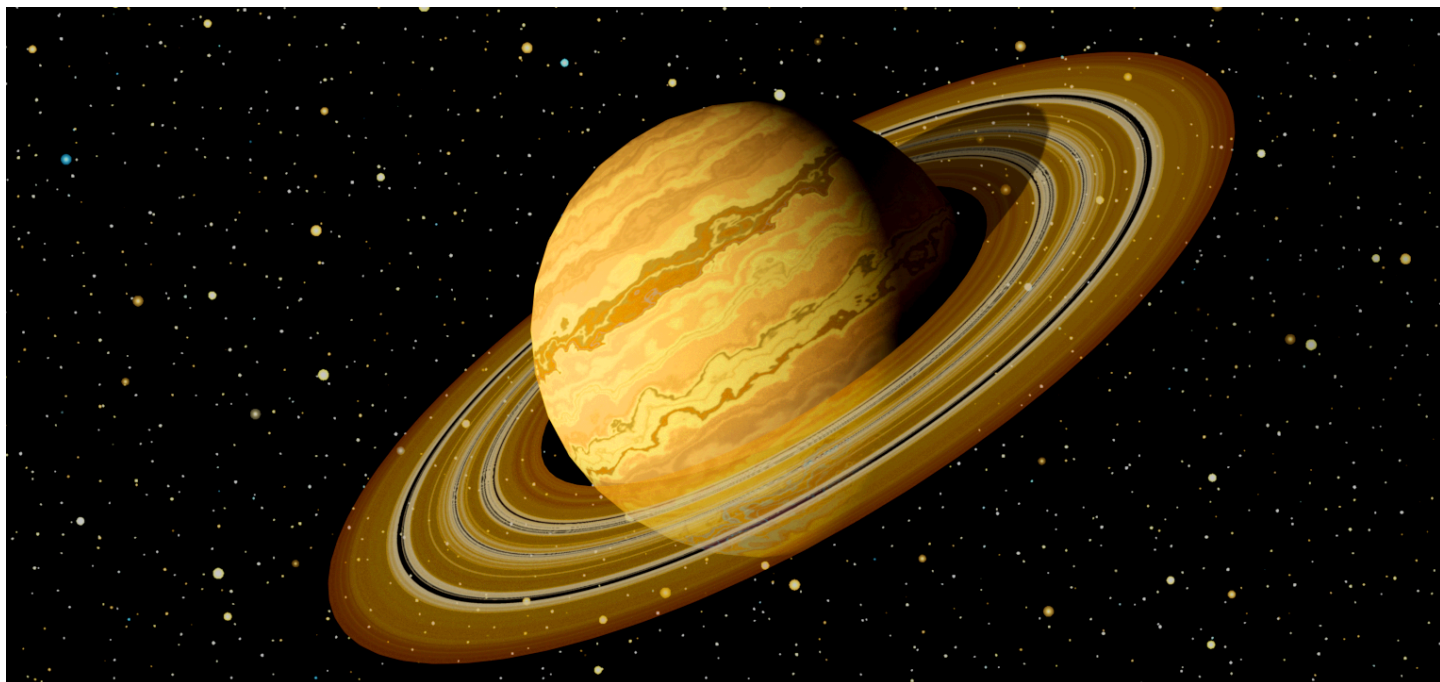


Planetary Rings

A shader plugin for Cinema 4D



Introduction

If you are creating a space scene, and you want a ringed planet in it, you can use Cinema 4D's inbuilt Planet shader, set to 'Saturn's Rings'. Unfortunately this is severely limited in what you can change (i.e. nothing) and the results are very ordinary.

This shader is an attempt to get better results without having to use a bitmap obtained from somewhere. It is fully procedural and is highly configurable.

Installation

Install the plugin in the usual way. When you run Cinema, this plugin is a channel shader. You can find it in the list of shaders when creating materials, in the 'plugins' sub-menu.

Basic principles

A material using this shader is intended to be applied to a Disc object. The Disc object should be circular if you want circular rings (as you probably would) but you can make it editable then use the Scale tool to scale it on one axis, in which case you will get elliptical rings. Who knows? Some planet, somewhere, might have elliptical rings...

For best results, the shader needs to be present in the material's color and alpha channels. It is not usually recommended to place the shader in the luminance channel. The reason is that you would normally want the planet at the centre of the rings to cast a shadow on them, but this won't happen if the shader is only in the luminance channel. You can, however, add it to both color and luminance if you need to. There is one issue where you might want to do just that - see the 'Casting shadows on the rings' section below.

Why do you need the alpha channel? If you look at images of ring systems, there are characteristic gaps between the various rings. You would want to see stars and other objects through those gaps, so they need to be transparent; this requires the shader to be placed in the alpha channel as well as color.

Of course, you can apply the material to any object but the results may not be very useful.

Colour and gradient modes

Rather than go straight into looking at each option, it's probably easier to start by looking at the various modes of operation. The first decision is which colour mode to use. Figure 1 shows the disc which will be rendered to show rings (the background is generated by StarScape):

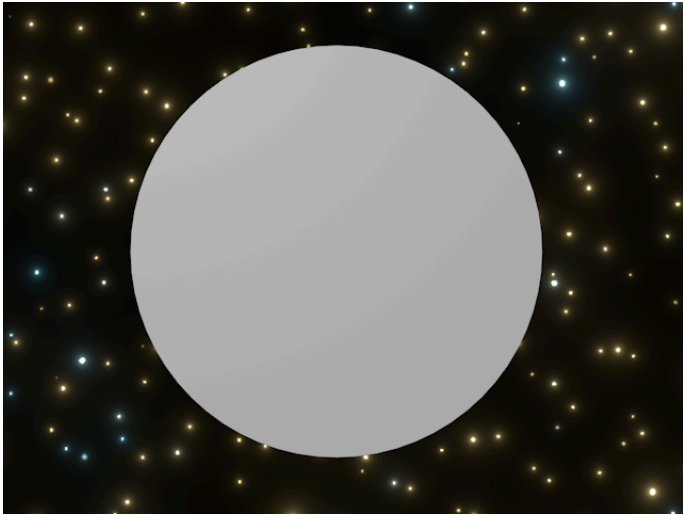


Figure 1. Basic disc before adding shader

Adding a Planetary Rings shader to the colour channel of an empty material, the colour mode is selected in the 'Color Mode' setting. The default option is 'Use Gradient' where the rings' colours are selected from a gradient. At this point let's choose a very simple (and wholly unrealistic!) red to blue gradient like this:

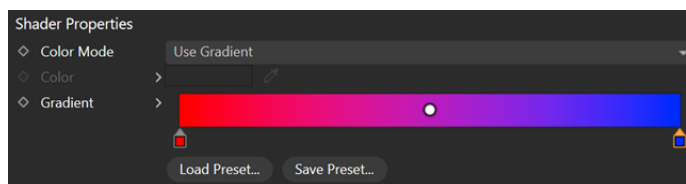


Figure 2. Simple red-blue gradient

Now there's another choice to make - the method used to select a colour from the gradient. The simplest choice is 'Distance'. Here, the colour selected is chosen by the distance of the ring from the centre, so we get exactly the result we'd expect:

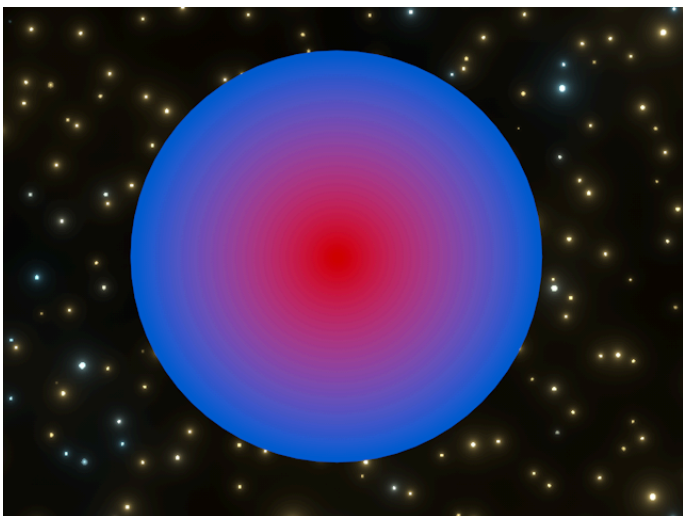


Figure 3. 'Distance' mode using the red-blue gradient

Planetary Rings

This is not exactly exciting or indeed looking like rings! This mode does have one real advantage though: if you want to have exact control over how many rings there are, their width, the gap size between them and the colours used, this is the mode to choose. The downside is that you spend a lot of time designing and tweaking a gradient. This example uses one of the gradient presets supplied with C4D, which looks like this:

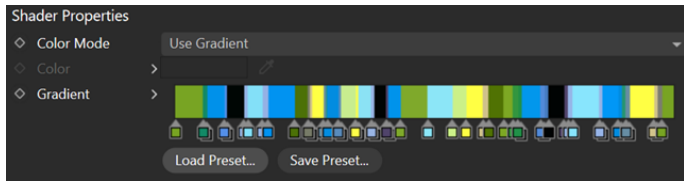


Figure 4. A more complex gradient

As you can see, it's a complex gradient with many knots. Some of the knots are black, and this is where the gaps between the rings will appear. The rendered result looks like this (still in Distance mode):

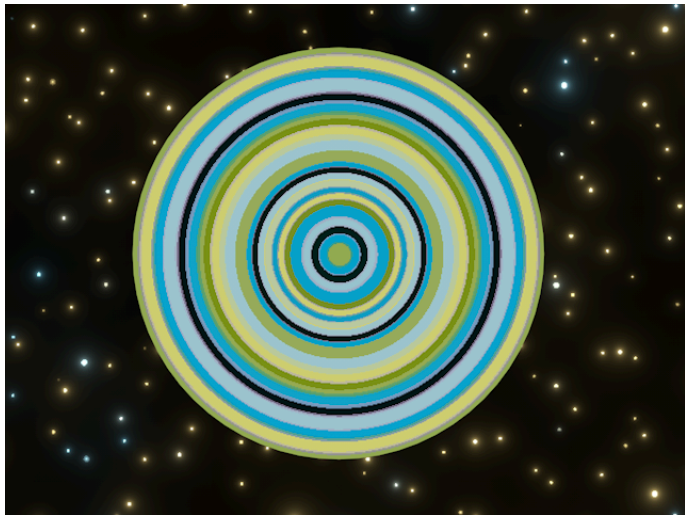


Figure 5. The complex gradient rendered as rings (Distance mode)

The colours follow the pattern from the gradient and ring gaps (black areas) appear exactly where expected.

