Ray Tracing

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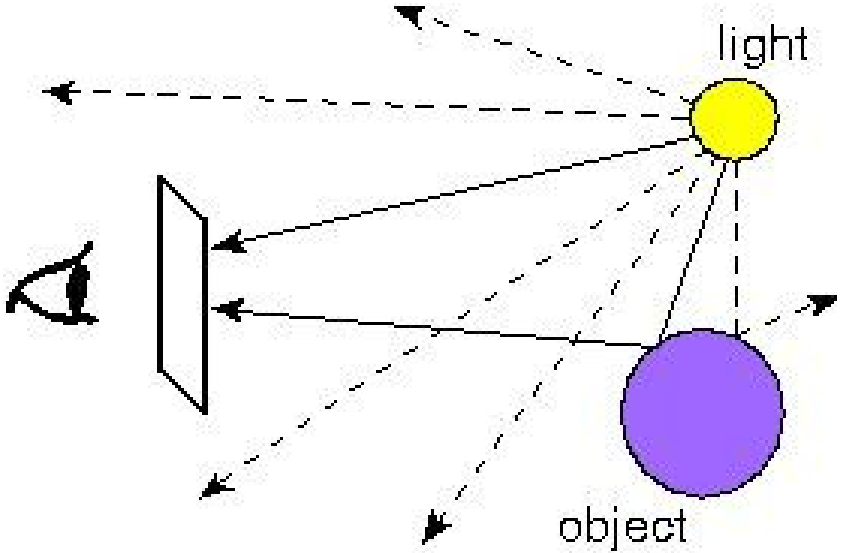
Definition

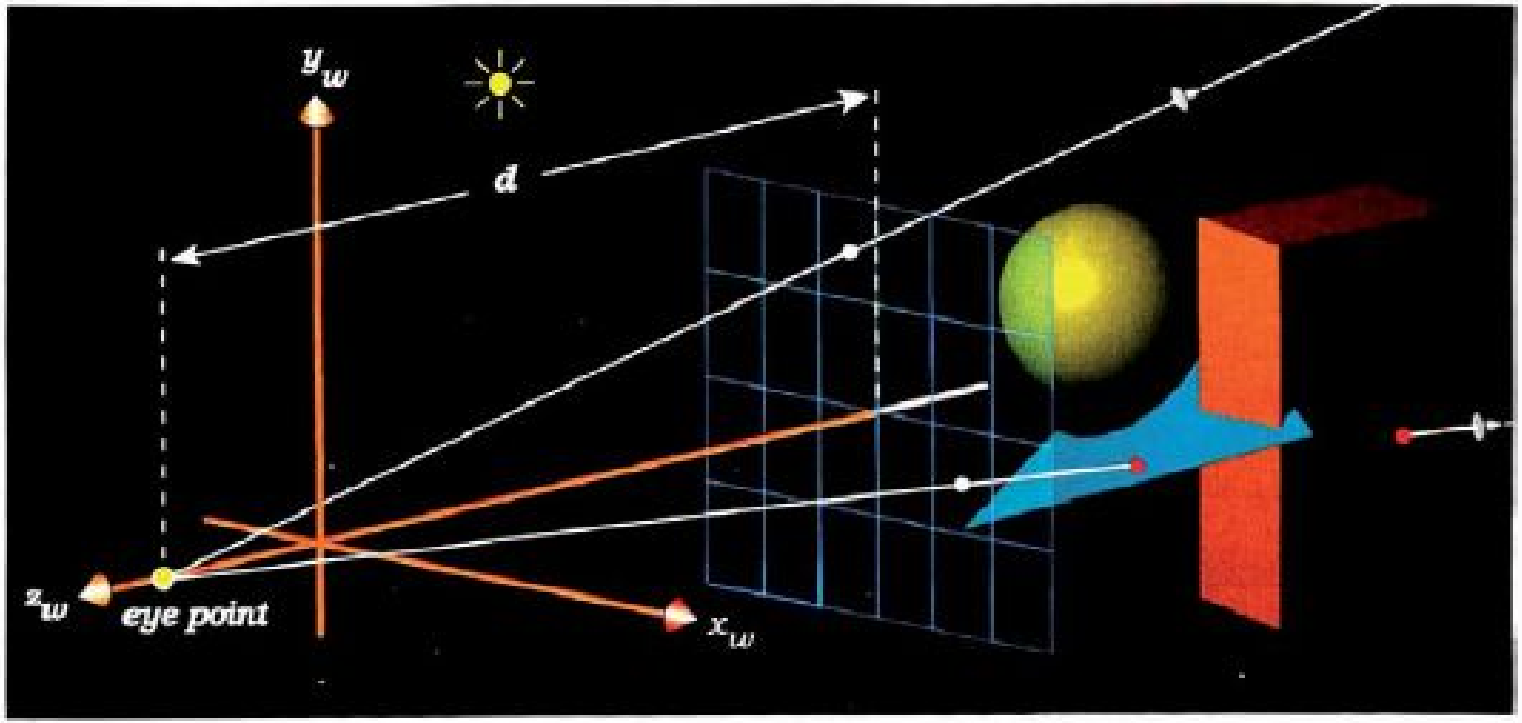
- Technique to create Computer Generated Images (CGI)
- There are many other:
  - Path Tracing (RT based)
  - Rasterization (GPUs)
  - Radiosity
  - ...

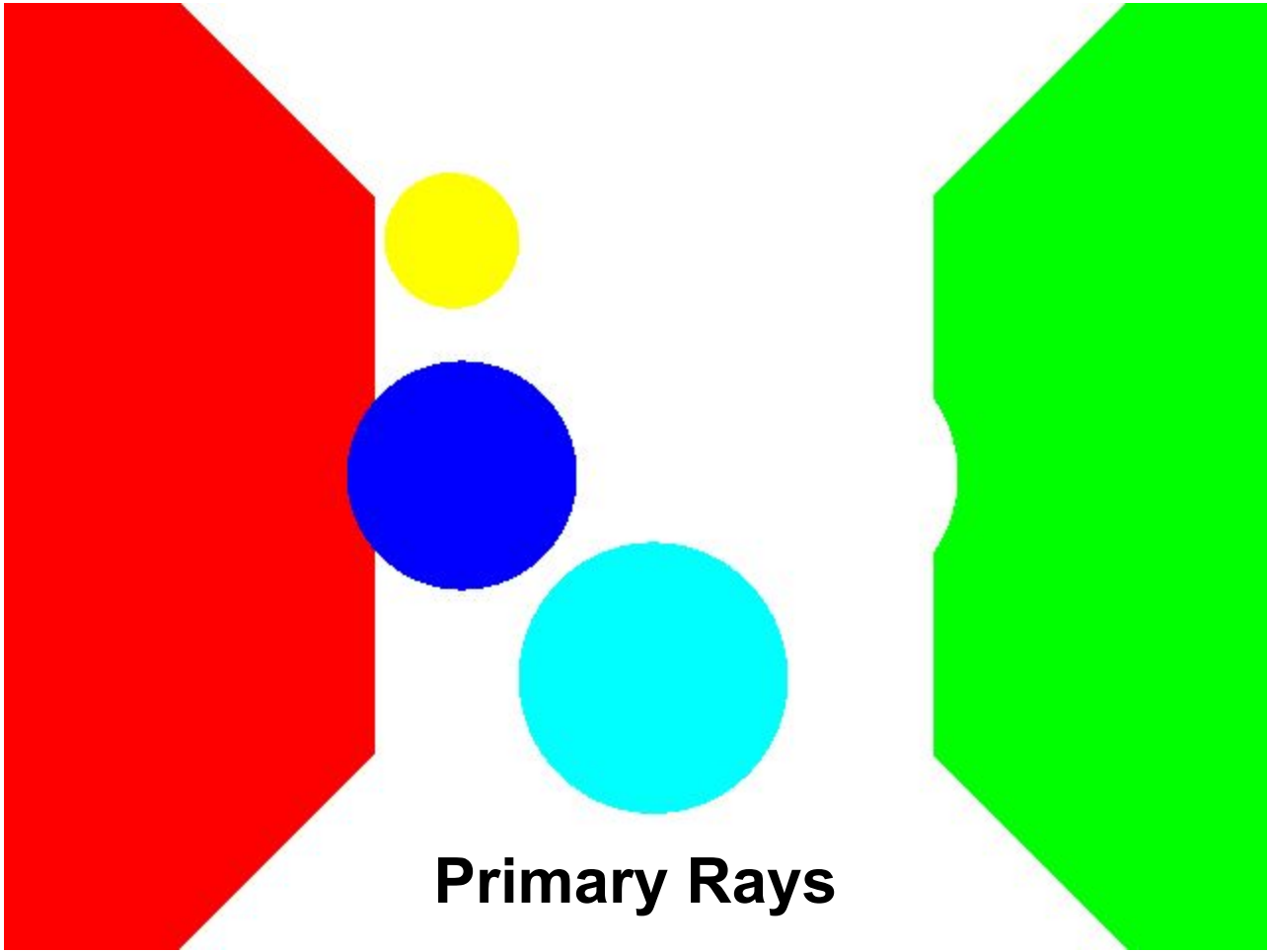
How light works

- Emit photons in all directions
- Only a small portion hit our eyes
- Very **inefficient** to simulate

