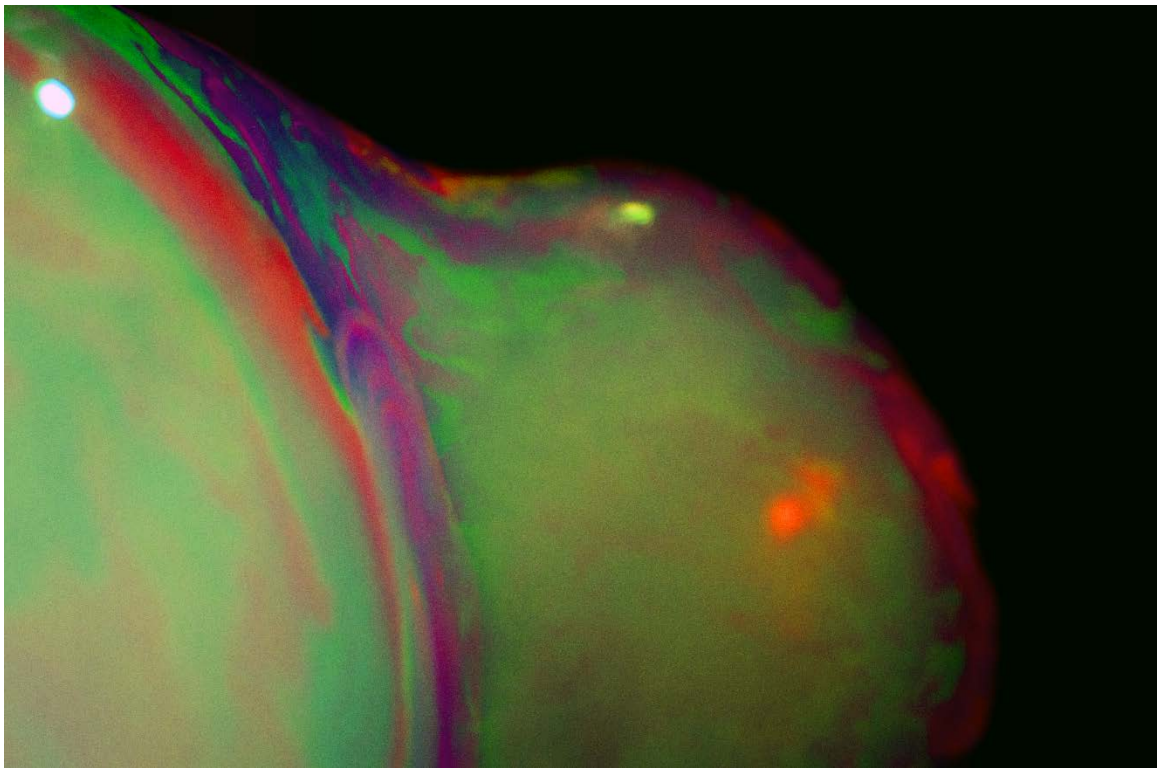
CU Boulder

Flow Visualization

Group 2 Report



Durkin , Ian Kenyon

Purpose

The purpose of this image is to capture a striking image of opaque fluid formation. This image is a collaboration with Andriy Wybaczynsky, William Vennard, and myself. Originally, the group had decided to pursue the formation of rain clouds indoors in the same vein as the work of artist Berndnaut Smilde. A location was scouted and equipment acquired, but when it came to the photoshoot day outside temperatures were not low enough to sustain the cloud. This required a plan B.

The group ended on using much of the same equipment to form these clouds but to use thin film bubbles to give the clouds their stability enough to be captured on film.

