

# Intro to Fulldome Production with Blender

## The 2.80 Edition

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2019 GLPA Conference

Part 1: Interface Tour and Initial Settings

Part 2: Output and Camera Settings for Fulldome

Part 3: Blender World Creation

Part 4: Various Objects, Materials and More

Part 5: Compositing View Layers

Part 6: Animating the Blender World Environment

Part 7: Various Animated Examples

Part 8: Notes on Video Output

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# Welcome to the Blender Fulldome Workshop at the 2019 Great Lakes Planetarium 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.

...have plenty of Blender experience but not with the new interface of version 2.80, this may help with the transition.

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

Special thanks to the following people for helping to review previous versions of this document:

Jeff Bryant  
Chris Janssen  
Ron Proctor  
Dan Tell

# Part 1: Interface Tour and Initial Settings

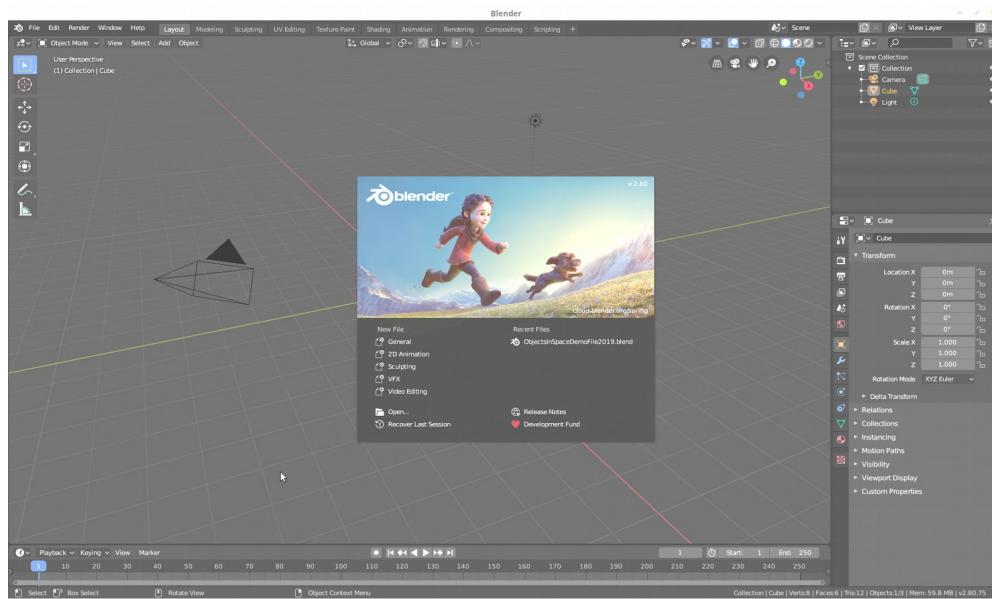
Intro to Fulldome Production with Blender

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This brief tour of the Blender interface applies specifically to version 2.80 and should apply reasonably well to versions 2.81 and beyond for a year or two. Version 2.80 has a vastly different look and feel from previous versions in the hopes of being more consistent with the prevailing commercial software packages. If you are learning Blender for the first time, it shouldn't matter, but when searching online you may run into older tutorials using those previous versions

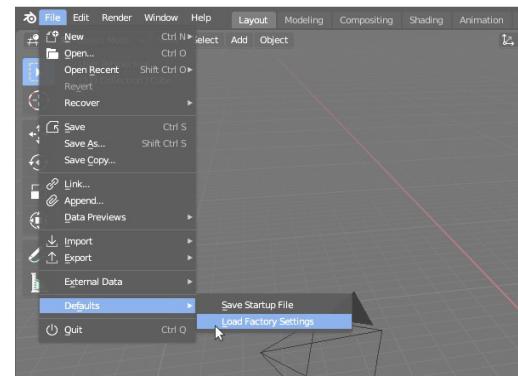


Blender 2.80 startup with splash screen

Click anywhere to get rid of the splash screen.

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

File > Defaults > Load Factory Settings



File > Defaults > Load Factory Settings



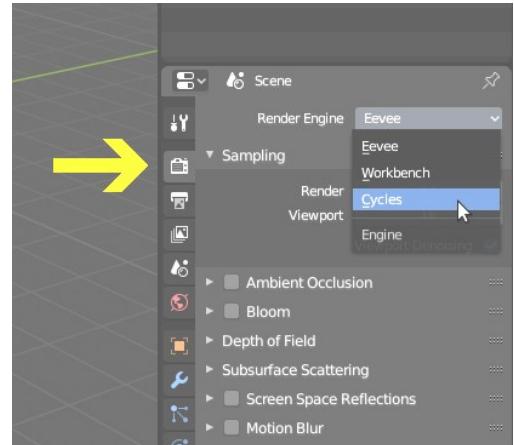
Note that many menu selections also list the keyboard shortcut, and tooltips to describe the function. Curious users can enable Python Tooltips in the Blender Preferences ( Edit > Preferences) to also reveal the underlying Python code.

## Blender Fulldome Part 1: Interface Tour and Initial Settings

As we begin there is one very important 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 now uses the Eevee render engine. It is super fast but cannot render fisheye images.

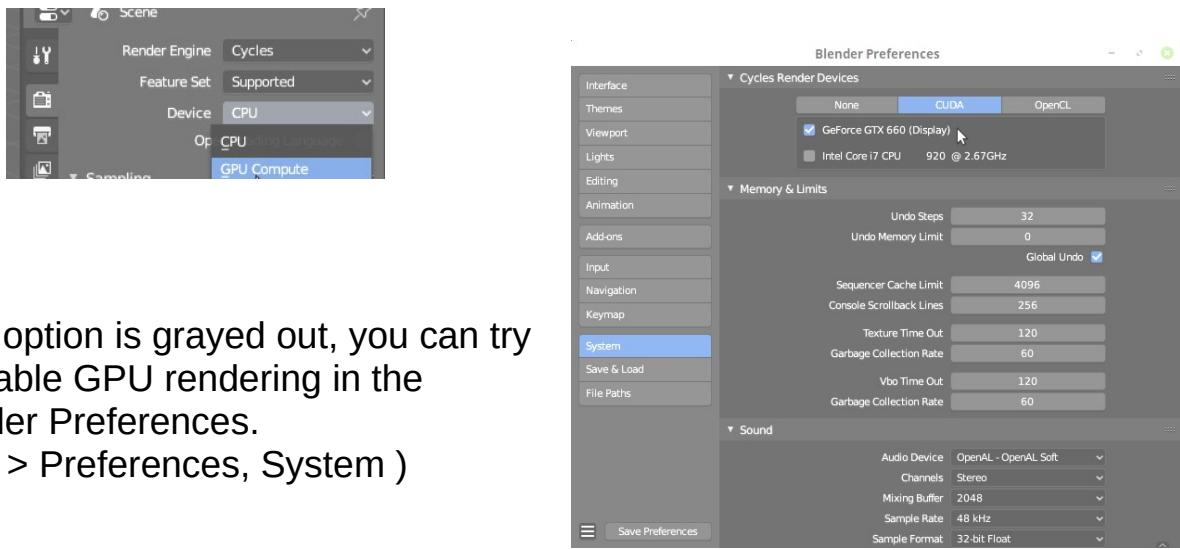
The Cycles Render engine is powerful and complex, giving us a great deal of control over lighting, materials, camera settings and more. For fulldome rendering specifically, Cycles can render fisheye images directly.

On the right hand side of the default Layout workspace, there is a Properties Editor with many context tabs. Click the tab icon that looks like a camera. That is the Render Context, and is where we change the engine from Eevee to Cycles.



The camera icon in Properites Editor

★ Some graphics cards can be used to render faster than the computer's processor. To try this, change "Device" from CPU to GPU Compute.



If the option is grayed out, you can try to enable GPU rendering in the Blender Preferences.  
( Edit > Preferences, System )

◆ Save startup file. We can do this through the menu File > Defaults > Save Startup File.

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/>

Most boxed off portions of any Blender screen are separate areas. Areas 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.

*Workspaces* are saved combinations of windows. You can make and save your own, plus there are several premade screens available. We'll mostly use the Layout, Shading, Compositing and perhaps the Animation workspaces in this workshop. Some additional workspaces you might find useful include Video Editing, UV Editing, Sculpting, and Scripting.

You can modify the existing workspaces and create your own to fit your changing needs.

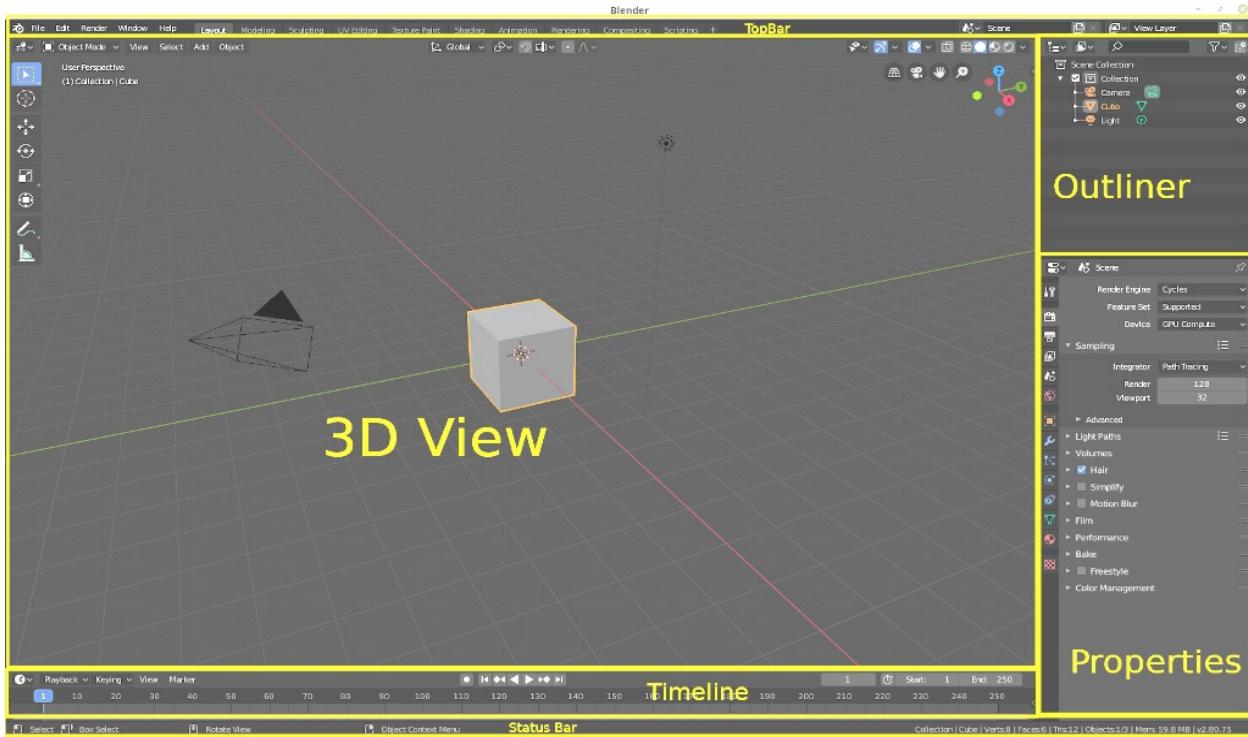


**Shortcut Tip:**

To quickly navigate the available workspaces use Ctrl and PageUp or PageDown keys:

***Ctrl-PgUp* and *Ctrl-PgDn***

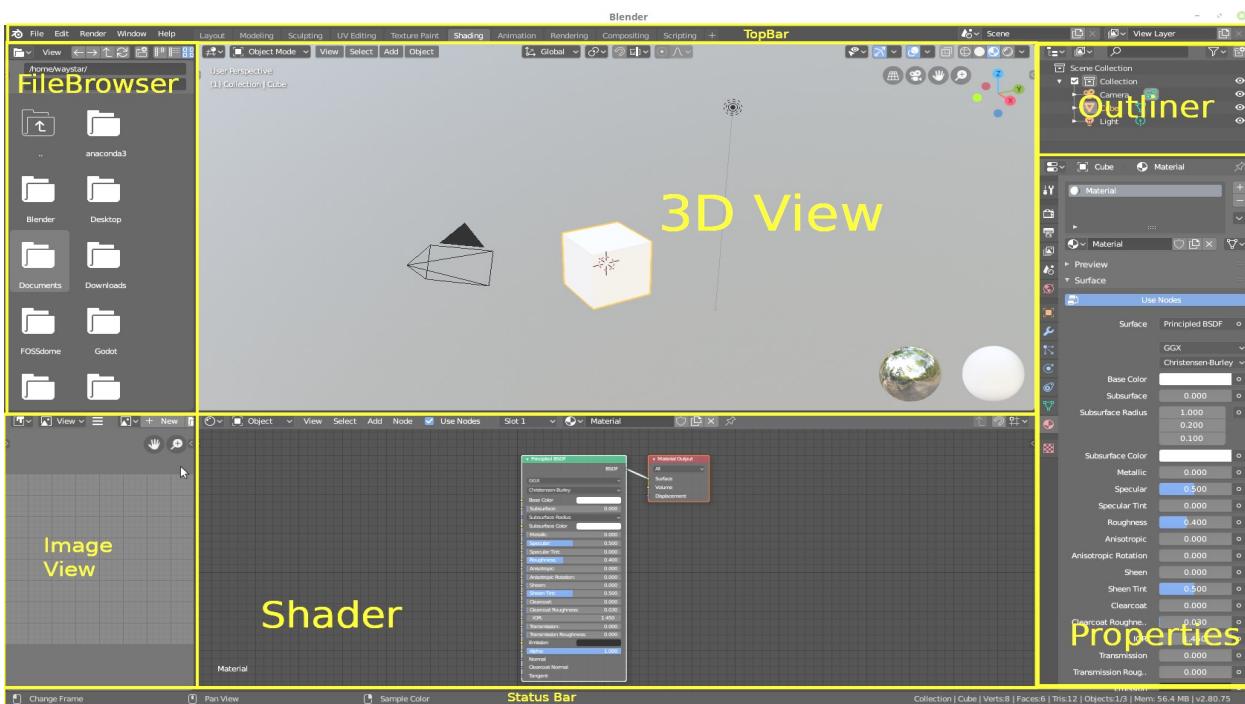
## Layout Workspace



In the Layout workspace, the viewport boxes contain the editors 3D View, Outliner, Properties, Timeline, TopBar and Status Bar.

- The TopBar contains the main menu, workspace tabs, and the current Scene and View Layer.
- 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 Output tab of the Properties editor.
- The Status Bar shows information in very small print, including helpful keys and commands available depending on what tool and object are currently selected.
- The 3D View Editor (also called “3D 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.

