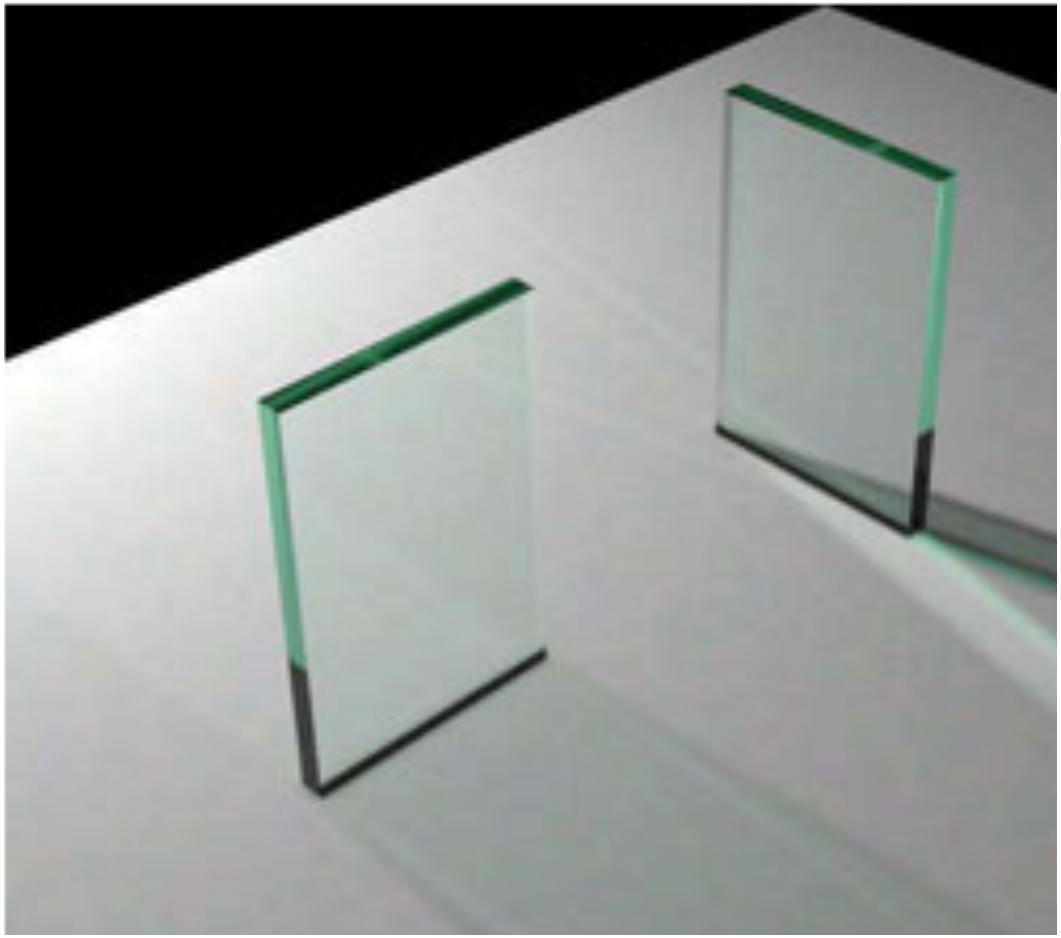
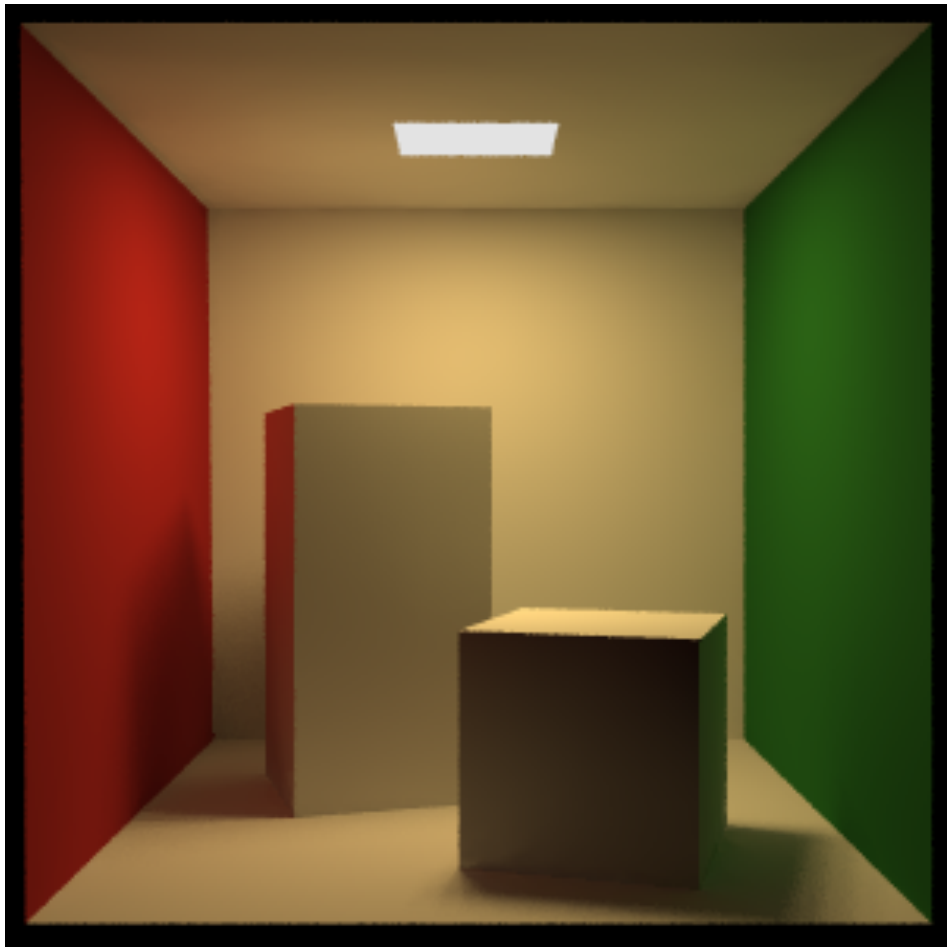




Computer Graphics

Lecture 12

Advanced Ray Tracing

Announcements

- Resubmission policy: you must **email me and the grader** after resubmitting. Submission comments are not sufficient.
- Now is a good time to start thinking about final projects - proposals will be due in about 3 weeks.
- Friday's class: bring a laptop if you can
- Before class on Friday:
  - Find a partner (different from your A1 partner)
  - Read the A2 handout
  - Accept the GH classroom invite to create your repo

Today

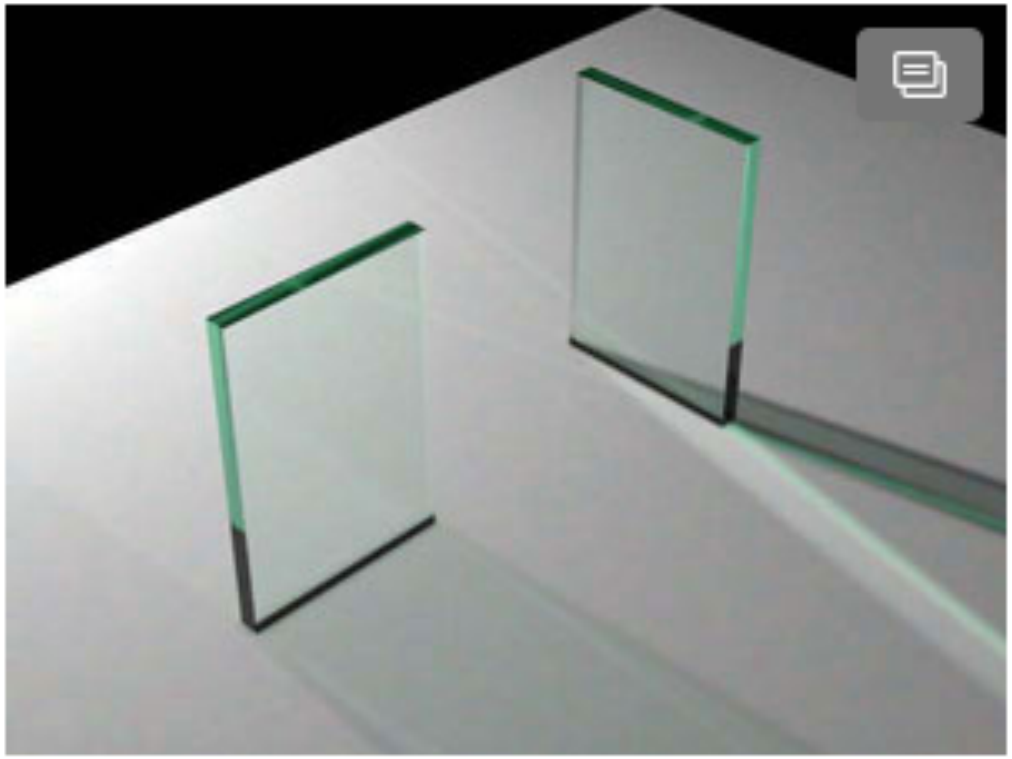
- Work on the L11 problems?
- A high-level overview of what comes next in ray tracing.
- Useful for A2 extensions and/or final project ideas.
- Not getting into gory detail -
  see the book references on the slides.

Ok, what *can't* we do?

