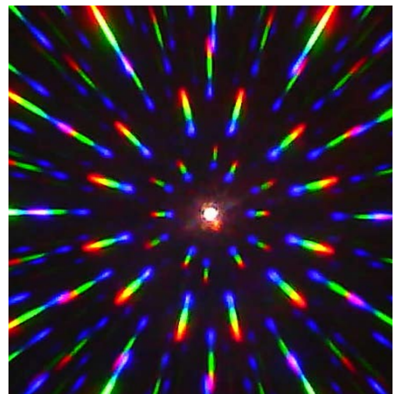
SPECTROCLICK

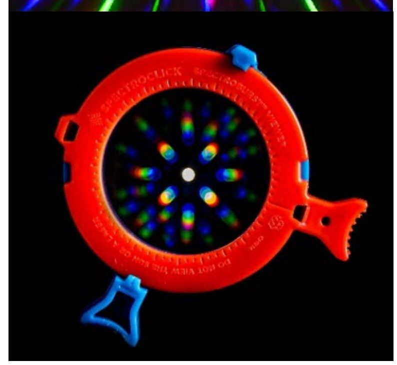
SPECTROBURST ™ VIEWER FAQS

What is a SpectroBurst™?



A SpectroBurst™ is the pattern of many rainbow-like color streaks viewed through "stacked, mutually rotated diffraction gratings." If you're looking at a white LED against a dark background, the center part of a SpectroBurst™ looks something like the image at the right.

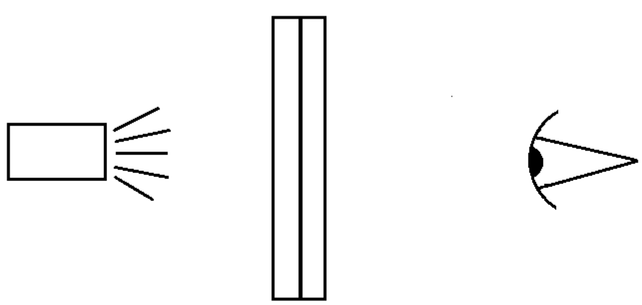
What is a SpectroBurst™ Viewer?



The Viewer is a set of two diffraction gratings mounted in plastic frames. The frames lock together and can be rotated in opposition to produce SpectroBurst ™ images similar to a kaleidoscope. They don't all look exactly like the picture here. Play with the angles! What patterns do you see? You'll have a light background during the day or in a well-lit room. For a dark background, use the Viewer at night or in a darkened room.

Do I shine the flashlight THROUGH the SpectroBurst™ Viewer or do I REFLECT the light from the Viewer?

While you can do either, you'll see cleaner, brighter patterns if the flashlight shines through the Viewer like this:



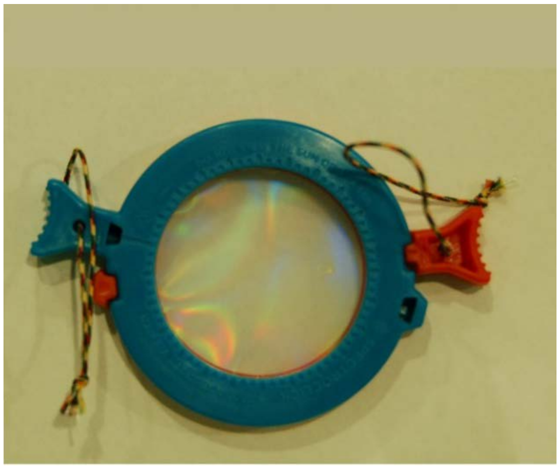
Flashlight   SpectroBurst™ Viewer   Observer

If you reflect the light from the grating film, any little wrinkle in the film breaks up the spectrum. Transmitting light through the Viewer, as shown in the drawing above, is quite insensitive to bends or wrinkles in the grating film. Also, only about 5% of the light is reflected (95% transmitted), so it's not as easy to see.

