

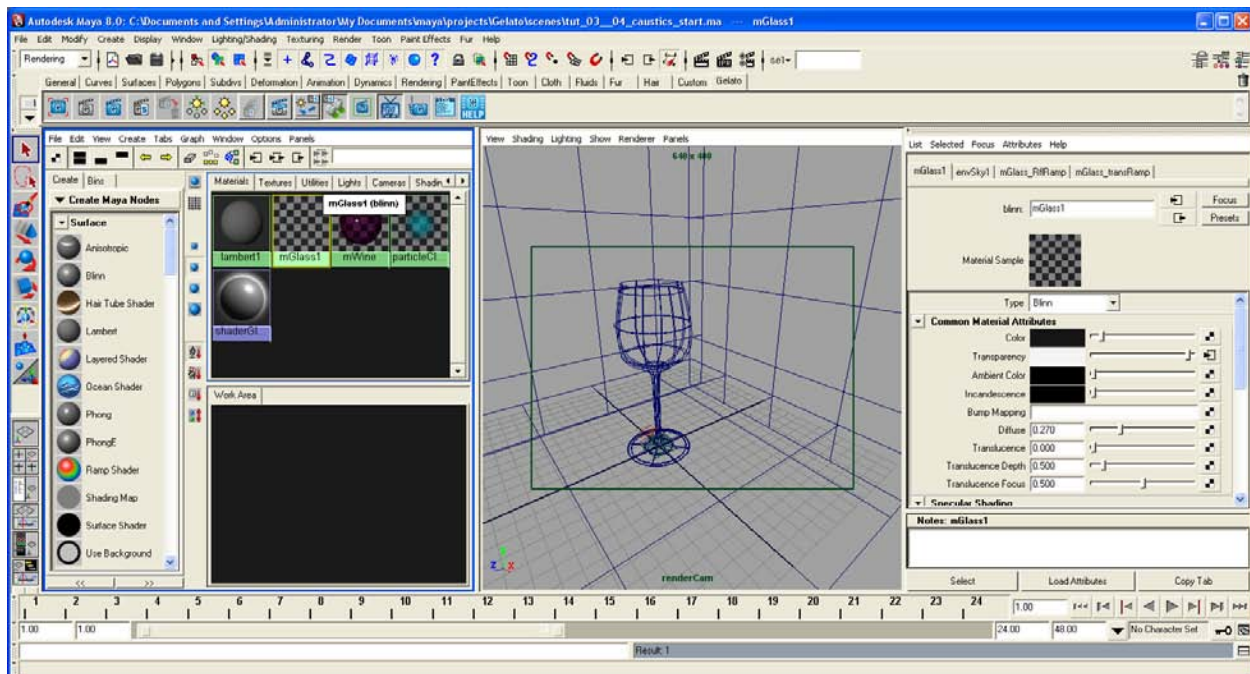
## 3.4 CAUSTICS



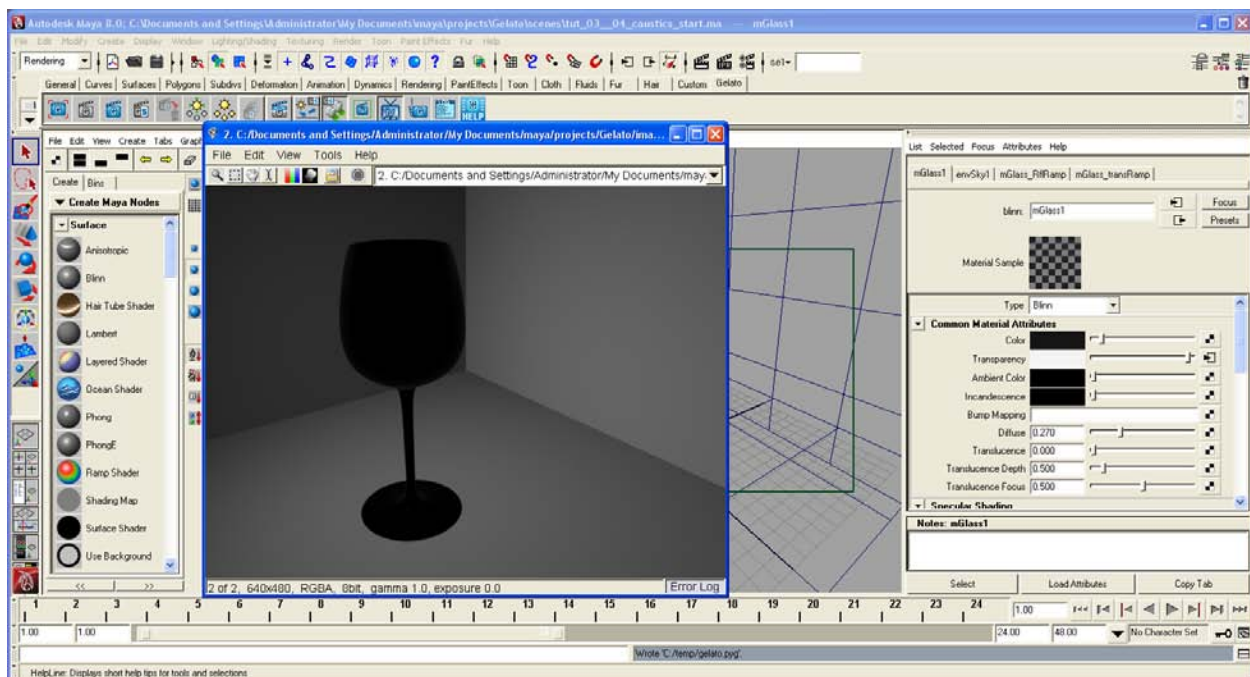
This is the companion to the movie, tut\_03\_04, part 4 of the 8 NVIDIA® Gelato® Advanced Tutorials.

Look at the sun shining through waves at a beach and you'll see caustic patterns playing over the sand beneath the water and across the sides of boats; in an enclosed pool, you'll see these light patterns shifting over the walls and other nearby objects. If you have a glass sitting on your table and there is some light around, you'll see pretty light effects on the table surface. These are caustics and the subject of this tutorial.

Caustics are a type of indirect light that remains focused instead of being scattered about as is seen with indirect illumination and subsurface scattering. This focused light creates very defined patterns on surrounding objects. Gelato uses a photon-based approach to produce caustic effects. So... let's see how this works...



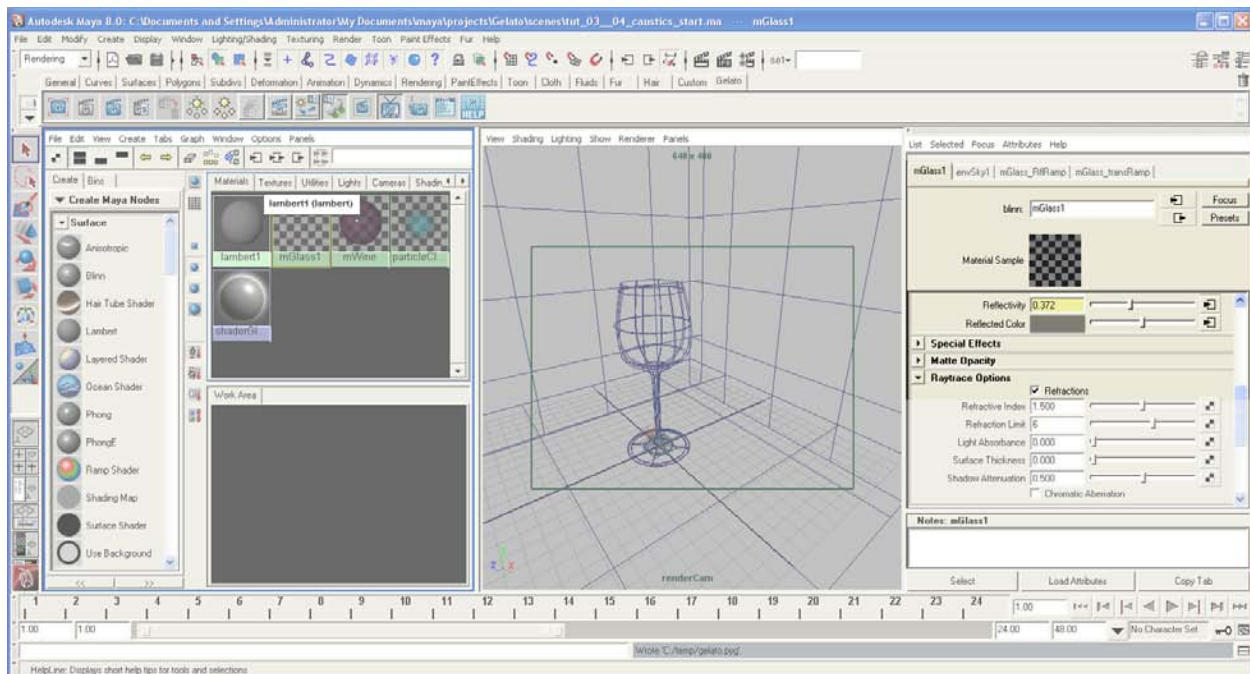
- Open "tut\_03\_04."



- Gelato Render.

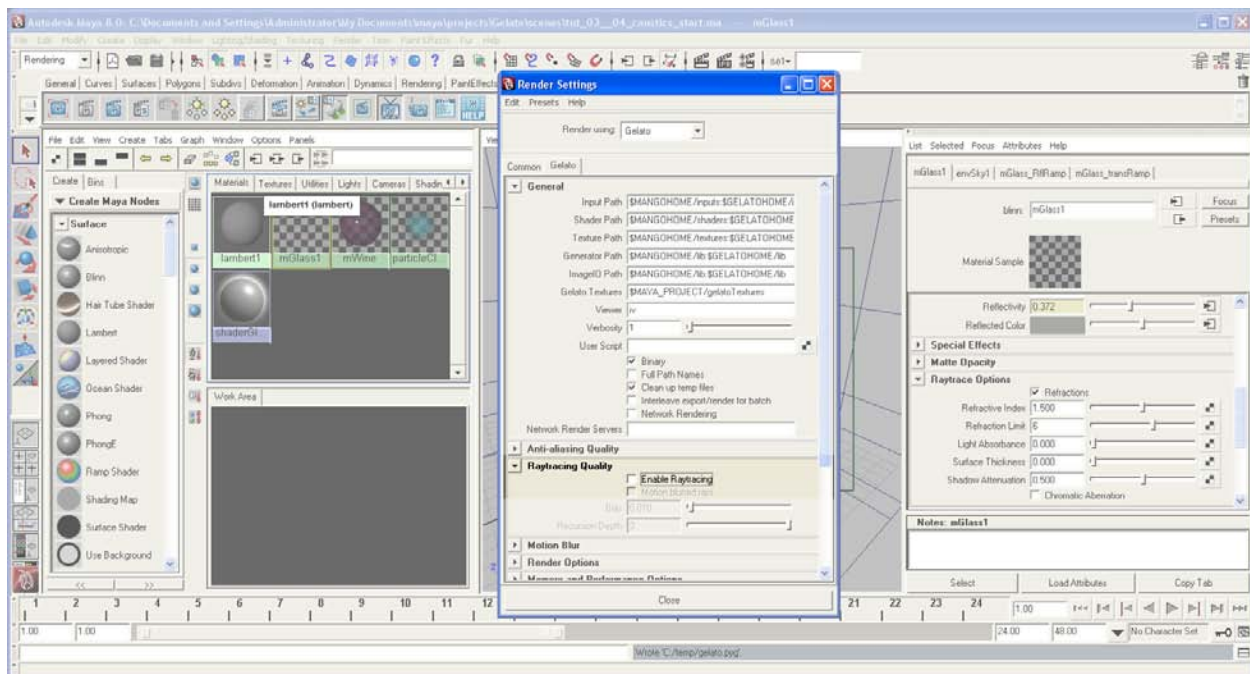
We have a black glass sitting on a solid surface, with two walls visible.

