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MCEN 4151-001
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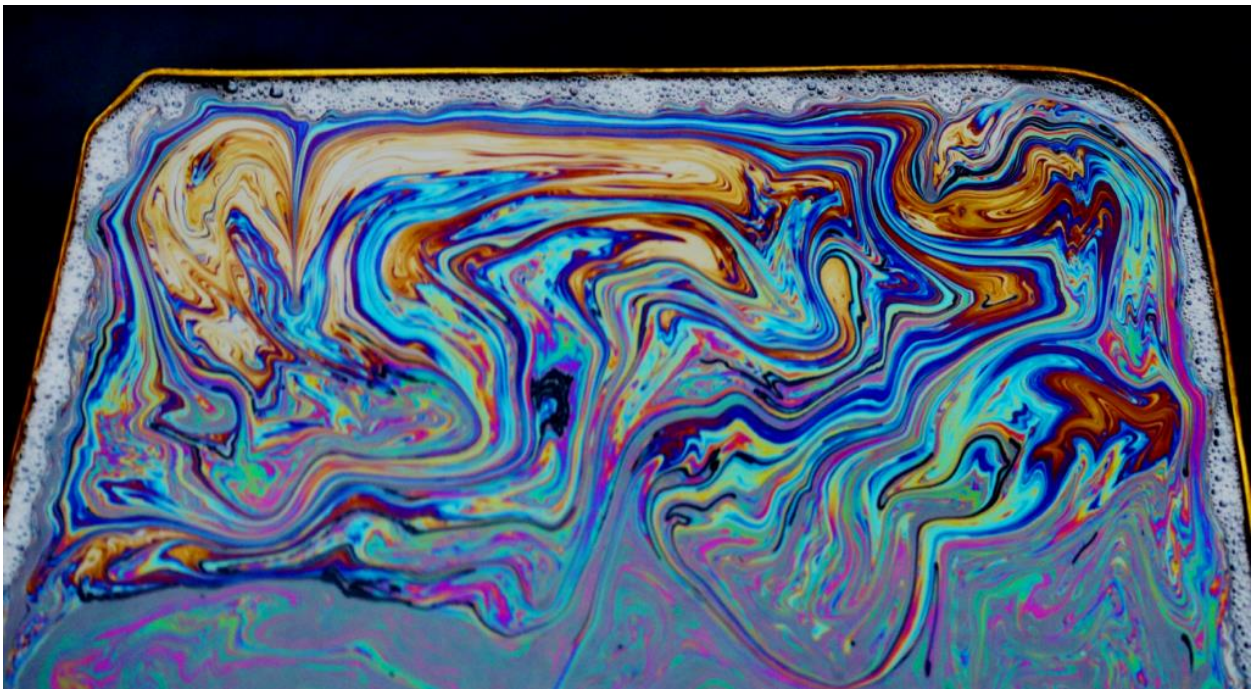
Team Third

Assisted By: Michael Karns, Charles Keeley, & Max Rodgers



My team for Fall 2018 includes Max Rodgers, Charles Keeley, Michael Karns, and myself. Our team idea involved observing thin film refraction. When a thin film of soap is exposed to the sun, different colors can be observed. Finding the right ratio of water, dish soap, and sugar took some trial and error as the film was often not strong enough to support itself in the beginning trials. Once the recipe was perfected, the team was able to consistently create thin films of soap displaying marvelous colors.

The water, dish-soap, and sugar solution was mixed in a large, thin cooking pan. A metal coat hanger was bent into a square with a handle to dip into the mixture. The team would dip the coat hanger underneath the surface of the mixture, then lift above the surface, hopefully leaving a thin film of soap inside the square of the coat hanger. During early trials, the team would add sugar and dish soap until the soap became strong enough to support itself. Waiting a few minutes seemed to yield the best results as the colors became more vibrant. The coat hanger was then held at a 45º angle for photographs. The experiment was performed outside as it was just beginning to snow with heavy overcast with only sunlight as our primary light source.

These colors are caused by thin film interference which occurs as a result of light waves reflecting off both the top and bottom surfaces of a thin film. The reflected rays are then out of phase of each other, their phase difference determined by their reflection separation distance. The figure below displays are physical representation of this phenomenon and how light waves refract inside the film and leave as multiple colors.

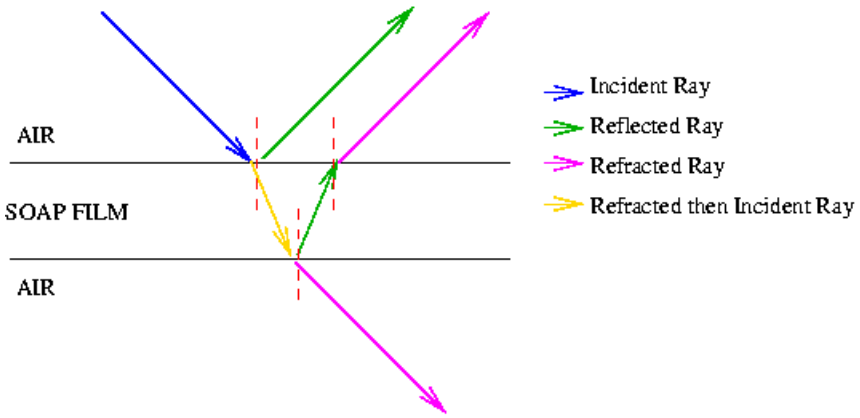


Figure 1: Thin film interference [1]

Different thicknesses of the film will yield different colors. The figure below shows at what thicknesses certain colors are visible.

