

# Monte Carlo Ray Tracing

CS 4620 Lecture 22

# Basic ray tracing

- Many advanced methods build on the basic ray tracing paradigm
- Basic ray tracer: one sample for everything
  - one ray per pixel
  - one shadow ray for every point light
  - one reflection ray, possibly one refraction ray, per intersection

# Basic ray traced image



[Glassner 89]

# Discontinuities in basic RT

- Perfectly sharp object silhouettes in image
  - leads to aliasing problems (stair steps)
- Perfectly sharp shadow edges
  - everything looks like it's in direct sun
- Perfectly clear mirror reflections
  - reflective surfaces are all highly polished
- Perfect focus at all distances
  - camera always has an infinitely tiny aperture
- Perfectly frozen instant in time (in animation)
  - motion is frozen as if by strobe light



# The Blue Umbrella

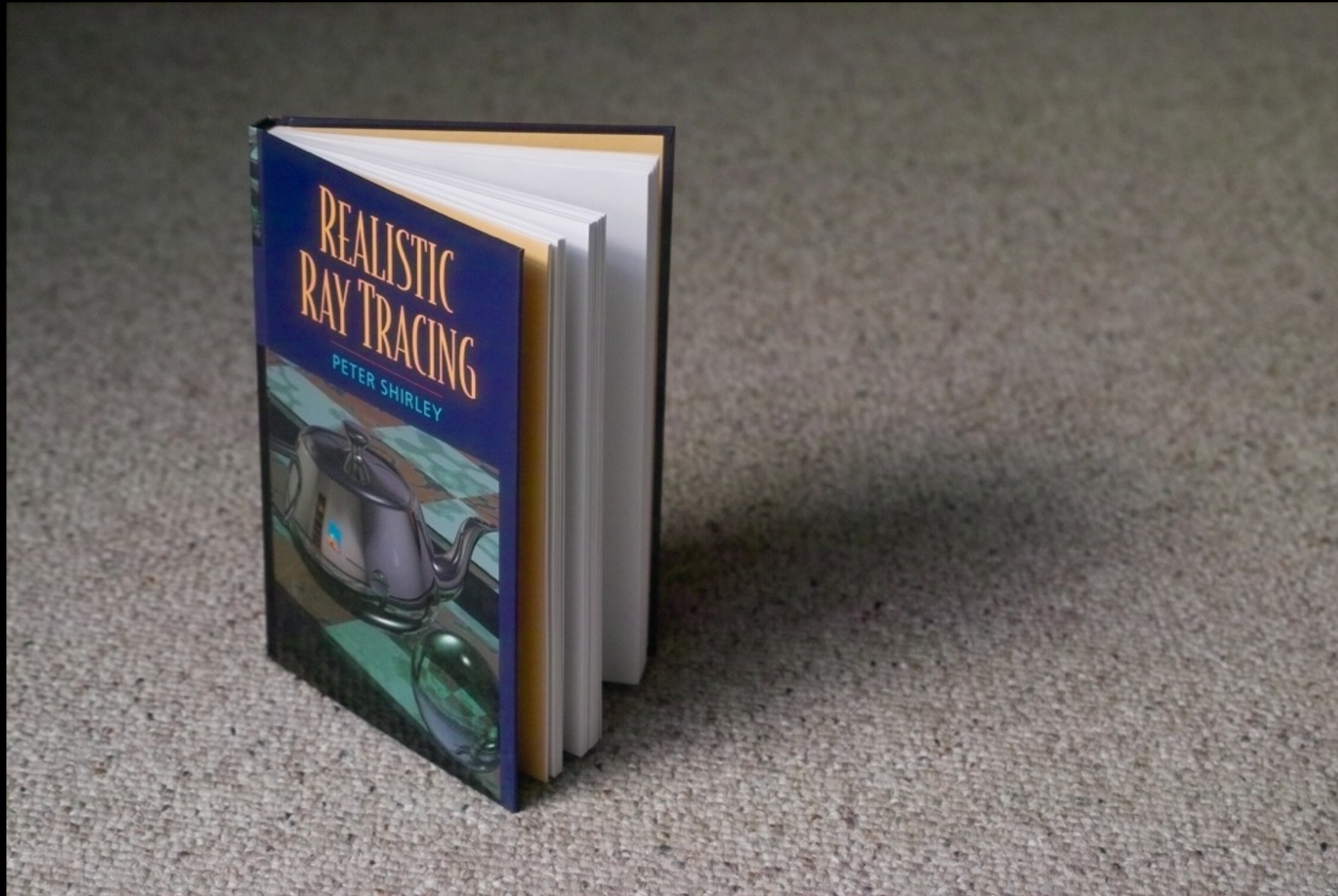


- Latest Pixar short
- Made partly to showcase new more photorealistic rendering
  - much of it based on the ideas we saw in this lecture

