

Intro to Fulldome Production with Blender

2017 Pleiades National Planetarium Conference

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Appendix A: Recommended Learning Resources

Appendix B: Notes on Video Output

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Welcome to the Blender Fulldome Workshop at the 2017 Pleiades National Conference!

This workshop is focused on some of the methods, tips and tricks useful for getting started with using Blender specifically to produce fulldome content.

If you...

...have little experience with graphics software, these materials may be helpful later on as you learn the basics.

...have experience with other software packages, this may be helpful in transferring your skills from other packages to Blender.

...know Blender, but haven't used it for fulldome, this should be a nice start toward building your own bag of tricks.

...already have plenty of experience working with Blender, perhaps you will find a new method or two. And please do let us know about the methods and tricks that you have found helpful in your own fulldome Blender work.

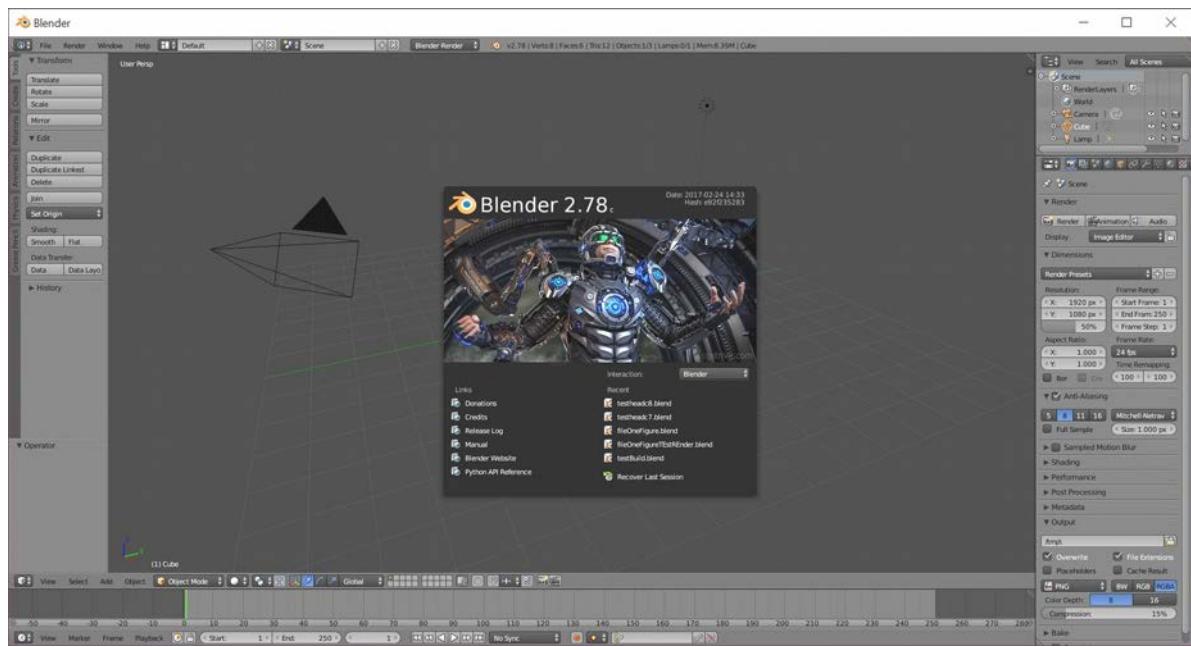
Most of all, we hope that you will enjoy the workshop and will use the provided materials as examples for further learning and experimentation.

Part 1: Interface Tour and Initial Settings

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This brief tour of the Blender interface applies specifically to version 2.78c, but will apply reasonably well to versions later than 2.60. As of this writing, version 2.79 has been released. Some interesting new features have been introduced, but very little has changed with the interface. Be forewarned that version 2.80 will include many changes to the look and feel of Blender in addition to some changes in workflow and functionality.

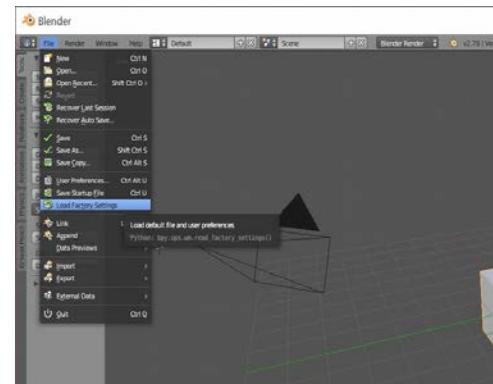


Blender 2.78c startup with splash screen

Click anywhere to get rid of the splash screen.

For this tour, we will use the default factory settings.

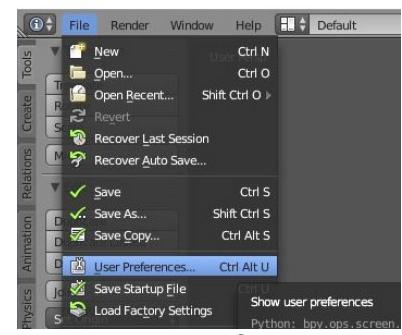
File > Load Factory Settings



File > Load Factory Settings

By default, Blender uses the *right* mouse button for selecting objects and the *left* mouse button for placing a special cursor in 3D space. If you are new to Blender, you may want to swap the left and right mouse button functions. To do this, we open the user preferences dialog.

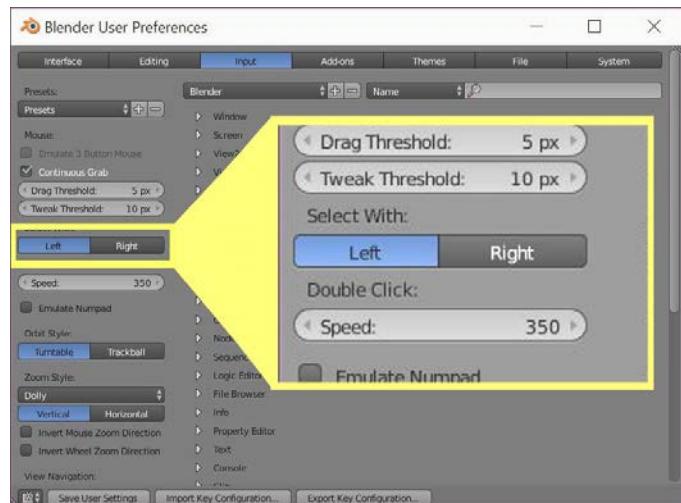
File > User Preferences



File > User Preferences

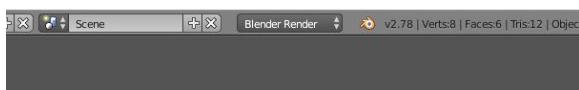
Through the User Preferences dialog, nearly everything is customizable. Themes, shortcut keys, input devices, render cards, file folder defaults and Add-ons can be selected and adjusted here.

- ❖ Under the Input panel, change "Select With:" from Right to Left.
- ❖ At the bottom of the User Preferences dialog, click Save User Settings.

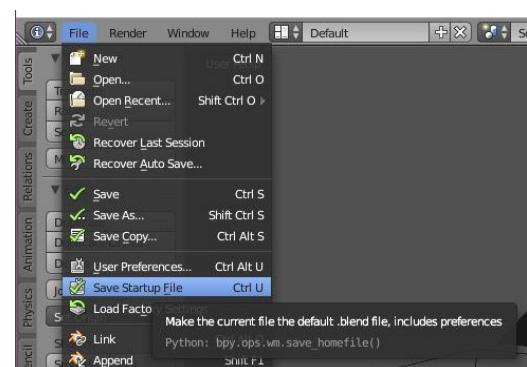


There is one more setting to change. The heart of 3D rendering is the *render engine*, the set of internal instructions that tells the software how to handle lights and materials. By default, Blender uses the older Blender Render engine. The newer Cycles Render engine is more powerful and complex, giving us more control over lighting, materials, camera settings and more. For fulldome rendering specifically, Cycles can render fisheye images directly.

Near top center, click Blender Render and from menu select Cycles Render.



- ❖ Save startup file. We can do this through the menu or using the keyboard shortcut Ctrl-U.



★ Note that many menu selections also list the keyboard shortcut, and that tooltips describe the function but also reveal the underlying Python code. These features can be disabled in the User Preferences.

We will set up the fulldome camera and save additional settings after the tour.

The Blender Interface is consistent across platforms so there are very few differences if you frequently switch off between Mac, Windows and Linux systems. Some operating system shortcuts interfere with default Blender keyboard shortcuts, so we'll include both keyboard and menu methods in our instructions.



The Blender online manual is an excellent resource and is quite worthy of bookmarking or downloading.

<http://docs.blender.org/manual/en/dev/>

Most boxed off areas are separate windows. *Windows* are used to contain *Editors*. Editors can have their own *toolshelves*, *tabs* and *panels*. Terms windows, editors, regions and viewports tend to be used interchangeably by many in the user community worldwide.

Screens are saved layouts. You can make and save your own, plus there are several premade screens available. We'll mostly use the Default, Compositing and perhaps the Animation screens in this workshop. Additional screens are preset for Video Editing, UV Editing, Game Logic, Motion Tracking and Scripting.

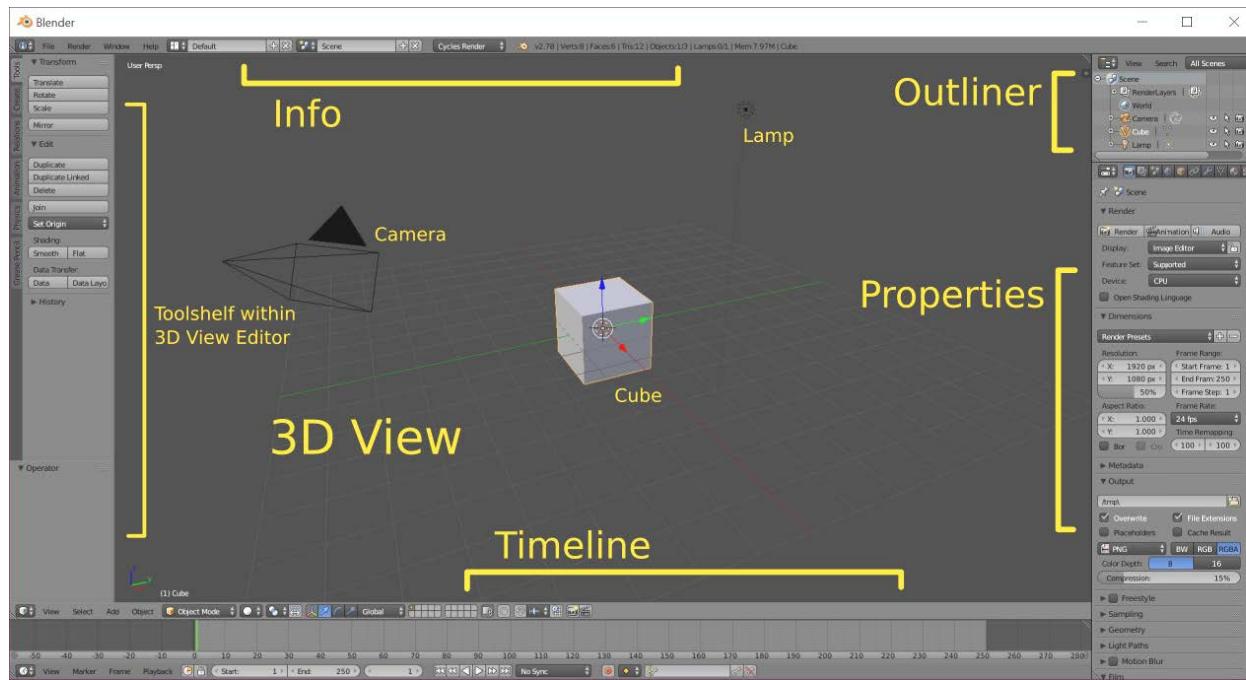


Shortcut Tip:

To quickly navigate the available screens use Ctrl and left or right arrows:

`Ctrl →` and `Ctrl ←`

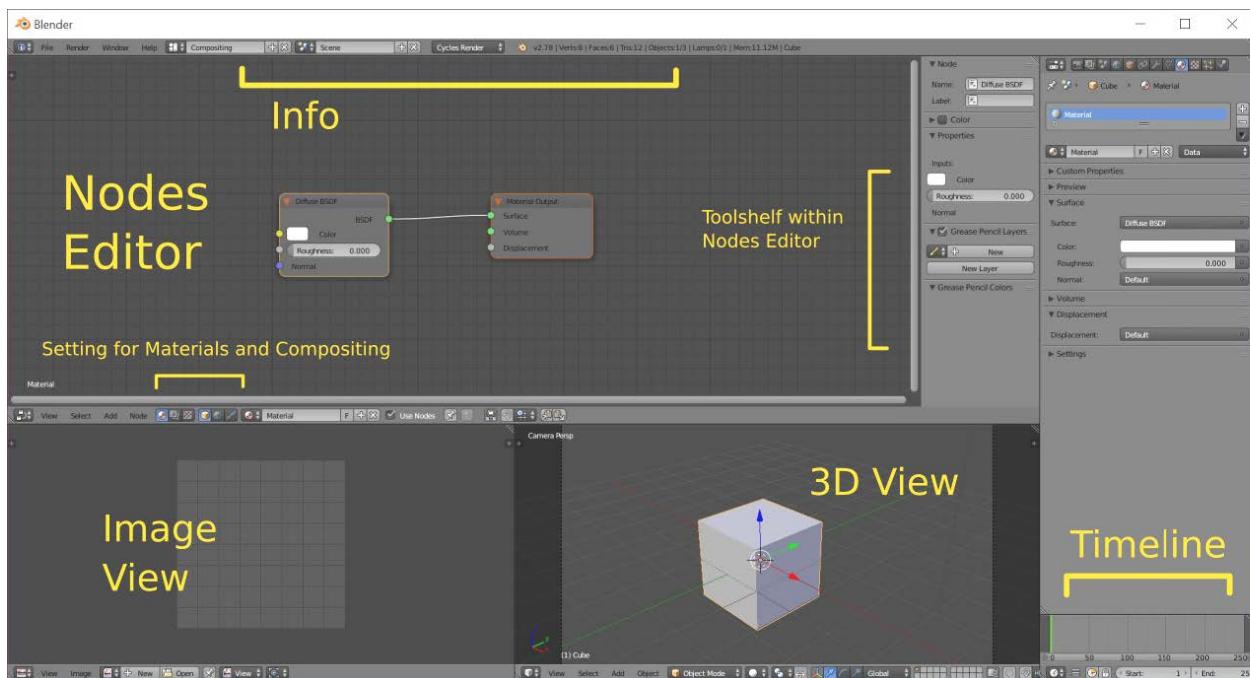
Default Screen



In the Default screen, the viewport areas contain the editors 3D View, Outliner, Properties, Timeline, and Info.

- The Info editor looks like a top menu toolbar, but is part of a hidden window.
- The Outliner shows hierarchy, object types and visibility status.
- The Properties editor contains pretty much all settings other than the user settings. Tabs for each property type change depending on the type of object selected. The tabs are further divided into panels.
- The Timeline editor can be set for seconds or frames. The scene can be put into motion forward or backward, and some settings here are duplicated from in the properties panel. For instance, changing the start or end frame in the Timeline will also change it in the Render tab of the Properties editor.
- The 3D View Editor (“viewport”) is where we spend a lot of our time. Here models, cameras, lights and more are created, modified, positioned and animated. Actions are performed using mouse, keyboard shortcuts, menus, tabs on the tool shelf or combinations. More on the 3D View later in the tour.