- Render transparent things - *transmission and refraction* (Ch 13.1)
- Rotate, scale, shear objects - *transformations* (more on this next week, and in 13.2)
- Intersect more kinds of objects - *Constructive Solid Geometry* (Ch 13.3)
- Area light sources, soft shadows, depth of field - *distribution ray tracing* (Ch 13.4)
- Global illumination (Ch. 23)
- More realistic surfaces (Ch. 24)

Transparency and Refraction

Our framework assumes surfaces (only) reflect light.

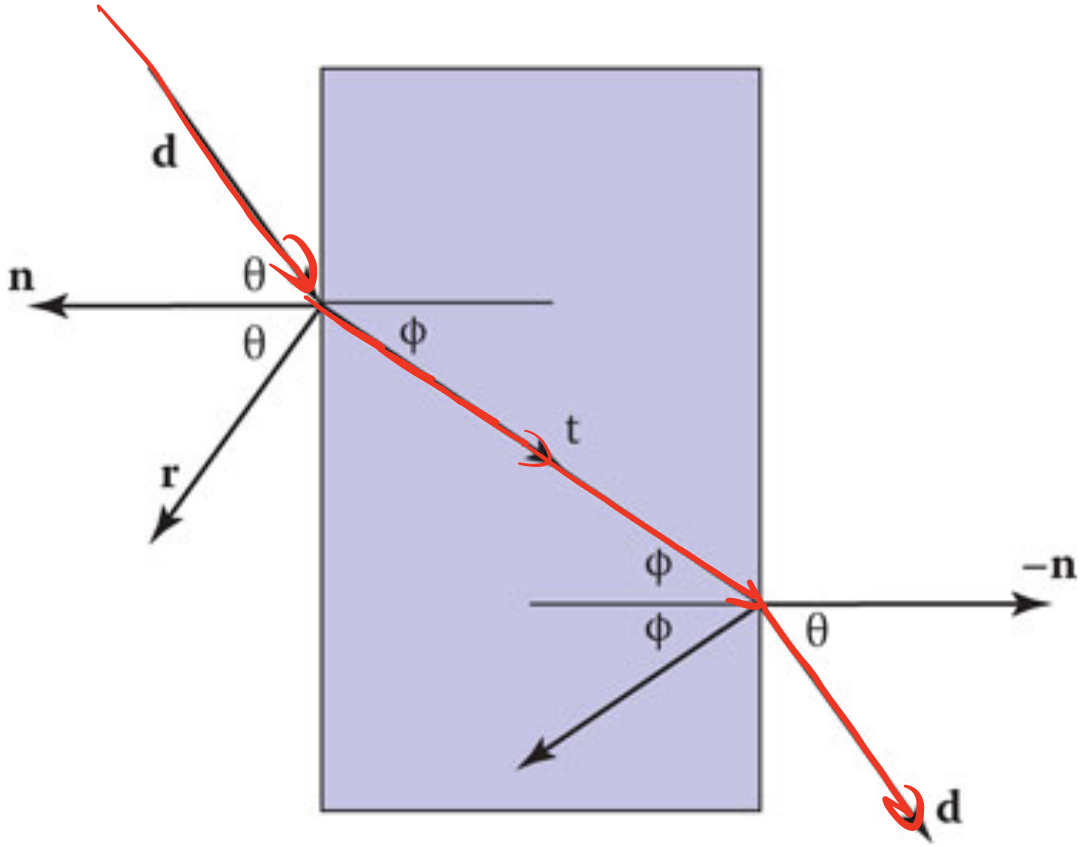


What if that's wrong?

Basically, physics

Laws of physics govern how light transmits through *dielectric* surfaces. Snell's law:

$$n\sin\theta = n_t \sin\phi$$



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Laws of physics govern how light transmits through *dielectric* surfaces. Snell's law:

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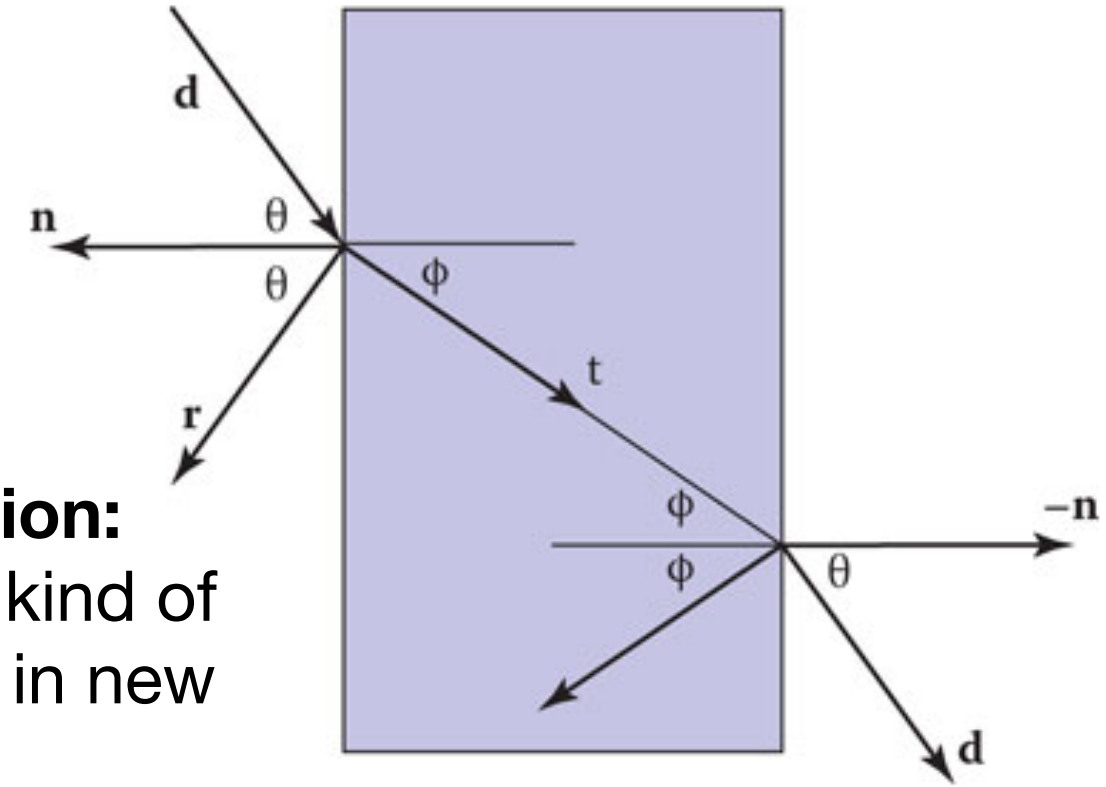
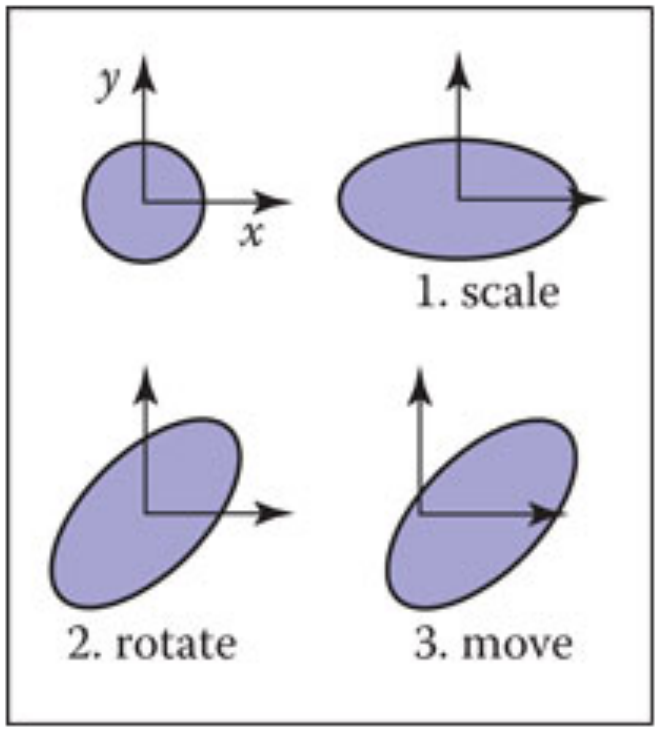


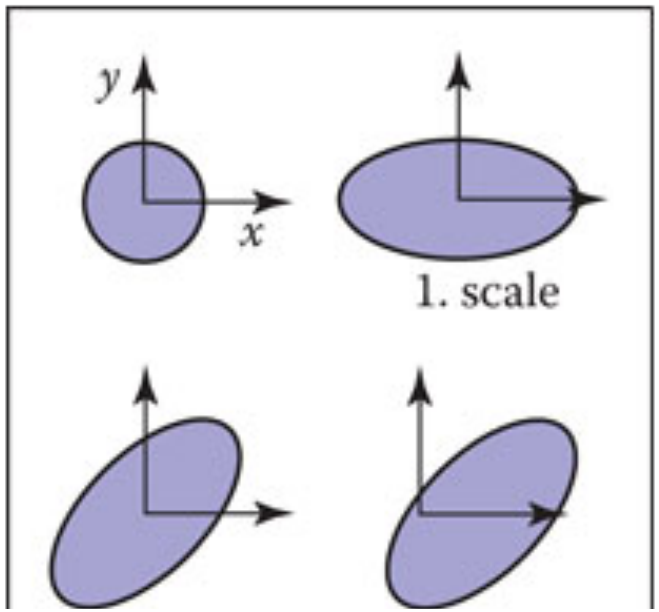
Similar to mirror reflection:
When light hits a special kind of surface, shoot a new ray in new direction.