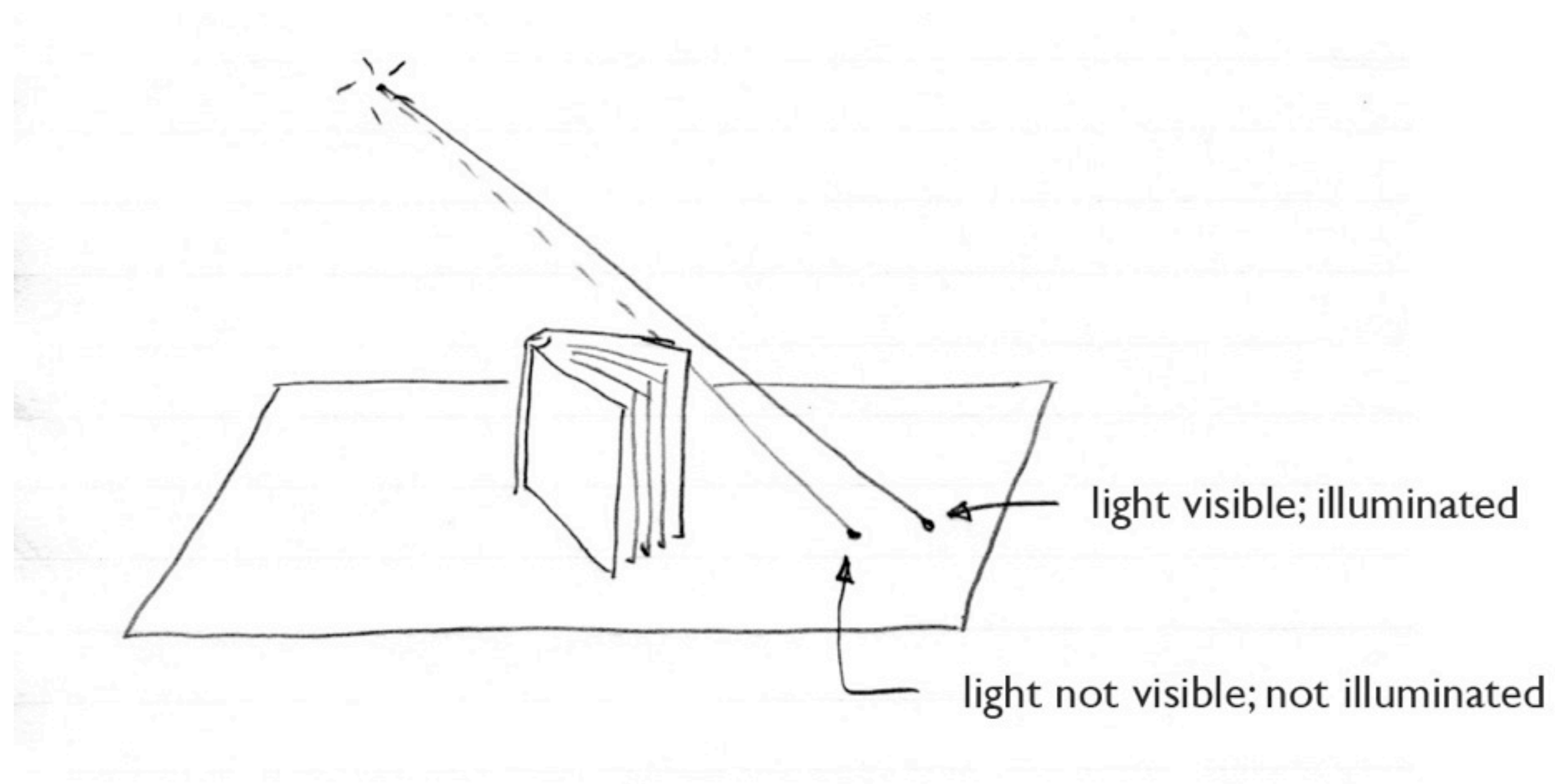
worth a look:

<http://rainycitytales332.tumblr.com>

# Soft shadows

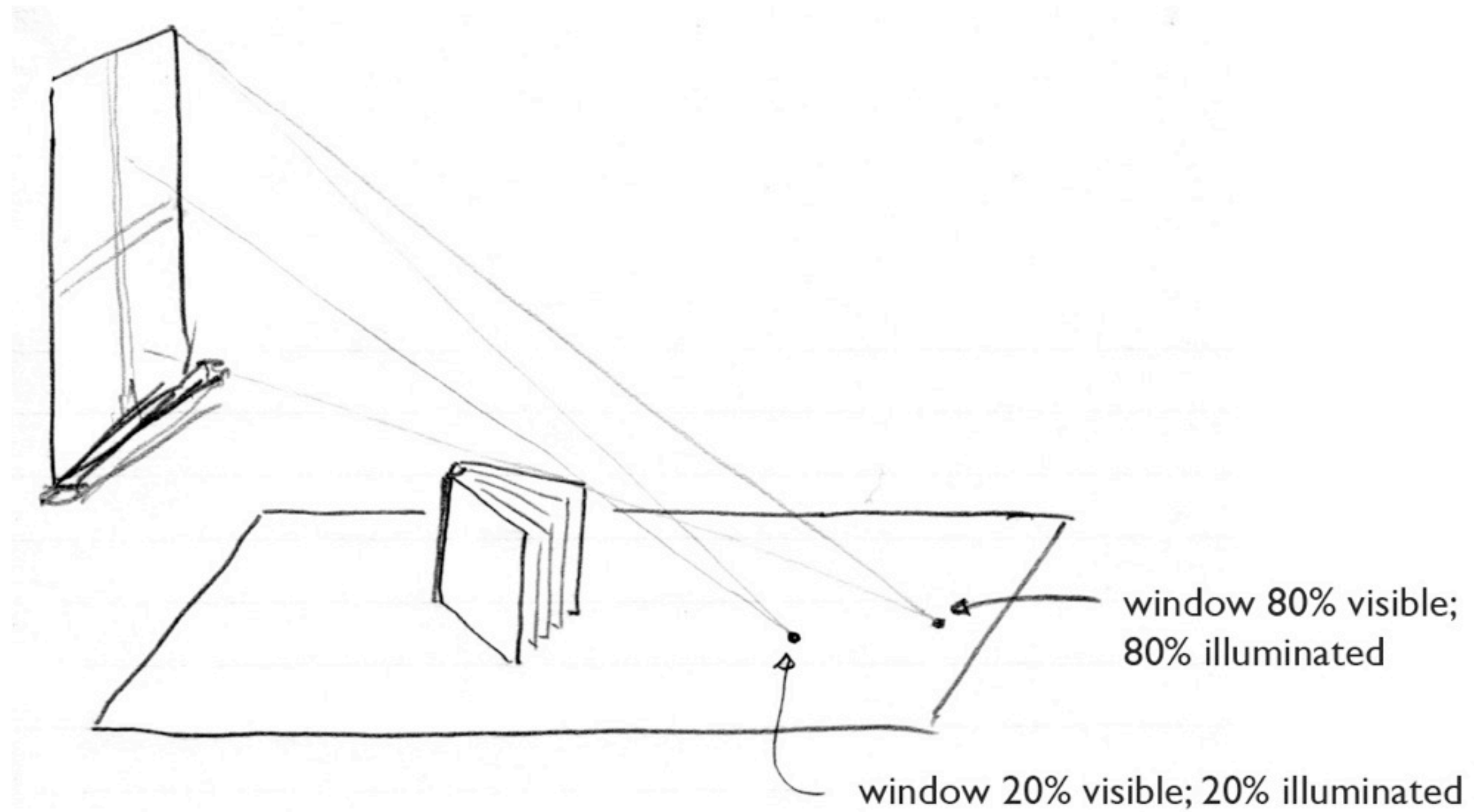


# Cause of soft shadows



point lights cast hard shadows

# Cause of soft shadows



area lights cast soft shadows

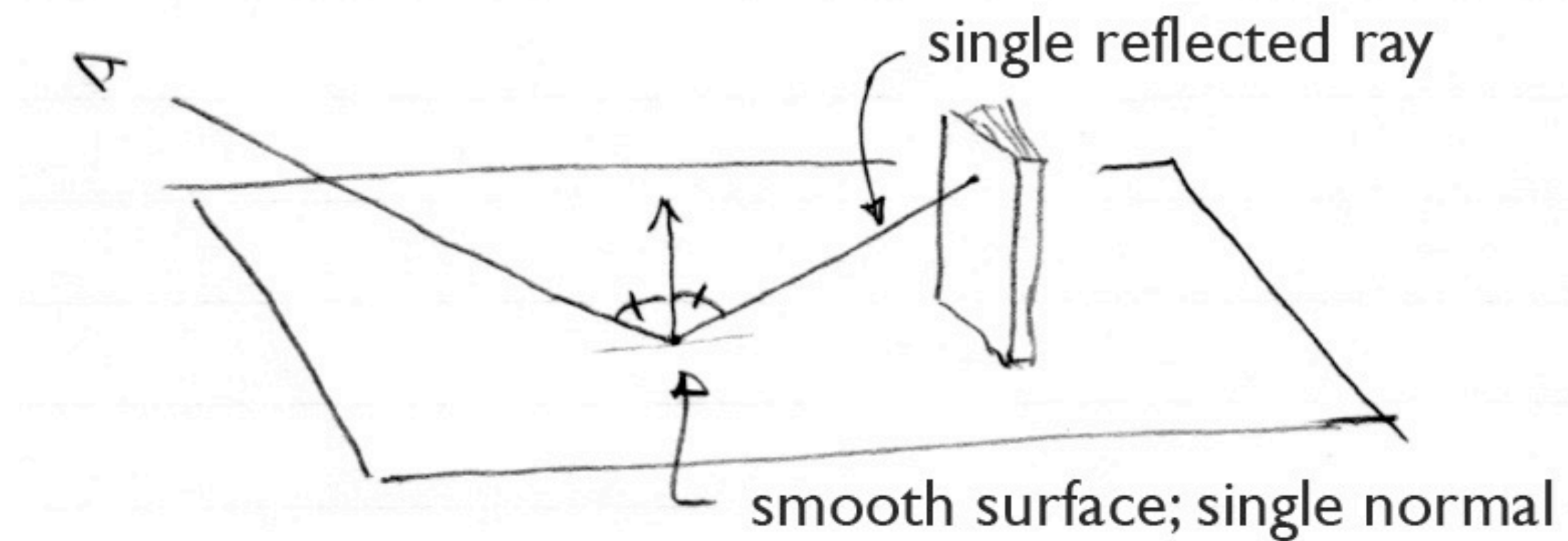


# Glossy reflection



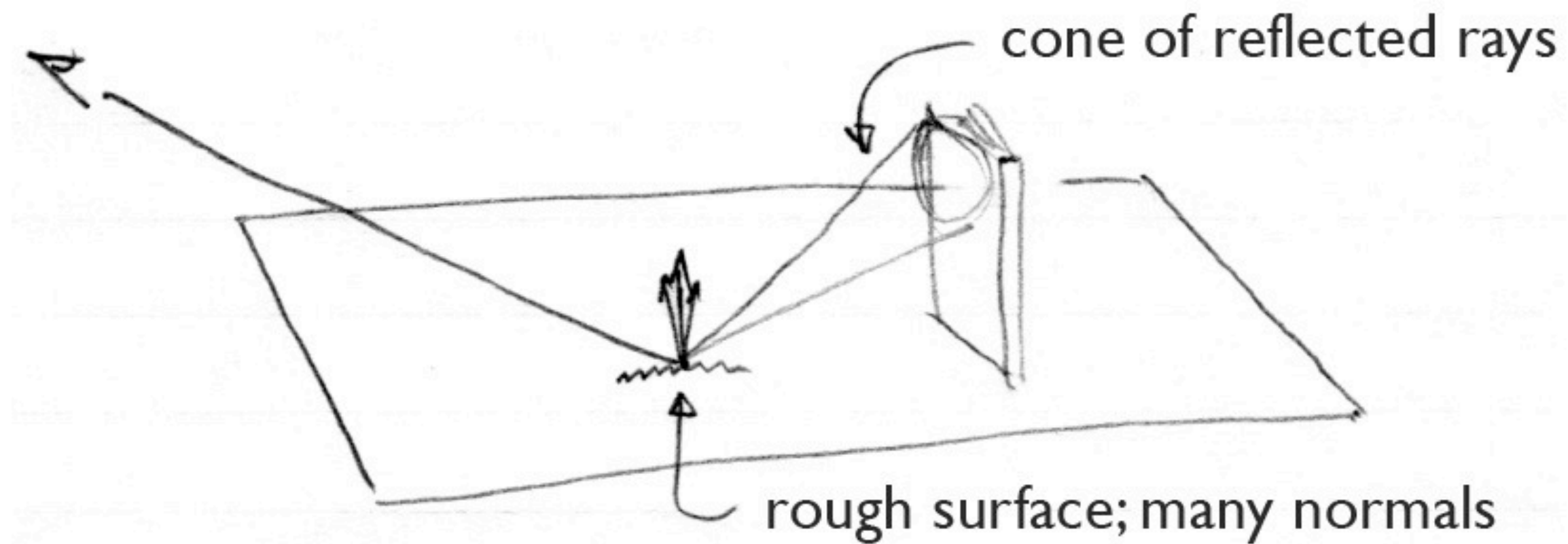
[Lafortune et al. 97]