Let's go back to the red-blue gradient. One thing you will have noticed is that there is no 'hole' in the centre of the disc where the planet would be. We can fix that easily enough by increasing the inner radius of the Disc object. If we do that, we get this:

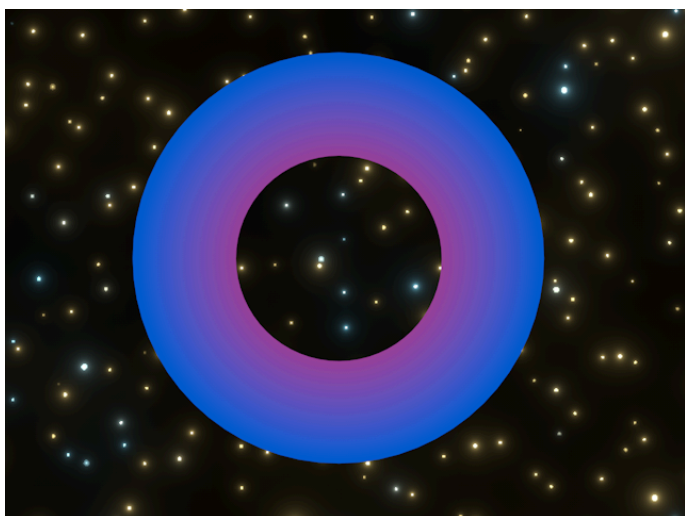


Figure 6. Red-blue gradient with the disc inner radius set to 50% of the disc radius

One slight problem: we've lost most of the red colour and the object is now mostly blue. There is a setting called 'Inner Cutoff' which fixes this. Increasing that value to 50% gives this:

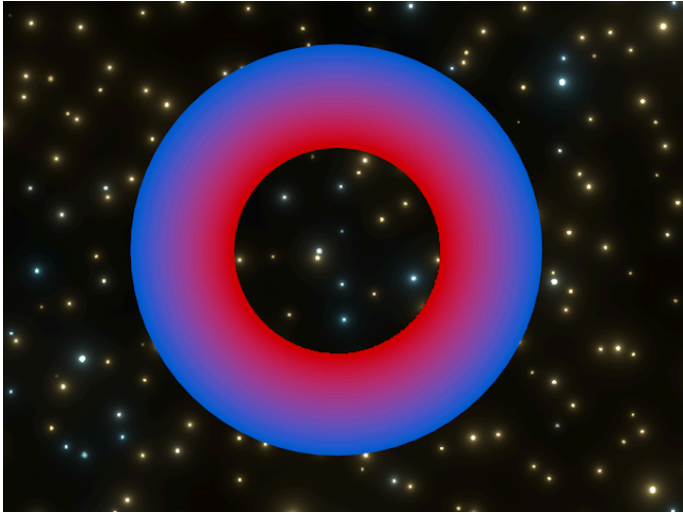


Figure 7. Inner Cutoff value set to 50%

Now we've got the full gradient back, because it has been compressed to fit in the visible part of the Disc object.

Note: you can use 'Inner Cutoff' in any mode but it only compresses the colour gradient in 'Distance' mode.

So, we can design a ring system using a complex gradient, but you could do that without this shader by using a circular gradient. The next mode is the most useful, and that is where the 'Gradient Mode' is set to 'fBm Value'. In this mode, colours are selected from the gradient using a fractal function. If we change the blue colour to black, then still with default settings we get this:

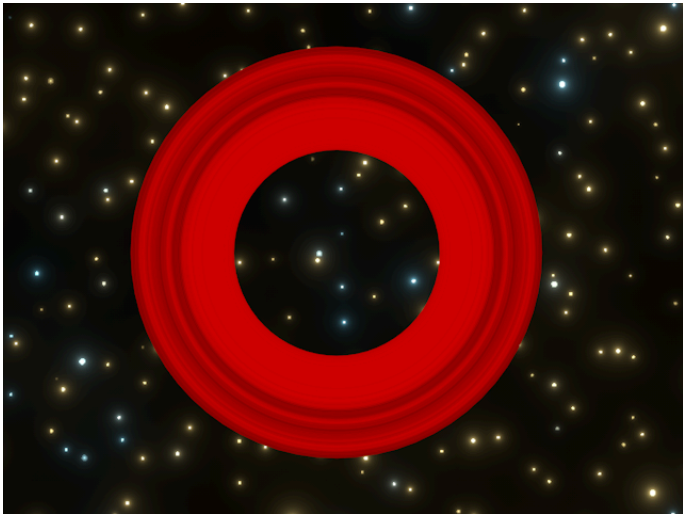


Figure 8. Using fBm Value mode with a red to black gradient

Now we're just starting to see the beginning of a ring system. This is a very simple gradient with only two knots; the default gradient used by the shader is more complex and gives better results as shown in Figure 9 below.

From now on, we'll use this default gradient as results are much better. It still contains only six knots compared to the complex gradient in one of the examples above. You can alter the ring system with various other controls as discussed later.

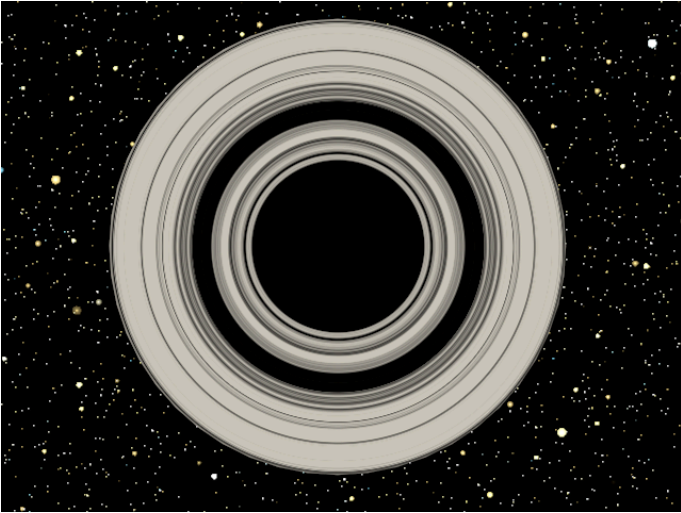


Figure 9. *fBm Value mode using the default gradient*

If you look carefully at the above image, there's a problem. First, the rings are completely opaque - you can't see any stars through them. In reality, you should be able to do so because rings are not solid. Secondly, where there are gaps in the rings you can't see any stars there, either. To test this out, increase the 'Inner Cutoff' to 100% and you see this:

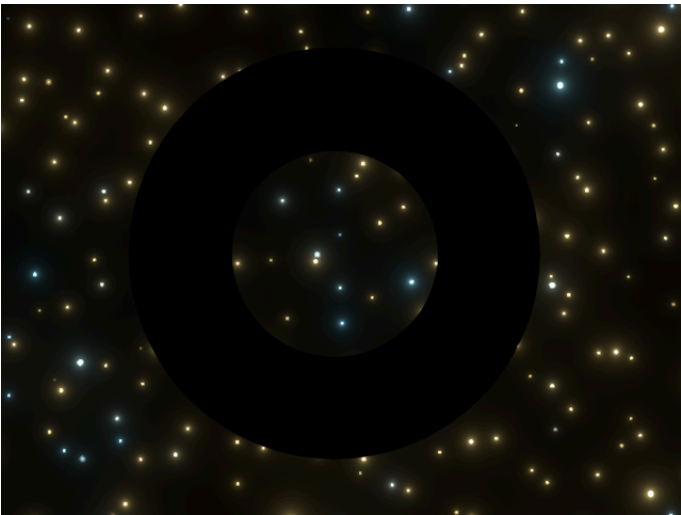


Figure 10. *As in Figure 9 but with Inner Cutoff increased to 100%*

You can see stars in the centre of the rings, because the Disc object has its inner radius set to greater than zero, making a hole. But then there is a black ring where nothing is visible. That's not right, and to fix these problems we need to use the alpha channel.

The easiest way to do this is to enable the alpha channel, add a Color shader which by default will be white, and reduce the brightness of the Color shader. In Figure 11 below the brightness is set to 50%.

Now the stars are visible through the rings - you can change the transparency by changing the brightness of the Color shader - and in the black gaps between rings. You can use the alpha like this in any mode. You could use the transparency channel instead, but an alpha is preferable because then you can save the alpha channel and use it in post if you need to. If you don't need to do that, you can just use transparency if preferred though it's probably a good idea to set its refraction value to 1.0, to avoid possible distortion.