## Shading Workspace

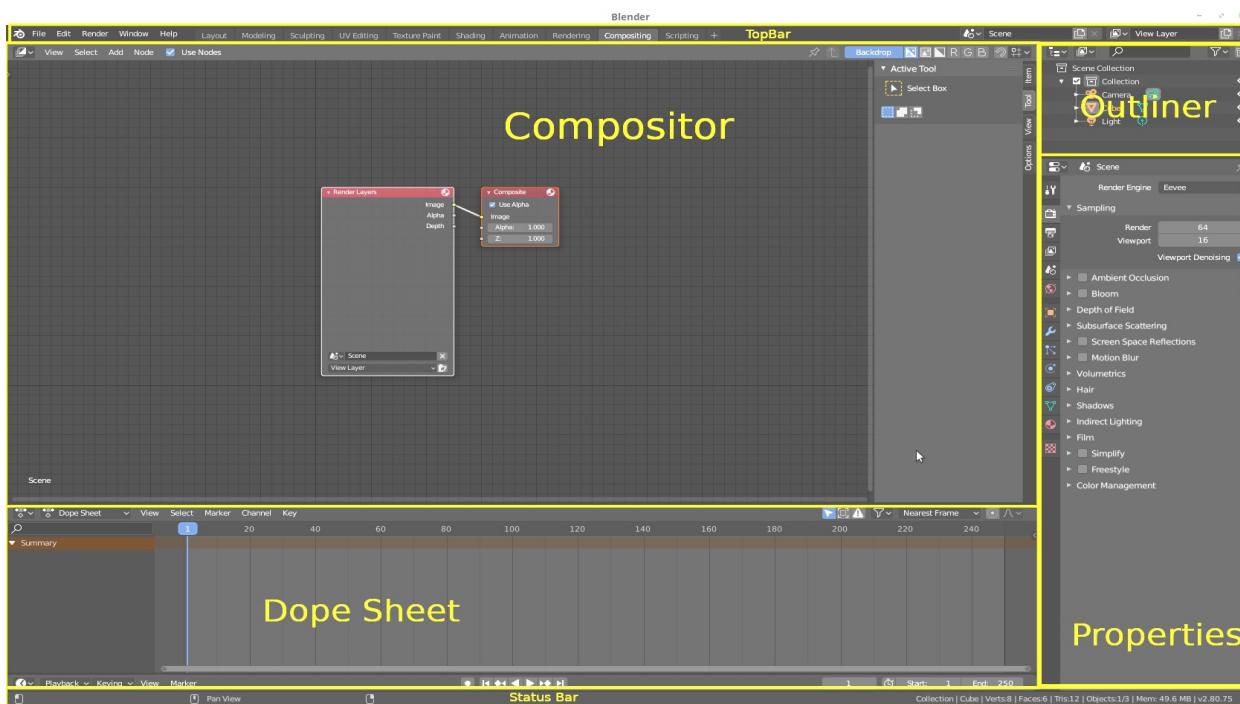


The Shading workspace contains many editors: TopBar, Status Bar, Properties, Outliner, 3D View plus Shader Editor, simple File Browser and Image view. The Image view editor is a viewer for seeing render and composite results, and the File Browser is for selecting external shading assets such as texture image files.

The Shader editor is useful for:

- 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.

## Compositing Workspace

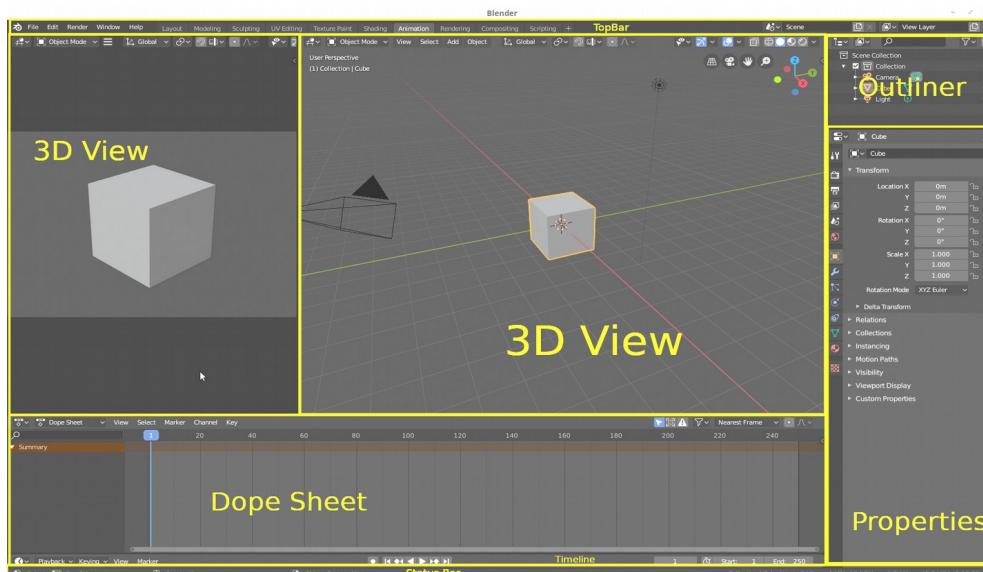


Earlier versions of Blender had Shading and Compositing sharing the same nodes editor. In Blender 2.80, Compositing nodes have been separated out into the Compositor. The Compositing workspace contains this separate node editor along with the familiar Outliner, TopBar, Status Bar, Timeline and the Dope Sheet which is also found in the default Animation workspace

Here is where multiple layers, scenes, images, videos can be combined in a variety of ways to get the desired final effect. Many compositing functions can be performed in this node-based system.

 Almost everything in Blender can be animated. Every numerical value can be made to change over time, even values in Shader and Compositing nodes.

## Animation Workspace

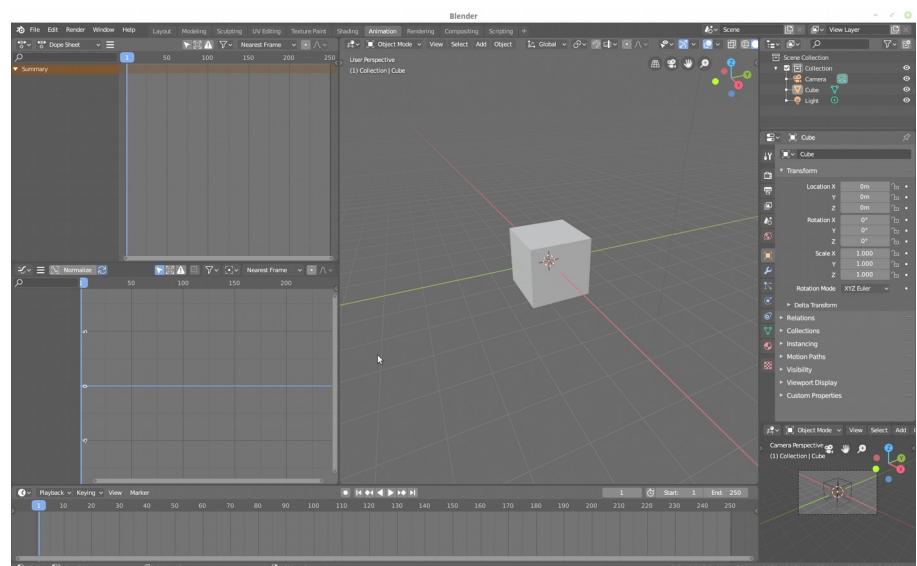


Default Animation Workspace

I personally prefer to include another animation-specific editor called Graph Editor.

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

The Animation screen is somewhat handy for organizing and tweaking the characteristics being animated. It contains several editors previously covered plus an animation-specific editor called the Dope Sheet.



Example of customized Animation Workspace



### 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 > New Window

### File Browser



One editor that you will encounter frequently is the File Browser. It will look different depending on whether the folders are shown as icons or file names. We use it whenever we Save As or Open files, Append from files, Import or Export models, Load image textures, image sequences, python scripts....

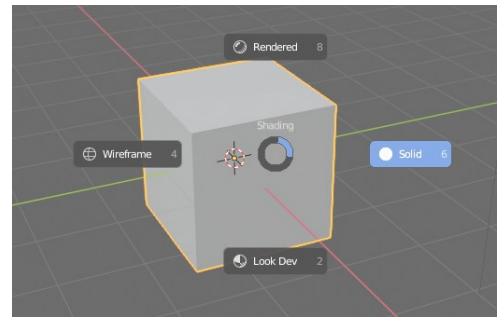
- As of version 2.80, it doesn't look like the folders interface in your operating system, as it was designed to be consistent across the various platforms. This may change in future versions as more users demand separate Mac and Windows file browsers.
- The default folder locations for types of files (textures, scripts, etc) can be set in User Preferences.
- When the File Browser opens, the TopBar 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

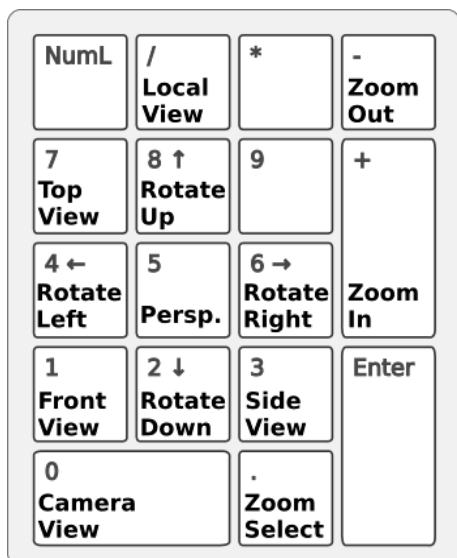
In the 3D viewport, *viewport shading* affects how we see the objects while working on them.

**Shift-Z** to toggle between solid and wireframe mode, **Z** to bring up a pie menu. Options in the pie menu can be selected by the mouse or by typing the number shown.

This shading can also be set with the mouse in the 3D View upper right toolbar.

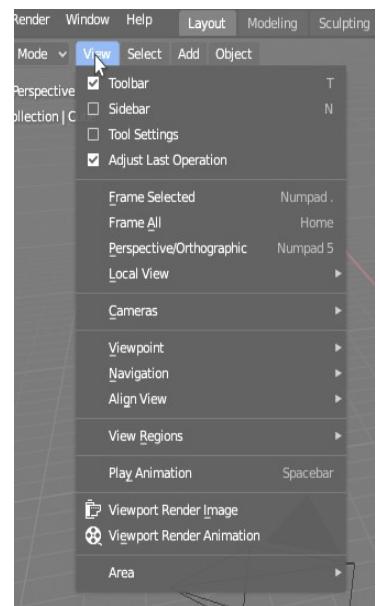


Viewport shading pie menu



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.

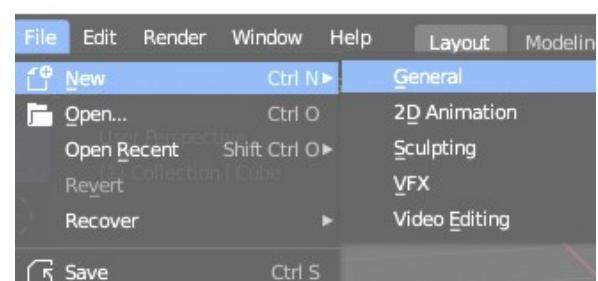
Having a numeric keypad is a time-saver when working with Blender in 3D View.



## 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 or menu box will show startup file types for specialized tasks. Select “General”
- If the current file has unsaved changes, Blender will prompt to either Save or Discard Changes.





# Part 2: Output and Camera Settings for Fulldome

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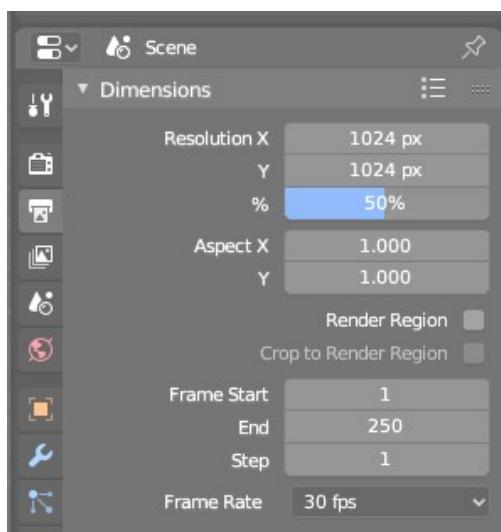
Start with a fresh new Blend file if you haven't already.



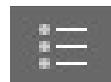
Before we set up the Camera and Output properties for fulldome rendering, we need to be certain that the Cycles Render engine is enabled. Only the Cycles Render engine has the capability to natively render fisheye formats.

### Output Settings

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



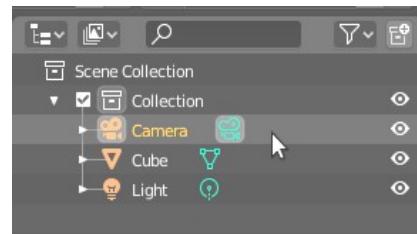
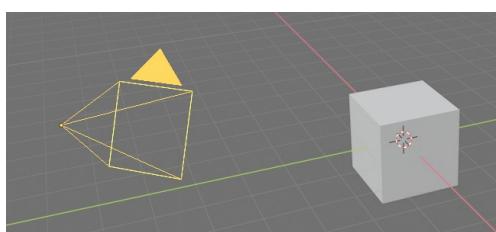
- In the Dimensions panel, set Resolution X and Y both to 1024.
- set Frame Rate if desired
- Set % for quickly making smaller test renders without retyping the resolution
- Note that settings can be saved as preset using the Dimensions presets menu



### 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 on “Perspective” to change Type to “Panoramic”

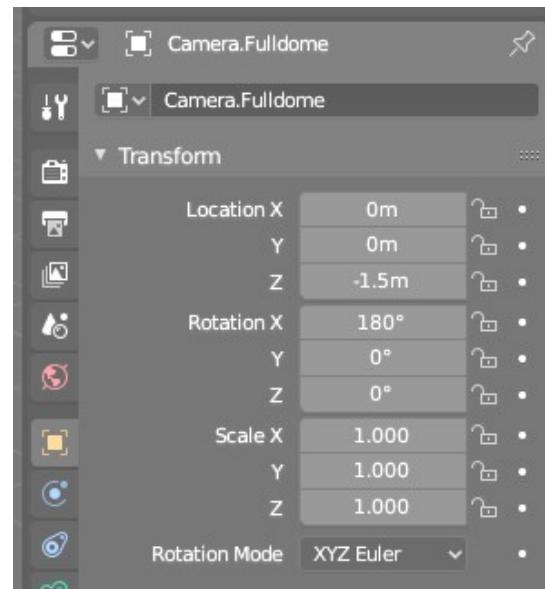


- Then for Panorama Type, select “Fisheye Equidistant” - this setting makes a fulldome master with the least amount of fuss. All we need to do is set the Field of View. For now we can leave it set to 180.

- 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 Shading workspace.



### Shortcut Tip:

To quickly navigate the available workspaces use **Ctrl** and **PageUp** or **PageDown** keys:

***Ctrl-PgUp and Ctrl-PgDn***

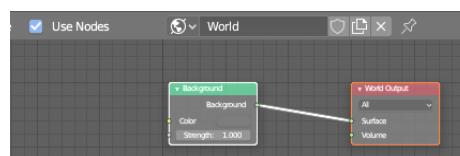
- In the Shader node editor, change data type from Object to World:



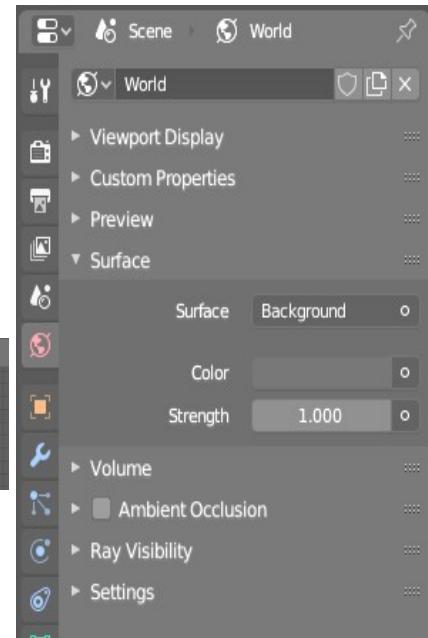
### WorkflowTip:

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

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



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.