*If refractions are enabled for an object's material, Gelato will render the object black if ray-tracing is not enabled in Gelato's Render Settings. This is something to keep in mind when working between Maya's software renderer and Gelato, as Maya will give the transparent glass in this circumstance.*



To confirm the preceding explanation...

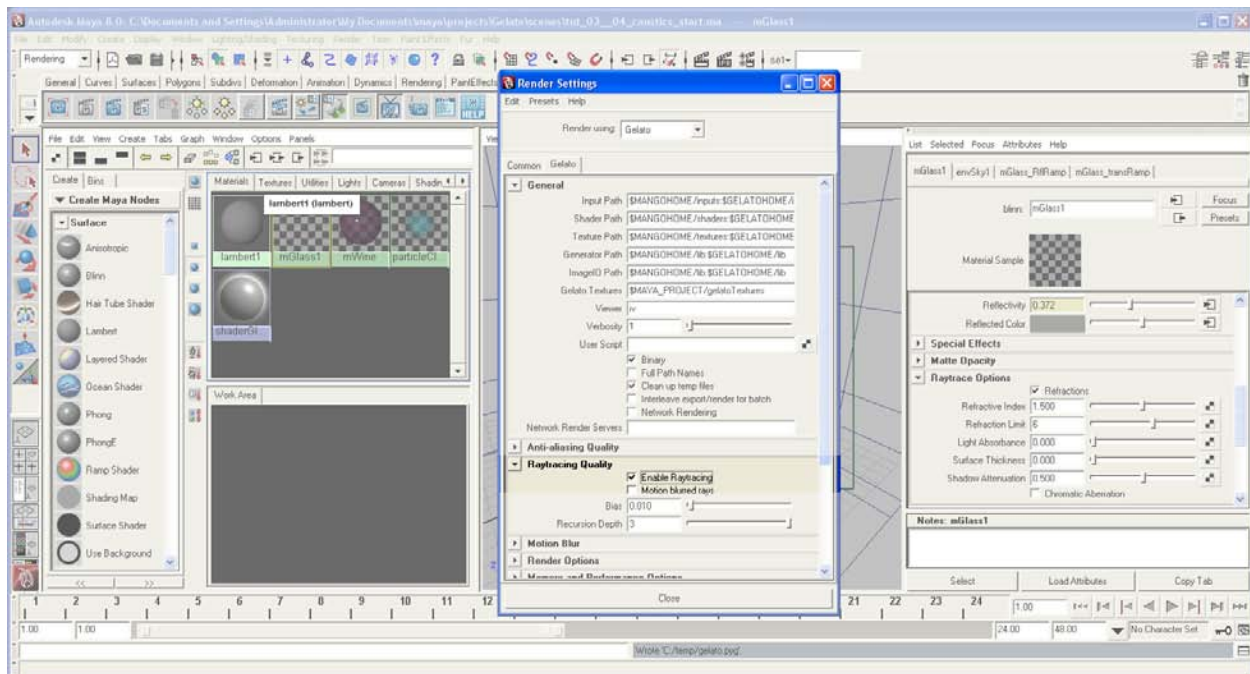
- In the Hypershade window, select “mGlass1.”
- “mGlass1” Attribute Editor > Raytrace Options.
- Notice that Refractions is, indeed, enabled.



- Open the Render Settings dialog > Gelato tab > Raytracing Quality.
- Notice that Enable Raytracing is turned off, explaining the black.

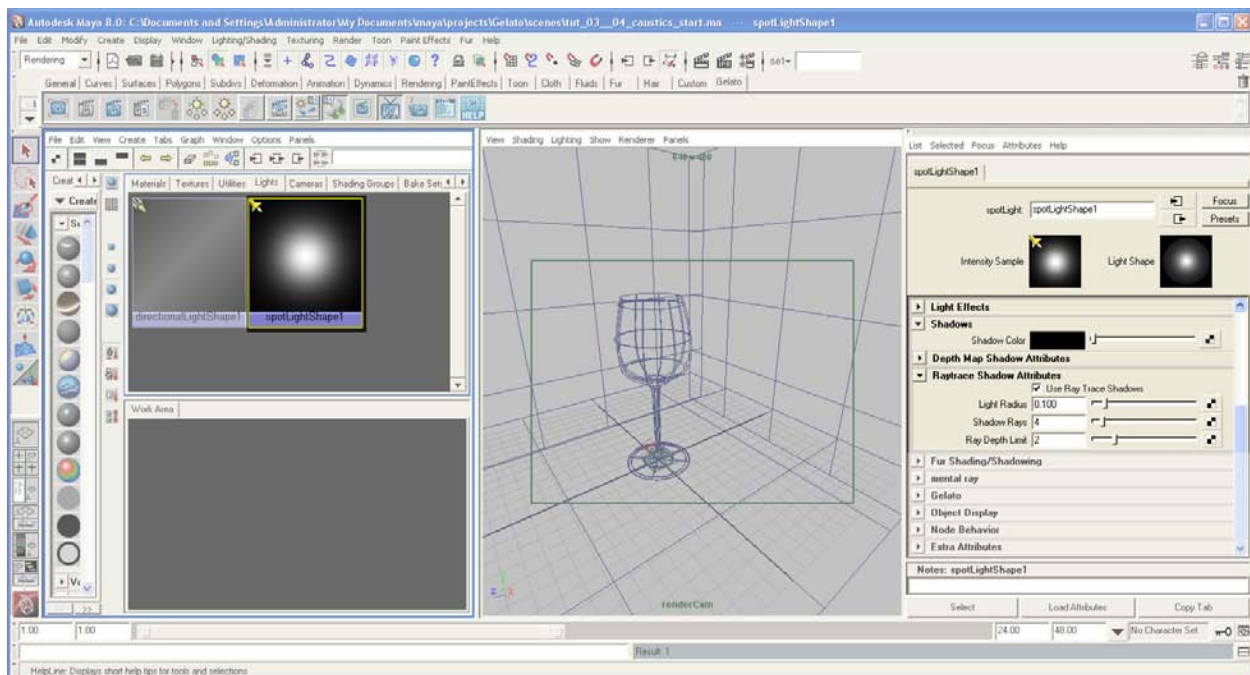
In order to see the glass transparency, we need to either turn off the refractions in the glass material or turn on ray tracing in Gelato, so...





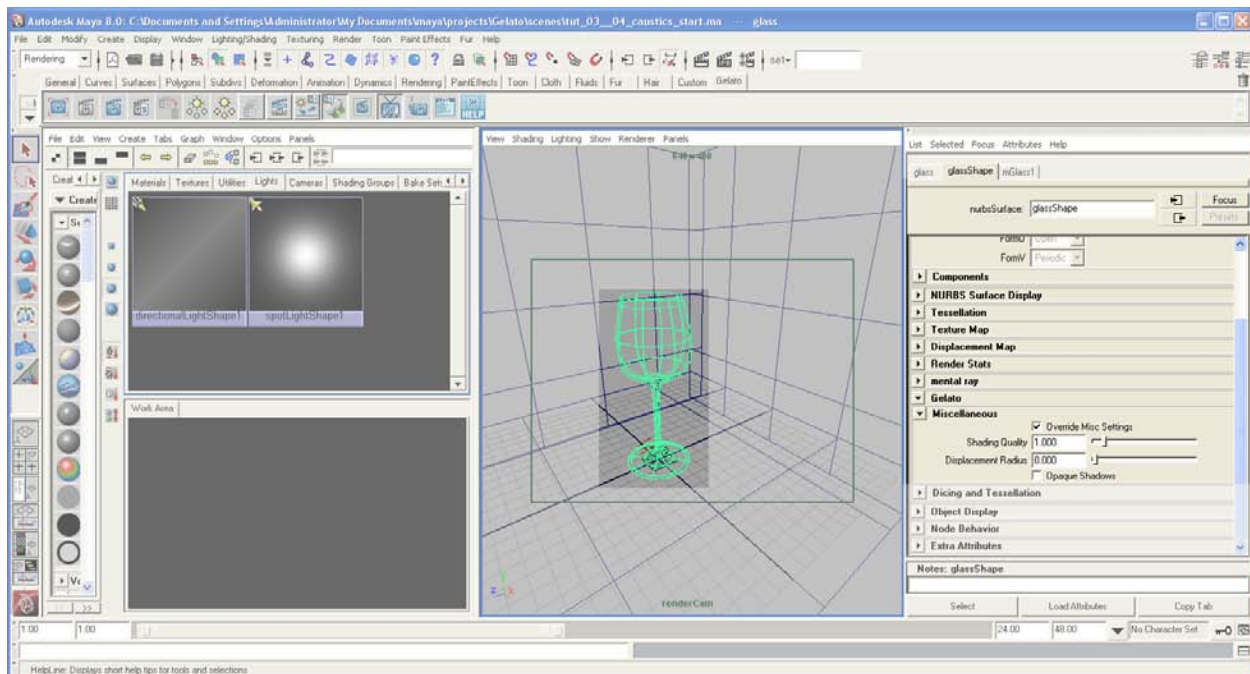
- Turn “Enable Raytracing” on.

The following two items have already been set up in the provided project file and will be shown here so that you are aware of them...

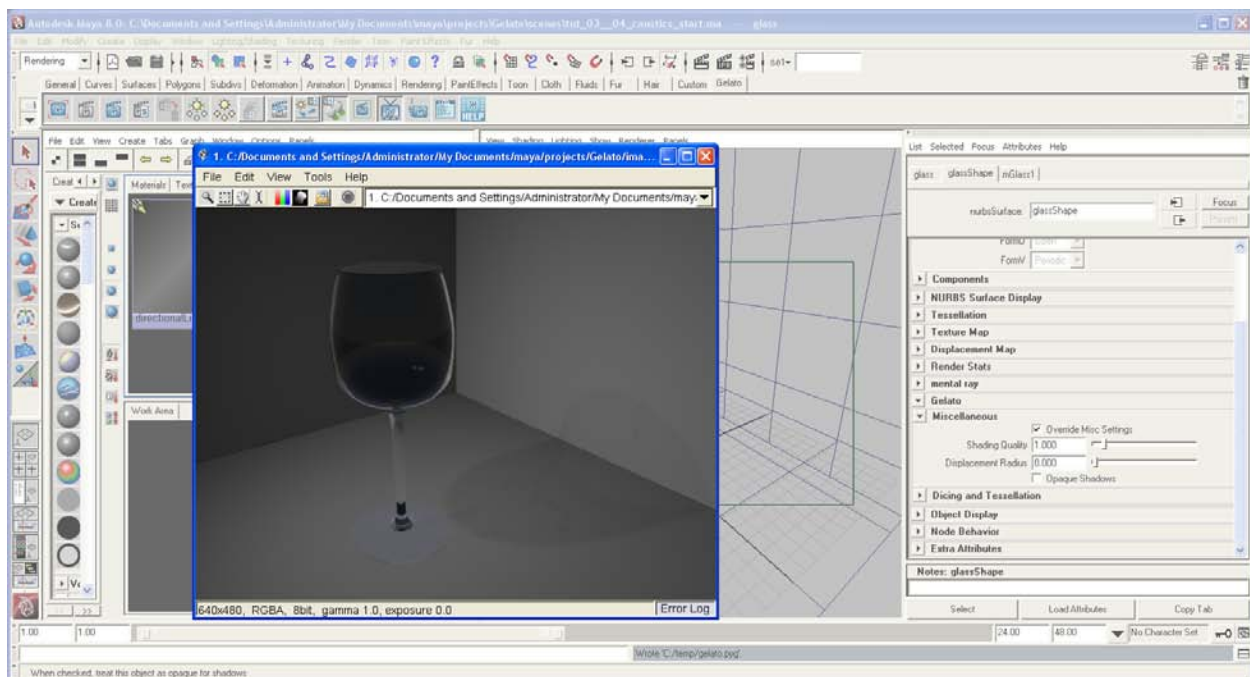


Ray-traced shadows have been enabled for the light...