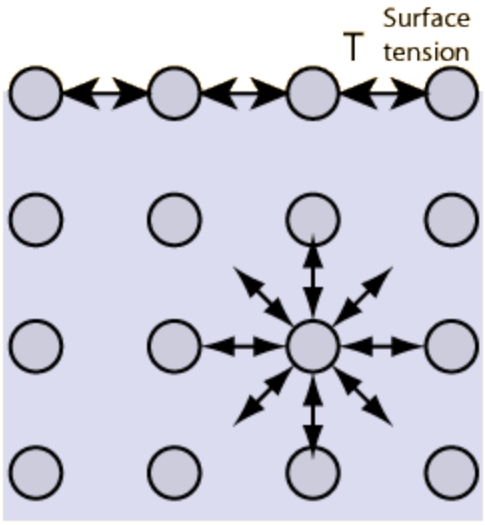
Description of Flow Physics

This experiment is a rather simple one to set up. It requires limited materials and equipment. Using a how-to from the Instructables website as a frame work, the group modified the experiment slightly. The mix used to make the bubbles consisted of water, cornstarch, dish liquid, baking powder, and sugar. Sugar was used due to a lack of the glycerin ingredient the original instructions called for. The amount of sugar used was a little trial and error and was just poured in until the bubbles remain as stable as needed for the photographs.

This bubble mixture was framed using two varying lengths of string, the bottom, longer, string having a weight at halfway to provided some tension to the frame. These strings were tied between two dowel rods in order to extend them in front of the fog machine.

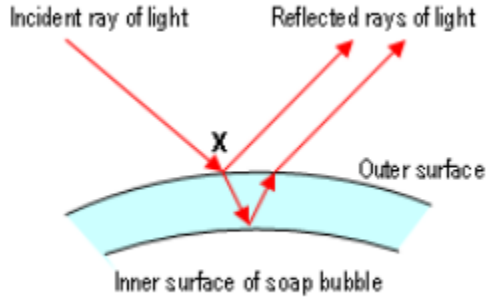
The fog machine is the most important part for this experiment as it served many purposes. On top of providing fog, the opaque nature of the fog was used in the night setting to bounce the light off of to further visualize the bubbles without disturbing the background. Further, the force of the fog leaving the fog machine was used to consistently push the bubble mixture out of its frame to form the bubbles captured.

The image displays two primary phenomena, surface tension and thin film light reflection. Surface tension is the phenomena that gives the bubble its shape and allows it to holds its shape. Surface tension occurs due to cohesion forces between fluid molecules. The molecules at the outermost and innermost layer of the fluid do not have molecule neighbors on all sides and thus adhere more strongly to the neighbors they do have. Below is a diagram that reflects this.



Surface Tension [3]

The other phenomena being displayed in the image is the reflection and refraction of light. This is how the bubble has varying colors of the rainbow. Light refraction says that the angle of the light entering a different medium will change based on the thickness of the medium. Different wavelengths will also have a different angle. This phenomena can be seen most directly by shining a white light into a prism and seeing a rainbow come out. In this specific example, the bubble is thin enough, estimated at around 600 to 700 nm, to allow for constructive and destructive interference between the rays of refracted light.[7] Light reflection says that the angle out board is related to the incoming angle of light varying but the quality of the reflecting surface. For this experiment, the bubble had varying wall thicknesses around the bubble thus causing the different wavelengths being reflected off. Below is a diagram of these two phenomena in parallel.



Reflection of light [1]

Photographic Technique

The photograph is taken on a Nikion D5100 digital SLR camera. The lens used has a focal length of about 50 mm. The specific picture used a f-number of 1.4-2 split and a shutter speed of 1/800 seconds. The ISO used was set automatically by the camera and is found to be 800. The resulting image has a size of 4928 x 3264 pixels. The idea behind using these settings was to preserve the detail in the bubble and fog cloud as much as possible while using very limited low light sources. The light source was a 13 W bulb. The bubble itself was about 3 feet in length and 2 feet in diameter. Below is the original image captured.

