Ray Tracing, Part III

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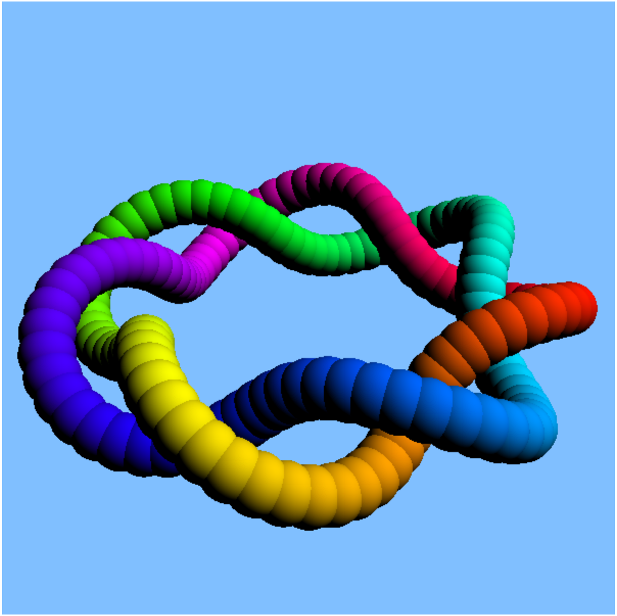
Fall 2015

Many things can be done with just spheres



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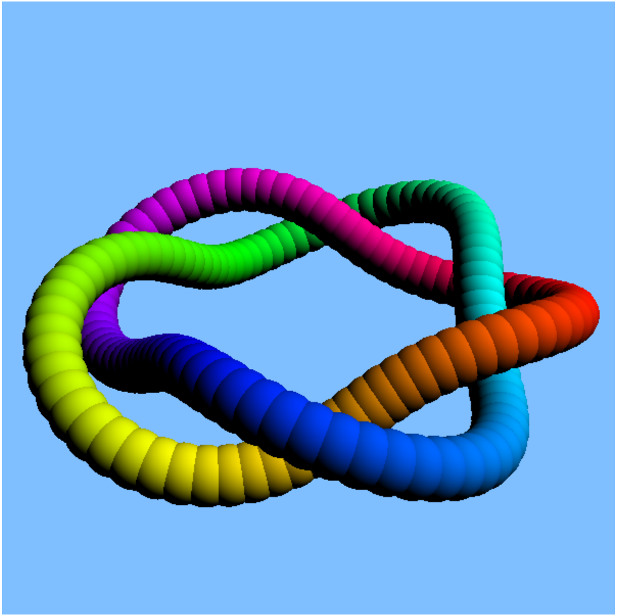

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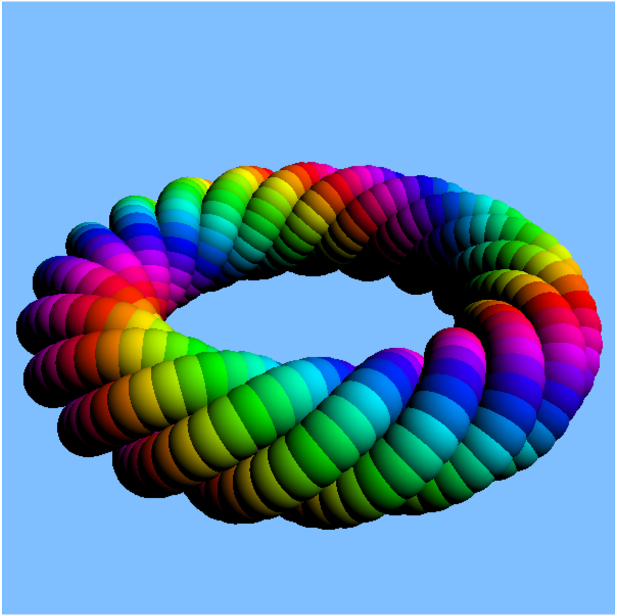