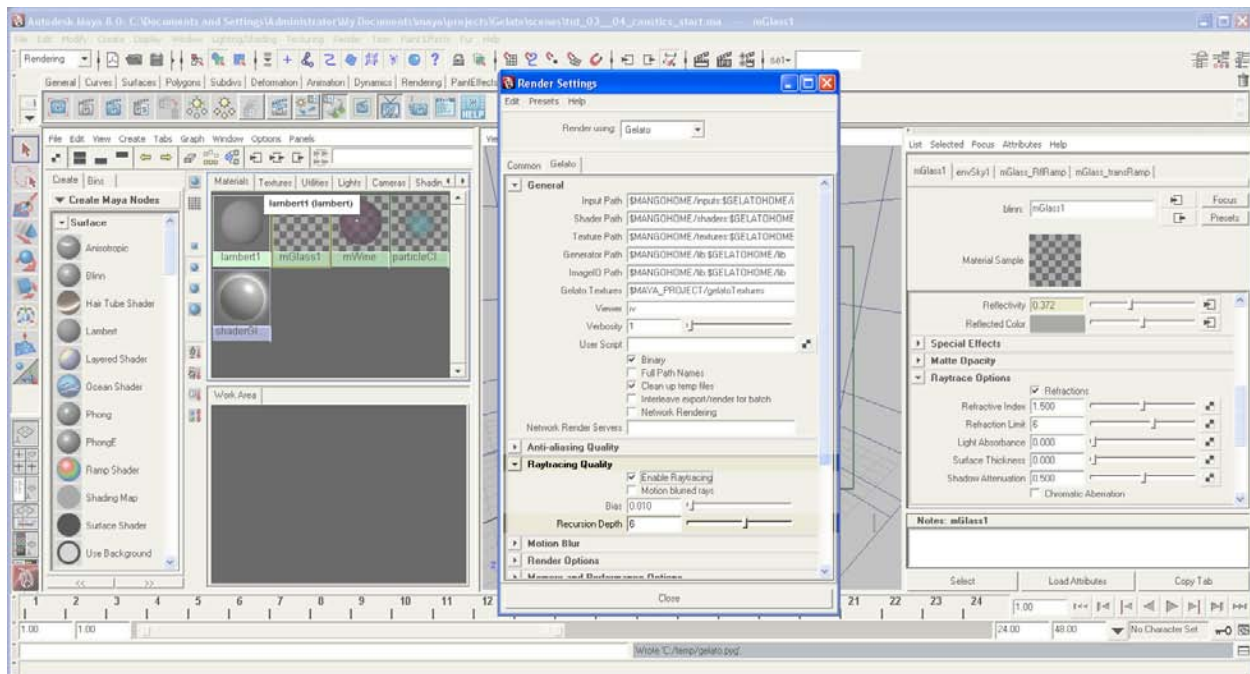
- Select the spotlight.
- In its Attribute Editor, scroll down to Shadows > Raytrace Shadow Attributes.
- “Use Ray Trace Shadows” is indeed enabled.
- The Light Radius is turned up a bit to 0.100.
- The Shadow Rays is set to 4.



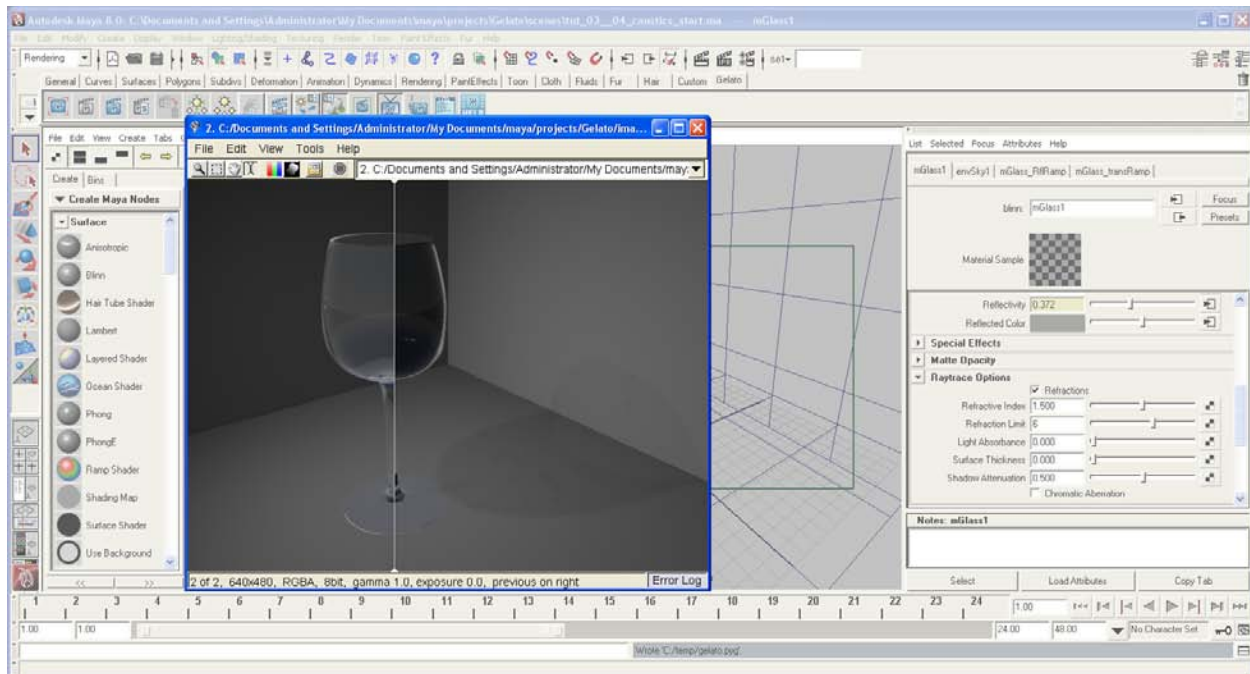
- Select the wineglass.
- glassShape Attribute Editor > Gelato > Miscellaneous.
- Notice that Opaque Shadows is turned off. This is important for transparent shadows.



- Gelato Render.
  - \* We have transparent shadows.
  - \* We are now beginning to be able to see through the glass, though we are still unable to see all the way through it.
- Because there is thickness modelled into the glass, the light has to pass through at least 4 surfaces, making it necessary to increase the recursion depth in order to see through the glass.



- Render Settings > Gelato tab > Raytracing Quality > change Recursion Depth to 6.
- Gelato Render.

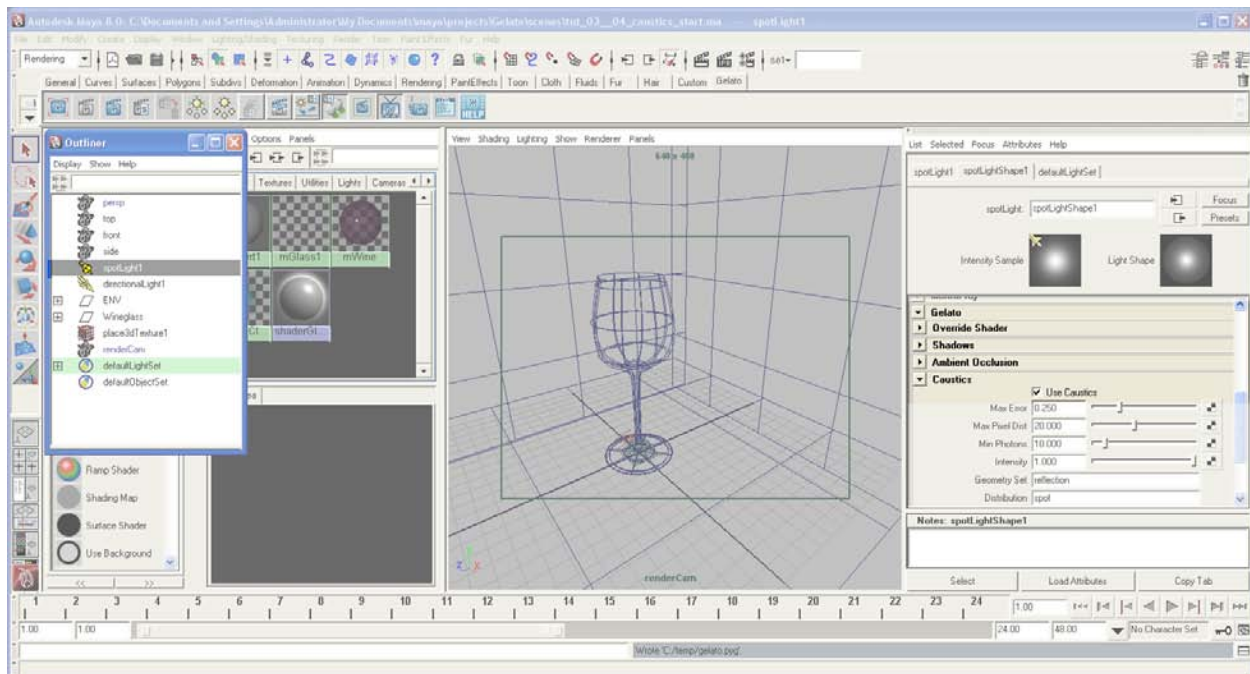


- Use the Wipe Tool to compare this render to the last.

The difference is “clear.” We can now see all the way through the glass.

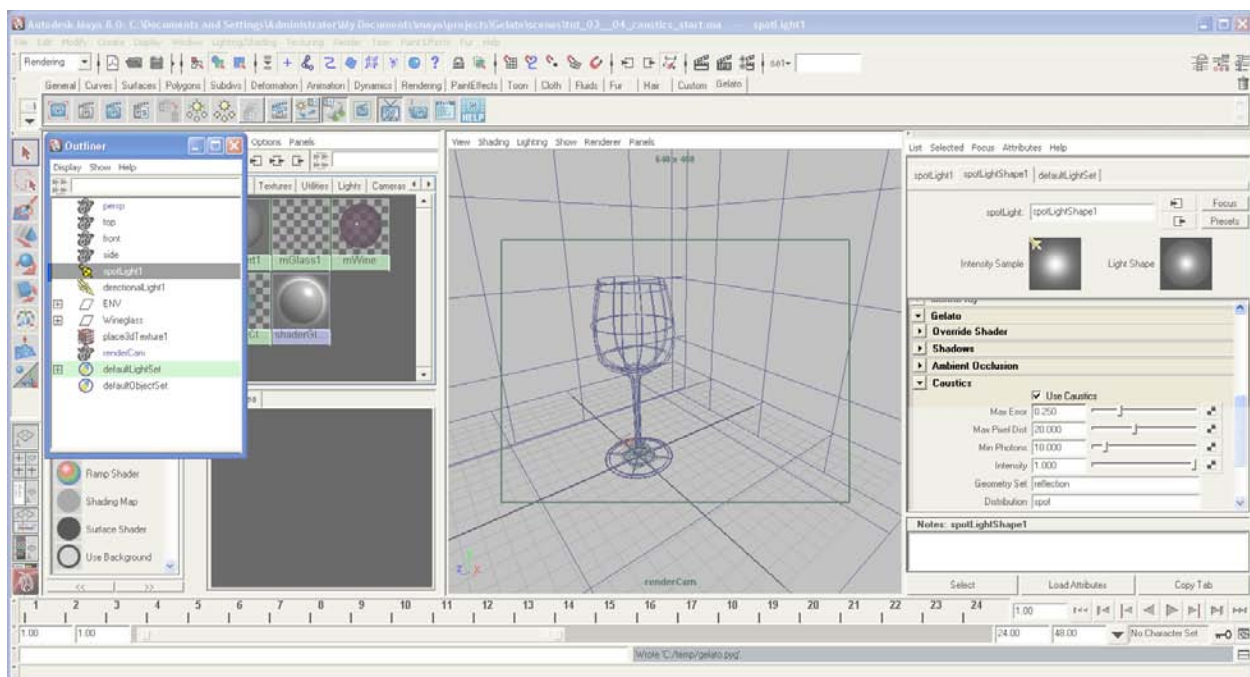
The groundwork is now laid out: we have ray-traced and transparent glass and shadows. We’re ready to add in the caustics...