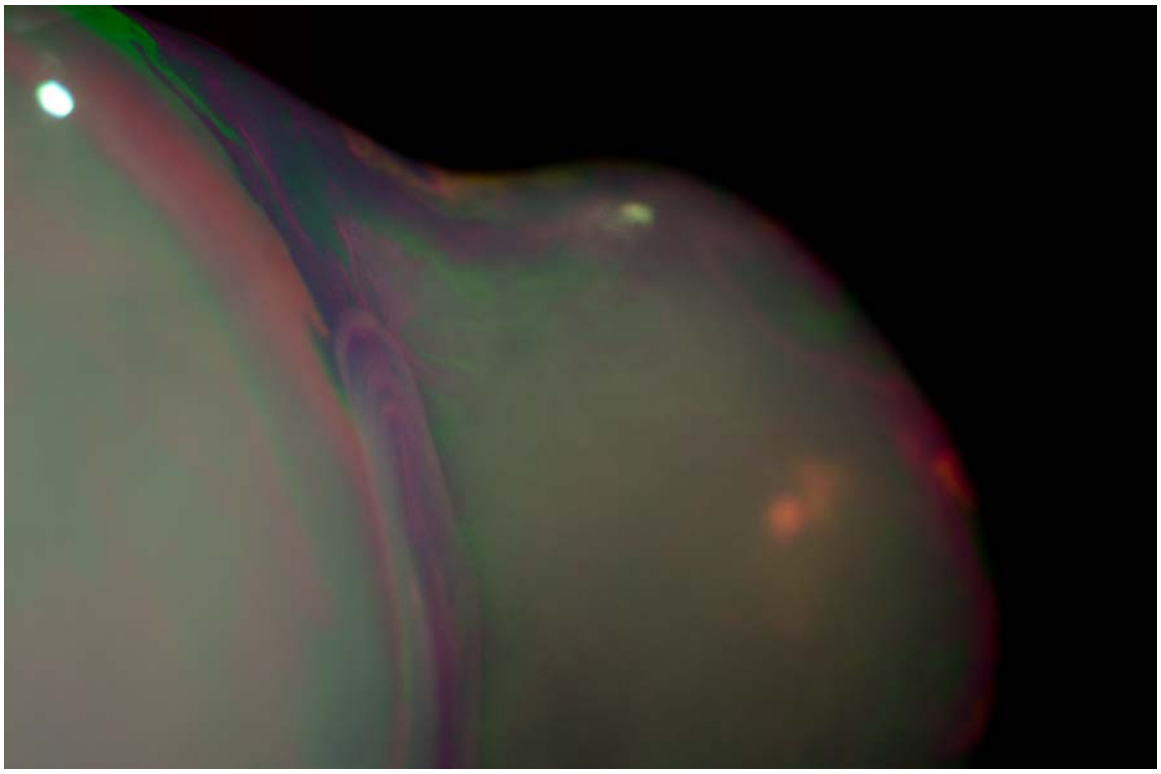


Figure 2: Original image

Post processing was performed on the image using Photoshop Elements. The saturation was heavily increased to give the rainbow more of an effect. Contrast is increased from there to add differentiation to the separations of the rainbow colors. Contrast was increased only slightly to turn off that black background, but too much provided an image that was much too dark in the subject. Brightness was increased slightly, too much provided the fog washing out the image.

