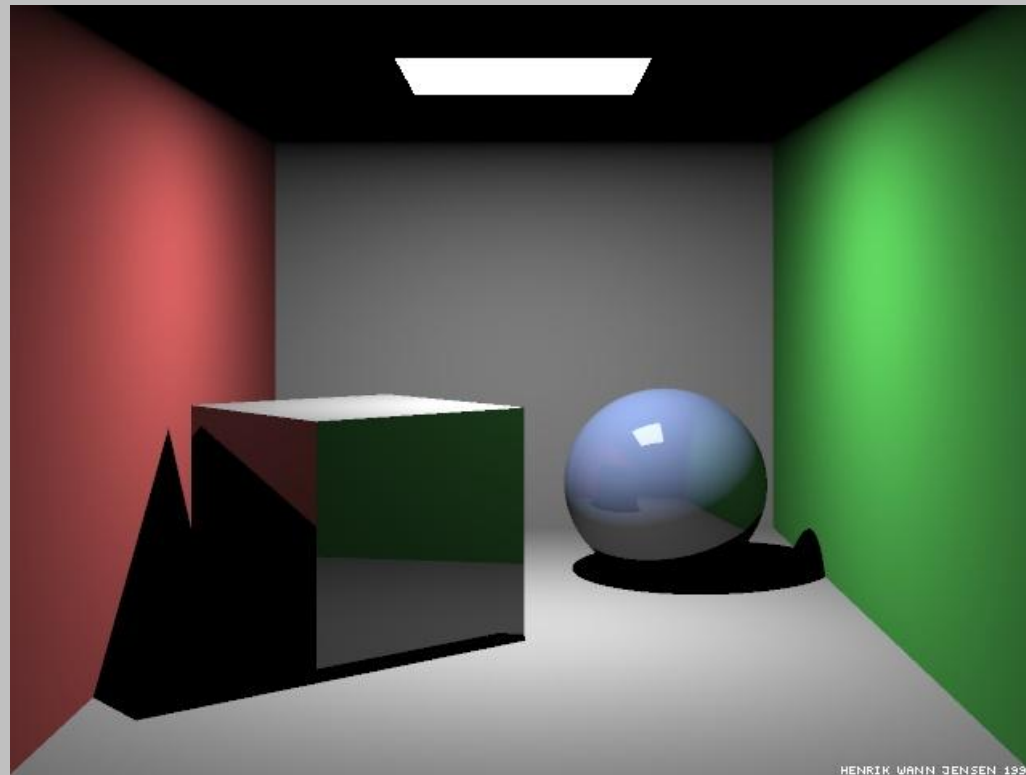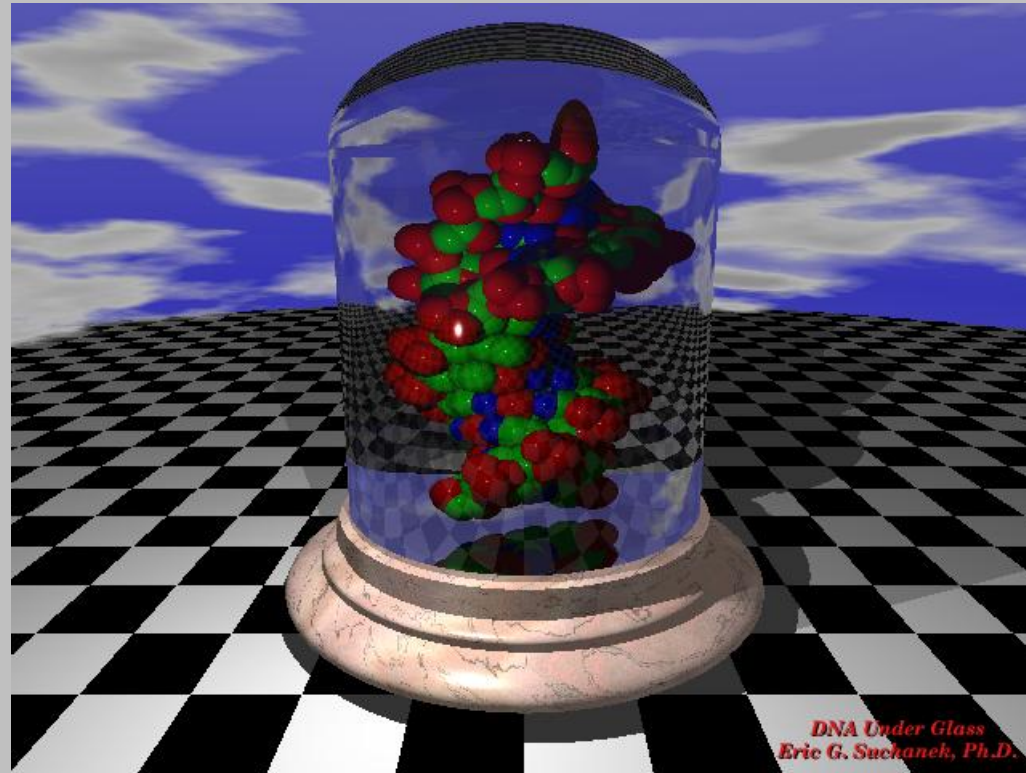# 80's: Ray-Tracing

What does ray-tracing do?
- Add reflection and refraction effects into the picture.
- Example 1: Simple reflection

- **Example 2: Multi-level reflections**

- **Example 3: Refraction through transparent object**

DNA Under Glass
Eric G. Suchanek, Ph.D.