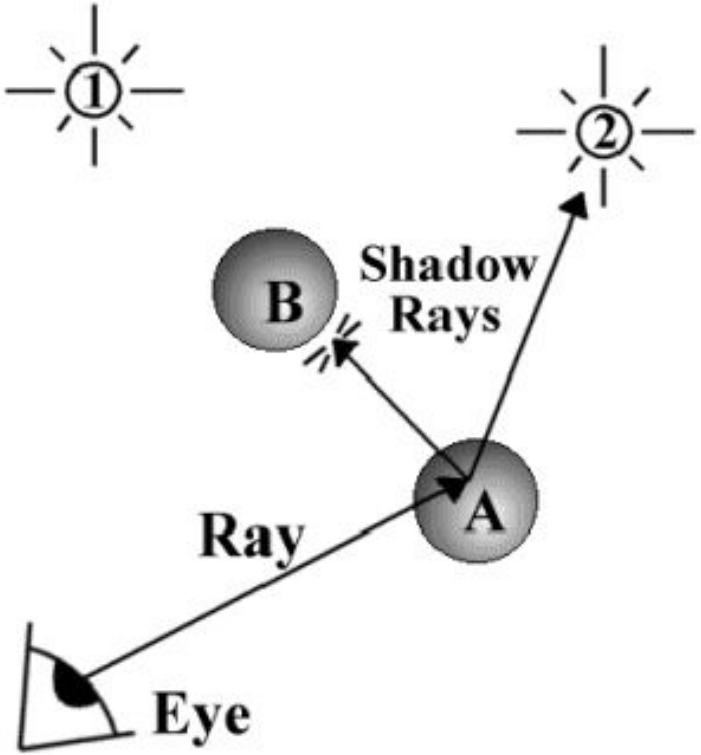


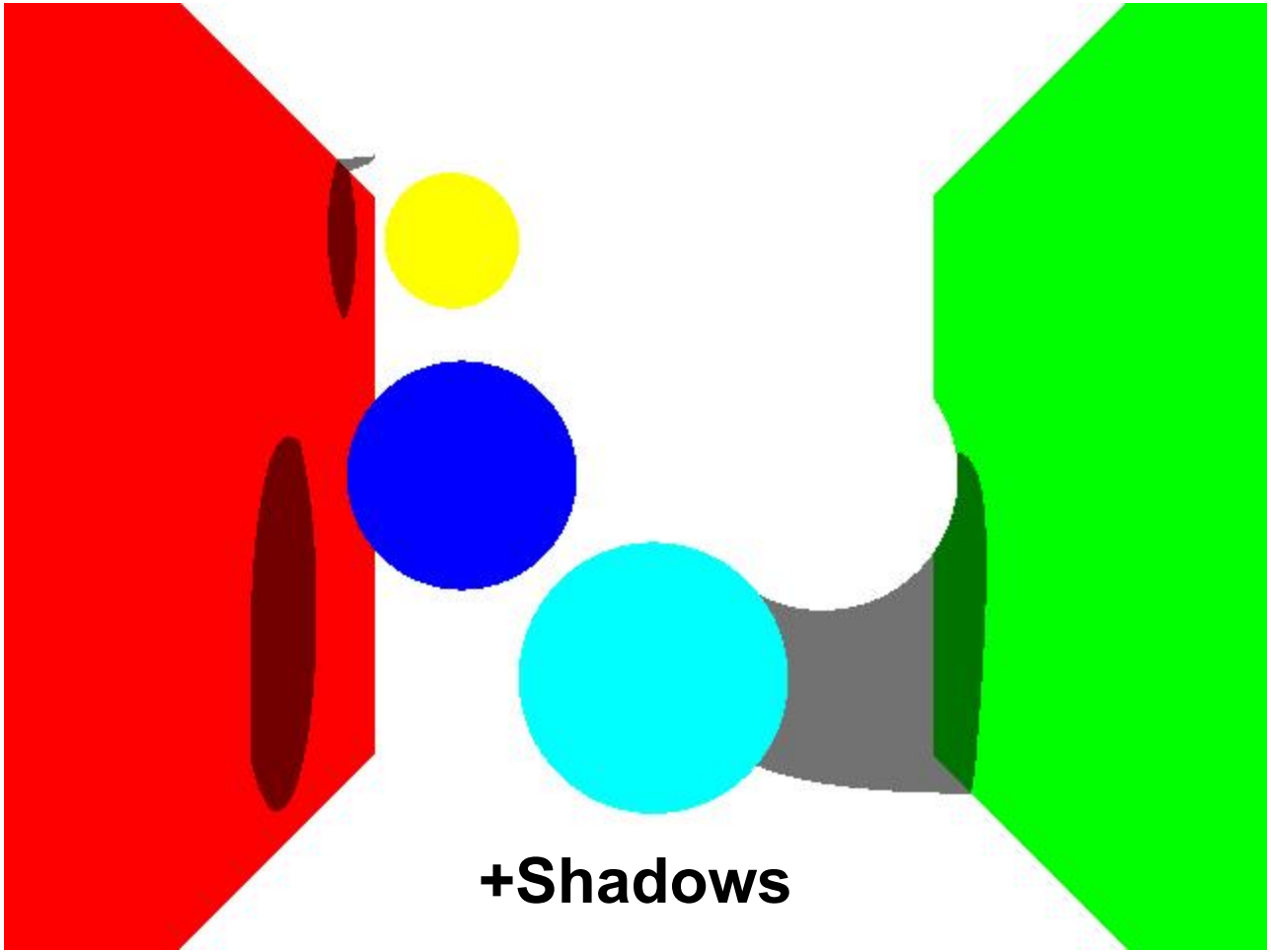
Ray Tracing (backwards): Primary rays



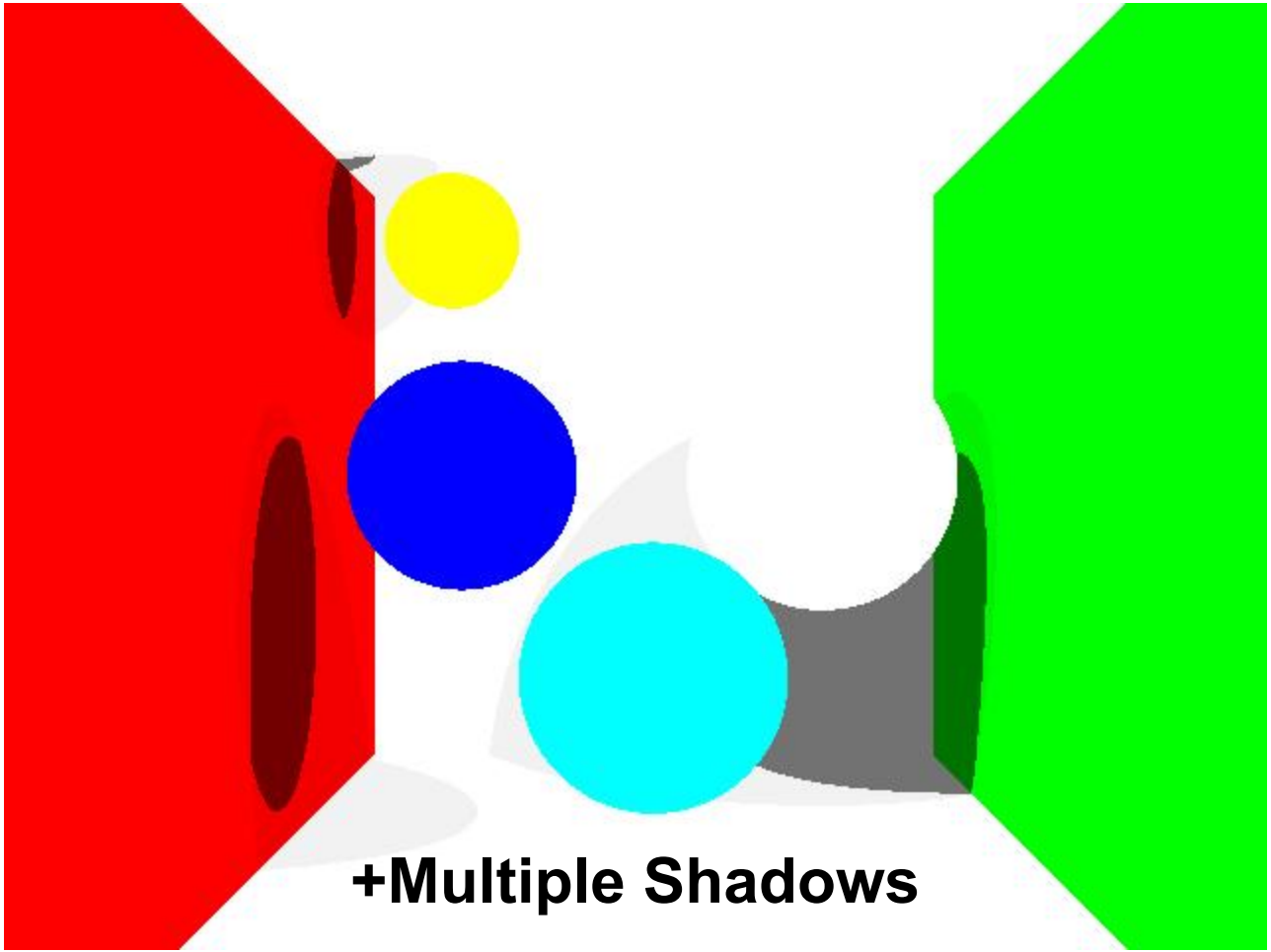

Primary Rays

Shadow Rays

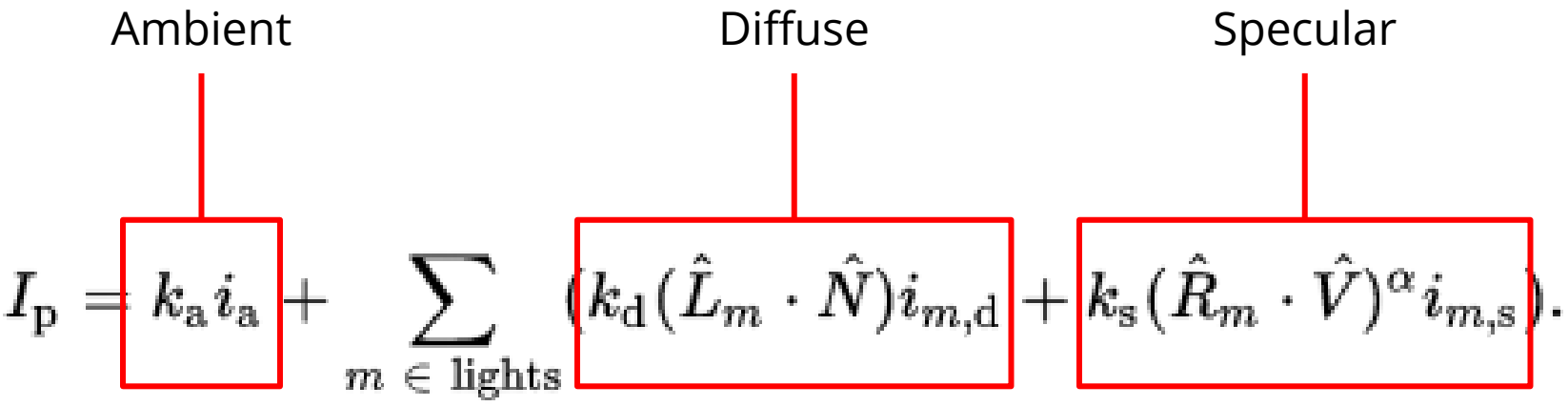



+Shadows

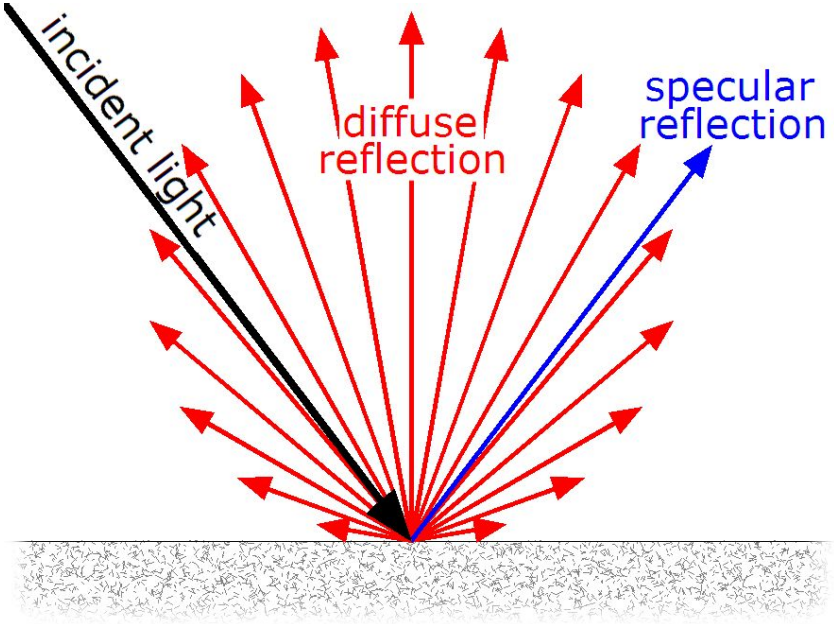
Bonus: multiple shadows