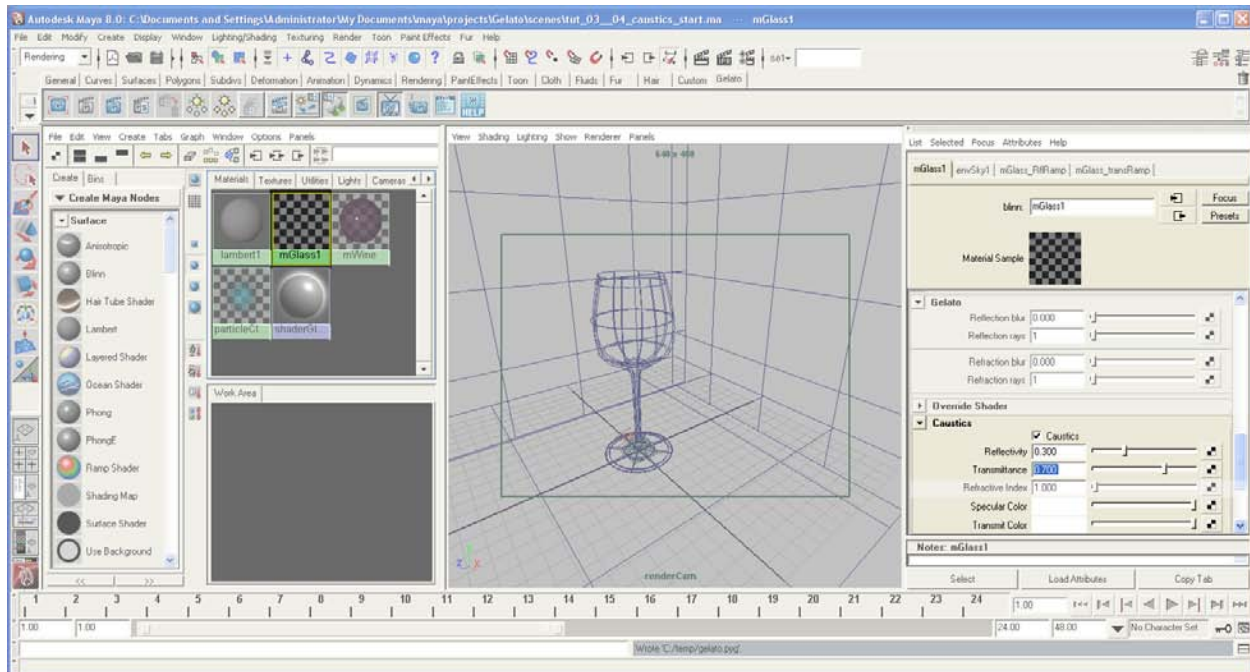


- Select the spotlight.
- Spotlight's Attribute Editor > Gelato > Caustics.
- Enable "Use Caustics."

If we were to render at this point, we would see no difference. Caustics need to be enabled in both the light and the object's material.



- Go to the Materials tab, select "mGlass."
- mGlass Attribute Editor > Gelato > Caustics > enable Caustics.



To see any results from enabling caustics, we need to also turn on a few more things in this section, as the settings here default to 0...

**Reflectivity** is used when objects are reflective and will transmit very reflective caustics

**Transmittance** is used for an object's transparency.

Those parameters each have an attribute controlling their color...

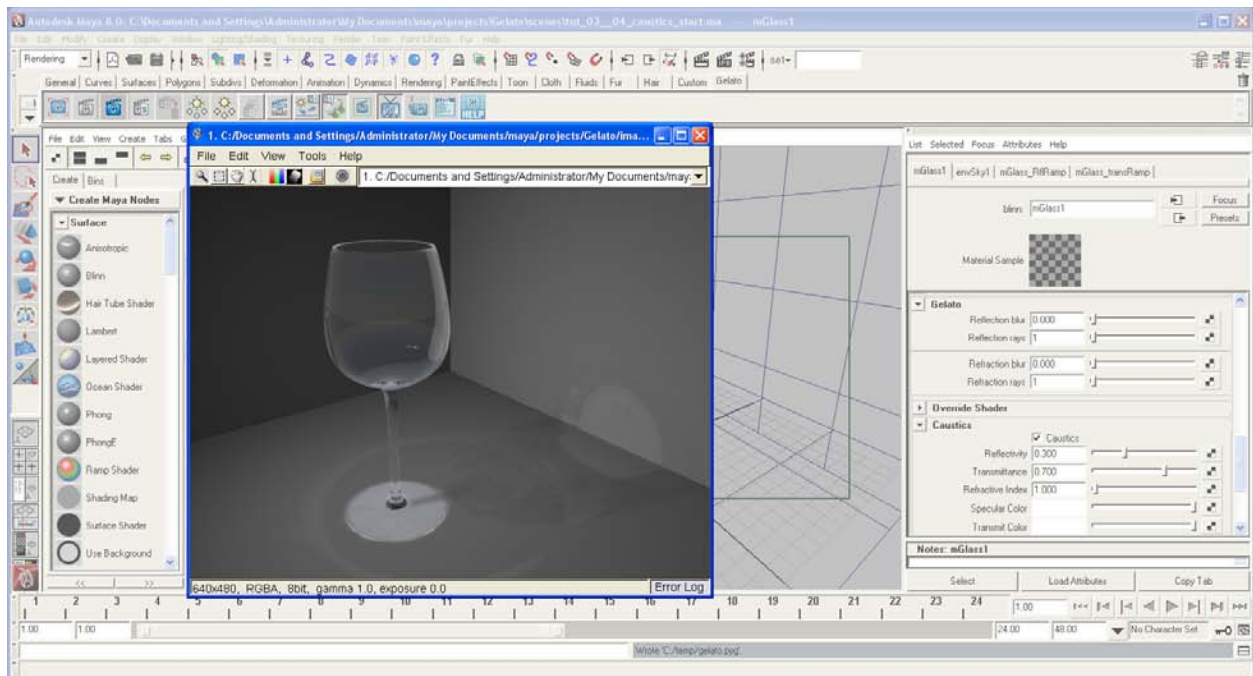
**Specular Color:** Reflectivity would emit the color defined here.

**Transmit Color :** Transmittance would emit the photons to produce caustics based on this setting.

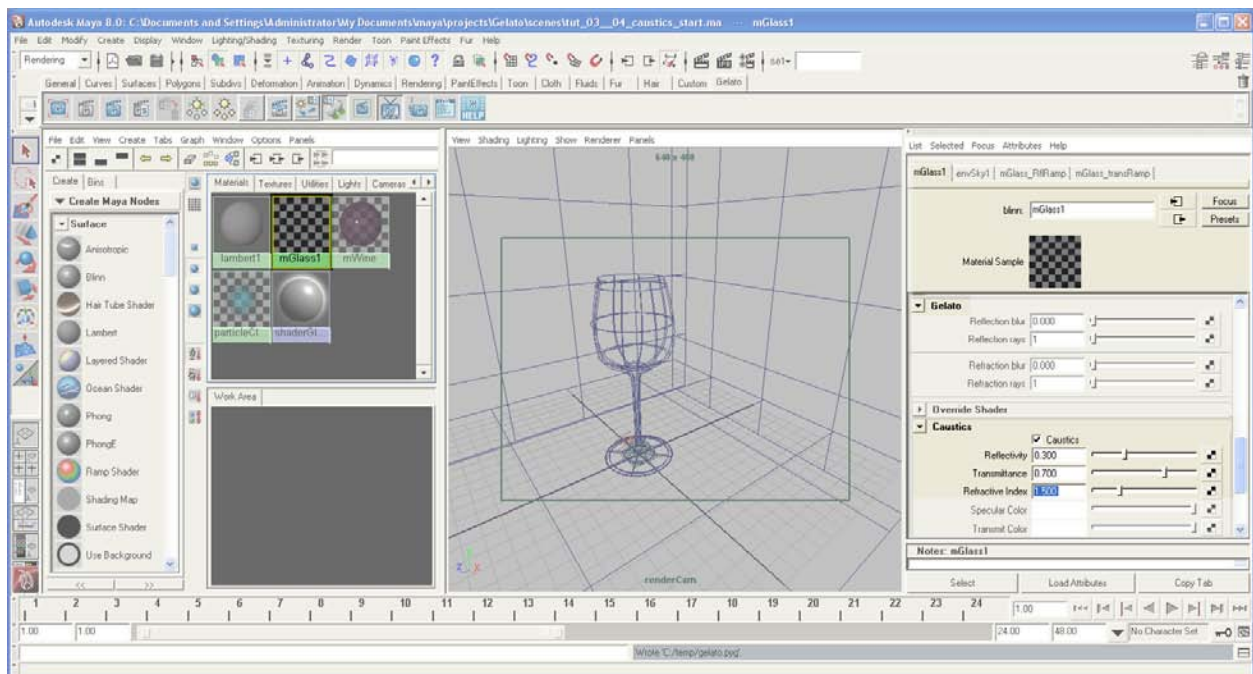
The glass is both reflective and transparent, so...

- Change "Reflectivity" to 0.300.
- Change "Transmittance" to 0.7000.
- Gelato Render.

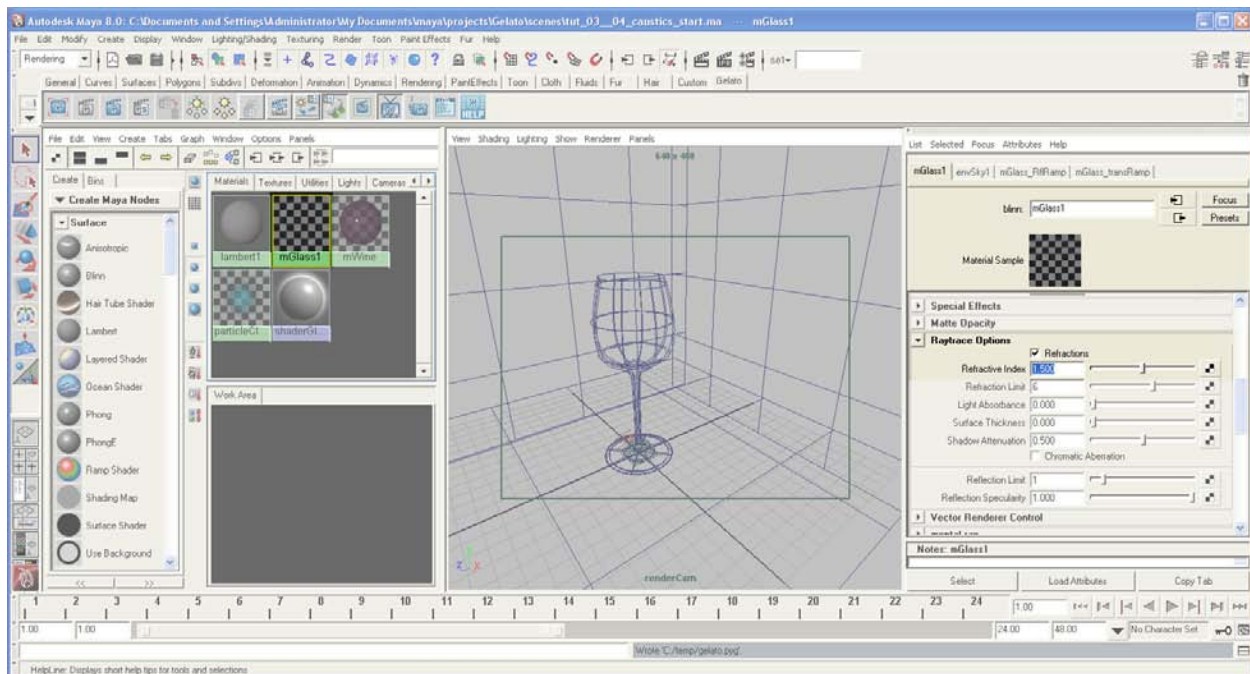




- Use the Wipe Tool to compare this image to the last.  
The caustics on the table, wall and glass are now very much in evidence.

