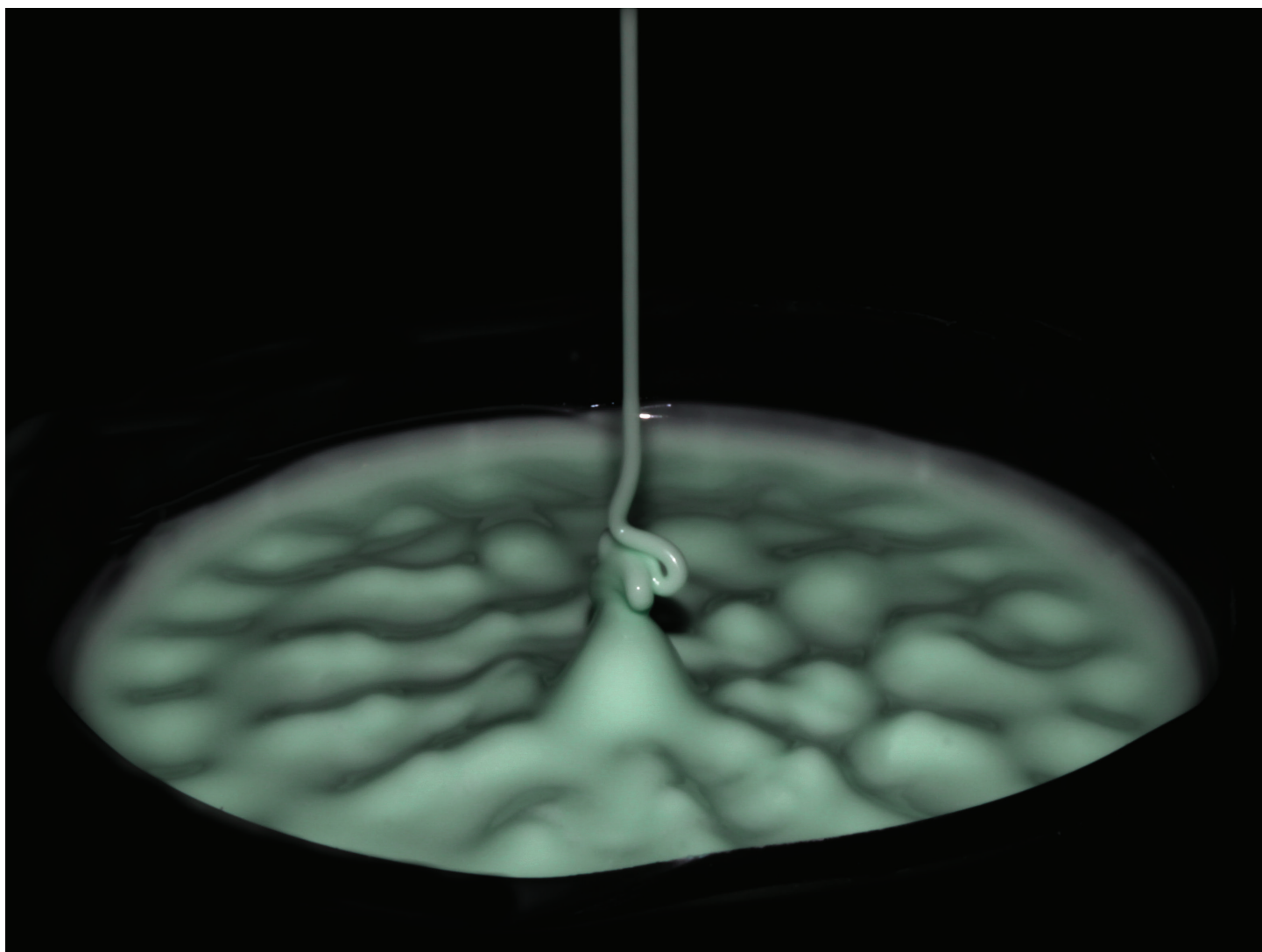


Solid Liquid: Report

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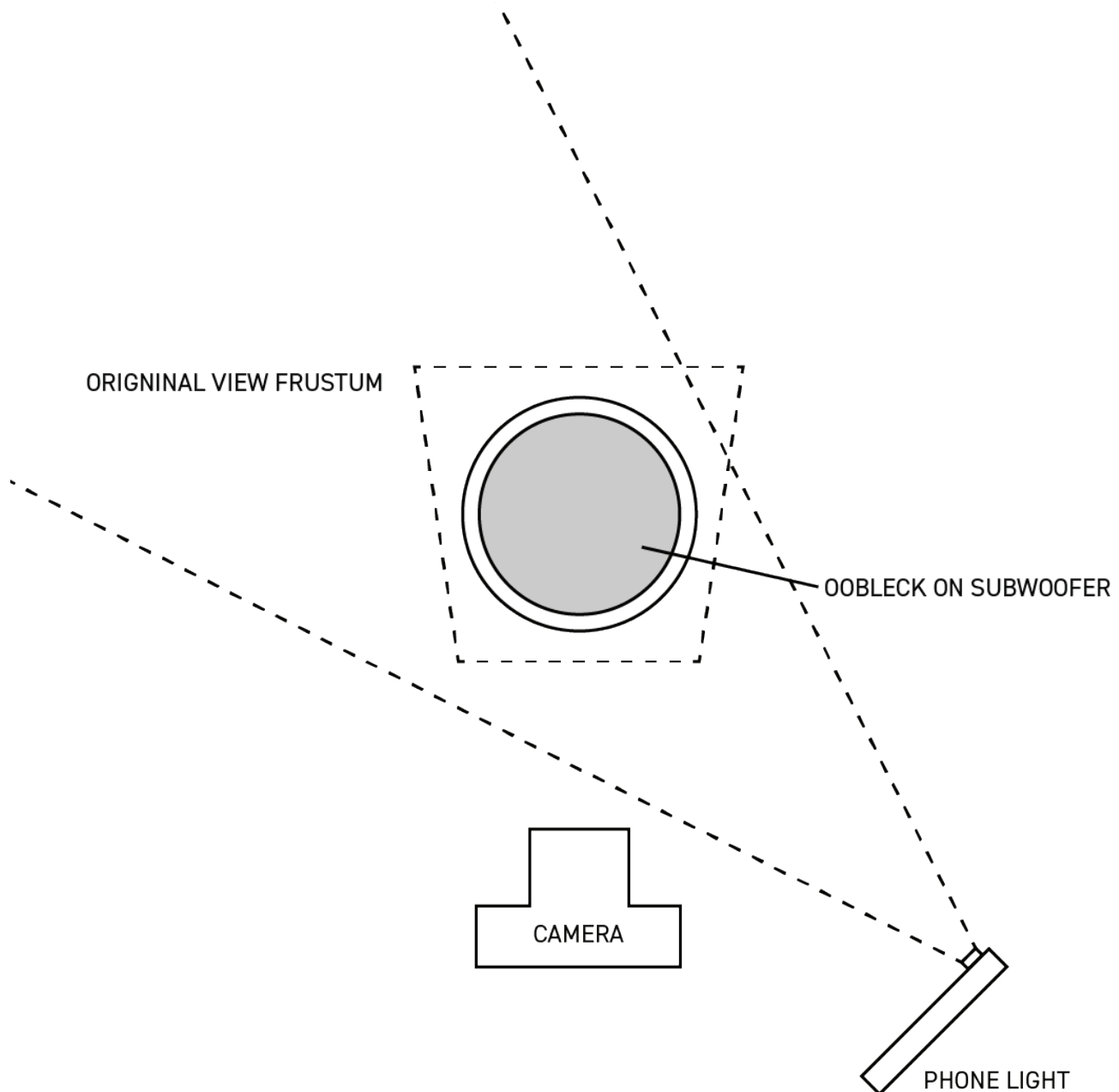


BACKGROUND

This image was taken on November 1st, 2022, with help from team member Isaac Martinez. The image shows a macro view of the standing waves formed in green oobleck. Originally we planned on taking a video of the fluid assuming that the standing waves would appear still in the video. However we could not get the framerate of the video and the frequency of the speaker to match and all our videos ended up blurry. After realizing this we decided to try and capture liquid and solid regions of oobleck interacting instead.

