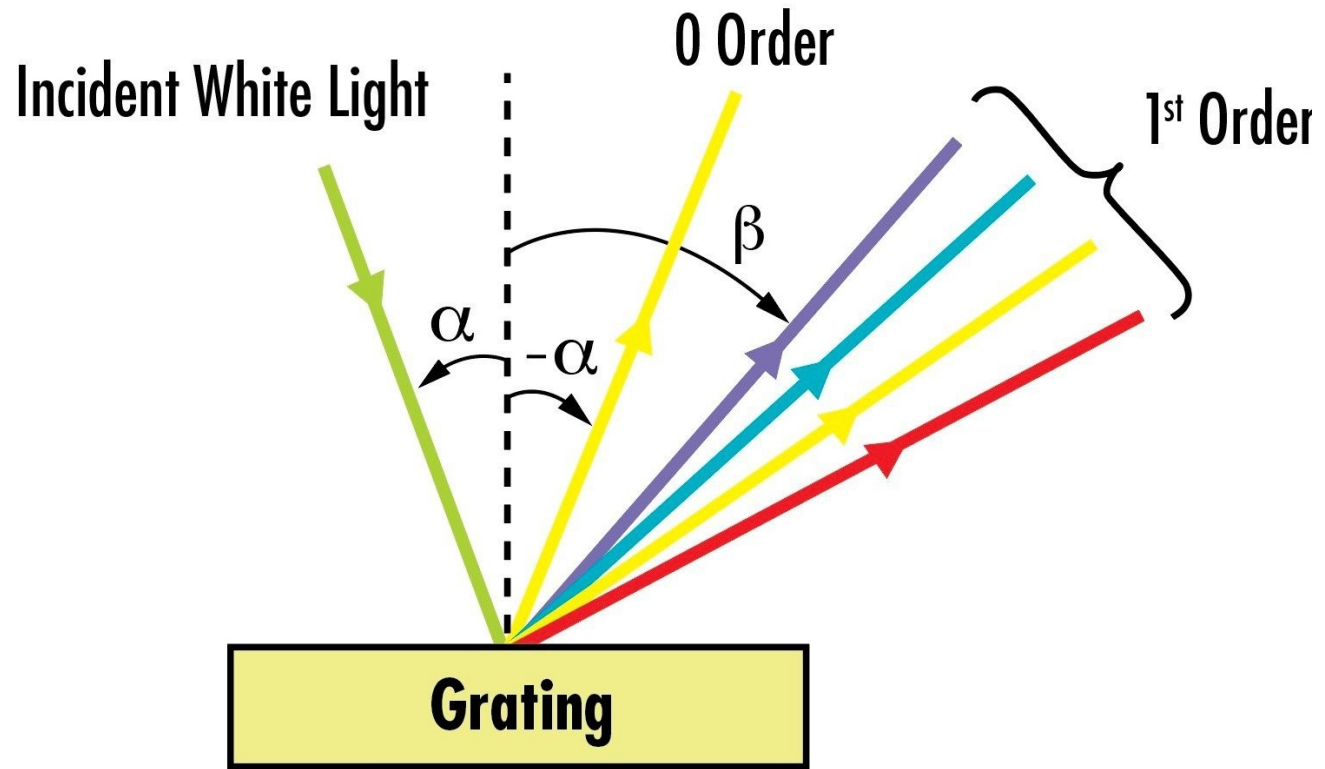
# Temelji

- G. H. Spencer & M. V. R. K. Murty - 1962. -  
General Ray-Tracing Procedure
  - Cilindrične i torusne površine
  - Vektorizacija defrakcije
  - Arbitrarna orijentacija  
i pozicija



