Lesson 31: Polarization

Polarization is something that people have known about (indirectly) for a long time, but for many years didn't understand.

- When you look at sunlight reflecting off of water, the glare can just about blind you!
- The same sort of thing happens when you get an intense glare from snow... "snow blindness."
- This happens because of the way hitting the surface changes the "shape" of the light wave. This is what we call polarization.
- If you took a piece of Iceland Spar (a type of crystal) and held a piece of tourmaline (another crystal) and held them both in front of your eye, you could get rid of that glare almost completely.

EMR is basically a bunch of transverse waves pointing in all sorts of directions all at once.

- Waves of light are vibrating up-down, left-right, diagonally back and forth, in every direction all at once.
- If you were to look at a beam of light coming straight at you and see its waves, you'd see something that looks like *Illustration 1*.
- This is what the waves look like normally. We call it **unpolarized** or **non-polarized** light.

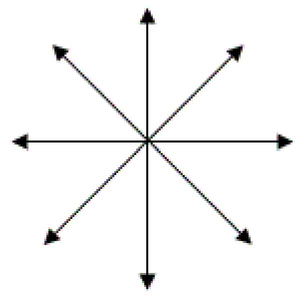

Illustration 1: Viewing EMR head on shows waves vibrating in every direction.

When light hits a reflective surface like water, it will reflect the light waves polarized slightly.

- This is because the waves that are vibrating in the direction that hits the surface get scrunched a bit.
- The part of the wave parallel to the surface isn't scrunched, but might bulge outwards a bit.
    - Imagine watching a basketball hitting the ground in slow motion. You'd see it squish vertically, and bulge out a bit horizontally.

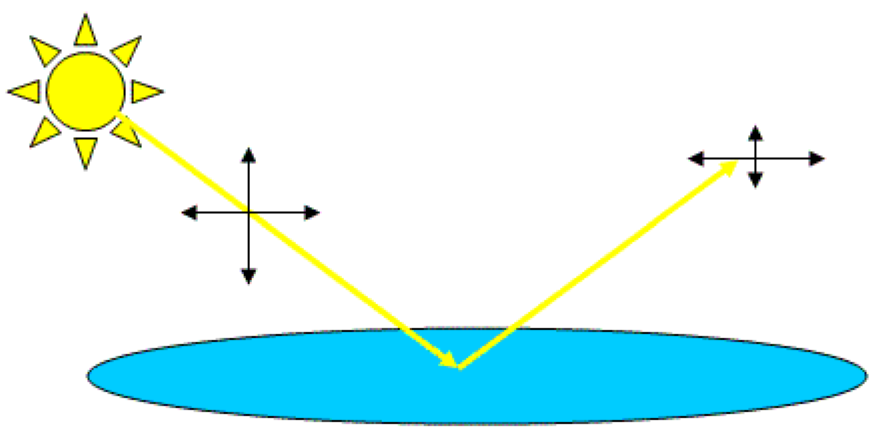

Illustration 2: Light reflected from a lake becomes polarized.

- Your eyes and brain have a hard time figuring out how to interpret this information, so we see this scrunched polarized light as a glare from the surface.

To get rid of the glare, we need to make the vibrations the same size again.

- To imagine how we can do this, imagine a regular fence made out of boards that are vertical. You put a piece of rope through the space between two of the boards.
- Stretch out the rope and get a friend to hold on to it on the other side while you grab the other end and shake it up and down to make waves that move vertically.
  - Will your friend on the other side see the waves coming towards him? Yup! Since the waves are vertical, they will pass through the vertical spaces in the boards.
- Now try shaking the rope side to side.
  - The waves will never reach your friend on the other side (even though he might see the rope shake a bit), since horizontal waves can't travel through a vertical opening very well.

A piece of Iceland spar and tourmaline, or a polarizing filter, would remove most of the waves vibrating in every direction, except one.

- In a polarizing filter there are long molecules aligned parallel that act almost like the fence boards in the example above.
- When the light goes through the polarizing filter only waves parallel to the molecules in the polarizing filter will be able to pass through.
- If the polarizing filter is vertical, then the only waves to get through would be…

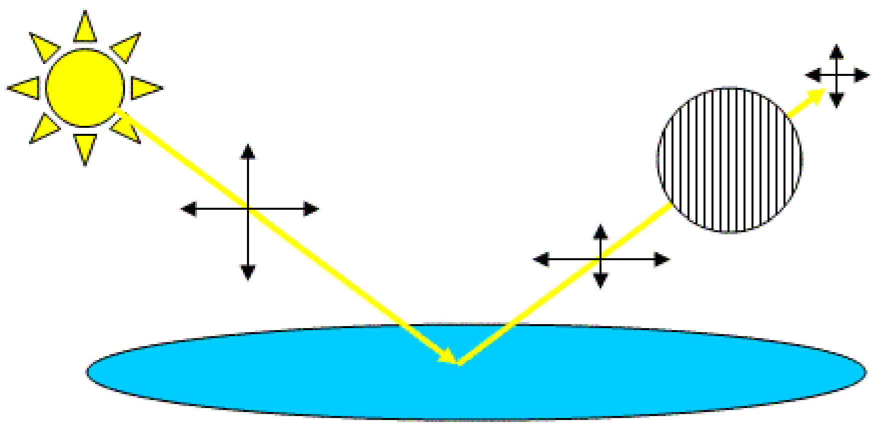

Illustration 3: The reflected light passes through a polarizing filter.

- The glare would be gone. Since the horizontal and vertical vibrations are equal, your eyes and brain can interpret the information correctly again. It just won't be as bright as it originally was.

Did you know?

The first European explorers that reached the Inuit in Canada's north learned a good lesson. The explorers kept having trouble with snow blindness. The Inuit showed them how to take a piece of bone and cut horizontal slits through it. When worn in front of the eyes, you don't get snow blindness anymore. The slits are acting as a primitive polaroid filter.

Knowledge of polarization and polarizing filters is actually very useful for photographers to know about.

- To reduce the effect of the glare while taking a picture in these conditions, we can put a polarizing filter on the camera so that it is aligned vertically.
- Although it won't get rid of all the horizontal waves, it will get rid of enough so that the waves are about equal. This will get rid of the glare.
- To see a real life example of what a polarizing filter can do, look at these two sample images of a person sitting behind a glass window below.
  - The first one is taken with no filter, the second with the filter in place.

Illustration 4: Photos taken without and with polarizing filters. Images courtesy of the Tiffen Company.

Video Killed the Radio Star!
Glare can happen from many surfaces, not just water, snow, and glass. You can watch a video of me getting rid of glare by clicking here.

If you place two polarizing filters on top of each other so that the are aligned 90° to each other, then you will see nothing.

- This happens because one filter is getting rid of the horizontal, while the other is getting rid of the vertical.
- With almost all of the light blocked out, you don't see anything.

Homework

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20, 24, 25, 28, 29, 30, 37, 39-42