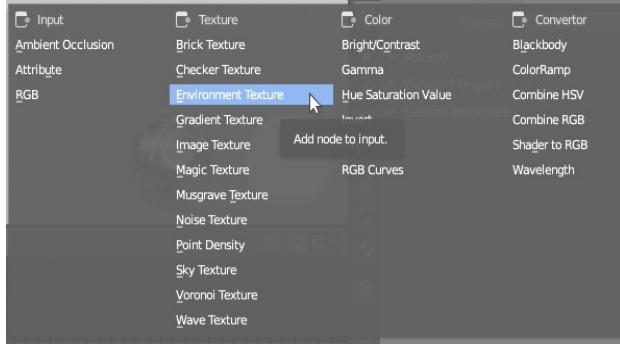


Instead of using a color for our World, we will use an environment map connected to the color input of the Background shader.

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

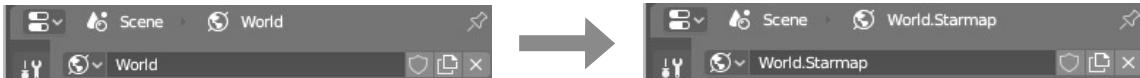


## Blender Fulldome Part 3: Blender World Creation



- 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 panel,  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:

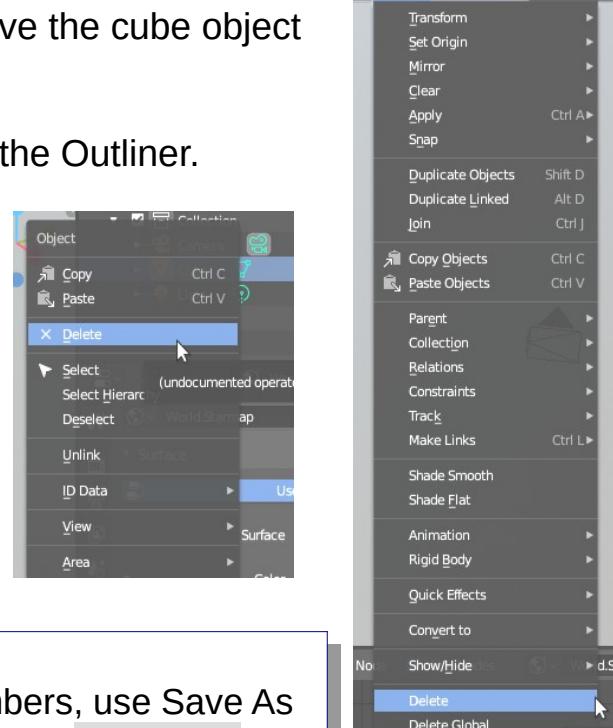
This and several other star maps are available to download for free from NASA/Goddard Space Flight Center Scientific Visualization Studio.

<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.

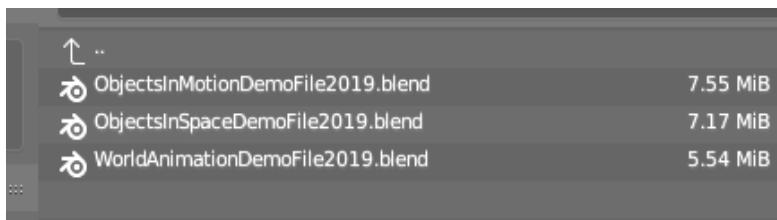
There are many excellent free tutorials available online for creating and setting up the properties for these objects.



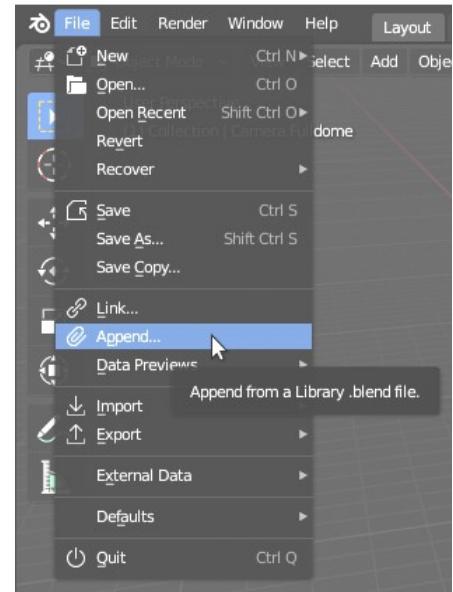
### Search Tip:

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, and “2.8” if using more recent version. This will weed out most of the much older and outdated tutorial and forum answers. Always double-check to make sure that your search results are for Cycles instead of Eevee if seeking information on materials or rendering.

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



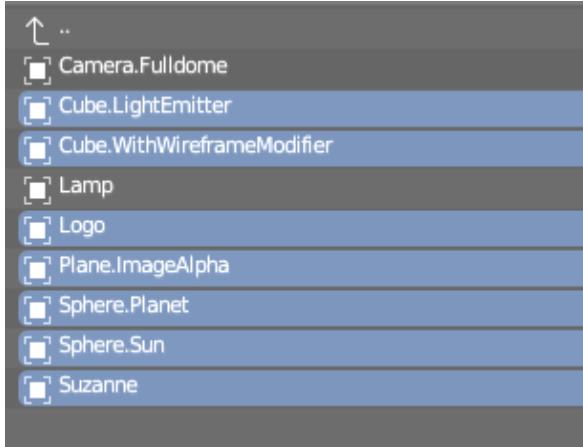
File > Append > ObjecstInSpaceDemoFile2019.blend



Inside the Blend file looks like a bunch of folders.

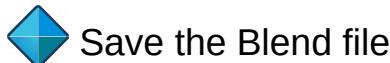
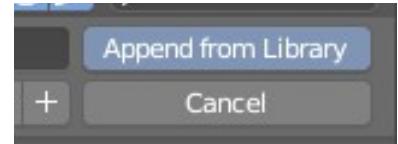
Enter the Object folder.

## Blender Fulldome Part 4: Various Objects, Materials and More



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

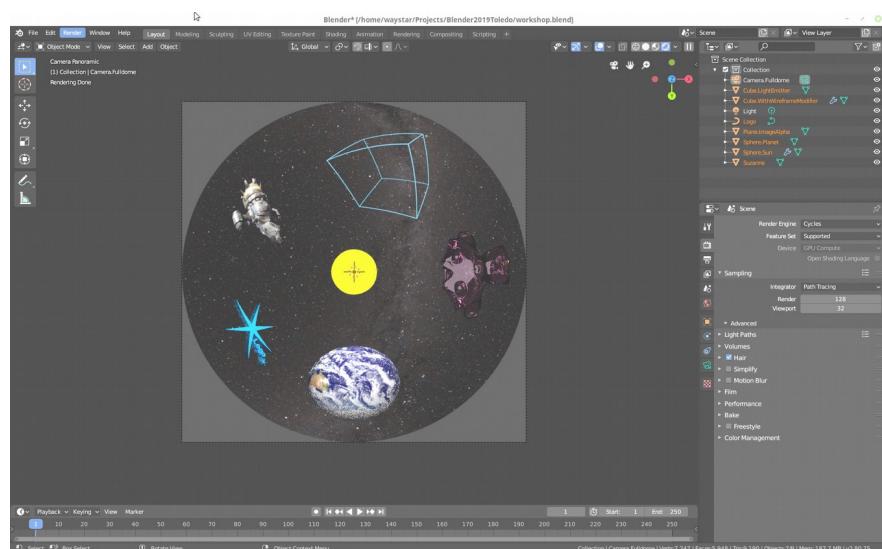
After selecting, click "Append from Library" in the upper right hand corner.



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

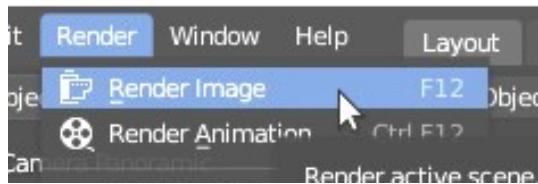
Numpad 0 for camera view

Select *Rendered* viewport shading using the upper right toolbar or hotkey Z to use the pie menu Note that the fisheye effect cannot be seen in wireframe or solid view.

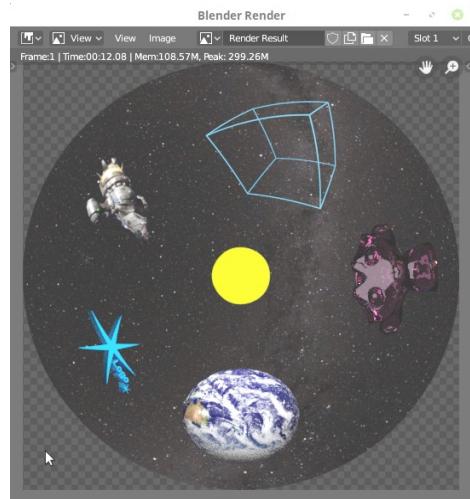


Compare the preview to a test render.

F12 or Render > Render Image



The 3D viewport render preview and the test render should look similar at this point.

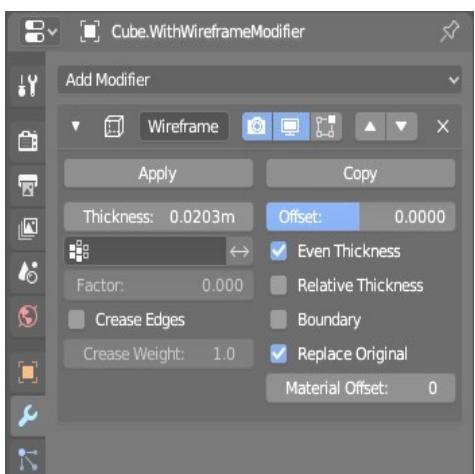




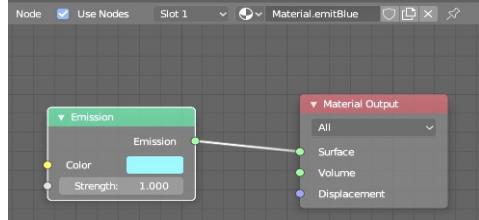
The rest of this section describes the individual objects and their characteristics in detail. Some or all may be skipped during the workshop, but is included for later study.



### 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.



### 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.



*Right-click over selected object to select Shade Smooth*

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.

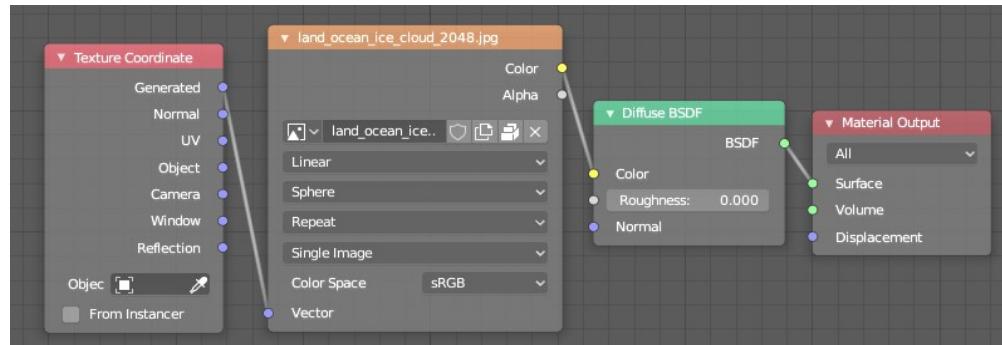
Shaders define the material. Shaders are the internal instructions telling the software how to achieve the effects.

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.



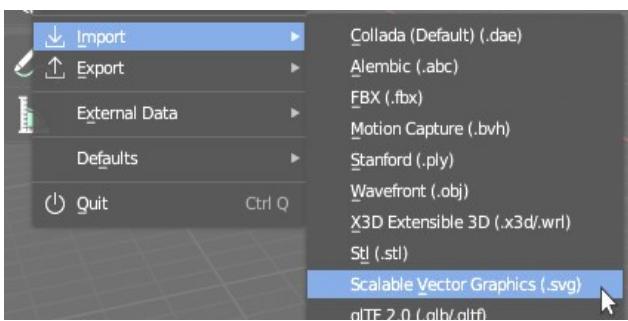
### Earth Ball ("Sphere.Planet")

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.

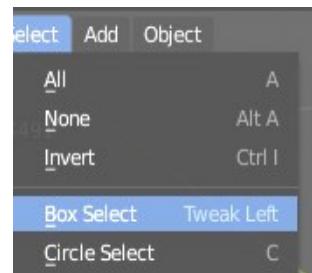
File > Import > Scalable Vector Graphics

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

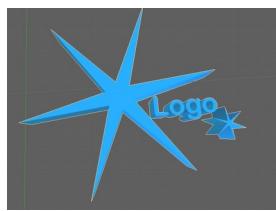
The **B** key starts the select, and the mouse is used to drag the select border around all of the curves.

Box select can also be started via the menu:

Select > Box Select

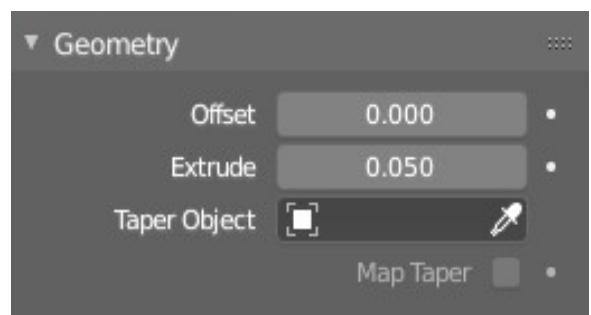


The selected curve objects are then joined as one object using **Ctrl-J** or Object > Join



Once joined into one curve object, the object was renamed "Logo"

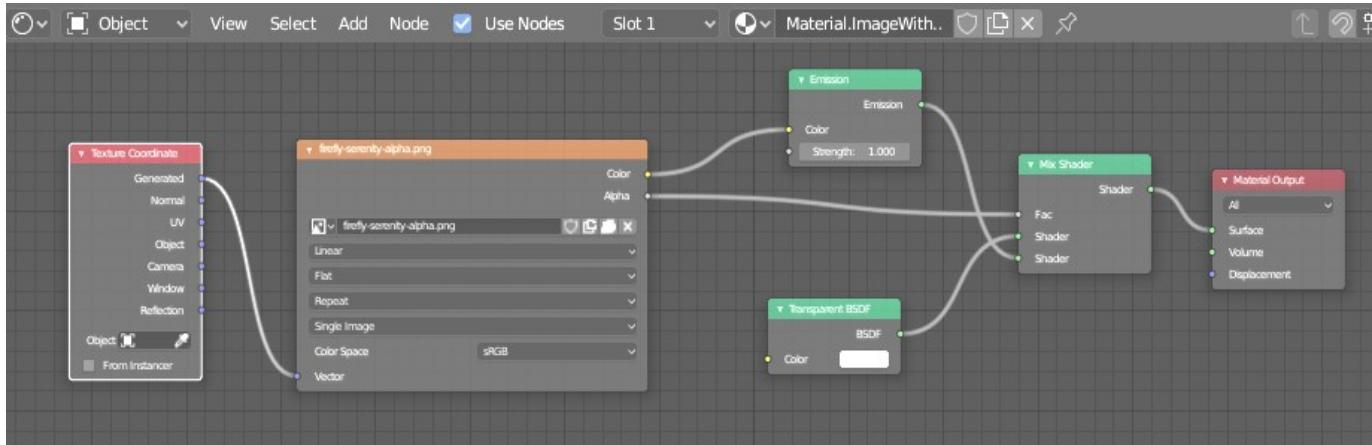
Finally, the curve was extruded as a Modification setting in the Geometry panel of Curve properties.