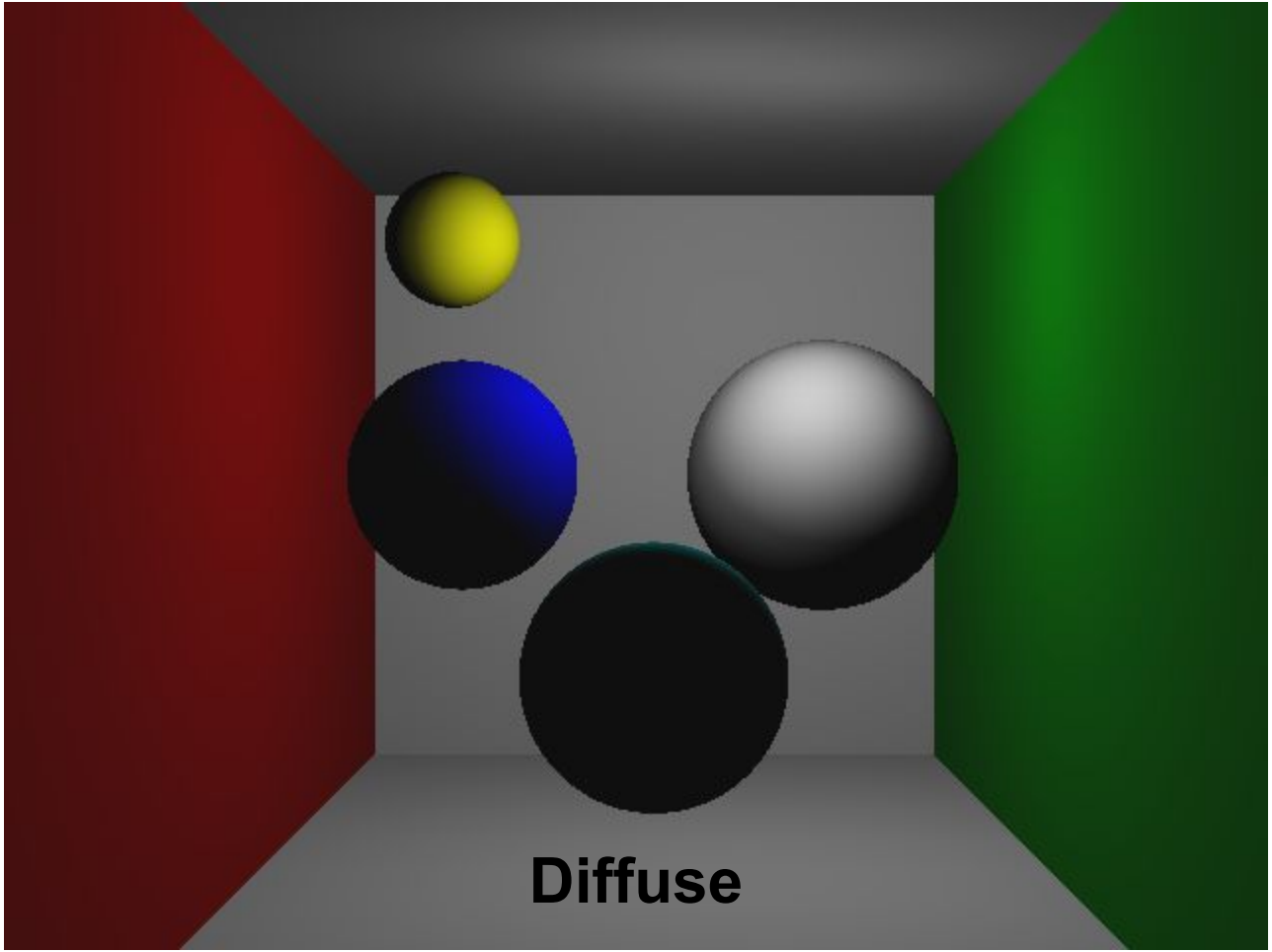

+Multiple Shadows

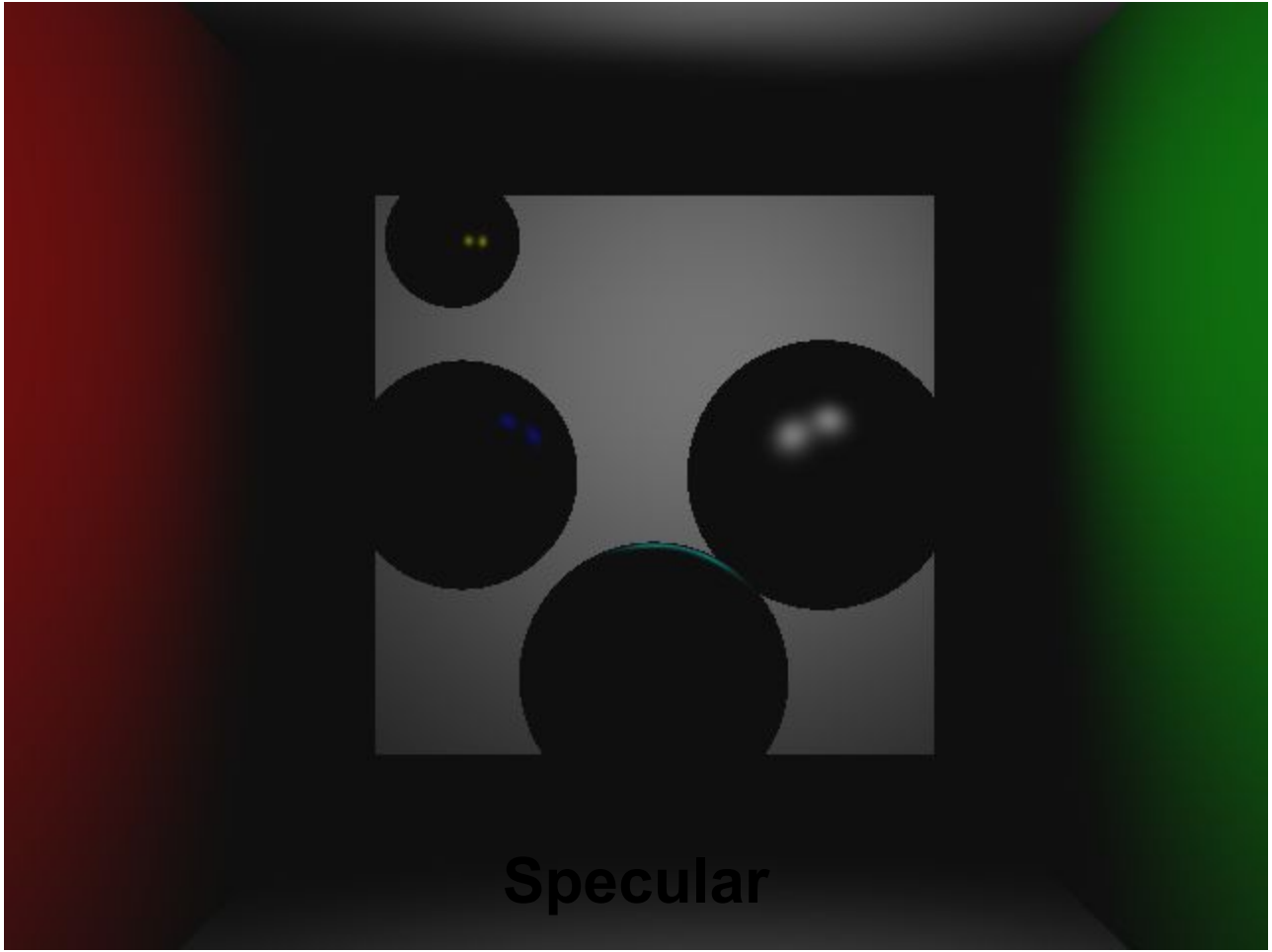
Phong equation

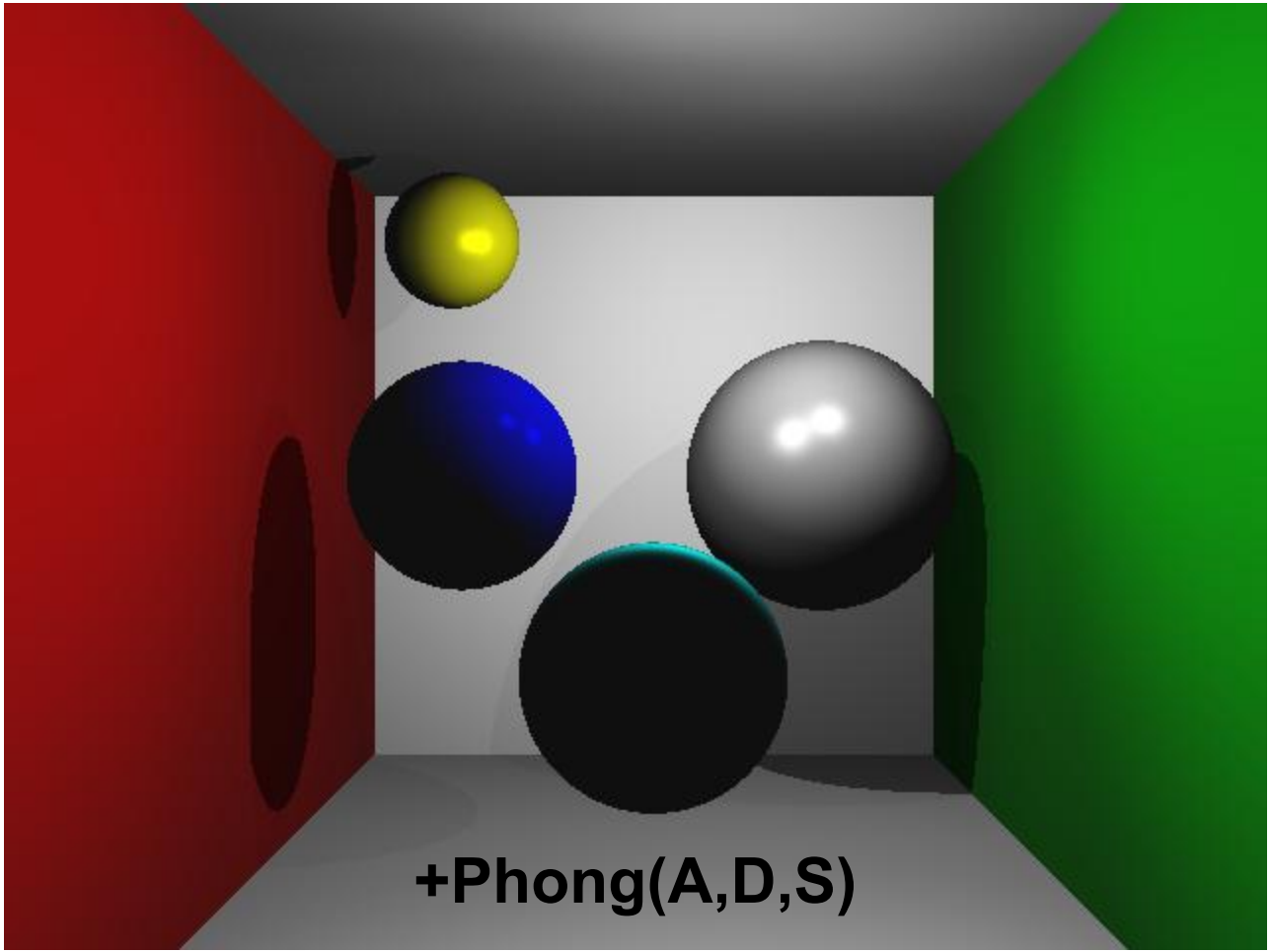


Diffuse and specular



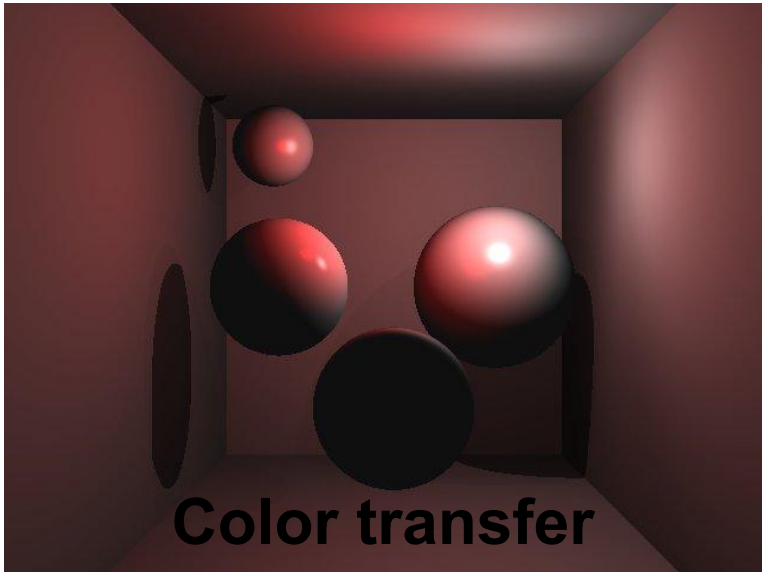

Diffuse

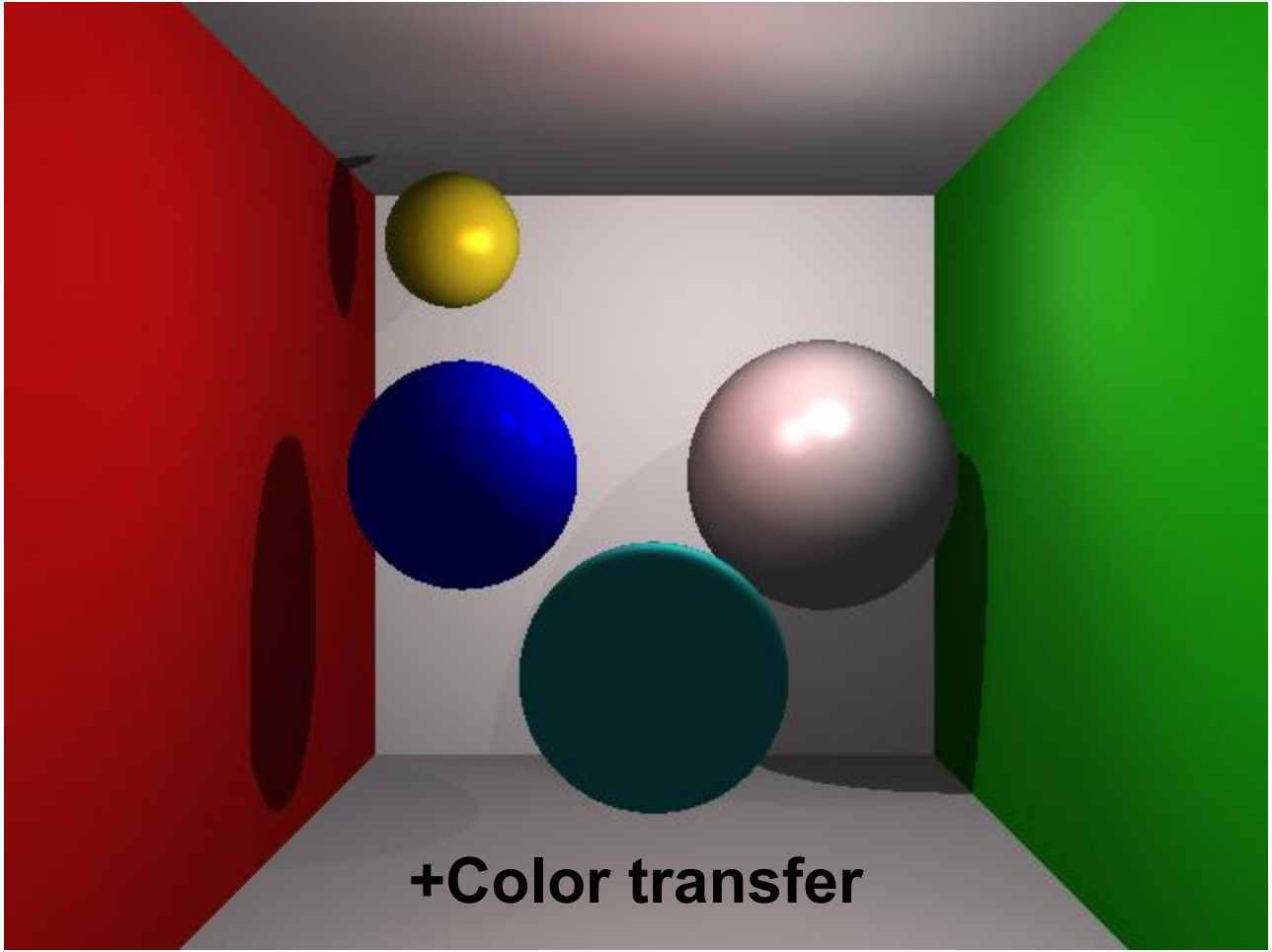

Specular


+Phong(A,D,S)