# Temelji

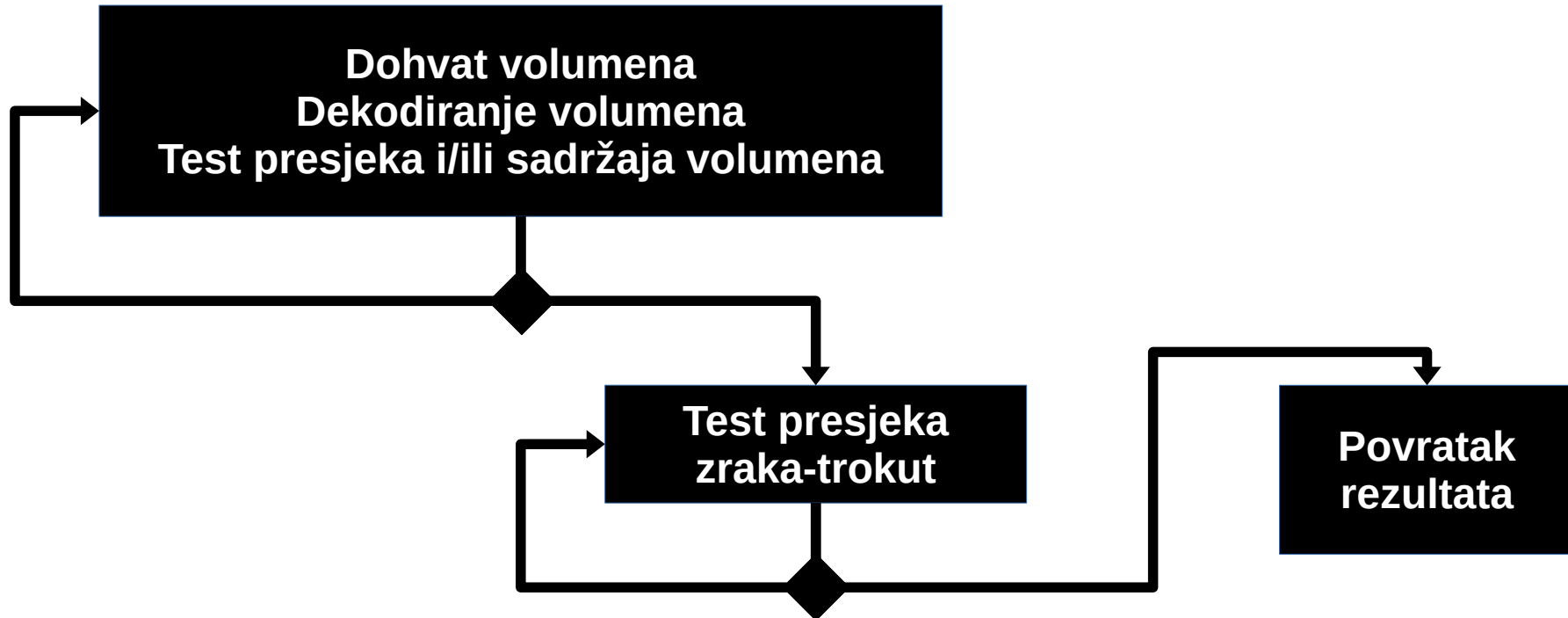
Defrakcija



# Temelji

- Siggraph i ACM – 1986.
  - Modernizacija, generalizacija
  - Heckbert, P. S., Hanrahan – 1984. – Poligonske površine
  - Toth, D. L. – 1985. – Parametarske površine
  - James Arvo – 1986. – Unazadno koračanje zrakama
  - Kay, T. L., Kajiya J. – 1986. – Složene scene
  - 30+ drugih