Compositing screen

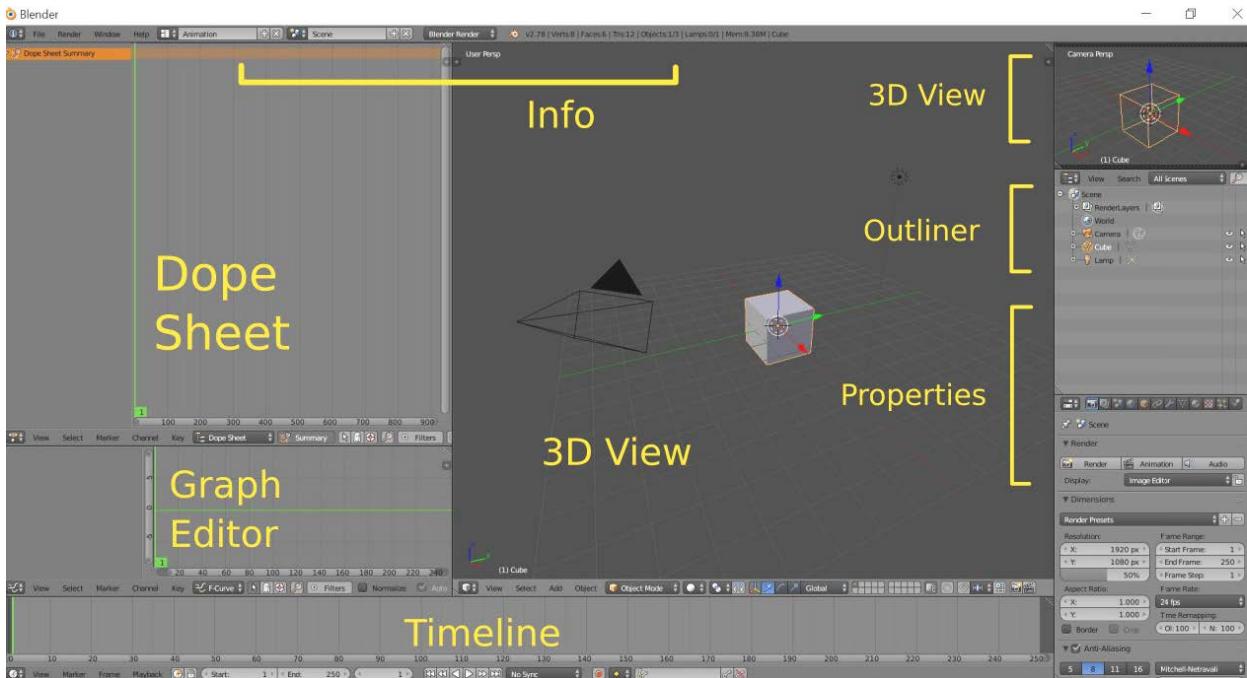


The Compositing screen is not only for compositing. It contains the Info, Properties, Timeline and 3D View editors. It also features the UV/Image editor for viewing render and composite results, and it prominently features the Node editor. The Node editor is useful for:

- Compositing multiple layers, scenes, videos, image sequences... Many compositing functions can be performed in this node-based system.
- Object materials can be set here. A variety of shader types are available. They can be setup through the Nodes editor and to some extent through the Properties editor. Materials can be mixed a variety of ways using both procedurally generated or premade image textures. The best part is that everything can be animated.
- World materials can be set here. World in this case refers to the full 360 degree sphere surrounding your scenes. The World materials can be 360 degree by 180 degree images, they can be procedurally generated, or even a mix of the two. World materials, too, can be animated, as we shall see.

Blender Fulldome Part 1: Interface Tour and Initial Settings

Animation screen



The Animation screen is handy both organizing and tweaking the characteristics being animated. It contains the Info, Outliner, Timeline and Properties editors along with two 3D Views, plus two animation-specific editors, the Dope Sheet and the Graph Editor.

Screen layouts can get very, very busy. It simply isn't possible to display all of Blender's functionality at the same time.

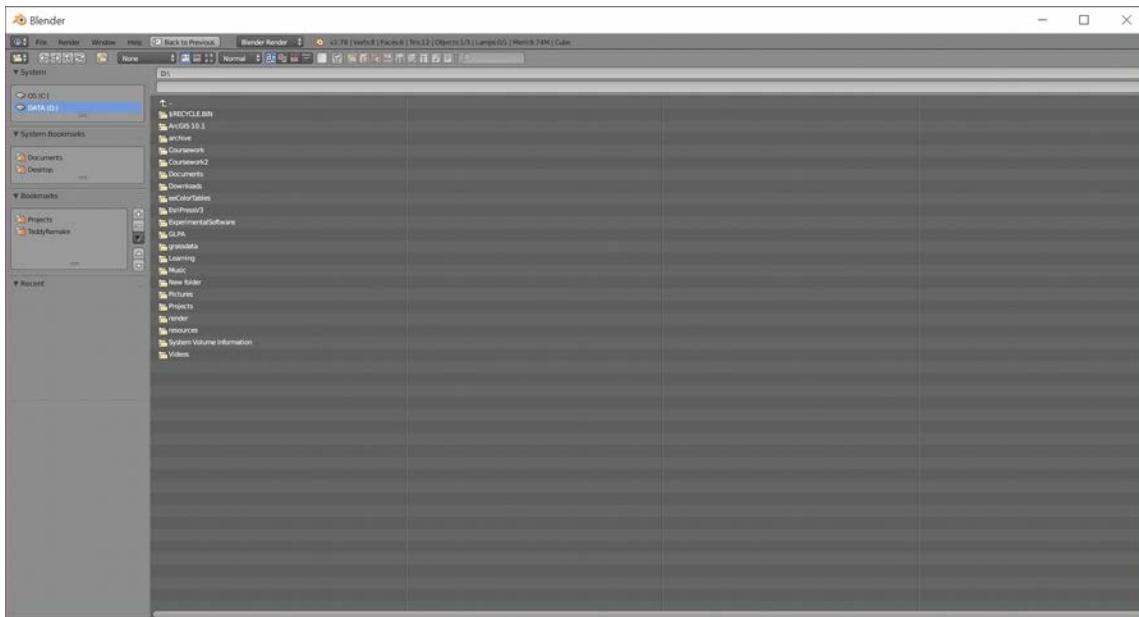


Dual Monitors Tip:

To use Blender across dual monitors, duplicate the window, move it to the second monitor and then select a different screen.

Window > Duplicate Window

File Browser



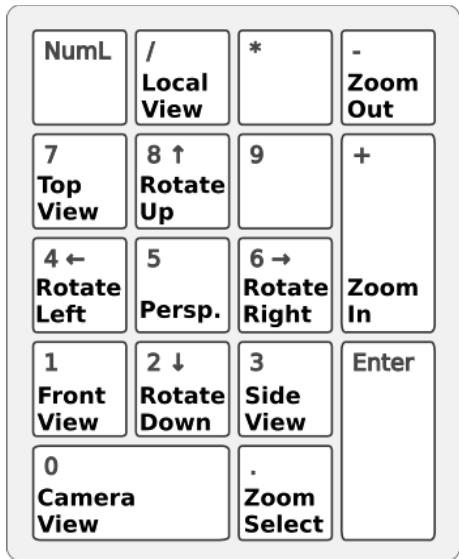
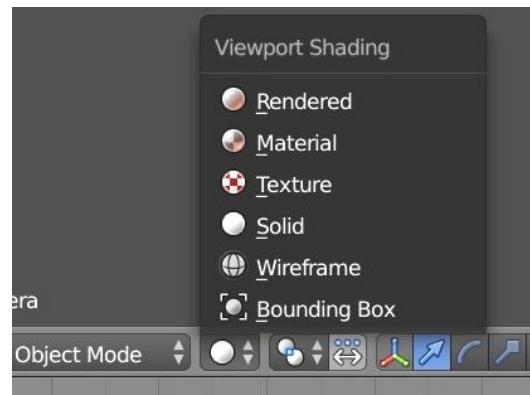
One editor that isn't present on any of the screens but you will encounter frequently is the File Browser. We use it whenever we Save As or Open files, Append from files, Import or Export models, Load image textures, image sequences, python scripts.....

- It can be accessed through the drop-down menu of editor types, but that's not usually necessary given that it will open as needed when the above actions are requested.
- It doesn't look like the folders interface in your operating system, as it was designed to be consistent across the various platforms.
- The default folder locations for types of files (textures, scripts, etc) can be set in User Preferences.
- When the File Browser opens, the Info editor window across the top changes to include a button for "Back to Previous" meaning close the browser and return to the previous Screen layout.
- On the left side is a tool shelf with panels for System folders, recent folders and bookmarks. Any settings specific to the file type and type of interaction will appear as a panel at the bottom.
- The options across the top of the File Browser includes folder navigation tools as well as buttons to create new folder, display image thumbnails and various options for sorting and filtering.
- The main region displays folder contents, both files and subfolders.

3D View Editor

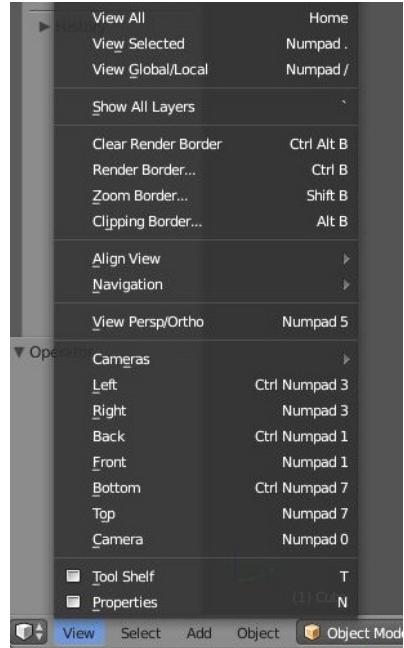
In the 3D viewport, *viewport shading* affects how we see the objects while working on them.

Z to toggle between solid and wireframe mode, Shift-Z to toggle to and from render preview mode. This shading can also be set with the mouse in the 3D View toolbar.



Our viewing position can be controlled through the menu system, but the keyboard shortcuts are well worth knowing. They use the numeric keypad found on most full size keyboards.

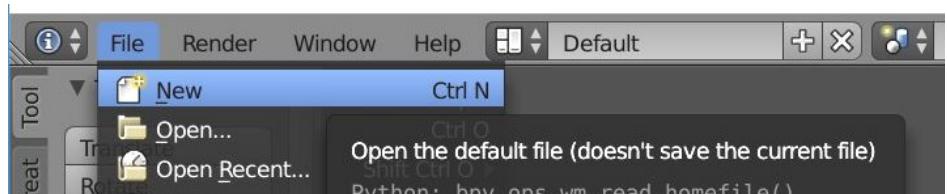
Having a numeric keypad is a time-saver when working with Blender in 3D View.



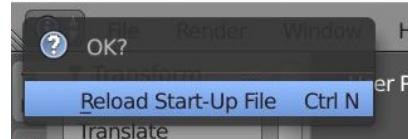
Start a new Blend file.

For the section we want a fresh file to work with. This will reset our 3D View and anything we changed other than the User Preferences and Startup File settings.

- Ctrl-N or File > New



- A dialog will pop up asking if it is okay. Hit enter or click "Reload Start-Up File"



Part 2: Output and Camera Settings for Fulldome

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Start with a fresh new Blend file if you haven't already.

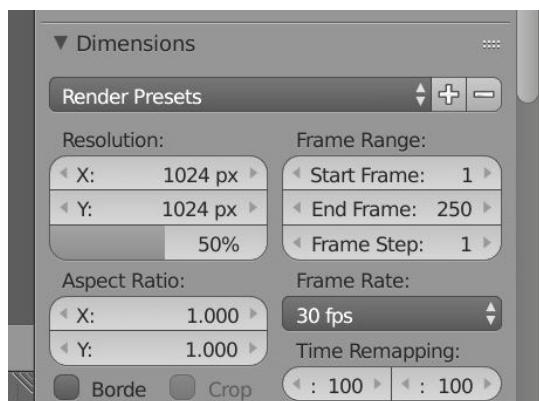


Before we set up the Camera and Output properties for fulldome rendering, we need to be certain that the Cycles Render engine is enabled. Only the Cycles Render engine has the capability to natively render fisheye formats.

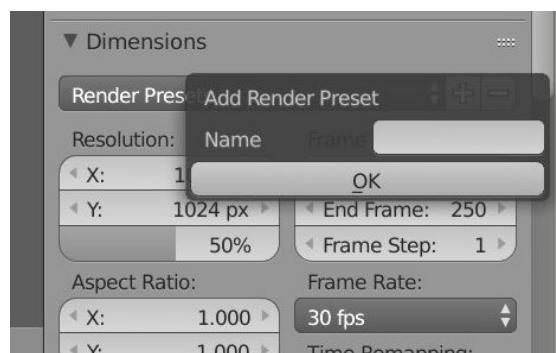


Output Settings

Output settings are best changed through the properties editor. The icon looks like a small SLR camera. At a minimum, we want the resolution to be square for a dome master.



- In the Dimensions panel, set Resolution X and Y both to 1024.
- set Frame Rate if desired



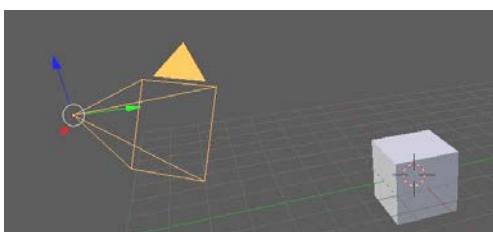
- To save these dimensions as a preset, click the “+”, type the preset name into the name box, then click OK.



Camera Settings

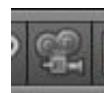
Camera settings are also set through the properties editor, but the camera must be selected in order for the options to appear.

Select the camera, either through the 3D View or through the Outliner:

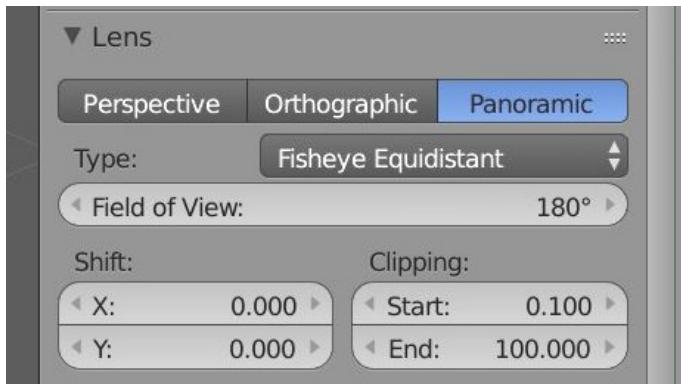


With the camera selected, the Properties Editor now reveals camera-specific tabs.

- In the Properties Editor, click the icon that looks like an old-fashioned movie camera.



Blender Fulldome Part 2: Output and Camera Settings for Fulldome

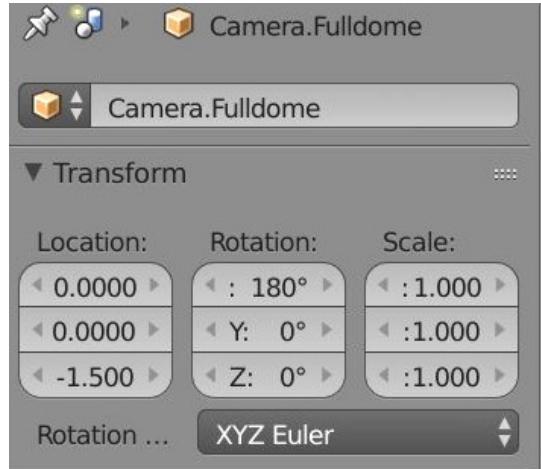
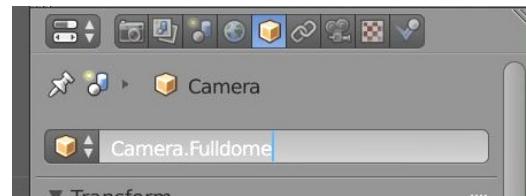


- In the Lens panel, click the “Panoramic” button.
- Then for Type, select “Fisheye Equidistant” - this setting makes a fulldome master with the least amount of fuss. All we need to do is set the Field of View. For now we can leave it set to 180.

- With the camera still selected, click the properties icon shaped like a cube to give our camera object a formal name.

Click inside the text field and change Camera to “Camera.Fulldome” -this will make it easier to reuse the camera later in other files.

- Finally, let’s position the camera near the middle of our scene. With the camera still selected as the active object and the object settings open, change the camera Location and Rotation to match these settings.
 - Location X, Y, Z: 0, 0, -1.5
 - Rotation X, Y, Z: 180, 0, 0



TransformTip:

Location, Rotation and Scale can be set with precision through Properties Editor or using keyboard shortcuts. The keys **G**, **R**, **S** are used for Grab (locate), Rotate and Scale. Use with the mouse for positioning objects by feel. Use with numbers for precision. For example, the sequence “**G X 0**” sets the active object’s X position to 0.

This works for all objects in 3D View: cameras, lamps, meshes, curves, etc.



Save the Blend file.

- Shortcut for Save is **Ctrl-S**, Save As is **Shift-Ctrl-S**
- Navigate to a suitable folder and give the file a name: **ObjectsInSpace**, then click “Save As Blender File”

Part 3: Blender World Creation

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Create a Blender “World”

World in Blender is the name for the environment map, background pattern or color surrounding the entire scene. It can be used as a simple background or can be used to provide color and light to the objects in the scene.

Switch to the Compositing screen.



Shortcut Tip:

To quickly navigate the available screens use **Ctrl** and left or right arrows:

Ctrl → and **Ctrl ←**



- In the node editor, select Shader as the node tree type, and select World as the data type to display.

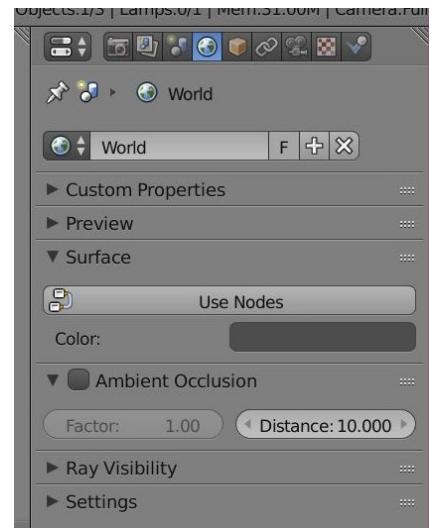


- In the properties editor, click the globe icon to see the World settings.



