

# 3GC3 Final Project

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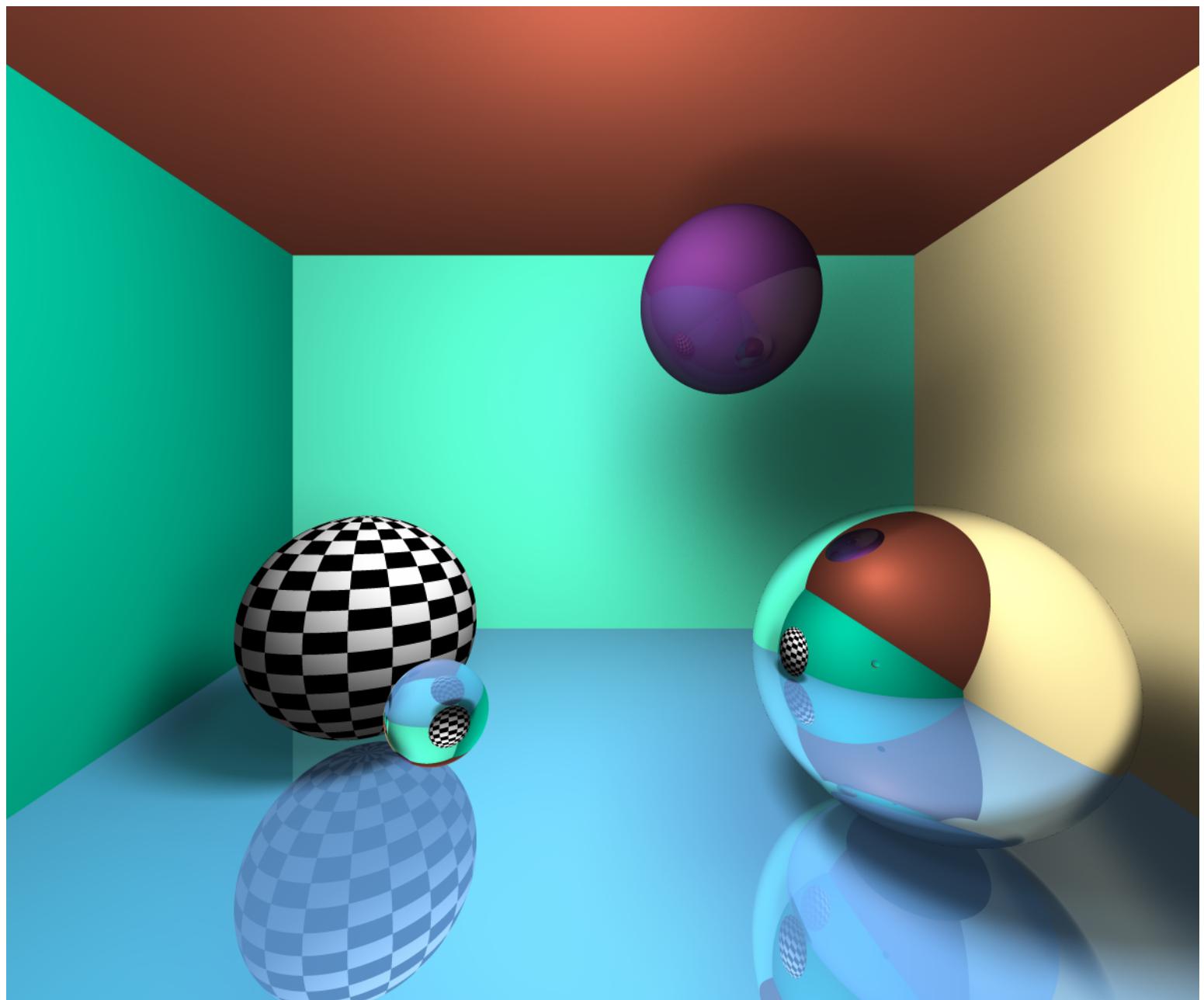


Figure 1: Reflective floor, 100% transparent sphere showing refraction, checkered sphere with texture mapping, mirror sphere. 64x random sampled anti-aliasing with 300 iterations for soft shadows. 13h50m of CPU time.

