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Image-Video #1
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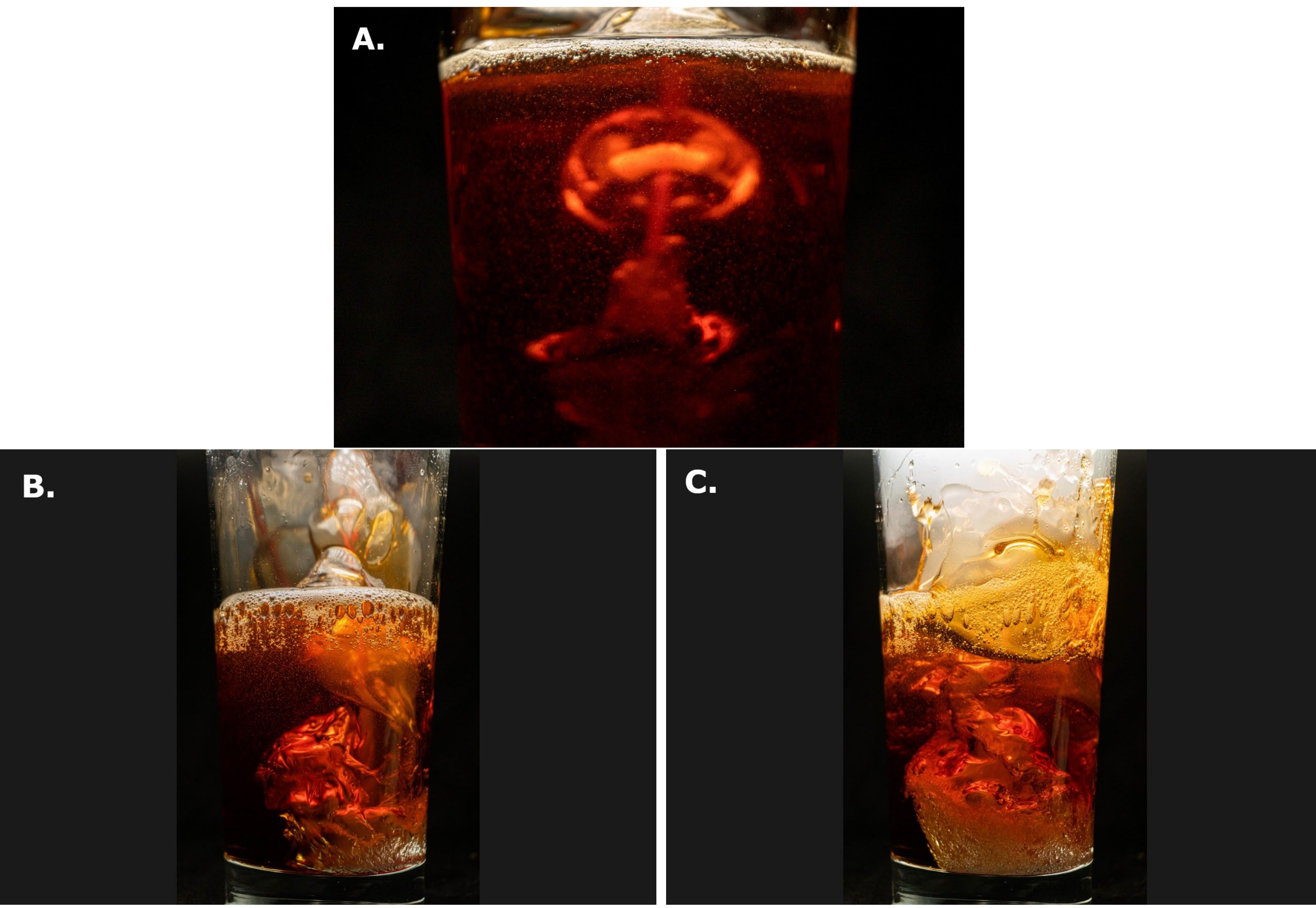
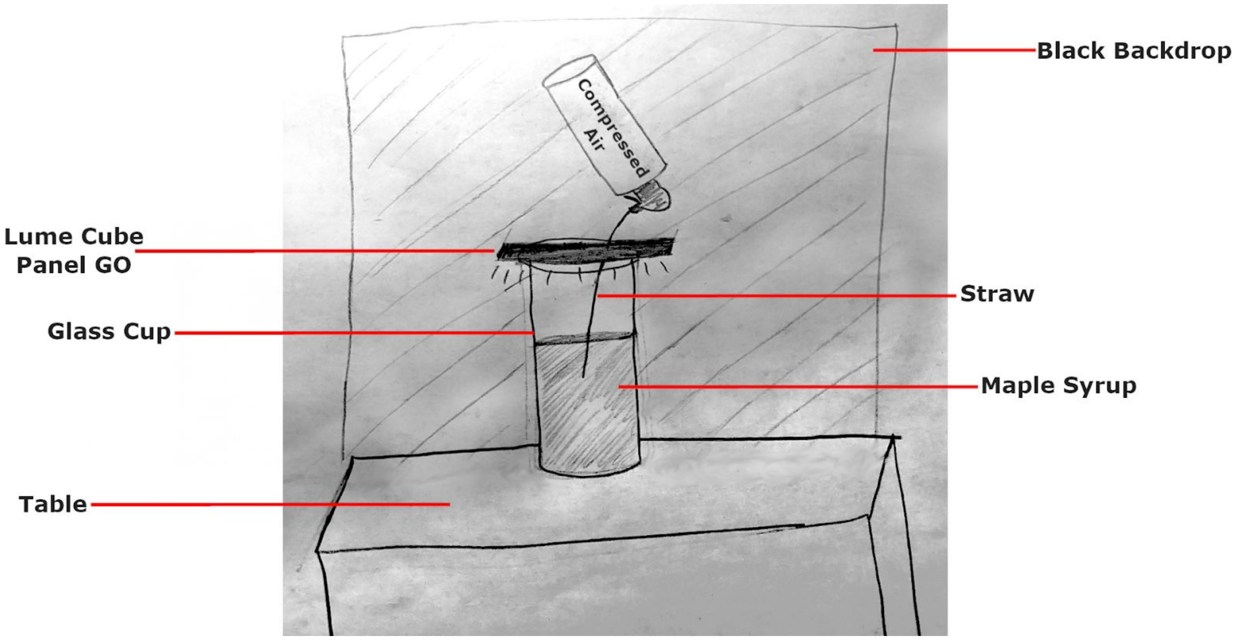
Flow Visualization: Aerosol and Maple Syrup