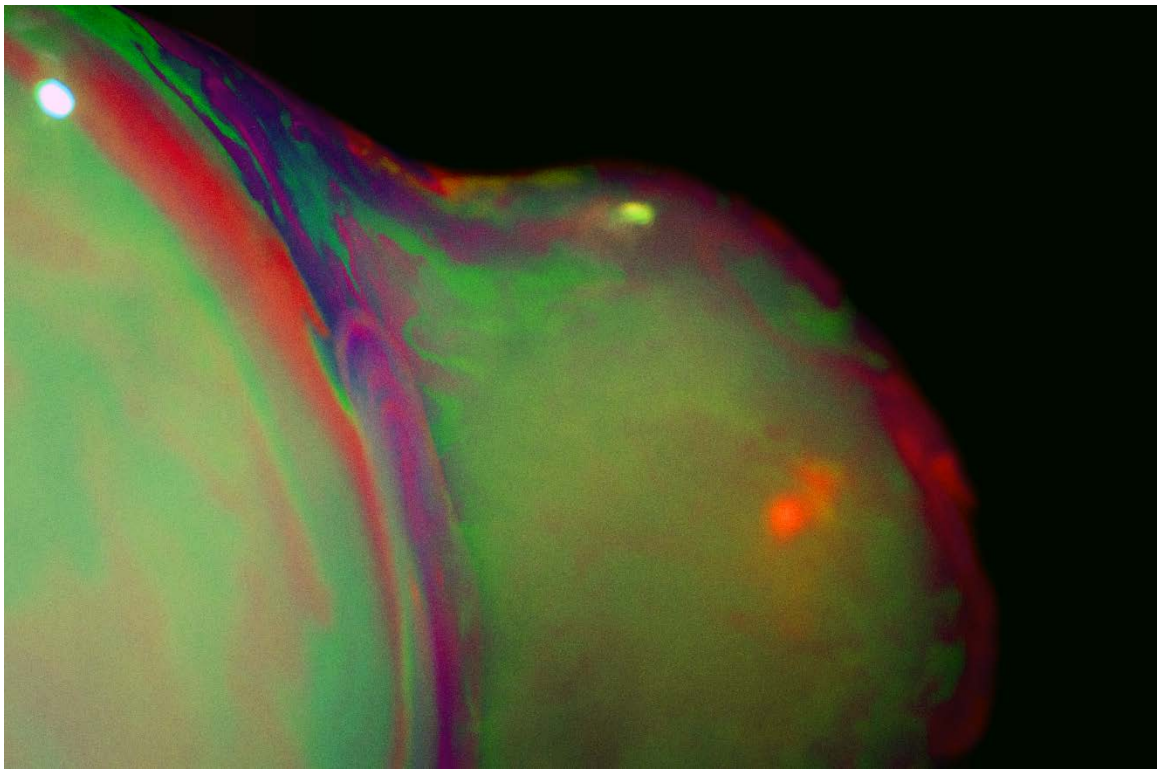


Figure 3: Image after post processing

Conclusion

While the group was unable to capture its original planned image due to environmental factors, we are quite pleased with the way the bubble pictures turned out. If this experiment had to be done again some minor changes would be made, mostly in the realm of planning as plan B is never expected. First off, waiting for no wind. The night of the photoshoot there were intermittent gust of wind that would disrupt or pop the bubbles. Once this occurred, we waited for the wind to die down to continue the experiments. Second, a solid black background. The background used was a unlit backyard, but if shutter speed was too low, the pictures started to reveal detail of the yard, not the black background we wanted. Third, either a larger soap bucket or a smaller bubble frame. Both, over the course of the experiment, became unwieldy.

Reference:

[1] Steven hendricks. (2015). *Get Wet Report*. Retrieved 13 November, 2015, from http://www.colorado.edu/MCEN/flowvis/galleries/2011/Get-Wet/Reports/Hendricks_Steven.pdf

[2] Jaewon kim. (2015). *Get Wet Report*. Retrieved 13 November, 2015, from http://www.colorado.edu/MCEN/flowvis/galleries/2011/Get-Wet/Reports/Kim_Jaewon.pdf

[3] Gsuedu. (2015). *Gsuedu*. Retrieved 13 November, 2015, from http://hyperphysics.phy-astr.gsu.edu/hbase/surten.html

[4] Jean hertzberg. (2015). *Particle Generation Continued*. Retrieved 13 November, 2015, from http://www.colorado.edu/MCEN/flowvis/course/Lecture2015/19.Particles3.pdf

[5] Instructablescom. (2015). *Huge Bubble Maker*. Retrieved 13 November, 2015, from http://www.instructables.com/id/Huge-bubble-maker/?ALLSTEPS

[6] Sciencelearn hub. (2015). *Reflection of Light*. Retrieved 13 November, 2015, from http://sciencelearn.org.nz/Contexts/Light-and-Sight/Science-Ideas-and-Concepts/Reflection-of-light

[7] Color and Film Thickness. (n.d.). Retrieved December 16, 2015, from http://soapbubble.wikia.com/wiki/Color_and_Film_Thickness