# Cause of glossy reflection



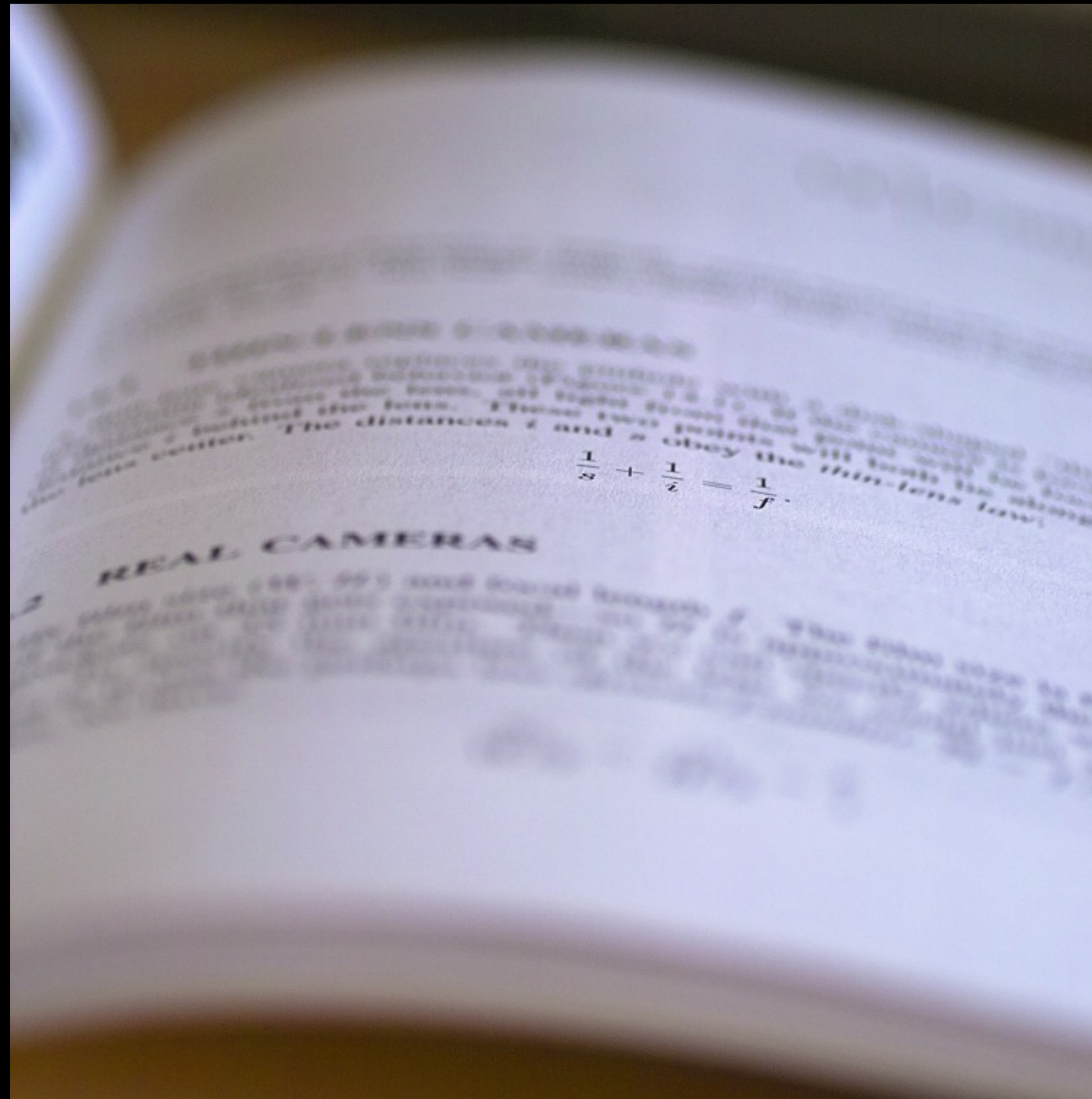
smooth surfaces produce sharp reflections