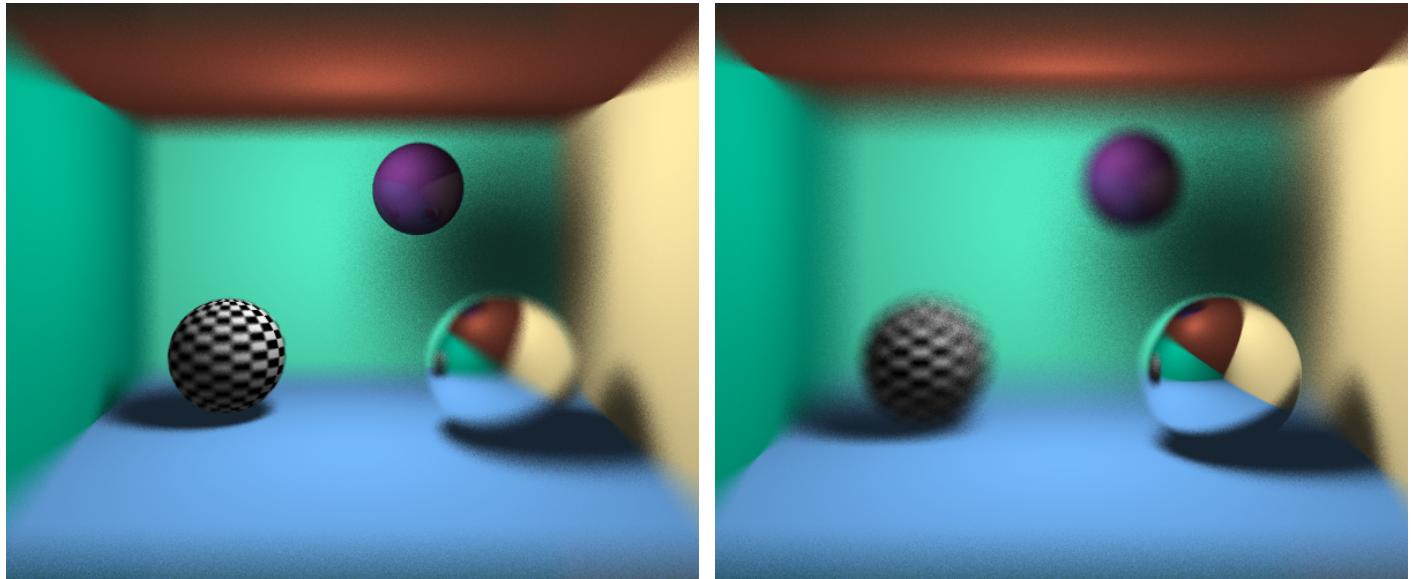
# Contents

## 1 Feature Overview

- CPU-based ray tracer
- Output to PPM bitmaps and a GLUT window
- Scene files for configuring rendering and scene parameters, materials, lights, and objects
- Support for planes, spheres, and disks
- Color and checkered material with proper texture mapping for spheres
- Materials specify coefficients for: ambient, diffuse, and specular light; transmission; index of refraction
- Multi-threaded rendering with a configurable number of threads
- Rudimentary refraction (no Fresnel effect)
- Soft shadows achieved by “jittering” point lights and averaging multiple renders
- Anti-aliasing with both regular (uniform) and random sampling techniques
- Adjustable depth-of field and camera field of view

## 2 Scene Files

### 3 Depth of Field



(a) `DepthOfField.scene`

(b) `DepthOfField2.scene`

Figure 2: A scene displayed with two different focal points. Minimal noise reduction, could be increased.