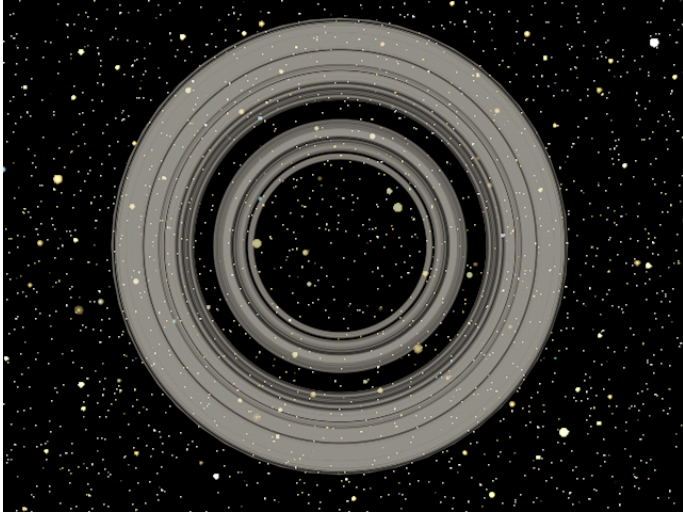


Figure 11. As Figure 10 but using a Color shader in the alpha channel

When it comes to saving an alpha, there's a problem. If you just use the Color shader as shown above, the alpha channel when saved looks like this:

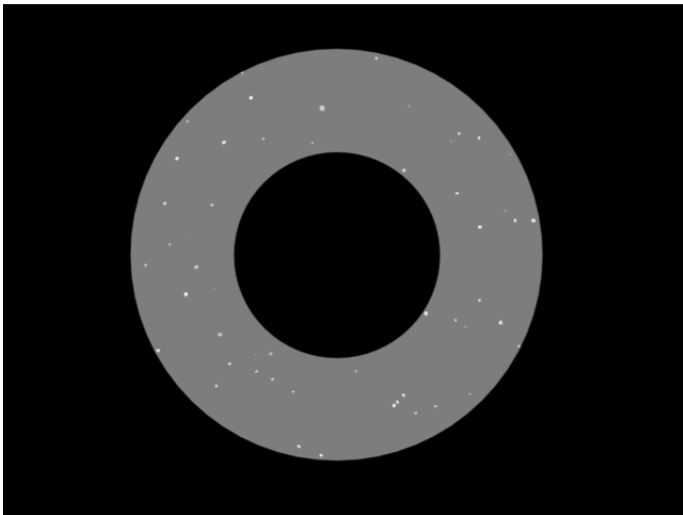


Figure 12. Alpha channel from the image in Figure 11

Which might be all that is required. But if you want a more detailed alpha including the light and dark areas of the rings, you can do it by copying the Planetary Rings shader in the colour channel to the alpha channel. This gives you much more control over the alpha than the simple Color shader does. You can alter the alpha shader as much as you like, and you don't have to use the same gradient or settings. If you do this, the alpha channel when saved looks as shown in Figure 13.

It's up to you which method you prefer. For convenience, there is a button labelled 'Copy to Alpha' at the bottom of the interface. This is only usable if the shader is not in the alpha channel itself; all it does is copy the shader in its entirety from the colour (or luminance or whatever) channel to the alpha channel.

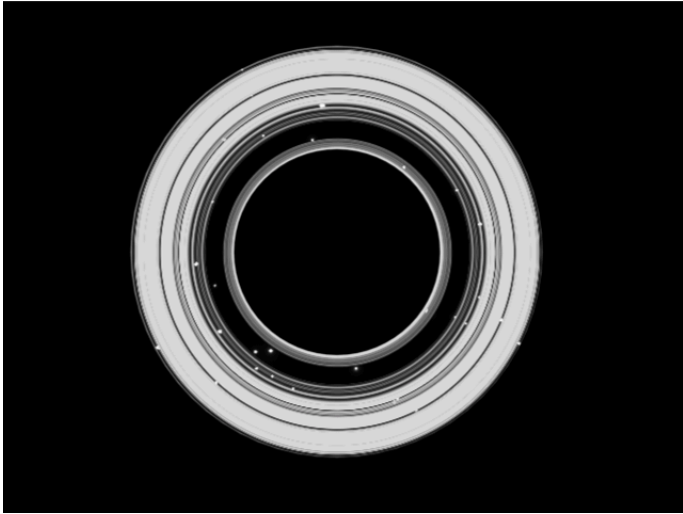


Figure 13. Alpha channel from the image in Figure 11 when the rings shader is used to generate the alpha

So far, we've used only the Gradient colour mode, but there is another mode - 'Single Color'. Instead of a gradient, a single colour which by default is a pale, grey-yellow, is used. In this mode, the same fBm fractal is used but this time the colour returned is always the same and the fractal returns different brightness values. Using a single colour sounds restrictive but you don't get a single, solid colour from this. Where the brightness returned from the fractal is very low, there appear to be gaps in the ring network, as you see in Saturn's rings. If all you want is a simple ring system, as seen here, a single colour is all you may need as shown in figure 14.

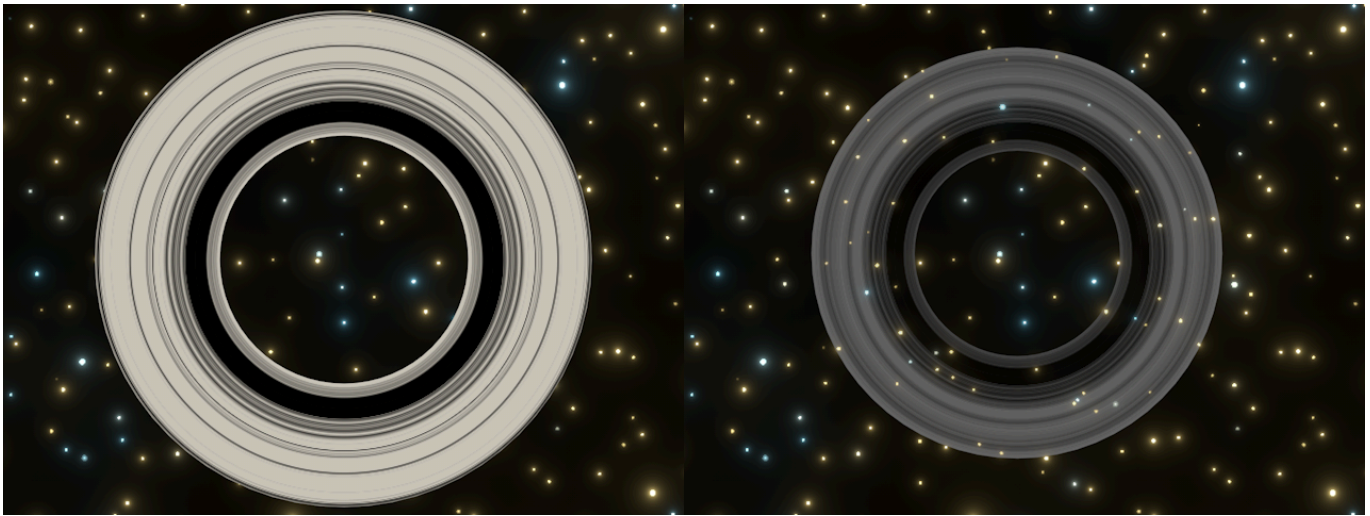


Figure 14. Single colour mode with no alpha channel on the left and with a simple Color shader in the alpha channel on the right

For another example, consider the rings of the planet Uranus. These are very thin and mostly blue, so an image like this can work well with a single colour. This is shown in Figure 15.

As with gradient mode you can copy the shader from the color channel into the alpha channel if preferred. Copying the shader may, depending on the colour used, make the ring colour more muted and the ring more transparent, so some thinner rings may disappear. This is easily fixed in the alpha channel: in single colour mode, change the colour to a brighter one, or, in either single colour or gradient mode, simply increase the brightness setting in the shader. Then the rings will become brighter, colours more saturated, and smaller rings reappear, but the rings become less transparent. You can use the transparency channel to fix that if required; then you have the advantage of an alpha channel, if needed, with the desired transparency for the rings which won't affect the alpha.

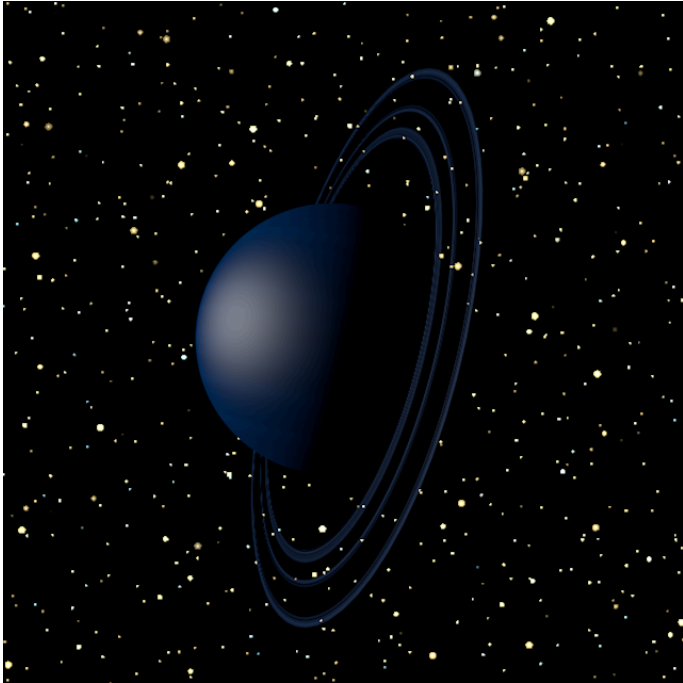


Figure 15. Uranus-like rings using single colour mode

Adjusting transparency therefore can often be done with the alpha channel alone. However, the adjustments to the alpha channel depend on the colours being used, so that brighter colours may require you to reduce the alpha channel brightness rather than reduce it. Sometimes, you have the colour and brightness just right, but the rings are too opaque. If that happens, you can simply enable the material's transparency channel and adjust the 'Brightness' setting. Be sure to set the 'Refraction Preset' to 'Custom' and the 'Refraction' to 1, or the stars or other objects seen through the rings might look very odd.