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:

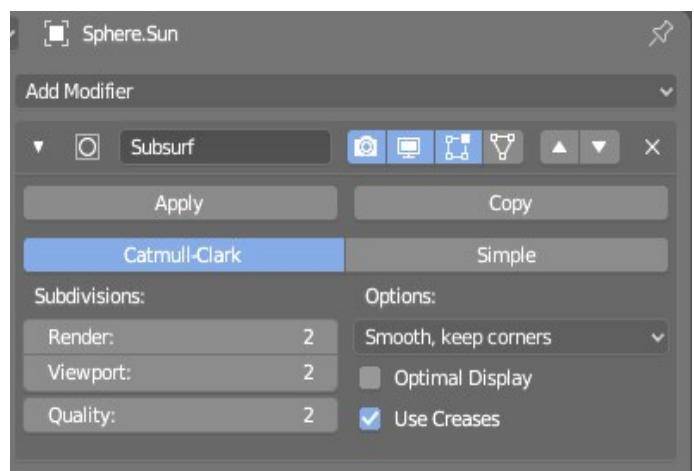
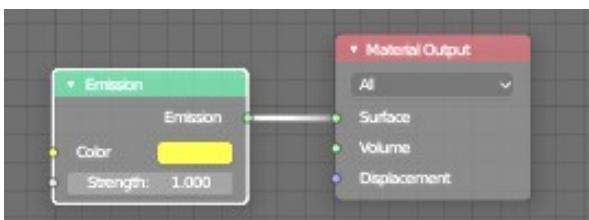
Add-ons are scripts enabled through user Preferences that extend the capabilities of Blender. “Import Images as Planes” automatically scales the image plane to the dimensions of the image. It also sets up the material nodes, although it uses a different coordinate method.



### Sun Ball (“Sphere.Sun”)

An Ico Sphere 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 Collections, Layers and Compositing nodes.

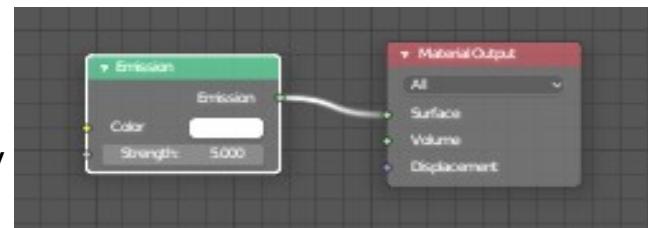




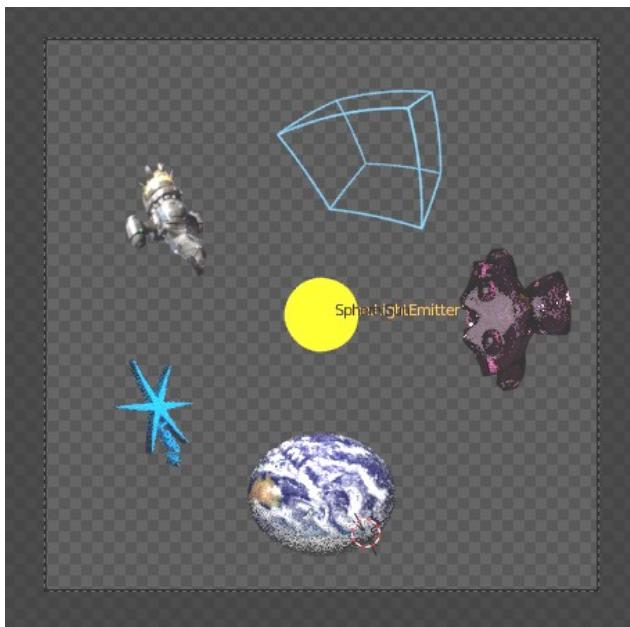
### “Cube.LightEmitter”

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 Ray Visibility in object properties to make it invisible to camera.



In the object properties Visibility panel, under Ray Visibility, deselect Camera.



With Camera deselected, the light emitted from the cube will illuminate the reflective objects in the scene.



# Part 5: Compositing View Layers

Intro to Fulldome Production with Blender

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2019 GLPA Conference, Toledo OH





## Collections



Blender has undergone many changes to how objects are managed within scenes. Older tutorials for earlier versions of Blender will refer to some types of layers that have been renamed or reworked in other ways. Always double-check the version you are reading about.

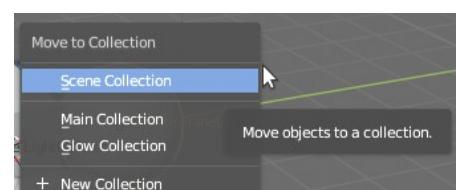
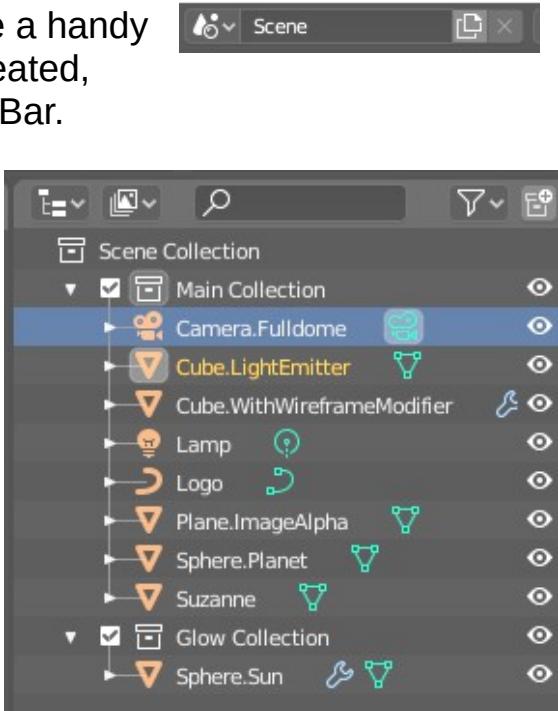
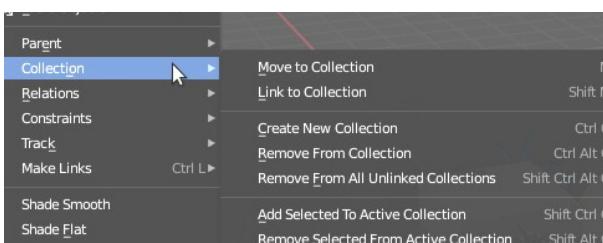
Each Blender file contains at least one **Scene**. Scenes are beyond the scope of this workshop, but they can be a handy tool for managing large projects. Scenes can be created, selected, renamed or deleted in the upper right TopBar.

**Collections** are a way to organize objects in whatever ways make sense to the user for a given project. Collections can control visibility for viewport or camera, and can be a way to keep objects organized by whatever criteria makes sense to the user.

Every Scene contains the **Scene Collection**. Smaller collections are defined within the larger Scene Collection. These smaller collections can be renamed to suit the project.

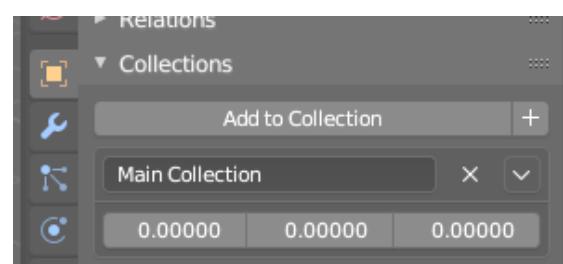
There are multiple ways to place an object into a collection:

**Hotkey method:** To place an object into a single collection, select the object and then press the **M** key, then select the desired collection or create a new one.



**Menu method:** *Object > Collection* will also permit selecting or creating a new collection

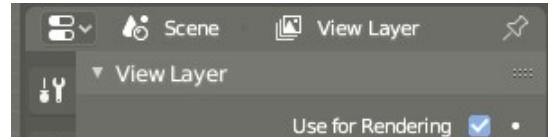
**Properties editor method:** In the Object properties Collections panel, select or create a new collection, or add to additional collections.



### View Layers

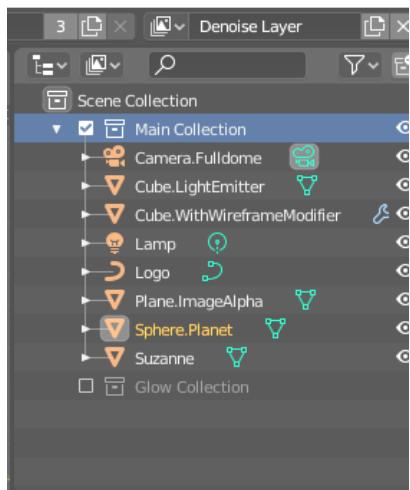
*View Layers* can be used to control visibility when working on cluttered scenes and they are a great way to separately render parts of the scene so that image processing can be performed on some elements differently than on others. These parts are then usually recombined in the final compositing stages.

*View Layers* can be selected or created at the top right of the TopBar. At least one *View Layer* must be enabled with “Use for Rendering” checked in order to render a scene.

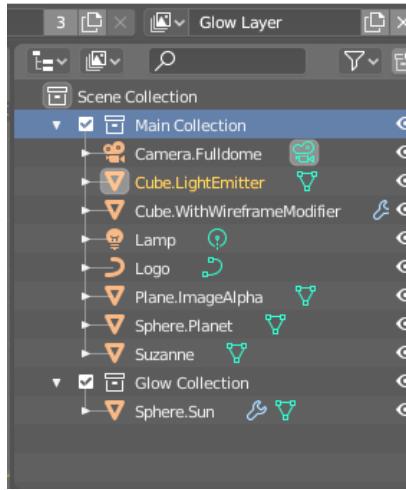


When a new *View Layer* is created, all collections are included by default. In the Outliner, uncheck the collections to exclude from the current *View Layer*.

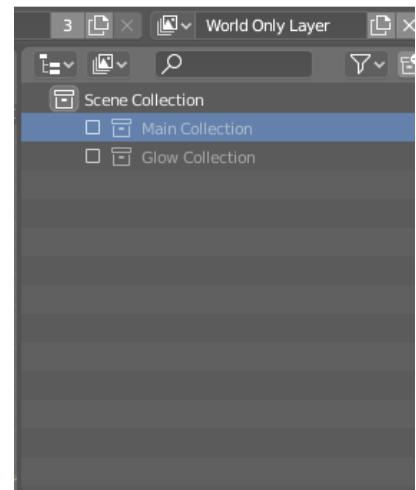
Our demonstration file is specifically using three *View Layers*:



Denoise View Layer



Glow View Layer



World Only View Layer

The Denoise layer contains the Main Collection, the Glow layer contains only the Glow Collection, and the World Only layer contains no collections.

We'll set up these *View Layers* so that each can have different *Render Passes*.



## Render Passes

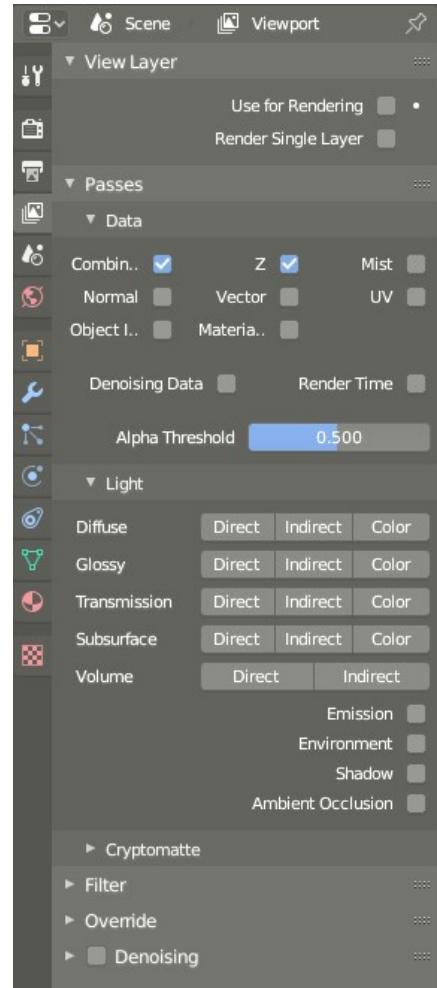
Elements in a View Layer can be further separated into passes carrying information about the object, materials and location in the 3D scene.

In the Passes panel of the View Layers properties, 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.
- Denoising will smooth out unwanted speckle-type artifacts.

The icon for View Layer properties looks like a stack of photos.



## Why separate the layers?

To complete our example scene, we want to make our Sun glow, but we don't want the other objects to glow. We also want to apply denoising to the objects in our scene, but we don't want denoising applied to the surrounding starfield, because the denoising would remove stars by mistake.

This is why we have separated our scene into three distinct layers. Then we must combine them in the best way possible for the effect we want to achieve.



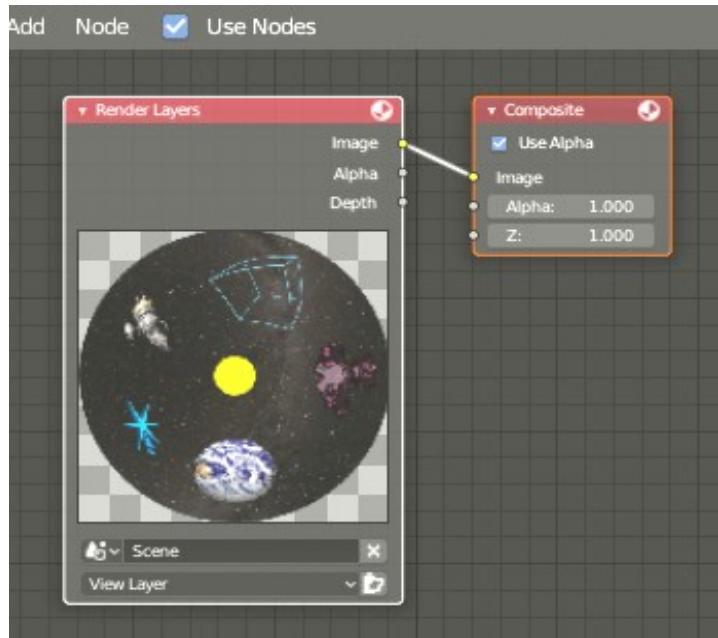
### A note about denoising...

Denoising reduces noisy artifacts very well without setting our render sampling super high, so it improves the quality without dramatically increasing render times. However, test carefully before rendering video sequences because the denoising could be applied differently from one frame to the next.

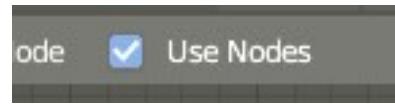


### Compositing

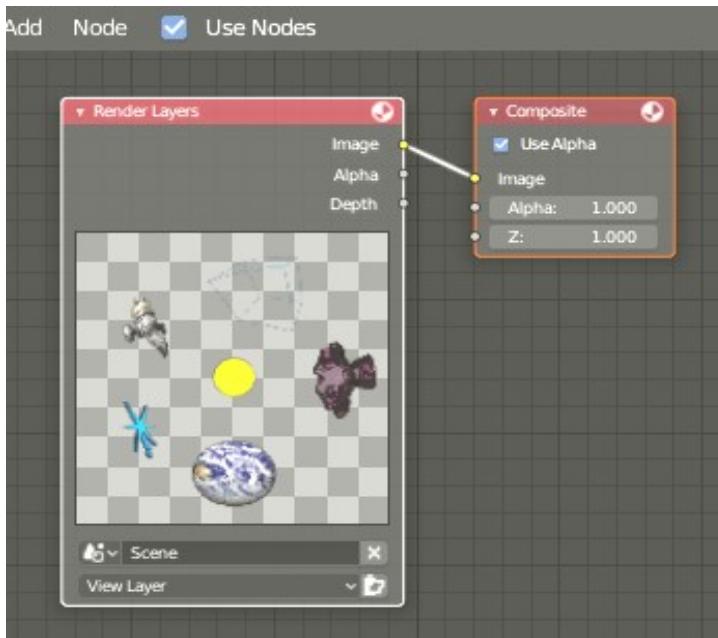
So far we've looked at nodes for creating object and World materials. The nodes system was originally put into Blender for compositing. This is where videos and image sequences can be combined and/or enhanced into a final product. Even if you use a dedicated software package for compositing, you may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



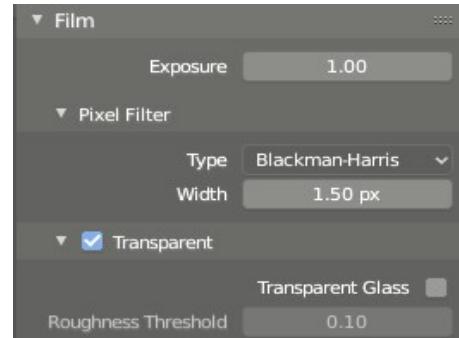
- To use the Compositing nodes, choose the Compositing Workspace.
- Click the check box for Use Nodes and a default node setup will appear.



