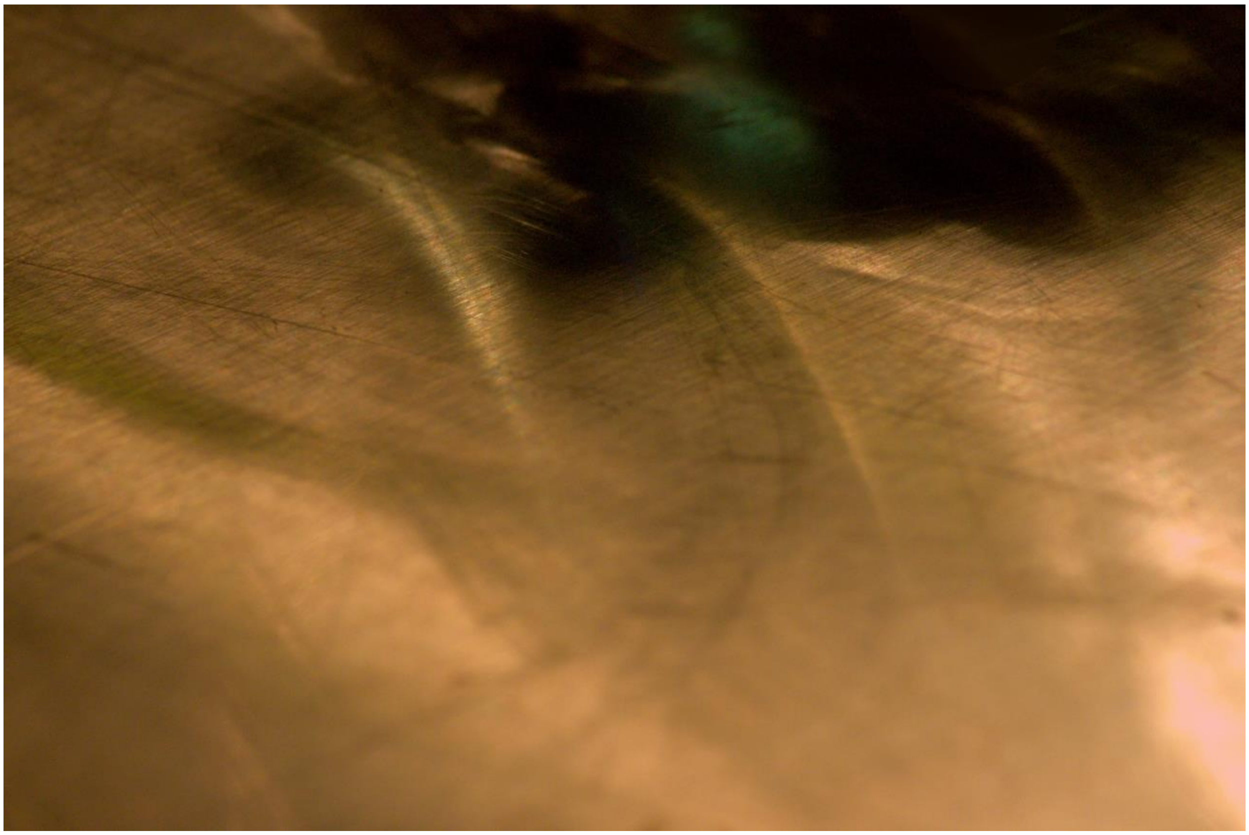
Losing My Marbles to the Light

By Stella Meillon

Flow Visualization F23 Section 001

09/25/2023



Context and Purpose

For my first experimentation with flow visualization, I wanted to create a visualization of light as a fluid. Light is often used in combination with another fluid element to help visualize the flow of the other element but is seldom visualized alone. The purpose of this experiment was to familiarize myself with my camera and the tools at my disposal, but I also wanted to try something different and see how that process would compare with the results of my peers.