Summary

If the above seems complex, it really isn't. What it comes down to is this:

1. Choose a colour mode.
2. Set the desired colour or gradient.
3. Adjust the other rings settings as shown below.
4. Add an alpha channel (optional).
5. Adjust transparency if needed (optional).

That's basically it. Several examples are supplied in the downloaded archive so you can see how it works.

Reference

This section lists all the various settings and what they do.

1. Color Mode

There are two options for setting the ring colour, 'Single Color' and 'Use Gradient', which are explained above.

2. Gradient Mode

When using a gradient, this setting determines how a colour is selected from the gradient. The first option is 'Distance'. For each point in the rings, the distance from the centre of the disc is calculated and then used to choose a gradient colour. So points at the centre will have the colour from the left-hand end of the gradient, while those on the outer edge have the colour from the right-hand end of the gradient.

Important: if the 'Inner Cutoff' value is greater than zero, the distance calculated is from the disc centre plus the cutoff value, causing the gradient to become compressed into the visible area. This only applies in distance mode.

This mode is best used if the planet is at a distance in the background. Since there is no fussy detail, which you wouldn't expect at distance anyway, it can look very good.

The alternative to 'Distance' is 'fBm Value'. This uses a fractal function to return a value in the range 0 to 1. This is then used to select a colour from the gradient; the lower the value, the more the colour tends towards the left of the gradient. This mode looks better in closeup, but not so much at a distance where a lot of the detail is lost and the result can simply look noisy.

Most of the remaining parameters are available in both single colour and gradient colour modes, with a couple of exceptions.

3. Definition

Roughly speaking this is a measure of how many individual rings you will see and how well defined they are. This is always a trade-off between a few, soft-edged rings and many, hard-edged rings. For example, using one of the C4D preset gradients, we get these results with a definition setting of 50%, 75% (the default) and 90%;

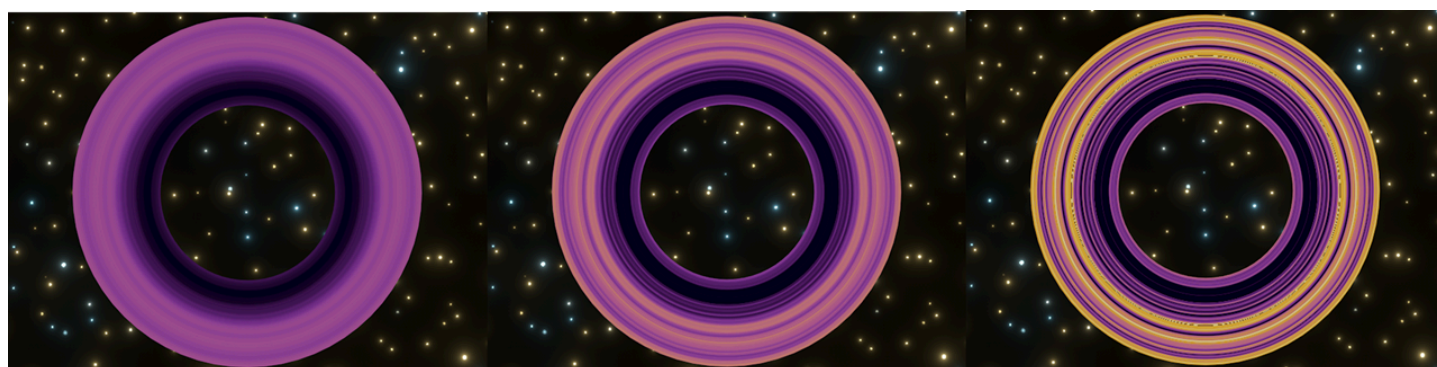


Figure 16. 'Definition' values 50%, 75%, and 90%

You can see the difference in ring definition quite clearly. As a rule, a setting of below 50% is not that useful, whereas above 90% the rings get noisy and you may start to see moire patterns. Low definition values are best for rings in the distant background, while high values are best for close-up renders.

This setting is not available when using gradient mode set to to distance.

4. Low Clip and High Clip

These are only available in single colour mode. Any value returned by the fractal which is lower than the low clip setting will be rendered as zero brightness (i.e. black); any value above the high clip will be rendered as 100% brightness.

Low clip is particularly useful as increasing it will reduce the number of rings and better define the gaps. Lowering the high clip will not increase the number of rings but will cause them to become brighter (and wider, reducing the gaps).

5. Inner Cutoff

A planet's rings start somewhere outside the planet atmosphere. This means that the ring system should leave a hole for the planet plus atmosphere. You can do this by increasing a Disc object's inner radius but if that's not possible, or you are using some other object, such as a Plane object, you can cut out the hole using this setting. Any point closer to the object's centre than this value will be rendered black, so it can be used in an alpha channel as well.

This setting does have an effect on the colour of the rings, which can be summarised as follows:

- single colour mode: no effect, as there is only one colour
- gradient in fBm value mode: no change to colours
- gradient in distance mode: the colour gradient is compressed into the remaining visible space on the object (i.e. that which is outside the inner cutoff)

6. Octaves

This is a measure of the complexity of the fractal function. Generally, a lower value results in fewer rings and the boundary between them is soft and blurred. With higher values, you see more and narrower rings with harder boundaries. Contrast these images, the first with 4 octaves and the second with 8:

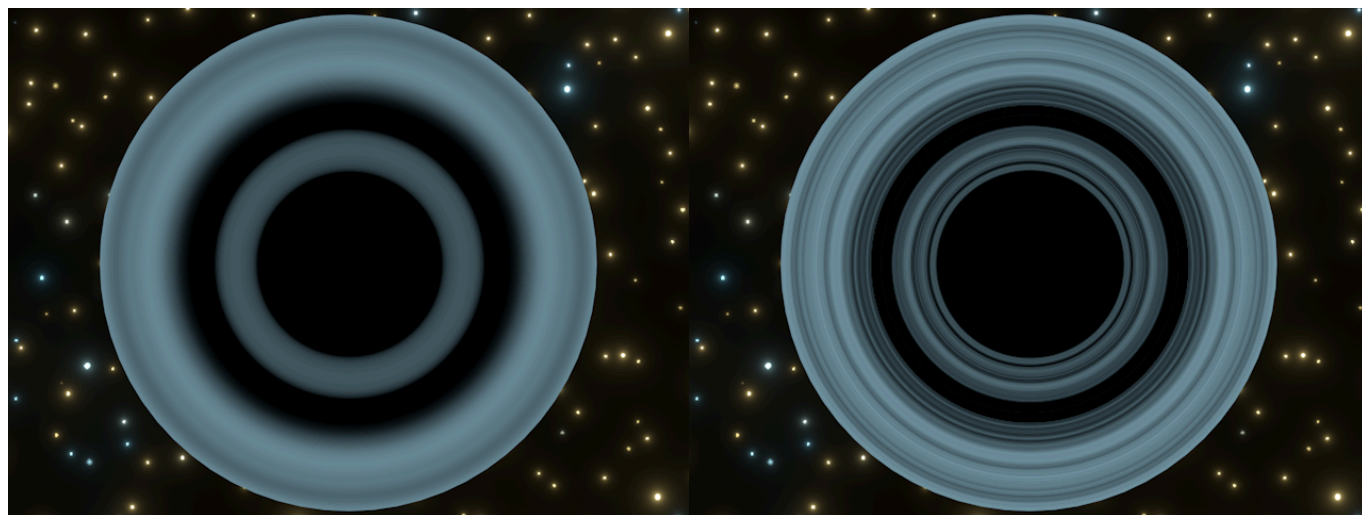


Figure 16. 'Octaves' values of 4 and 8

For most purposes anything less than 4 octaves isn't very useful, while you won't see much difference above 9 octaves unless you are looking at the rings in extreme closeup, where higher values may deliver more detail.

7. Lacunarity

Another way to alter the fractal result. For most purposes, you can leave this at 2. Altering this value even by a small amount can have a profound effect on the result. As with octaves, lower values produce fewer and softer

rings, and higher values do the opposite.

Changing the lacunarity can have a very useful effect for close-up renders. In this image, the lacunarity is at the default of 2, but the definition has been increased to 90% give more detail in the ring system:

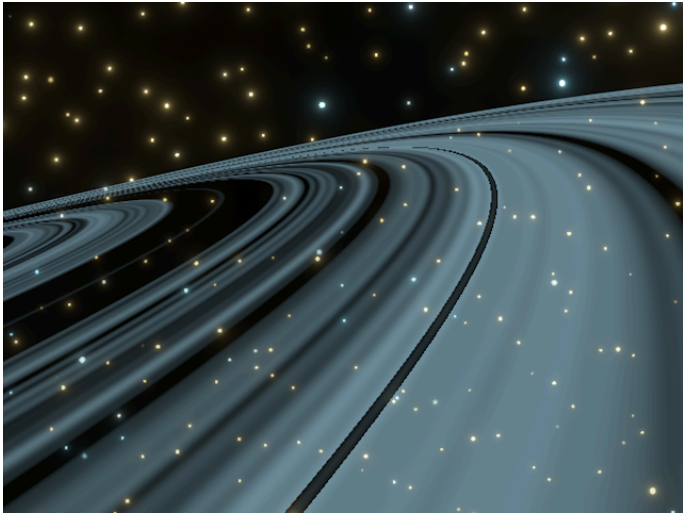


Figure 16. Close-up render with Lacunarity of 2

This is okay, but in reality the rings aren't solid structures but made up from large numbers of pieces of rock and ice. We can simulate this by increasing the lacunarity to 6:

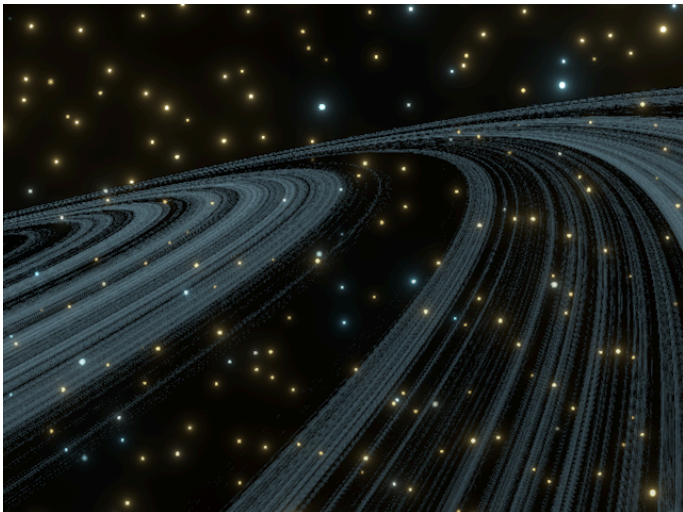


Figure 17. Close-up render with Lacunarity of 6

The ring structure has changed. but more to the point, each ring no longer looks solid but more as though they are made up of fragments.