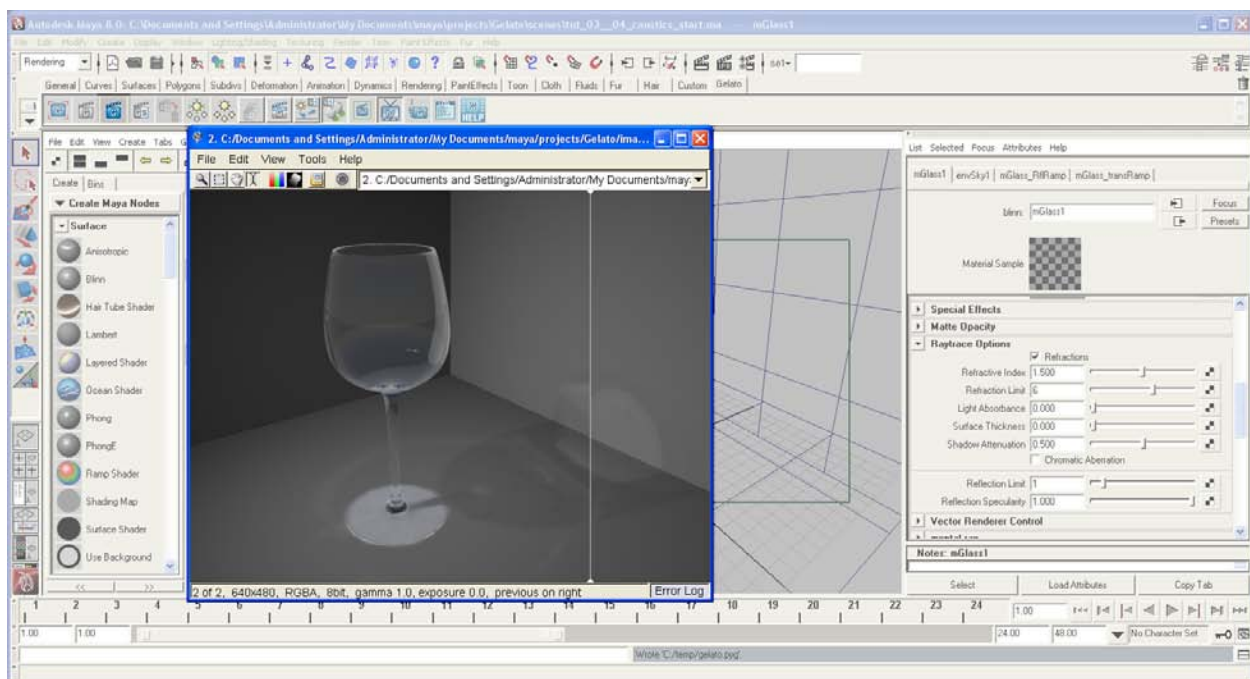


- In the real world, light bends as it's transmitted through glass, so let's now enable refraction for the glass...
- Change the Refractive Index to 1.5

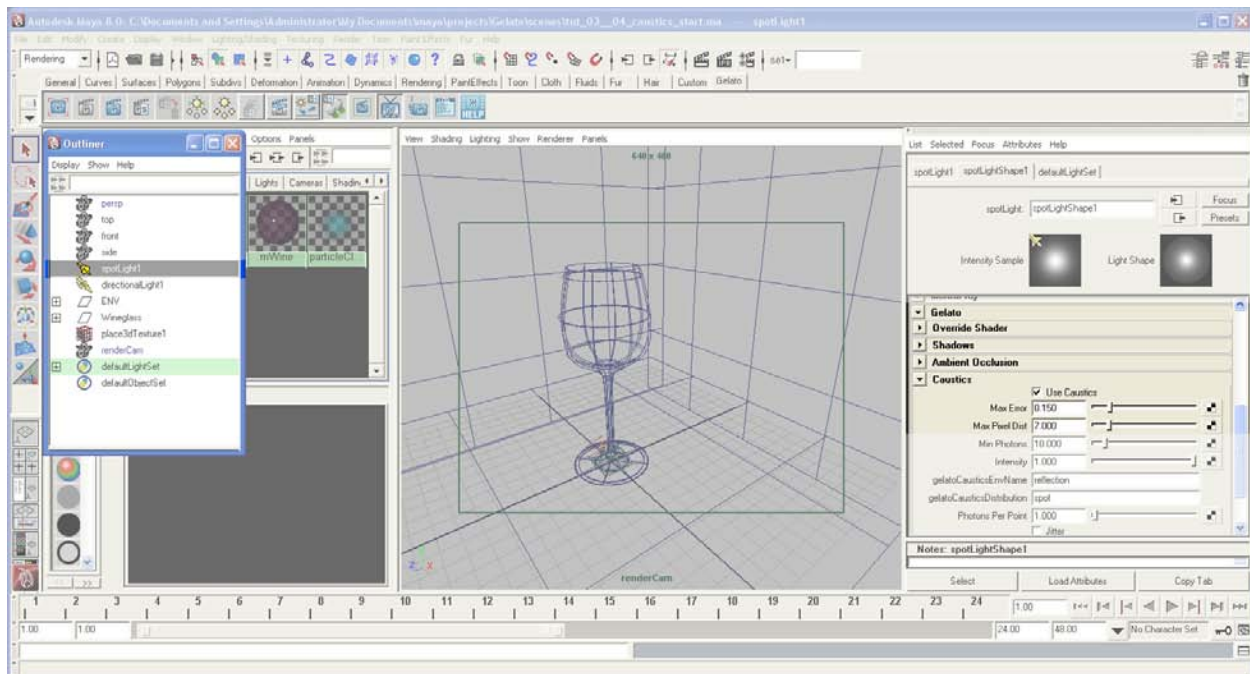


To be physically accurate, now that we've changed the refraction for Gelato, we need to also change it for the object's material within Maya...

- mGlass Attribute Editor > Raytrace Options > ensure the Refractive Index is set to 1.500 (this was preset for this project).
- Gelato Render.

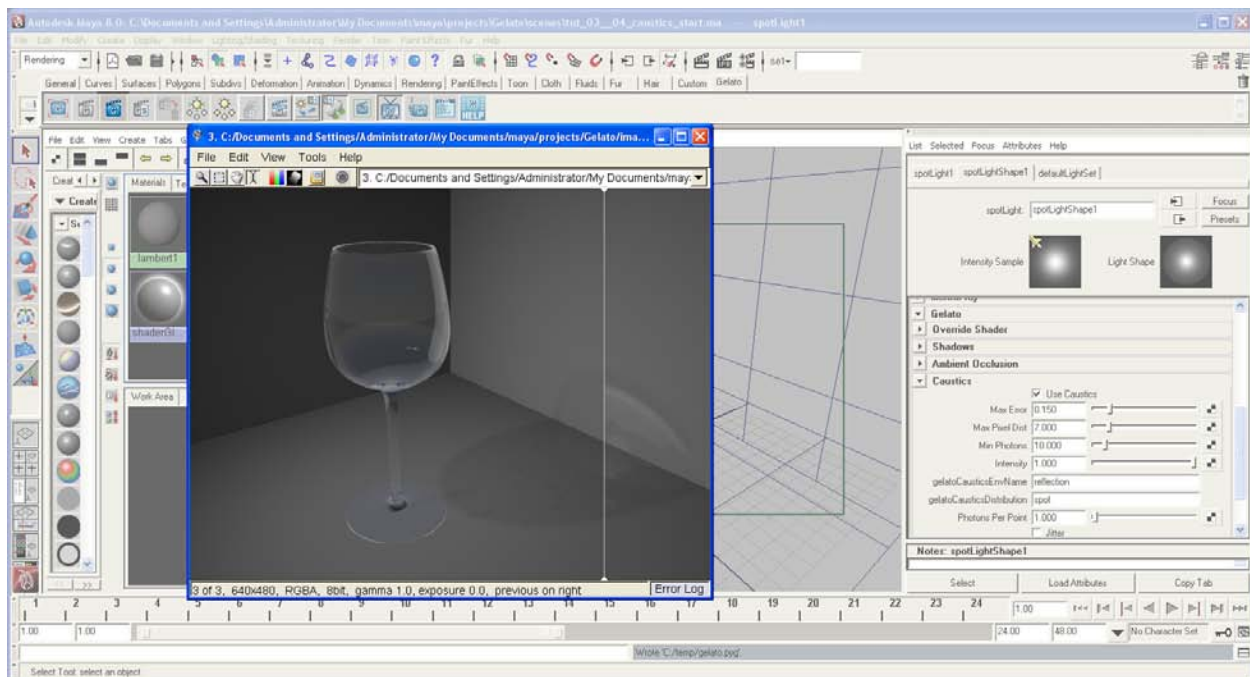


- Use the Wipe Tool to compare this image to the last.
- \* The shape of the caustics has changed.
- \* There are some artifacts.



The Gelato settings for the light will allow us to address the artifacts...

- Select the spotlight.
- Spotlight's Attribute Editor > Gelato > Caustics.
- Change: Max Error to 0.150.  
Max Pixel Dist to 7.000.
- Gelato Render.

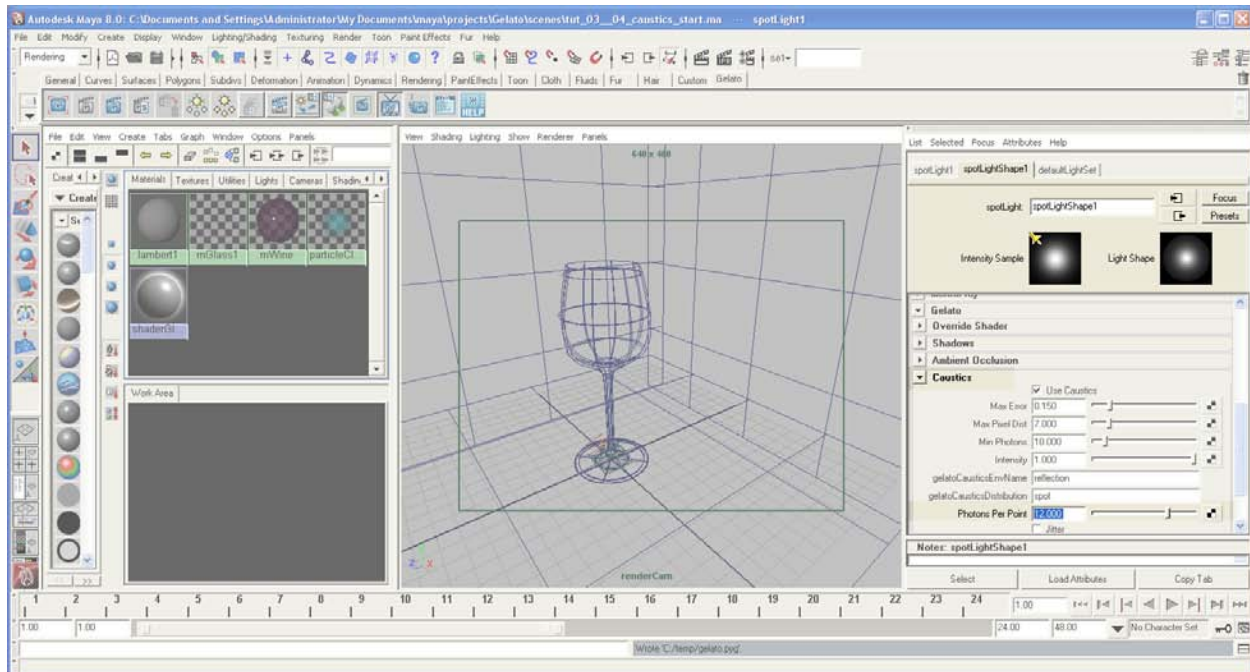


We lost artifacting; however, we also lost the caustics!!!