# Specijalizacija komercijalne hardverske potpore



# Specijalizacija komercijalne hardverske potpore

VK\_KHR\_ray\_tracing\_pipeline

Naredbe

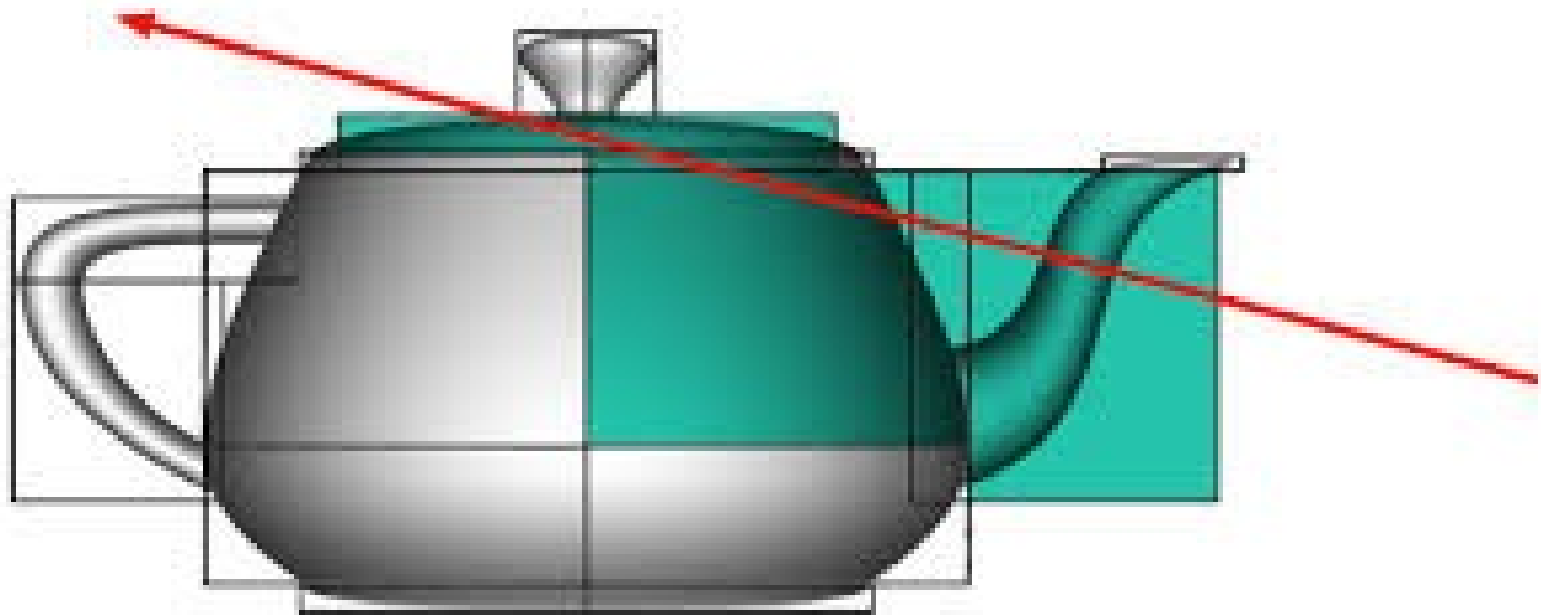
- vkCmdSetRayTracingPipelineStackSizeKHR
- vkCmdTraceRaysIndirectKHR
- vkCmdTraceRaysKHR
- vkCreateRayTracingPipelinesKHR
- vkGetRayTracingCaptureReplayShaderGroupHandlesKHR
- vkGetRayTracingShaderGroupHandlesKHR
- vkGetRayTracingShaderGroupStackSizeKHR

# Specijalizacija komercijalne hardverske potpore

VK\_KHR\_ray\_tracing\_pipeline

Strukture

- `VkRayTracingPipelineCreateInfoKHR`
- `VkRayTracingPipelineInterfaceCreateInfoKHR`
- **`VkRayTracingShaderGroupCreateInfoKHR`**
- `VkStridedDeviceAddressRegionKHR`
- **`VkTraceRaysIndirectCommandKHR`**
- Proširuje `VkPhysicalDeviceFeatures2`, `VkDeviceCreateInfo`:
  - `VkPhysicalDeviceRayTracingPipelineFeaturesKHR`
- Proširuje `VkPhysicalDeviceProperties2`:
  - `VkPhysicalDeviceRayTracingPipelinePropertiesKHR`