WorkflowTip:

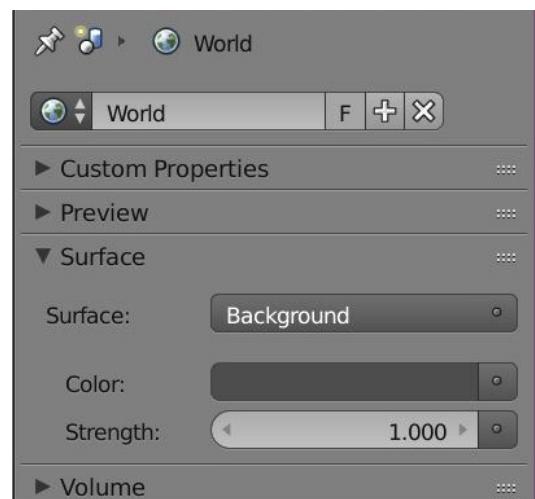
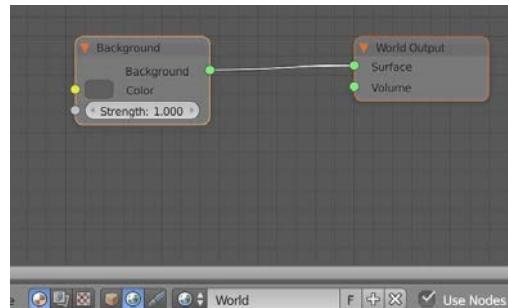
When working with shader nodes, keep the corresponding Properties Tab visible. Some settings are easier in one than the other. Used together, they speed up the process considerably.



- Instruct Blender to *Use Nodes* by either checking the box in the Node Editor toolbar or by clicking the “Use Nodes” button in the Surface panel of the World properties tab. This will automatically create the initial node setup.

The initial node setup is very simple. In the Node Editor we see a Background shader with color and strength connected to the output node.

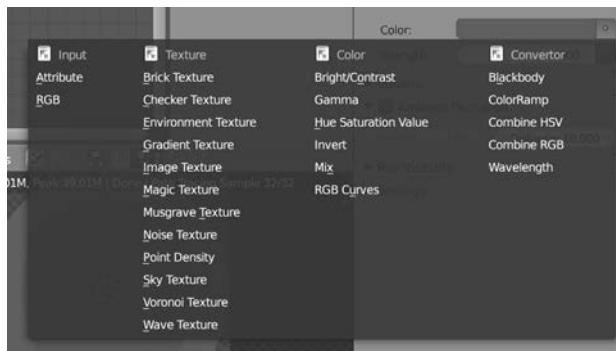
In the Properties Editor, we see the same information.



Blender Fulldome Part 3: Blender World Creation

Instead of using a color for our World, we will use an environment map connected to the color input of the Background shader.

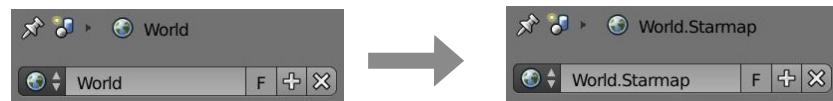
- In the World properties Surface panel, click the box with the dot in the Color setting.



- Under the *Texture* heading, select Environment Texture.
- Note that an Environment Texture node has been created and connected to the Background shader node.
- In either the Node Editor or the Surface properties, click the Open button.



- Navigate to the folder containing the textures for this workshop, select and open the image file starmap_4k.jpg
- Since we will want to reuse this World and possibly even animate it in the future, we need to rename it. In either the Node Editor or Properties Editor, click into text field and change "World" to "World.Starmap"



Texture Resource Tip:

This and several other star maps are available to download for free from NASA/Goddard Space Flight Center Scientific Visualization Studio.

<http://svs.gsfc.nasa.gov/3895>

Before we finish this section, we need to remove the cube object from the center of the scene.

- Select the cube in either the 3D View or the Outliner.
- Delete the cube through either the menu in the 3D View toolbar or through the Outliner.

To delete through the Outliner, right-click and choose "Delete" from the list of options.



Save the Blend file.



Incremental Saving Tip:

To save files with incremental version numbers, use Save As but instead of typing in a new name, press the Numpad + key. That will add 1 to the end of the file name. File.blend becomes File1.blend, File1.blend would save as File2.blend, etc.

Part 4:

Various Objects, Materials and More

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Appending objects and materials from other Blend files

To save time in our workshop, we will import a variety of premade demonstration objects. These objects have different properties that will be of use for further study. We will use these assets to see how shading properties can be set to interact or not depending on the desired effect.

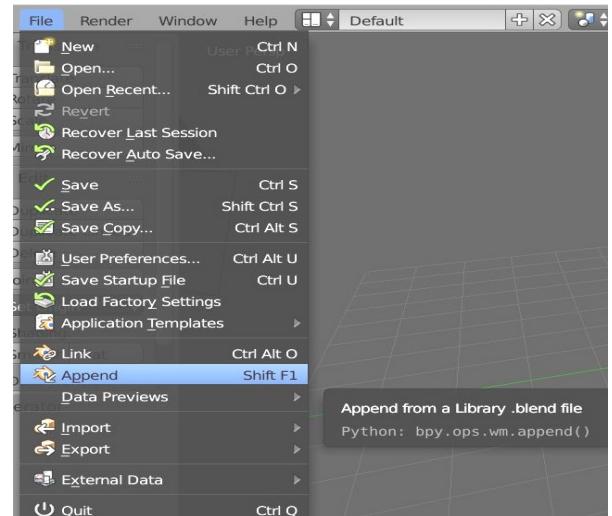
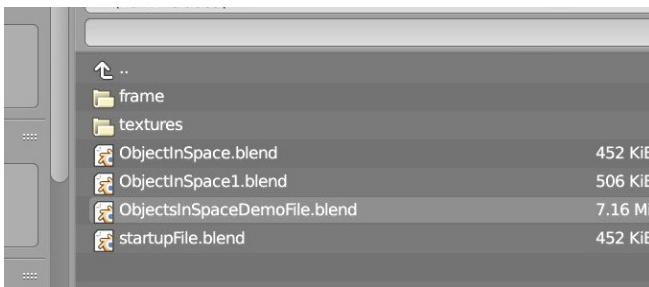
There are many excellent free tutorials available online for creating and setting up the properties for these objects.



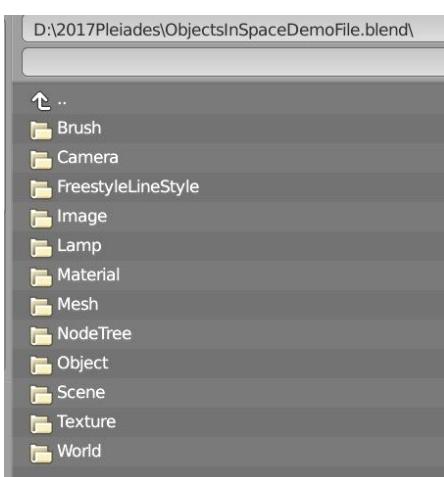
Search Tip:

When searching Google or other engines to figure out how to do something in Blender, make sure to include both “Blender” and “Cycles” in the search terms. This will weed out most of the much older and outdated tutorial and forum answers.

Blender can *import* a number of different 3D model file types, some natively and some by enabling import/export addons in User Preferences. To import from another blend file, we use the Append feature.



File > Append > ObjectInSpaceDemoFile.blend



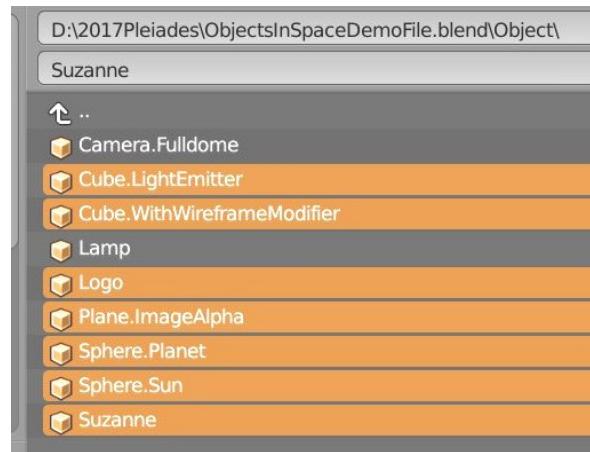
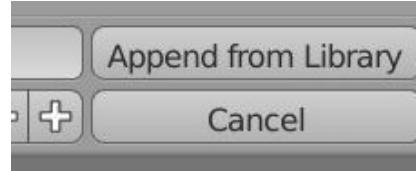
Inside the Blend file looks like a bunch of folders.

Enter the Object folder.

Blender Fulldome Part 4: Various Objects, Materials and More

Shift-click to select everything but the camera and the lamp.

After selecting, click “Append from Library” in the upper right hand corner.

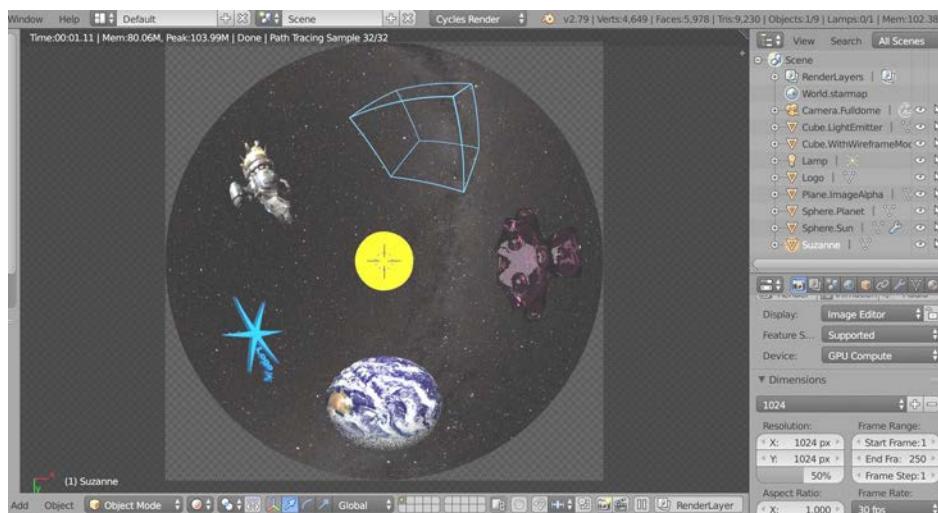


Save the Blend file.

After adding the items from the demonstration file to our working file, the render preview camera view should look like this:

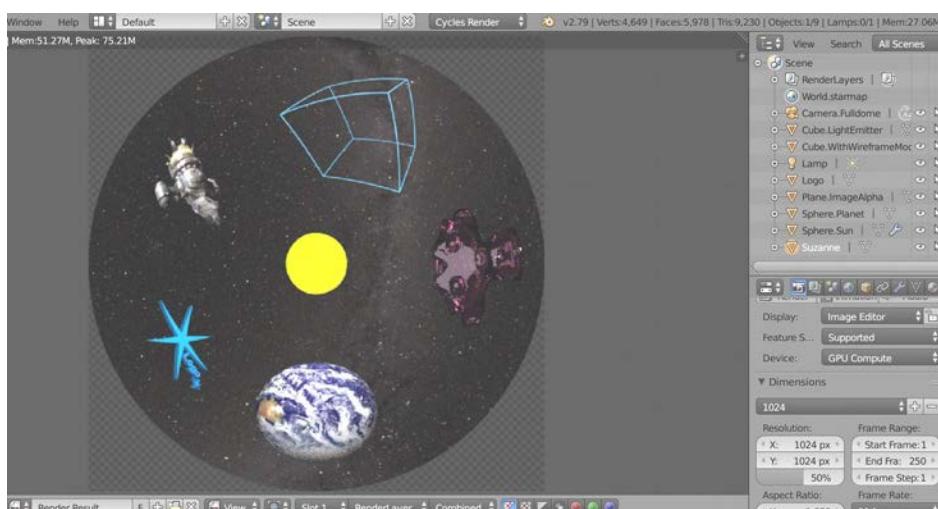
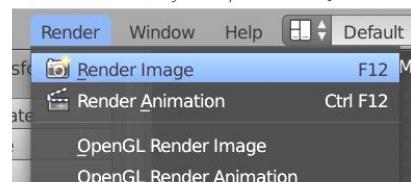
Numpad 0 for camera view

Shift-Z for render preview. Note that the fisheye effect cannot be seen in wireframe or solid view.



Compare the preview to a test render.

F12 or Render > Render Image



They should look similar at this point.

To exit Render Result, press Esc key or change the editor to 3D View.



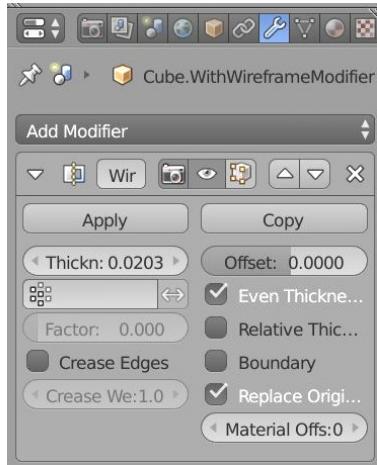


The rest of this section describes the individual objects and their characteristics in detail. Some or all may be skipped during the workshop, but is included for later study.

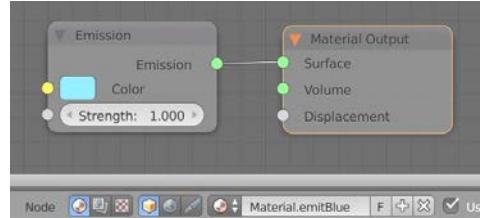


Wireframe Cube (“Cube.WithWireframeModifier”)

This is a solid 3D cube with a material emitting blue light and with a modifier presenting it as a wireframe.



The modifier has not been applied to make the change permanent, so we could still change the thickness if we want.



Modifier settings are in the Properties Editor. Click the wrench icon to access them.

The eye symbol in the wireframe modifier panel toggles the visibility of the effect. Because the material is emitting, making the effect invisible shines a lot more blue light on the other objects.



Glass Monkey Head (“Suzanne”)

Suzanne is a Blender mascot available for adding just like the cubes, spheres and other built-in shapes.

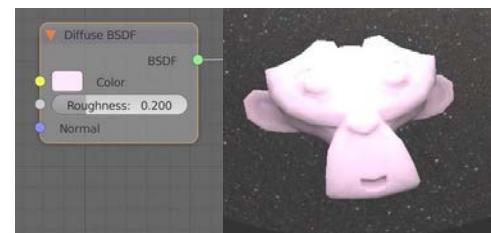
The model was added, simple smooth shading was applied, and the model was given a glass material. Compare Glass, Diffuse and Glossy.



Materials in Blender are what define how we see 3D objects. Characteristics including light, color, texture and transparency and how they interact with other objects are all defined through materials.

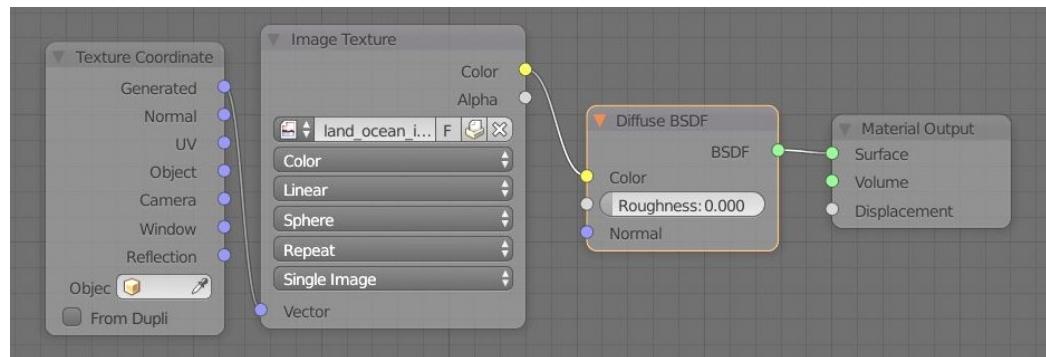
Shaders define the material. Shaders are the internal instructions telling the software how to achieve the effects.

Materials consist of 3 shaders. One for Surface, one for Volume and one for Displacement. Given how frequently surface shaders are used, it is not uncommon to see the terms “material,” “shader” and “surface shader” used interchangeably.



Earth Ball (“Sphere.Planet”)

The planet is a UVsphere with an image texture applied to a Diffuse Shader.



The projection method is set to “Sphere” and the texture is applied using Blender’s internally generated coordinates for mapping.

Logo

The Logo model is an imported 2D SVG file.