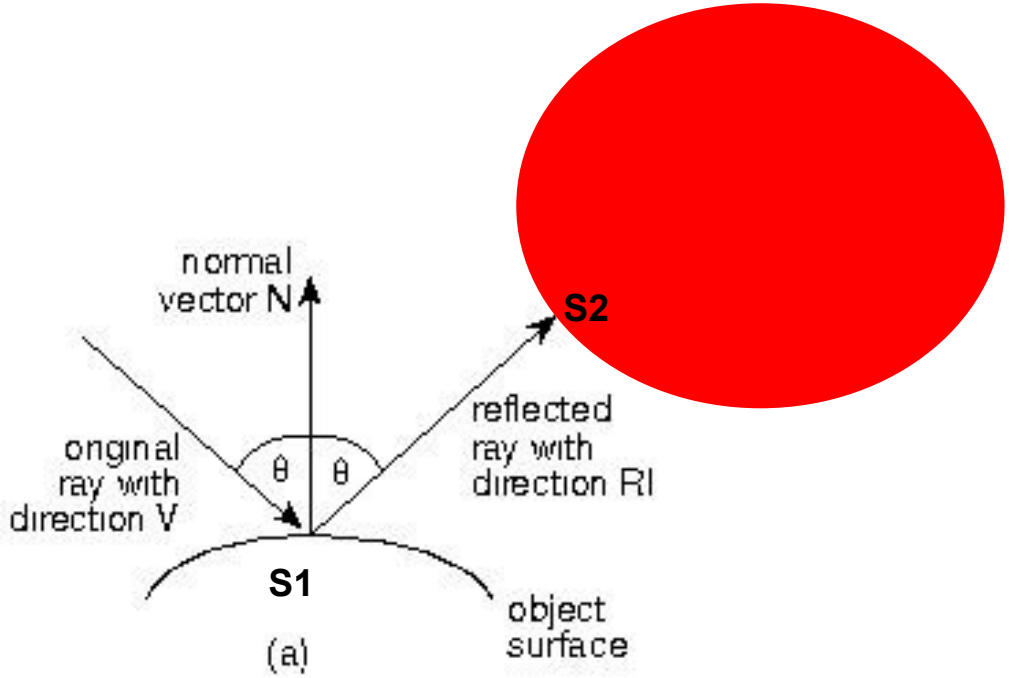
Bonus: color transfer + light attenuation

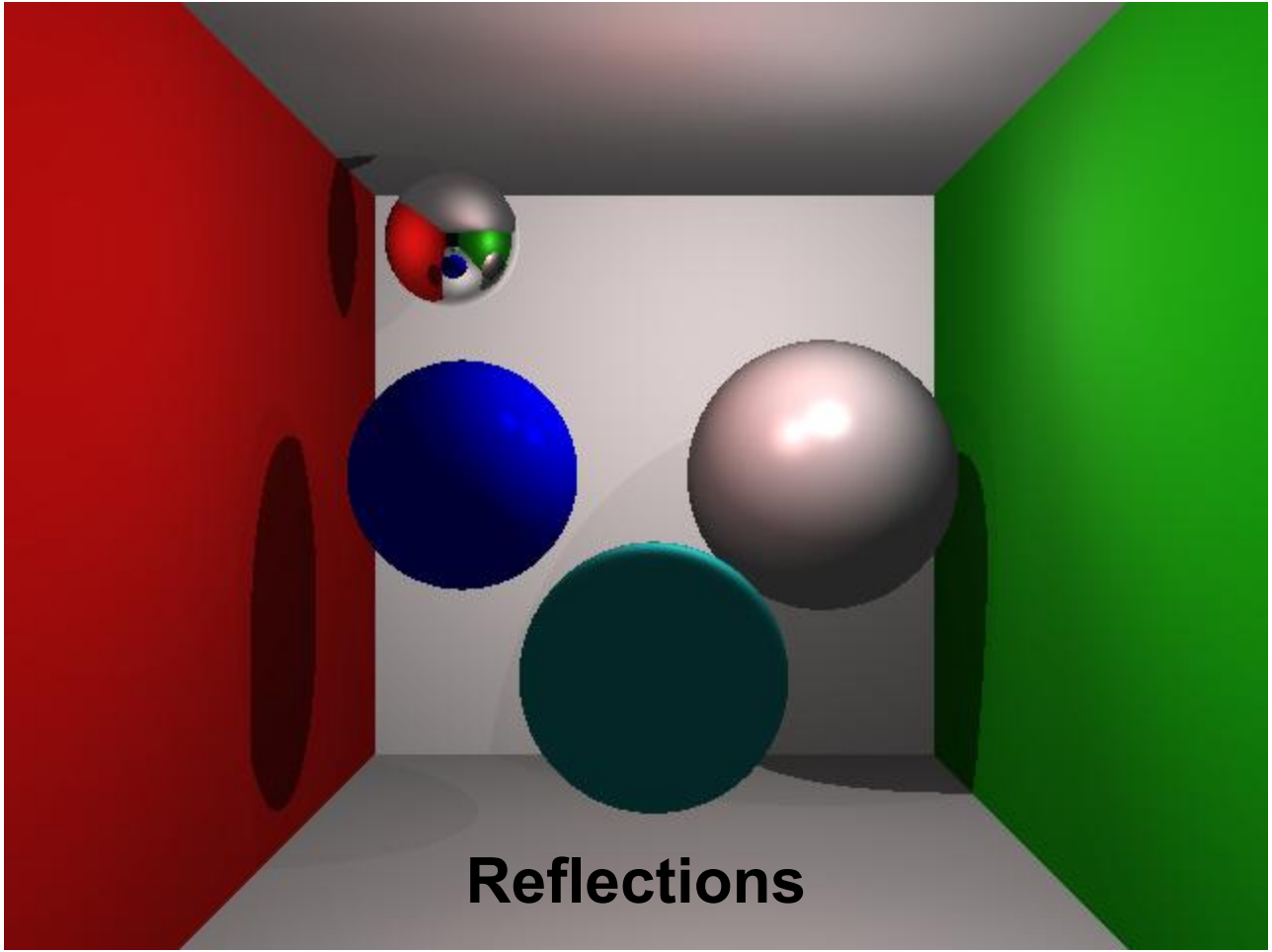
- Merge light color and surface color in Phong
- Objects farther from the light sources receive less light