Flow Description

As seen in Figure 1, the setup for my experiment included an industrial lamp with a plastic cup full of ⅝” diameter marbles propped against it. The light traveled from the power lamp to the plastic of the cup, then through the marbles, back out from the cup, and then reflected on a zinc countertop. The light created a dappled and wavy pattern against the countertop from being diffracted through the round marbles (which is composed of glass scrap (cullet) and silica). I selected a variety of colors, although the marbles themselves were each a solid color.

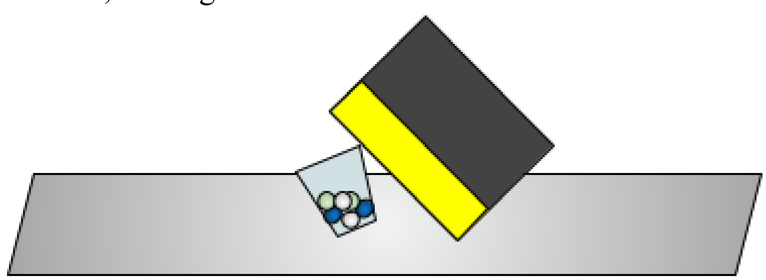


Figure 1: The setup for this experiment included an industrial lamp and a transparent glass of marbles atop a zinc counter.

The diffraction of the light through the marbles can be defined by Bragg diffraction, which models light passing through a sphere. As seen in Figure 2 from Encyclopaedia Britannica, the light is incident upon the surface and is reflected based on its waves and the medium of contact.

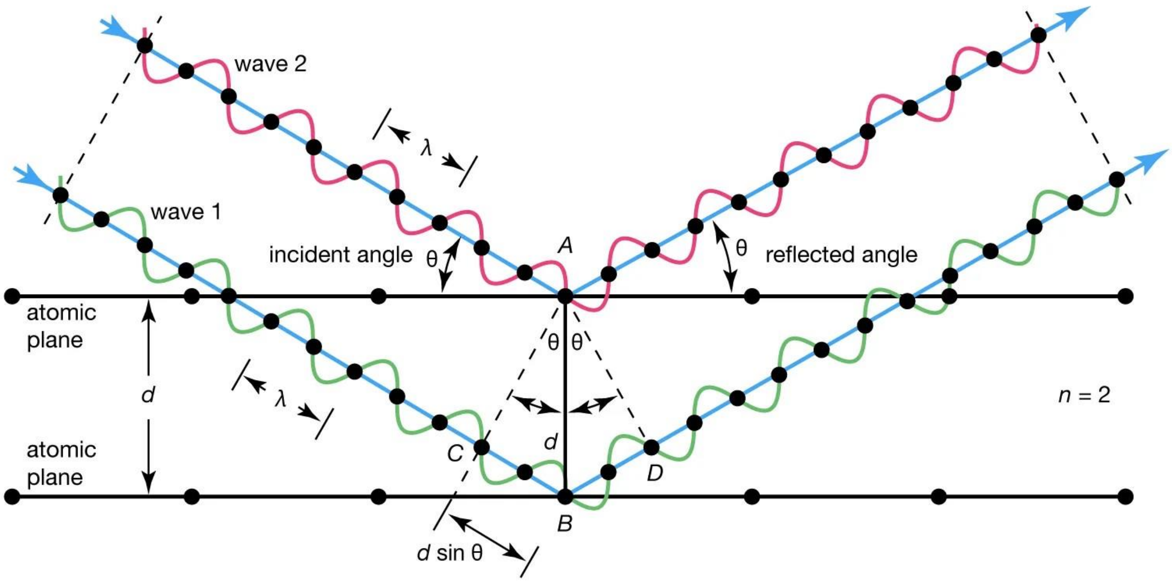


Figure 2: Bragg Diffraction, as described by Encyclopaedia Britannica, describes light through a crystal. λ represents wavelength, θ is the angle of the light, *d* is the distance between the two planes, and *n* is the number of waves.

In Figure 2, the diagram demonstrates two waves in phase hitting atoms A and B with a difference d between the lattice planes of a crystal. The reflected angle is θ and is equal to the incident angle. The Bragg law states that $n\lambda = 2dsin(\theta)$, which will describe the number of wavelengths *n*. For any fractional representation of *n*, the reflected wavelengths will destructively interfere with each other and reduce the effect of the light reflection.