File > Import > Scalable Vector Graphics

The imported file creates several Curve objects. The curve objects were selected using Border Select.

The **B** key starts the select, and the mouse is used to drag the box border around all of the curves. Border Select can also be started via the menu.

Select > Border Select

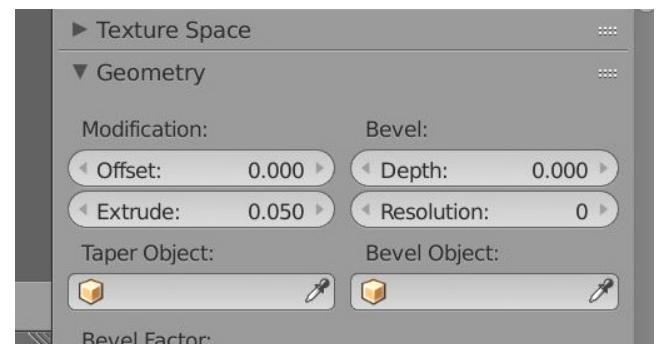
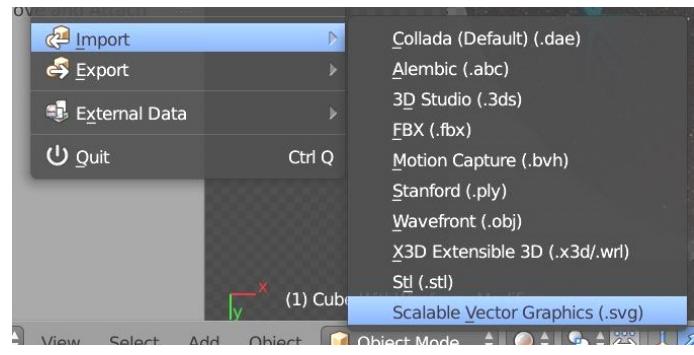
The selected curve objects are then joined as one object using **Ctrl-J** or Object > Join



Once joined into one curve object, the object was renamed “Logo”

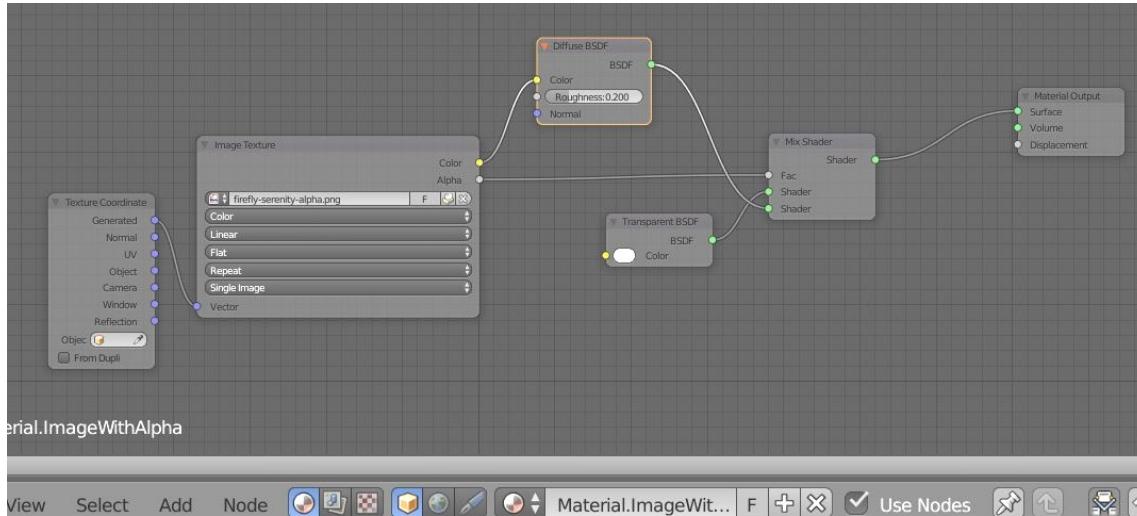
Finally, the curve was extruded as a Modification setting in the Geometry panel of Curve properties.

Try at home with your own planetarium logo. Most vector drawing programs can save or export to the SVG format.



Firefly Image (“Plane.ImageAlpha”)

Images and image sequences with alpha channels can be useful in fulldome scenes.



The material of this plane uses a Mix Shader. The Image Texture color output feeds into a Diffuse Shader which in turn feeds into the Mix Shader. A transparent shader also feeds into the Mix Shader, and the two are managed by the image texture alpha output feeding into the factor socket of the Mix Shader node. Note that the image texture in this case requires a Texture Coordinate input to use Blender's internally generated coordinate.



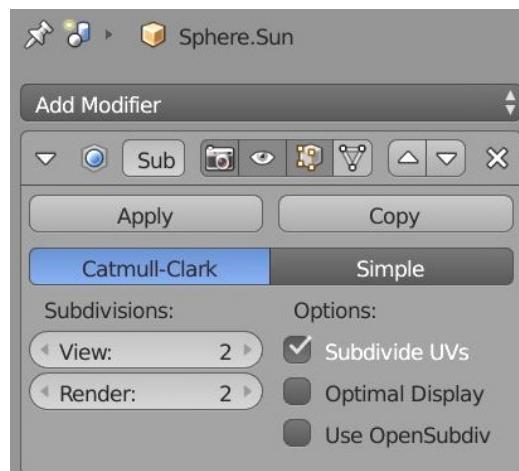
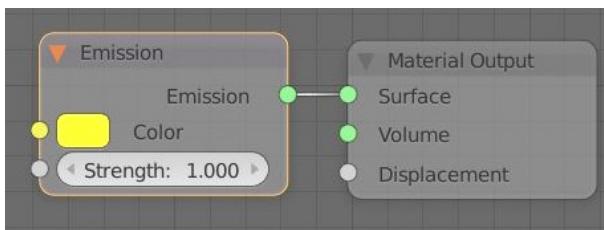
Add-on Tip:

Add-ons are scripts enabled through User Preferences that extend the capabilities of Blender. “Import Images as Planes” automatically scales the image plane to the dimensions of the image. It also sets up the material nodes, although it uses a different coordinate method.

Sun Ball (“Sphere.Sun”)

An Icosphere was added with an Emission shader and a Subdivision Surface Modifier.

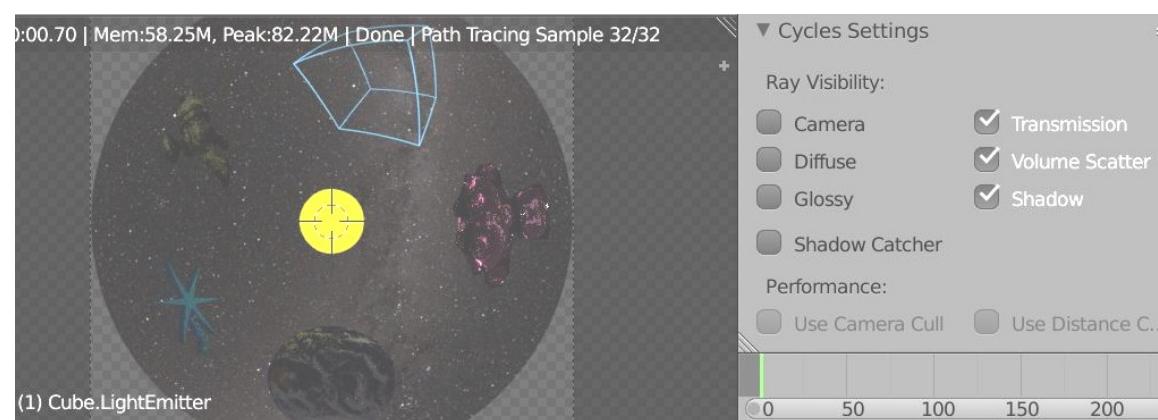
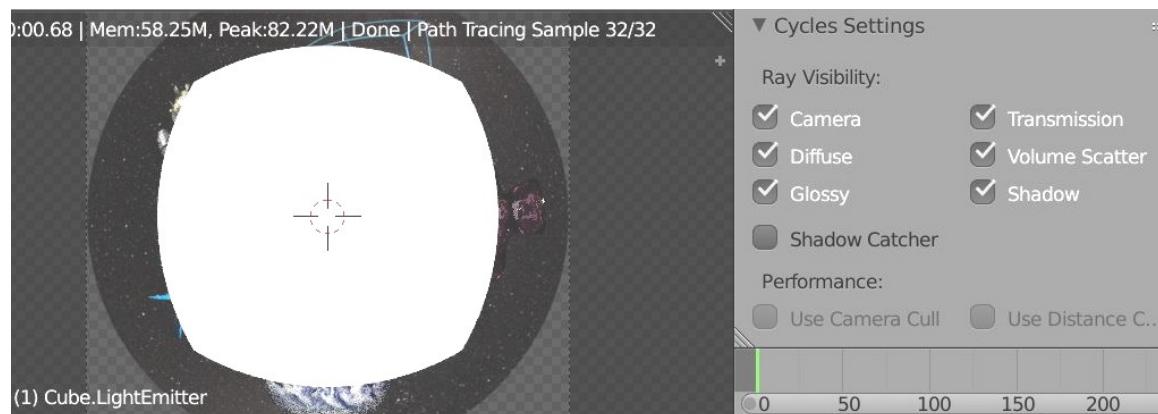
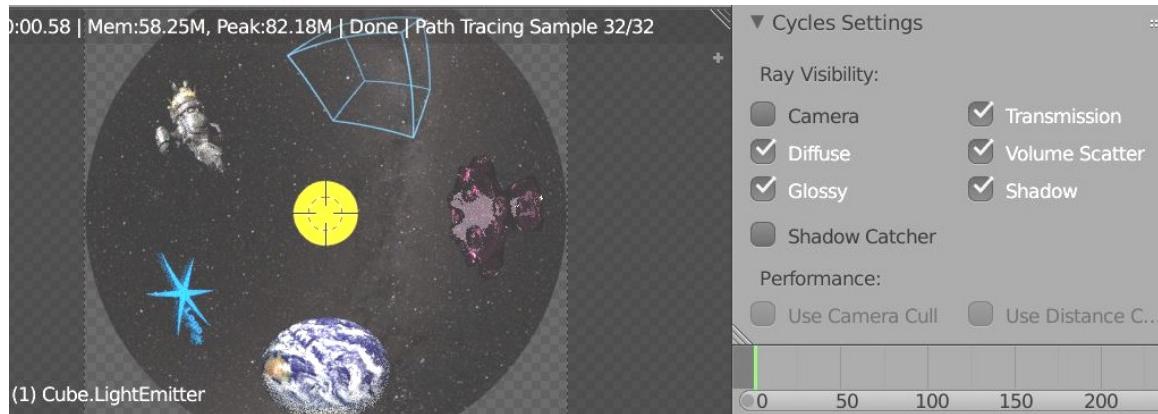
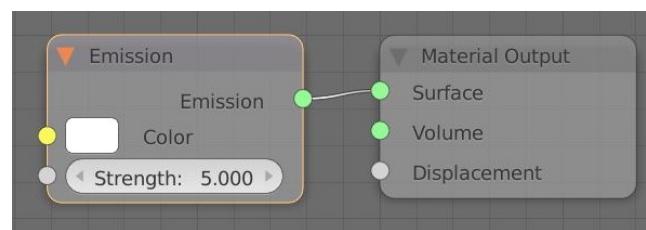
It will be made to glow in the next part of this workshop using RenderLayers and Compositing nodes.



“Cube.LightEmitter”

This cube object is only used to provide lighting to the other objects in the scene.

It started out as a default cube, emission material set to strength of 5 and used Cycles Settings Ray Visibility in object properties to make it invisible to camera.



Part 5: Compositing Render Layers

Intro to Fulldome Production with Blender

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Render Layers

Render layers are a way to separately render parts of the scene so that image processing can be performed on some elements differently than on others. These parts are then usually recombined in the final compositing stages.

 Many users find Blender's layers to be confusing. There are a few different types and they don't behave like layers in other commonly used software packages.

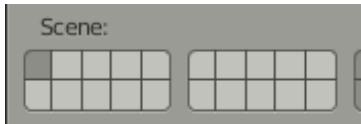
So... If you find them to be confusing and frustrating, know that you are not alone. The good news is that the next major version, 2.80, will include a major overhaul to Blender's handling of layers.

For now... having a good example on hand to refer to in your fulldome Blending will be a great way to use the layers without investing a lot of time figuring them out.

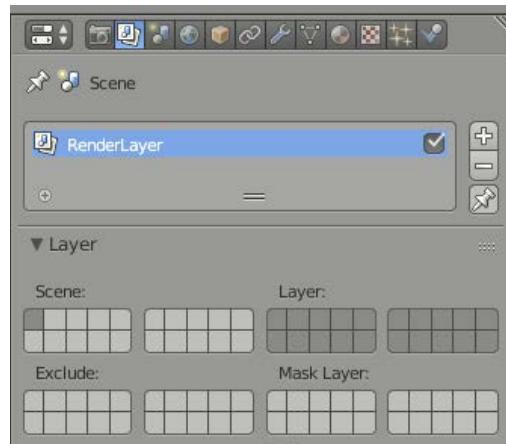
At least one Render Layer must be active in order to render a scene.

In the Layer panel of the Render Layers Properties, are the settings for managing the layer slots.

- Scene layers are the layer slots visible in the scene.



This set of layer slots is also visible in the toolbar of the 3D View.



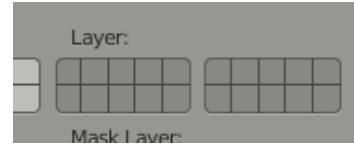
Selected objects or groups of objects can be moved to a different layer in the 3D View by pressing the **M** key or through the menu: *Object > Move to Layer*

Individual objects can also be moved to a different layer through the Relations panel in the Object Properties.

Objects can be present on multiple scene layers. Shift-click to select multiple layers.

Blender Fulldome Part 5: Compositing Render Layers

- Scene layers to be included in Render Layer
In the Layer panel, to the right of Scene layers, is another set of layer slots. These are the layers to be included in the selected Render Layer.
- Below those are 2 additional sets of layer slots. One is for excluding instead of including, and the final is for specialized masking.



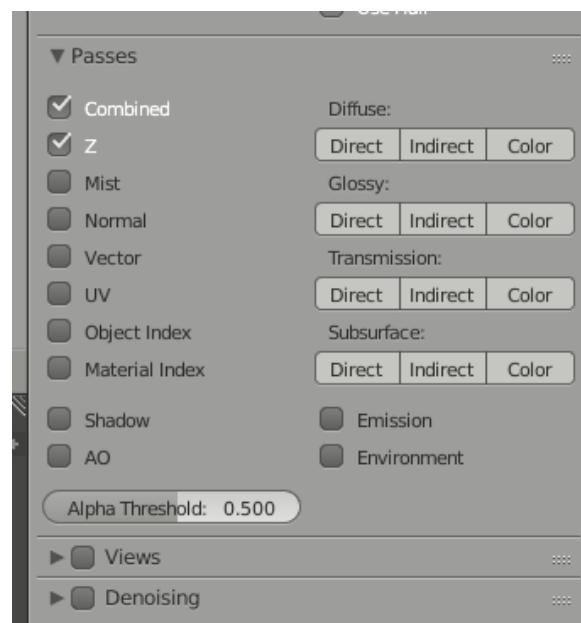
Render Passes

Elements in a Render Layer can be further separated into *passes* carrying information about the object, materials and location in the 3D scene.

In the Passes panel, we specify the information sent to the Compositor.

We won't use many of them in our Compositing example, but we will use a few.

- Combined is all the information, including color and transparency.
- Z is depth, the distance of objects from the camera.
- Environment is the World separated from the other scene elements.



RenderLayers: Why?

To complete our example scene, we want to make our Sun glow. We also want to apply Denoising to the objects in our scene, but we don't want Denoising applied to the surrounding starfield. So we need to separate our scene into three distinct layers. Then we must combine them in the best way possible for the effect we want to achieve.



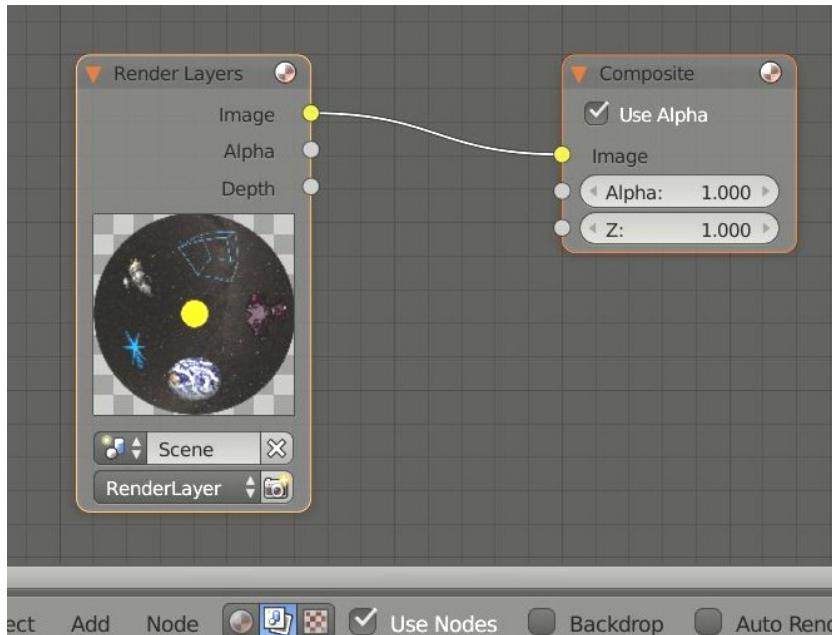
New for version 2.79!