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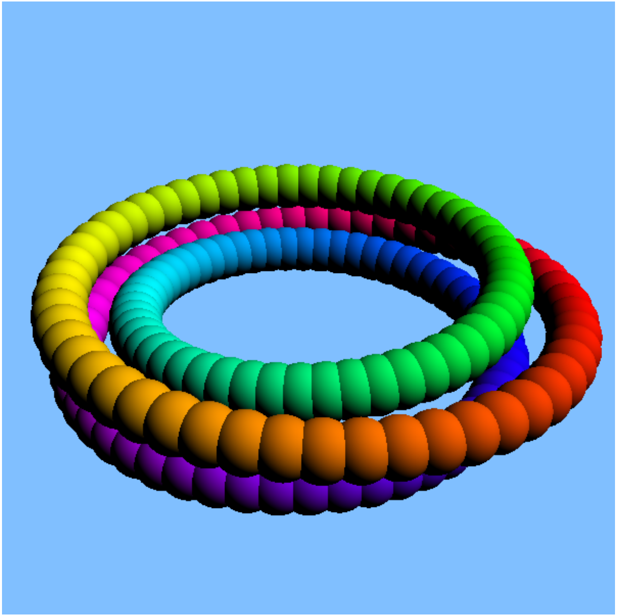
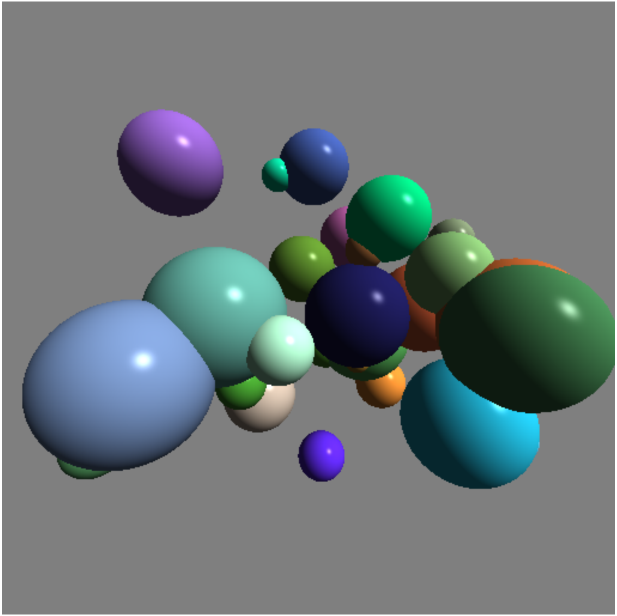
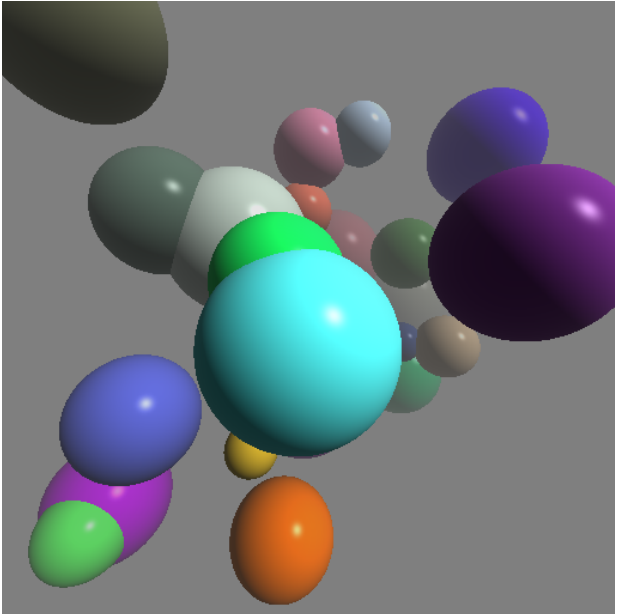


