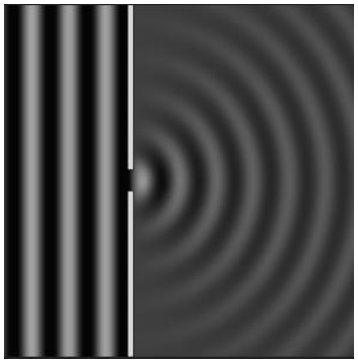
Mysteries of Photography #19: Diffraction

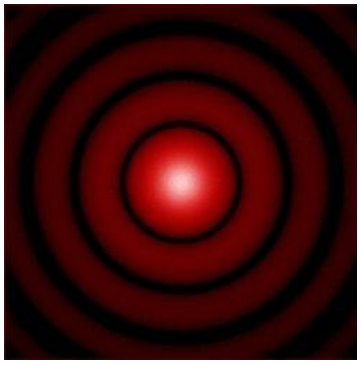
In the previous Mysteries, we discussed Refraction where light passing through a transparent medium at an angle to the surface will bend. This is the pencil in the glass of water effect, also the prism splitting white light into a rainbow.

Diffraction is a completely different kettle of fish. It is, in my opinion anyway, completely weird.

Light, as we discussed in an earlier Mysteries, is both a particle and a wave and can act like one or the other depending on how you look at it. Diffraction is dependent on the wave nature of light and it is what happens when light encounters a non-transparent edge.

In photography, we are interested in the special case when light is passing through a hole (e.g. a lens aperture). Side on, light passing through a hole acts just like a wave in the sea when it meets a harbour opening (left).





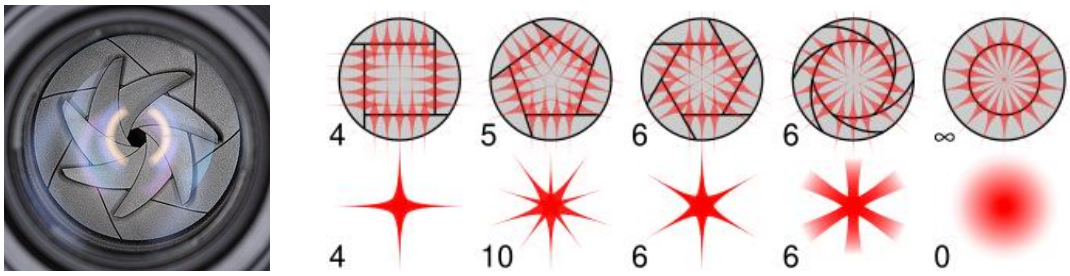
End on, looking down the lens with a perfectly circular aperture (right), it looks like this: bright central area with concentric rings around it. The weird thing is that this is most obvious when you have a very small aperture but it actually happens all the time at the edge of any aperture. It is just that this effect is not strong enough for us to see it with larger apertures.

The light and dark rings come from the light acting as a wave and forming an interference pattern.

In the real world of photography, our lens do not have perfectly circular apertures. When we have an image with a limited number of bright light sources and we use a smaller aperture we get a starburst effect as shown here in this great image of Busselton Jetty from Robyn Wright.

So where do the pointy bits in the image come from? This comes from light interacting with multiple edges and the diffracted light waves causing interference patterns with high and low points as the waves interact with each other. In the example from Robyn, we have 8 pointed stars.

From this we know that her camera has eight blades in its aperture mechanism as in the example on the left.



Aperture with even numbers of blades produce the same number of points in their starbursts. However, if they have an odd number of blades, the interference patterns are much more complex and you see twice the number points as there are blades (see above right). Also, if your aperture was perfectly round, you would just get a fuzzy ball of light with rings of light as shown previously.

So, the take home message is that the smaller the aperture, the more of the light reaching your camera sensor will be spread out due to edge diffraction, reducing the resolution of your image. However it is all a matter of compromise with the smaller aperture increasing your apparent depth of field. Also, of course, it you have some very bright lights on a dull background, you may want to stop down to a very small aperture to maximise diffraction effects and induce starburst highlights in your image.

As I stated at the beginning of this article, diffraction is an example of our physical world being really quite weird. Alternatively, you might conclude that the world is filled with Mysteries and Wonders!

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