Denoising is a long-awaited feature finally available as of this latest version, 2.79. It reduces noisy artifacts very well without setting our render sampling super high, so it improves the quality without dramatically increasing render times.



Compositing

So far we've looked at nodes for creating object and World materials. The nodes system was originally put into Blender for compositing. This is where videos and image sequences can be combined and/or enhanced into a final product. Even if you use a dedicated software package for compositing, you may find use for Blender's built-in compositing system.



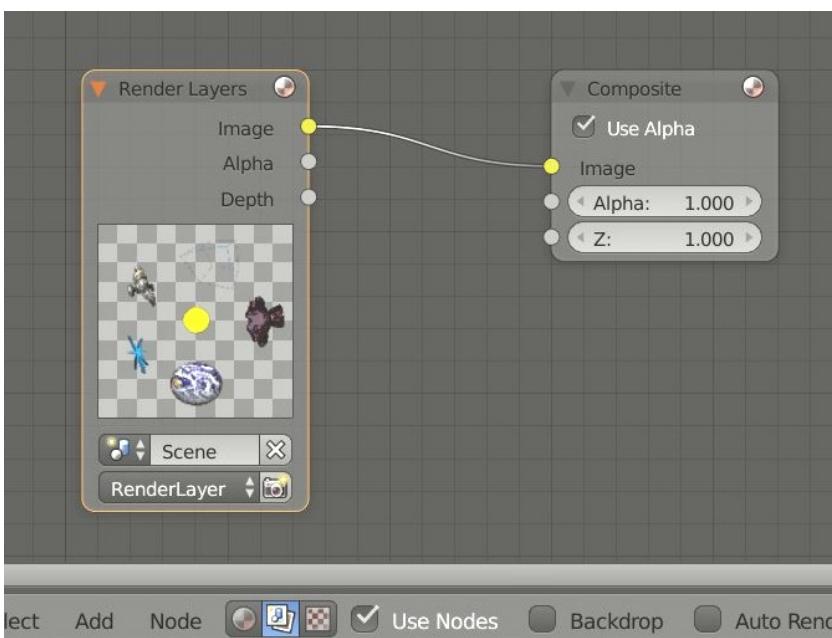
- To use the Compositing nodes, switch the Node Editor from Shader to Compositing.



- Click the check box for Use Nodes and a default node setup will appear.

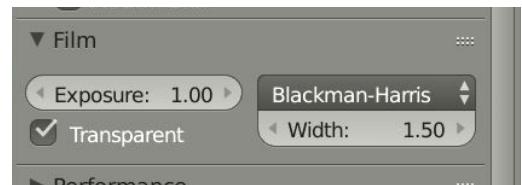
If a test render has been made, the window in the node will display the contents of the render layer.

When working with compositing nodes, it can be handy to keep the Properties Editor on the Render Settings tab to manage rendering and output settings.



- In the Film panel under the Render Settings property tab, click the box for Transparent.

Recall that the Render Settings are under in the Properties Editor, in the tab with the little SLR camera icon.



- Notice that the renderlayer input node now shows no background.

RenderLayers: Setting Them Up

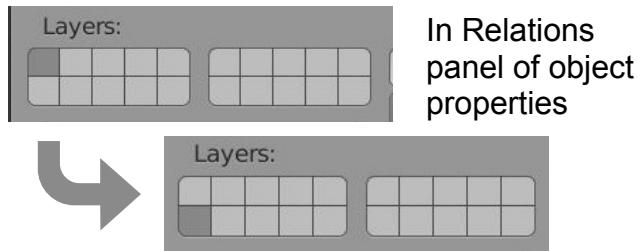
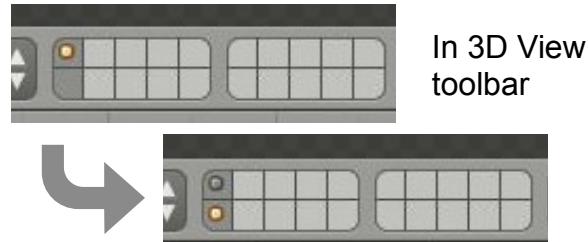
Since we plan to use a Renderlayer for glow objects, we need to isolate the Sphere.Sun object from the others.

- With the Sphere.Sun object selected, move it to the scene layer slot below the one used originally.

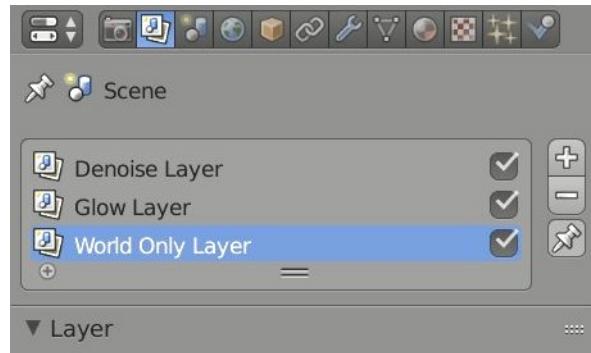
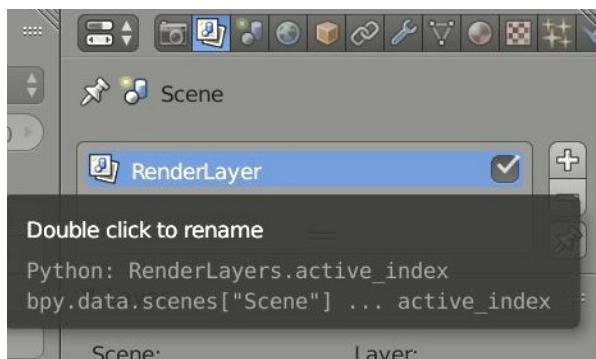
It can be moved in the 3D View as mentioned earlier using the **M** key or *Object > Move to Layer*

Or...

The selected object can be moved in the Relations panel of the Object tab of the Properties Editor. Using this method requires only clicking the box to place in layer slot.

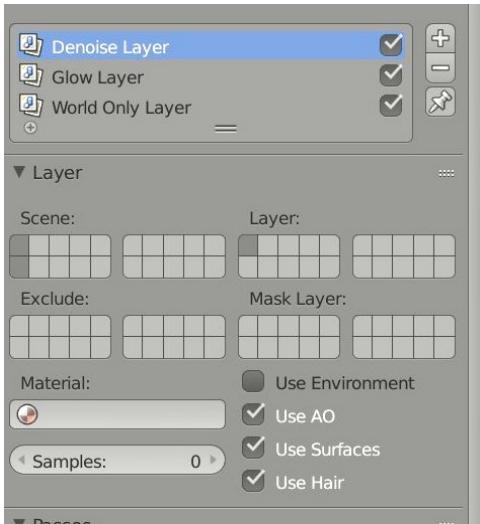


- Create two new RenderLayers, adjust settings and modify the existing one.
- Rename “RenderLayer” to “Denoise Layer”, then add two more RenderLayers, “Glow Layer” and “World Only Layer”

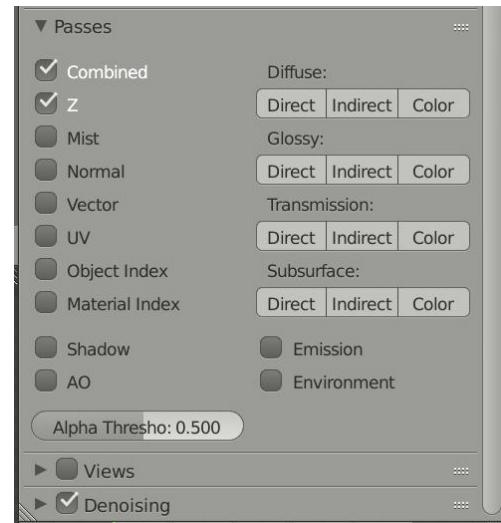


Save the Blend file.

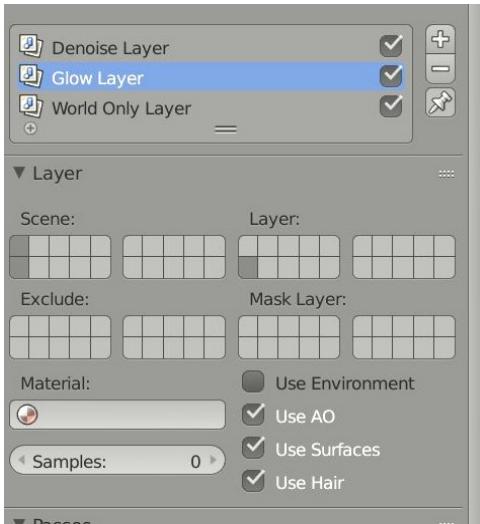
- Denoise Layer



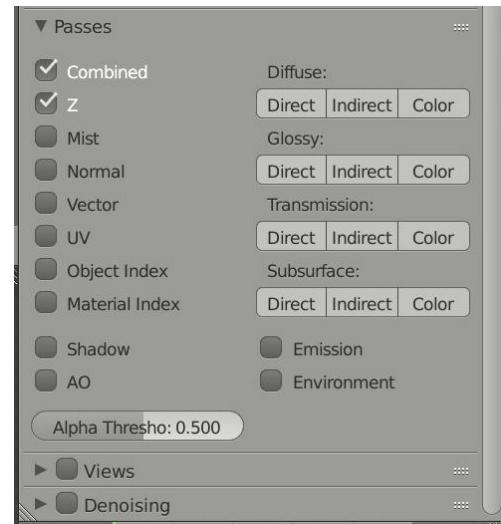
- Scene and Layer slots
- uncheck Use Environment
- Enable Denoising



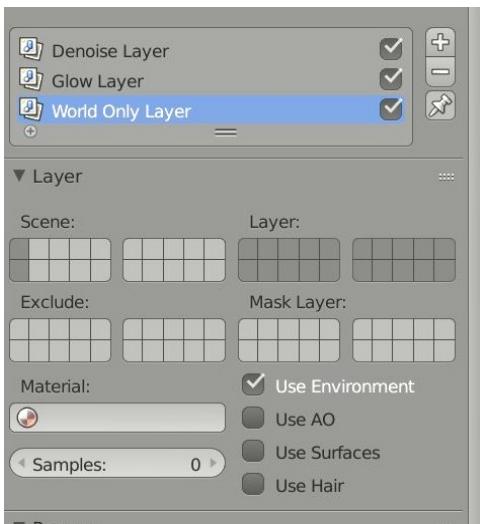
- Glow Layer



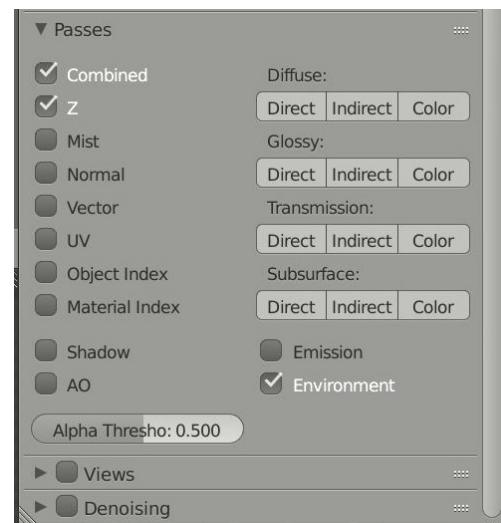
- Scene and Layer slots
- uncheck Use Environment



- World Only Layer



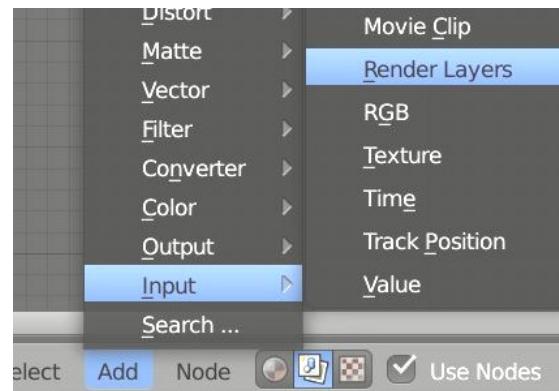
- Scene and Layer slots (Layer slots can be any for this one.)
- Make certain that Use Environment is enabled
- Enable Environment pass



Blender Fulldome Part 5: Compositing Render Layers

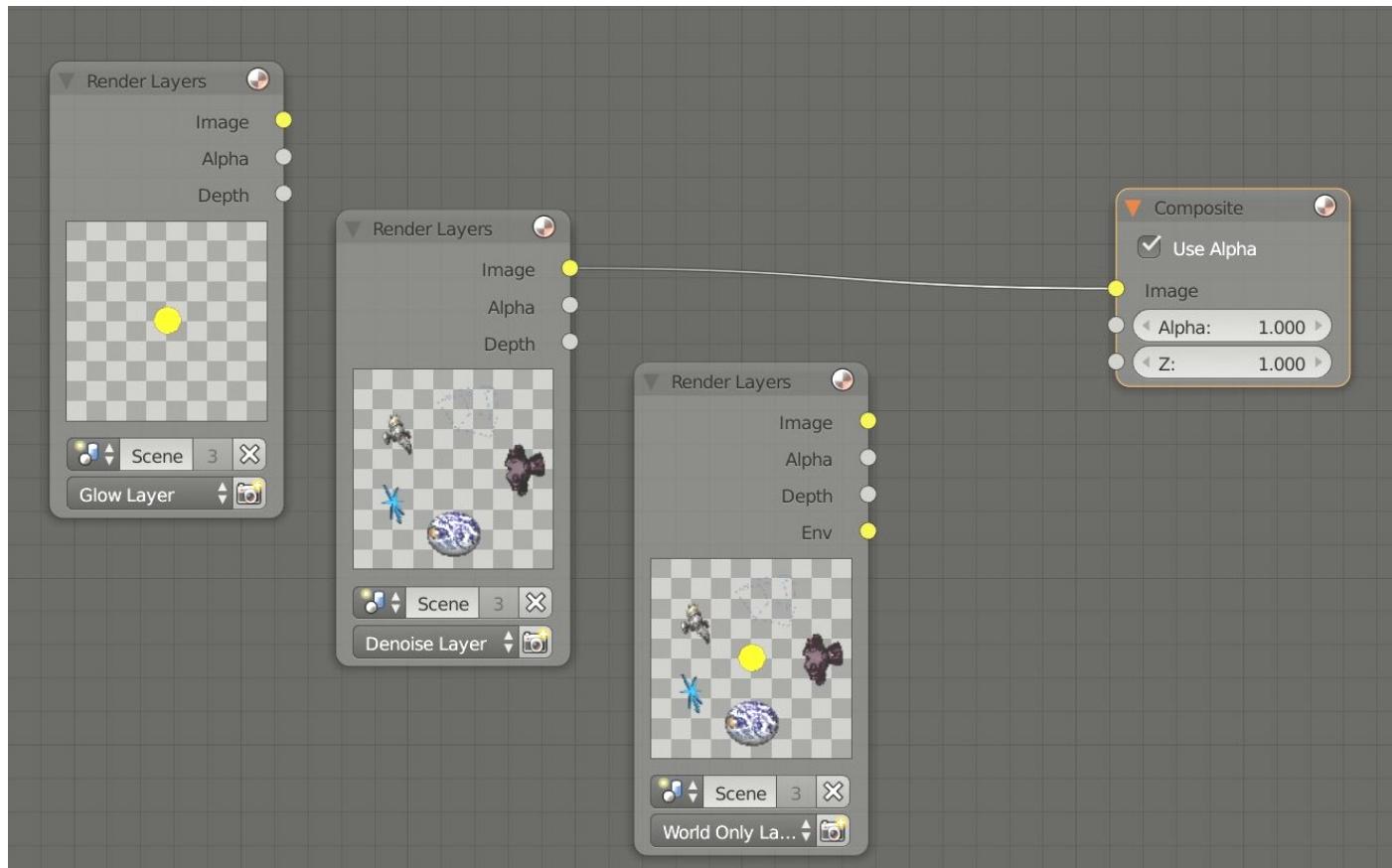
- In the Node Editor, add two more input nodes

