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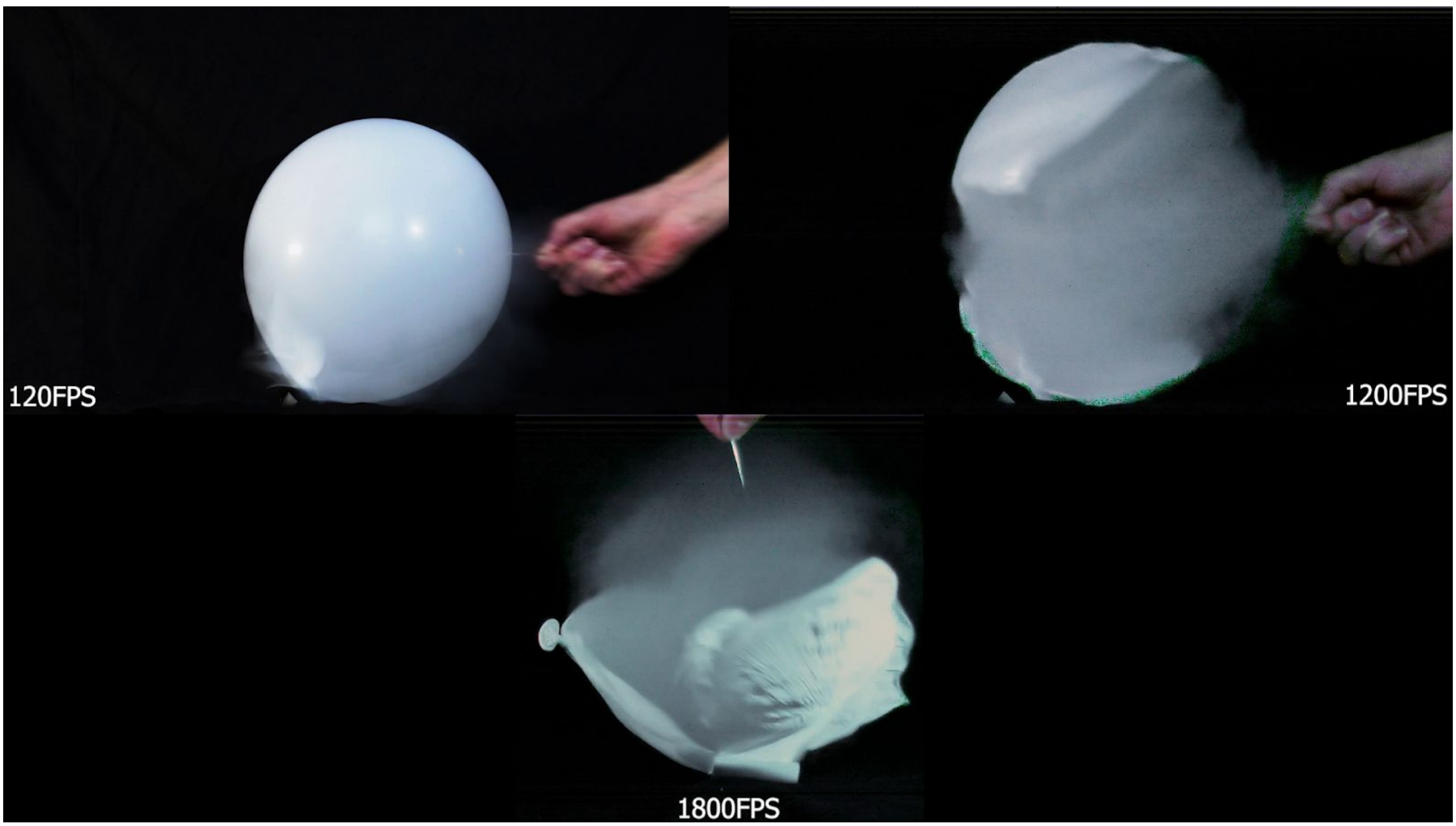
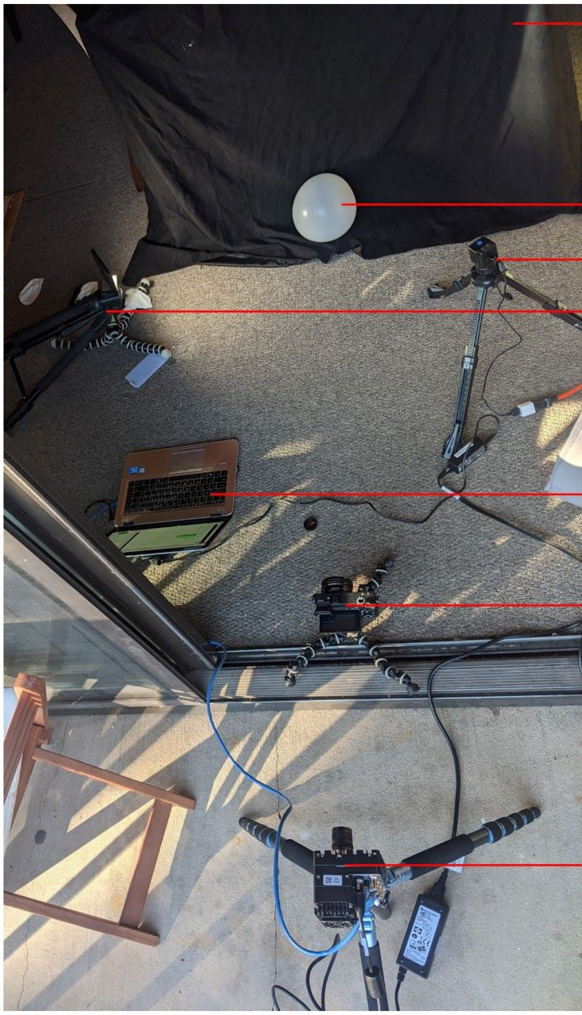
ATLS 4151-001
Image-Video #3
11/08/2020