8. Offset

Perhaps you like the number and colour of the rings, but not the pattern produced. What this value does is offset the position used by the fractal to select a colour (or brightness in single colour mode). If you look at the image in Figure 17, you can see that there is a wide gap between the inner and outer rings. If you'd prefer that wasn't there, we can offset the fractal position. The same render with a 20% offset is shown in Figure 18 below.

You can use the offset value to change the ring pattern if you don't like what the other settings produce.

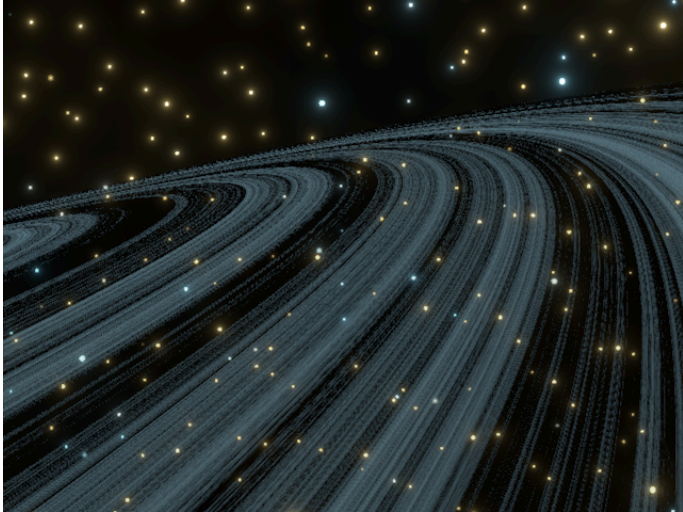


Figure 18. Same image as Figure 17 but with an 'Offset' of 20%

9. Color Shift

Suppose the gradient chosen is this one (a preset supplied with C4D):

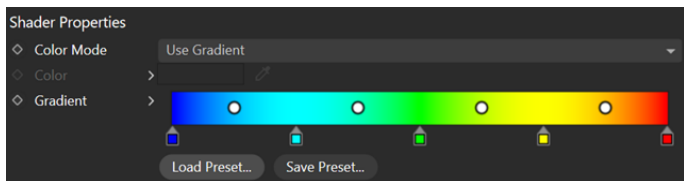


Figure 19. Colourful gradient

When used with all the default settings, we get this result (no alpha was applied):

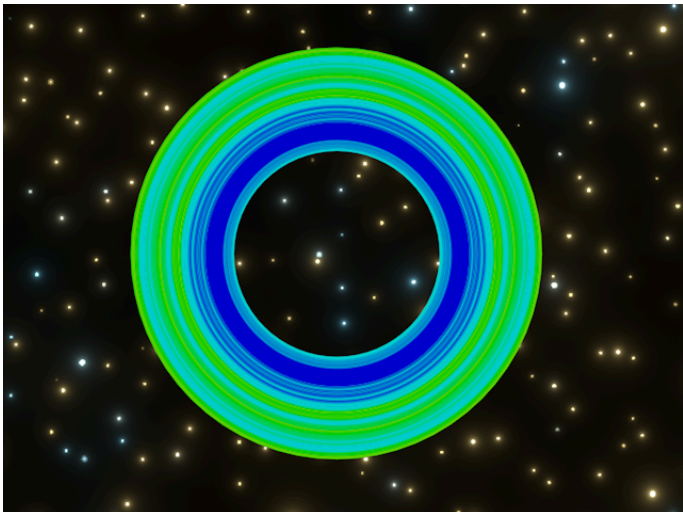


Figure 20. Using the gradient from Figure 20 with a 'Color Shift' of zero

We can see that the colours returned are mostly from the left side of the gradient; there are none from the right side. If this happens, you can shift the colours to the right using this setting. In the images in Figure 21 below, the colour shift has been set to 20% and 50% respectively:

Use this carefully. Values which are too high will mean that all the colours come from the right of the gradient.

Note that you can use this setting with single colour mode but the color isn't changed, only the brightness.

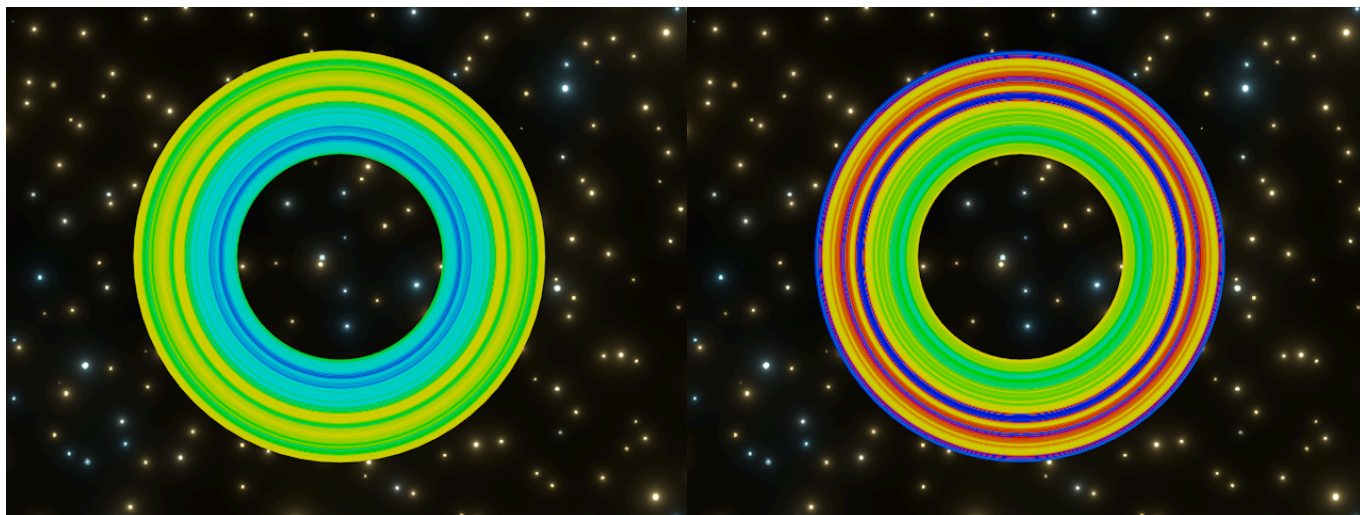


Figure 21. Same gradient as Figures 19 and 20, but with 'Color Shift' values of 20% and 50%

10. Wrap Shift

This is used in conjunction with the Color Shift setting. If you have a high shift value, the index into the gradient may exceed the maximum value (which is 1.0). Such values will only return the colour at the extreme right of the gradient. If this switch is checked, which it is by default, values greater than 1 will wrap round to the start and colours from the left of the gradient will be sampled. Compare this image where 'Wrap Shift' is off, to the above image with 50% colour shift:

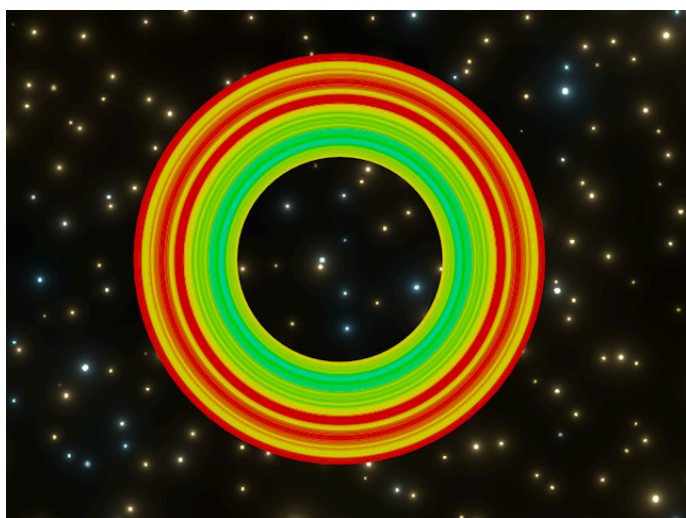


Figure 22. Same as the right-hand image in Figure 21, but with 'Wrap Shift' turned off

Now we've lost the blue colours at the left of the gradient, and if the colour shift was increased to 100% the ring colours would be almost entirely red.

This setting is not available in single colour mode because there it has no meaning since there is only one colour.

11. Colour correction

The next four controls are colour correction settings which are the same as used in any other software. Very briefly they are:

Brightness: alters the brightness of the rings; 100% gives maximum brightness, and -100% results in zero brightness (black).

Contrast: alters the contrast between different colours.

Saturation: alters the colour intensity; the brightness is unchanged but the colour looks more or less vibrant depending on the setting. If the colours are already fully saturated, increasing this value has no effect.

Gamma: alters the gamma value applied to the output colour.

