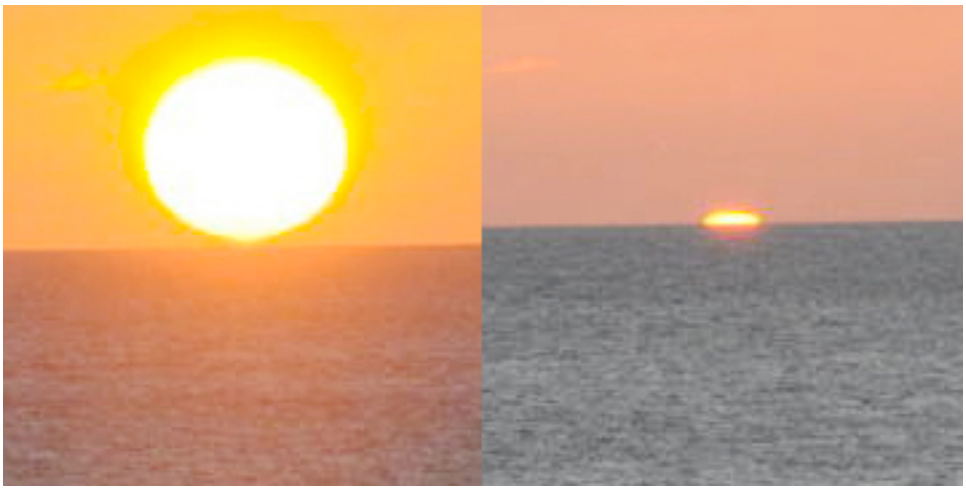
The Green Flash and Physics of the Setting Sun

Alex Dzierba

When we were on vacation in January, my wife and I were watching the setting Sun over the ocean. There wasn't a cloud in the sky and the air was crystal clear; so clear that it was hard to look at the Sun directly. Just before the Sun dipped below the horizon, it turned a bright green for a second or two. We both saw it at exactly the same instant. This phenomenon is called the "green flash." Even though I knew about the green flash (I talked about it when I taught physics at the university) I had never seen it before. The conditions have to be just right and it is best to be looking at the setting Sun over a large body of water.

There is a lot of physics at work in understanding what we see when watching the setting Sun and *refraction* plays a huge role. In a vacuum, light travels in a straight line but when passing through a medium such as glass, water or air, light bends. This is called refraction. When you put a straight stick into a bucket of water, refraction is the reason that the stick appears to be bent. Refraction is why lenses can focus light.



Look at the two photos that I took of the setting Sun over the ocean. In the photo to the left, the bottom of the image of the setting Sun is just touching the horizon. At this instant the Sun is actually entirely below the horizon. Refraction of light in the atmosphere causes the light rays to follow the curvature of the Earth so that the Sun appears to be just over the horizon. In the photo to the right, the image of the Sun is just about to disappear. That's when you might see the green flash. The evening I took the photo, the sky was not clear enough to see the green flash.

The light from the Sun contains all the colors of the rainbow (also an effect of refraction) from red to yellow to green to blue to violet light. The amount of bending depends on the color. Violet light bends more than blue light that bends more than green and so on. Red light bends the least. So the last color to creep over

the horizon as the Sun is about to disappear should be violet. The next to last should be blue and after that should be green.

So why don't we see a violet flash since violet should be the last light to creep up over the horizon? That is because the atmosphere absorbs most of the violet and ultraviolet light from the Sun. And that's a good thing for our health. So what about the blue light? When you view the light from the Sun along the line of sight, the blue light is scattered off the air molecules in a direction perpendicular to the line of sight. That is why, when you look straight up to the sky (away from the Sun) on a sunny day the sky is blue. The light from the Sun moving parallel to the ground has its blue light scattered downwards and this is the color that you see. So when you look at the light from the setting Sun, the atmosphere absorbs the violet light, scatters the blue light and all you are left with is a reddish-orange color. And the color of the last light to creep over the horizon, just as the image of the Sun disappears, is green light – which gives rise to the green flash.