Transformations and Instancing

Next week we'll talk about how to transform objects:

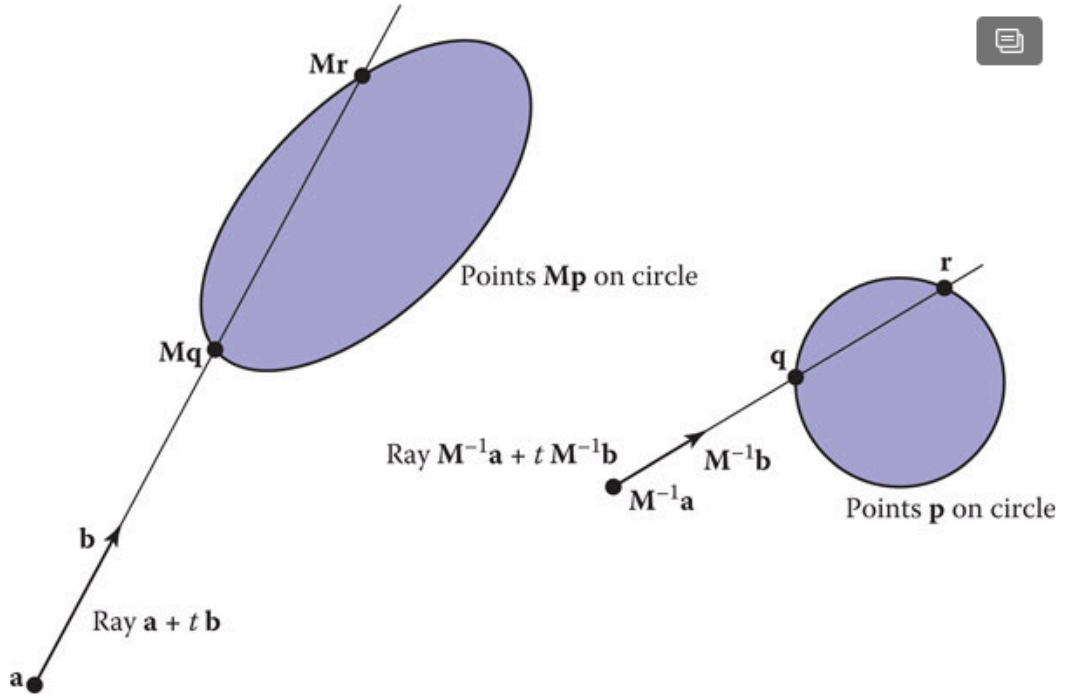


Transformations and Instancing

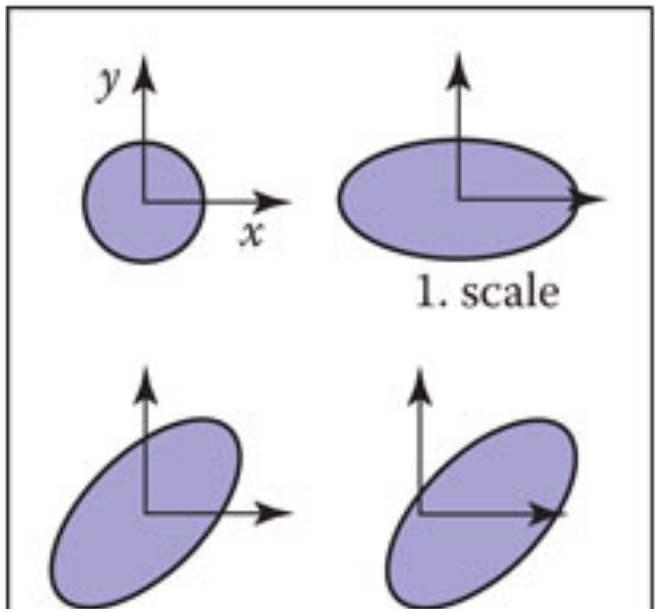


Next week we'll talk about how to transform objects:

When ray tracing, we can alternatively transform the *rays:*



Transformations and Instancing



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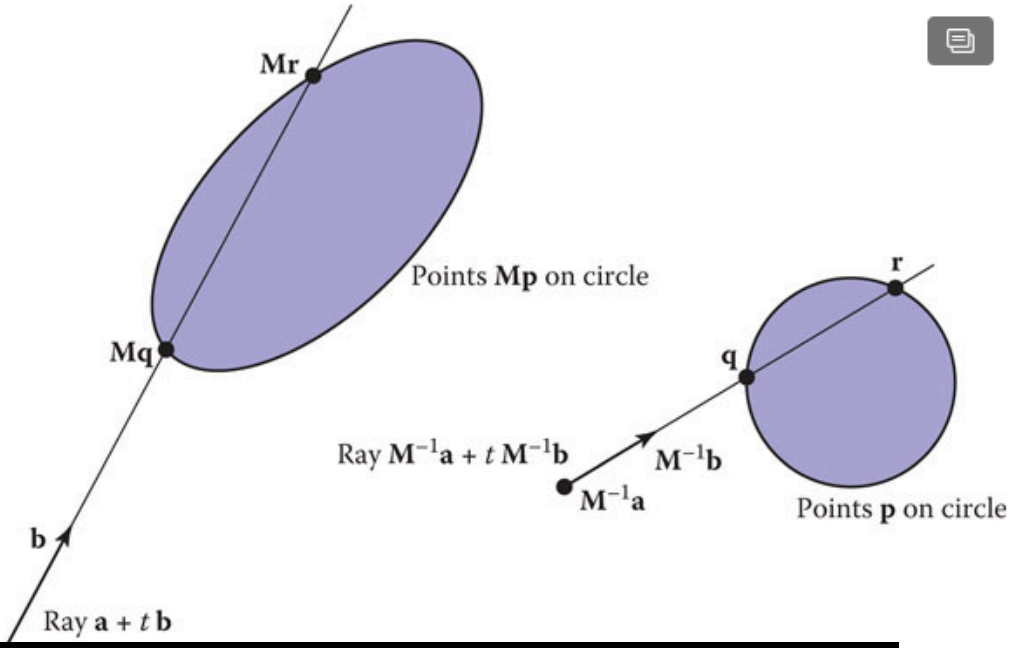
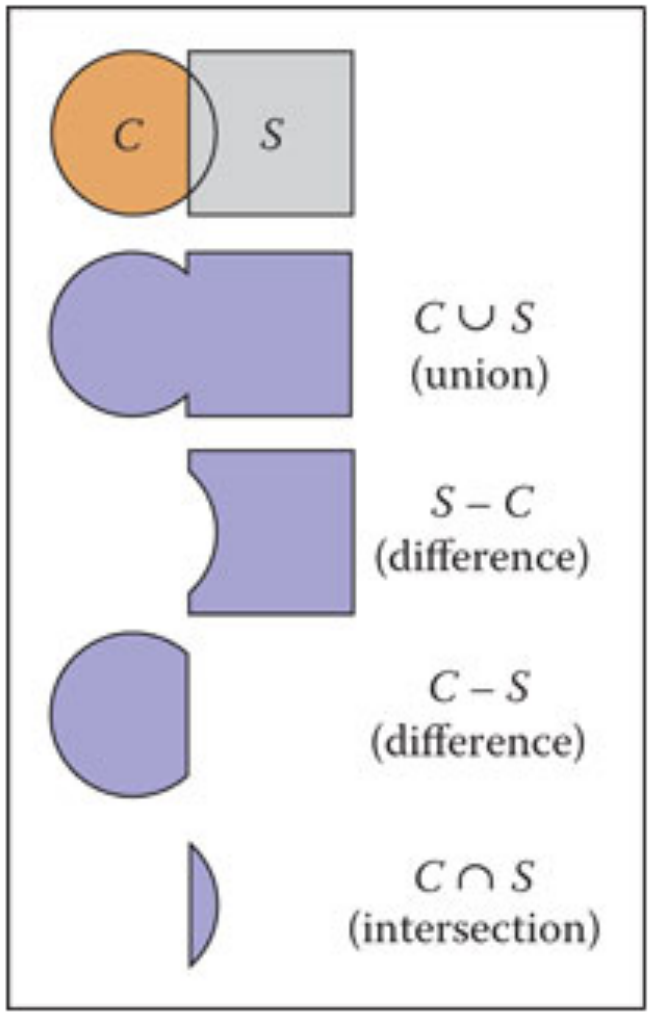


Same idea allows us to include multiple *instances* of the same object in a scene.