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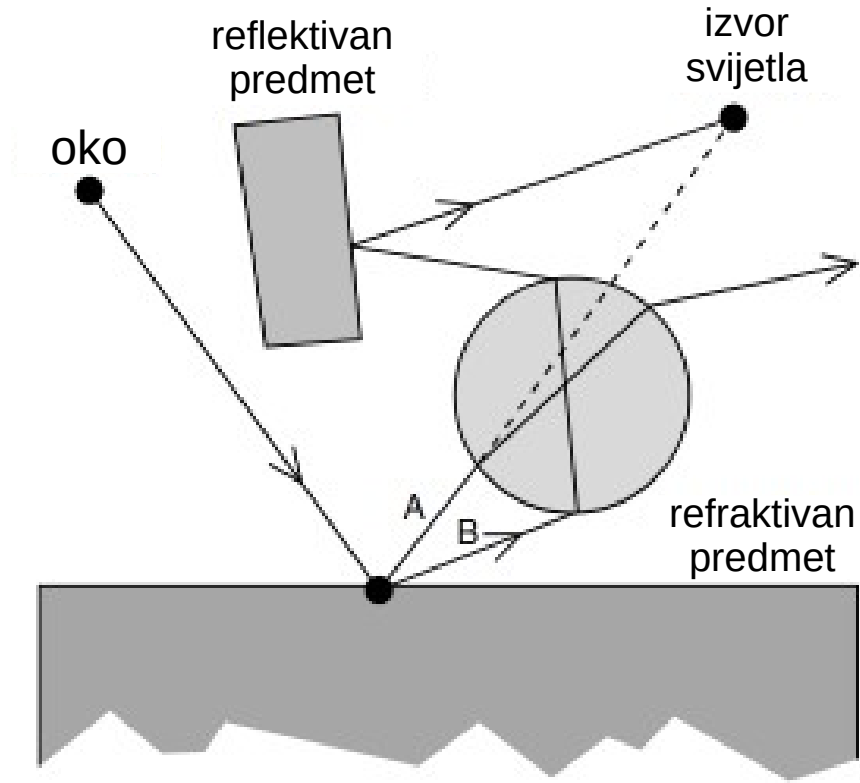
# Vrste svijetla

- Točkasto (engl. *point light*)
  - Usmjereno  
(engl. *directional light*)
  - Ambijentno  
(engl. *ambient light*)

# Prijenos svjetlosti

- Refleksija  
(engl. *reflection*)
- Refrakcija  
(engl. *refraction*)
- Absorpcija  
(engl. *absorption*)
- Raštrkavanje  
(engl. *scattering*)