SETUP

This image was taken with the oobleck sitting on the 3 in subwoofer of a JBL Charge 4 bluetooth speaker. The speaker was set to emit sound at 65 hz, a frequency that we found produces good standing waves. Finally more oobleck was poured from about 5 in above the pool of oobleck. The camera was close to the oobleck, probably around 4 in away, looking down at about 30 degrees. To its right, about 60 counter clock-wise around the oobleck, a phone flashlight was used to light the scene from 5 in.



PHYSICS

There are two primary physical phenomena that can be observed in this image. The phenomena is the standing waves that form on the surface of the oobleck, and the second is the pile of solidified oobleck in the center of the image. These are caused by very different things, but together they create a cool effect.

The standing waves are likely observed because the pool of oobleck is tightly enclosed by the walls of the speaker. These walls reflect any waves that hit them back into the pool of oobleck. Eventually many waves of the same frequency form and are reflected back into the pool. Because they all have the same frequency they resonate with each other and interact in predictable ways as they move across the oobleck. If two waves of the frequency pass by each other they will amplify their peaks and troughs when they align and flatten them when they do not. The walls and matching frequencies also cause this to happen in the same locations throughout the liquid.

The solid oobleck is caused by the long starch polymers oobleck is made of getting tangled under stress. If something is moving slowly through oobleck it gives the polymers in the suspension time to untangle themselves and move around each other. However if something is moved quickly through the oobleck it causes stress in the fluid and friction between the starch polymers as they quickly try to untangle themselves. This friction ends up in tight molecular knots that make the oobleck feel solid.

VISUALIZATION TECHNIQUE

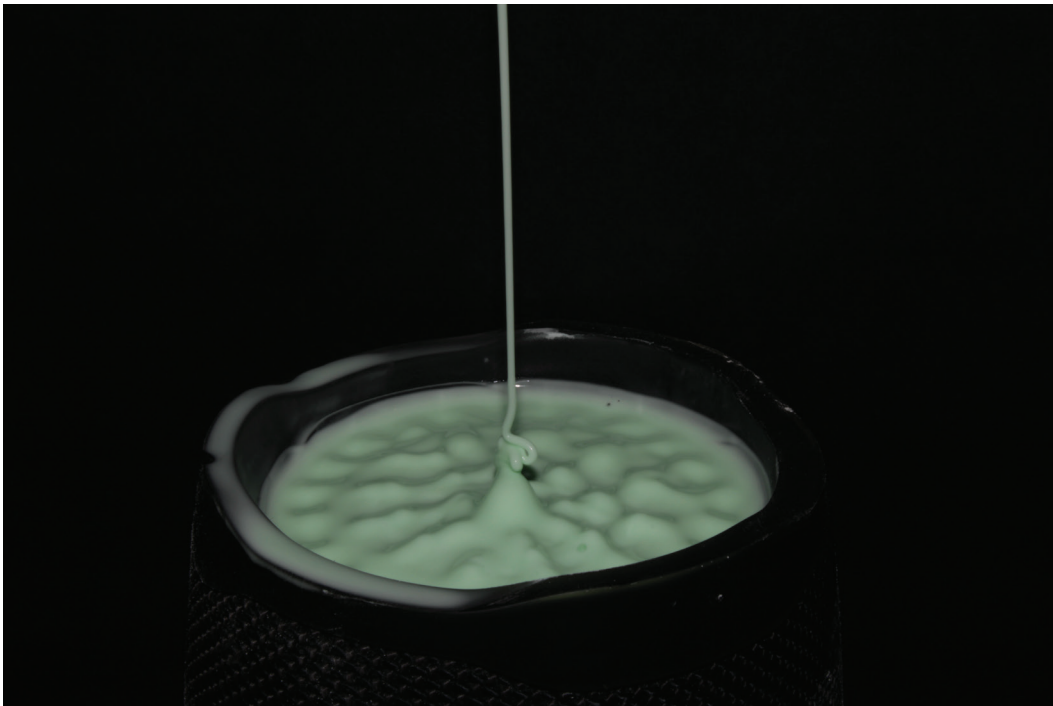
This is a simple boundary visualization, where we are visualizing the boundary between the green ferrofluid and the air around it. A phone flashlight behind and to the right of the camera was used to light the scene and all other lights were minimized.