What is the difference between the two frames?
The blue frame has a 500 line per mm single dispersion diffraction grating, and the red frame has a 200 dot per mm double axis diffraction grating. It is easy to see the difference if you separate the Viewer and look at a light separately with each frame.

How do I take apart and assemble the two frames?
Line up the two handle tabs with the two notches, and the frames will pull apart.

There are two ways to line up the notches to put the frames back together: with the handles opposite or touching. We at SpectroClick find it easiest to assemble the Viewer starting with the handles far apart, but feel free to try it both ways.




I just see a smear of different colors. How can I get a clear SpectroBurst™ image?
Look through the Viewer at a small light bulb, such as the provided LED flashlight, or look at a distant light. A point source of light will produce a circular SpectroBurst ™ image. Do not look at the sun or a laser.

I spilled something on my SpectroBurst™ Viewer. Can it be cleaned?
The plastic frame and Mylar® diffraction grating film may be gently washed with water and a soft cloth. Cleaners may damage the film.

I've seen the way a prism breaks up light into rainbow colors. Are the diffraction gratings in the SpectroBurst™ Viewer just a thin kind of prism?
No, a diffraction grating uses a different process to break up light into rainbow colors. A prism works by changing the speed of light, while a diffraction grating uses the wave properties of light. Detailed explanations are below!

How does the diffraction grating work to make the rainbows?

First, keep in mind that light acts like a wave. Let's suppose you take two waves and add them together. What will happen? It depends on whether the waves line up crest-to-crest or crest-to-trough (or something in between). If it's crest-to-crest, you take two little waves and get one big wave. If it's crest-to-trough, the waves cancel, and you wipe out both waves. So now take light, and pass it through the grating. If you look straight through the grating at the light source, all the colors line up so you see a bright spot (the waves add). But if you don't look straight through, the grating shifts the crests and troughs a different amount for each color. That means that at any given angle, only some of the colors add up to where you can see them. At small angles, you see blue. At larger angles, you see green. At even larger angles, you see red. And then, as you go to even bigger angles, you see the same sequence all over again!

What is the difference between a diffraction grating and a prism?

A prism changes the speed of light differently for different colors -- it bends the light differently for the different colors. A diffraction grating does not bend anything. It shifts the position of wave crests so that they add together (so they can be seen) at different angles. Prisms work by changing light speed, while diffraction gratings work by changing wave properties of the different colors.

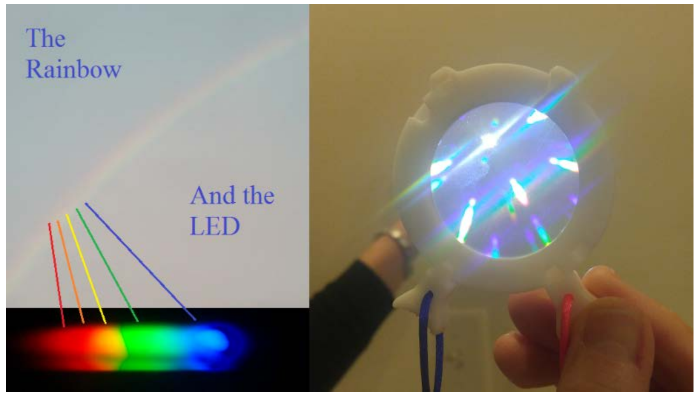
When I try the Diffraction Detective activity the lights don't look like the charts in the instructions. Help!

The four charts show idealized versions of the spectra produced by each kind of light bulb and they assume that blue comes out to the left of red. Half the light coming through the diffraction grating goes right to left. The size and shape of the spectra you see will vary with the configuration of the light bulb; most likely you will see elongated spectra. Look for the patterns – for instance, if you look carefully you'll see a small gap between the blue and green parts of the spectrum for a blue pump LED. You won't see this with any of the other lights.