## 4 Soft Shadows

TODO

## 5 Refraction

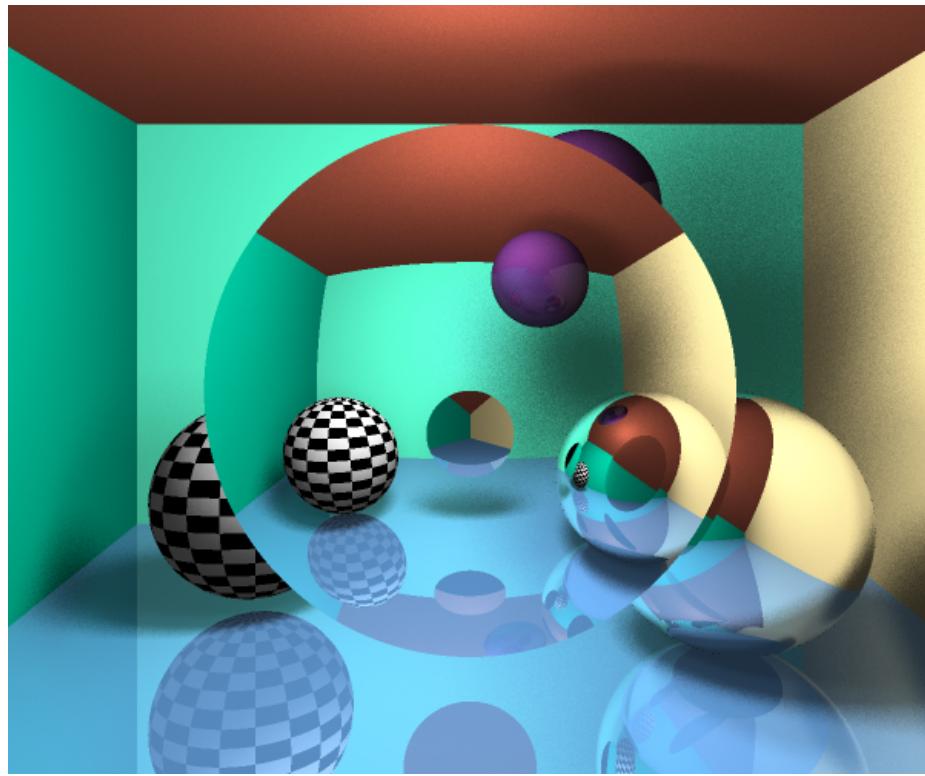


Figure 3: `DiskLens.scene`. A 100% transparent disk with a refractive index of 2.5 placed in front of the scene.

## 6 Reflection

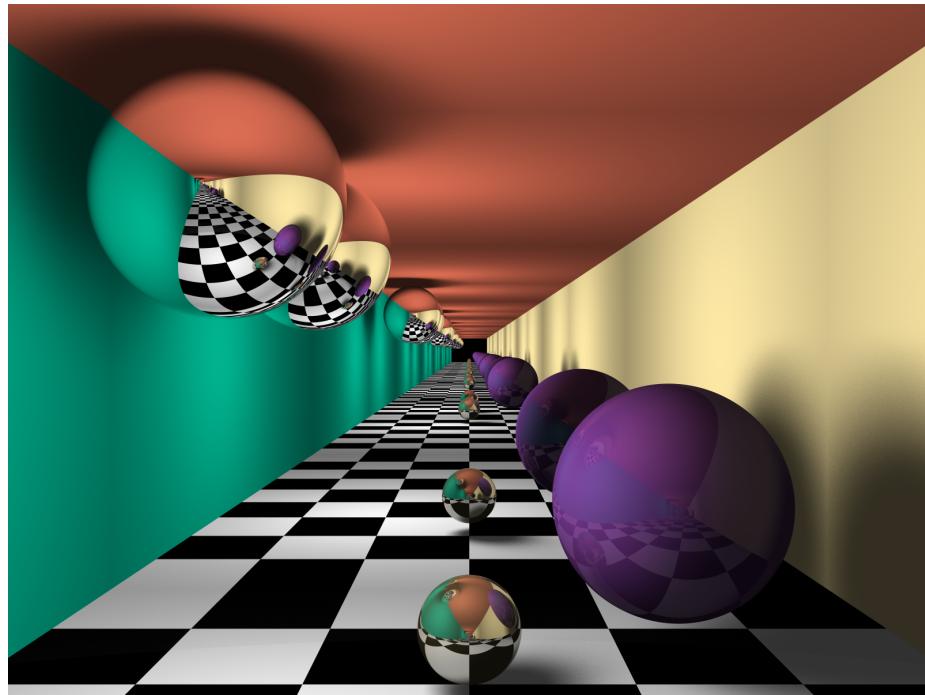


Figure 4: `HallOfMirros.scene`. Hall of mirrors with a maxDepth of 15.