Flow Visualization: Balloons and Gas Experiment

The goal of this project was to capture the effects of balloons popping in slow-motion, as well as the vortex properties of the expelled gas contained within. The medium chosen for this project was tap gas. The intended execution for this experiment was to record slow-motion video on one camera, but I instead opted to capture varying speeds at different resolutions, and using multiple cameras. The results of this experiment was this video: https://youtu.be/AmSAO2MG_oQ. Here is a still for reference.



The setup for this experiment was relatively straightforward. Please refer to the diagram below. I put a black backdrop against a table, and set a white balloon at the bottom. I used a bi-directional lighting set up, two lights coming from the right and left of frame at 45 degree angles, for highest contrast/detail. The cameras were positioned



36in - 48in from the balloon, attached to small tripods. The slo-mo cam required an additional laptop. After I started recording the cameras, I penetrated the balloon with a needle from the right of frame.

The moment the balloon pops is when the flow begins. For this experiment, there is vape gas inside the balloon, so the flow is visible. It's important to note that a balloon can pop in two different ways, opening regime (single break line) and fragmentation regime (multiple brake lines) (Ball, 2015). My needle caused the balloon to have an opening regime, so the flow of gas is relatively intact immediately after the pop. However, once the pop progresses, the quickly moving latex creates drag and wind, causing the gas to push away from its source. This creates noticeable movement and vortices, which are easy to see in the slow-motion footage. Soon after, the gas dissipates. What interests me about this experiment is the comparison to how water reacts in the same situation. In my previous experiment, I had a similar setup with water, but it abided by gravity whereas the gas is too light to be affected the same way. This resulted in two very different outcomes.

This experiment was aided visually by the use of a black backdrop, and bi-directional lighting. The goal was to showcase the detail in the moving gas, which it does. I tried different gases and light positions, and settled on a generic vape pen gas with the angled lights (plus natural lighting). Other materials included generic white balloons, tripods, and extension cables.

The lighting in this experiment was output from a Lume Cube Panel GO and Lume Cube V1, both set to 80% power at 3500K. They were put on tripods, angled at the subject from either side, about ~16in away. There was slight practical/natural lighting from the surrounding environment.

Shooting this was a trial-and-error experience. With higher framerate comes lower quality and vice versa. I started by shooting on both my mirrorless Sony a6500 at 120FPS*, 1920x1080p, and on the borrowed Phantom Micro C110 at 1200FPS, 1280x720p. These are the first 3 videos shown, played back at 100%, 20%, and 2% speeds. Note that the framerate of the final video edit is 24FPS, so frames are lost depending on the shot. However, the forth video shown is a new Phantom shot, which I chose to capture at the highest framerate for my setup, 1800FPS at 512x512p (1.33% speed). Finally, I showcased all the videos together, visualizing the different framerates. This is important because it gives the viewer context to how fast the flow was moving in real time.