What is the difference between the single dispersion and double axis dispersion gratings?

Think of an oven rack with many parallel metal strips. If you shrank it, so that instead of a couple of centimeters or more between the strips, you have about the width of hair between strips, you'd have a single dispersion grating. It's a periodic structure of parallel lines. Take a second oven rack and put it on top of the first one, but turned 90 degrees. Now you have two stacks of parallel lines, perpendicular to each other -- that's a double axis dispersion grating! Another way to think of this is that each plane of each grating is like the corrugated core of a cardboard box, except transparent.

What happens with stacked gratings?
If you start with two single-dispersion gratings, and you align them so that the corrugations are parallel to each other, typically you see what looks like just one single-dispersion grating. But if you put one perpendicular to the other, you get what looks like just one double-dispersion grating. That's because you've built a double dispersion grating out of two single dispersion gratings. But if the second grating isn't exactly perpendicular or exactly parallel to the first grating, the diffraction orders (or rainbows) you see aren't exactly perpendicular (or parallel) to each other. They're rotated just by the amount that you rotated the second grating with respect to the first.



Here's picture of a (faint) rainbow, a single diffraction order from an LED as seen through a linear diffraction grating, and a half dozen overexposed diffraction orders or spectra seen through a SpectroBurst Viewer prototype.

Why are those little lines on the face of the SpectroBurst™ Viewer?
The fiducial lines let you set the angle between the two gratings consistently by aligning the long pointer line with a short, vernier line. Each short line is 5°, and each slightly longer line (grouping 5 of the short lines) is 15°. This makes it easier to reset an angle to see the same pattern if you rotate the Viewer or take it apart.

The two frames look pretty similar. Can I put two orange (double axis) or two blue (single axis) Viewer frames together?
Great idea! As you can see in the picture below, we designed the frames to be interchangeable. You'll get a simple pattern of crossed lines of spectra with two blue frames together. Putting the two orange frame double axis gratings together produces the full SpectroBurst™ image that led to the founding of SpectroClick, Inc.! We use this same image in our spectrometers to do chemical analysis.

What kind of light is in the SpectroClick flashlight?
When we tested the flashlight, we saw a bright blue region, then a dim region, then bright green, yellow, and weaker red, all blurring together. That's exactly what is expected for a blue LED pumped white continuum LED. It is NOT a tricolor LED.

Can I replace the batteries in the SpectroClick flashlight?

Yes! The cap on the flashlight unscrews (counterclockwise when looking towards the top of the cap). There are two CR2032 lithium batteries inside that may be popped out and replaced with the +/labeled side visible as you push the batteries into the compartment. Caution: the battery holder is small enough to be unsafe (choking hazard and sharp edges) for young children. If it pops out when you remove the batteries, be sure to align the stem of the battery holder with the groove in the plastic flashlight body when pushing the holder back into place.

Note: if you have the rectangular flashlight that came with the prototype SpectroBurst™ Viewer sold in 2016, the instructions are: With the flashlight on, continue to pull until the plastic insert pulls free of the rear part. You may need to use a tool such as a broad screwdriver to give you enough leverage. Slide the clear plastic shim on top of the batteries out of the way, and replace the three LR44 alkaline batteries. Slide the shim back in place, reassemble the two square parts, and if the batteries are oriented correctly, you're back in business until your kid brother hides it for a week with the light on.

The flashlight is too bright! Is there any way to dim it?
Yes! The flashlight contains two CR2032 batteries. It will operate using just one if you replace the LOWER battery with two pennies.
To replace one battery:
1) Turn off the flashlight.
2) Unscrew the plastic cap by turning the orange cover counter-clockwise.
3) Remove both batteries. If anything else falls out, line up the parts and reinsert them. (If you have to reinsert the parts, first place the lens, then the bulb, and finally the T connector, making sure the silver color T connector is recessed at the compartment edge.)
4) Put two pennies into the battery compartment.
5) Put one of the original batteries on top of the pennies, with the + side facing you.
6) Make sure the battery is flush with the top of the flashlight body and carefully screw the orange plastic cap back on, making sure it is correctly threaded.