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

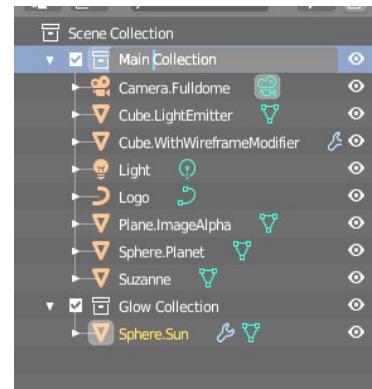


- Notice that the RenderLayer input node now shows no background.

## View Layers to Render Layers: Setting Them Up

In this section we set up the Collections, View Layers and input nodes for Compositing:

- Using one of the methods previously mentioned, create a new Collection called “Glow Collection” and move the Sphere.Sun object into it.
- Rename “View Layer” to “Denoise Layer”, then add two more RenderLayers, “Glow Layer” and “World Only Layer”

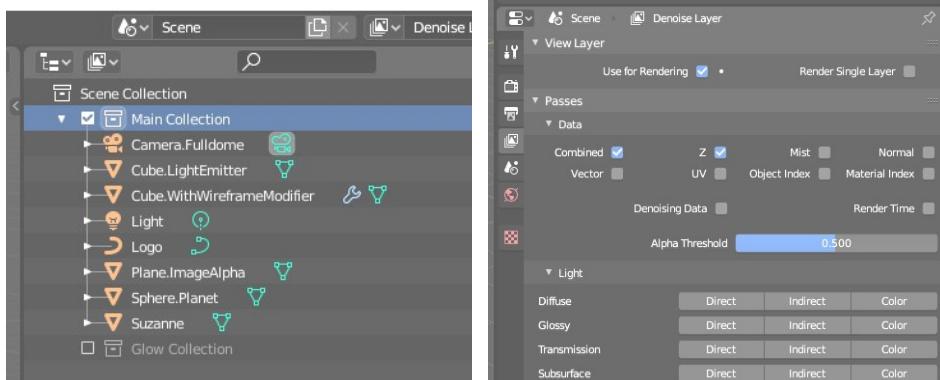


## Save the Blend file.

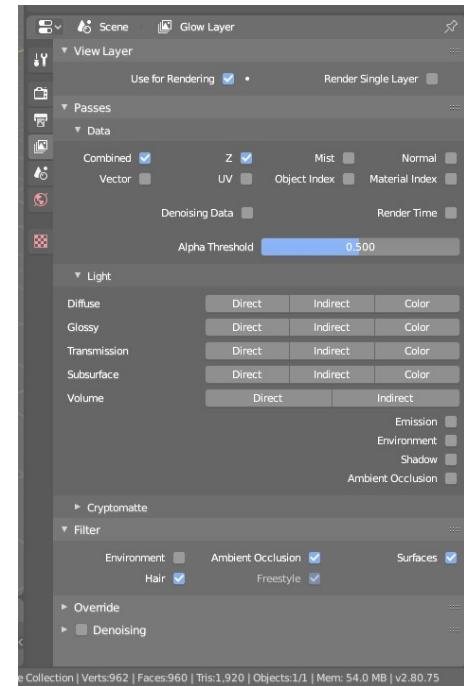
The next page shows the specific settings for each View Layer.

# Blender Fulldome Part 5: Compositing Render Layers

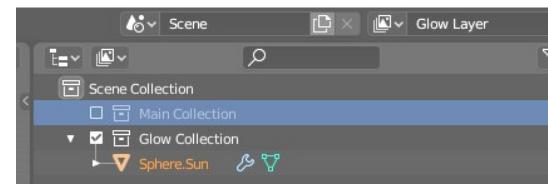
- Denoise Layer
  - Select Denoise Layer in TopBar
  - Deselect the glow collection in the Outliner
  - In View Layer Properties Filter panel, uncheck Environment
  - Enable Denoising



## • Glow Layer

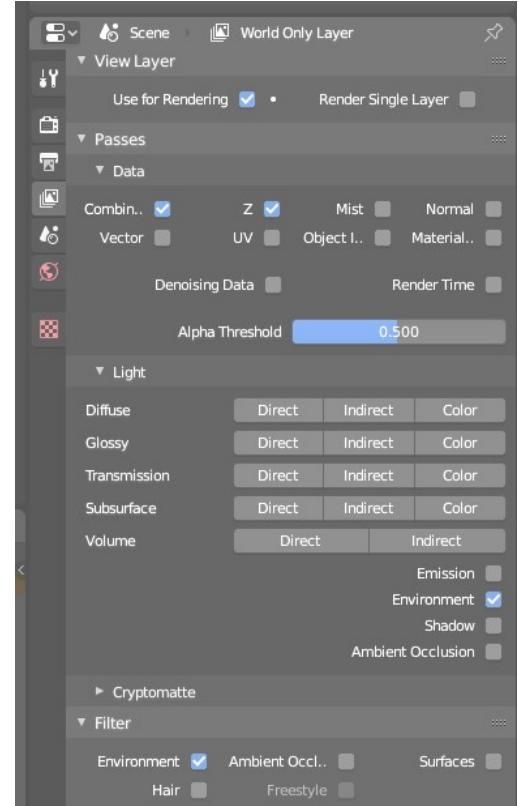
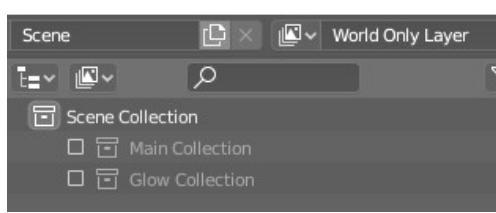


- Select Glow Layer in TopBar
- Deselect main Collection in the Outliner
- In View Layer Properties Filter panel, uncheck Environment



## • World Only Layer

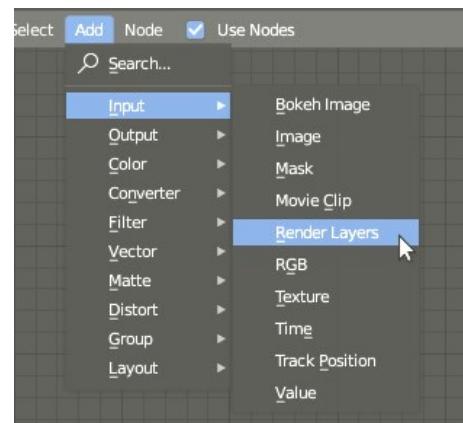
- Select World Only Layer in TopBar
- In View Layer Properties, enable Environment in both Light Passes and Filter



## Beginning the Node Tree

- In the Compositor, add two more input nodes...

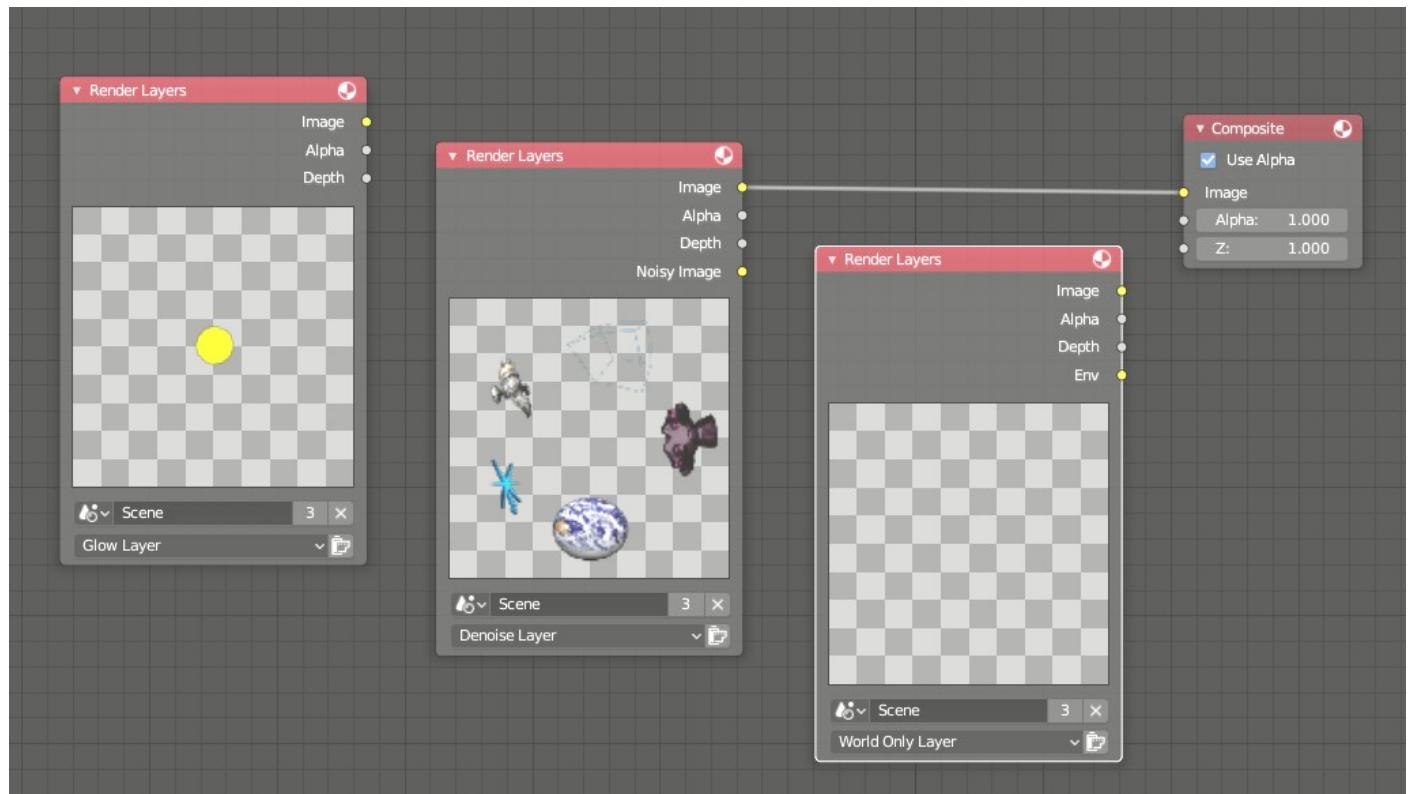
Add > Input > Render Layers



- For each Render Layer input node, select one of the View Layers

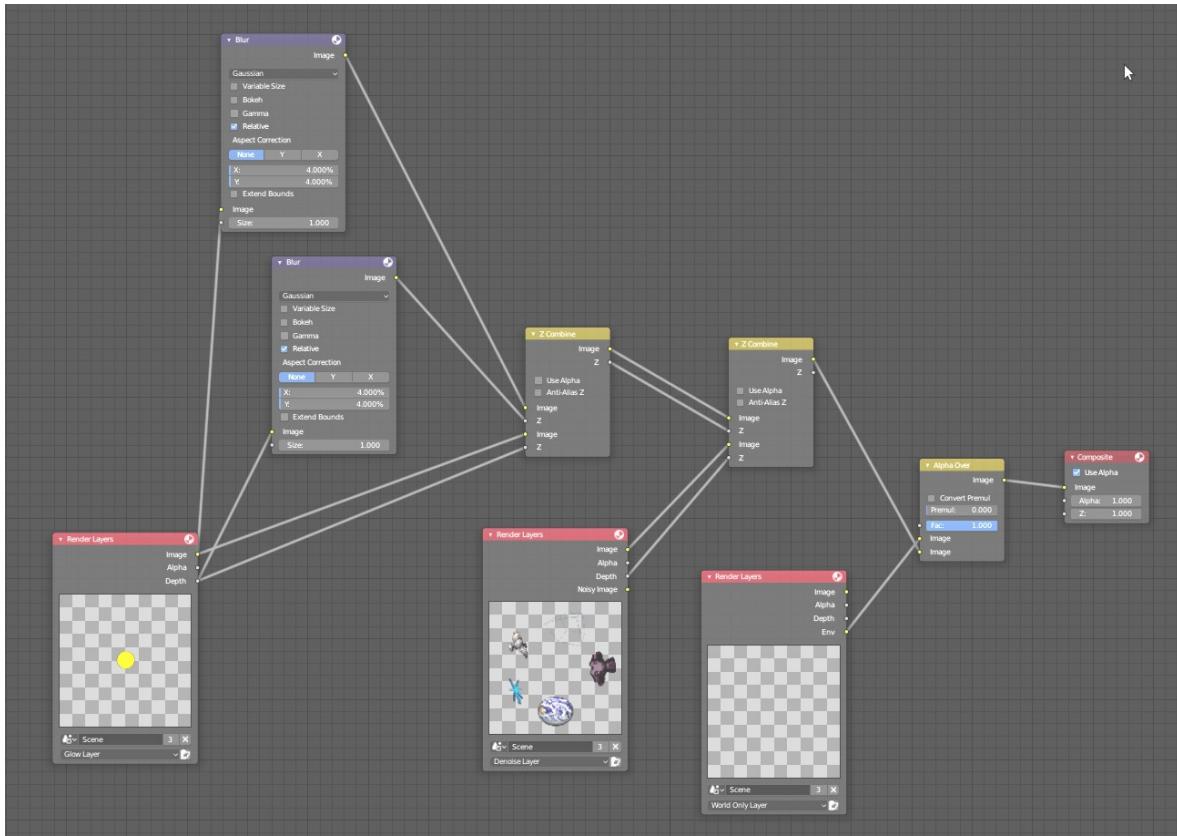
Your node setup so far should look something like this:

Notice that the Glow Layer only contains the Sphere.Sun object, the Denoise Layer has an output for the noisy version of the image layer and that the World Only Layer contains an extra output node socket, “Env” for “Environment”



## Blender Fulldome Part 5: Compositing Render Layers

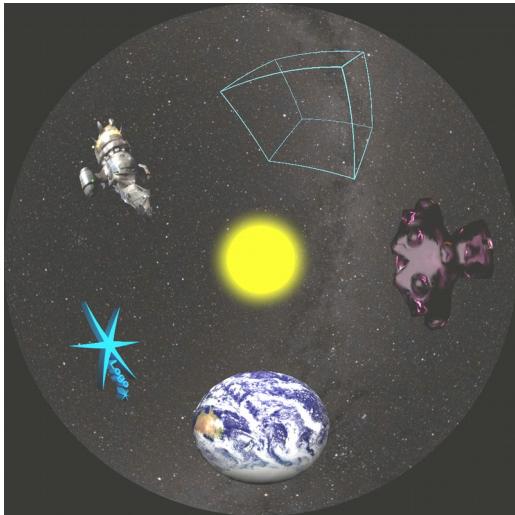
- If you feel brave, you can try adding, setting and connecting the following nodes:



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.