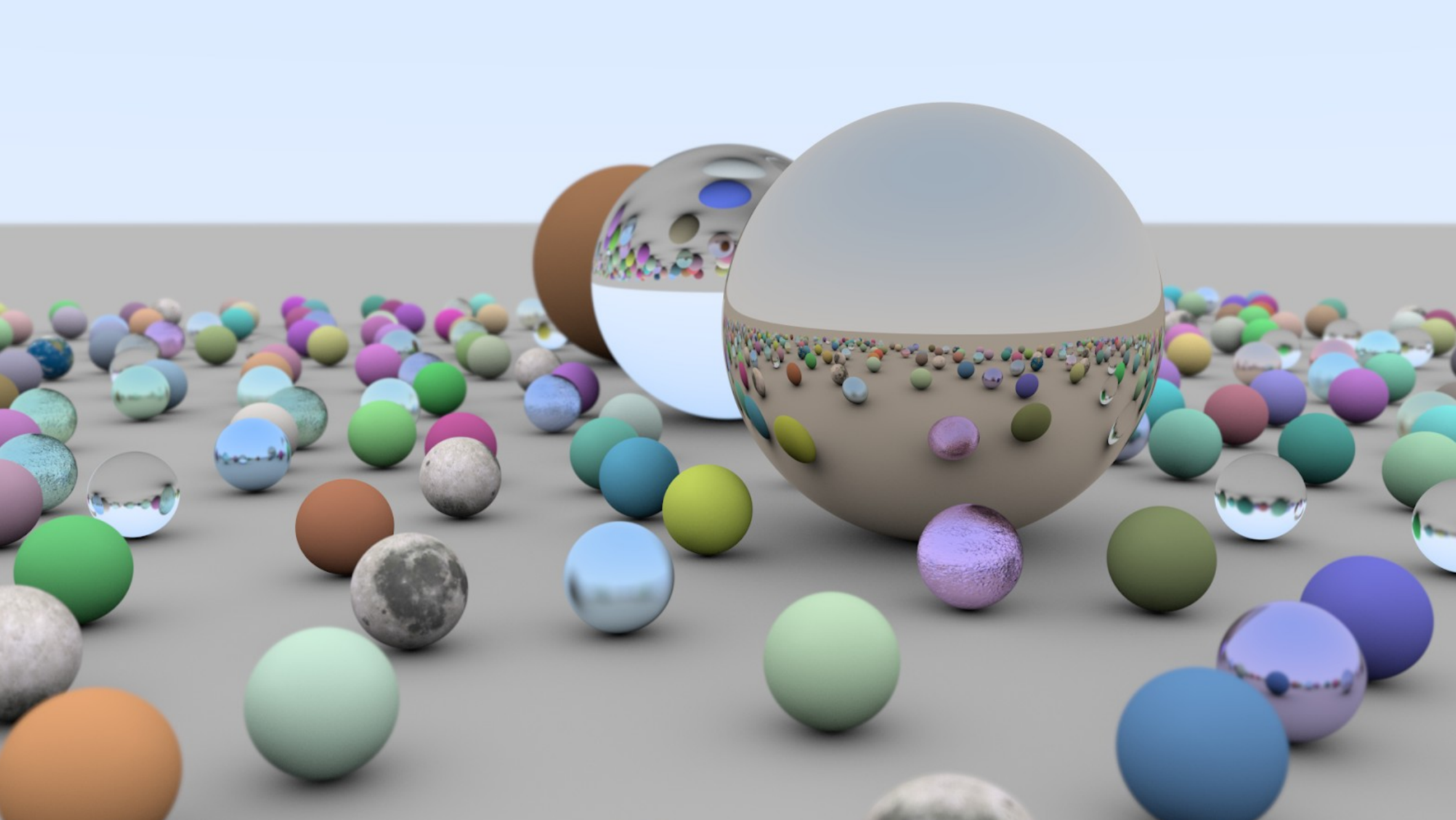
# Osnovni princip rada



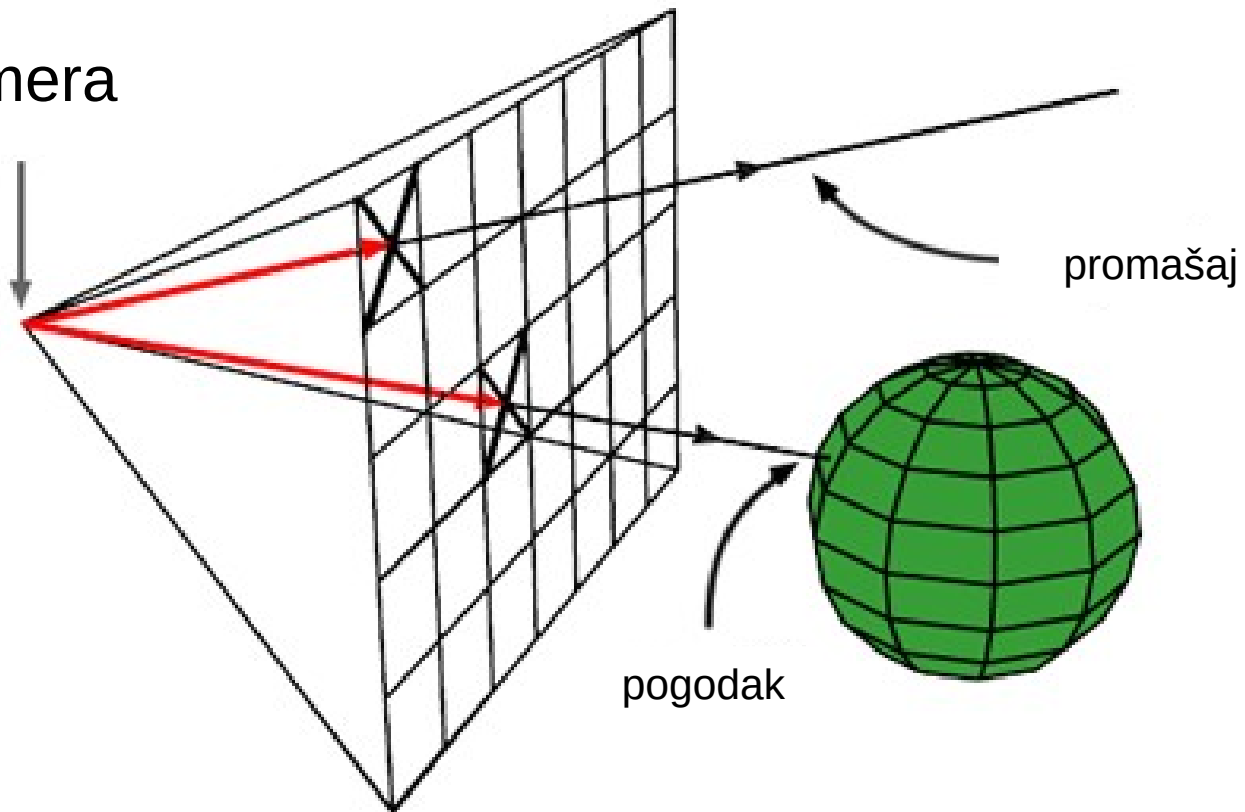
- James Arvo

# Zakonnitosti

- Snellov zakon
