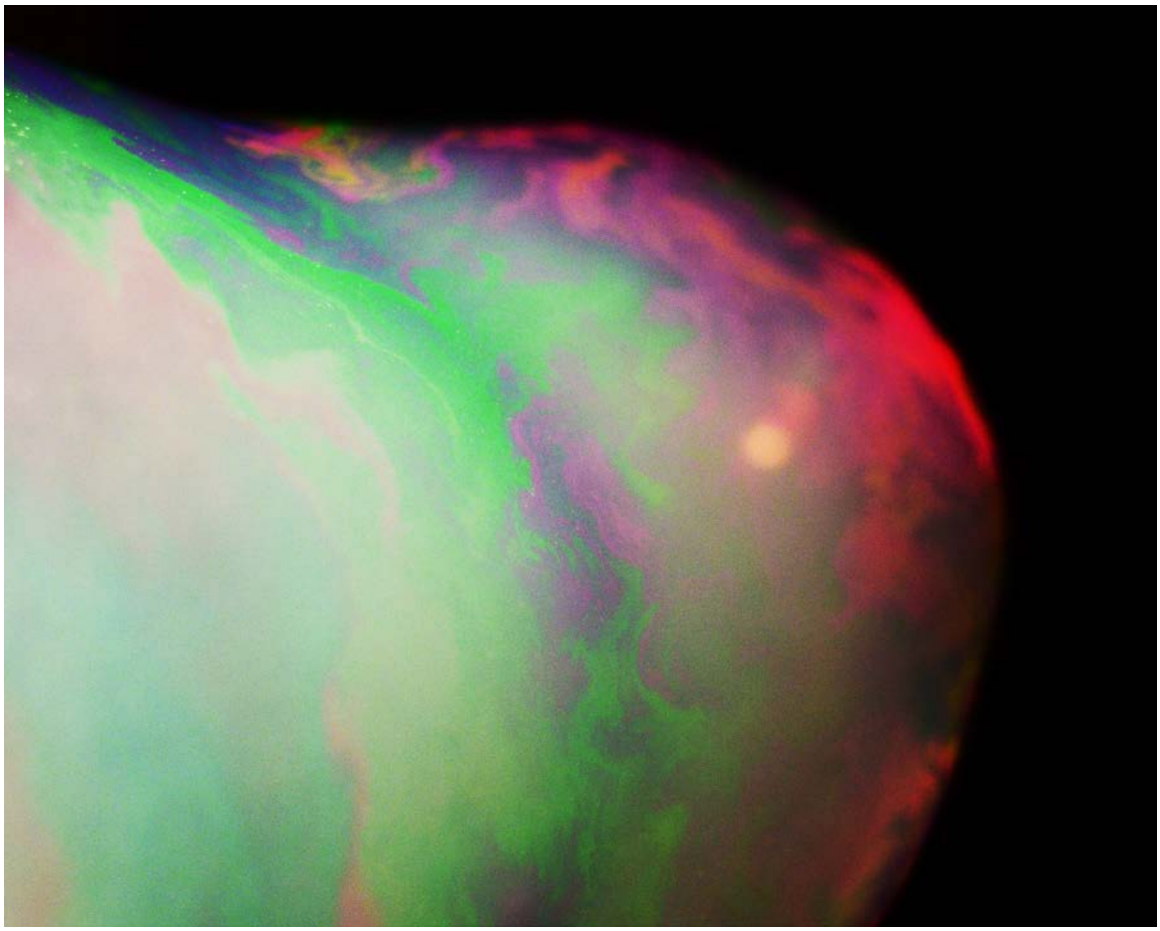
Group Image 2



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MCEN 4151: Flow Visualization
11/9/15

Introduction:

The goal of this project was to capture light distortion on the surface of soap film bubbles. The bubble chosen for the image was a freestanding bubble created in team member Andriy Wybaczynsky's back yard. The following report outlines the experimental setup, physics behind the flow phenomenon, and the photographic techniques used to achieve the photo.

Experimental Setup:

To capture the fluid phenomenon in this experiment the bubbles were produced using a homemade bubble wand made of two dowel rods and a piece of string. The soap mixture used was taken from Instructibles.com[1]. Sugar was added to the mixture in an attempt to make the bubbles last longer, it was undetermined weather this had an effect.

The soap mixture contained the following:

- 12 cups of water
- 1 cup of cornstarch
- 1 cup of dish liquid
- 2 tablespoons of baking powder
- ¼ cup sugar

To aid in blowing the bubbles while also making them more visible the bubbles were filled with fog. The fog machine used was a small Heshan Tongfang Lighting Technology CO Fog Machine. The fog solution used was made of glycol and distilled water. The fog machine was placed directly behind the bubble wand and was used to actually blow the bubbles. Once the bubble was created there is only a few seconds to capture it before it pops. The camera was positioned to the side looking along the subject. A diagram of the setup can be seen in Figure 1.

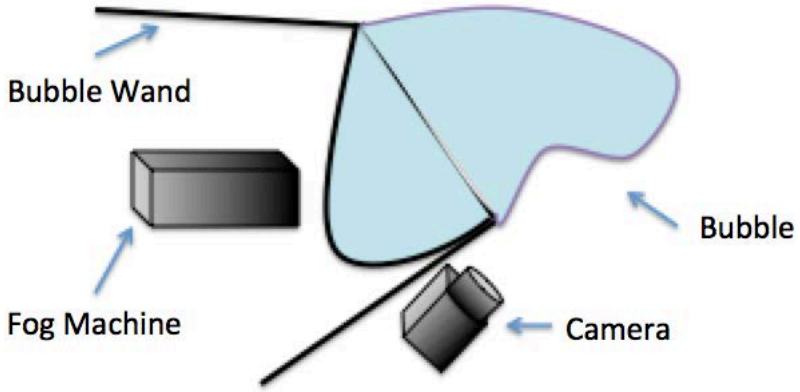

Figure 1: Experimental Setup

Flow Phenomenon:

The secret to the beauty behind soap bubbles lies in the light physics behind the phenomenon. Soap bubbles are made up of three layers, a layer of water sandwiched by two layers of soap molecules as seen in Figure 2.