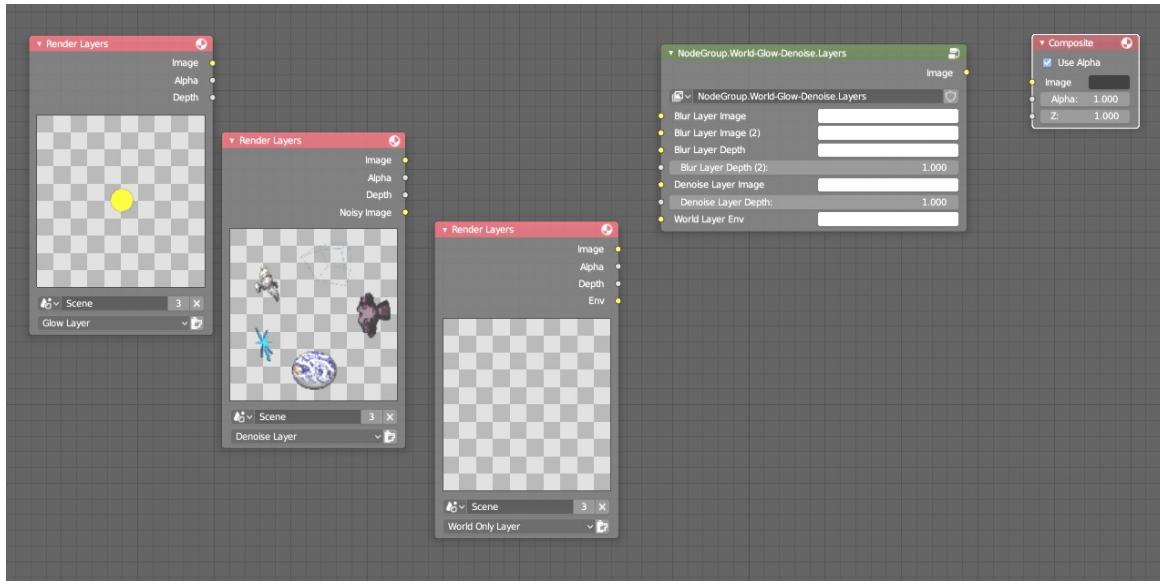
The render result combines the elements nicely.



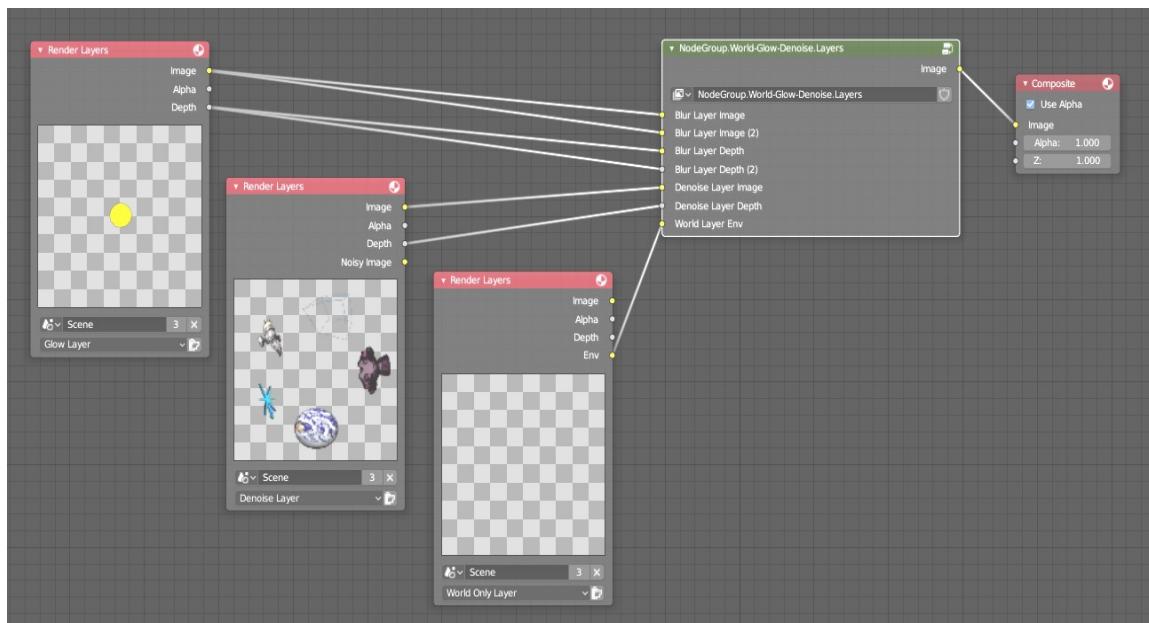
Save the Blend file.

## 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 > ObjectsInSpaceDemoFile2019.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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2019 GLPA Conference, Toledo OH

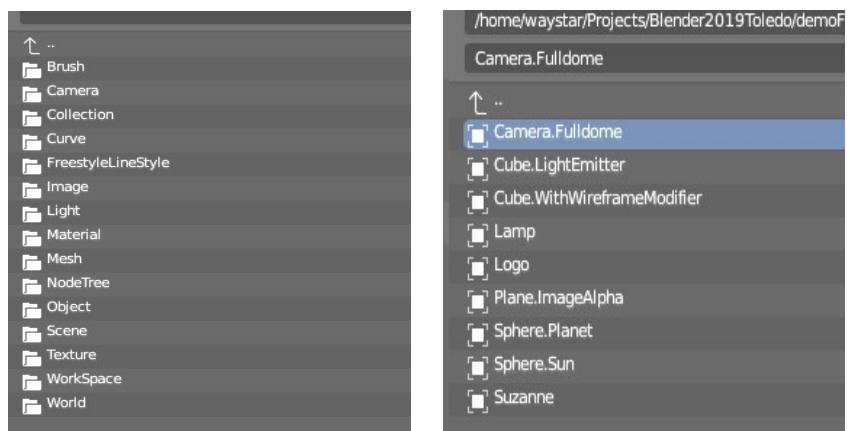


In this section, we will take the previously made World environment with starfield and we will animate it to give the appearance of diurnal motion. A finished example can be found in the demonstration file `WorldAnimationDemoFile2019.blend` for later examination.

- ❖ Start with a fresh new Blend file if you haven't already. `Ctrl-N`
- Check Settings: Cycles Render (not Eevee), 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 both 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 shows which camera is active by putting a pale highlight around the movie camera icon.





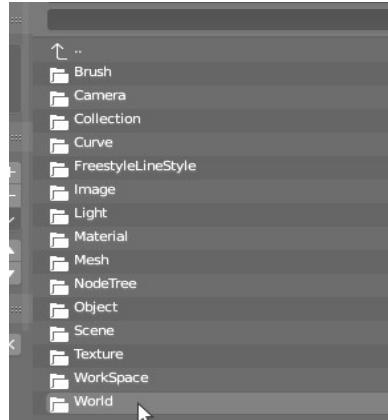
### Save the Blend file.

- 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

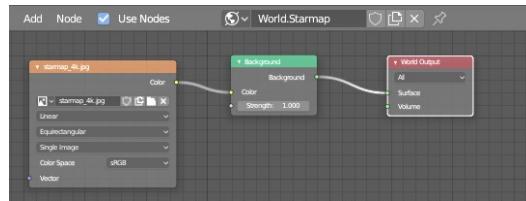
- Either set it up from scratch as in Part 3, or append it from an earlier file.



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



The node tree will appear in the Node Editor



- Next add two nodes, Texture Coordinate and Mapping:

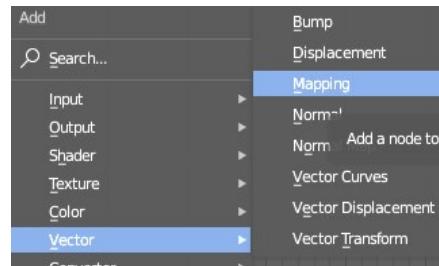
Texture Coordinate node

Add > Input > Texture Coordinates



Mapping node

Add > Vector > Mapping

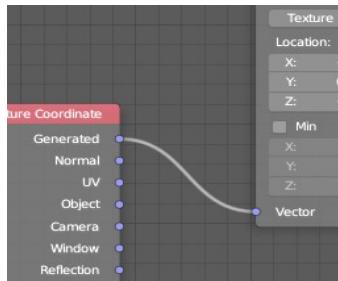


Shortcut Tip:

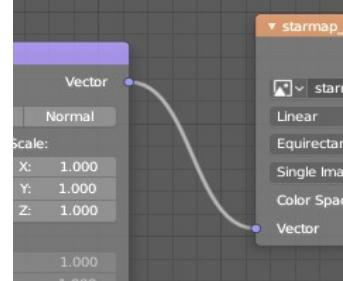
In the Nodes Editor, 3D View and several others, the “Add” menu can be more quickly accessed using: **Shift-A**

- Connect the node sockets:

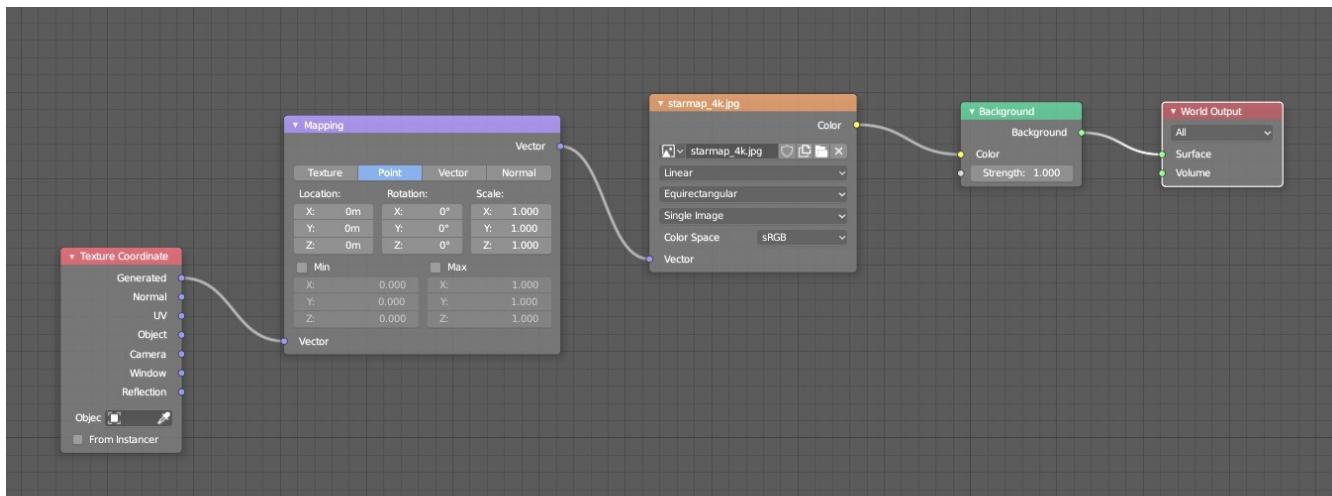
Texture Coordinate  
Generated output socket  
to Mapping Vector input socket



Mapping node  
Vector output to Environment  
Texture Vector input socket



The node setup should look like this when finished:

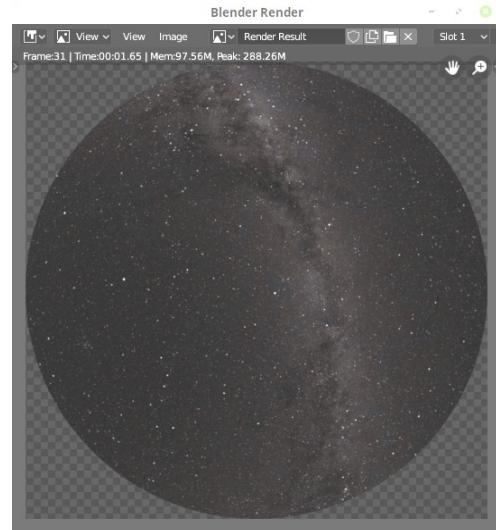


Save the Blend file.

Simulate Latitude

- Make a test render using F12 shortcut or menu.

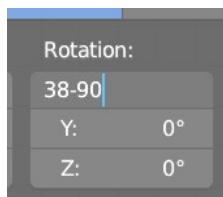
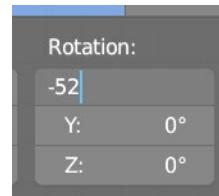
Note the position of Polaris in the image. Our camera is aimed straight “up” along the Z axis, so our World environment map appears to have us at the North Pole.



## 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...

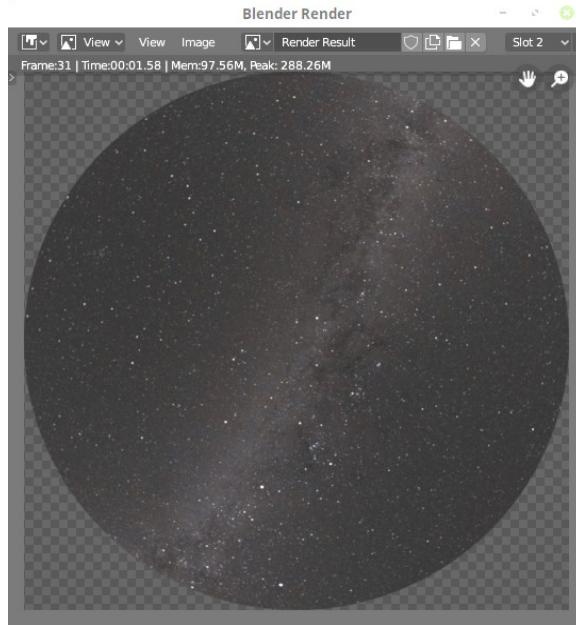


...or enter "38-90" and the calculated value will be entered.

- 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.



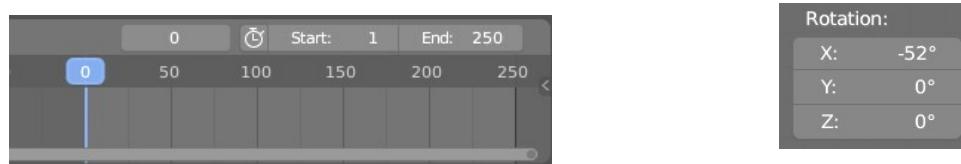
Save the Blend file.

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 at frame 0 in the Timeline Editor and that the rotation Z mapping value is 0 in the Node Editor.

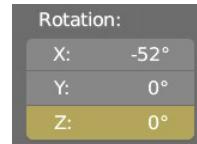


- Make a keyframe for the rotation Z mapping value

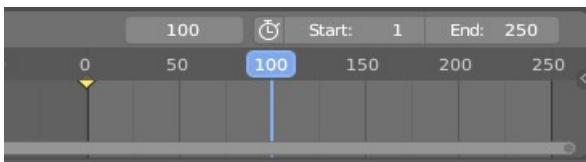
Hover and right-click then insert single keyframe.



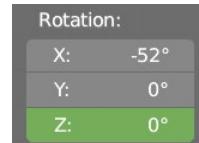
Value boxes with keyframes are yellow if the timeline is currently resting on a keyframed frame.



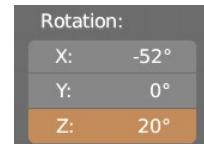
- Go to frame 100, either using the mouse to change timeline or by entering the frame number in the Timeline editor toolbar.



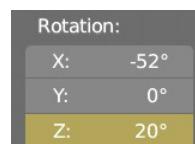
Notice that the box values with keyframes are green if not currently on the keyframed frame.



- Change the rotation Z mapping value to 20. The color changes from green to orange, because the value has been changed but the keyframe has not been set.



- Make a keyframe for the rotation Z mapping value. Note that the box has changed from orange to yellow.