# Cause of glossy reflection

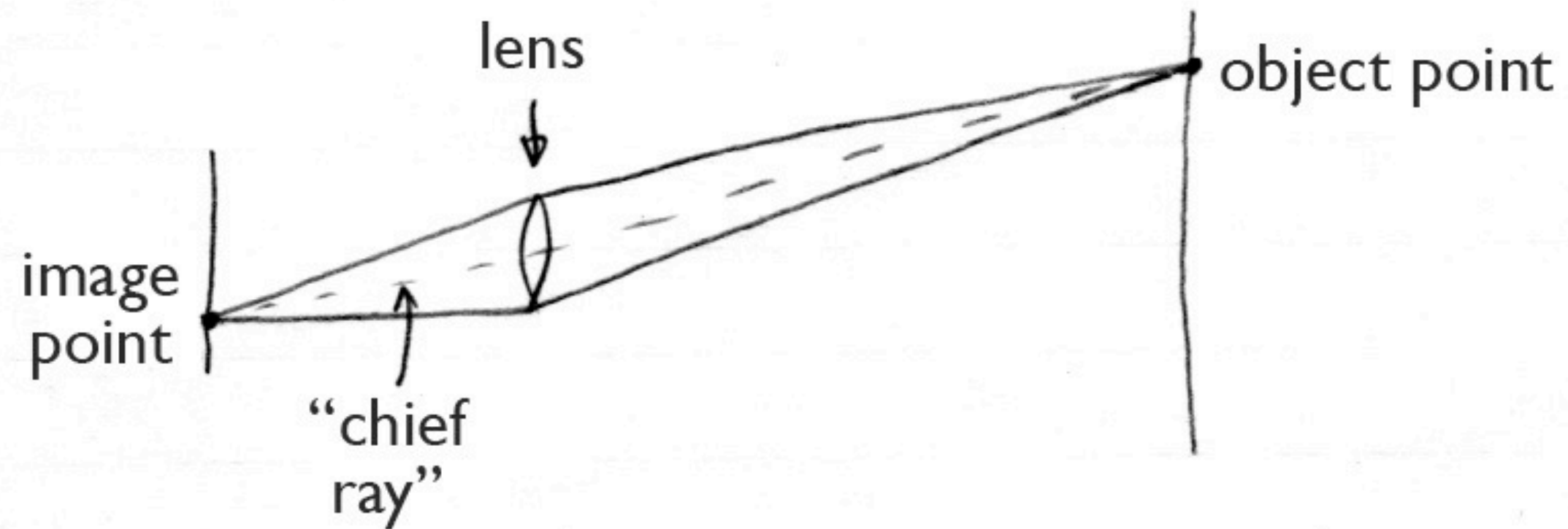


rough surfaces produce soft (glossy) reflections

# Depth of field

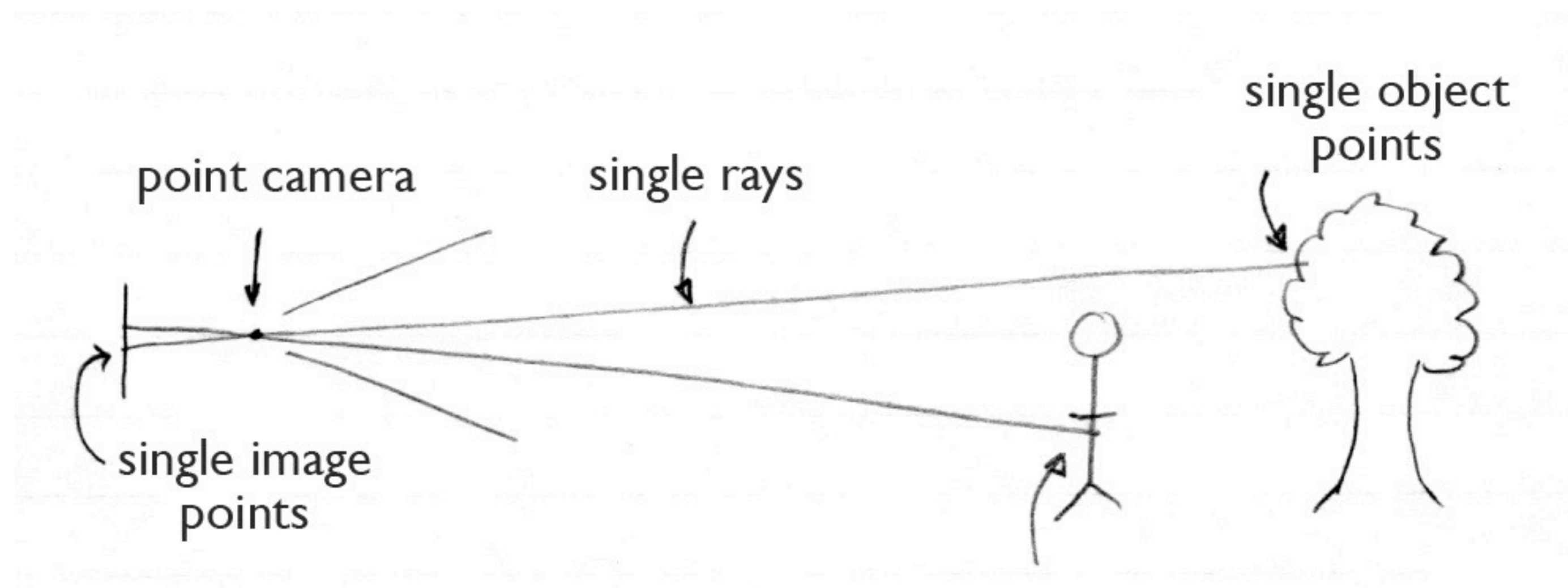


# Cause of focusing effects



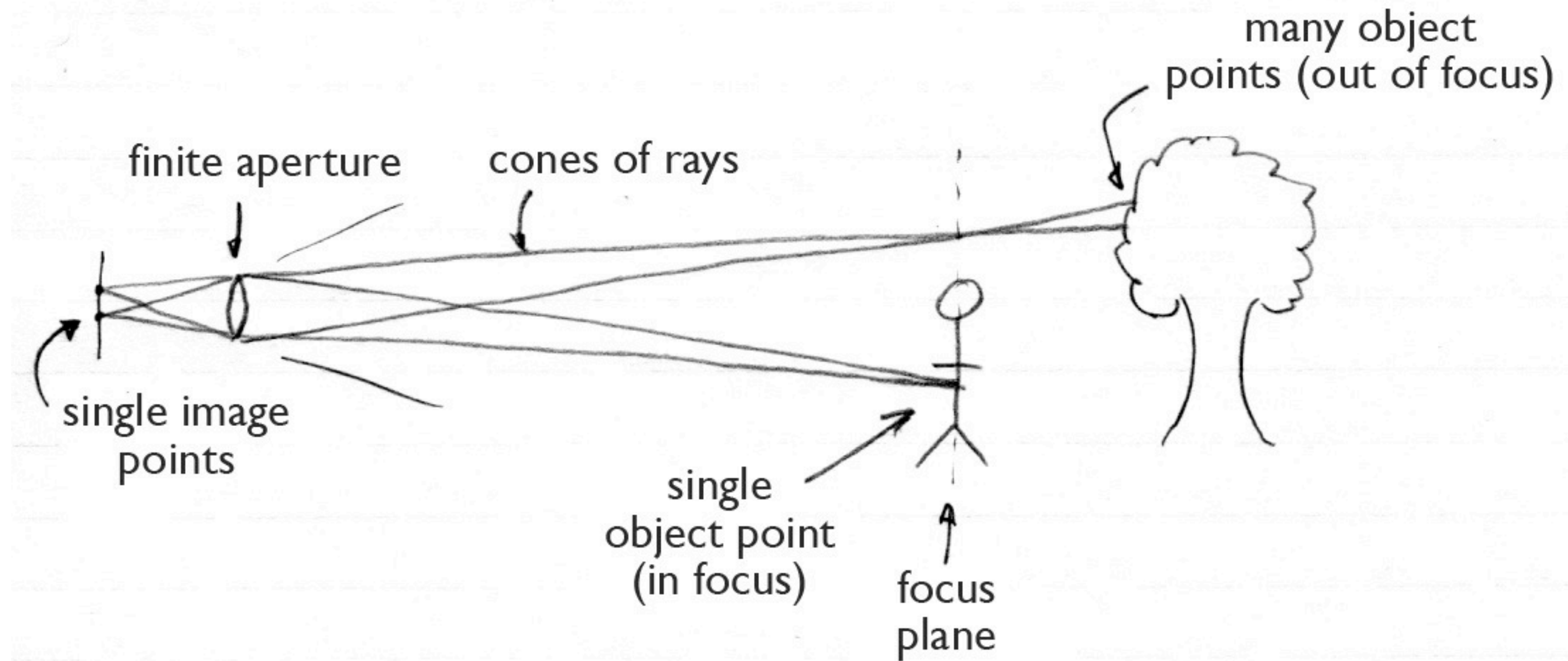
