IV 1: Get Wet Report

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I. Purpose of Experiment

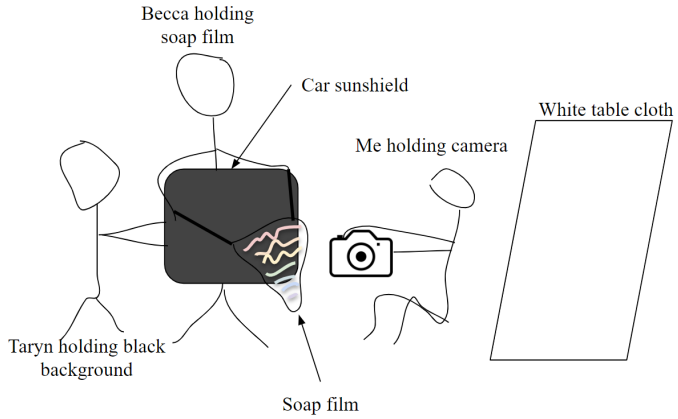
The purpose of this project was to "Get your feet wet" in the field of flow visualization, the practice of taking photos of fluid phenomena. The assignment was to take a photo of any fluid flow we could think of. This helps us start thinking and recognizing fluid flow all around us, as well as give us a chance to practice taking photos with a higher quality camera than our phones.

My inspiration for this image was an exhibit that I saw at the San Francisco Exploratorium back in 2018. The exhibit consisted of a trough of soapy water and a bar that could be lifted out of the water by a pulley. When the bar was lifted out of the soapy water, it would create a large soap film in the space. I noticed that the longer I held the film, the more colorful it became.

My goal for this project was to capture the amazing spectrum of colors that occurs within a soap film or bubble. My original idea was to take a photo of just a soap film, but I also decided to experiment with taking photos of bubbles (made by Jamie Joung). Spherical bubbles display the same phenomena as soap films, but can be harder to get an infocus image because of the curve of the bubble.

II. Setup

For this set up I used a white table cloth, a car windshield sunshade, cloth string, 2 sticks, tub of bubble soap, and a bolt. To make the soap film, I tied the string to the two sticks and attached the bolt at the bottom to weigh down the string, like shown in the diagram.



Setup for imaging soap film

The strings were then dipped into the tub of soap (using string made out of natural fiber is best as it allows for the soap to be soaked into the strands, which helps the film stay formed) and when lifted a film would form between the strings. When the strings are originally lifted, the soap film starts out clear. After about 5-10 seconds, pink and green gradients start to appear. After about 15 seconds more colors will start to appear. At about 20 seconds from first forming the bubble are what I believe to be the best time to start taking photos as the most colors are present. After about 25-30 seconds, more darker colors start to swirl in from the top, but the bubble is at risk of popping soon.

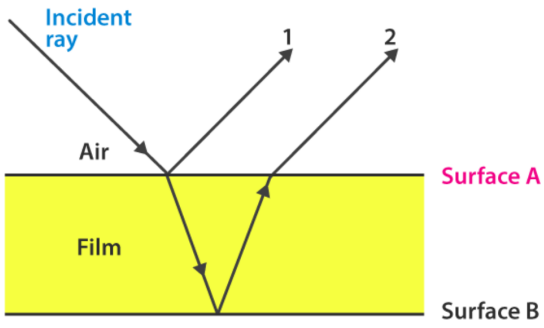
To take the photo, I had the white table cloth behind me to help reflect light to where I was taking a picture, and then behind the soap film I used my car sunshade as a black background. I took this photo outside so that I could use natural sunlight instead of artificial light. Since there were so many pieces for this set up I had my roommates help me. Rebecca Coryell created the soap films using the sticks and string. Taryn Hovenkamp held my car sunshade right behind the soap film and in front of Rebecca. Jamie Joung blew bubbles that I took photos of when I was experimenting with other options. While taking the photo, I had to take it at an angle to keep my reflection out of the frame.

If someone were to want to recreate this, Corrie White[1] has photos of a much more efficient and effective setup that they used. Instead of having a white background behind the photographer, they cut a hole in white cardboard to stick their camera lens through. The soap film device was wire that was held in place and a cup of bubble soap would then be lifted to submerge the wire, thus keeping the wire in place.

III. Fluid Mechanics

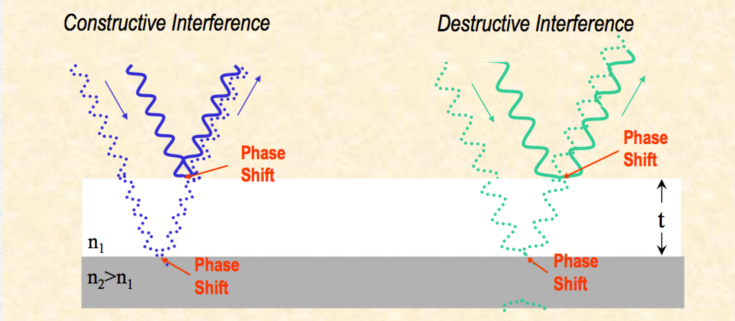
The reason why bubbles and soap films display a spectrum of colors as they settle is because of thin film interference. Thin film interference is when the light waves reflected by the upper and lower bounds of a very thin film (the soap in this case) interfere with one another which can either enhance or reduce reflected light.