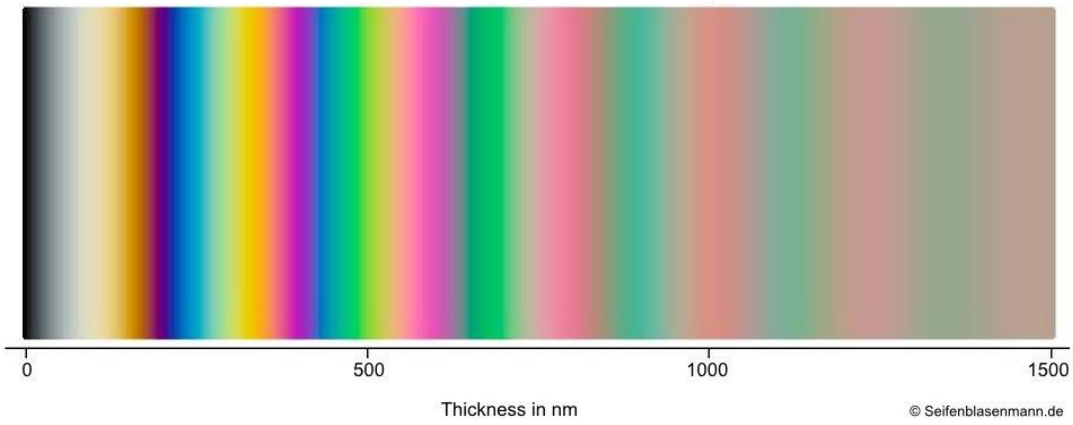


Figure 2: Color seen from thin soap films at varying thicknesses [2]

The field of view was about 8 inches, with the coat hanger being about 6 inches wide. The coat hanger was held about 3 feet from the camera, with the image being captured over the shoulder of the coat hanger holder. The camera model used for this photo was the Canon T6i Rebel. The original image has a width and height of 6,000 x 4,000 pixels and the final image has 1300 x 842 pixels. The aperture was f/5, the shutter speed was 1/80 sec., and the ISO setting was 800. The figure below shows the original image.

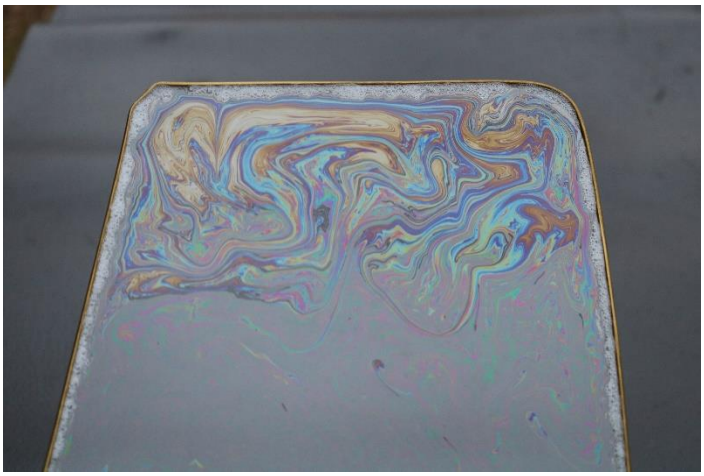


Figure 3: Original image

In post-processing, a color curve was applied to the image to darken the background. The photo was also cropped as seen in the final image. The figure below shows the curve applied to the image in post-processing.

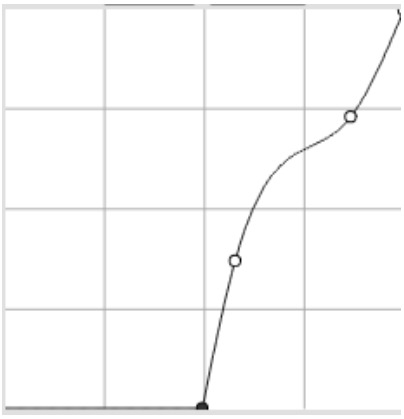


Figure 4: Color curve applied in post processing

I was extremely surprised how vibrant the colors turned out, even before post-processing, especially on an overcast day. One mysterious phenomenon that our team noticed was that the colors would seem to "solidify" as the film was exposed to the freezing (< 32ºF) air. When the film popped, the colors would still stay relatively static as it fell until it fell back into the mixture, almost as if the colors had been "painted on". It would have been nice if the bottom half of the image was as focused and vibrant as the top half, and also if the coat hanger was at a 90º angle to the camera for a more symmetric view. Overall, this was a fun team project and I'm very happy with my final image.

References

[1] Davis, C. L. (n.d.). Interference from Thin Films. Retrieved December 17, 2018, from http://www.physics.louisville.edu/cldavis/phys299/notes/lo_intthinfilm.html

[2] Color and Film Thickness. (n.d.). Retrieved December 17, 2018, from http://soapbubble.wikia.com/wiki/Color_and_Film_Thickness