what lenses do (roughly)

# Cause of focusing effects



point aperture produces always-sharp focus

# Cause of focusing effects



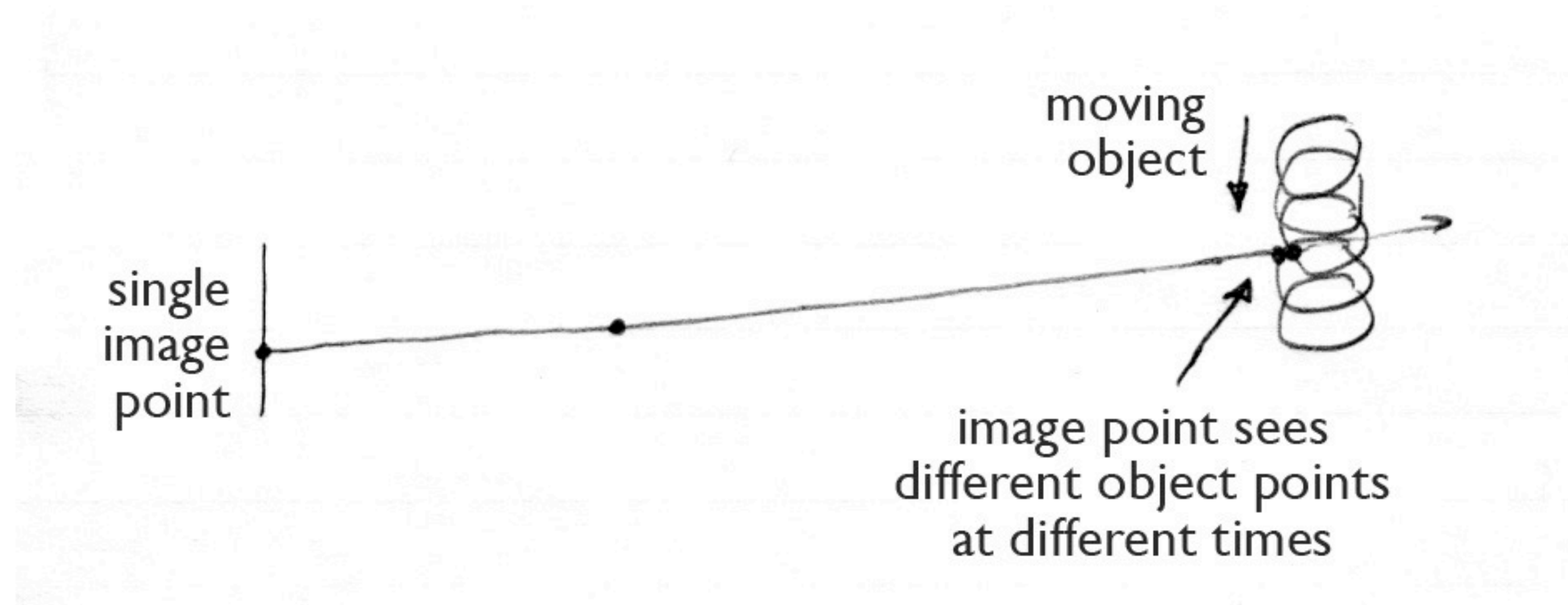
finite aperture produces limited depth of field