The goal of this project is to capture the unique properties of bubbles and aerosol interaction among a viscous fluid. The mediums chosen for this project were Maple Syrup and Compressed Air. Originally the execution of this experiment was to capture the interaction of fluids in real time or slow-motion video formats, but both proved to not have quick enough capture speeds. Instead, I opted for high shutter speed photography, in bursts of images that showcased changes in the flow over the course of



hundredths of seconds. The results of this experiment were the three selected images below.



The set up for this experiment was relatively simple. Please refer to the diagram above. All I used was a glass cup (approx. 6in tall, 3in diameter), a light source placed directly on top (slightly offset so there's an opening for the straw), and black backdrop. You may notice the lack of camera positioning in the diagram. This is because I changed the camera positioning multiple times during the shoot.

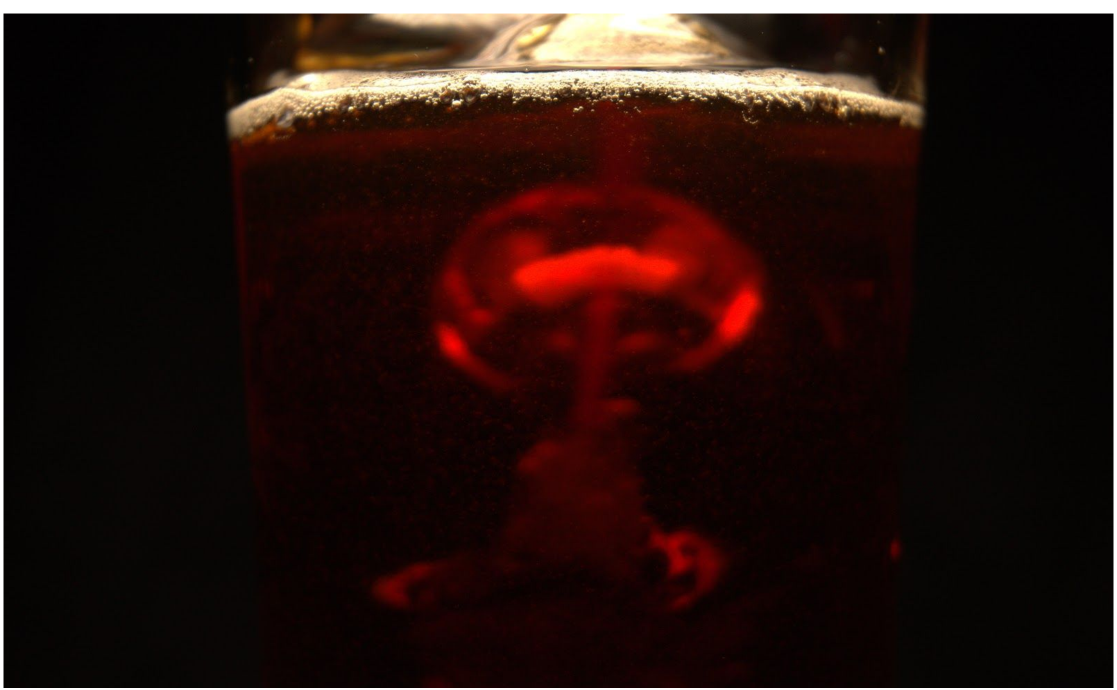
As for the flow specifically, there's a lot going on. Due note that from photo A to C, the flow is progressing forward in time. In A, you can see the flow beginning to form as a result of the vapor being released from the can, through the straw, into the maple syrup. Specifically, the pressure inside of the can is forcing the vapor out as I pulled on the trigger. You can see what looks like a mushroom cloud inside of the maple syrup, but it's actually a bubble filled with vapor rising to the surface. Above it, the surface is stretching into a dome due to the bubble pushing the syrup away from it. The surface tension is high, but still has yet to break. In B, the bubble we saw in A has popped, but more are on the way. As I held down the trigger on the compressed air can, bubbles were being created at a rate of ~5-10 per second. This creates a rotational flow, also known as a vortex, between the syrup and vapor, which we can start to see forming in B (Childs, 2011). At the top of the syrup, you can see some small bubbles along the side of the glass as the liquid height rises due to the space towards the bottom of the glass being taken up by the vapor bubbles. Finally, in photo C, we can more visibly see the vortex and the bubbles getting smaller, due to the increased pressure coming from the can. Also, a "smoke" starts to be released from the bubbles above the surface of the syrup, originating from the can. At this point the syrup becomes very chaotic and starts splashing and bubbling rapidly.