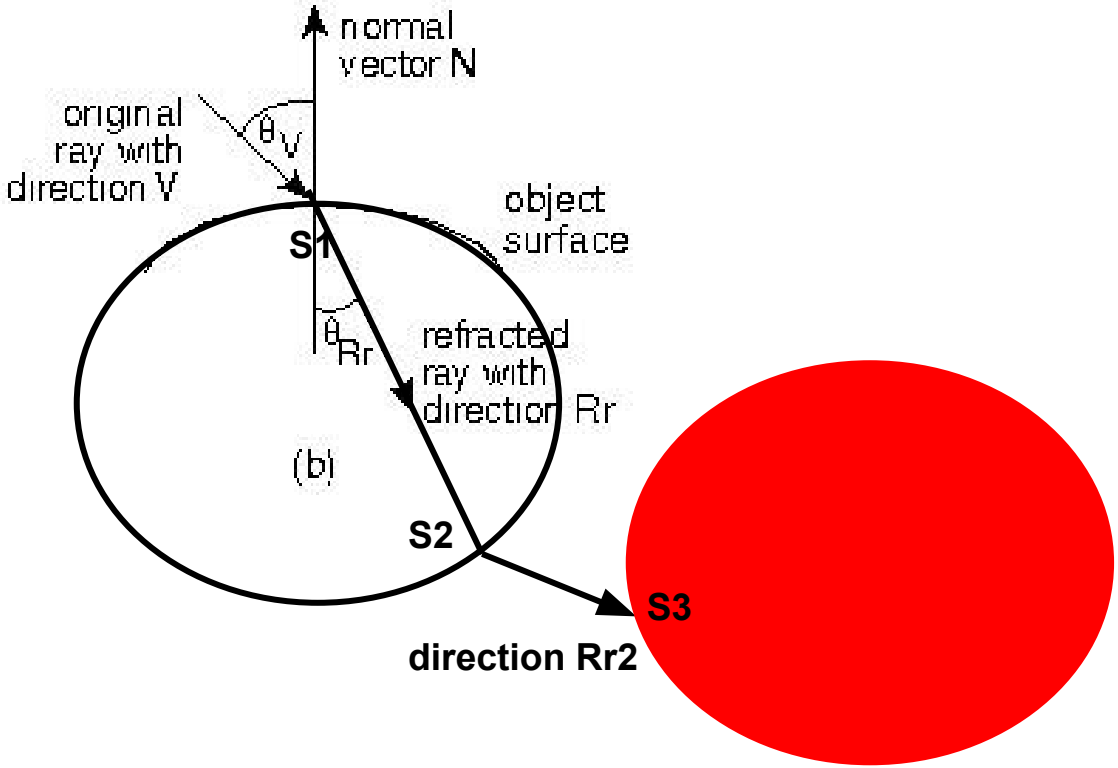

+Color transfer

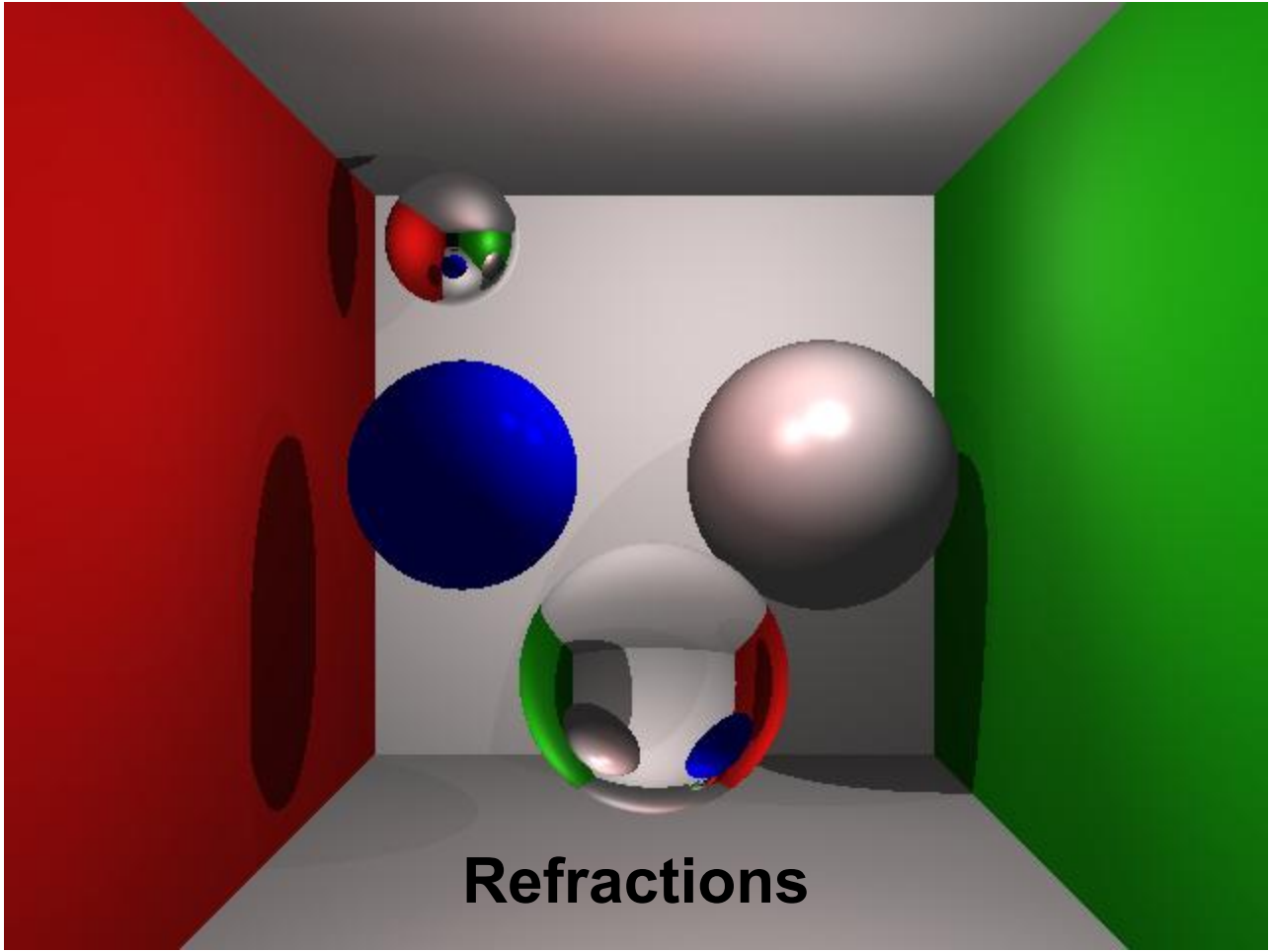
Reflections




Reflections

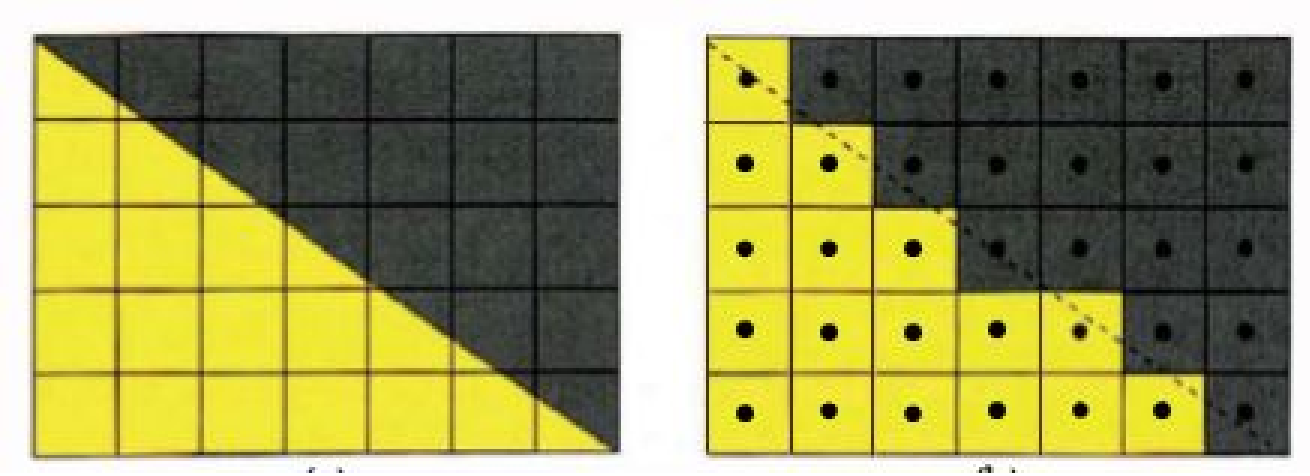
Refractions




Refractions

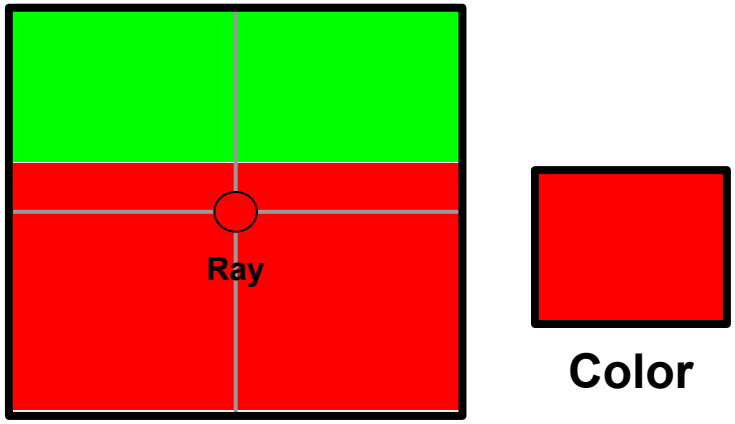
Aliasing

- Recording device has lower freq. than recorded event
  - Bad quaility images → Jaggies

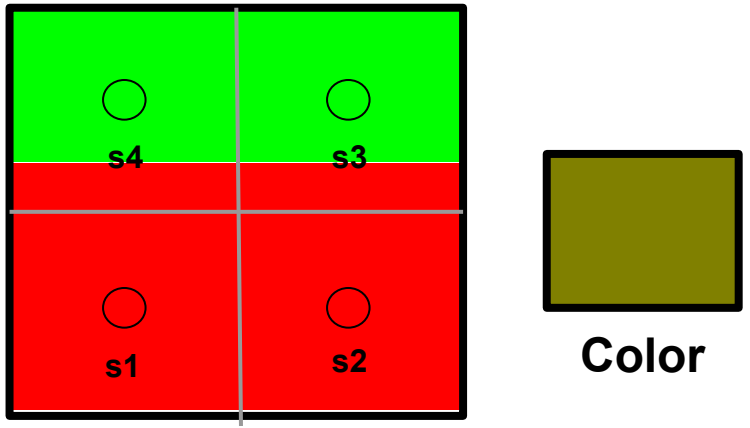


Anti-Aliasing

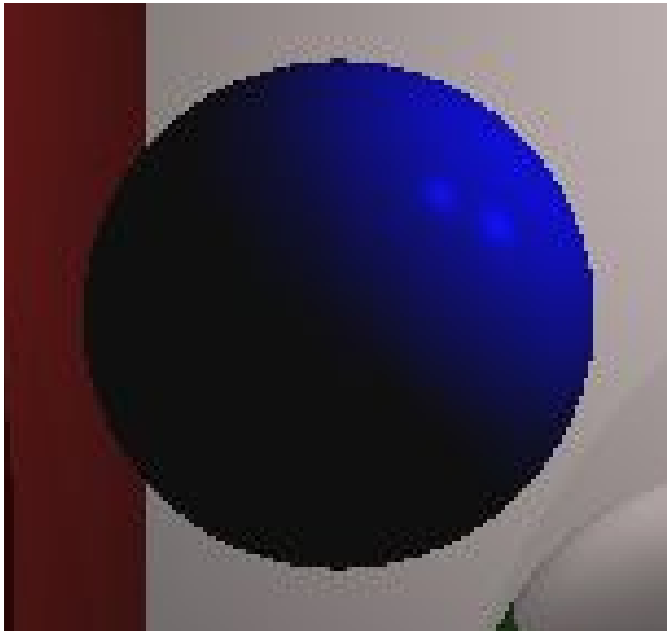
- Filtering methods (outside pixel)
- **Sampling methods (inside pixel)**
  - Multiple samples per pixel→ Color average