- Why does not the previous polygon scan-conversion model include reflection and/or refraction effects?

  - The polygon scan-conversion method is an object-precision method that projects one polygon at a time onto the image plane.

  - The surrounding environment that could be reflected through a polygon onto the image plane is not, and cannot be easily handled.

Basic Concept of Backward Ray-Tracing:

- A ray is sent out from the center of projection through a pixel on the image plane.

- The ray is intersected with the objects in the scene.

- The first (the nearest) intersection point is found.

- The shading value at this point can be calculated if the surface normal vector and light direction is known.

- If we stop here, the result will be same as the polygon scan-conversion method.

Shadow rays

Transmitted ray
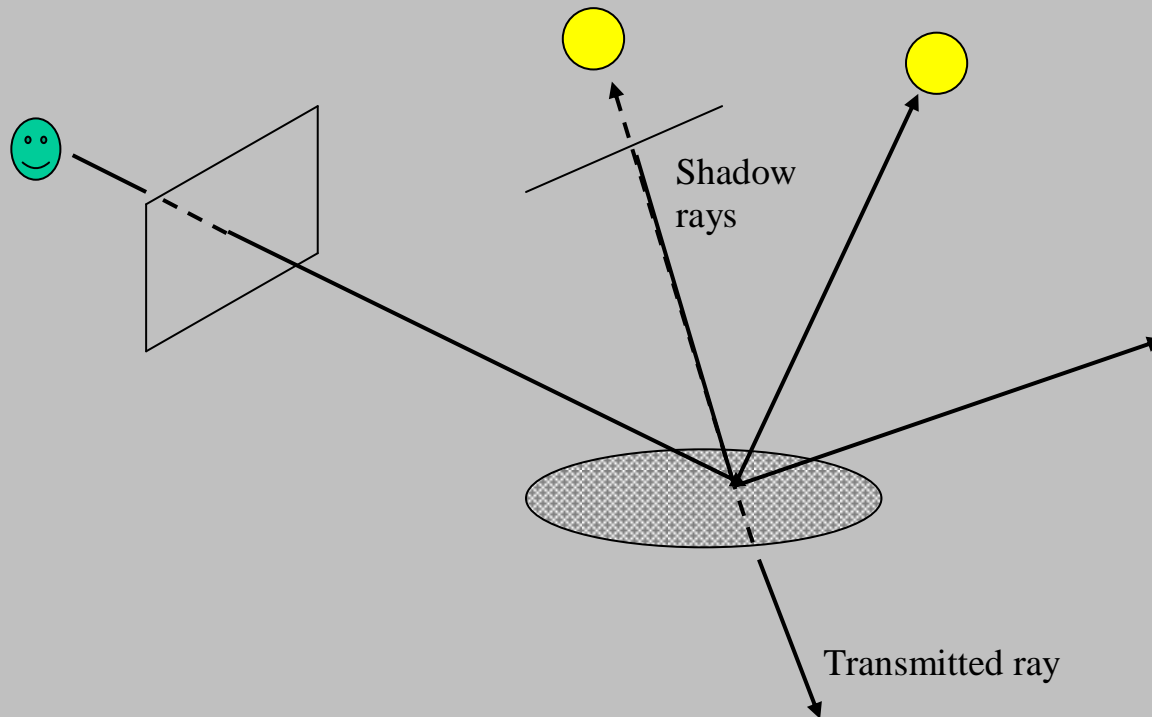
The ray-tracing method, however, does not stop here:

- A reflection ray is sent out from this intersection point along the direction of ideal mirror reflection.
- This reflected ray, called secondary ray, will intersect with other object(s) in the scene.
- The nearest secondary intersection point is found.
- The shading value from this point can be calculated as well based on its surface normal and light direction.
- This shading value will have some contribution to the pixel on the image plane.

- Furthermore, a refraction ray may also sent out from the first intersection point, if the object is transparent.
- This refracted ray, also called secondary ray, will intersect with other object(s) in the scene.
- The nearest secondary intersection point is found.
- The shading value from this point can be calculated as well based on its surface normal and light direction.
- This shading value will have some contribution to the pixel on the image plane.

- If you like, these secondary rays can be reflected or refracted further.

- The color value stored in the pixel on the image will be an integration (precisely, a weighted summation) of shading value at the primary intersection point, and those from secondary intersection points.

Ray-Tracing Algorithm: An Image-Precision Method

```
for (i = 0; i<ROWS; i++)
   for (j=0; j<COLS; j++)
   {
       construct the parametric line equation, L,
          for the ray from the origin
          and passing through pixel (i,j);
       image[i][j] = ray_tracing(L);
   }
```

Stay tuned. We will study in detail the ray-tracing function.