Visualization Technique

The technique behind the image included carefully propping a cup of marbles against an industrial light atop a reflective zinc surface. The light was a 500 W portable lamp, and it provided sufficient lighting on a dark exterior patio to put light through the cup of marbles and create a reflective image. The materials were sourced from the Integrated Teaching and Learning Lab in the CU Boulder engineering center.

Photo Technique

The focal length was 1.28 m and shot with a DSLR Canon EOS Rebel T2i, with a Canon EF-S f/13.0, the exposure was 1/3200, the focal length was 250 mm, and the ISO was 6400. I chose 55-250 mm lens. The original and final image width and height was 5196×3462 pixels. The aperture was these settings through trial and error. Since the environment was very dark and the light source was extremely bright, I used a quick shutter speed but wanted the sensitivity to be high enough to pick up on the light waves from the marble reflection.

To produce the final image, I made changes to the original light settings and also had to crop and edit out the rim of the cup that was left in the image. I reduced the brightness and evened out the color scale and then lowered the RGB curve. This also accentuated the waviness of the light and brought the focus to the wavy patterns.

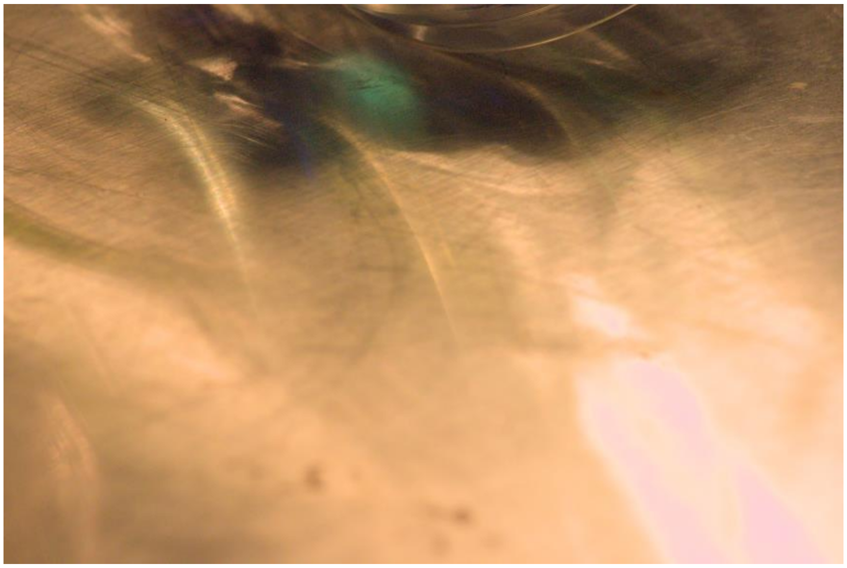


Figure 3: The raw image of the setup.

The image reveals patterns of light that are diffracted by the cluster of marbles. I did not have a specific intent in mind given that the project was a way to discover light flow and different properties. I do wish I was able to play more with the different color projections from the marbles, and I played a lot with different tissue paper colors in front of the light to see if that could have an effect on the reflection. It was unsuccessful, however, so I got rid of most of the obstacles between the light and the marbles and was able to produce brighter color reflections. Going back, I would investigate the reflections on different surface types and investigate the way the light can affect the marbles in different patterns or mediums. How would it change if the marbles had been in a different medium, or if I used different patterns of marbles? These are things I would like to play with given the opportunity to recreate the scenario.

References

Centers for Disease Control and Prevention. (n.d.). *National Marble Day: A look at the manufacturing of Glass Marbles*. Centers for Disease Control and Prevention. https://blogs.cdc.gov/niosh-science-blog/2022/07/21/mm-marble-day/#:~:text=The%20raw%20materials%20used%20for,for%2024%20hours%20or%20longer

Britannica, T. Editors of Encyclopaedia (2023, September 22). Bragg law. Encyclopedia Britannica. https://www.britannica.com/science/Bragg-law