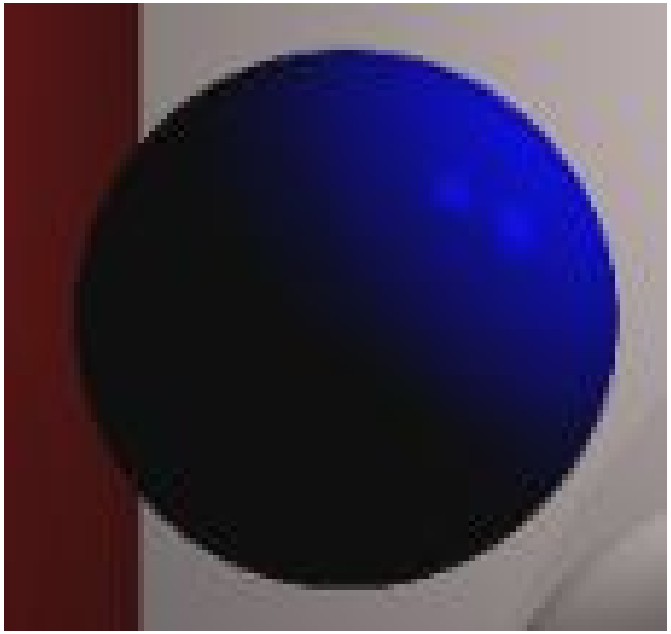
Pixel
No AA



Pixel
Regular-AA s = 4



No AA



AA - Regular s = 32

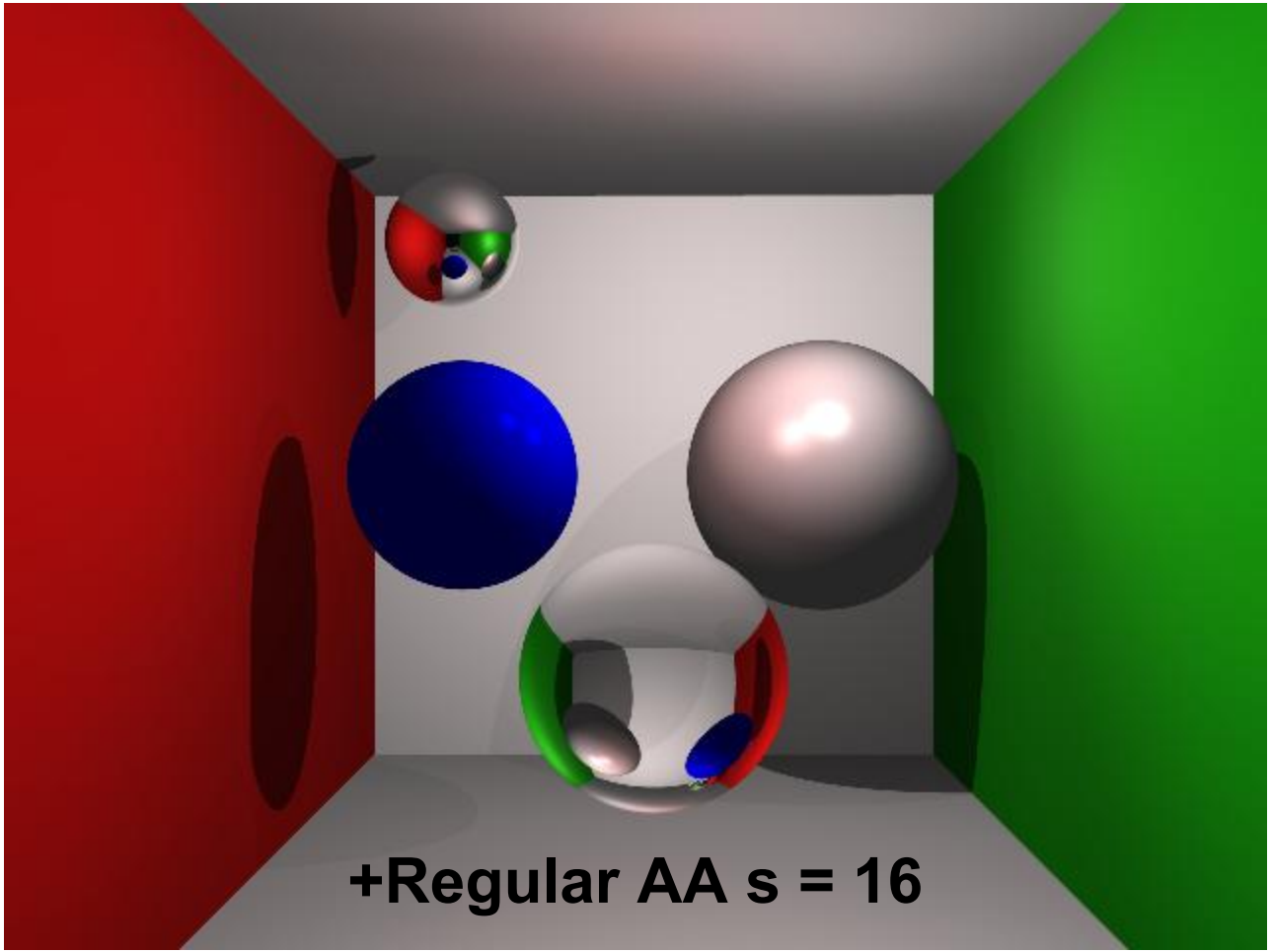
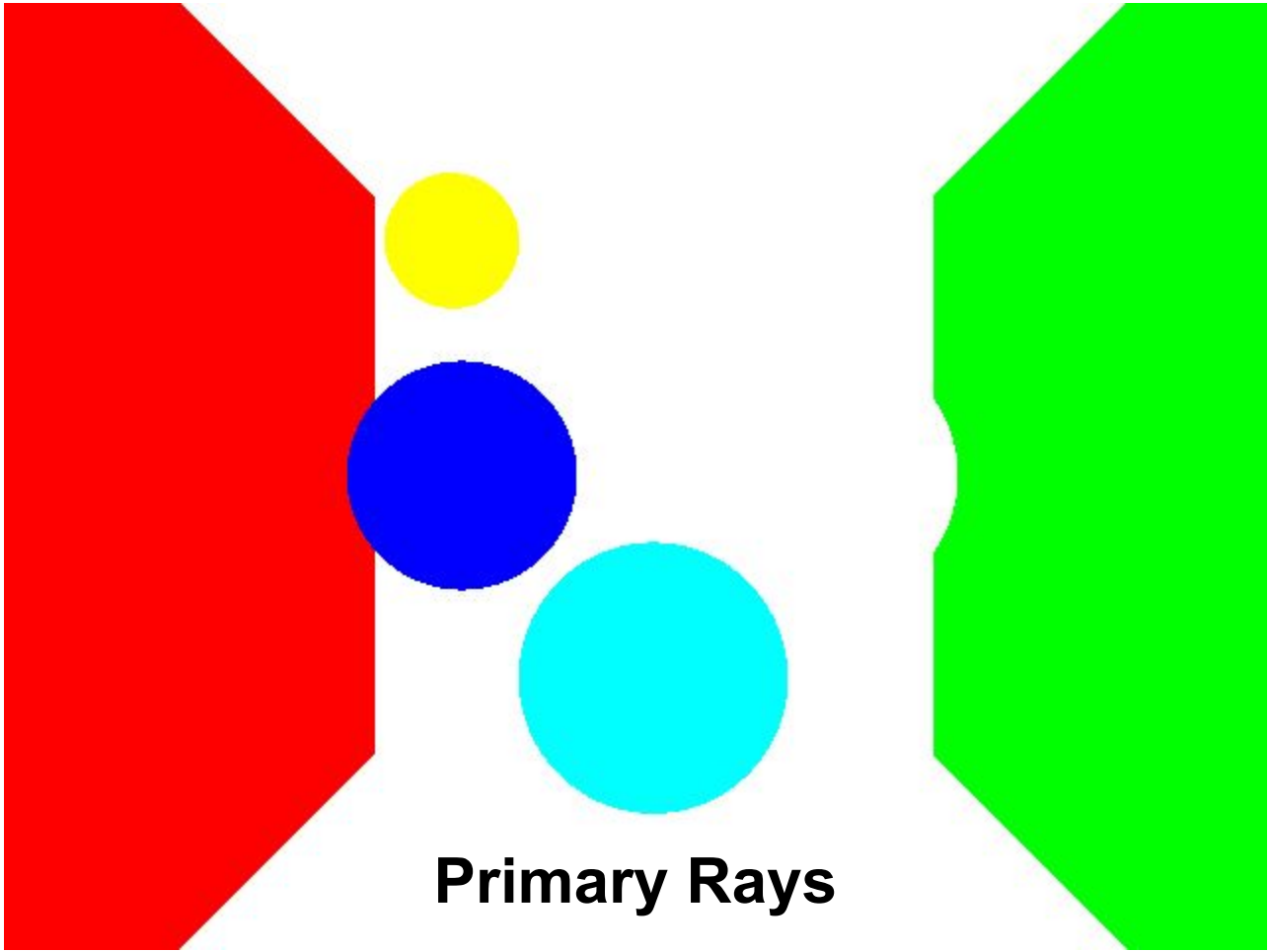
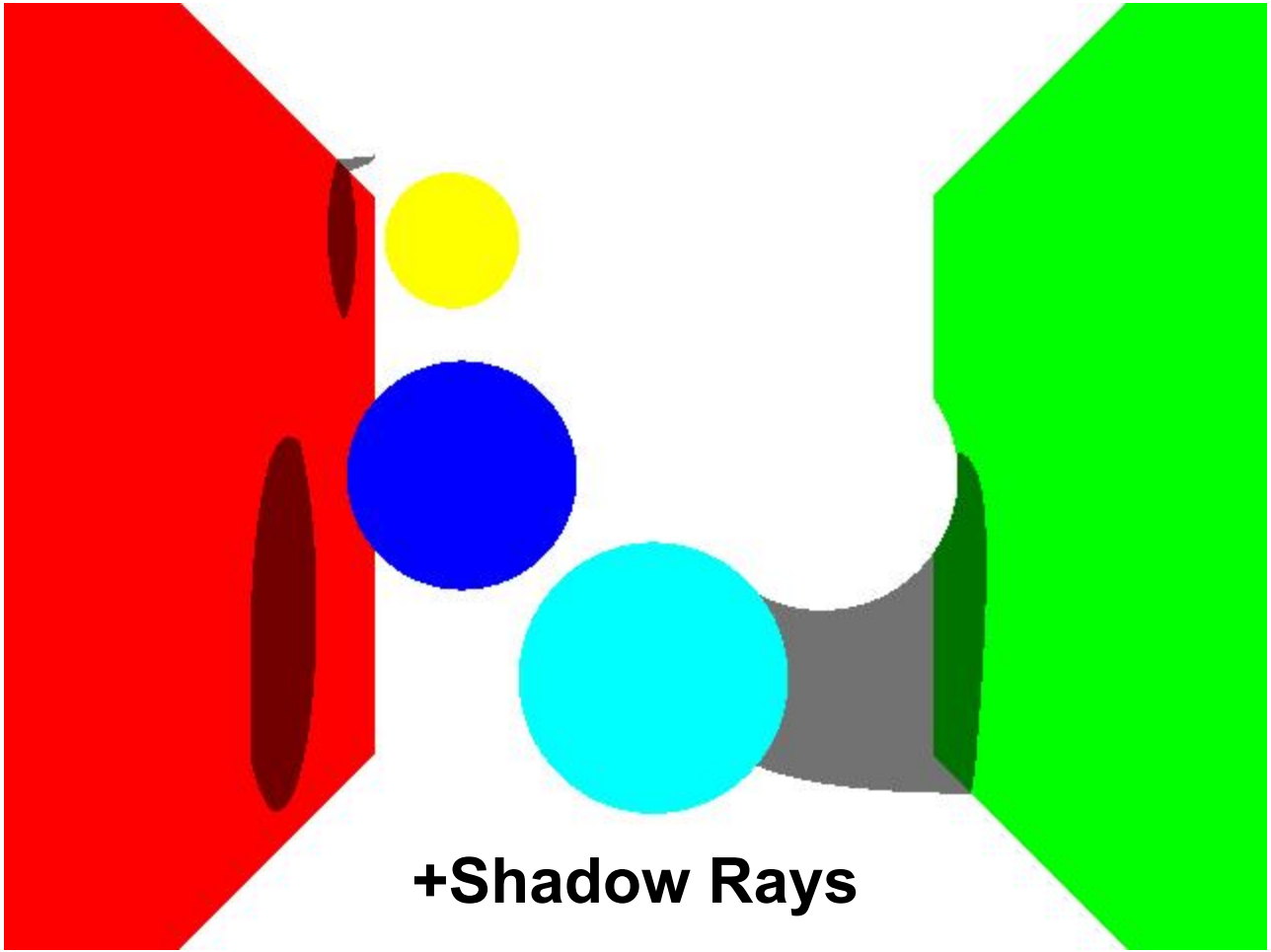
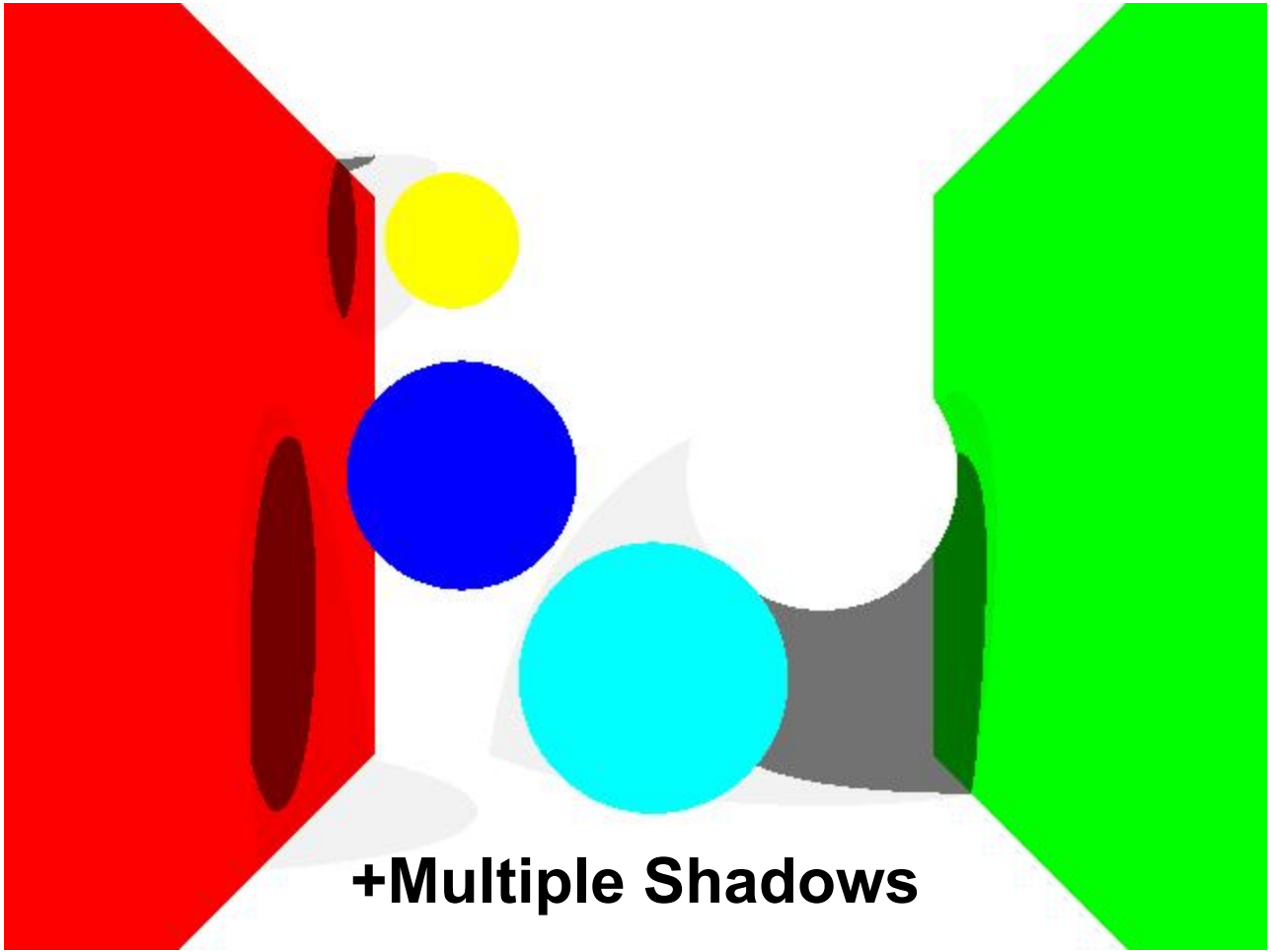
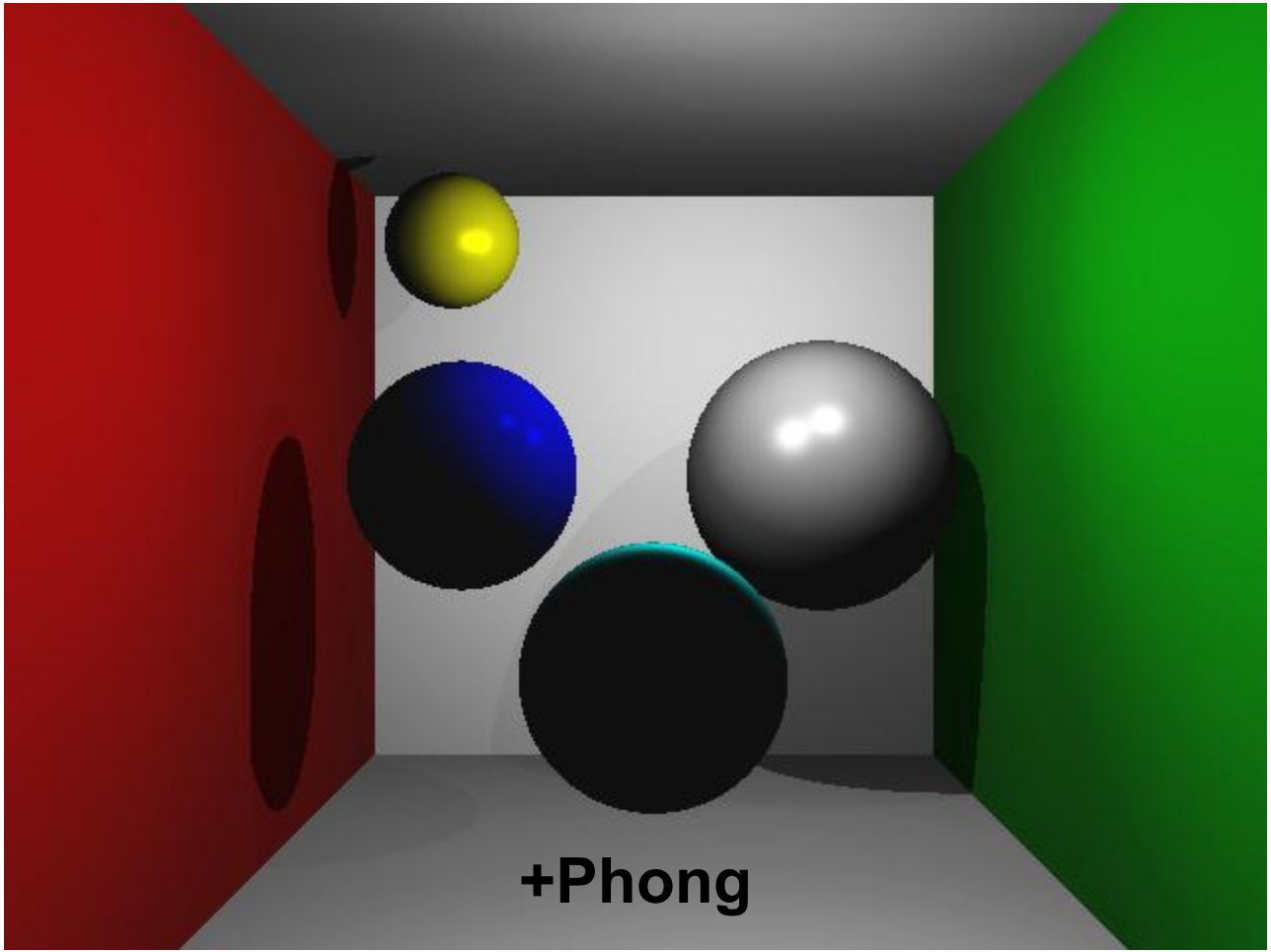