There are two lightwaves that are observed, one from the lightwave (1) reflecting directly off the surface of the film and the other from the lightwave (2) passing through the surface, through the soap before reflecting off the bottom surface and passing through the soap and then top surface once again[2].



Two light waves created from entering light wave[3]

Based on what phase the waves are in, they will either have constructive (they combine) or destructive (they subtract from each other) interference or a mix in between. The phase the waves are is based on the thickness of the film and the source of light.



Constructive vs Destructive Interference[4]

Since the soap film has a non-uniform thickness (due to gravity and the weight of the soap pulling down on itself), we see a gradient of color. If I photographed a larger soap film, we would see the repeating gradient on the rainbow as lightwaves 1&2 phase in and out with each other as the thickness increases.

(part explaining droplet)

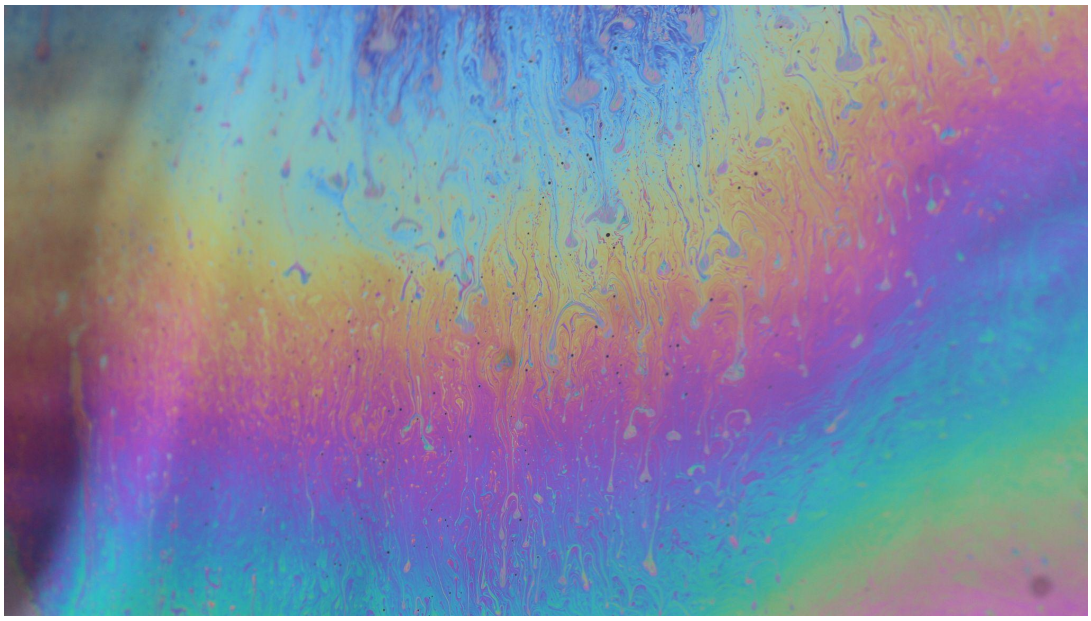
As the soap molecules gather around a small particle of dirt, or whatever else may be trapped in the soap film, that area gets heavier