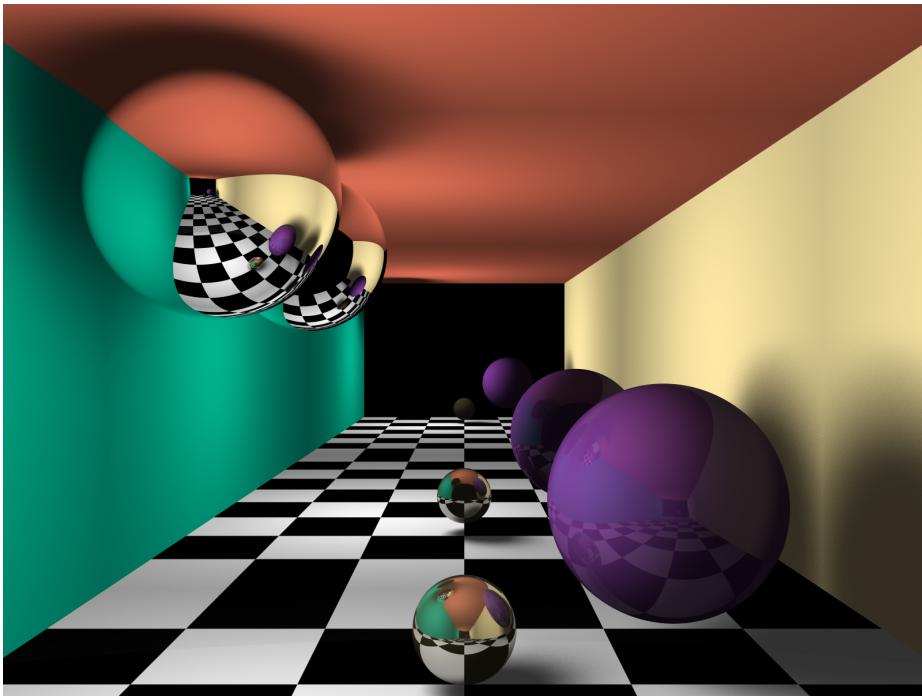


Figure 5: `HallOfMirros.scene`. Hall of mirrors with a `maxDepth` of 2.

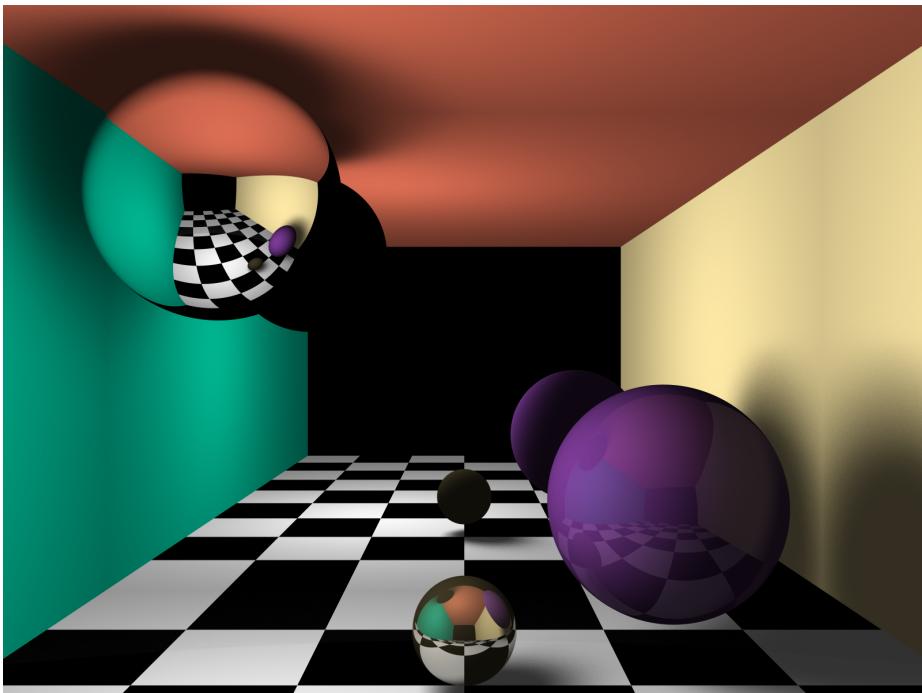


Figure 6: `HallOfMirros.scene`. Hall of mirrors with a `maxDepth` of 1.