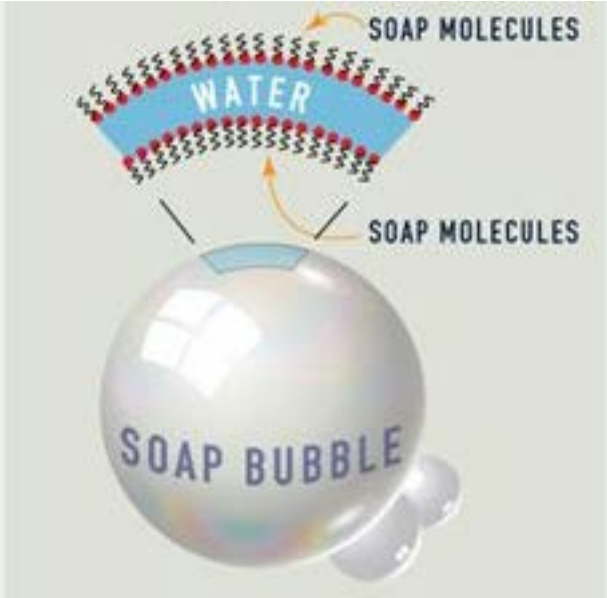

Figure 2: Soap bubble layers [4]

Due to gravity the water is pulled downward making the top of the bubble thinner and thinner until it breaks. The amazing interference colors seen on the surface of soap bubble are cause by light refracting off the surface. The colors are dependent on the thickness of the bubble and angle of incidence. The maximum reflection occurs at an angle of incidence of about 30 degrees; in the image this is where the brightest colors can be seen. An illustration of this phenomenon can be seen in figure 3.

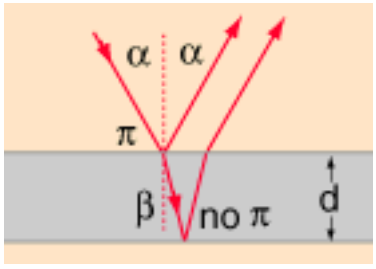

Figure 3: Maximum Reflection[3]

Given an estimation for film thickness and a 30 degree angle of incidence the wavelength for maximum reflection(λ) can be calculated.

$$\lambda = 2nd\ cos\beta/(m-1/2) = 549.99nm$$

Where n is the index of refraction of the film, d is the thickness of the film, β is the angle within the film, m is the number of wavelengths (in this case m=1)[3]. The wavelength of about 550nm corresponds to the color green in the visible spectrum. This number agrees with the color seen in the image, as the majority color is green. Other wavelengths are seen as the angle of incidence is changed along with the bubble film thickness.

Photographic Technique:

The camera used was a Nikon D5100 with a 50mm lens and fixed aperture of F1.8, shutter speed was set to 1/800 seconds and the ISO set to 400. The camera was about 1 foot away from the subject and the field of view for the shot is about 5feet by 5feet. Post processing was done using Photoshop Element 13. The photo was cropped from 4928x3264 to 3771x3017 pixels. Other post processing included increasing the contrast and adjusting the sharpness. Some of the photo became washed out with brightness but ultimately was worth it to get the colors to stand out. Both the original image and the final image are shown bellow in Figure 4.

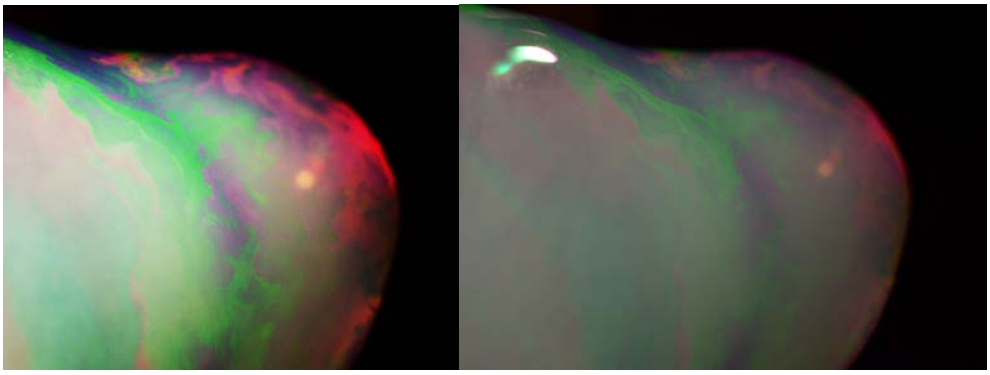

Figure 4: Final Image (left), Original Image (right)

Conclusion:

The result of this experiment was beautifully colored image of a soap bubble. The bubble film created and shown in the photo was difficult to capture in focus. The duration of the bubble was short and there was a low light environment. This resulted in only of the portion of the bubble being in focus. To improve this experiment in the future adding glycerine to the soap mixture should help improve the life of the bubble. Also using a high-powered light source would help to improve the intensity of the colors.

References:

[1] Instructables.com: soap mixture
http://www.instructables.com/id/Huge-bubble-maker/step3/The-Mix/#step1

[2] Digg.com: Soap Bubble Video
http://digg.com/video/amplifying-bubbles-with-fog-and-lube

[3] Hyper Physics: Soap Film Physics
http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/soapfilm.html

[4]WebExhibits: Soap Bubble Picture
http://www.webexhibits.org/causesofcolor/15E.html