# Motion blur





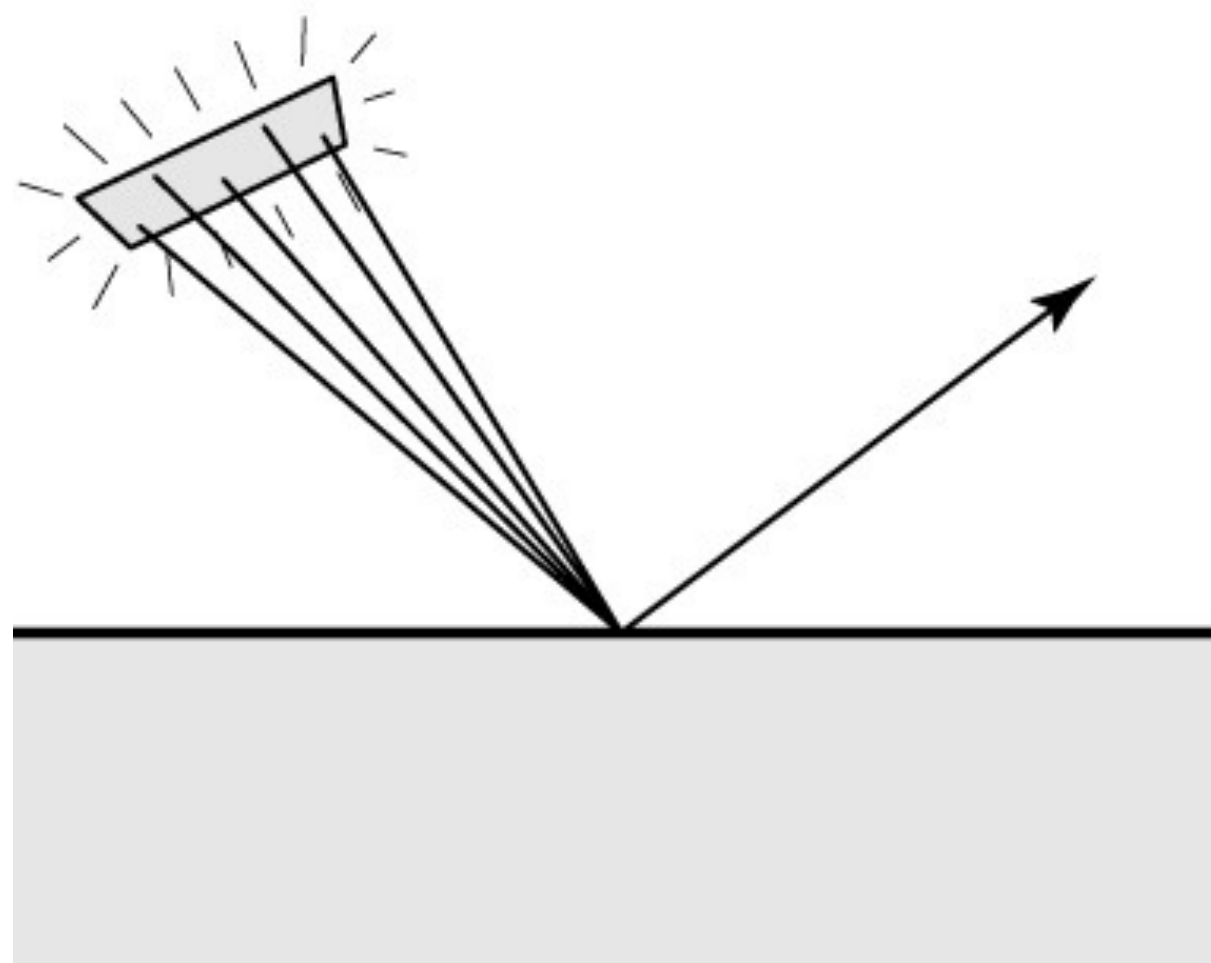
# Cause of motion blur





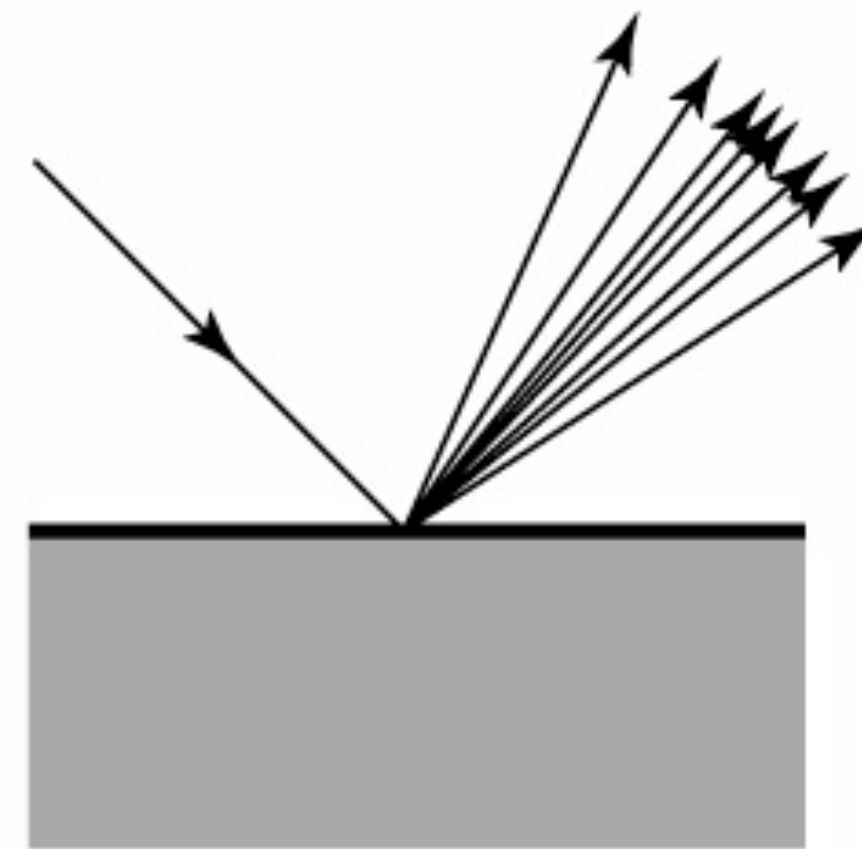
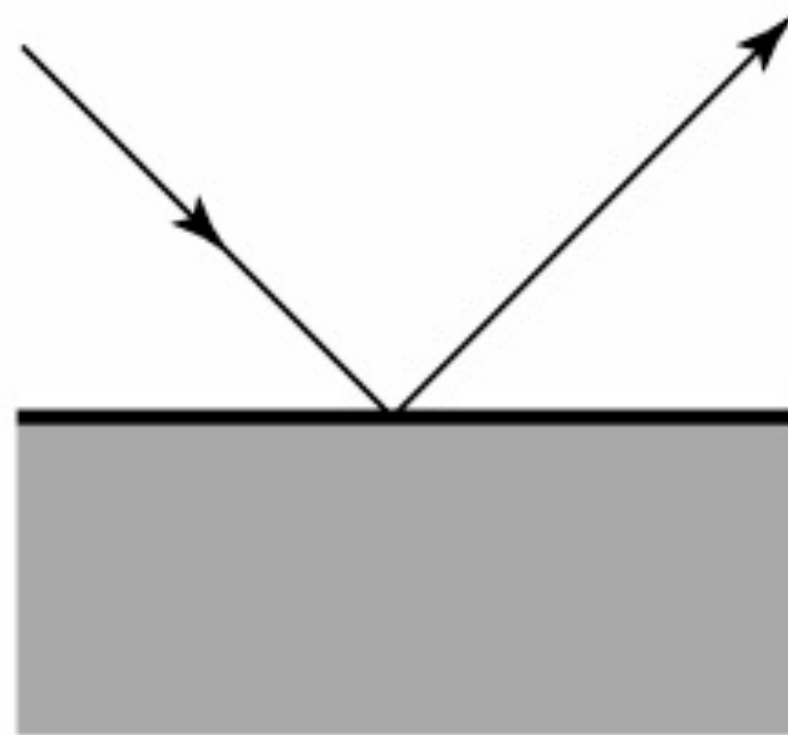
# Creating soft shadows