## 7 Objects

### 7.1 Types

TODO

### 7.2 Texture

TODO

## 8 Anti-Aliasing

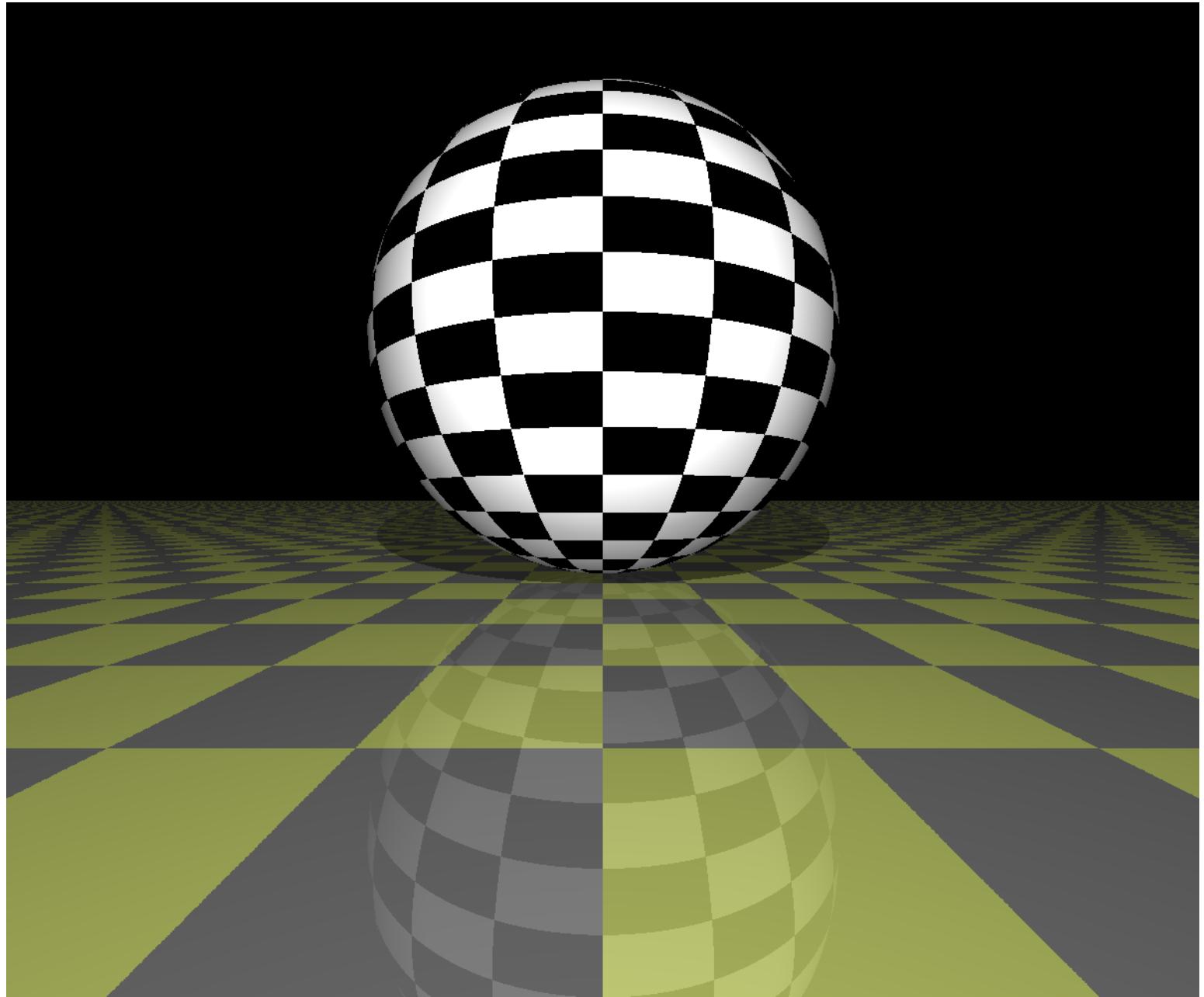


Figure 7: No anti-aliasing.