Add -> Input → Render Layers

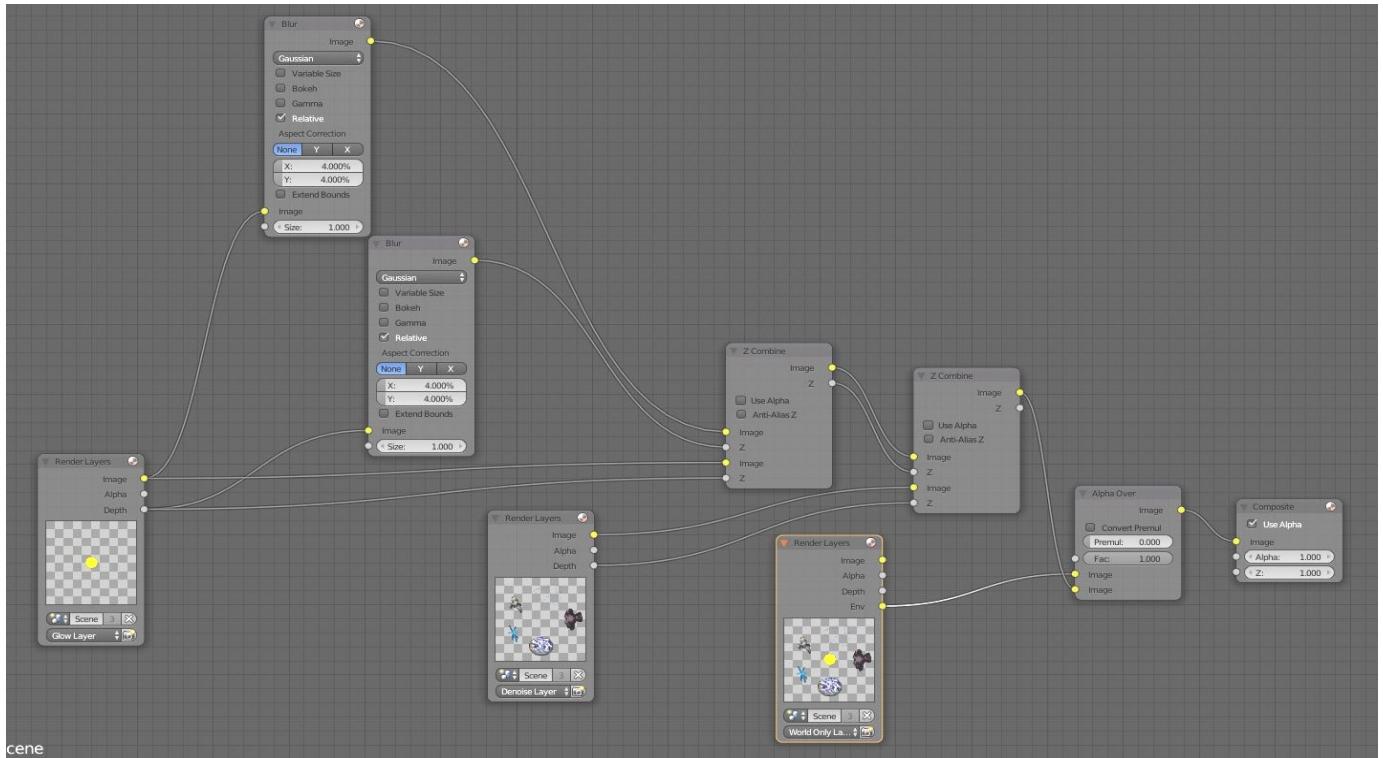


- Your node setup so far should look like this:

Notice that the Glow Layer only contains the Sphere.Sun object and that the World Only Layer contains an extra output node socket, “Env” for “Environment”



- If you feel brave, you can try adding, setting and connecting the following nodes:



We use the Glow Layer image blurred and combined with itself to get that nice glowy feel. To mix properly we use Z Combine node to account for depth.

Z Combine is also used to mix the Glow Layer and Denoise Layer. This way, if we use this scene for an animation, the glowy Sun will pass behind foreground objects with glowiness intact.

Finally an Alpha Over node is used to combine the Env output from the World Only Layer with the rest of the scene.



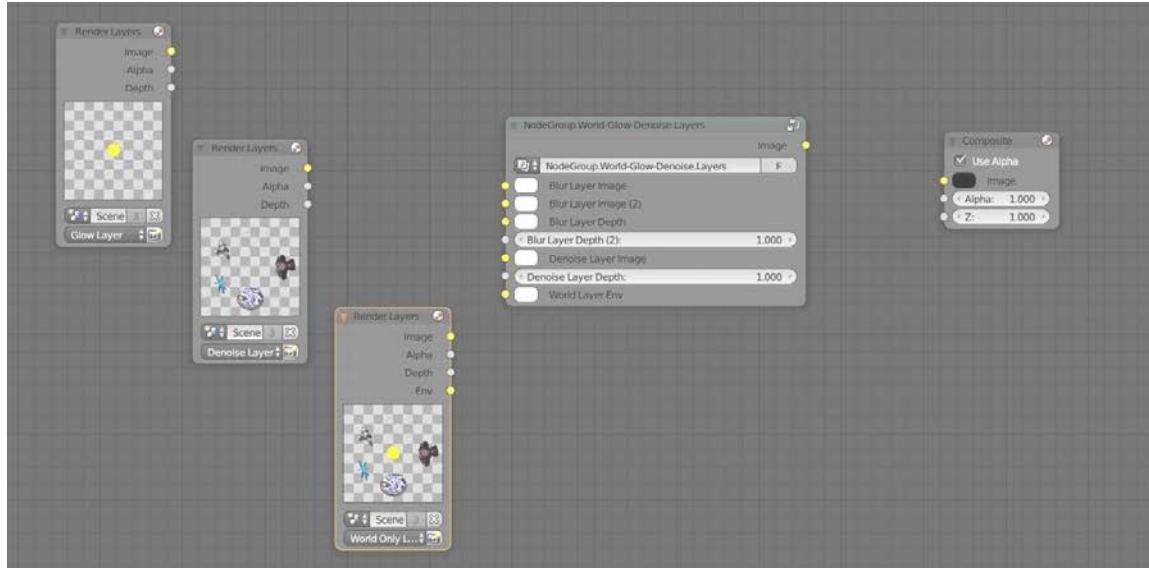
The render result combines the elements nicely.



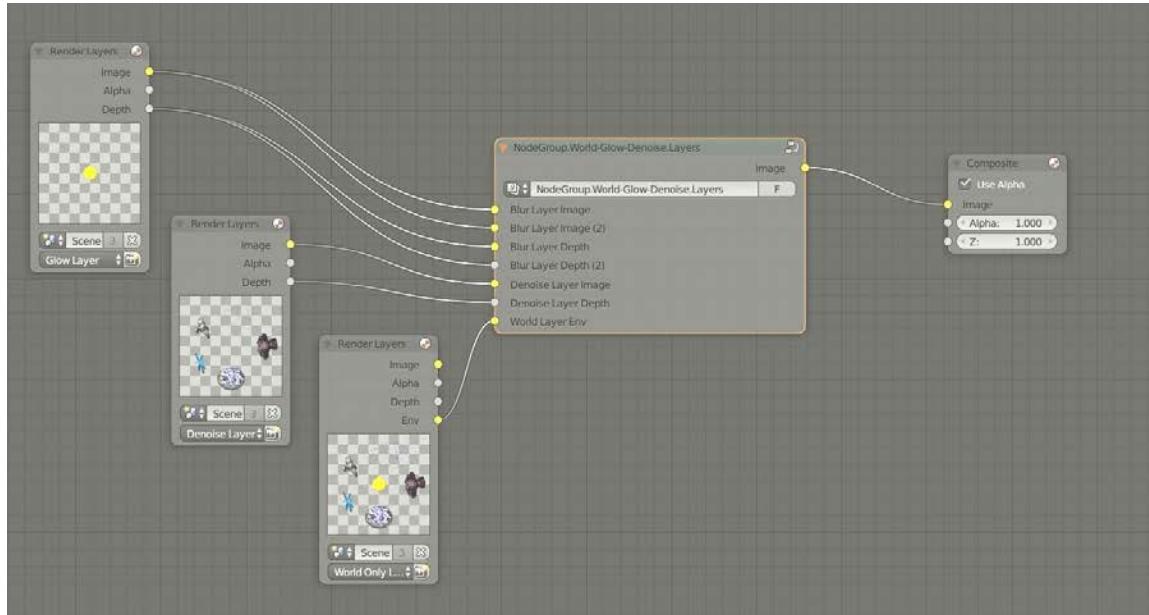
Save the Blend file.

Blender Fulldome Part 5: Compositing Render Layers

- If you prefer, instead of creating the entire node structure, you can append a premade node group from the Demo file. You still need to set up the RenderLayer Input nodes, and you'll need to connect them to the node group, but the rest of the work is done as an example.
- File > Append > ObjecsInSpaceDemoFile.blend
- Enter the NodeTree folder
- Select “NodeGroup.World-Glow-Denoise.Layers”
- In the node editor, Add > Group > NodeGroup.World-Glow-Denoise.Layers



- Then connect the Render Layer input nodes and the Composite output node



 Save the Blend file.

Part 6: Animating the Blender World Environment

Intro to Fulldome Production with Blender

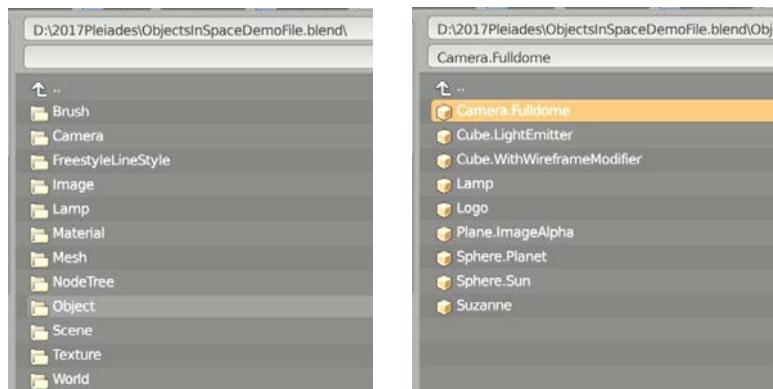
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In this section, we will take the previously made World environment with starfield and we will animate it to give the appearance of diurnal motion. A finished example can be found in the demonstration file `WorldAnimationDemoFile.blend` for later examination.

- ❖ Start with a fresh new Blend file if you haven't already. `Ctrl-N`
- Check Settings: Cycles Render, Output Dimensions
- Select and delete the default Cube object

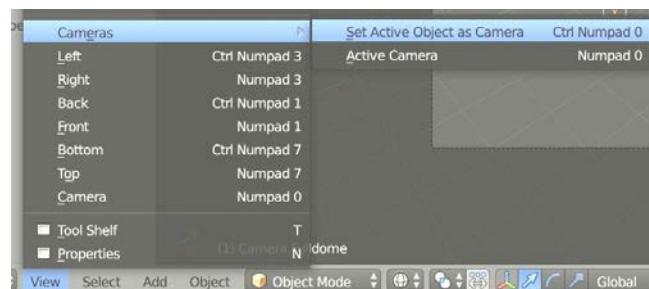
- ❖ Set up fulldome camera or append from an earlier file.

- If appending, import the camera from the list of Objects, not Cameras. By appending it as an Object instead of a Camera, it will appear in the Outliner Editor and the 3D View.



- If the fulldome camera was appended from an earlier file, make it into the active camera for both previews and renders.

This can be achieved by either deleting the other camera or by selecting the fulldome camera and setting it using the keyboard shortcut `Ctrl-NumPad 0`



`View > Cameras > Set Active Object as Camera`

Notice that the Outliner Editor shows which camera is active by putting a pale circular highlight around the movie camera icon.

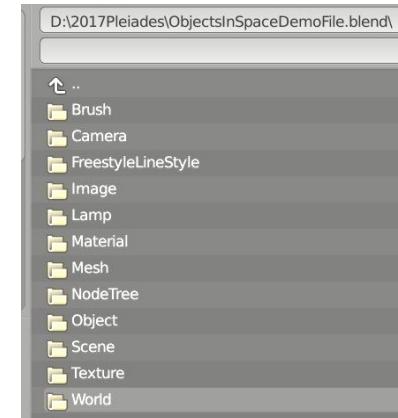


Save the Blend file.

- Shortcut for Save is **Ctrl-S**, Save As is **Shift-Ctrl-S**
- Navigate to a suitable folder and give the file a name: **WorldAnimation**, then click “Save As Blender File”

Set up World environment starfield and prepare it for animation

- Either set it up from scratch as in Part 3, or append it from an earlier file.



- If appending, the appended World will not be active by default. Go to the Node Editor of the Compositing Screen and select the World from the drop-down menu.

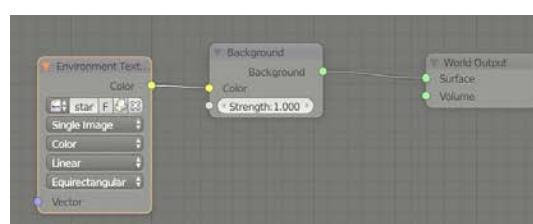


Recall that the Node Editor can be used for compositing or materials and that materials can be for objects or worlds.



If you cannot see the World drop-down menu, make sure that the Node Editor is set for both Materials and World.

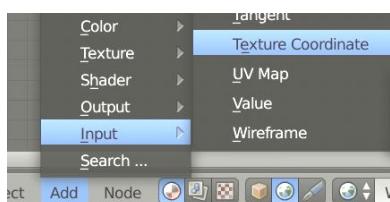
Once the appended World is active, the node tree will appear in the Node Editor



- Next add two nodes, Texture Coordinate and Mapping:

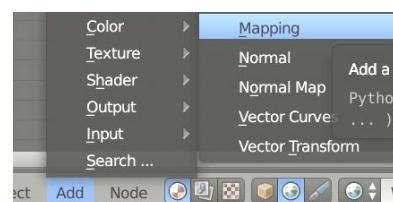
Texture Coordinate node

Add > Input > Texture Coordinate



Mapping node

Add > Vector > Mapping

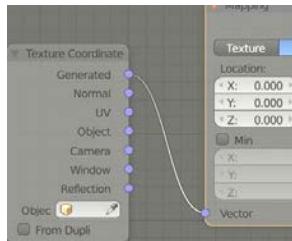


Shortcut Tip:

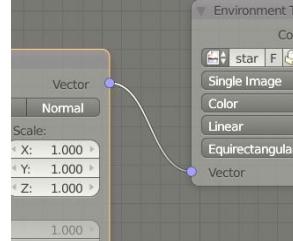
In the Nodes Editor, 3D View and several others, the “Add” menu can be more quickly accessed using: **Shift-A**

- Connect the following node sockets:

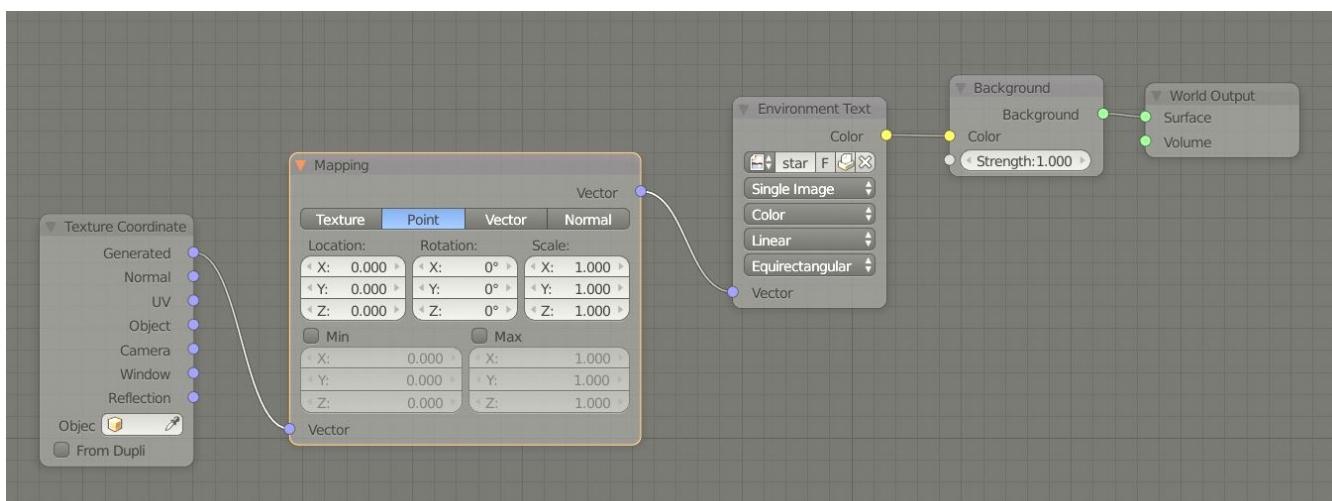
Texture Coordinate node
Generated output socket
to Mapping Vector input socket



Mapping node
Vector output socket to
Environment Texture Vector input socket



The node setup should look like this when finished:



Save the Blend file.

Simulate Latitude

- Make a test render using F12 shortcut or menu.