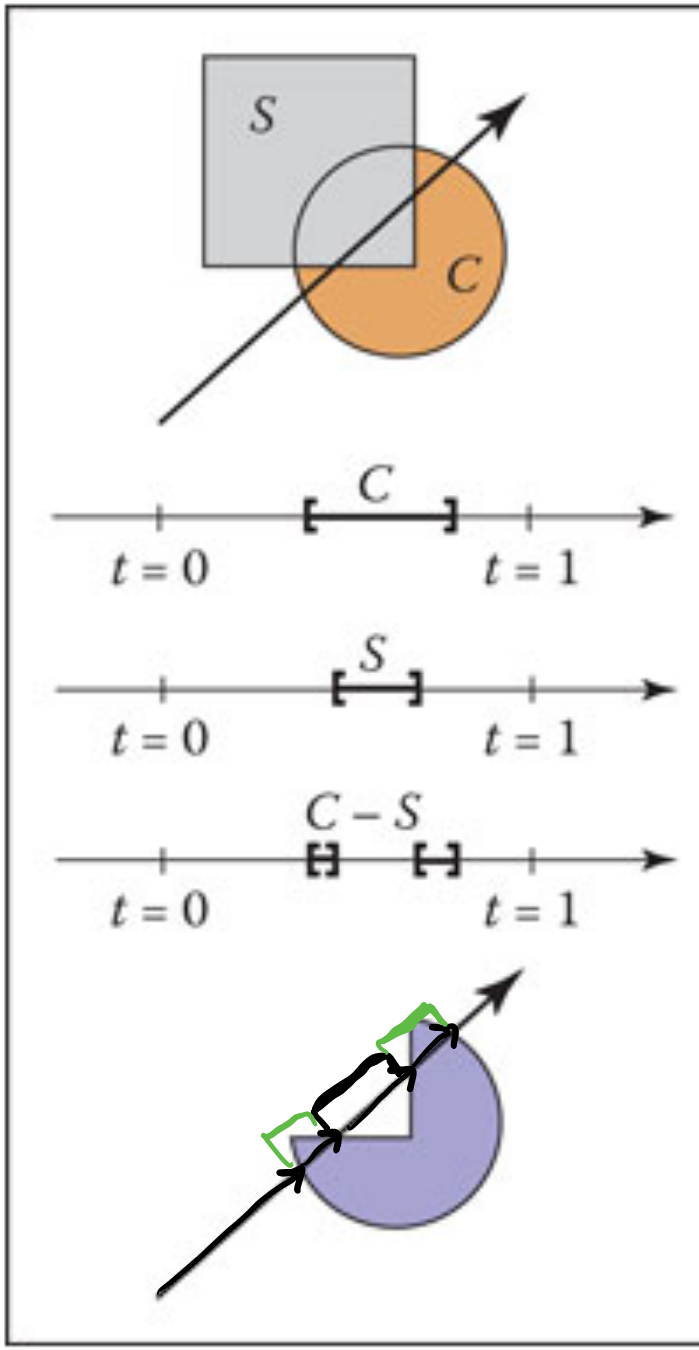
Constructive Solid Geometry

Compose objects from other objects using set operations:



Constructive Solid Geometry

- Intersections yield **intervals** of *t*
- Perform the set operations on those intervals to determine overall intersection.



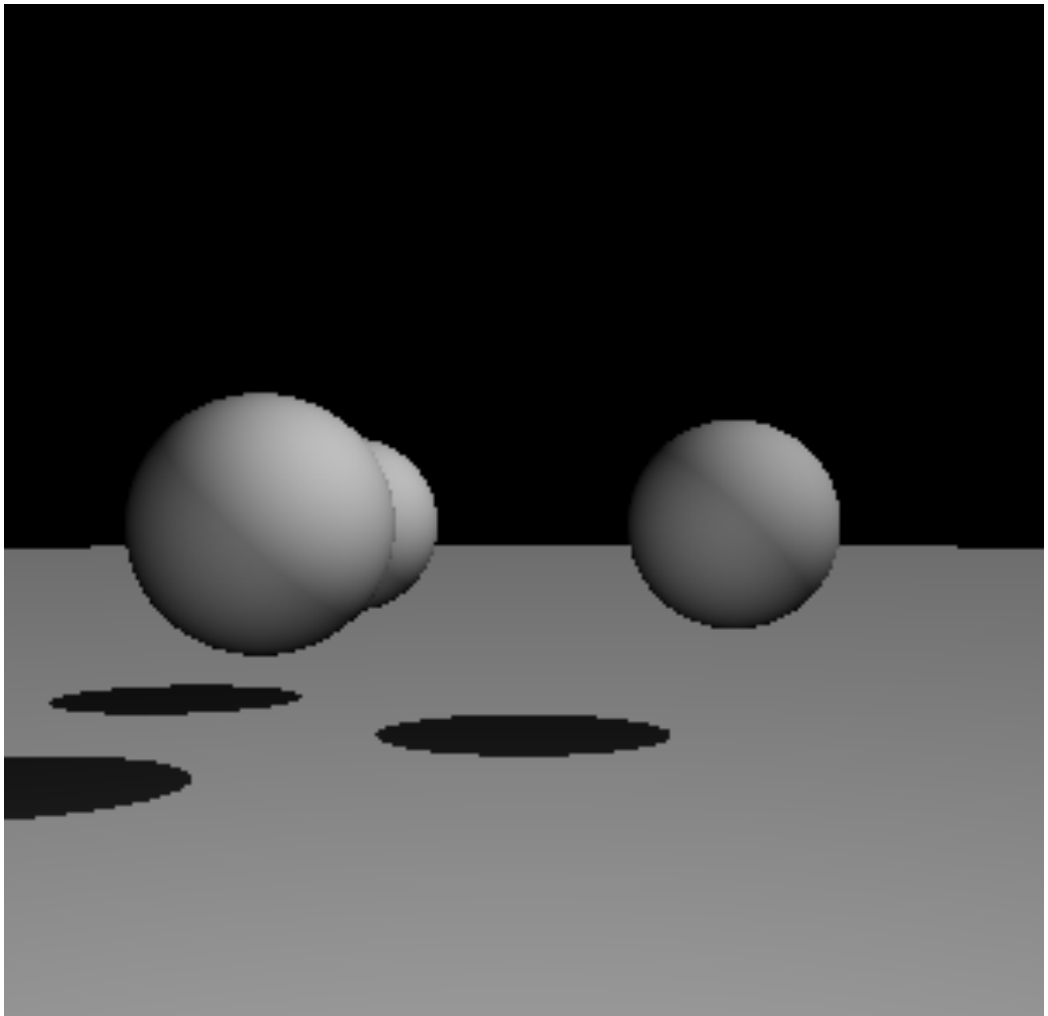
Distribution Ray Tracing

Problem: X

Solution: Compute multiple rays per pixel, (randomly) sampling property Y for each one.