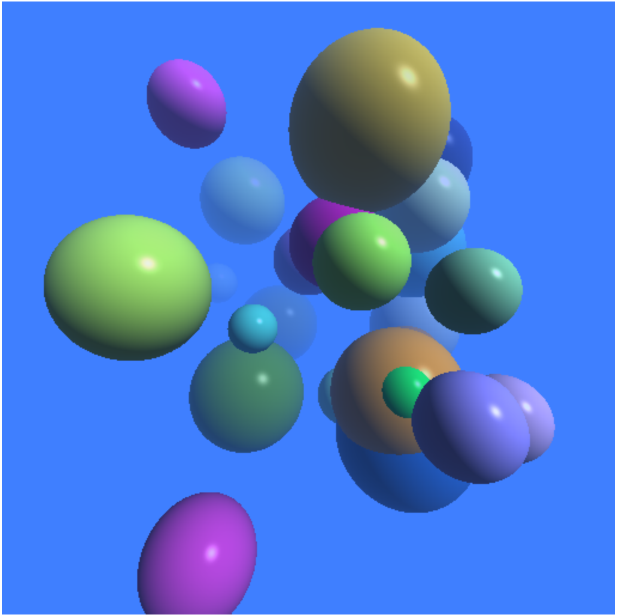
Random spheres



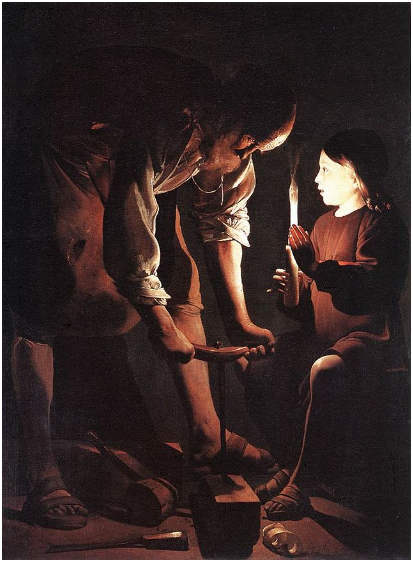
Fog: depth cueing with distance



Colored Fog for Effects

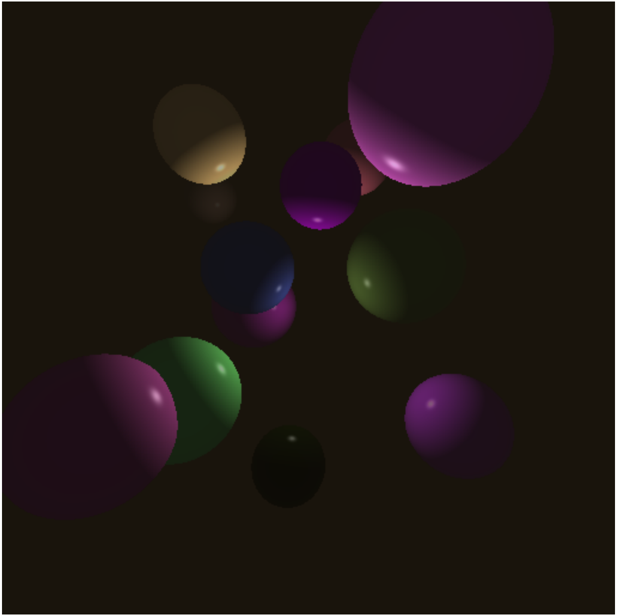


George de La Tour, St. Joseph

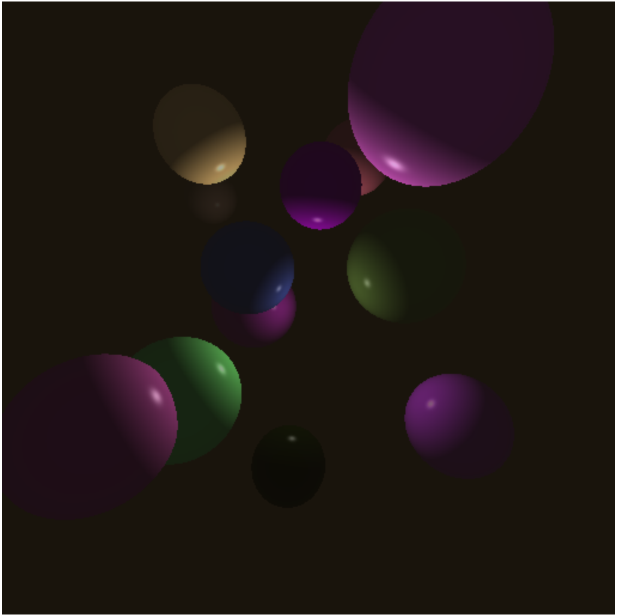


Gerrit Van Honthorst, de Koppelaarster

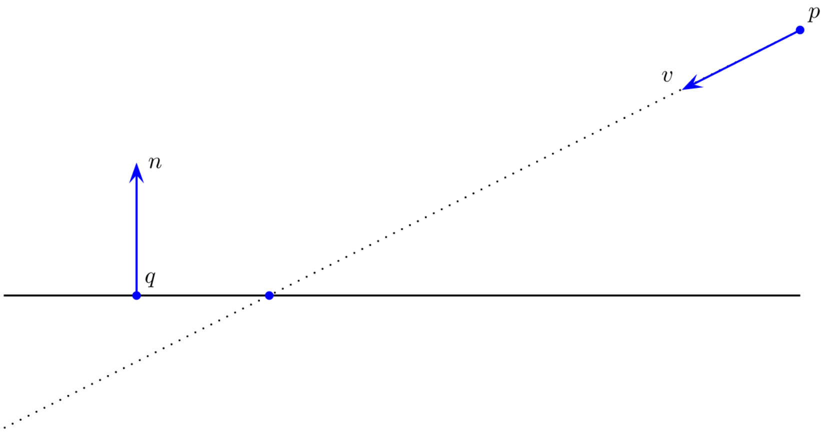
Rembrandt World



It would be nice to have some shapes other than spheres.

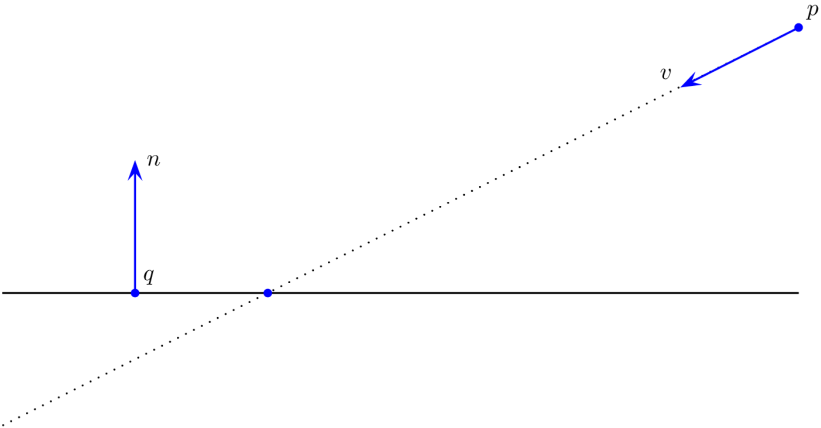


Intersecting a ray and a plane



- Plane defined by point and normal.
- Use same strategy as sphere? What is the equation to solve?

Intersecting a ray and a plane