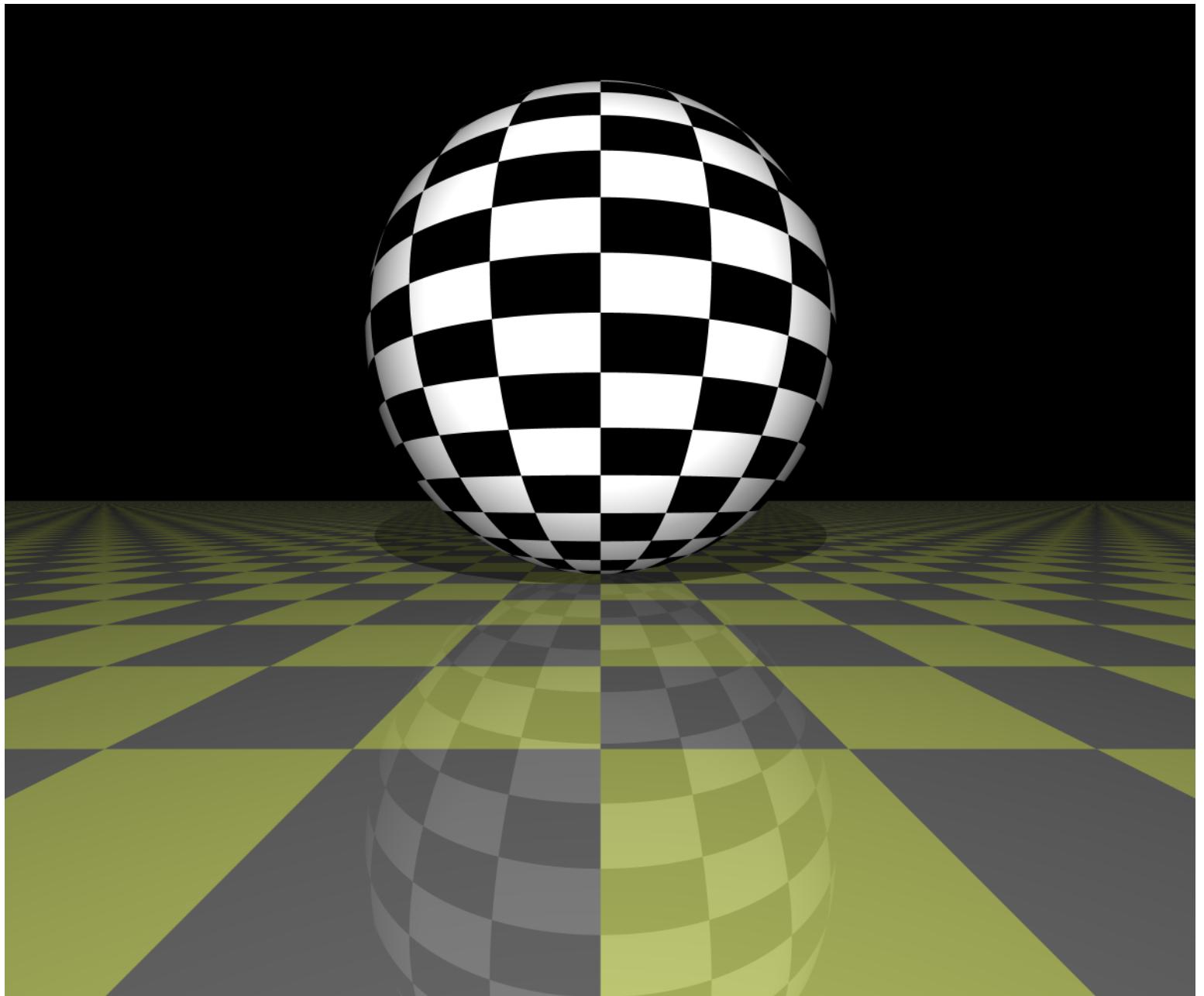


Figure 8: 64x AA using regular sampling.