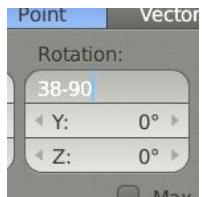
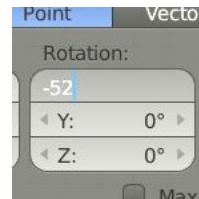
Note the position of Polaris in the image. Our camera is aimed straight “up” along the Z axis, so our World environment map appears to have us at the North Pole.



Blender Fulldome Part 6: Animating the Blender World Environment

- In the Mapping Node, change the Rotation X value from 0 for -52. This will put our starfield at 38 degrees.

We could enter the number directly...



...or enter "38-90" and the calculated value will be entered.

- Before making another test render, click in the Render Result toolbar "Slot 1" and select "Slot 2" from the menu.



- Now make the new test render. Note the change in positions. Go back to Slot 1 to compare.



Workflow Tip:

Use render slots to check for differences in test renders. You can switch by selecting the slot with the mouse or use J to step through the slots forward and Alt-J to step backwards. Alternate between J and Alt-J to toggle between two consecutive slots.

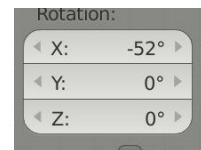
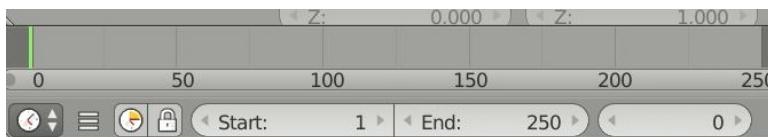
 Save the Blend file.

Now we can animate!

Simulate Diurnal Motion

We will hold the rotation X value constant while changing the rotation Z value. **Keyframes** are used to store values for properties at different times. We will use them here to set the rotation value at different frames of the timeline, then extrapolate for constant motion.

- Make sure that we are still at frame 0 in the Timeline Editor and that the rotation Z mapping value is 0 in the Node Editor.

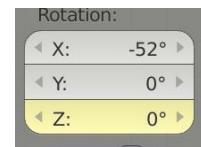


- Make a keyframe for the rotation Z mapping value

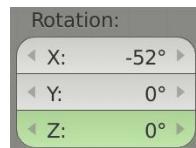
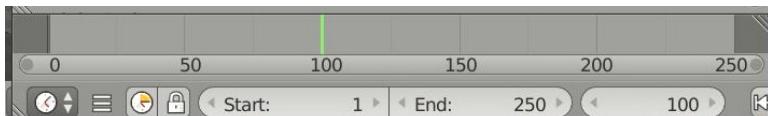
In the Mapping Node, hover over the “Z:” rotation value and right-click, then select *Insert Single Keyframe* from the pop-up menu.



Value boxes with keyframes are yellow if the timeline is currently resting on a keyframed frame.

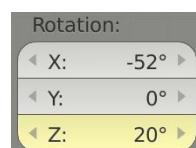


- Go to frame 100, either using the mouse to change timeline or by entering the frame number in the Timeline editor toolbar.



Notice that the box values with keyframes are green if not currently on the keyframed frame.

- Change the rotation Z mapping value to 20.
- Make a keyframe for the rotation Z mapping value. Note that the box changes from green to yellow.



Save the Blend file.

◆ Extrapolate Motion

Currently the simulated diurnal motion slowly begins at frame zero, speeds up a bit, and then slows again to a stop by frame 100. For this example we want continuous motion, so we need to tell Blender how to extrapolate.

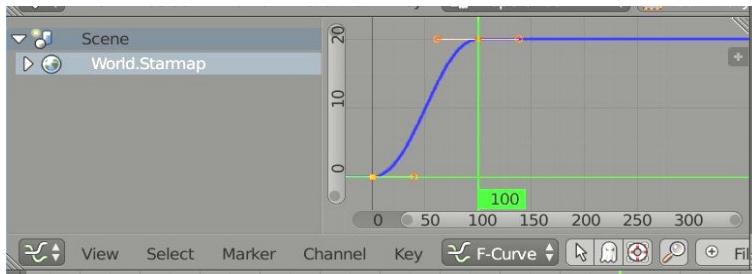
- Change to the Animation Screen.



At first we might not see anything for the World environment keyframes.

If there is no curve visible, either go back to the Node Editor and select the Mapping node, or enable viewing of channels of non-selected data.

In the Curve Editor toolbar there is a set of three buttons:



Toggle the arrow button to allow viewing of curves for unselected data.

Now we see the World.Starmap mapping keyframes plotted on the chart even if the node isn't selected.

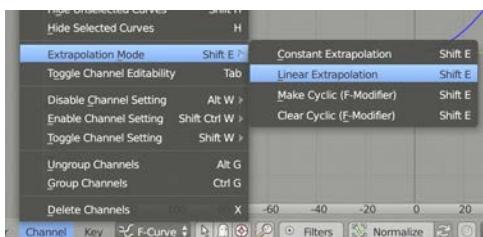


Screen Space Tip:

To temporarily enlarge a single Editor to fullscreen, use:

Ctrl ↑ or **View > Toggle Maximize Area**

- With the World.Starmap curve still selected, use the menu to extrapolate:



Channel > Extrapolation Mode > Linear Extrapolation

Change the World name to World.StarmapDiurnal (either in Outline Editor or Properties Editor). If you append this World environment into another file, the animation settings will transfer with it.



Save the Blend file.

Later, if you want to change the speed of the simulated diurnal motion, you can go to the Mapping node and replace one or both of the keyframes, or you can select and move keyframes in the Curve Editor. As you learn more about Blender and animation curves you will find more ways to alter motion.

Part 7: Various Animated Examples

Intro to Fulldome Production with Blender

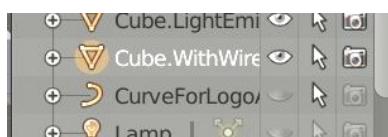
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This section examines the contents of the example file ObjectsInMotionDemoFile.blend – the contents are the same as in the earlier demonstration file, but these have all been animated in some way that may be of future use. Play around and experiment with changing different settings to see how it affects the output.



Tip:

There is a lot going on in this demonstration file, and the examples aren't related. To examine them one at a time you can append the objects into your own Blend file or you can use the Outline Editor to control which of the objects you can see.



The eye icon controls what is visible in the 3D View, and the Camera icon controls what is rendered.



Wireframe Cube ("Cube.WireframeScaling")

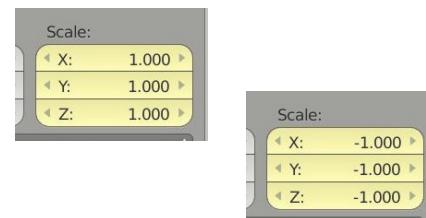
Scaling changes at regular intervals.

Keyframes were set at 3 different frames.

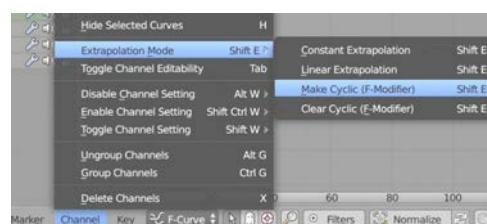
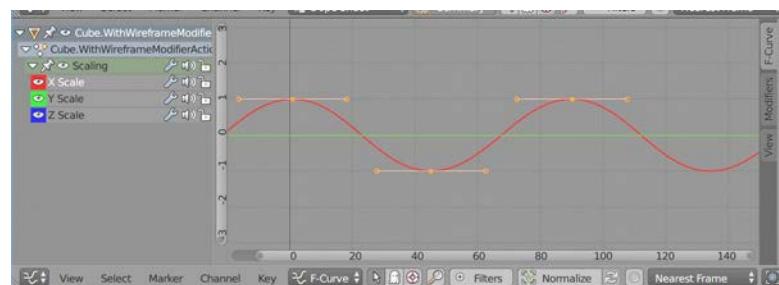
Frame 0: scaleX = 1, scaleY = 1, scaleZ = 1

Frame 45: scaleX = -1, scaleY = -1, scaleZ = -1

Frame 90: scaleX = 1, scaleY = 1, scaleZ = 1



In the Graph Editor, F-Curve
Modifiers were enabled and then
the curves were made to repeat.



Channel > Extrapolation Mode > Make Cyclic



Learn more about F-Curve Modifiers and the Graph Editor:

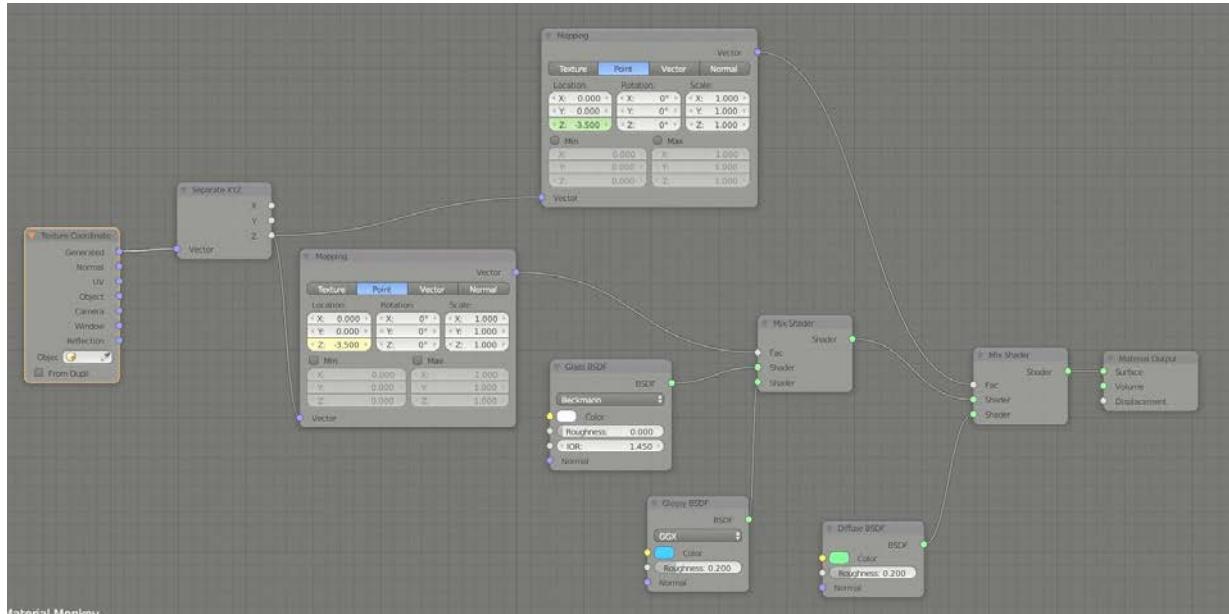
http://docs.blender.org/manual/en/dev/editors/graph_editor/fcurves/introduction.html

Glass Monkey Head (“Suzanne”)

Change from purple glass to blue glossy to green diffuse then back.



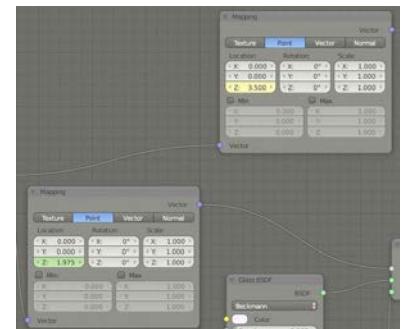
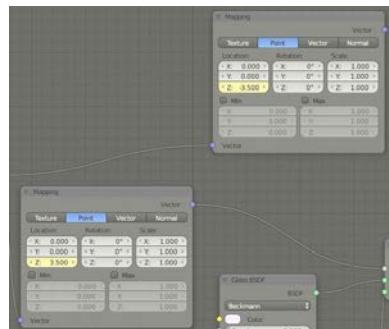
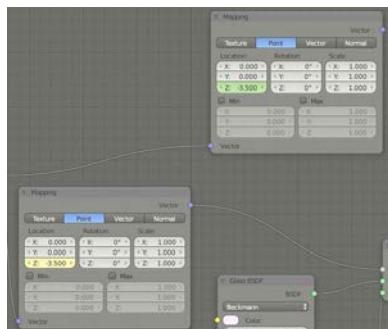
The change happens along the Z axis of the monkey object.



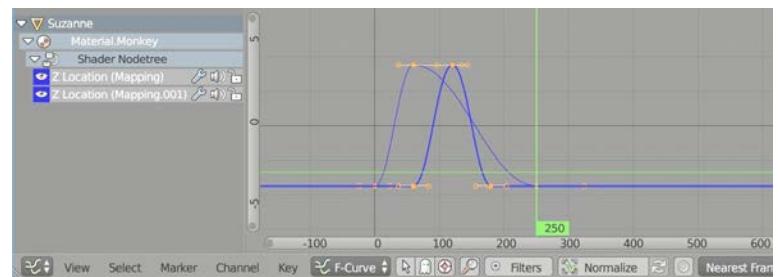
Frame 0

Frame 60

Frame 120



Graph editor showing curves for keyframes of Mapping nodes.



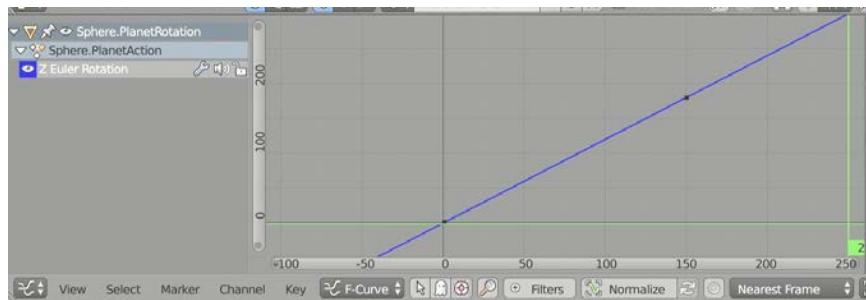
Learn more about Mix Shader and other Shader nodes:

<http://docs.blender.org/manual/en/dev/render/cycles/nodes/types/shaders/mix.html>

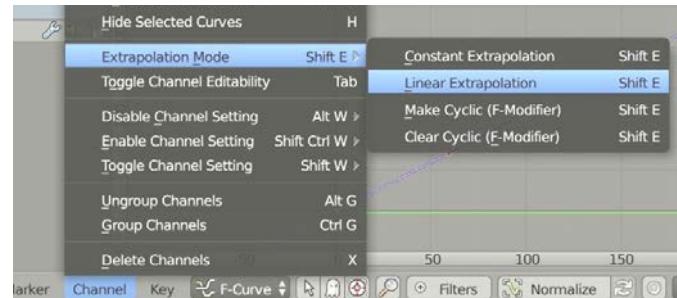


Earth Ball (“Sphere.PlanetRotation”)

Simple rotation of the sphere object. Two keyframes set for Z rotation.



Rotation made continuous.

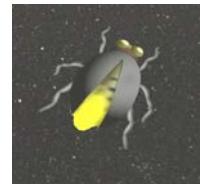
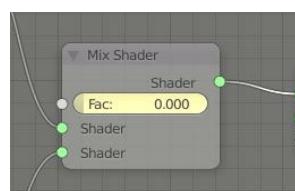
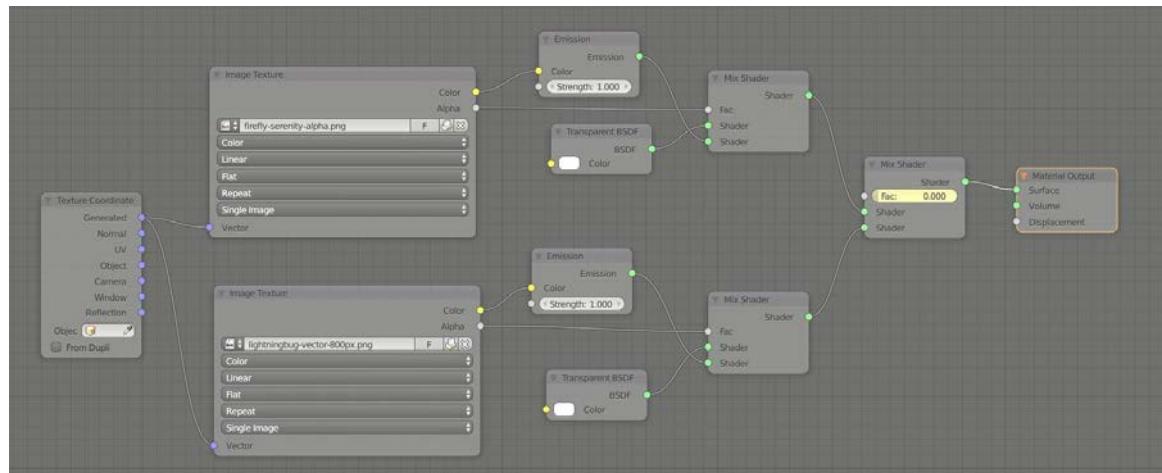


Channel > Extrapolation Mode > Linear Extrapolation



Firefly Image (“Plane.ImageAlpha”)

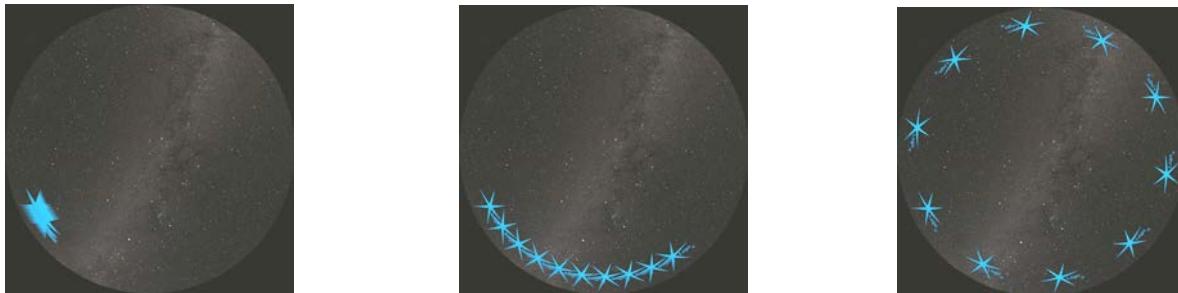
Image dissolves into another image and back again. The final Mix Shader node Factor value is keyframed to control which image is shown.