- Fresnelove rovnadky

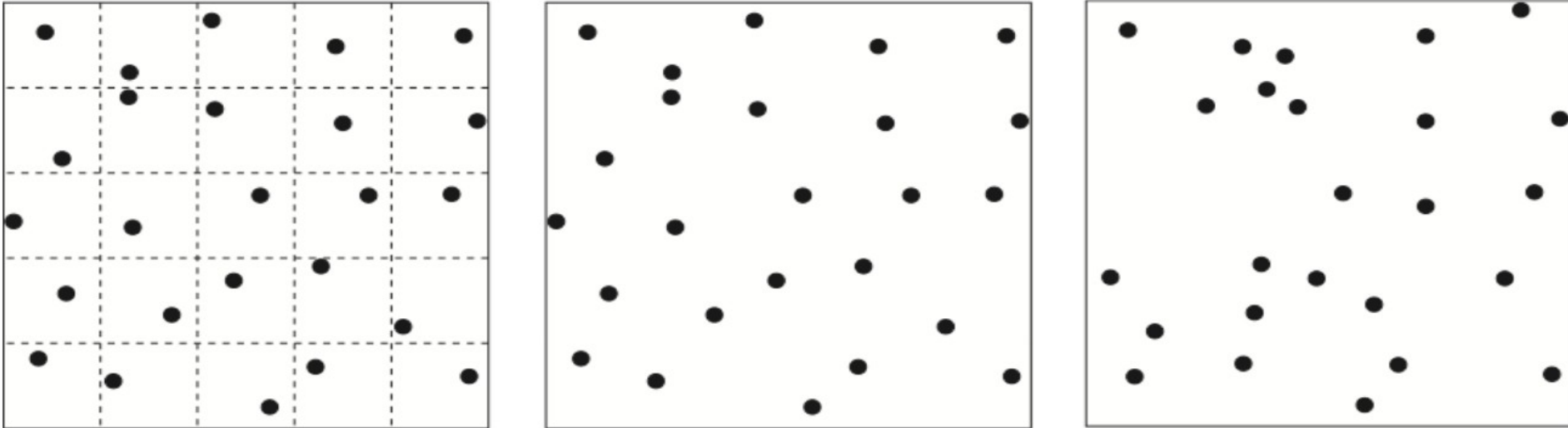


kamera



promašaj

pogodak



Suffern, (2007). Figure 04.07. [EPS image]