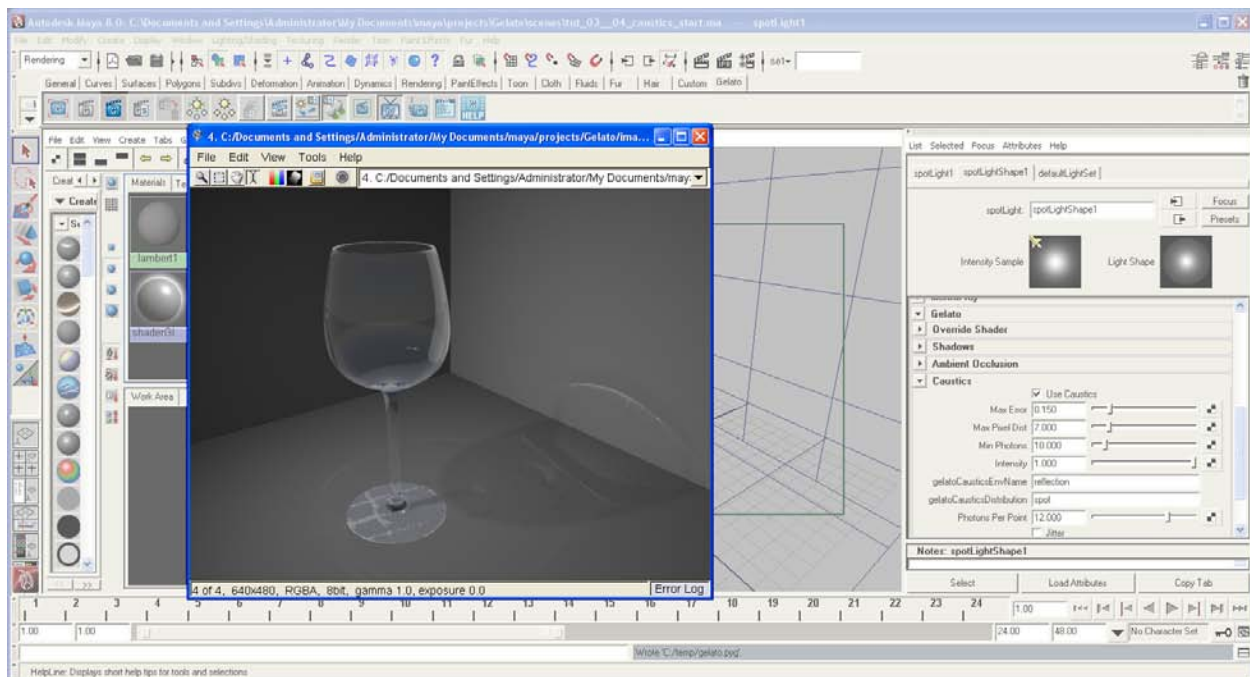
- Use the Wipe Tool to review this tragedy.

As we filtered out the artifacts, we filtered out the caustic detail. Of course, this is easily addressed...





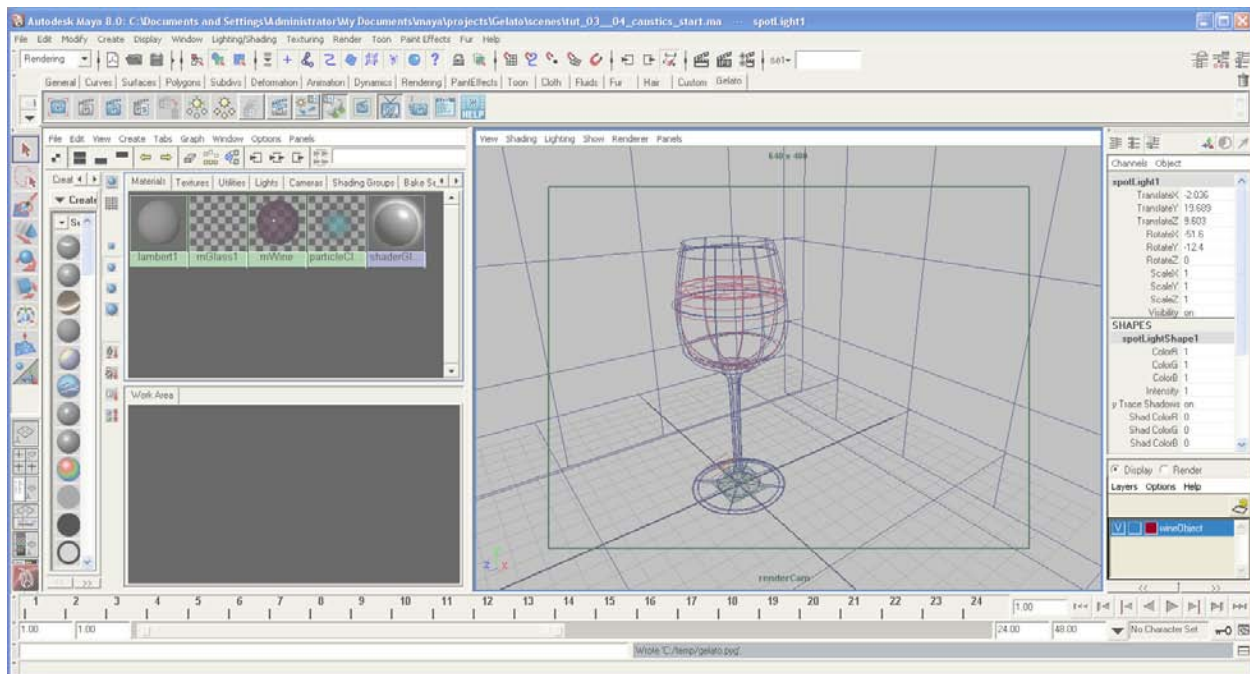
- Change the Photons Per Point to 12.000.
- Gelato Render.



- \* We have reclaimed the caustic detail.
- \* The artifacts are beginning to disappear as these caustics become more refined.

To continue to refine this, continue to work on the artifacts by decreasing the Max Pixel Dist and the Max Error while continuing to increase the Photons Per Point to maintain the detail.

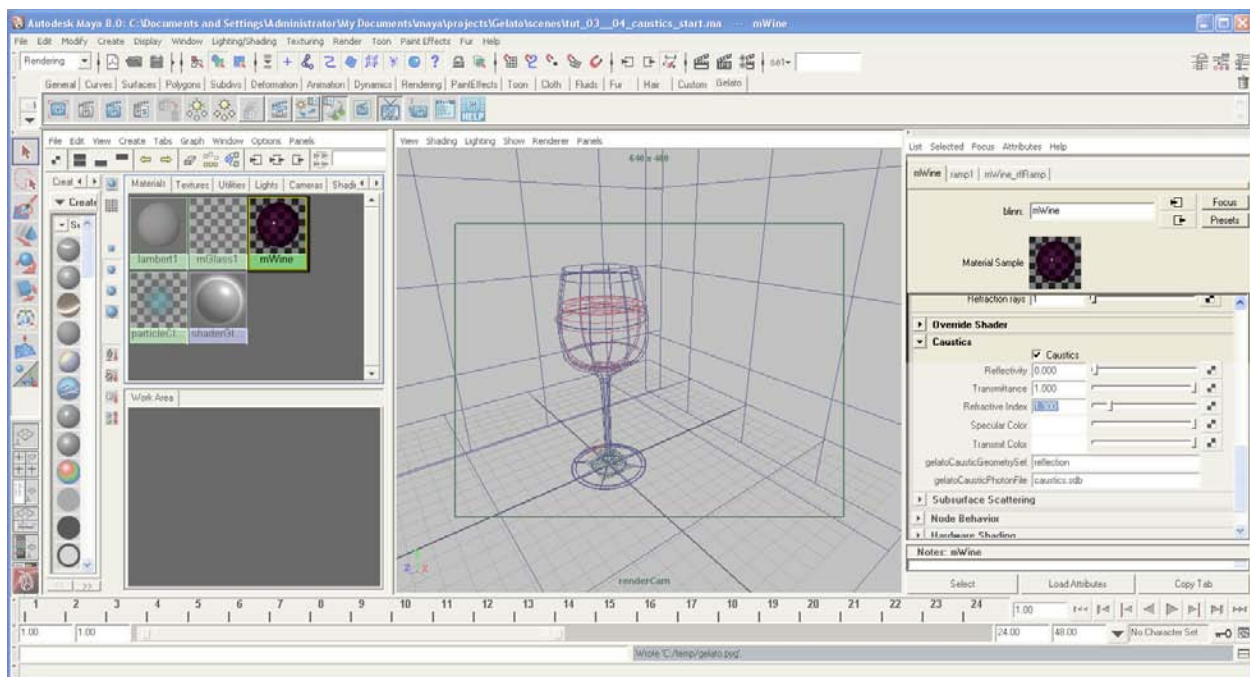
Increasing the Photons Per Point is going to increase render times, so, for the purposes of this tutorial, we are going to leave this as is.



What's a wineglass without some wine?

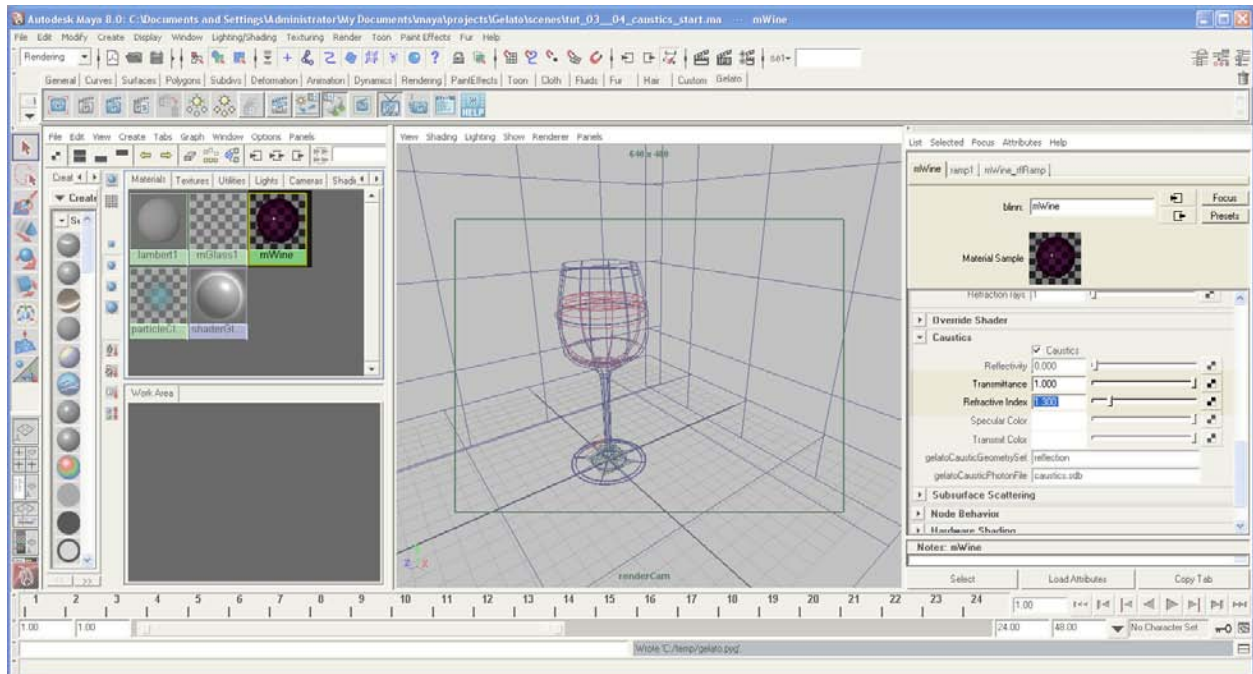
- Bring up the Layer Editor.
- Enable the visibility of the wineObject layer.

We now see the wine in the glass.