PHOTOGRAPHIC TECHNIQUE

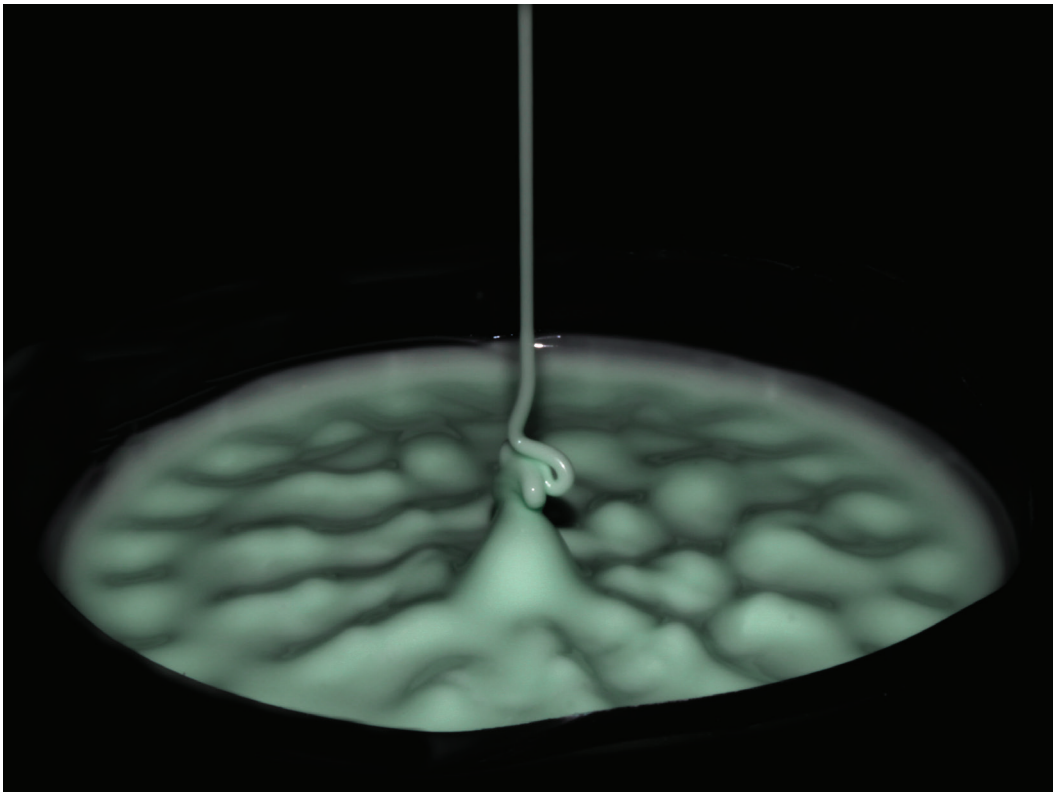
The image was taken with a Canon EOS Rebel T7. The focal length was 55mm, ISO was 100, f-stop was 36, and the shutter speed was 1/200 sec. I had two main concerns when taking this image. I wanted the image to be as large as possible, and fast enough not to be blurry, without the image being too dark. 55mm is the largest focal length I could produce with my current lens and produced the most magnification so I decided to use it. The phone flashlight produced a surprising amount of light and I was amazed I was able to keep the f-stop at 36 with the fast shutter speed and low ISO I was using.

The waves were annoyingly difficult to see in the original image, and most of the post processing went into getting them to be as visible as possible. This primarily consisted of raising the contrast and adjusting the curves to widen the narrow range of brightnesses in the original image. I also removed a lot of distracting residue from the edges of the speaker that was visible in the original image.

Unedited



Edited



REFLECTION

This visualization was extremely fun, it's always a pleasure to get to play with oobleck. It was also very interesting to experiment with the oobleck in an attempt to find different ways to get it to interact with its surroundings. The two most interesting interactions we discovered were the solidification and coliling observed in this image, and the spike observed growing out of the center of a nut in my partner Issac's image.