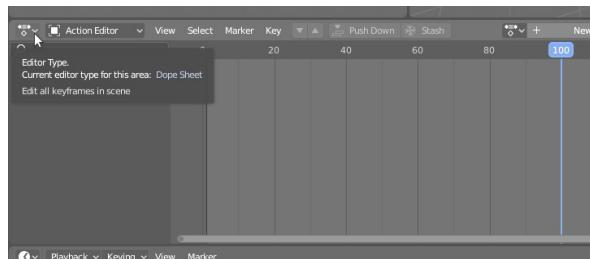
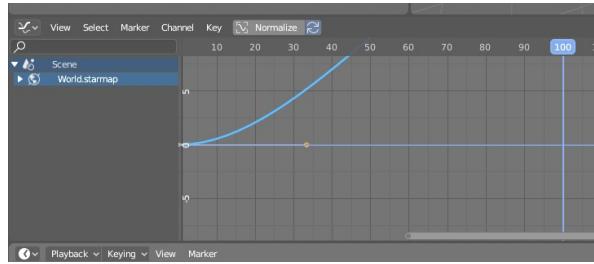
## Save the Blend file.

### Extrapolate Motion

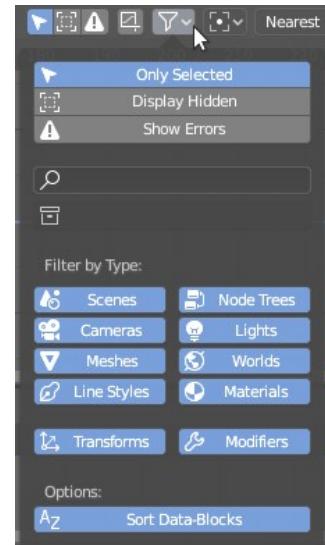
Currently the simulated diurnal motion slowly begins at frame zero, speeds up a bit, and then slows again to a stop by frame 100. For this example we want continuous motion, so we need to tell Blender how to extrapolate.

- Change to the Animation workspace.

For this exercise, we will switch from the default Dope Sheet Action Editor to the Graph Editor...



We can select and change or we can hover over the editor and use **Ctrl-Tab** to toggle between the two editor types.



- The Graph Editor can display graphs for all animated properties.

We can filter what is visible by a variety of criteria.

Use this if you have too many properties cluttering the editor or if you are trying to find a property that isn't visible.

- Keyframes on curves in the Graph Editor can be selected by clicking or using Box Select.

Use the mouse scroll wheel to zoom in and out of the curve, and make the editor fullscreen if needed.

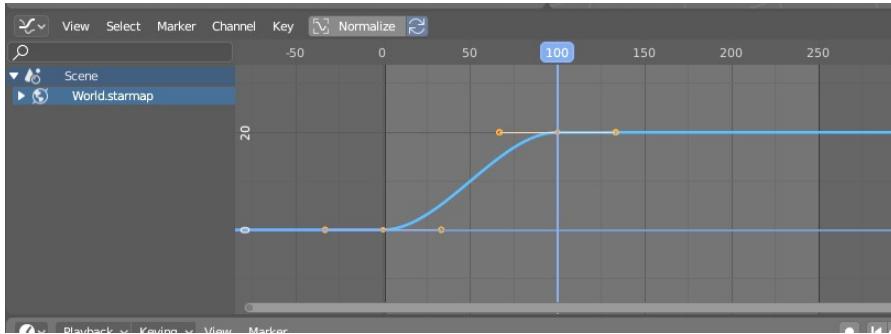


Screen Space Tip:

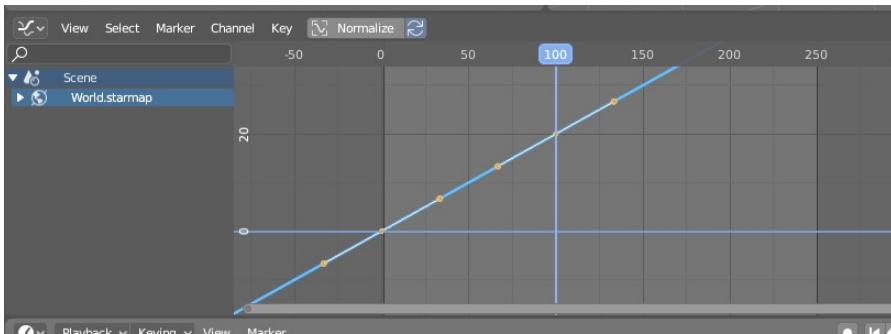
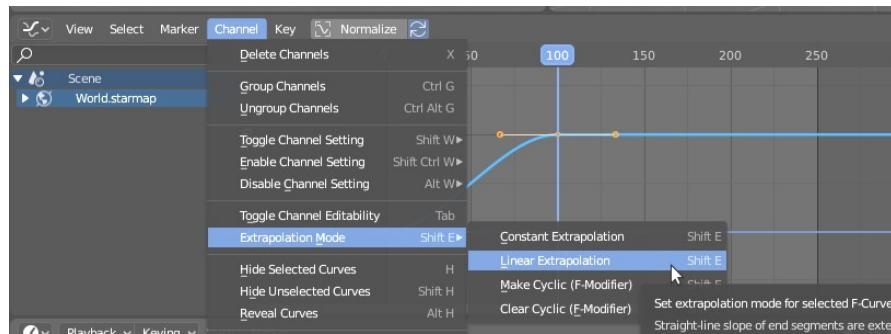
To temporarily enlarge a single Editor to fullscreen, use:

**Ctrl-SpaceBar** or **View > Toggle Maximize Area**

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



Channel > Extrapolation Mode > Linear Extrapolation



The curve is now a continuous line, so your starry sky will now rise and set.

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.

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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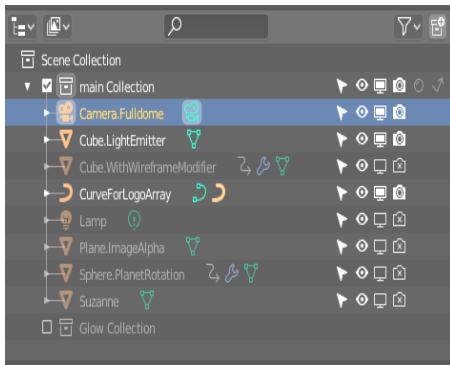


This section examines the contents of the example file `ObjectsInMotionDemoFile2019.blend` – the contents are the same as in the earlier demonstration file, but these have all been animated in some way that may be of future use. Play around and experiment with changing different settings to see how it affects the output.



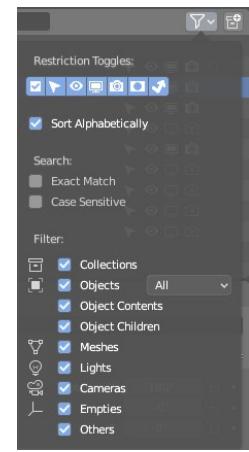
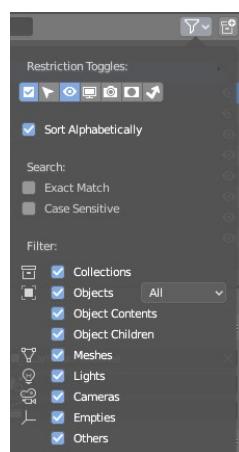
### Tip:

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 arrowhead controls what can be selected, the eye controls what is visible in the 3D view editor, the monitor controls global visibility in all editors, and the camera controls what is visible in rendering.

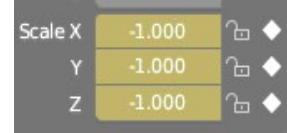
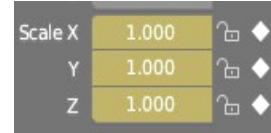
The control icons themselves can be controlled by clicking the funnel-shaped filter icon and then selecting which ones to use.



### Wireframe Cube (“Cube.WithWireframeModifier”)

In this example, the scaling changes at regular intervals.

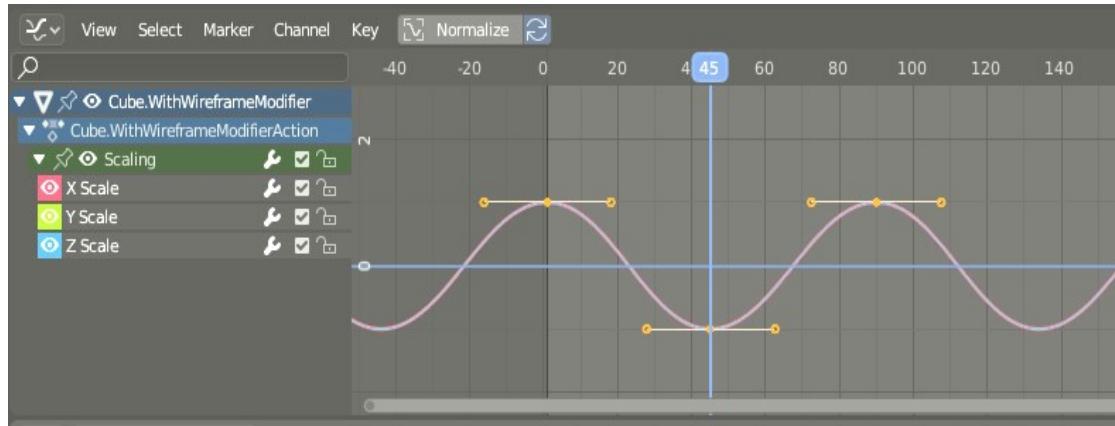
Keyframes were set at 3 different frames.



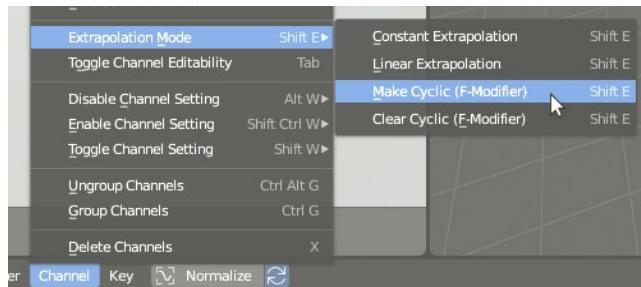
Frame 0: scaleX = 1, scaleY = 1, scaleZ = 1

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

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



In the Graph Editor, the curves for XYZ were selected together and made to repeat.



Channel > Extrapolation Mode > Make Cyclic



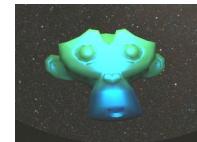
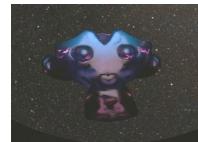
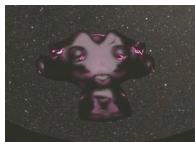
Learn more about F-Curve Modifiers and the Graph Editor:

[http://docs.blender.org/manual/en/dev/editors/graph\\_editor/fcurves/introduction.html](http://docs.blender.org/manual/en/dev/editors/graph_editor/fcurves/introduction.html)

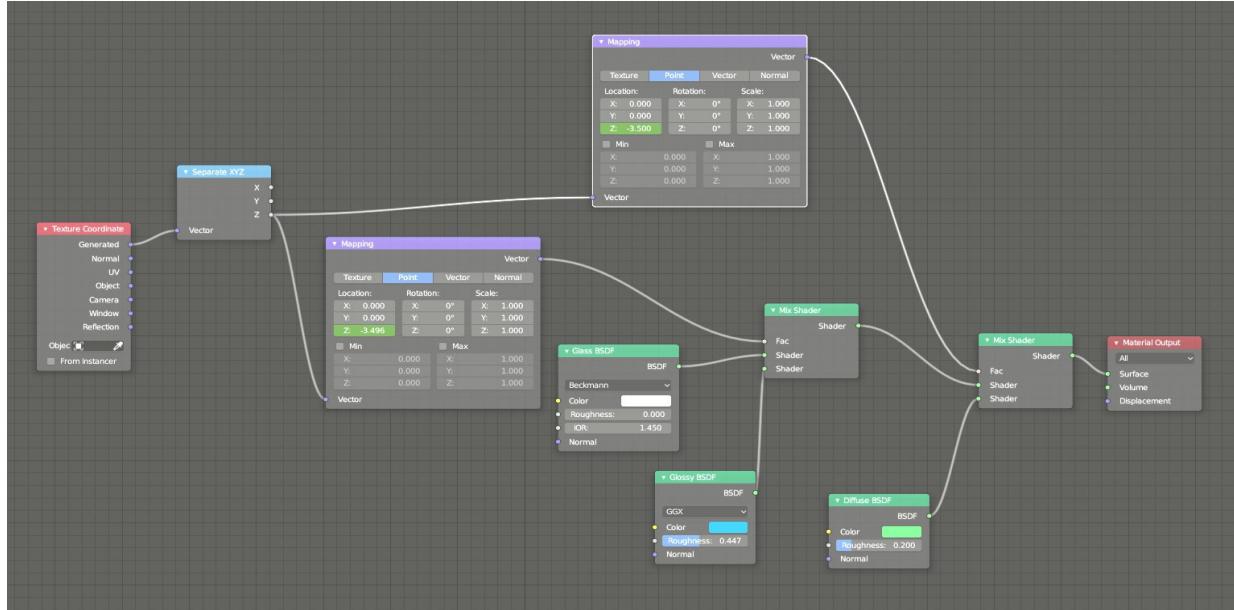


## Glass Monkey Head (“Suzanne”)

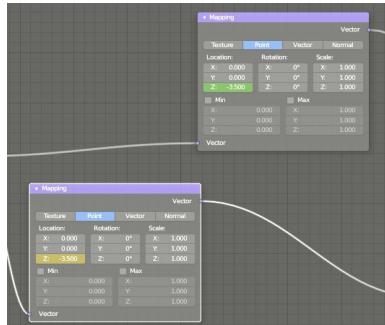
Change from purple glass to blue glossy to green diffuse then back.



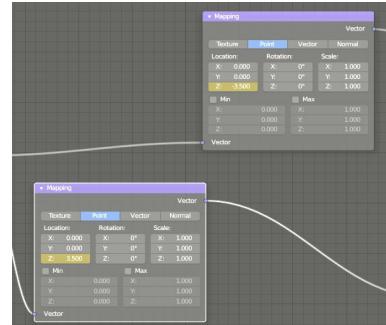
The change happens along the Z axis of the monkey object.



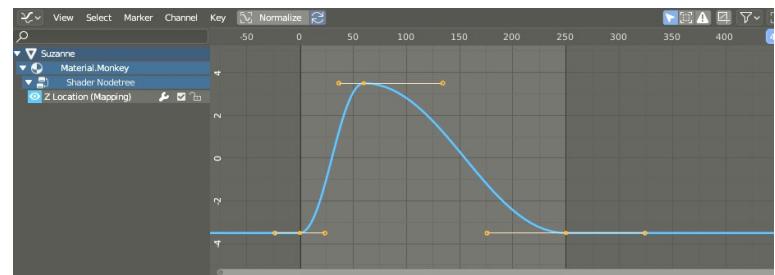
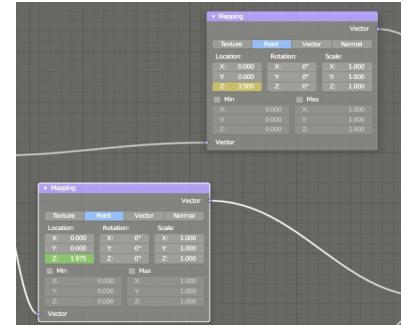
Frame 0



Frame 60



Frame 120



Graph editor showing curves for keyframes of Mapping nodes.