12. Disable Reflectance

If turned on, this switch will automatically disable the reflectance channel in the material. It's only available in the Color channel to avoid conflicts if the shader is added to other channels (what do you do if the switch is enabled in Color but disabled in, say, Alpha?).

This switch is not available if Redshift is used. In that case you will need to disable reflection manually in the Redshift material.

Setting the number of rings

One problem with the system so far is that you cannot control how many rings you get unless you design a gradient accordingly. What if you just want (for example) 20 rings? With gaps between then that would require 39 knots! A simpler method is to use the 'Set Rings' settings and for this we need to use the gradient in distance mode. In that mode, without using 'Set Rings', the default gradient and settings produce this:

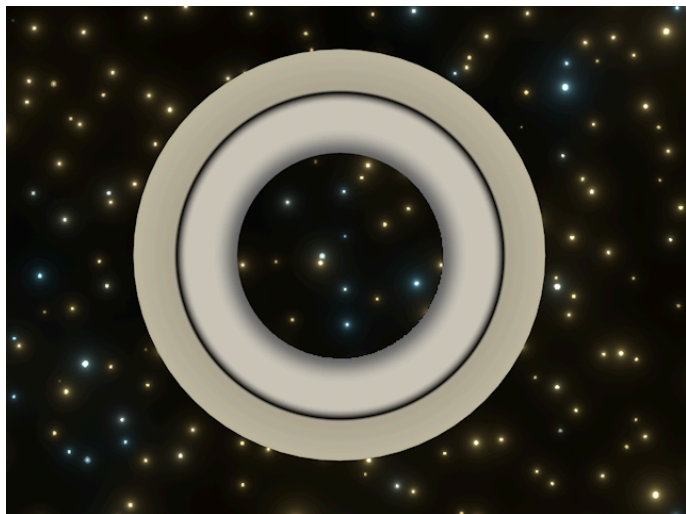


Figure 23. The default colour gradient in 'Distance' mode

There are two rings and a gap. Now, if 'Set Rings Count' is turned on, with the default settings we get this:

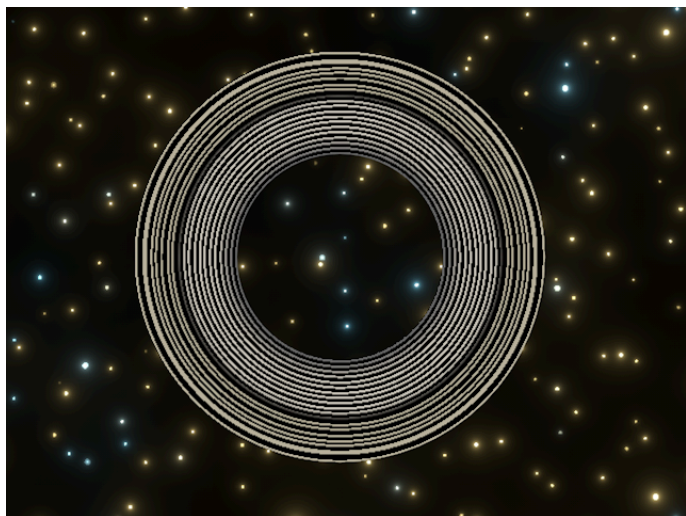


Figure 24. Same gradient as in Figure 23, but with 'Set Rings Count' turned on.

There are now 20 rings, because that is the value in the 'Rings' setting. Adjusting the gradient and tweaking

the settings we can get this:



Figure 25. Same scene as Figure 24, but with the 'set rings' parameters adjusted

Very importantly, note that this works best in close up. Distance shots tend to give a moire pattern if you have too many rings or the rings are too thin. You can reduce the moire effect by increasing the ring thickness, which may or may not be appropriate to your image, or by increasing image resolution (but then of course you have a larger rendered image and longer render times, which you might not want), or by improving antialiasing in the render settings. That is probably the best solution but again, will cause longer render times.

Note that using the denoiser will probably make things worse in this case, not better.

13. Set Rings Count

Turn on this switch to enable this mode. It is only available with the color mode set to gradient and the gradient mode set to distance.

14. Rings

The number of rings. Small numbers can be surprisingly effective, but generally the default value of 20 is fine.

15. Width

How wide the rings are. What works best here is up to you. You may want to increase this (and possibly reduce the number of rings) for distance shots. Very small widths work best in close up.

16. Pos. Variation

This setting varies the spacing out of the rings over distance. A value of zero means that the rings are evenly spaced. This doesn't look entirely natural, so a bit of variation in spacing looks much better. The default is 10%.

17. Width Variation

If greater than zero, adds variation to the width of each ring.

18. Seed

The seed value for the random number generator used in the spacing and width variation. You can change this if you don't like the variation pattern.

19. Copy Shader to Alpha

This button will copy the current instance of the shader to the alpha channel. Any existing shader in the alpha

channel will be permanently deleted (that is, it cannot be undone). The button is available in all channels except the alpha channel itself. It is not available in Redshift.

Tips for using the shader

1. Channels to use in the material

Having created a material, the shader can be added to the color or luminance channels. Color works best for the 'solid' rings but Luminance may work better for the thin rings when 'Set Rings Count' is turned on. It's up to you.

It is generally recommended that you turn off the Reflectance channel in the material. Reflection doesn't work well with this shader. Although planetary rings are reflective (if made of ice, for example) if you really need reflecting rings, you will need to adjust the reflection settings carefully.

2. The object to use

Normally, you would apply the shader to a Disc object. Assuming you want a planet in the middle of the rings, then you can set the inner radius of the disc to leave a 'hole' for the planet. You could use a Plane object instead. If you do, you will need to set the 'Inner Cutoff' value to make the hole for the planet. There would normally be a slight gap between planet and rings, so adjust the disc inner radius or inner cutoff accordingly.

Important: anything outside of the ring circles or inside the inner cutoff will be rendered black. With a Plane object, rendering at this point would show something like this:

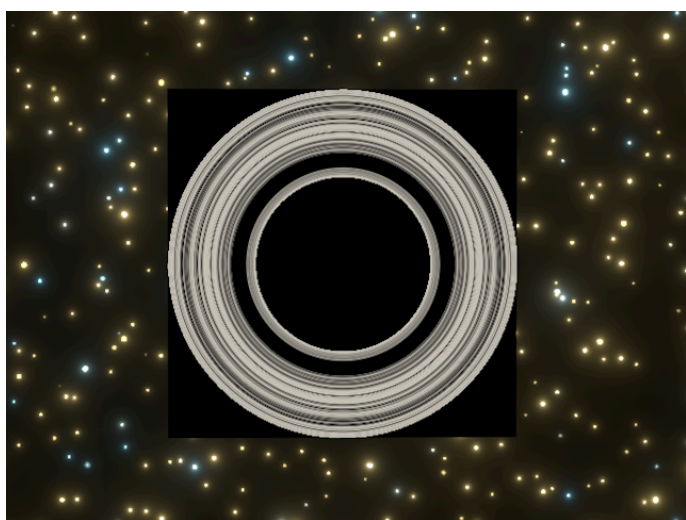


Figure 26. Using the shader on a Plane object rather than a Disc. Note the black rectangle which will require an alpha channel to remove it

Clearly, we need to get rid of that black rectangle, which means you will have to use an alpha channel. In this case a simple Color shader won't work correctly and you will have to copy the rings shader to the alpha channel. Then the use of a Plane object will work as expected.

3. Casting shadows on the rings

You would expect that the planet at the centre of the rings will cast a shadow on them. But see the image in Figure 27 below, where the shader is in the color and alpha channels.

You can see the shadow cast by the planet, but it looks as if a segment has been cut out of the rings, since you can see the stars very clearly in the shadowed area, even though the rings themselves are opaque. From the renderer's point of view, this is correct - no light is falling in the shadow area, therefore the shader can only return black, which in the alpha channel means completely transparent.

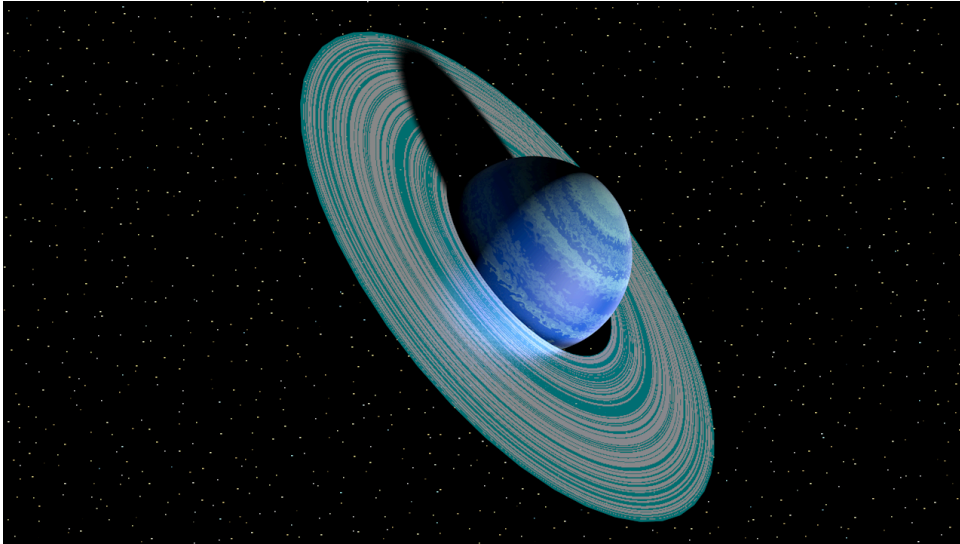


Figure 27. Planet casting a shadow on the rings

There are several ways to fix this. In order of simplicity they are:

a) Change the light shadow colour from black to grey, or reduce the shadow density. This works quite well, though you can still see some stars in the shadow area, but that doesn't matter if the rings are already partly transparent. Unfortunately changing the shadows may affect other areas in the scene. An example of the result is shown in Figure 28.