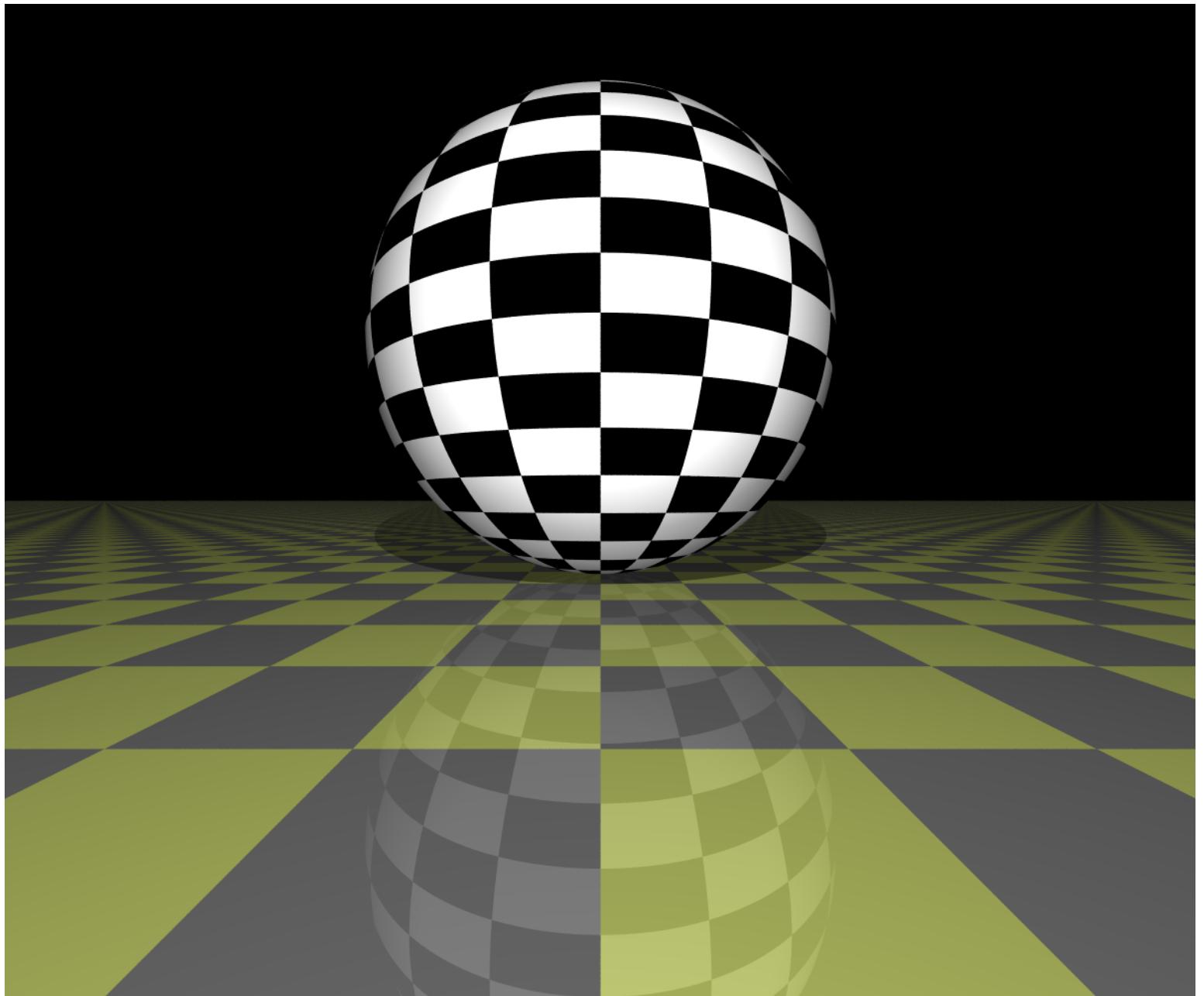


Figure 9: 64x AA using random sampling.

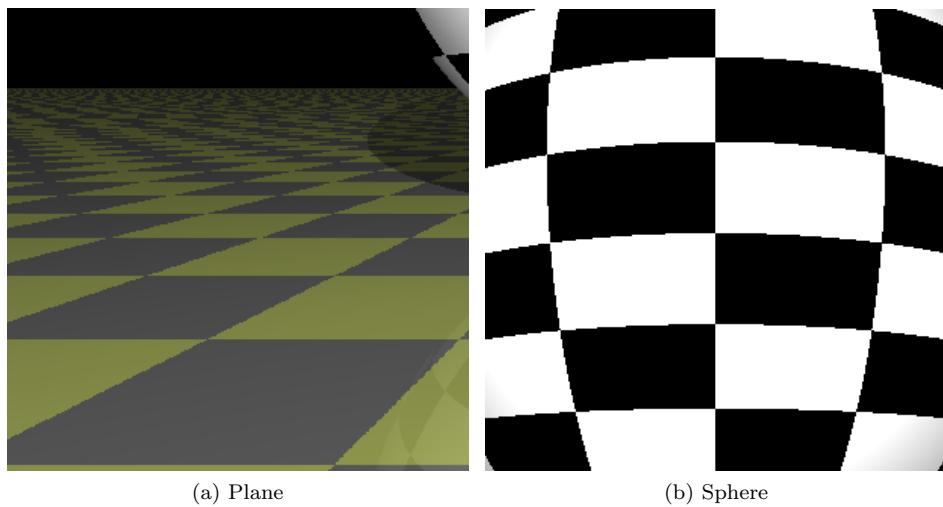


Figure 10: Vanishing plane and checkered sphere without anti-aliasing.