- Plane defined by point and normal.
- Use same strategy as sphere? What is the equation to solve?
- Solve for t: $n \cdot ((p + tv) - q) = 0$

Intersecting a ray and a plane

$$
\begin{aligned}
n \cdot (p + tv - q) &= 0 \\
n \cdot p + t(n \cdot v) - n \cdot q &= 0 \\
t(n \cdot v) + n \cdot (p - q) &= 0 \\
t &= \frac{n \cdot (q - p)}{n \cdot v}
\end{aligned}
$$

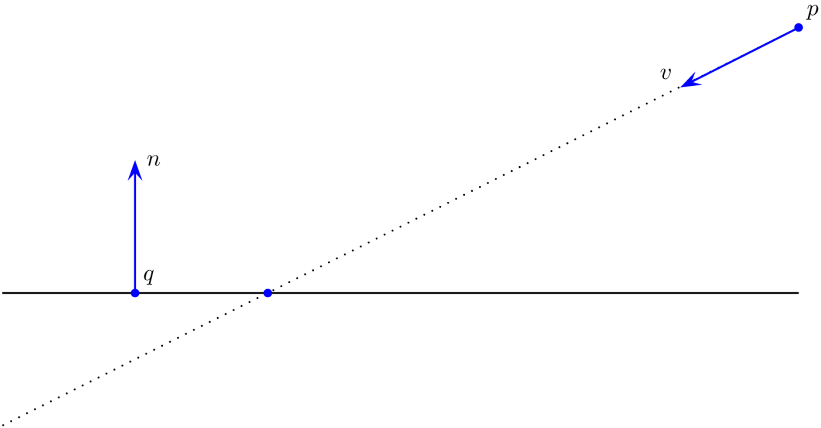
- The intersection point is $p + tv$

Intersecting a ray and a plane

$$\begin{aligned} n \cdot (p + tv - q) &= 0 \\ n \cdot p + t(n \cdot v) - n \cdot q &= 0 \\ t(n \cdot v) + n \cdot (p - q) &= 0 \\ t &= \frac{n \cdot (q - p)}{n \cdot v} \end{aligned}$$

