



**Team Second Project**

**MCEN-5151 Flow-Visualization 2024**

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- 1. Context and Purpose:** The purpose of this image was to visualize flow patterns by using a holographic sheet as background and to visualize Rayleigh Plateau instability as the flow phenomena. Holographic sheets have unique light reflective properties that can create dynamic visual effects because of light interaction. For this project Alex and Jessica helped me by bringing the materials that were required to construct our experimental setup, I tried assisting them with the setup and brought materials to do our experiment. I was having trouble focusing my camera, Jessica assisted me in doing that.
- 2. Flow physics:** To construct our flow apparatus, we took two wooden planks and set up our glass sheet over the planks, we then placed our background holographic sheet under the glass sheet, and we used a table lamp for the purpose of our lighting (figure-2). To visualize our flow, we have mixed dish soap with oil and water over the glass sheet. Oil and water do not mix with each other due to their difference in densities and surface tension, but due to the low surface tension property of dish soap, it reduced the surface tension of water making it easier for the oil to disperse in water. Other than changes in surface tension, I think Rayleigh Plateau instability (figure-1) takes place when a falling stream of fluid breaks up into smaller droplets and this instability occurs due to surface tension, which drives the fluid to lessen its surface area [1,2]. It mainly explains why fluid stream breaks up into droplets and Rayleigh Plateau phenomena is relevant in this experiment because I was able to observe the formation of oil droplets in water in the picture. Since, we have used a holographic backdrop, the incidence of light into the sheet causes diffraction, splitting light into multiple beams that reflect a spectrum of colors which explain why we were being able to see green and pink colors under the glass sheet.

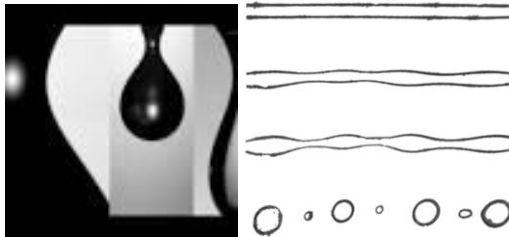


Figure 1: Rayleigh Plateau Instability adopted from [3],[4]

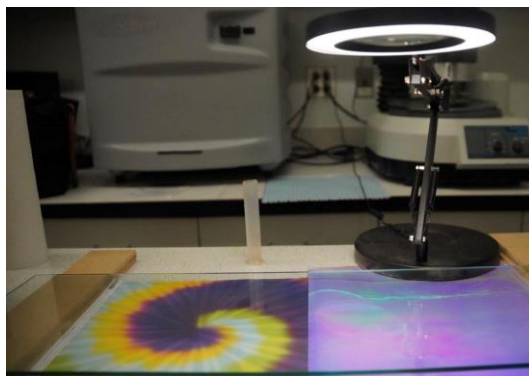
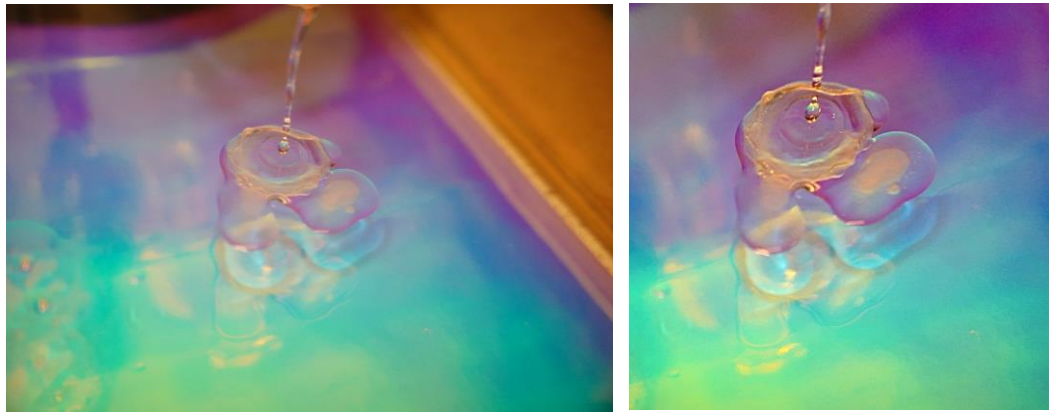


Figure 2: Flow Apparatus



(a)

(b)

Figure 3: (a) Unedited Image, (b) Edited image

- 3. Visualization Technique:** For the visualization technique, we have used clear coconut oil, water, a little bit of dish soap and a holographic pink light sheet as our background material. We began by adding a small spot of oil to the glass sheet, then built up layers by adding dots of water and dishwashing liquid to the center of the oil placed over the glass sheet [5]. As for lighting, we have used a table lamp and normal LED room lighting.
- 4. Image Acquisition Details:** Since we wanted to capture close shots of the bubbles and oil droplets formed, the distance between the lens and our object of interest was low. Sony alpha 7 was used to capture this image. This digital camera has a focal length of 28-70 mm, ISO range from 100 to 51200, and a 24.2MP full-frame Exmor R CMOS sensor. The picture was taken with an ISO of 10,000, focus of 42 mm, aperture of f/2.8 and a shutter speed of 1/4000s. The resolution of the original image is 1616\*1080 and the resolution of the final edited image is 1162\*1106 pixels. For image processing, I cropped the image and then I reduced the exposure, highlights and increased the overall contrast of the image so that the oil droplets in the image becomes more visible.
- 5. Conclusion:** The image reveals the visualization of flow patterns of oil, water and dish soap when a holographic sheet is used as a backdrop. It also shows the flow physics of Rayleigh plateau instability. I think the image fulfills my intent. However, it would have been better if I was able to use a macro lens for capturing the small bubbles and the flow patterns formed at a high magnification, allowing me to see the fine details of the flow dynamics.

## 6. References:

- [1]. [Plateau–Rayleigh instability - Wikipedia](#)
- [2]. <https://www.princeton.edu/~stonelab/Teaching/Oren%20Breslouer%20559%20Final%20Report.pdf>
- [3]. Li, Y., Zhai, J., Xu, D. *et al.* The study of Plateau–Rayleigh instability with DPD. *Eur. Phys. J. Plus* **136**, 648 (2021). <https://doi.org/10.1140/epjp/s13360-021-01599-2>
- [4]. [File:Pinch-off in two-fluid systems.webm - Wikipedia](#)
- [5]. [How to Create Abstract Photos with Oil and Water and a Little Dish Soap](#)