Fall 2018 Team Third Total Internal Refraction

MCEN: 4151

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INTRODUCTION

This is the second image produced by the team of Ivan Komodore, Justin Truong and Garrett Gerchar. For this image we wanted to visualize the total internal refraction experiment in which a laser light shot into a fluid flow cannot penetrate the outside wall of the fluid flow. We initially had an underpowered laser that would not penetrate through our vessel to shoot the laser into our fluid flow. This experiment provides a very interesting visualization of the total internal Refraction of light through a fluid flow.

SETUP, PROCEDURE, AND FLOW

To start we melted a hole into a Nalgene water bottle and sourced a high-powered laser pointer that was able to penetrate the outer layer of the Nalgene we were using as a vessel for our fluid flow. Next, we covered the hole of the Nalgene with some electrical tape and filled it with water which we would use as the fluid. The water was then diluted with about two tablespoons of coffee to give the light a medium to reflect off of and illuminate the fluid flow. We then aligned our laser from the adjacent side of the Nalgene to the hole so it would illuminate the fluid as it flowed out of the container.

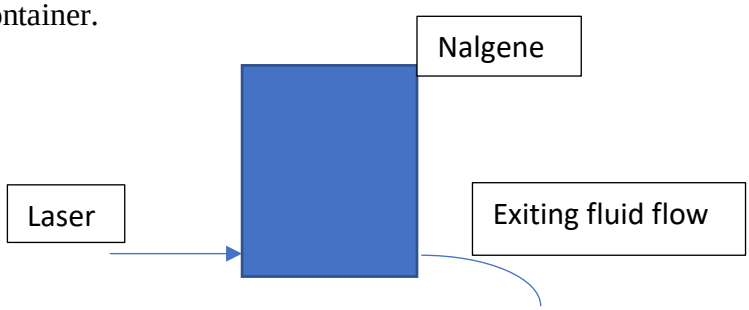

Figure 1: Experimental setup

After getting the setup as seen in Figure 1, person A (Garrett Gerchar) would engage the laser into the fluid flow while person B (Justin Truong) pulled the Electrical tape away allowing the fluid to flow. This then allowed Person C (Ivan Komodore) to hold the camera 8 inches away from the flow out of the Nalgene illuminated by the laser and capture the image of the flow seen in Figure 2.

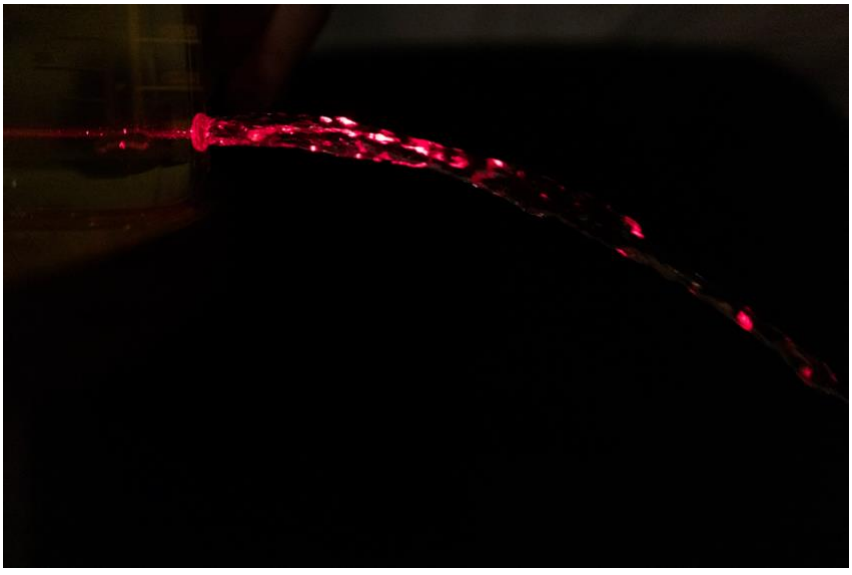

Figure 2: Original Image of Flow

Figure 2 shows the captured image of a total internal refraction of a laser light into a laminar fluid flow. You can tell this is a laminar fluid flow because it has a consistent form and looks still even though it has consistent flow in the regime photographed [1]. Laminar flow is able to form an outer boundary layer that doesn't allow the light to penetrate causing total internal refraction that can you see as the light bends through the fluid flow.

VISUALIZATION AND LIGHTING TECHNIQUE

This experiment was simple to setup since all information to be captured was the light illuminating the fluid as it flows. We turned all the lights off in the room we were photographing to ensure all data reached the camera. We did this because we wanted to capture the light encapsulated in the fluid flow. Illuminating the fluid with coffee gave it particulate matter the light could illuminate showing the flow as it traveled from the Nalgene. All that was needed was to capture the light illuminated internally in the flow.

PHOTOGRAPHING TECHNIQUE

The setup for capturing this fluid flow is relatively simple. The camera is about 6 inches from the water, coffee mixture as it flows out of the Nalgene. The focal length is 30mm. We used an exposure time of 1/2000 and an ISO of 6400. This Photo was taken on a SONY ILCE-6300. The photo went through post processing to produce Figure 4. The post processing done on this image was simply brightening the curves to bring up the red from the laser as it illuminated the particles in the fluid flow.

IMAGE AND CONCLSUION

Figure 4 shows how the fluid flow captures the laser light and its total internal refraction within the fluid flow. I really like how you can clearly see the laser light within the fluid and its first bend within the fluid. The information within the photo hides some of the physics of the total internal refraction as it flows but shows how the laser light is encapsulated in the fluid flow. Why does the fluid exhibit laminar flow even at slow speeds? Is there a critical speed of water that exhibits laminar flow? A more high-powered laser and nicer camera would greatly improve this experiment.

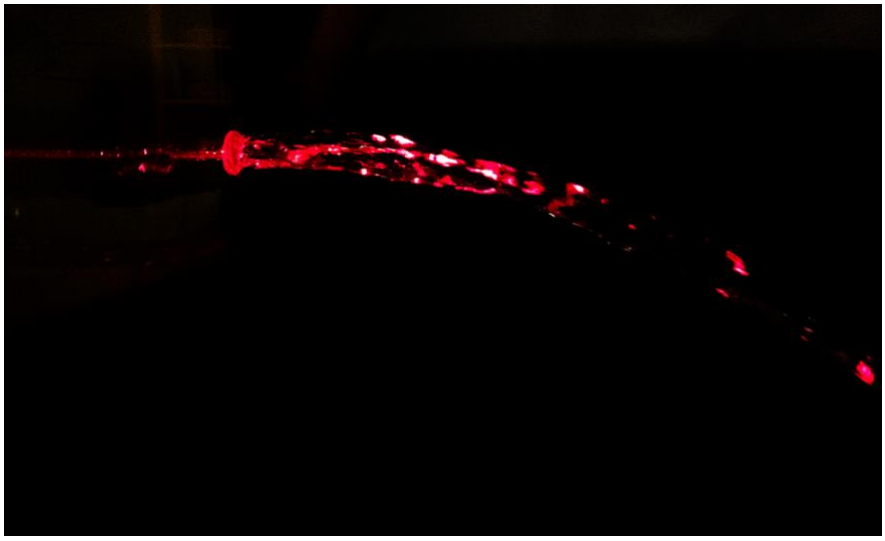

Figure 4: Final Production Image

REFRENCES

"Laminar flow" Accessed 12/18/18.
https://www.britanica.com/science/laminar-flow