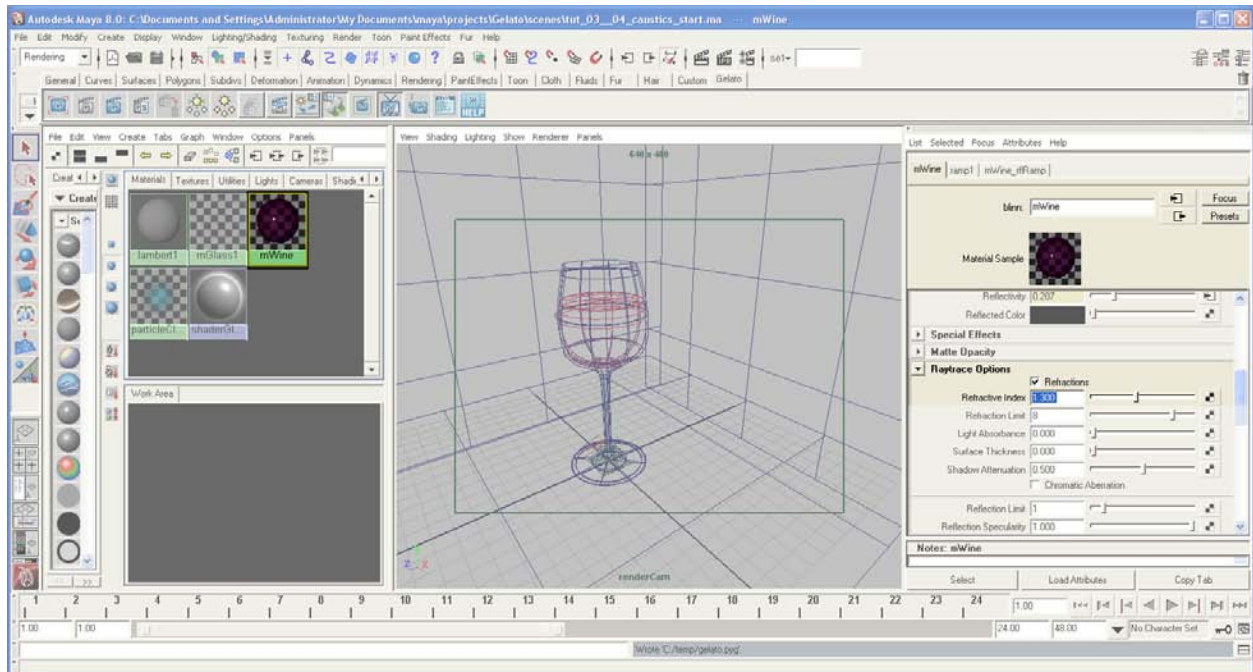


We're going to take a look at those color settings in the Gelato Caustics section...

- In the Hypershade, select "mWine."
- mWine Attribute Editor > Gelato > Caustics > enable Caustics.



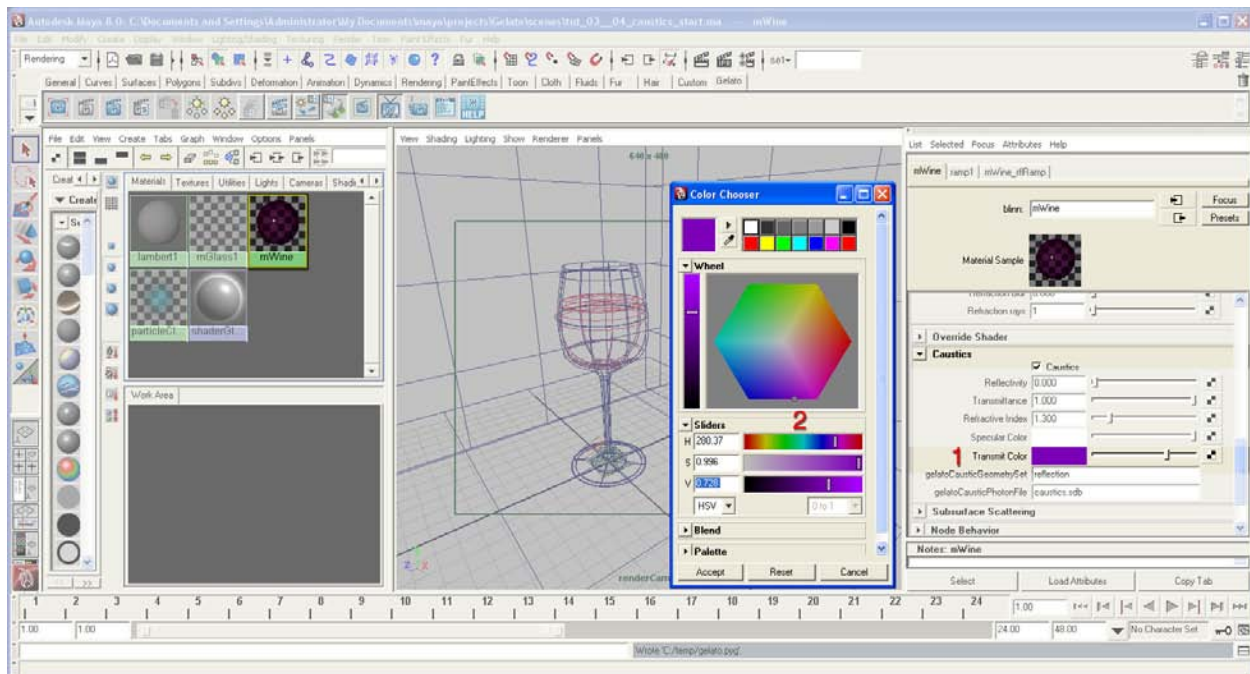
- Change the Transmittance to 1.000.
- Change the Refractive Index to 1.300.



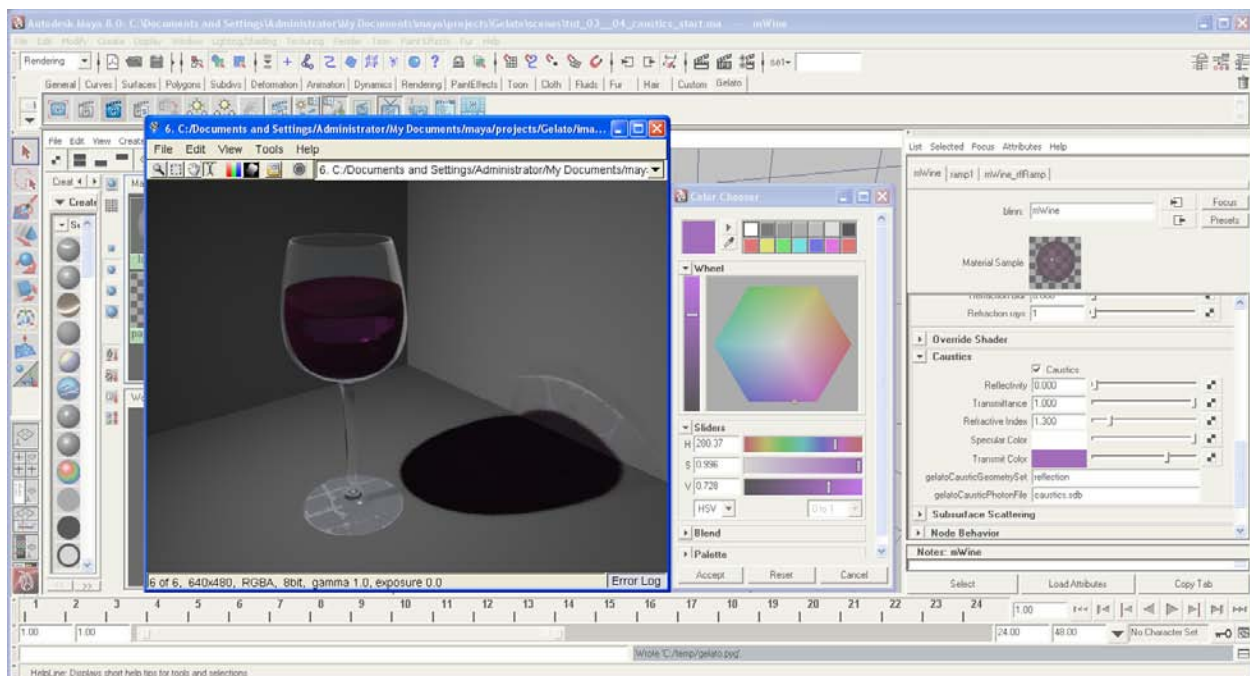
If you recall from the wineglass setup, it was noted that the refractive index should be the same for both Maya and Gelato, so let's get Maya in line...

- mWine Attribute Editor > Raytrace Options.
- Change the Refractive Index to 1.3000.



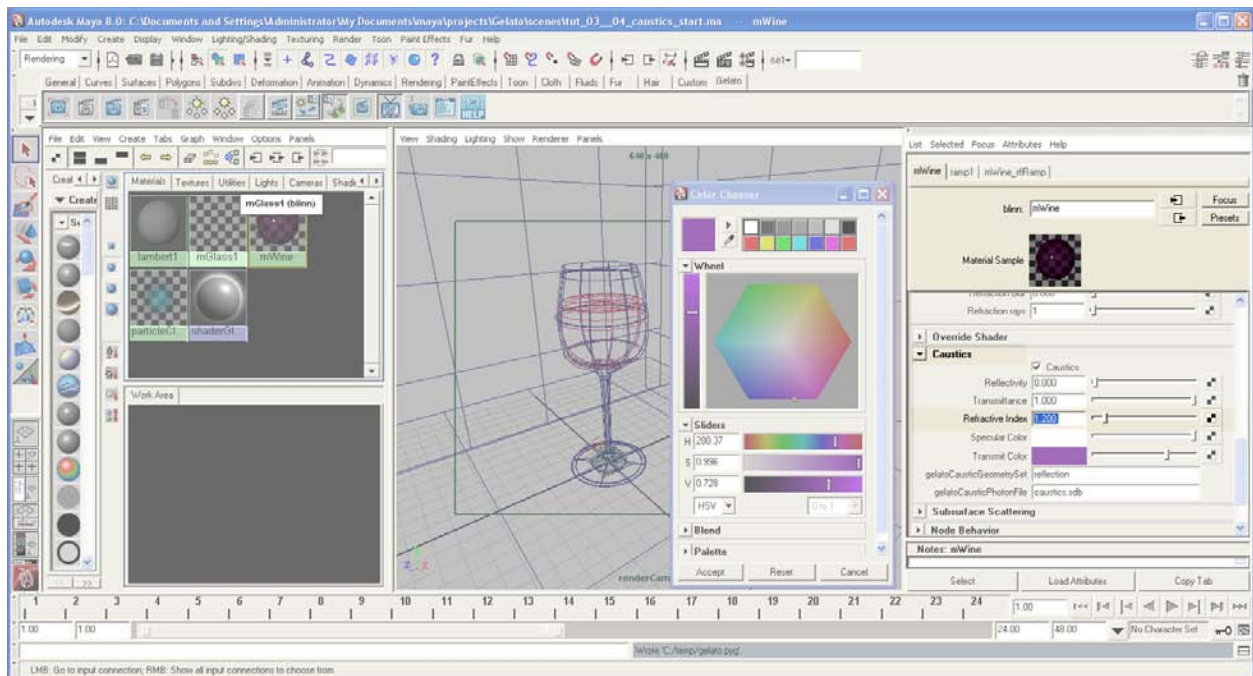


- mWine Attribute Editor > Gelato > Caustics.
- **[CLK]** the field next to Transmit Color.
- In the resulting Color Chooser, choose a purplish color.
- Gelato Render.