+Regular AA s = 16

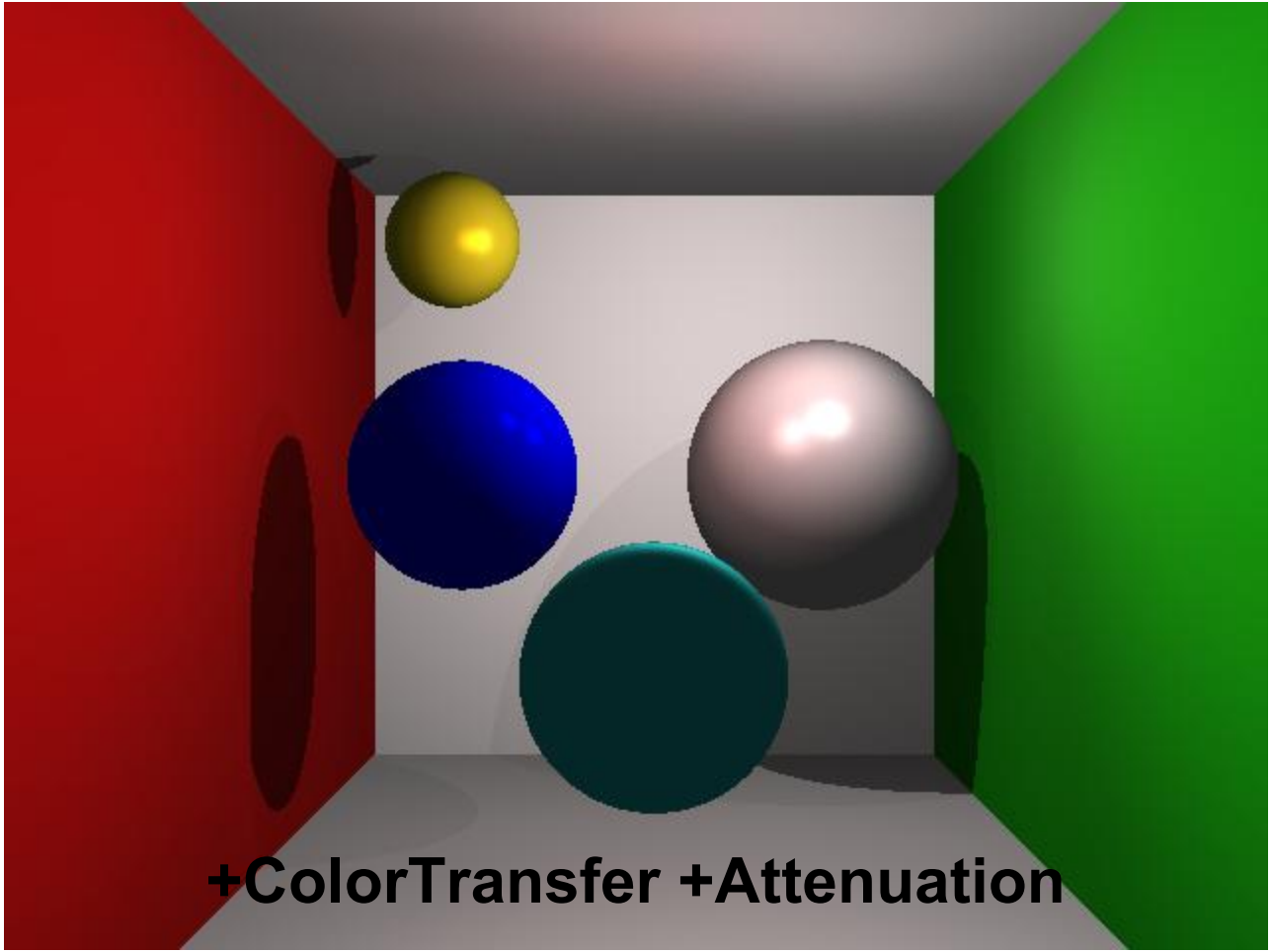
Image evolution

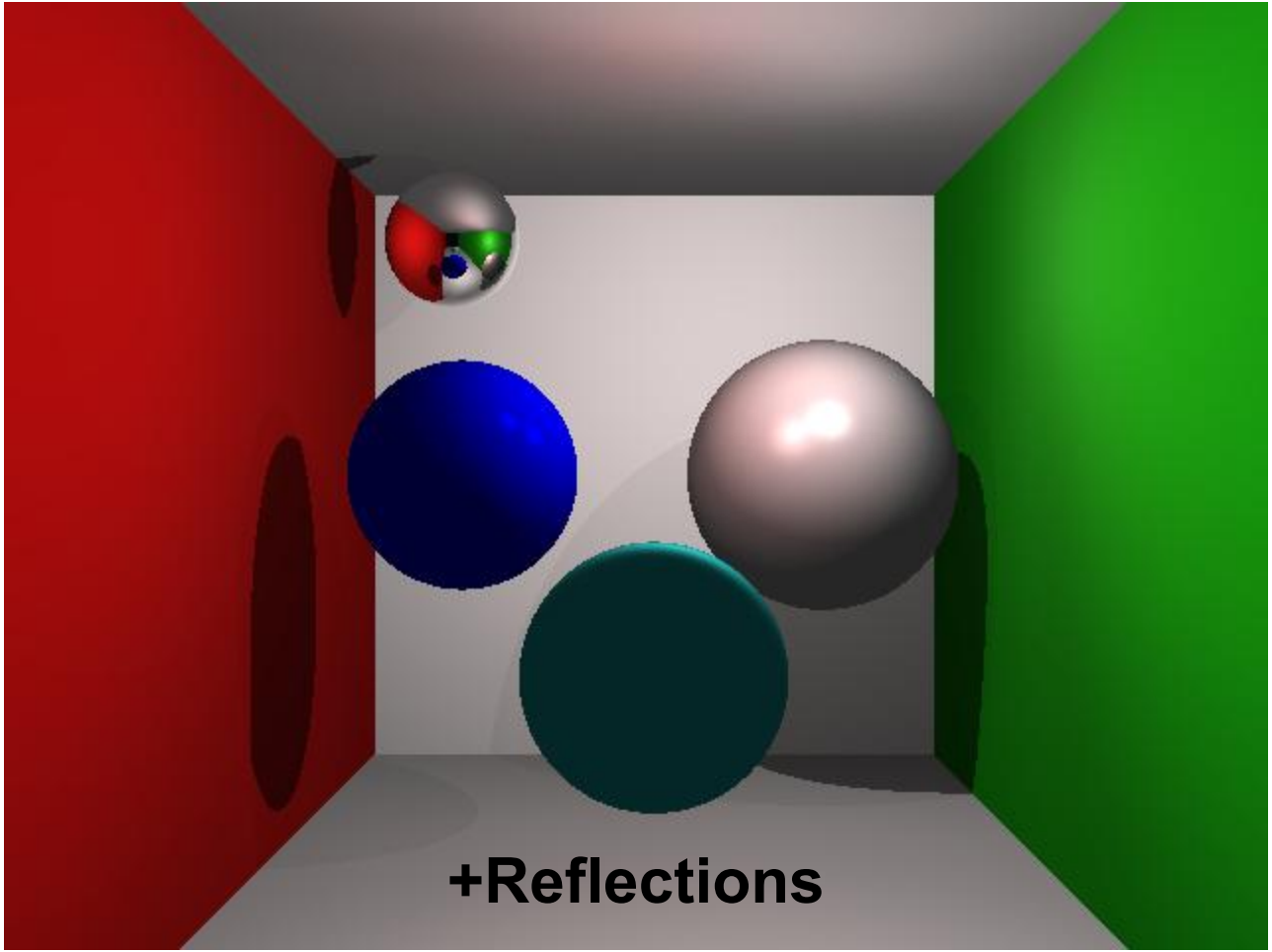

Primary Rays

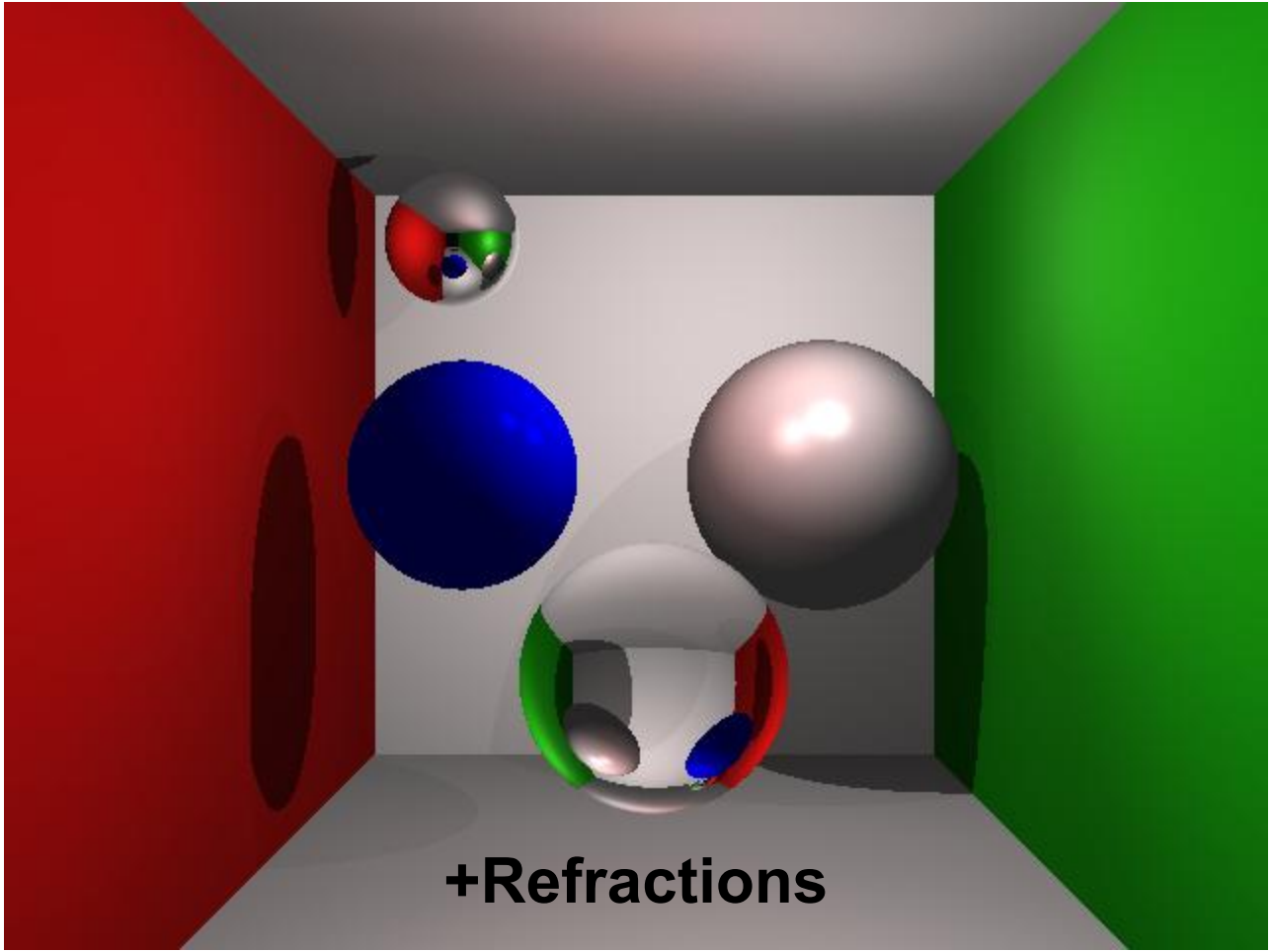

+Shadow Rays

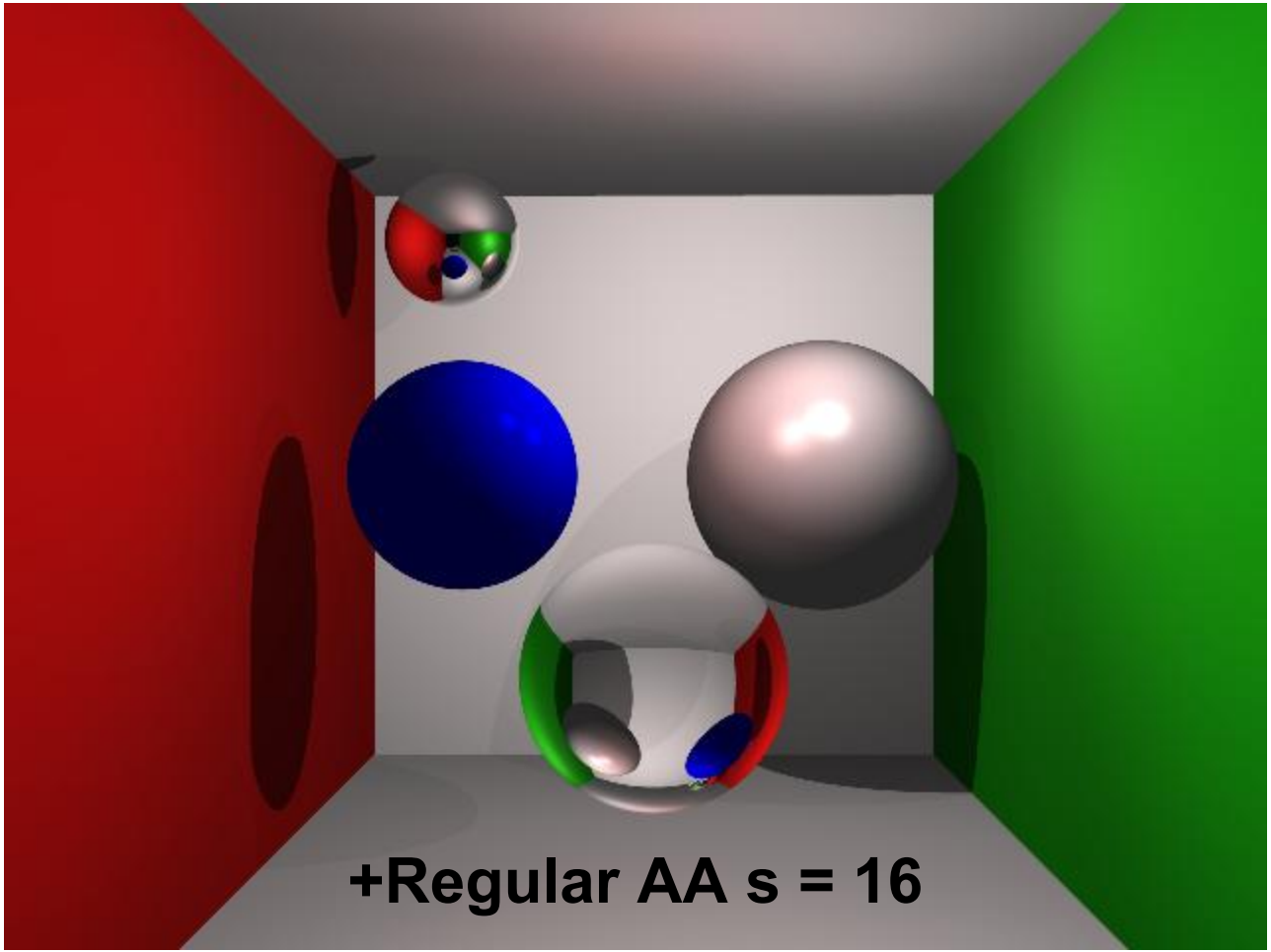

+Multiple Shadows