Available at [www.pearsoned.com](http://www.pearsoned.com) (Accessed 08 Jan 2010)

# Razlike u implementaciji

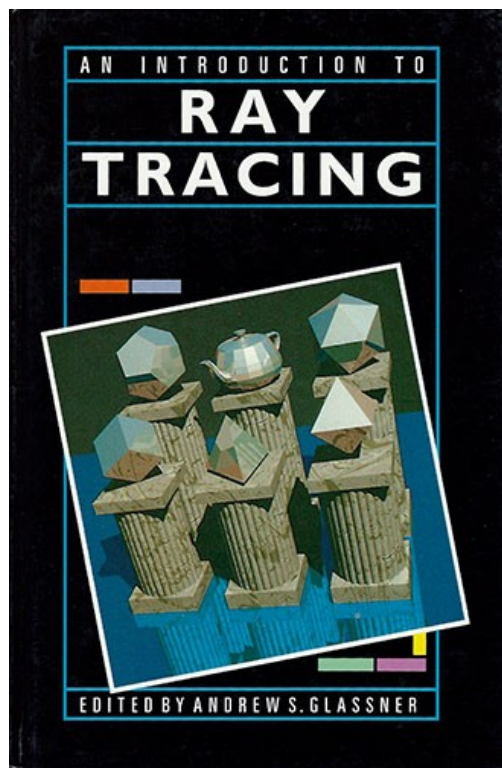
- Ambijentalna okluzija (engl. *ambient occlusion*)
- Mekane sjene (engl. *soft shadows*)
- Odrazi (engl. *reflections*) – indirektna svjetlost
- Prozirnost (engl. *transparency*)
- Globalno osvjetljenje (engl. *global illumination*, GI) (predobrada)
  - Dinamika osvjetljenja
- Ispravnost sjena za sve vrste izvora
- Dubinska oština (engl. *depth of field*, DoF)
- Kaustika (engl. *caustics*)
- Volumetrijsko osvjetljenje i magla



# Smanjenje cijene

- Prihvatanje ograničenja – stilistički izbor
- Offline prikaz
- Kombinirani grafički cjevovod – početak RX/RTXa
- Pojednostavljenja ovisna o primjeni
- Uklanjanje buke (engl. *denoising*)
- Povećanje manje slike (engl. *upscaling*)

# Izvori informacija



## **An Introduction To Ray Tracing** Andrew S. Glassner

- Temeljni detalji o teoriji, algoritmima, ...
- Vrlo jednostavno objašnjava osnove
- Malo zastarijela

# Izvori informacija



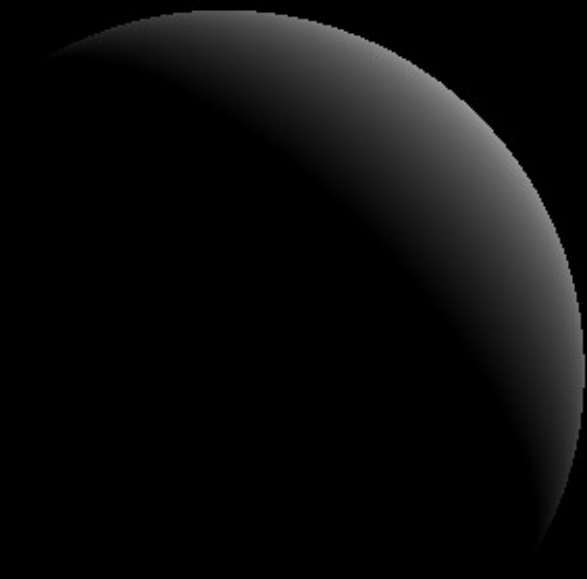
## Ray Tracing in One Weekend

Peter Shirley, Trevor D. Black, Steve Hollasch

- Objašnjenja
- C++ popratni materijali
- Besplatno



Demo



# Izvori informacija

- Znanstveni radovi
- Siggraph
- YouTube – loša gustoća informacija
- Postojeći FOSS kod
- Eksperimentiranje/nagađanje – umjetničko izražavanje