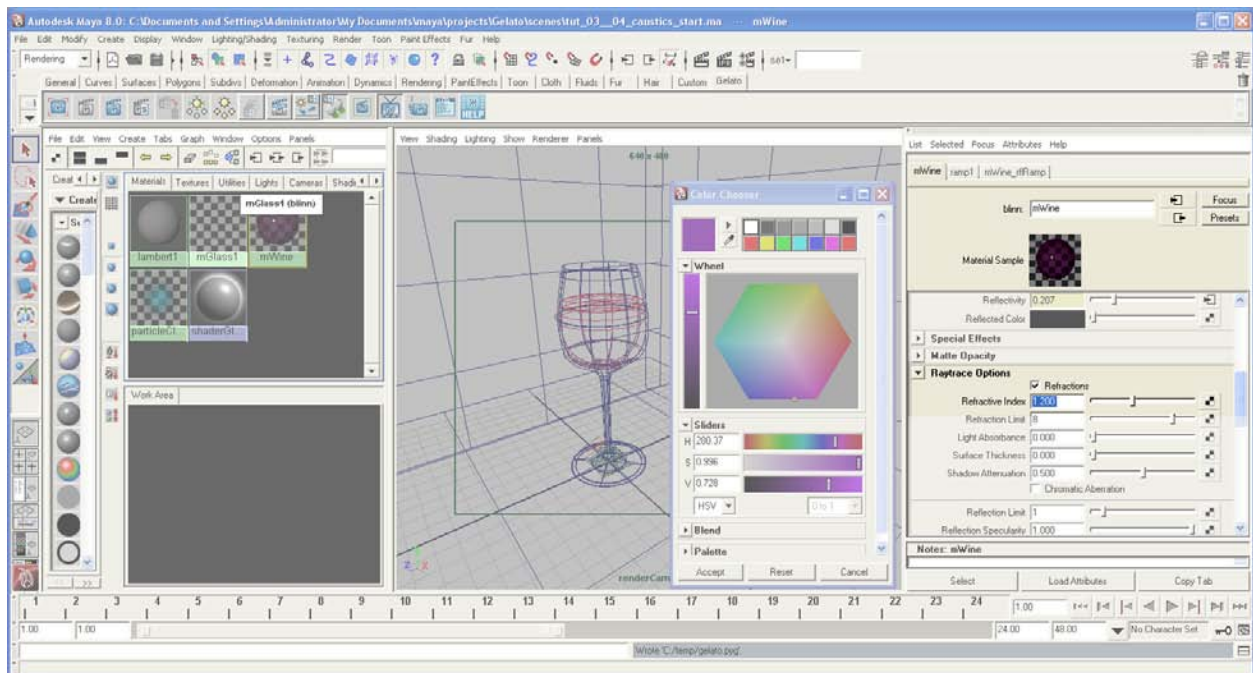


The caustics and transmitted color resulting from the wine are visible.

Let's change the shape of those caustics. To do this, as we have already seen, we need to adjust the refractive index.

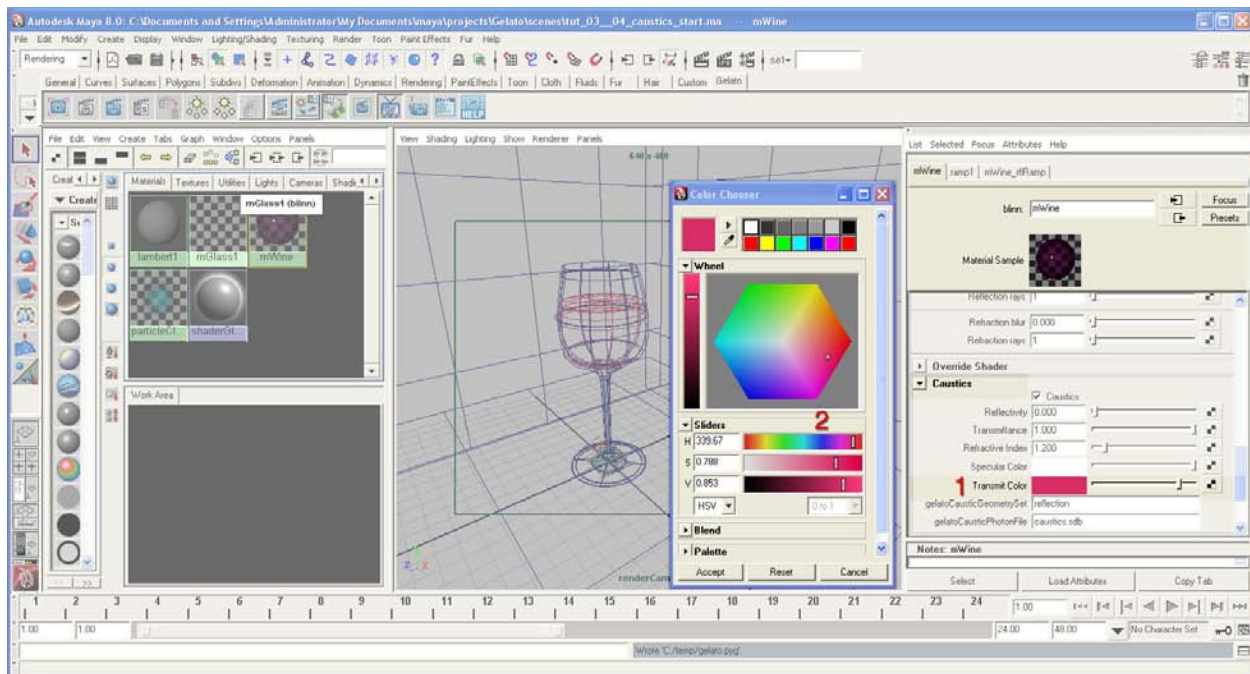


- mWine Attribute Editor > Gelato > Caustics > change Refractive Index to 1.200.



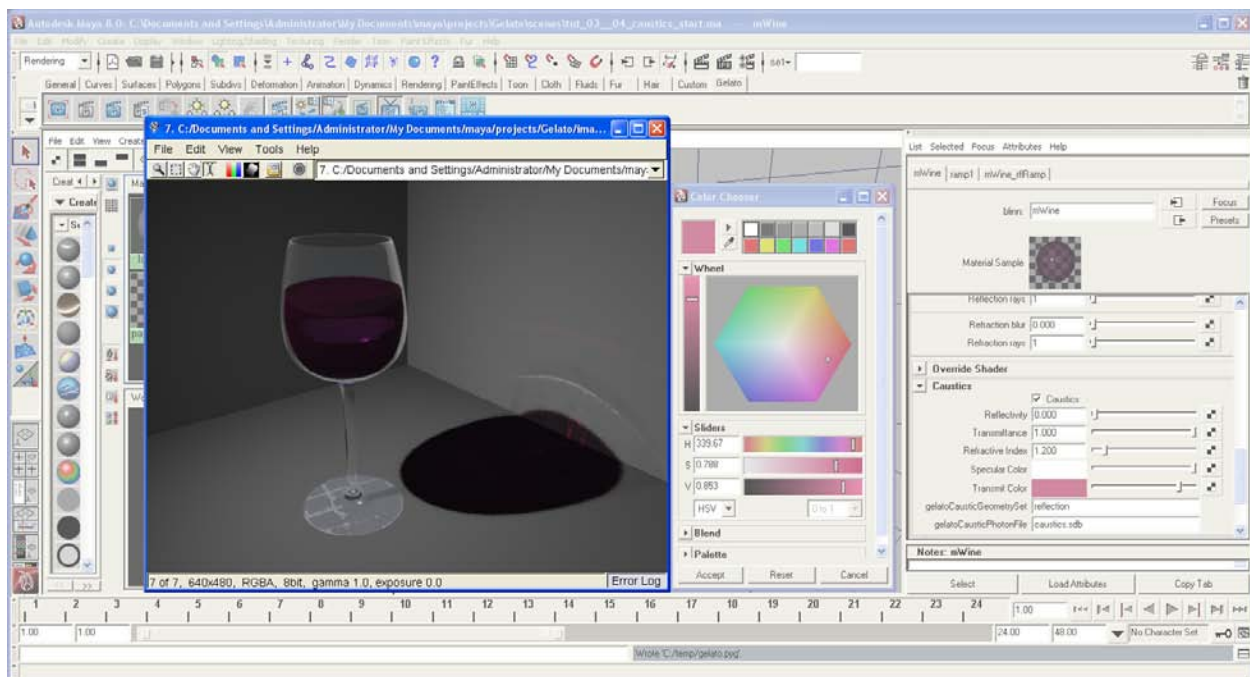
We need to change this for Maya as well, so...

- mWine Attribute Editor > Raytrace Options > change Refractive Index to 1.200.



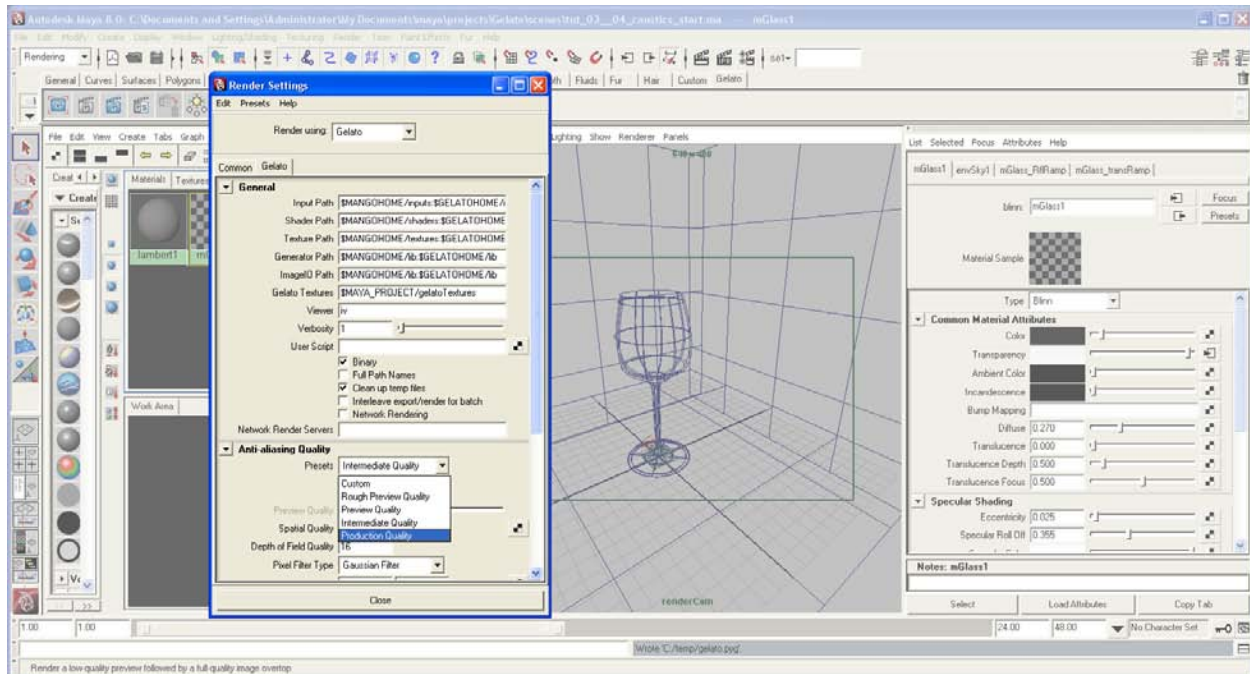
Let's also adjust the wine's Transmit Color...

- mWine Attribute Editor > Gelato > Transmit Color > **[CLK]** on field.
- Make the color redder, maybe a bit lighter, something appropriate for red wine.
- Gelato Render.



Now that we have decreased the refractive index for the wine material, we can see that the caustics are more focused.





We're going to leave this as is. If you would like to continue working on it, here are some things that could be addressed:

- \* A higher Photon Per Point value will yield more detail.
- \* Adjusting the Shadow Rays would remove noise from the shadows on the glass (Spotlight's Attribute Editor > Shadows > Raytrace Shadow Attributes > Shadow Rays).
- \* The reflections could be blurred to remove anti-aliasing artifacts on the ray traced reflections.
- \* The anti-aliasing on the entire image could be upped by changing Render Settings > Gelato tab > Anti-aliasing Quality > Production Quality.

We'll leave this in your capable hands to experiment with as you will; always keep in mind as you're working that how perfect an image needs to be varies with a project. It's not always necessary to achieve perfection to get a satisfactory result.