This experiment was aided visually by spraying the compressed air into the syrup with the can orientated upside down. This causes the hydrofluorocarbon liquid to be expelled from the can alongside the gas (air), creating a smoke-like effect (Chemtronics, 2020). This process is safe if not directly applied to the skin, and expelled in small amounts (UN Environment Programme, 2016). In my case, the experiment was contained within the confines of the glass. As for the specific materials used, the syrup was "Private Selection Grade A 100% Maple Syrup" purchased from King Soopers and the aerosol was "Insignia Compressed Air" purchased from Best Buy.

The lighting in this experiment was output from a Lume Cube Panel GO set to 100% power at 3500K. It was put inside a plastic sandwich bag to protect it from splashes, and placed directly on top of the cup. There was negligible practical lighting from the surrounding environment.

Since I needed to capture images very rapidly, I chose a 1/640sec shutter speed, which decreased the brightness of the images. To compensate, I set the Lume Cube output to at its max, I increased my ISO to 1600, and lowered my aperture to the f/5.6 minimum. I couldn’t lower it any more since my focal length was zoomed into 50mm. I chose to zoom so I could capture as much detail as possible, while still staying within focus range. For photo A, the end of the lens was positioned approx. 3in from the closest edge of the glass, and the camera was framed for landscape. For B and C, it was approx. 6in from lens to glass, and framed for portrait (camera had a 90° roll).

All images were shot in ARW format at 6024 by 4024 pixels on a Sony a6500 mirrorless camera. Images were edited in Adobe Lightroom 2020. A boost in the highlights and shadows was added to bring out details in the darker parts of the image, as well as a slight sharpness increase. This is what A looked like before any edits:



These images revealed to me that while a viscous liquid like maple syrup will react similarly to water, it will do so at a slightly slower rate, resulting with the forces created by the bubbles to become more visible on camera. I do believe it would be hard to get similar images with water, given the same camera limitations/settings. In the future, I would like to try this experiment on more liquids, especially something with an extremely high viscosity like molasses, which could allow me to capture the physics at a slower rate, with higher fidelity. I could even conduct this on a non-viscous fluid, which could create interesting results. But overall, I'm very satisfied with the results I obtained thus far.

Works Cited

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