- For area lights: use many shadow rays
  - and each shadow ray gets a different point on the light
- Choosing samples
  - general principle: start with uniform in square



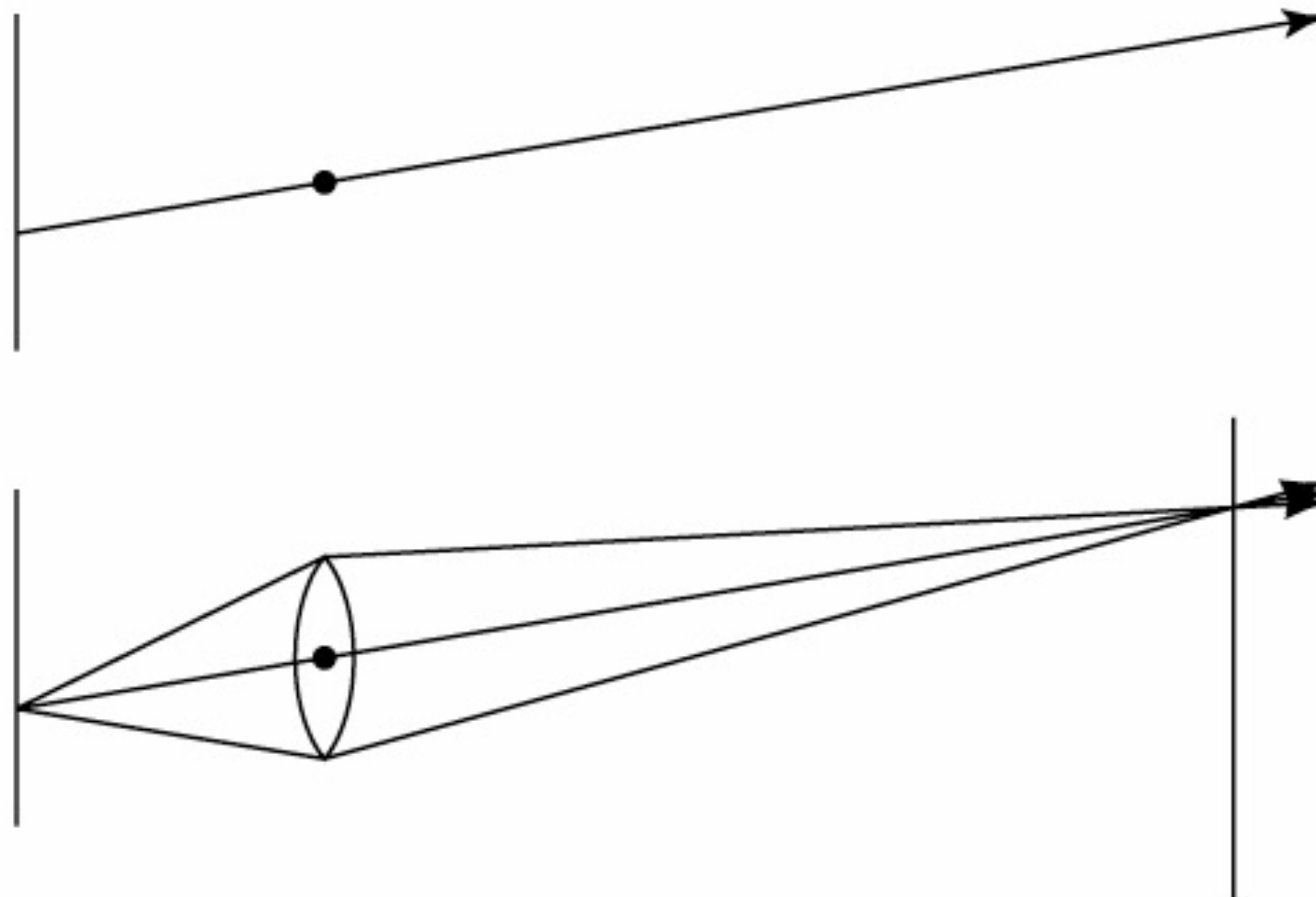
# Creating glossy reflections

- Jitter the reflected rays
  - Not exactly in mirror direction; add a random offset
  - Can work out math to match Phong exactly
  - Can do this by jittering the normal if you want



# Depth of field

- Make eye rays start at random points on aperture
  - always going toward a point on the focus plane



# Motion blur

- Caused by finite shutter times
  - strobing without blur
- Introduce time as a variable throughout the system
  - object are hit by rays according to their position at a given time
- Then generate rays with times distributed over shutter interval