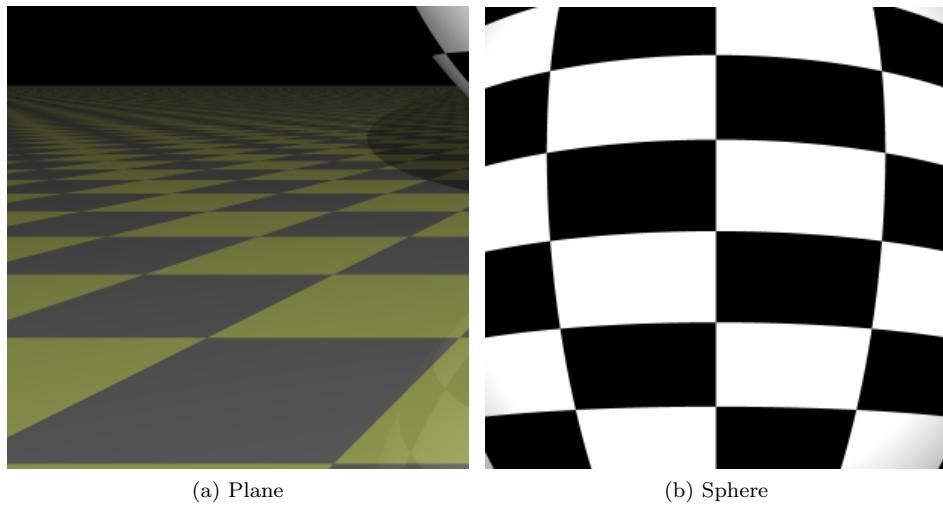


Figure 11: Vanishing plane and checkered sphere with 64x AA using regular sampling.

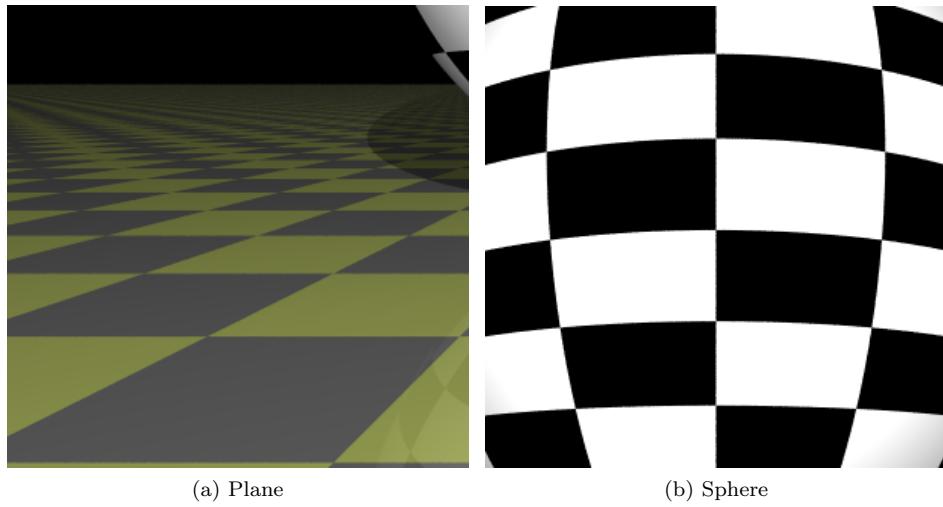


Figure 12: Vanishing plane and checkered sphere with 64x AA using random sampling.

## 9 References

These items are referred to throughout the codebase with [n].

1. <https://www.scratchapixel.com/lessons/3d-basic-rendering/ray-tracing-generating-camera-rays/generating-camera-rays>
2. <http://www.3dkingdoms.com/weekly/weekly.php?a=2>
3. <https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-shading/reflection-refraction-fresnel>
4. [https://graphics.stanford.edu/courses/cs148-10-summer/docs/2006-degreve-reflection\\_refraction.pdf](https://graphics.stanford.edu/courses/cs148-10-summer/docs/2006-degreve-reflection_refraction.pdf)
5. Chapter 10 of “Ray Tracing from the Ground Up” (Kevin Suffern)
6. <http://cg.skeelogy.com/depth-of-field-using-raytracing/>
7. <https://stackoverflow.com/a/13686064/4909532>
8. <https://www.scratchapixel.com/lessons/3d-basic-rendering/minimal-ray-tracer-rendering-simple-shapes/ray-sphere-intersection>
9. <https://people.cs.clemson.edu/~dhouse/courses/405/notes/texture-maps.pdf>
10. Exercise 18.1 from “Ray Tracing from the Ground Up” (Kevin Suffern) p.350