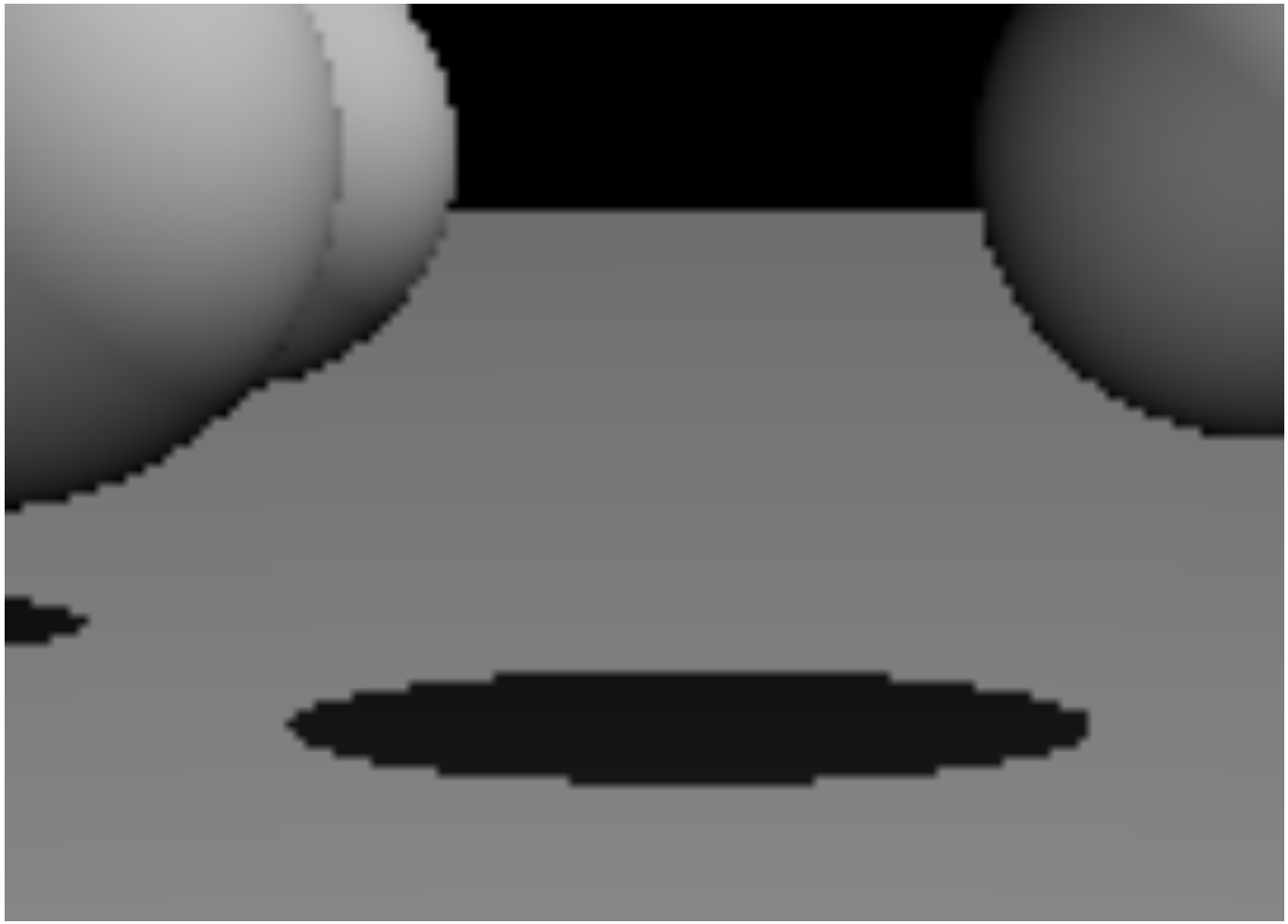
Distribution Ray Tracing

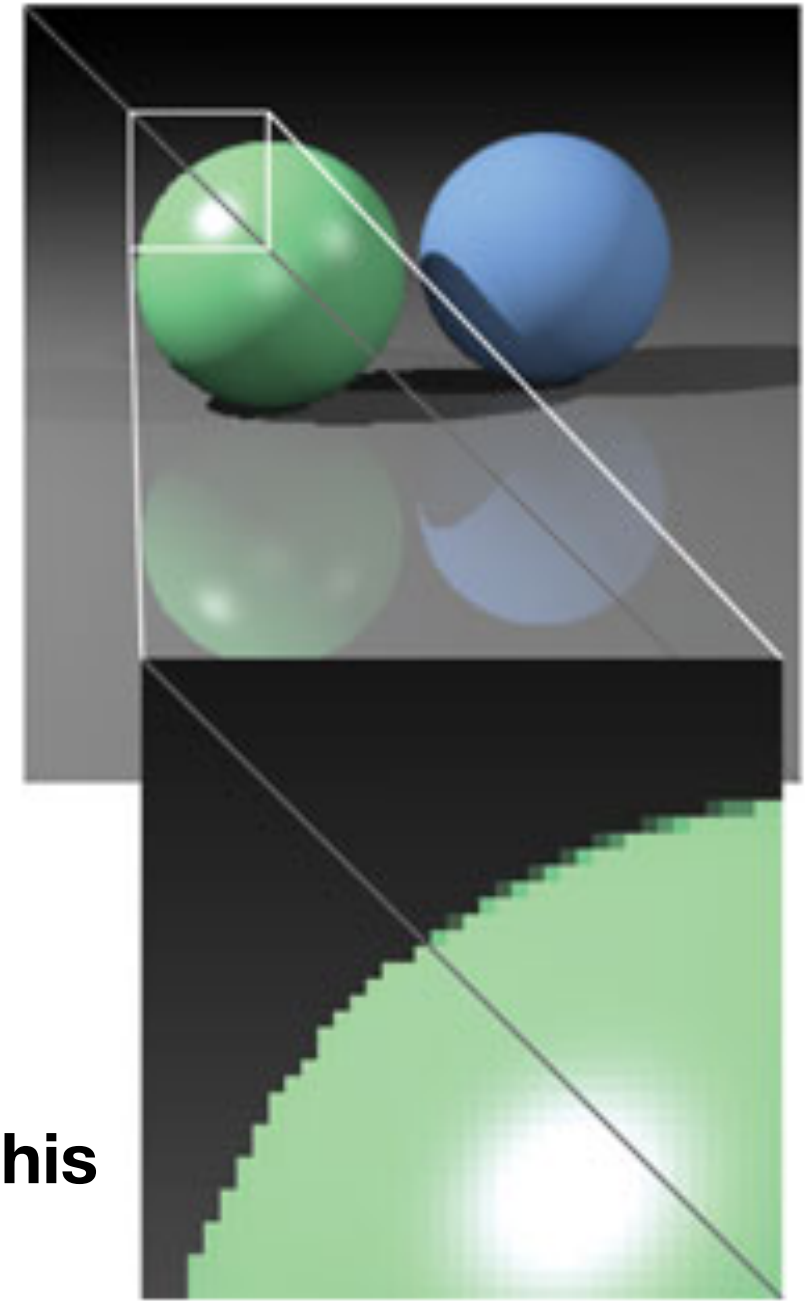
Problem: jagged object and shadow edges



Distribution Ray Tracing

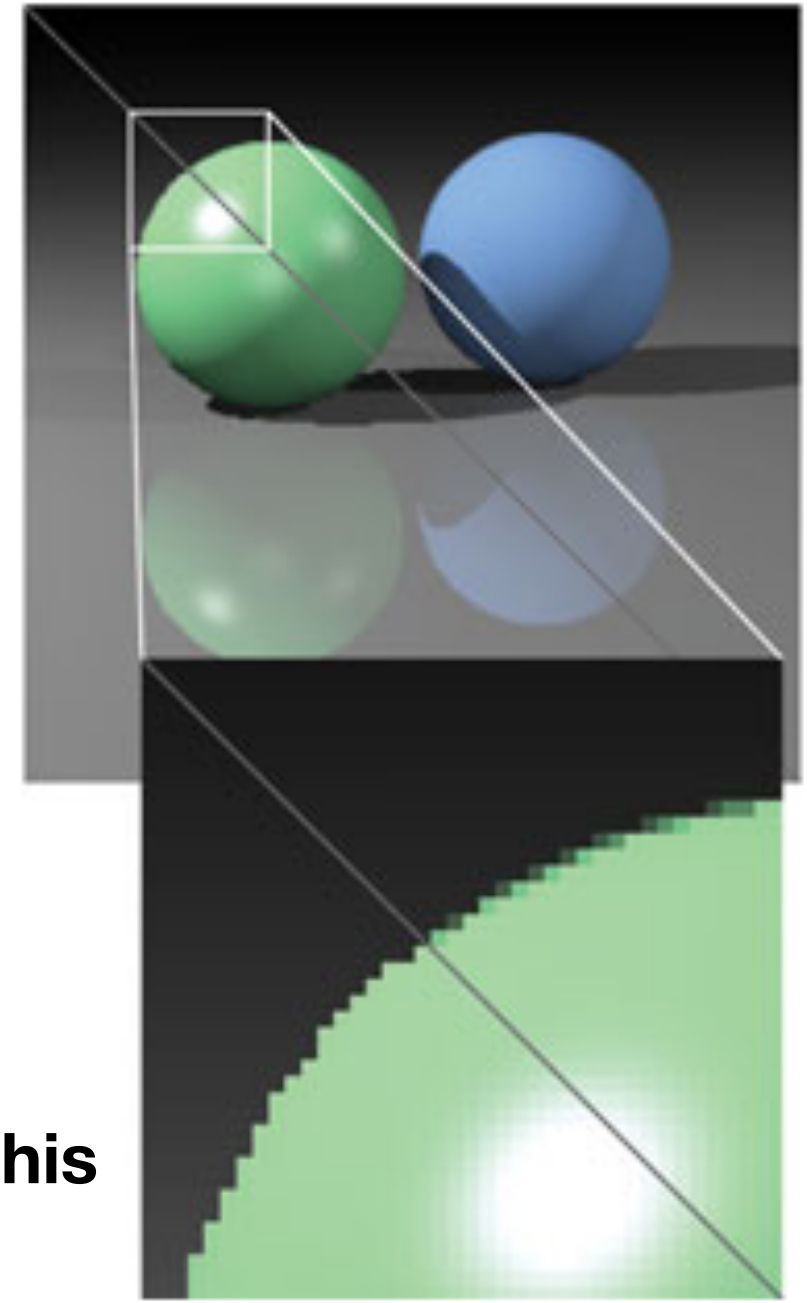
Problem: jagged object and shadow edges





we want this

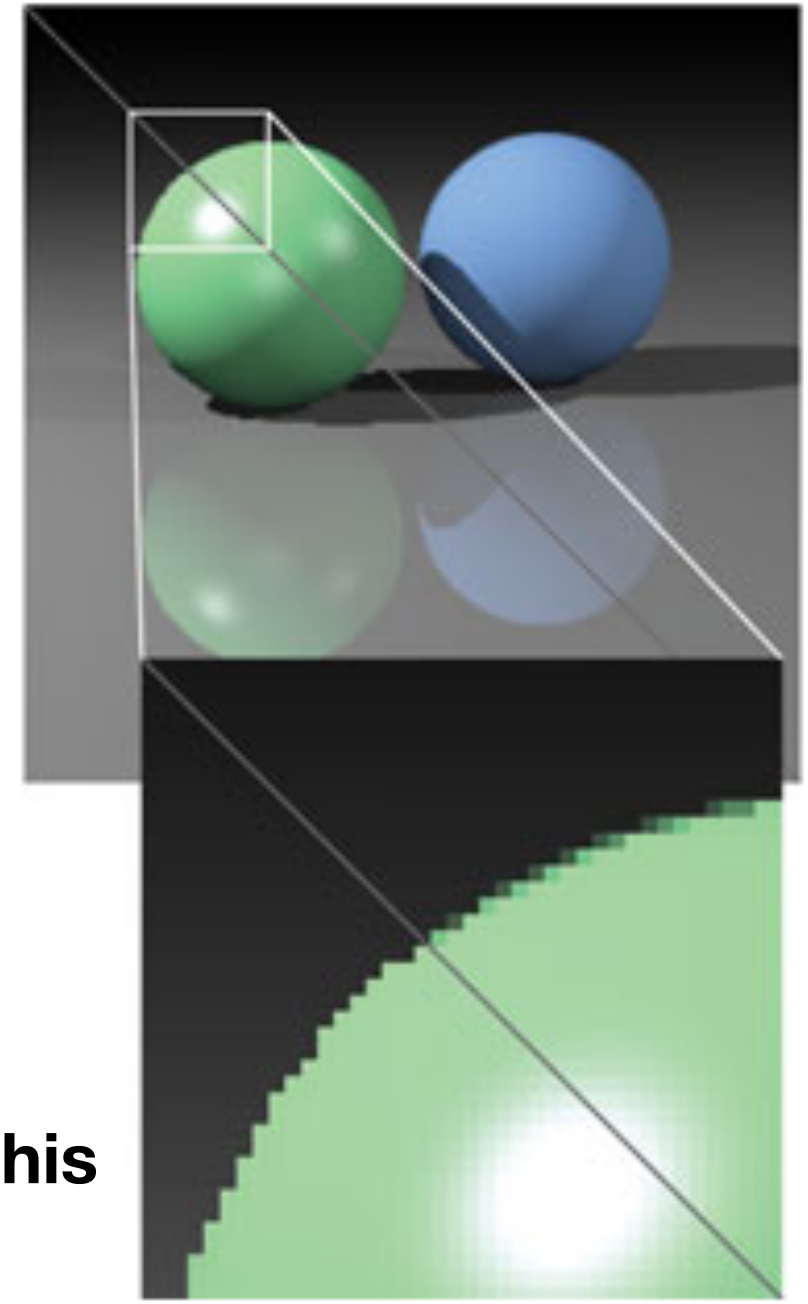