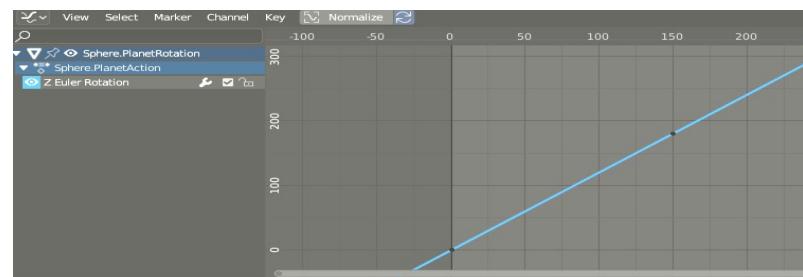
Learn more about Mix Shader and other Shader nodes:

[http://docs.blender.org/manual/en/dev/render/shader\\_nodes/shader/mix.html](http://docs.blender.org/manual/en/dev/render/shader_nodes/shader/mix.html)

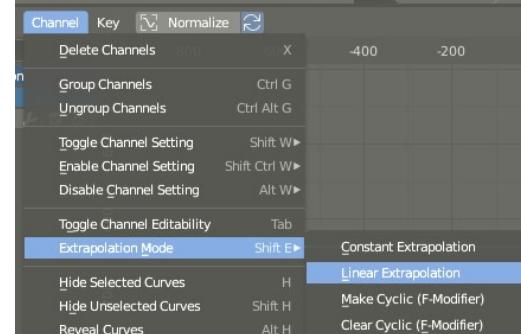
### Earth Ball (“Sphere.PlanetRotation”)

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

Rotation made continuous.

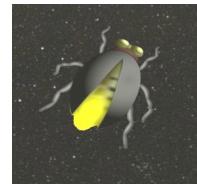
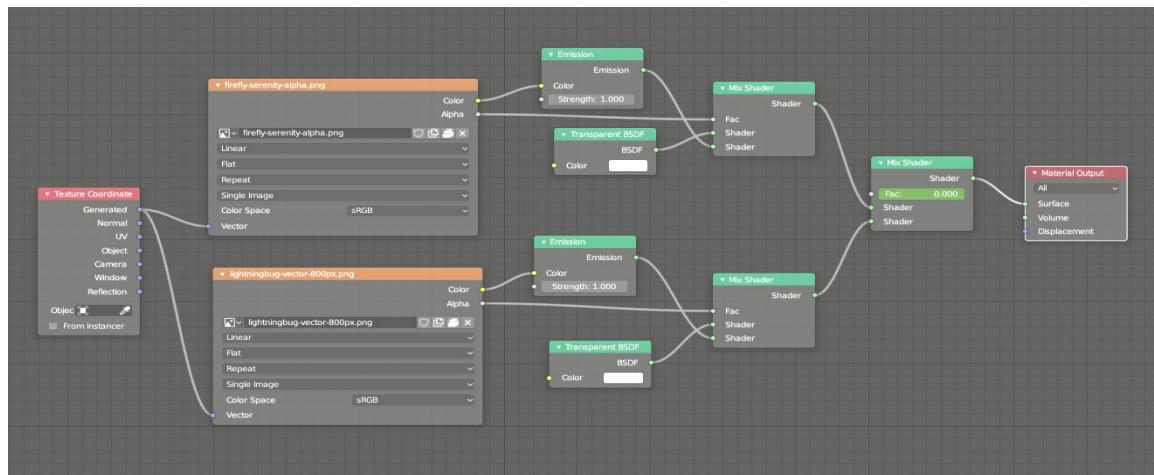


Channel > Extrapolation Mode > Linear Extrapolation



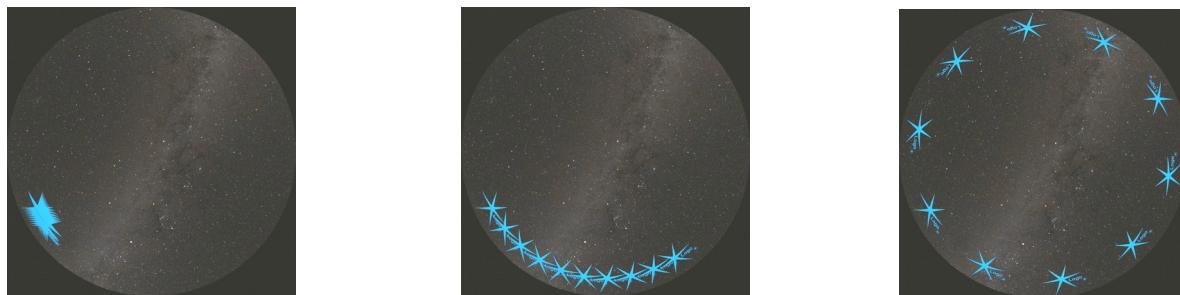
### Firefly Image (“Plane.ImageAlpha”)

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



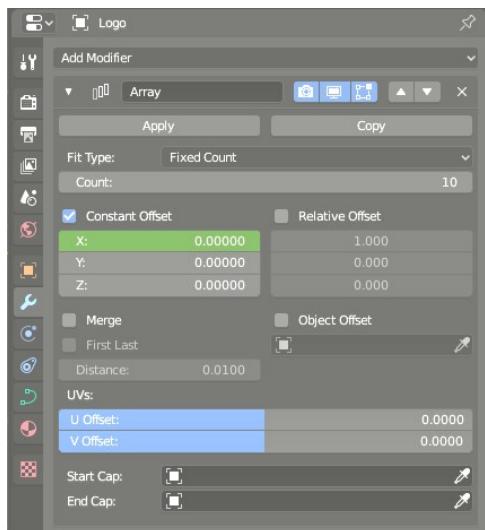


Copies of the logo appear and spread out in a circle around the center of the scene.

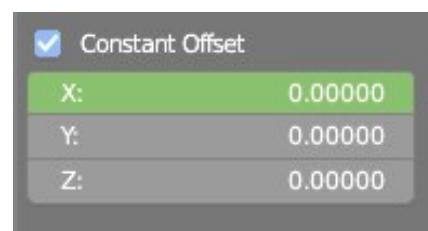


Two modifiers are applied:

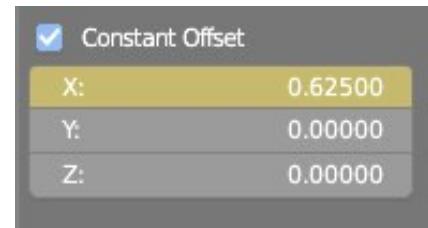
An Array Modifier makes instances of the logo object appear spread out at intervals.



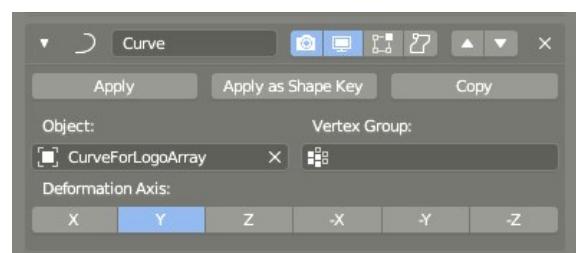
Frame 0



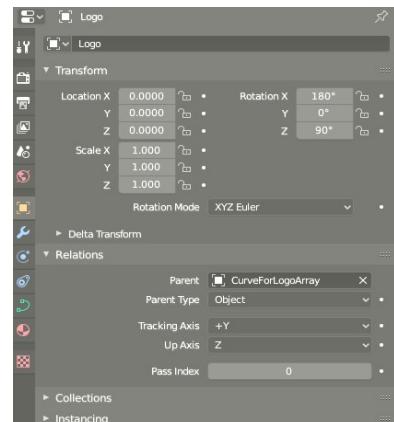
Frame 180



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



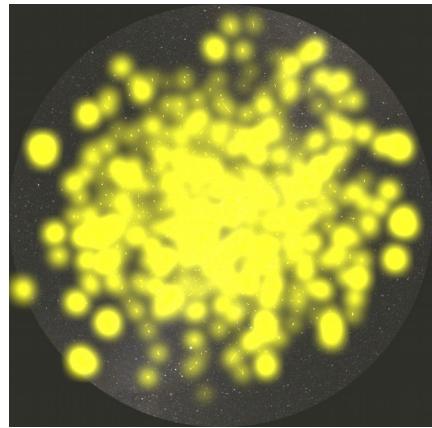
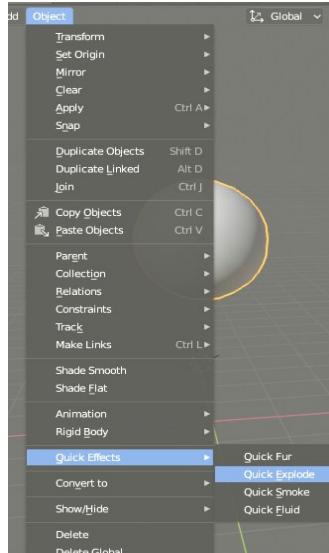
Note that the Curve, a Bezier Circle object, is set as the “parent” of the logo object.



### Sun Ball (“Sphere.Sun”)

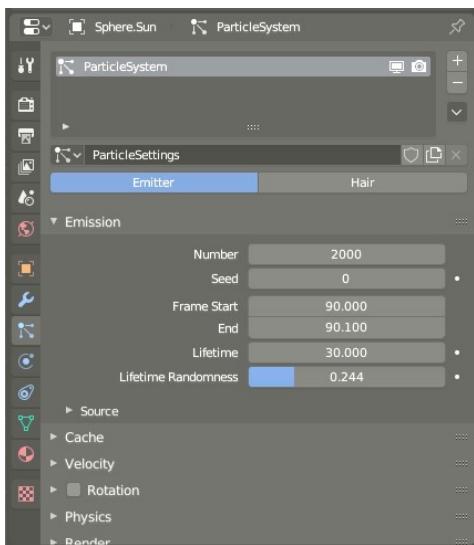
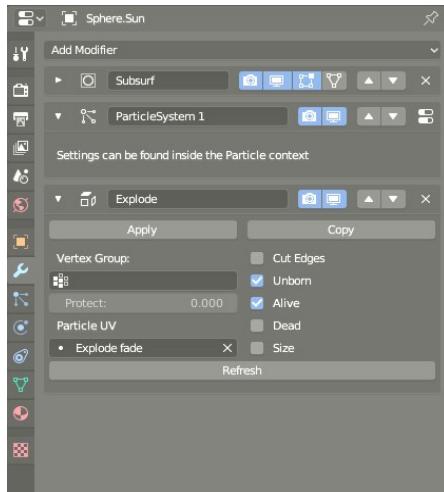
A cheesy but fun effect in which we blow up the Sun!

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.



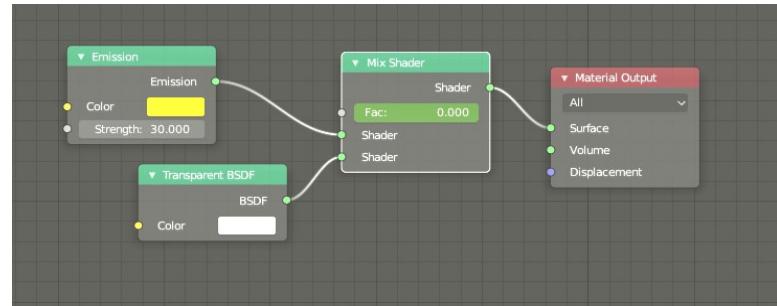
Object > Quick Effects > Quick Explode

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.



# Part 8: Notes on Video Output

Intro to Fulldome Production with Blender

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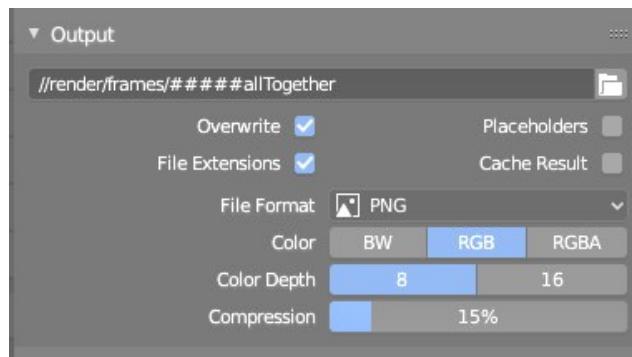
Your fulldome system will have its own video setting requirements or may require special proprietary software to encode properly for your dome. Here are some notes that may help in choosing output settings when rendering from Blender.

## 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 Output 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.



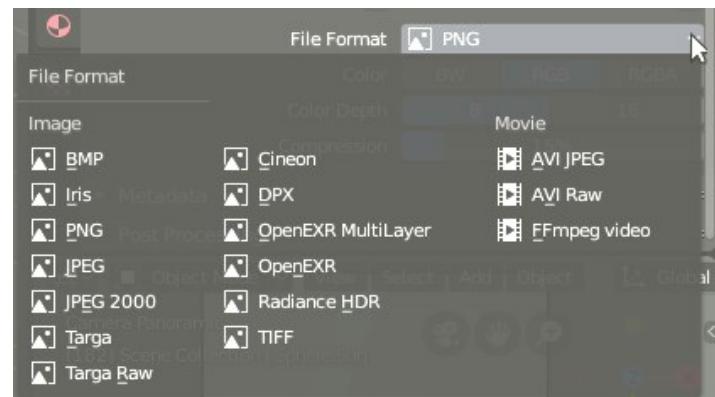
More information on Output Options can be found in the Blender online manual:

<https://docs.blender.org/manual/en/dev/render/output/index.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”



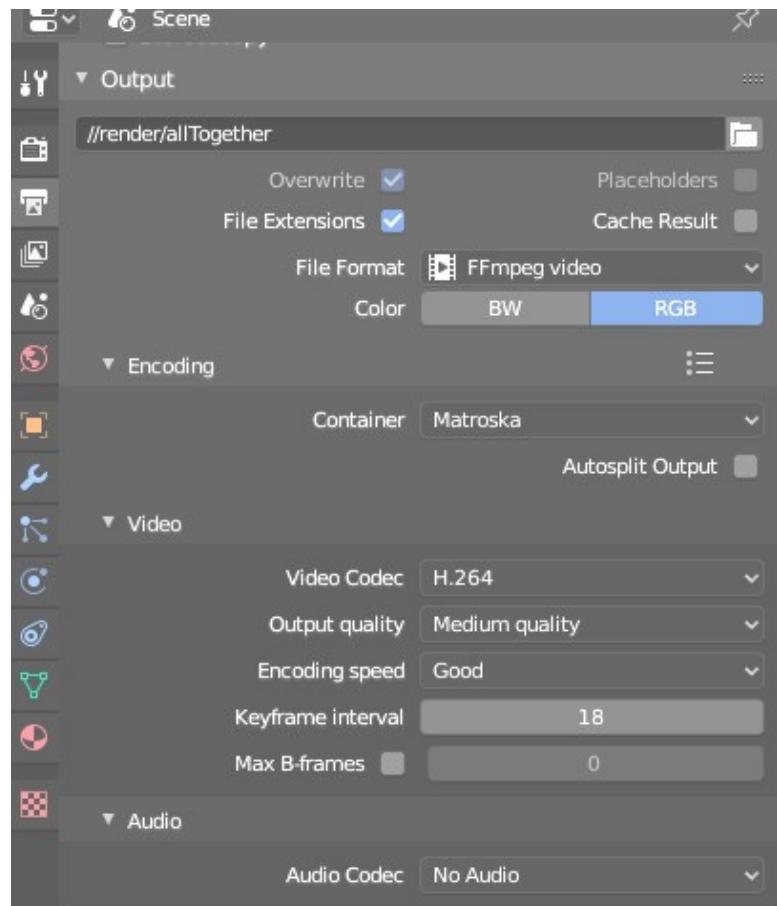
The Encoding panel is where you can select the Codec and associated parameters for your output.

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 Encoding presets.



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



When you find what works, create your own presets and save to your own startup file.



More information on Video Output can be found in the Blender online manual:  
[https://docs.blender.org/manual/en/dev/render/output/file\\_formats.html#video-output](https://docs.blender.org/manual/en/dev/render/output/file_formats.html#video-output)