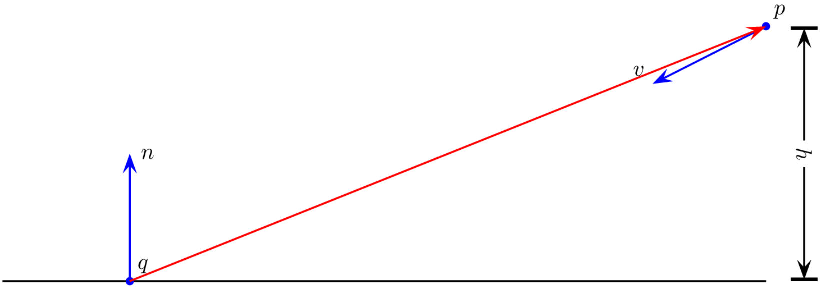
- The intersection point is $p + tv$
- But there's other ways.

Intersecting a ray and a plane



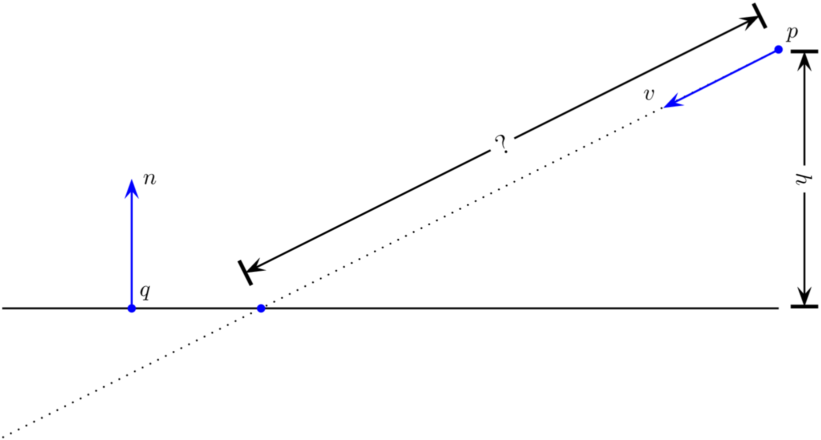
- $v \cdot n < 0$ tests for intersection (one-sided plane).
- Need to find the distance from p to intersection point.
- Can we find the sides of the triangle? What is the height?

Intersecting a ray and a plane



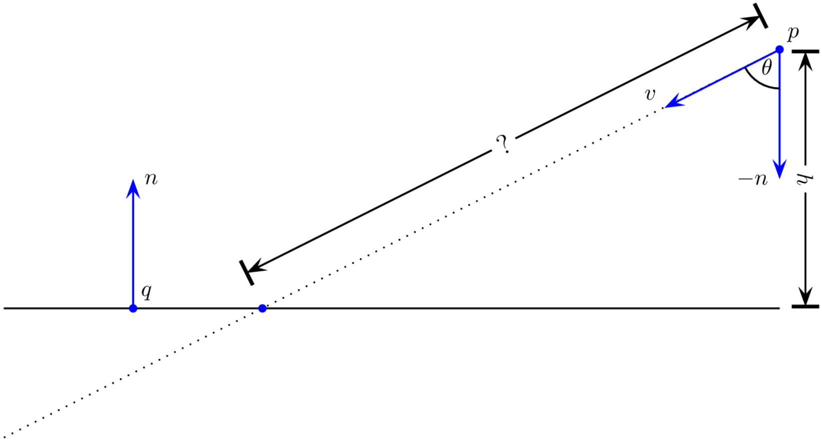
- $h = (p - q) \cdot n$ gives us the height h of p from the plane.