we have this



we want this

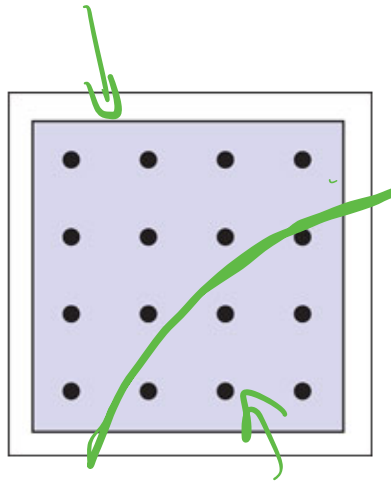
we have this

Idea: **supersample** rays within each pixel.



we want this

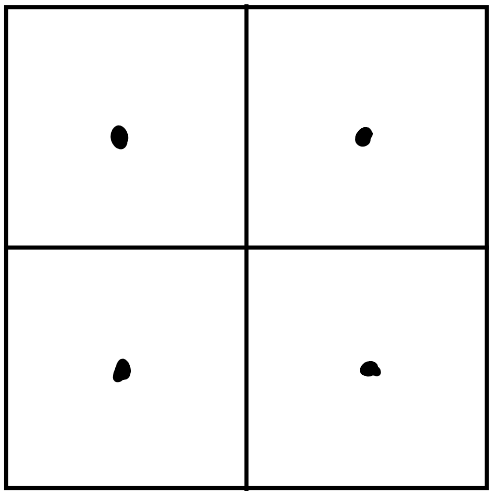
we have this



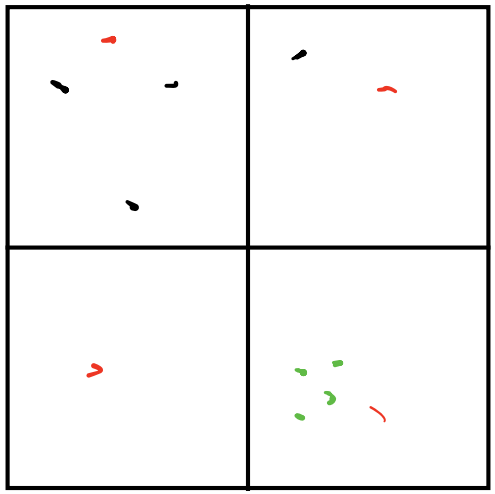
Idea: **supersample** rays within each pixel.