That's it! The flashlight works just like it did before, but puts out less light.

The one-battery light level may be more comfortable for individual or close-up use, while the two battery level is better at a longer distance (for example, down a long hallway or the length of a classroom).

Can I use the SpectroBurst™ Viewer to figure out what kind of lights are in my cell phone screen?
Your screen can display many colors. Does it do so with many different LEDs or with just a few? Does it start with white light and cut out colors you don't want to see, or does it only turn on the colors you need in each pixel? You can figure it out! There are free sketch programs for most cell phones.

Download any of them. Paint the background solid black. Then put a dot (the smaller the better) in the middle of the screen. Look at the dot with the SpectroBurst™ Viewer. Put the Viewer close to the screen and then back up. Try it with the single axis/blue frame grating, the double axis/red frame grating, and with both together. Depending on what color you chose, you may see single colors or multiple colors. Now that you know what you're looking at, change the dot to white. When you back away from the dot, does it split into 3 colors (for a tricolor LED), multiple dots, or a continuum? Now you know what kind of light your cell phone produces!

Can I take my SpectroBurst™ Viewer Outside?
Yes! Take it outside at night. Look at the moon – with different phases, you'll get different SpectroBurst™ patterns! Look at Jupiter, Mars, and the brightest stars such as Sirius in the Northern Hemisphere and Canopus in the Southern Hemisphere. Dark skies make it easier. But the best are STREETLIGHTS! Can you tell which are high pressure sodium vapor lamps, and which are low pressure? Which are mercury lamps and which are LEDs? For making this kind of determination, it's best to use the blue frame linear diffraction grating.

The way to tell high pressure and low pressure sodium lamps apart is to look at the yellow part of the spectrum. Low pressure lamps will have a bright yellow line from sodium atomic emission. High pressure lamps will seem a little bit dim where yellow should be, but be bright on both the green and red sides of the yellow region. Why? Because all those cold sodium atoms at high pressure near the outside of the light are absorbing light emitted by hot sodium atoms in the interior. For a laboratory quality spectrum showing how pressure changes the sodium spectrum, click here.

Why is there a small hole in the SpectroBurst™ Viewer handle?
You can run a narrow piece of cord through the hole and tie a loop on the handle. Now you can tack it on a bulletin board or hang it from a clip to keep your Viewer nearby. If you hang your Viewer in front of a window, you'll see a transmitted diffraction pattern when the sun shines directly through the Viewer – look for the pattern on the floor or the opposite wall!

I've heard that diffraction gratings are used in chemical analysis. How does this work?
Except for people who are blind or color blind, we see many colors in the world. Different colors correspond to different chemical compounds or structures. If we see a green leaf, we see mainly green light. But we know that the sun puts out light of all colors. That means that the leaf only reflects green, but it soaks up or absorbs blue, yellow, and red light. We can measure reflectance, but it is often easier to measure the removal of light from a light beam. In this case, we see the light that is not absorbed (that is, we can't detect the light that a material absorbs, we can only see the light that it does not absorb).

Let's suppose we start with a beam of light going through water. Water is clear; for practical purposes, it does not absorb visible light. Now, add a little bit of red food coloring. Red light gets through. The green and blue light does not come through – the food coloring blocks the blue and green light and we just see the red. If we put very little food coloring in, then we see only a weak color, because not much blue or green gets blocked by the food coloring. If we add a lot of coloring, then the amount of red light coming through does not change, but the amount of green and blue goes way down, so the intensity of red we perceive is high. If we measure the intensity of green or blue light, we then get an indirect measurement of the amount of red food coloring. The amount of red light never changes, but the amount of the other colors goes down as the amount of food coloring goes up. You can do this type of experiment with our SpectroClick Kit!

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