Intersecting a ray and a plane



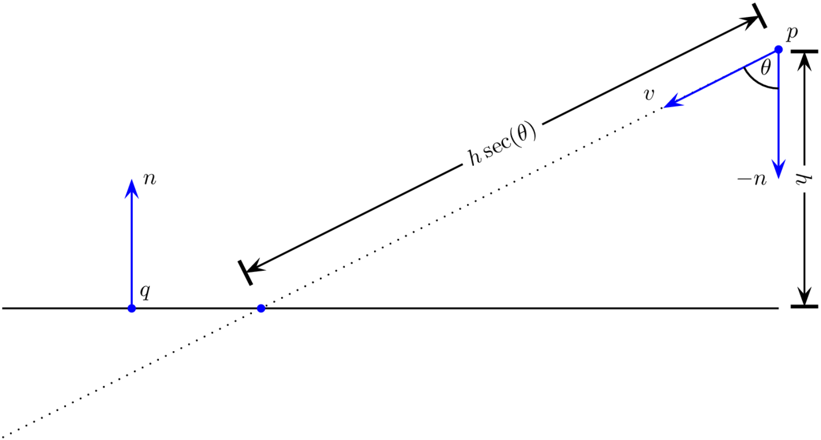
- Any ideas?

Intersecting a ray and a plane



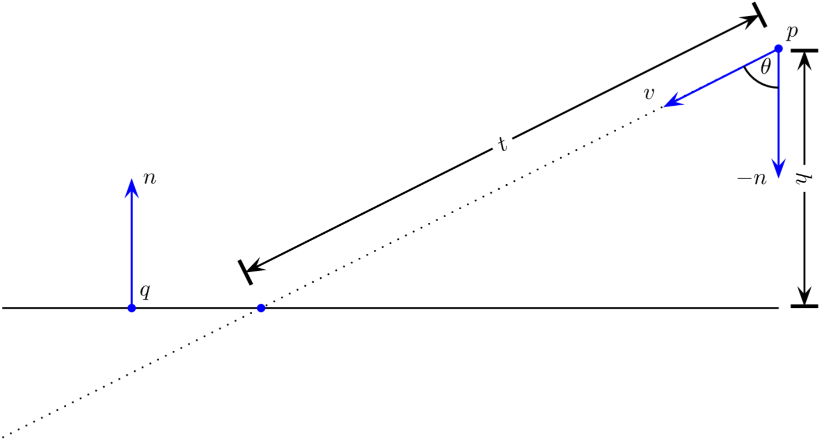
- $v \cdot -n = \cos\theta$

Intersecting a ray and a plane



- $v \cdot -n$ gives us: $\cos\theta = 1/\sec\theta$

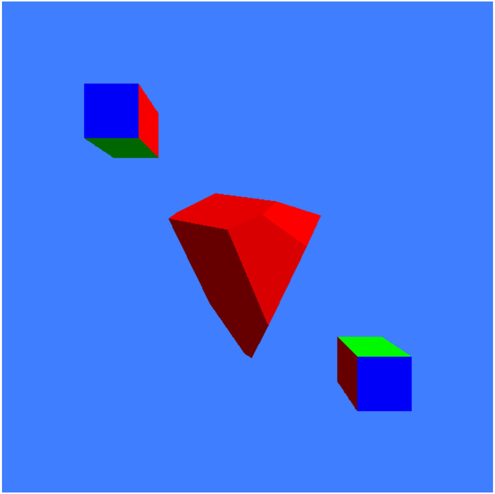
Intersecting a ray and a plane



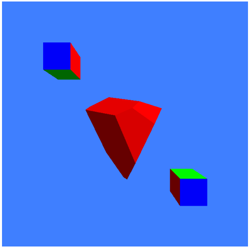
$$t = h\sec(\theta) = \frac{h}{\cos\theta} = \frac{(q-p)\cdot n}{v\cdot n}$$

- Desired point is $p + tv$
- The same result as the other method.

Plane delimited shapes



Plane delimited shapes



- Plane normals all point outward.
- Intersect the ray with all planes of the object.
- Ray should hit every plane. (And if not?).
- Ray hits object if it enters all entering planes before leaving first exit plane.
- The hit point is the last plane entered.
- If the last plane entered is nearer the eye than the first plane exited, the ray hits the object.
- Special case of *intersection*. Think about intersecting all the other shapes we can raytrace.

Further Reading

- https://www.siggraph.org/education/materials/HyperGraph/raytrace/rtinter0.htm
- https://en.wikipedia.org/wiki/Quadric
- http://marctenbosch.com/photon/mbosch_intersection.pdf
- http://www.emeyex.com/site/projects/raytorus.pdf
- http://www.geisswerks.com/ryan/BLOBS/blobs.html
- http://www.cs.cornell.edu/courses/cs465/2003fa/homeworks/raytri.pdf