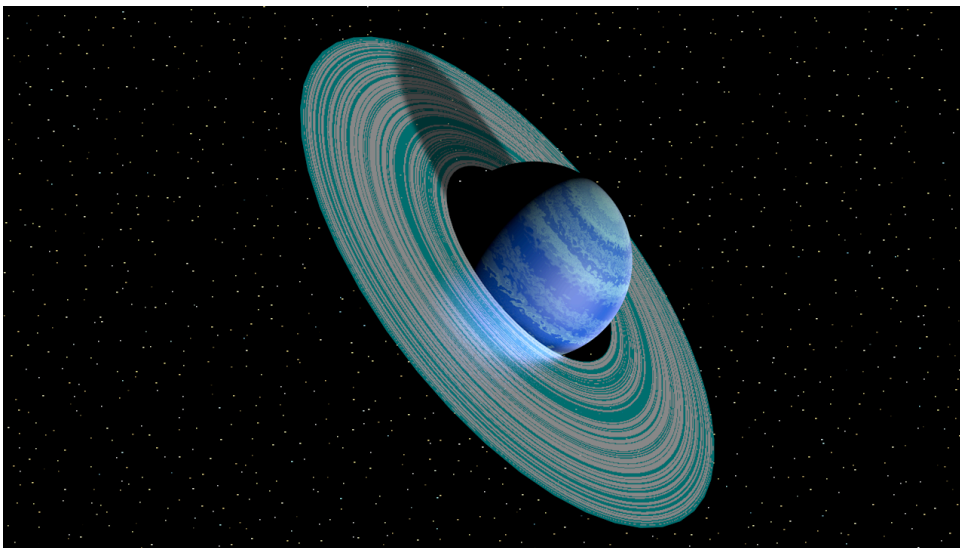


Figure 28. Reduced shadow density

b) Copy the shader in the color channel to the luminance channel and turn down the 'Mix Strength' setting. This produces good results, but makes the rings brighter; to fix this, reduce the 'Brightness' setting in the shader in the luminance channel. The example in Figure 29 below has a mix strength in the luminance channel of 10%.

c) Add another light to the scene, such as a spherical area light. Make sure shadows are off, and in the light settings ensure it only affects the rings object. Altering the light intensity will change the shadow darkness, but don't make it too low or the 'cutout' effect will be seen. Again, the extra light will brighten the rings to some extent and this can be reduced in the 'Brightness' setting of the shader in the color channel. The result is shown in Figure 30 below.:

You can use whichever method suits your render best.

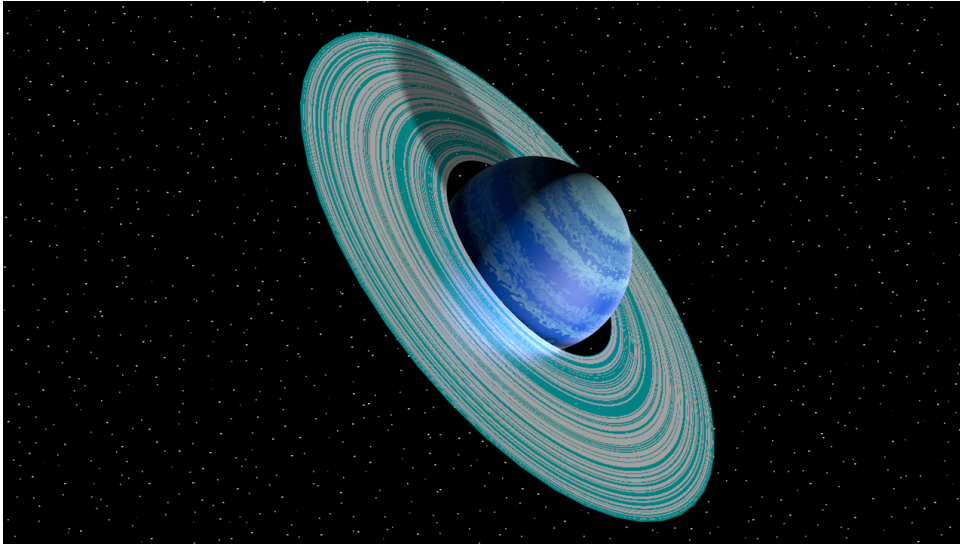


Figure 29. Using the luminance channel to reduce the shadow density

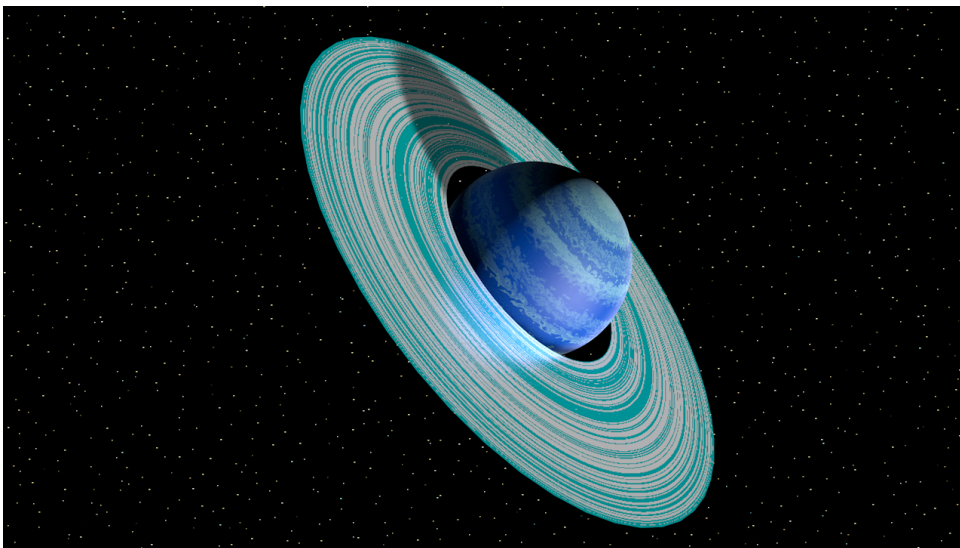


Figure 30. Using an additional light to light the rings object only

4. Illuminating rings from below

The rings don't transmit light, so if the ring object is lit directly from below, the underside of the rings are illuminated but the top is not. You can solve this in a couple of ways.

- a) Copy the shader in the color channel to the luminance channel and adjust the 'Mix Strength' setting as required.
- b) Or add a separate light to illuminate only the top of the rings, as described above in the shadows on rings section.

Again, it's a matter of choice but in general using the luminance channel in the material is the simplest method and gives good results.

Using this shader with Redshift

So far, the shader has been used in the standard renderer. It would be nice to create a Redshift shader to do the same, but currently that isn't possible (and may never be). However, you can still use the shader in Redshift - it just needs a few more steps.

The first thing is to add the shader to a Redshift C4D Shader Material. The process for this is explained in detail on my site at https://www.microbion.co.uk/html/blog31_01_25_c4dshader_redshift.php if you aren't sure how to do this.

This give us a node tree like this:

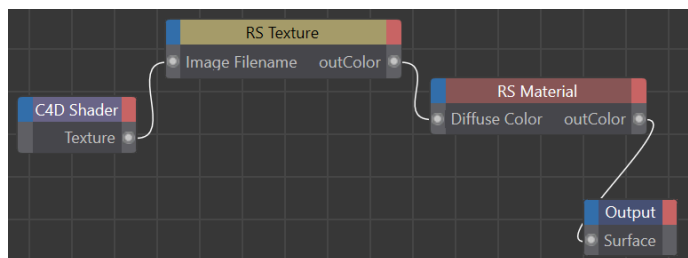


Figure 31. Node tree in Redshift to use the rings shader

And the result is as expected:

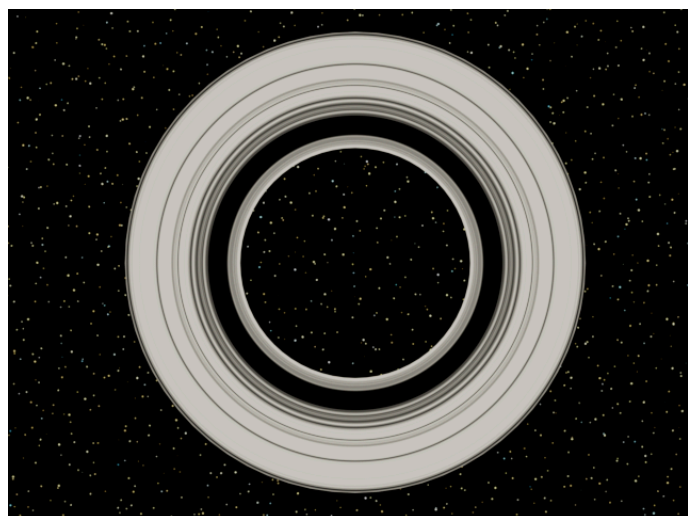


Figure 32. Default shader rendered in Redshift

The problem is how to achieve the necessary transparency. The simplest way is to use the Overall Opacity setting in the Redshift Material node:

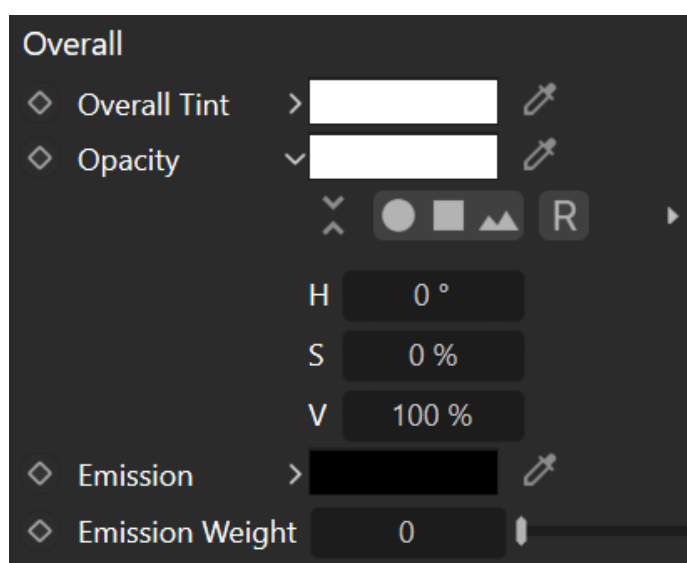


Figure 33. Reduce the 'V' setting to increase transparency

You can adjust transparency either by altering the opacity colour or (easier) turning down the 'V' value, which is the brightness of the opacity colour. Setting 'V' to 50% results in this:

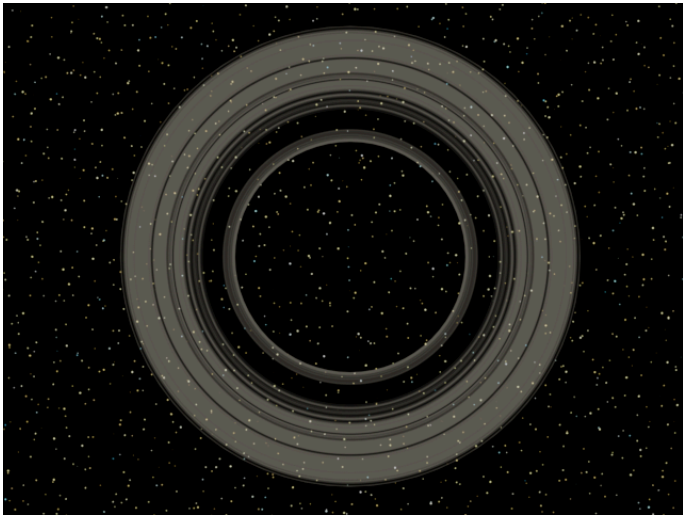


Figure 34. Same as Figure 32 with 'V' set to 50%

This is exactly the same as adding a Color shader to the alpha channel of a standard renderer material. But what if we want to use the rings shader as an opacity control in the same way as adding it to the alpha channel as described above? Redshift doesn't give us an alpha channel in the same way. You might think we could simply plug the C4D shader node into the opacity colour of the Redshift material, but doing that gives two more problems as seen here:

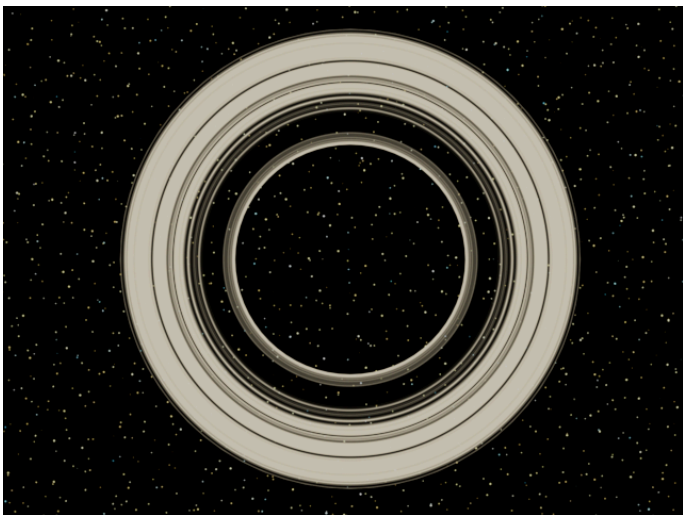


Figure 35. Using the rings shader to control opacity

There is not only a colour shift compared to Figure 32 but there's no transparency either. You can reduce the brightness of the rings in the rings shader but then the colour change is even more obvious and some of the rings disappear, as you can see in Figure 36 compared to Figure 34.

The way around this is to get the overall brightness of the rings shader and feed that into the opacity setting. We can do this by adding the red, green and blue values together and dividing by three, to give a single grayscale value. The node tree shown in Figure 37 will do that, and the result is shown in Figure 38.

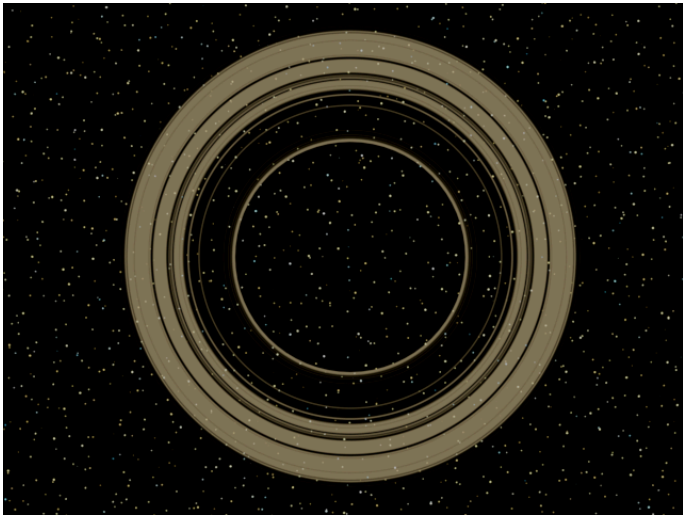


Figure 36. Same as Figure 35 but with reduced brightness in the rings shader

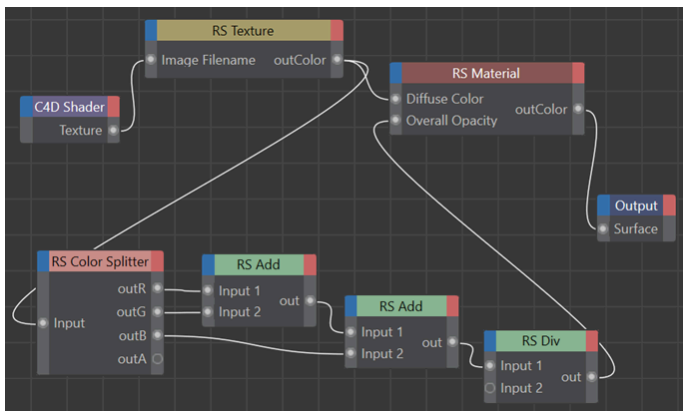


Figure 37. Using the brightness of the rings colour to control transparency

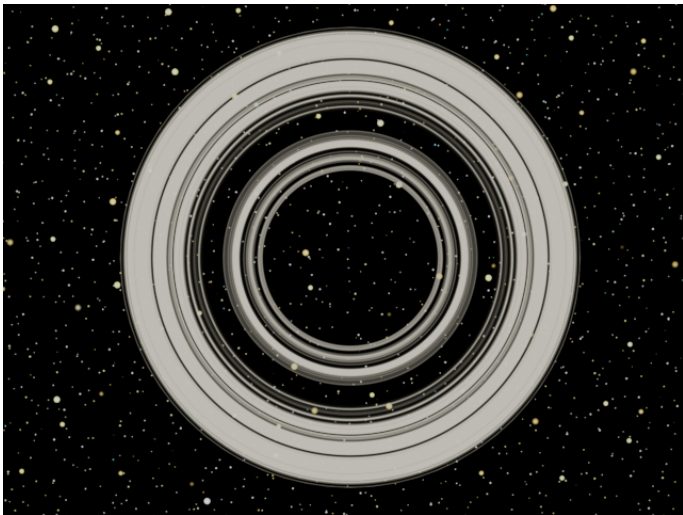


Figure 38. The result from the node tree in Figure 37.

You can see the stars in the gaps between rings but the rings themselves are opaque. To increase transparency we just need to reduce the value fed to the opacity control in the Redshift material, which we do by dividing the sum of the RGB values by a larger number than three. In Figure 39 the sum value was divided by 12.

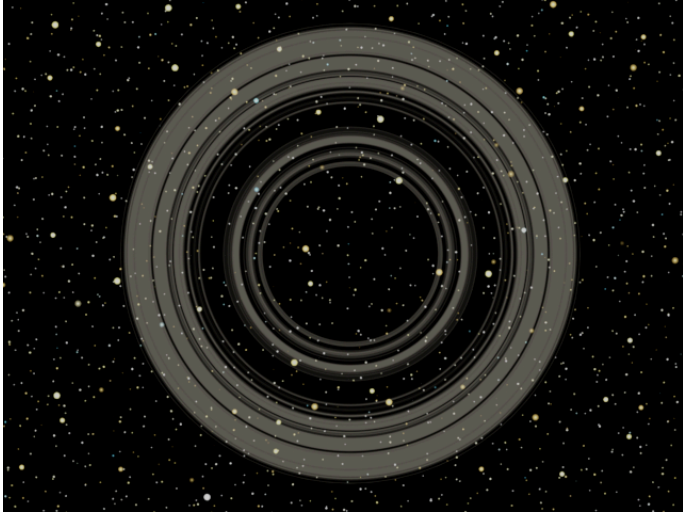


Figure 39. Increasing transparency by reducing the brightness of the ring colour

Finally we have a comparable render to that achieved in the standard renderer.

You can do exactly the same thing in the new Redshift node editor if you add a Reference node and drop the C4D Shader material into that. A sample file with such a node tree is included in the download.

Other than the transparency methods, the shader works in Redshift as it does in the standard renderer. In fact the banner image at the start of this manual was rendered in Redshift.

And finally...

I hope you find the Planetary Rings shader useful, perhaps in conjunction with the Gas Giant shader from my site. You can get the latest version from <https://microbion.co.uk/html/planettrings.htm> and if you have any comments (or find any bugs) you can contact me at <https://microbion.co.uk/html/contact.htm>.

Steve Pedler

March 2025