Regular, Random, and Stratified Sampling

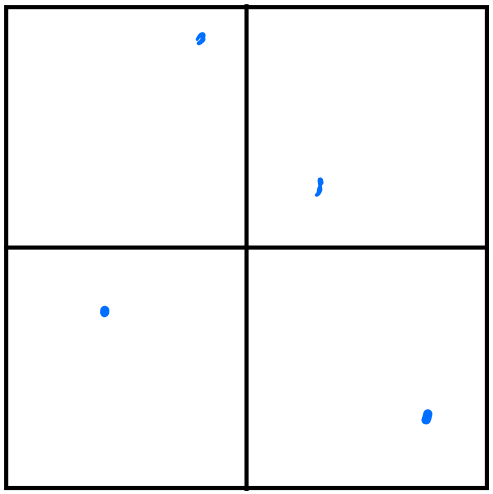
Regular



Random

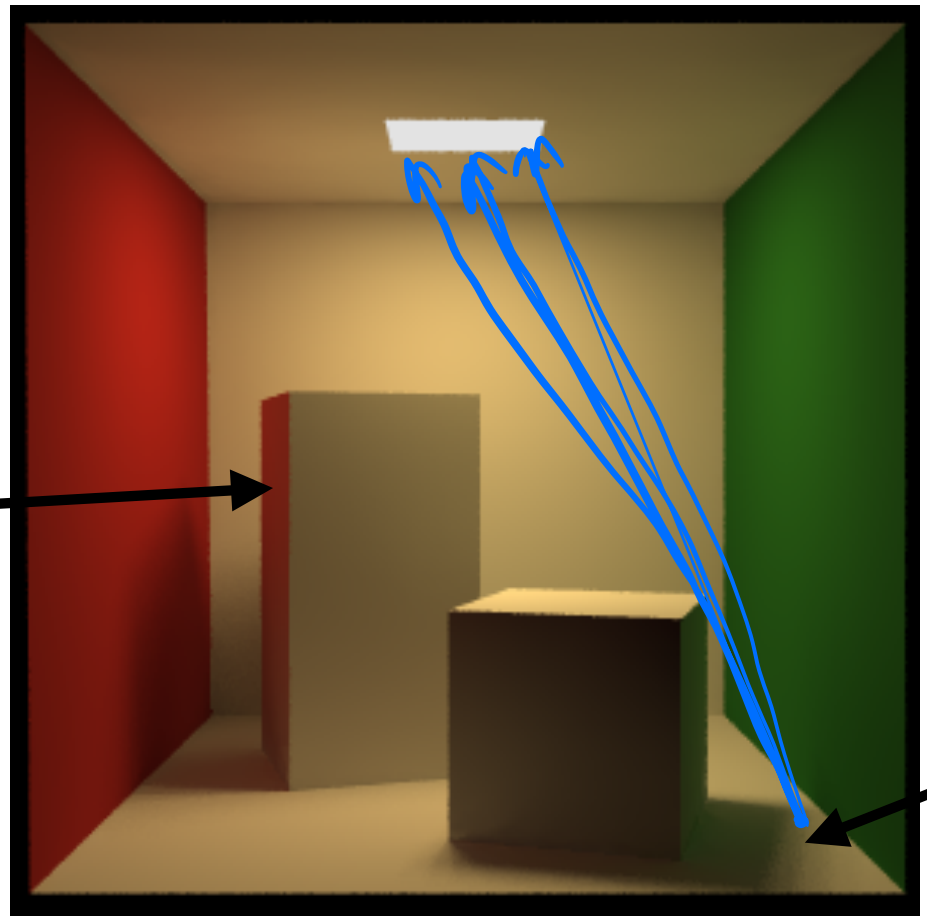


Stratified



Distribution Ray Tracing

Problem: area light sources



Distribution Ray Tracing

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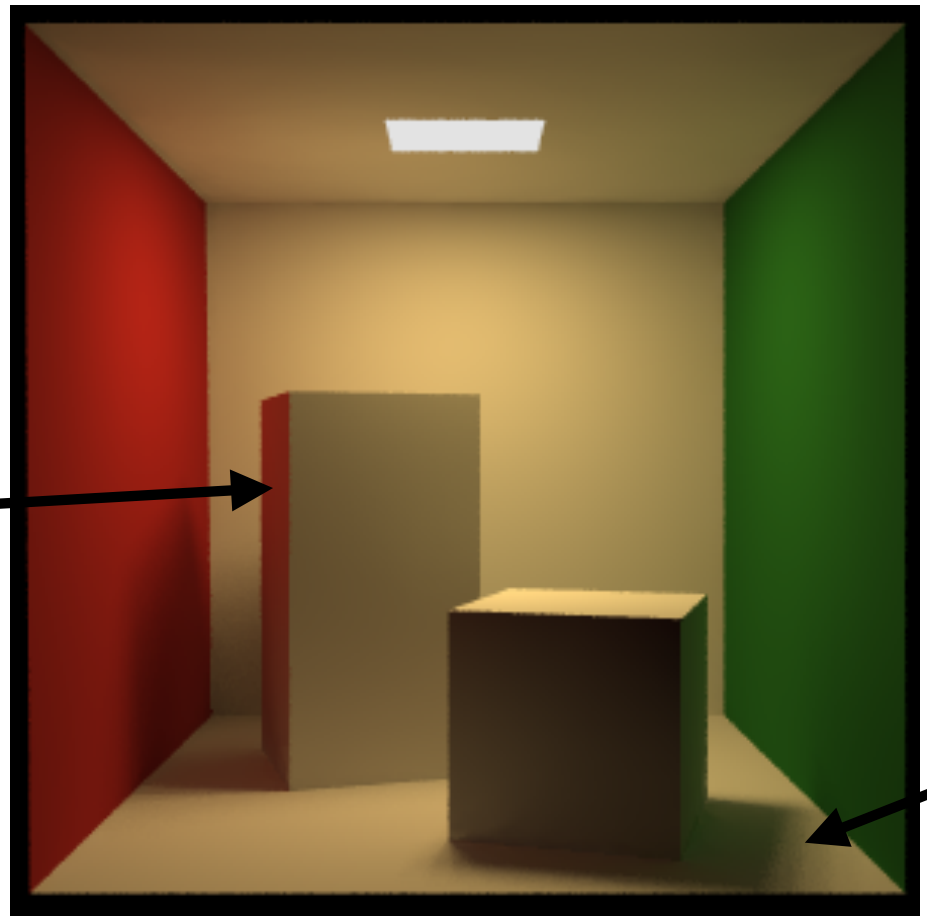
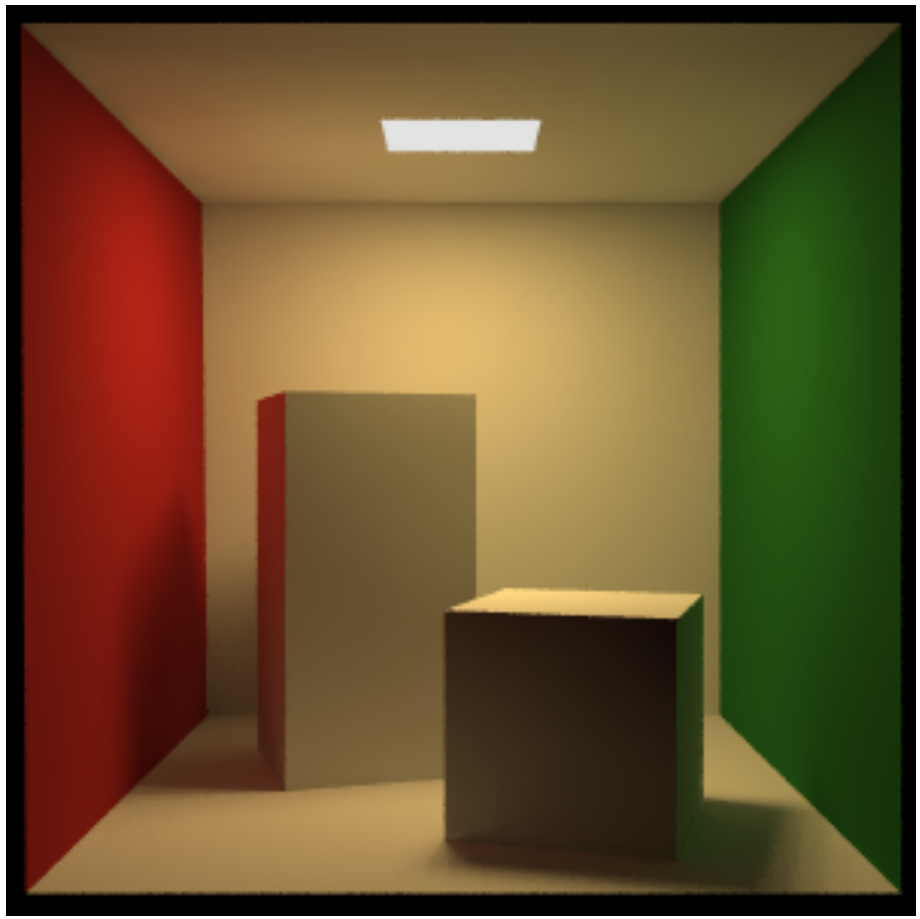


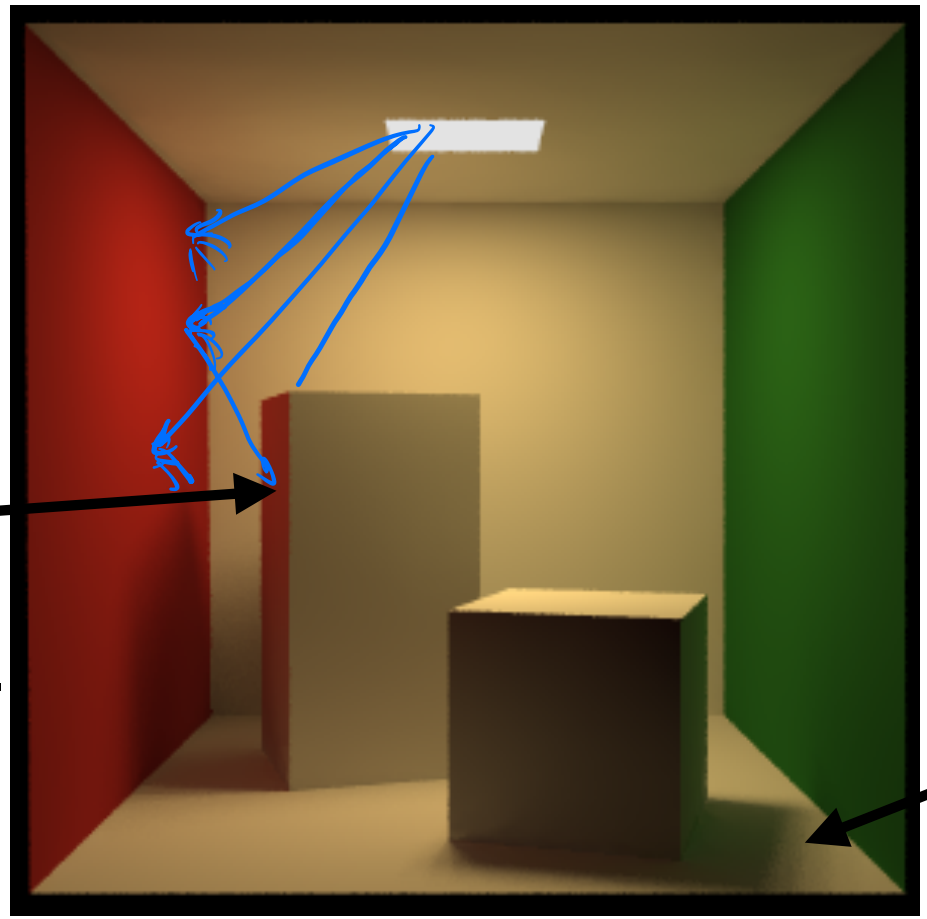
Distribution Ray Tracing

Problem: area light sources



Distribution Ray Tracing

Problem: area light sources



global illumination

This one's trickier..