IV. Photographic and Visualization Techniques

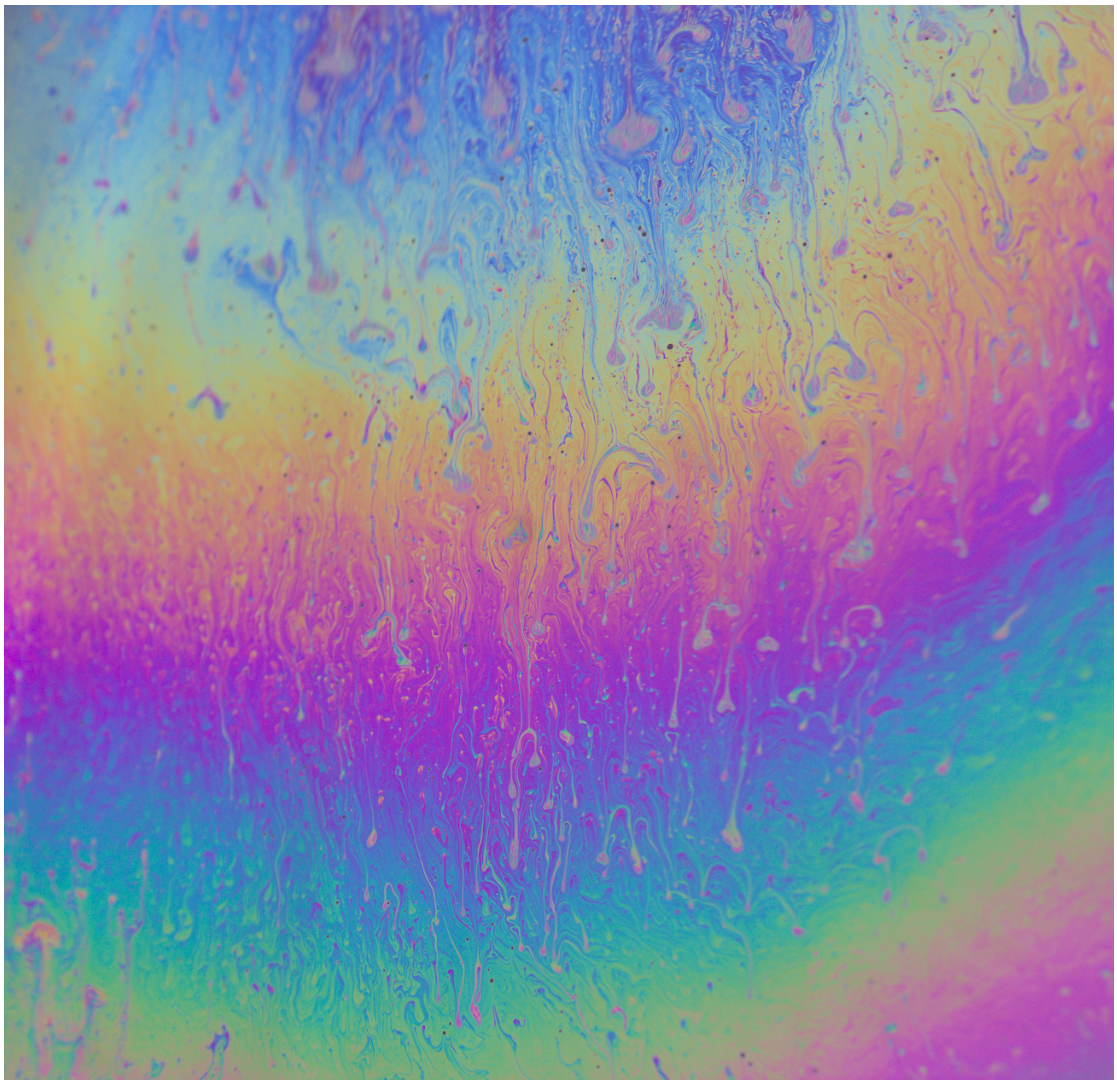
When taking the photo, I found I had the best results when letting the camera auto adjust the settings. Since it was my first time using a camera that had more than just a shutter button, I had little understanding in how to adjust aperture and ISO and shutter speed appropriately. The settings that the camera chose were; ISO:200, F-Stop:f/7.1, Exposure:1/60, Focal Length:37mm.

This photo was taken at about 20 seconds after initially lifting the strings. For focusing, I used the manual focus setting since the curve of the soap film and the angle I had to be in relation to the soap film made it so only certain areas would be in focus, and I wanted to be able to choose what I wanted in focus. Since it was only my second time using the camera, most of the photos came out blurry.

When editing this photo I decided to adjust the colors and brightness just enough to highlight the colors that naturally occurred without overdoing it to the point that the photo would look fake. Since the photo was taken at an angle and my camera was very close to the soap film, the edges were very out of focus. I ended up cropping out most of the blurred edges in the photo as well as some shadows that ended up in frame. The original photo size was 5184x2916 pixels. I cropped the photo to 1300x1259 pixels.



Original Photo



Edited photo

V. Image Remarks

I am really happy with how this photo turned out. I love all the colors that appeared and the way the colors dripped down the film, creating even more amazing movement within the photo. Although the edges are out of focus, the center is very clear, even to the point that you can zoom in and see even more detail. One of my favorite details about this photo are the tiny black/brown specks that are mixed in with the colors and are only visible if you zoom in.

I wish that I had been able to capture more photos since I finally had the technique down and since so many of my other photos came out blurry. The photo I chose was my second to last photo of the session as most of my other photos came out blurry. I had wanted to return to the set up and take more photos, but I unfortunately got COVID shortly after and had to spend the rest of the week in my room alone and had no other chances to take more photos.

If I were to develop this idea further, I would want to experiment more with photographing bubbles or getting a series of images/videos of the soap film as it progresses since the change it goes through is very vibrant and unique. I had experimented a little with bubbles and was able to get an amazing photo (that I didn't turn in) that showcased the thin film interference but also had a fun story occurring in the reflection of the bubble.

References

[1] “Liquid Drop Art: Set-ups, Soap Film Set-up.” Accessed September 26, 2022. https://www.liquiddropart.com/TheArtofSplash/Set-Ups/i-QbrwFCW

[2] “BU Physics: Thin-Film Interference.” Accessed September 26, 2022. http://physics.bu.edu/py106/notes/Thinfilm.html

[3] “Aakash: Thin Film Interference.” Accessed September 26, 2022. https://byjus.com/jee/thin-film-interference/

[4] “High Point Physics: Thin-Film Interference.” Accessed September 26, 2022. https://physics.highpoint.edu/~jregester/potl/Waves/InterferenceColors/interfcolors.html