Blender Fulldome Part 7: Various Animated Examples

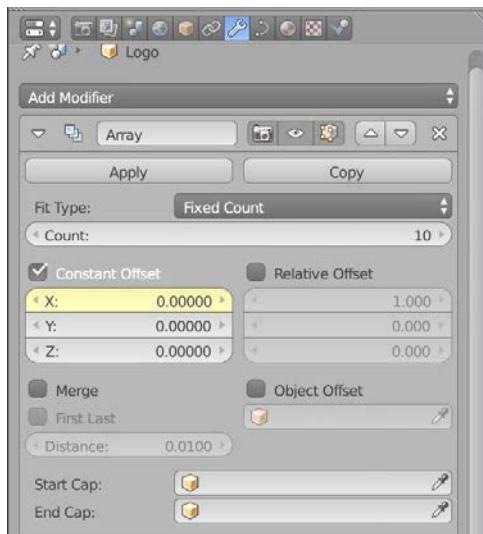


Copies of the logo appear and spread out in a circle around the center of the scene.

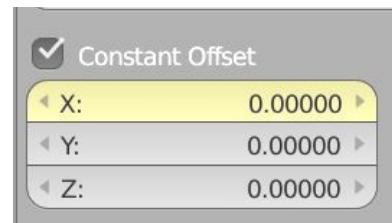


Two modifiers are applied:

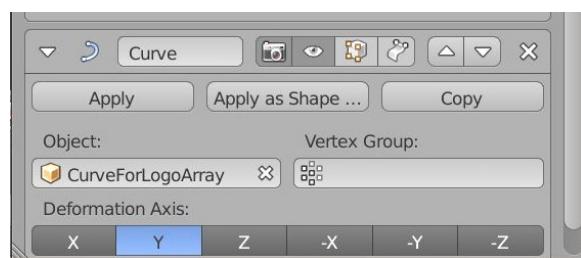
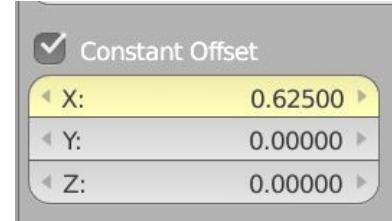
An Array Modifier makes instances of the logo object appear spread out at intervals.



Frame 30

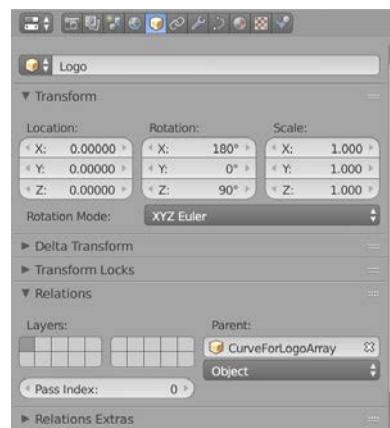
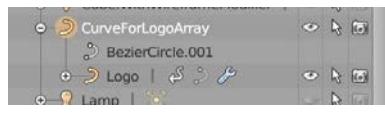


Frame 180



A Curve modifier is used to provide the path along which the logo object instances are distributed.

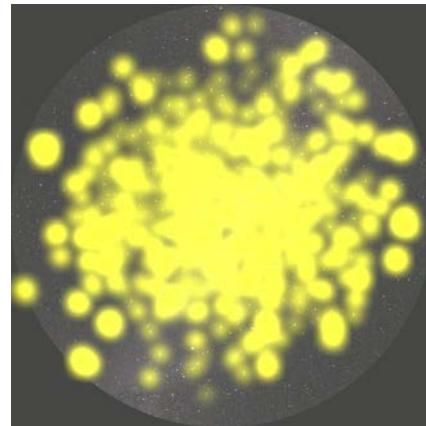
Note that the Curve, a Bezier Circle object, is set as the “parent” of the logo object.



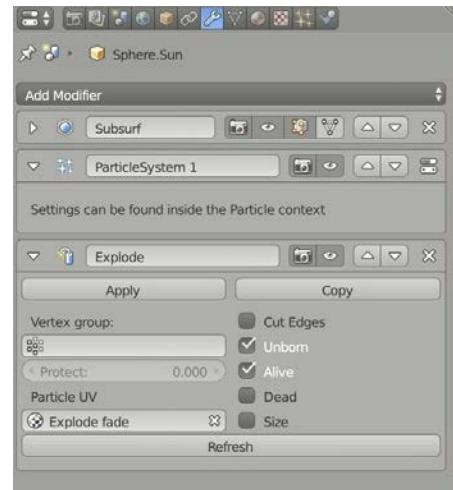
Sun Ball (“Sphere.SunExplosion”)

A silly but fun effect in which we blow up the Sun!

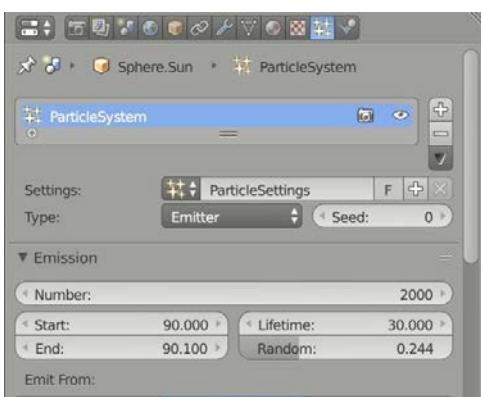
Many custom effects can be created using Blender. A few examples are provided with built-in setups. Here, the “Quick Explode” effect is applied to our sphere object.



Object > Quick Effects > Quick Explode

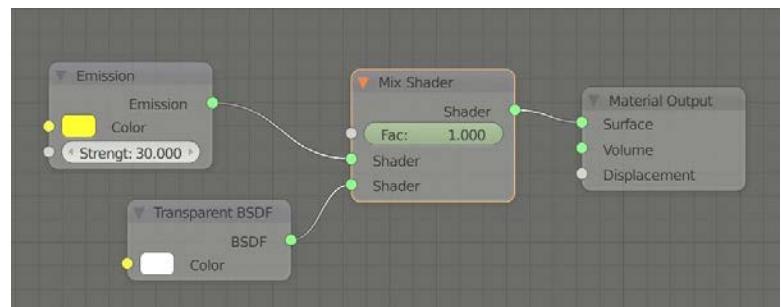


Two Modifiers, Explode and Particle System, are created and added to any existing Modifiers.



The Particle System settings are tweaked so that the pieces appear suddenly and have a short lifetime.

The Emission Shader is mixed with a Transparent Shader. The Factor value of the Mix Shader is keyframed to fade out the material.



Appendices:

Intro to Fulldome Production with Blender

2017 Pleiades National Planetarium Conference

Official Blender User Manual

<http://docs.blender.org/manual/en/dev/index.html>

Very useful. Includes a wealth of information on both render engines, so always check to make sure that you are looking in the Cycles sections.

Also a great starting point if trying to find search terms.

Blender Fundamentals

[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=kes2qmijy7w&list=PLa1F2ddGya_8V90Kd5eC5PeBjySbXWGK1)

[v=kes2qmijy7w&list=PLa1F2ddGya_8V90Kd5eC5PeBjySbXWGK1](http://www.youtube.com/watch?v=kes2qmijy7w&list=PLa1F2ddGya_8V90Kd5eC5PeBjySbXWGK1)

This series of brief video tutorials from the Blender Foundation is currently (October 2017) one of the best and most up to date introduction to using Blender. After watching the first few, feel free to skip around and watch the ones that interest you most.

Blender Basics 5th Edition

http://www.cdschools.org/cms/lib04/PA09000075/Centricity/Domain/81/BlenderBasics_5thEdition2017.pdf -direct link

<http://www.cdschools.org/Page/455> -main page with additional resource links

<http://www.youtube.com/playlist?list=PLjNL5V9Xne2Y05kGUaLmJJCZABtJUBC2H>
-YouTube channel

This PDF is a very nice textbook created and used by a high school instructor.

Blenderartists.org – A Blender Community

<http://blenderartists.org/forum/forum.php>

One of the oldest and most active online communities for Blender users. A good place for asking Blender questions.

Blender Stack Exchange

<http://blender.stackexchange.com/>

Another good place for asking questions. Google and other search engine results from Blender Stack Exchange are most helpful.

Blendertarium

<http://groups.google.com/forum/#!forum/blendertarium/>

A Google group founded by our very own Ron Proctor. The group is a friendly place for discussing dome-related Blender questions.

BlenderNation

<https://www.blendernation.com/>

News site for all things Blender. Tutorials, development news, resources...

A few tutorials of particular interest. Not aimed at beginners, but certainly of interest and lots of fun.

Space nebula world environment.

Mark Kingsnorth created and shared a wonderful node group for creating a space nebula to surround a Blender scene. These can also be rendered out as equirectangular images or animated sequences for use in full 360° projects.

The node group can be downloaded from his website, and he made a YouTube video detailing the creation of the node group.

<http://www.markkingsnorth.com/2017/02/16/nebula-node-group-v1-2-released/>

<http://youtu.be/7EtXI4ePzO4>

Micropolygon Displacement (good for rocky planets, asteroids and comets)

Creative shrimp sells training on topics of interest for fulldome science creators, but also offers some free tutorials. The tutorials aren't as in-depth, but are still of value.

<http://www.creativeshrimp.com/exoplanet-blender-tutorial.html>

Fire Shader

A very nice multi-part written tutorial on using Volume Materials instead of Surface Materials. Although the tutorial creates an animated camp fire, the node setups can be adapted to make a nebula.

<http://real3d.fr/fire-shader/>

Adding Clouds to Blender Cycles' Sky Texture

A video tutorial creating a World environment with clouds that can be animated.

<http://youtu.be/Tr6wTyfAO04>

How to Make Earth (Cycles)

Blender Guru has many great tutorials. This is one of the most popular.

<http://www.blenderguru.com/tutorials/earth-cycles>

Blender Tutorial: Planets Colliding Animation

A fun tutorial. Delightfully easy to follow.

<http://youtu.be/epyqHzoCxa0>

How to Create the Northern Lights in Blender 3D and GIMP

One of several methods for simulating an aurora with Blender.

<http://www.youtube.com/watch?v=duUw9BpJtl>

Your fulldome system will have its own video setting requirements or may require special proprietary software to encode properly for your dome. Here are some notes that may help in choosing output settings when rendering from Blender.

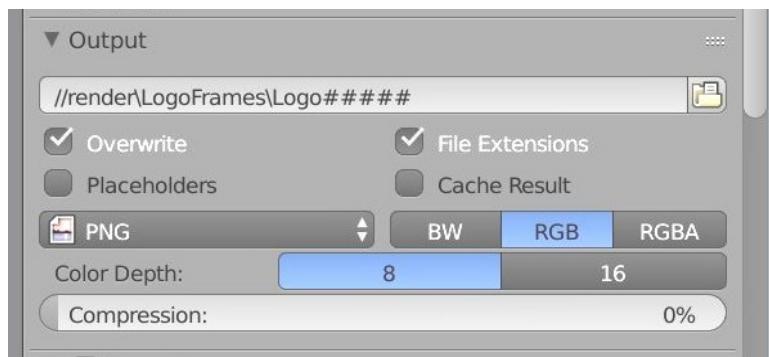


Image Sequences

Image sequence are often recommended as output for any video project. Reasons include:

- If the rendering is interrupted, it can be resumed without needing to rerender the already successfully rendered frames. If it were rendering straight to video, all progress would be lost.
- Useful for editing and compositing with other sequences.
- Some fulldome systems need the final product as dome master frames anyway.
- Once the frames are rendered to a sequence of images, Blender or nearly any video editor can be used to load the sequence and encode a video file.

To render as an image sequence, use the Output panel in the Render Settings area of the Properties Editor.



The images will render with the frame number added to the base filename. It is best to add some “#####” characters to the base filename. The “#” characters will be replaced by frame numbers with zero padding in place.

If you are resuming rendering that was stopped or interrupted, uncheck the box next to “Overwrite” and Blender will skip rendering the frames already present in the output folder.



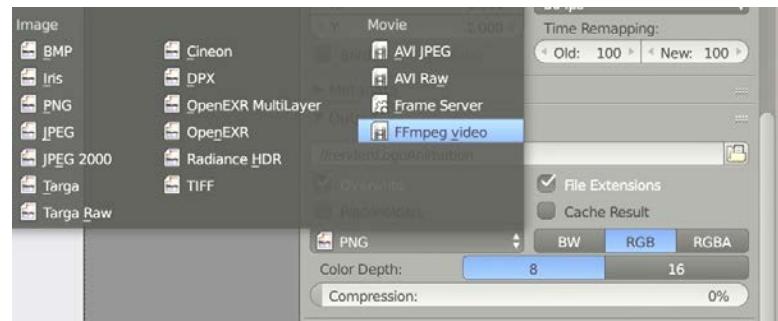
More information on Output Options can be found in the Blender online manual:
<http://docs.blender.org/manual/en/dev/render/output/output.html>

Video Encoding

FFmpeg is a great command-line resource for encoding video, and Blender uses it “under the hood” for encoding.

Instead of selecting an image type for output, select “FFmpeg video”

Version 2.79 is set up a bit different from previous versions so tutorials out there might not look the same as your set up.

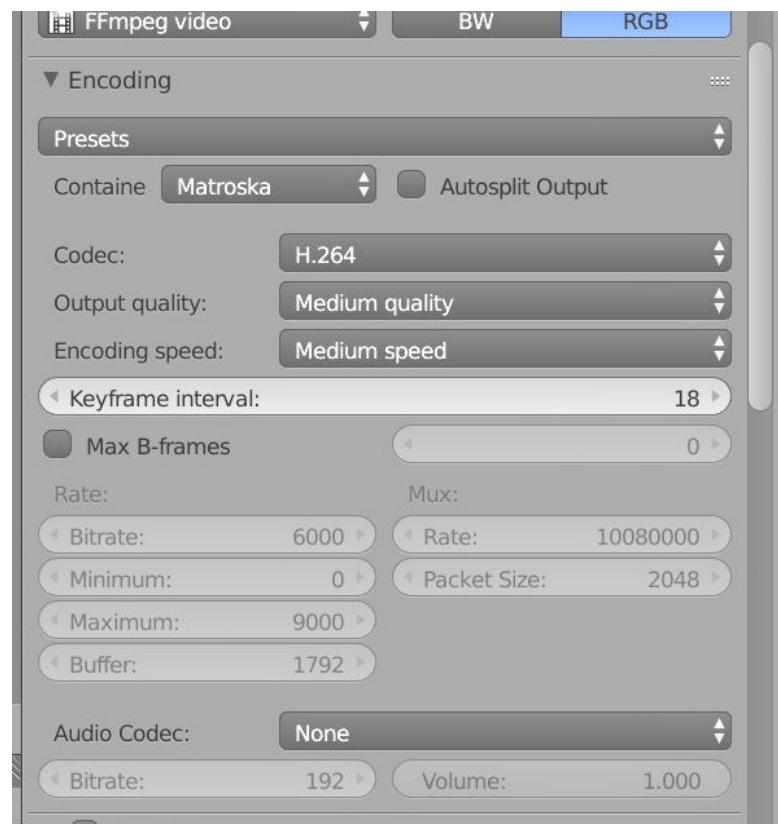


The Encoding panel is where you can select the Codec and associated parameters for your output.

Finding settings that work best can be trial-and-error.

If you don't know where to start, try comparing your fulldome system settings to the available presets.

Select the closest preset, then change the settings to get the closest match possible.



More information on Video Output can be found in the Blender online manual:
<https://docs.blender.org/manual/en/dev/render/output/video.html>