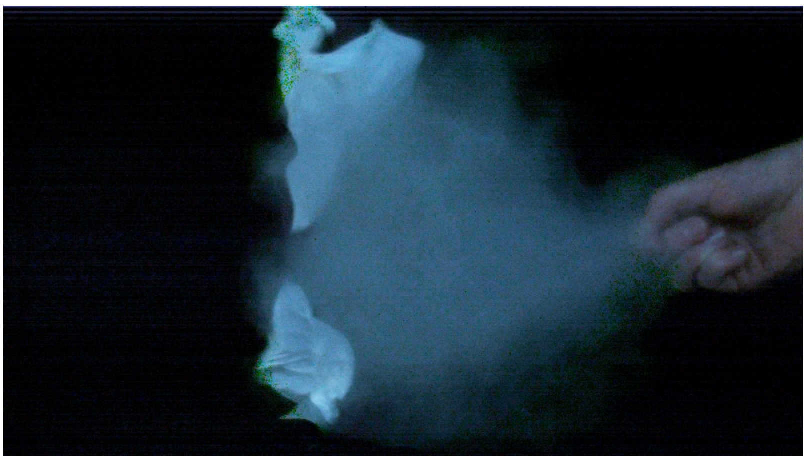
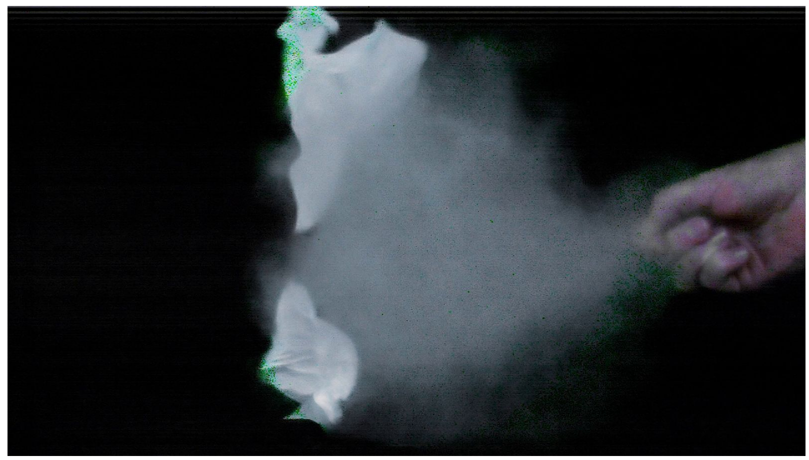
Additional Specs:

Sony a6500	*Phantom Micro C110*
Narrow FoV	Narrow FoV
~36in from center of balloon	~48in from center of balloon
Manual Focus	Manual Focus
1/125 Shutter Speed	Auto Shutter Speed
1250 ISO	Auto ISO
f/3.5 Aperture	f/1.4 Aperture
35mm Zoom	25mm Prime
Color grade: contrast boost, highlights & white levels decrease, and black levels slight decrease. All done to increase clarity and realistic flow depiction. Minimal cropping used. Edited in Adobe Premiere Pro 2020.	Color grade: contrast boost, color temp shift (towards orange), highlights & white levels decrease. **Advanced denoising and sharpening filters (Red Giant's *Magic Bullet VFX Suite*) used to correct noisy footage.** All done to increase clarity and realistic flow depiction. Edited in Adobe Premiere Pro 2020.
Digital	Digital

**Note: Framerate followed NTSC standards. For example, when referring to 24FPS, I specifically mean 23.976FPS (aka, 24 - (24 * 1/1000)).*

Sony a6500 before/after:


Phantom Micro C110 before/after:

These videos revealed a lot of the physics behind this flow that I was initially unaware of, since I experienced it in real-time. When slowing the footage down, you can really see how the gas moves in reaction to the pop. The biggest question that came up for me during this experiment was “How can I get the best image for showcasing the flow?”. In the future, I can see myself increasing fidelity by adding more powerful lights to the setup, to allow for higher framerates and less noise, as well as thicker gas for visualization.

Works Cited

Ball, P. (2015). Two Modes of Balloon Bursting Revealed. Retrieved from https://physics.aps.org/articles/v8/105