Ch 23

soft shadows

Distribution Ray Tracing

Problem: glossy reflection

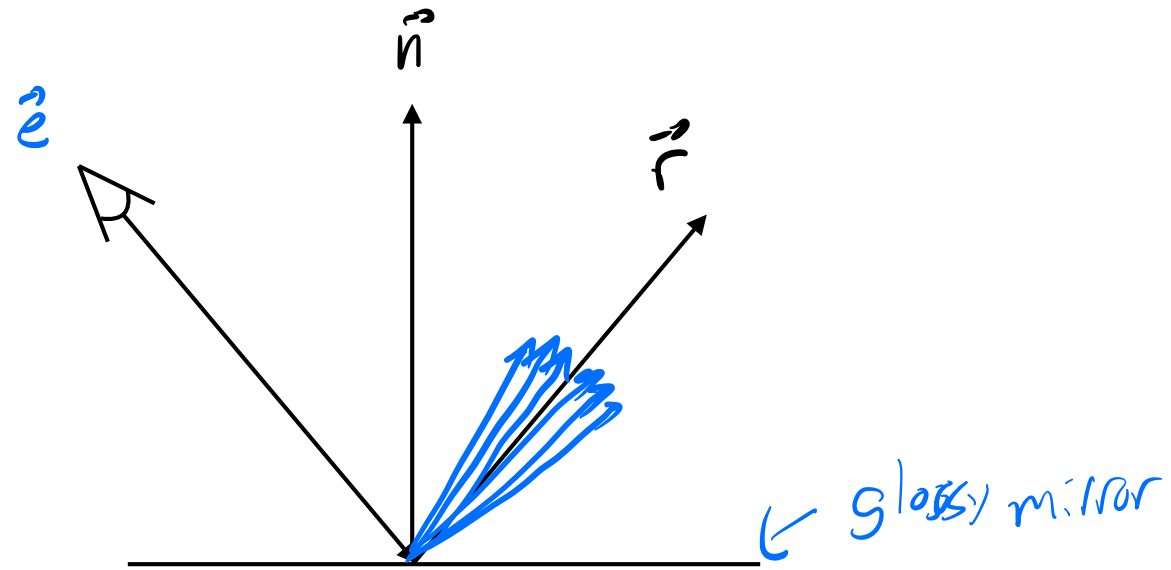
Mirror

Glossy Mirror

Images: Kevin Suffern http://www.raytracegroundup.com/

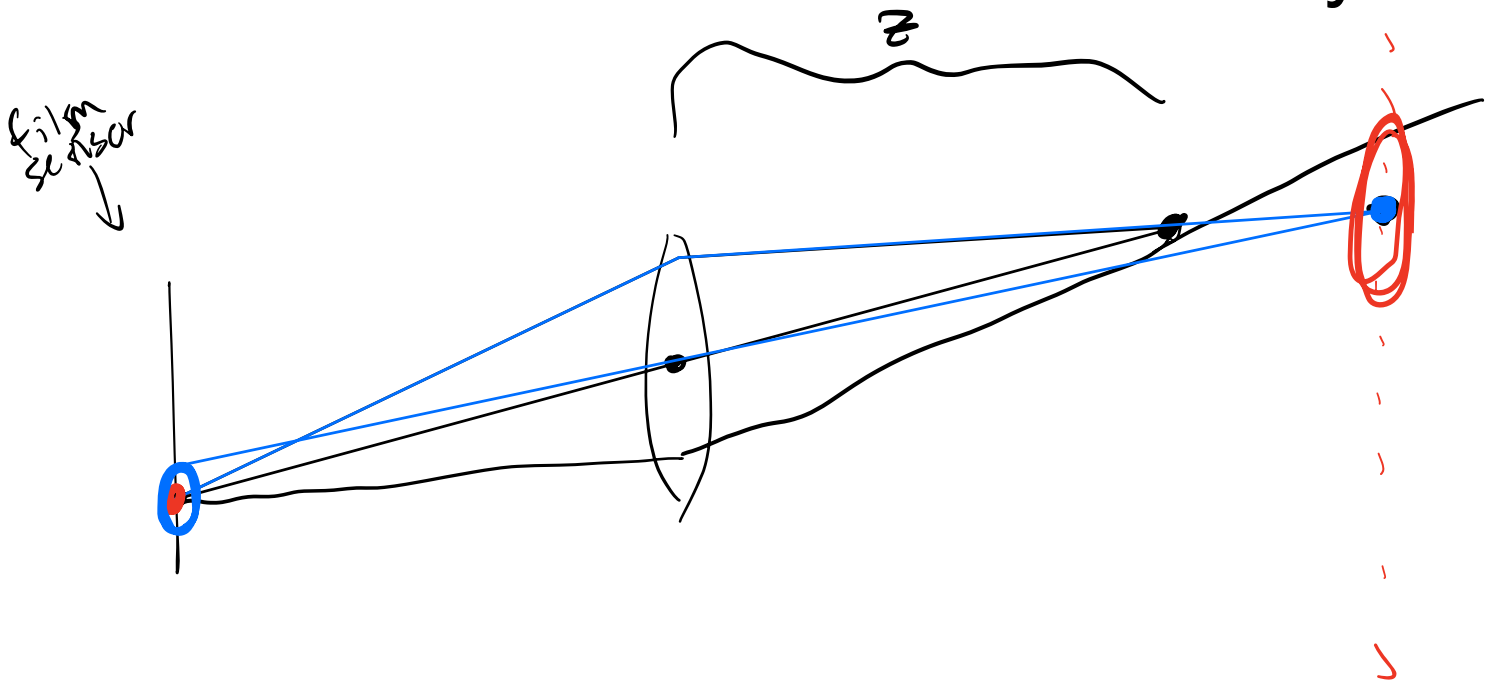
Distribution Ray Tracing

Problem: glossy reflection



Distribution Ray Tracing

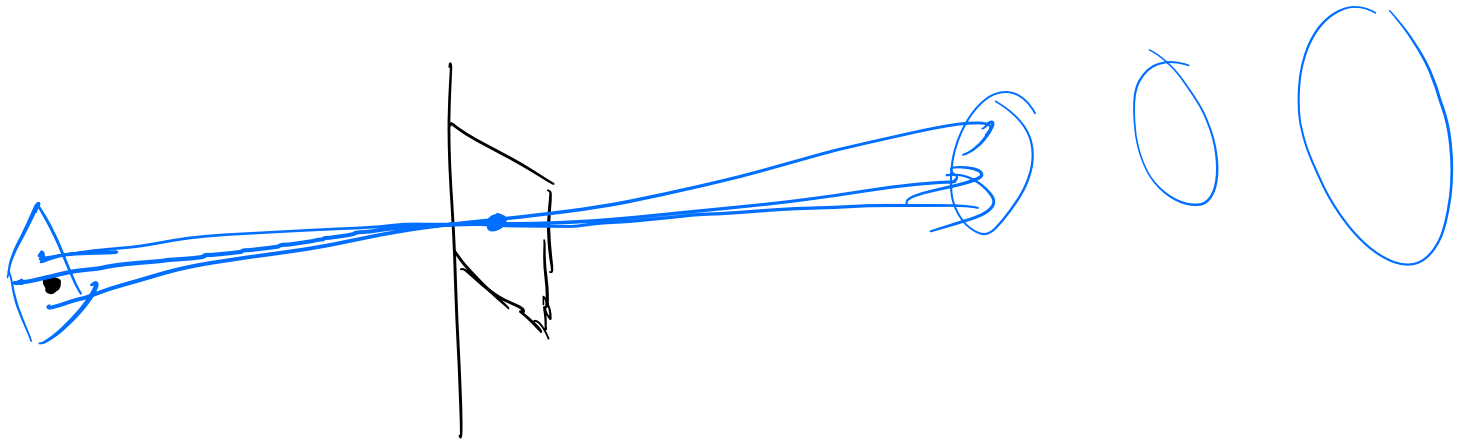
Problem: Defocus Blur - what is it really?



Distribution Ray Tracing

Problem: Defocus Blur - how do we fake it?

randomly perturb the ray origin



Distribution Ray Tracing

Problem: Motion Blur

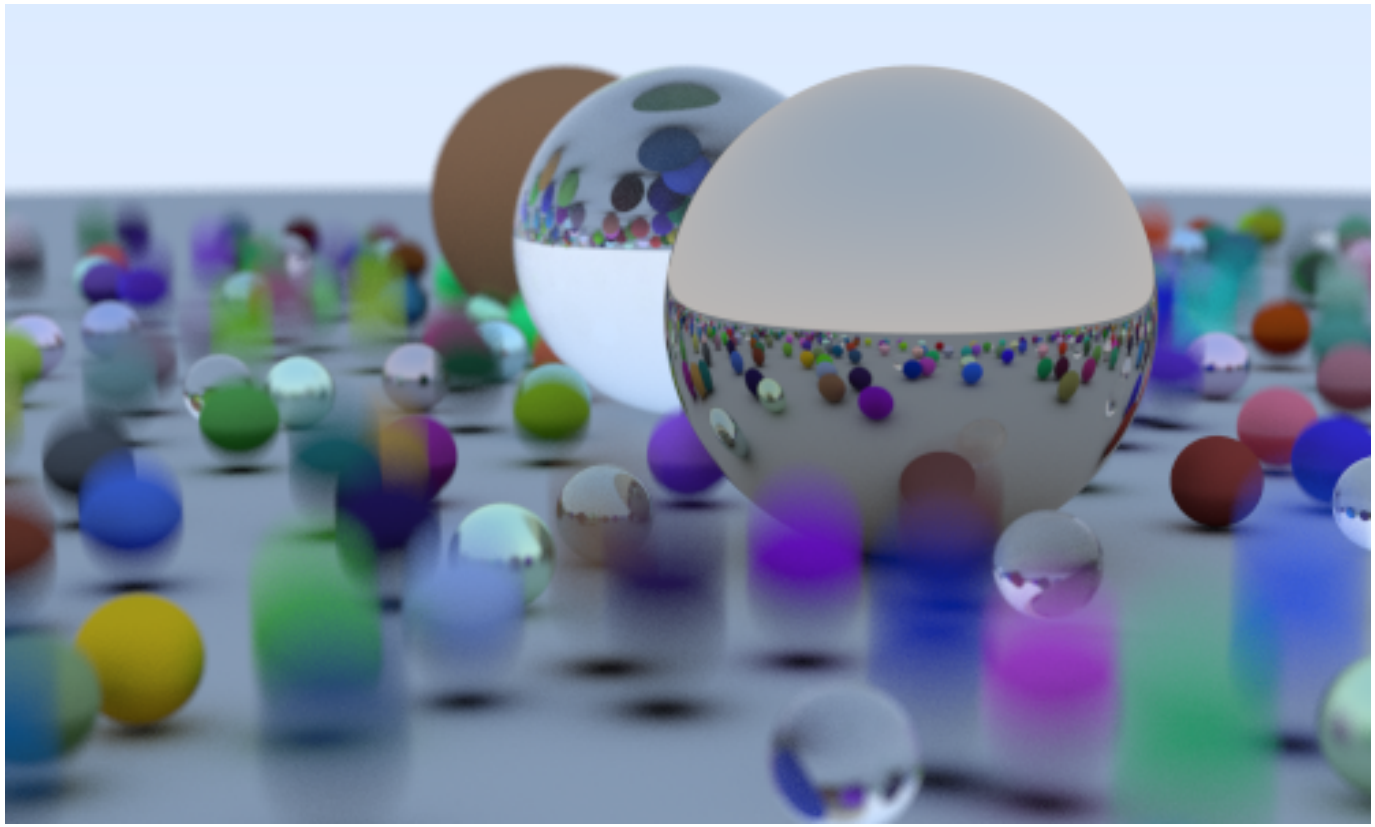


Image: Peter Shirley

Plot twist:
sample from a 1D interval, not a rectangle!

Up Next

- Today was: slowing down ray tracing
- Friday is: implementing ray tracing (A2)
- Monday is: speeding up ray tracing
- Thereafter: Transformations - positioning, scaling, rotating, shearing, etc. of objects and cameras in the scene.
- Intro to object-order rendering.