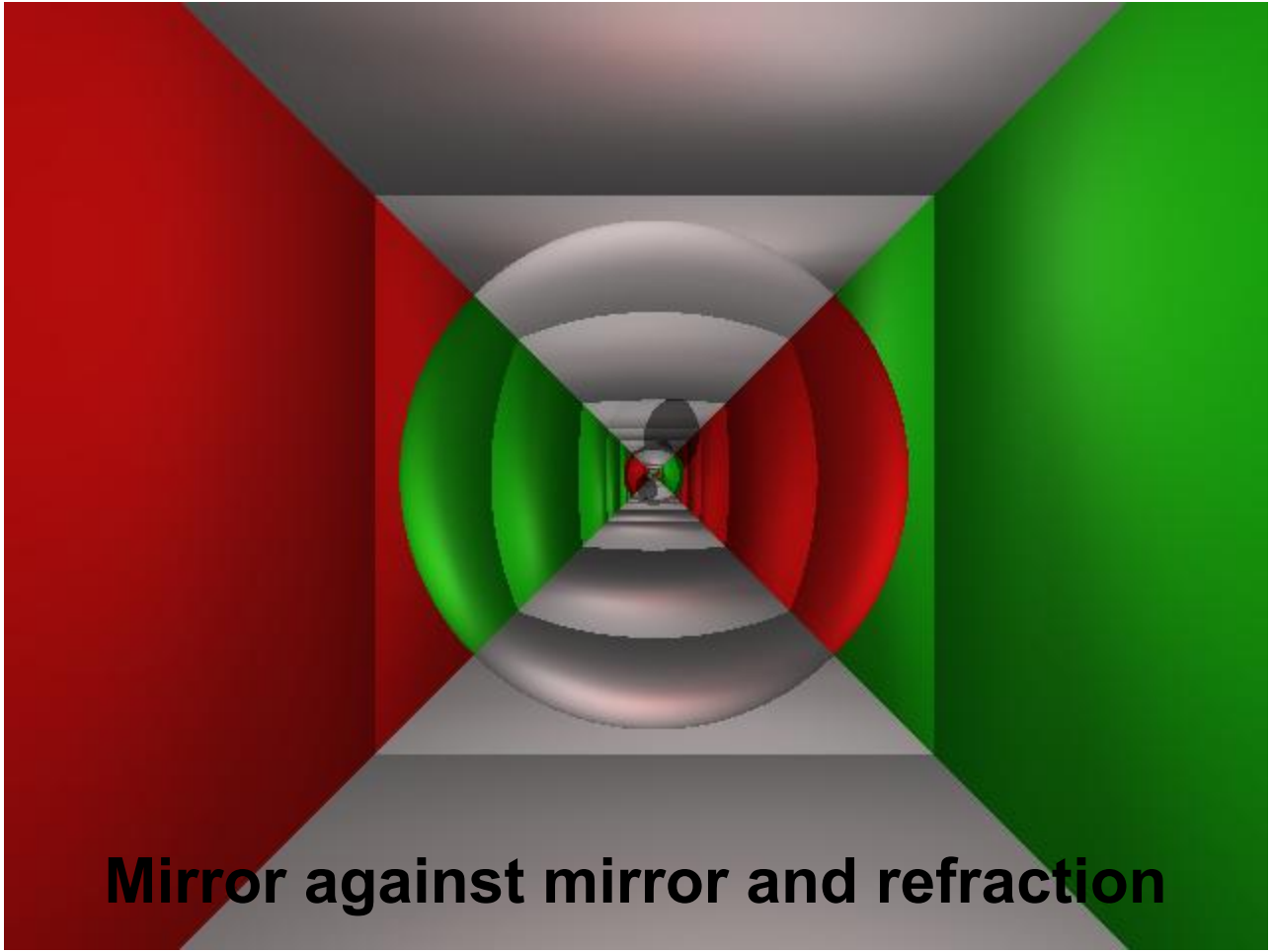

+Phong

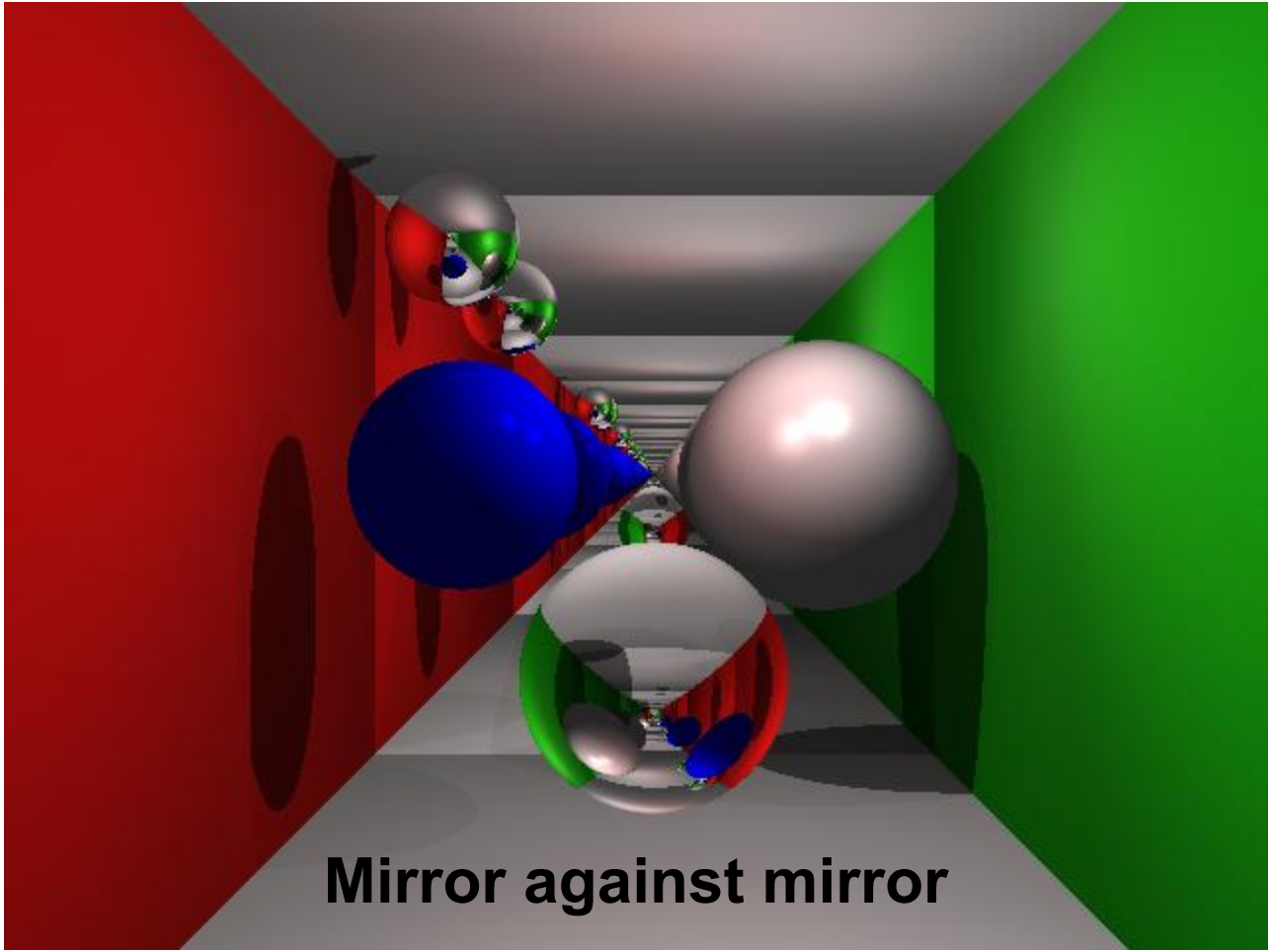

+ColorTransfer +Attenuation


+Reflections


+Refractions


+Regular AA s = 16


Mirror against mirror and refraction


Mirror against mirror