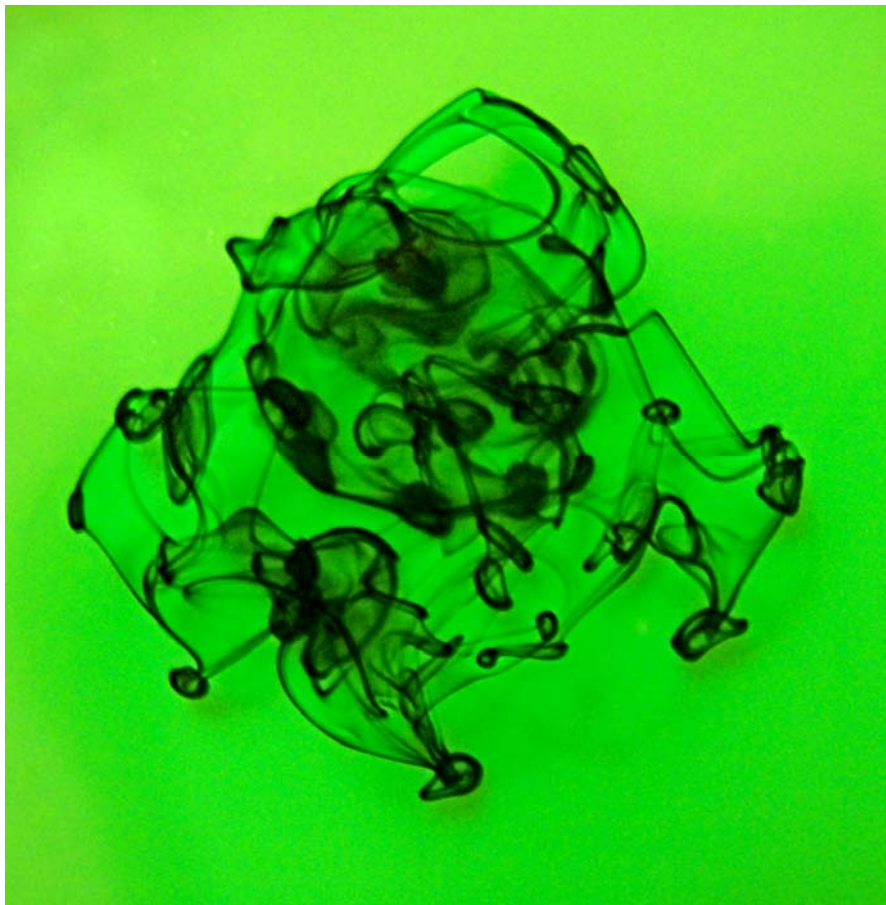


# Assignment #1: Get Wet

Joseph Van Amberg  
Flow Visualization

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# Introduction

The purpose of this assignment was to capture a phenomenon of an interesting and intriguing fluid flow. I chose to capture an image of a single drop of green food coloring dropped into a bowl of water. The phenomenon I was trying to observe is known as Rayleigh-Taylor instability. Since food coloring is slightly denser than water, it will sink in water when not mixed together. As the food coloring sinks to the bottom of the bowl and disperses through the water, a fascinating flow can be seen.

## Body

In order to capture the flow of the dye I used a white bowl filled with water, dropped in one drop of green dye from above, and took the picture from above.

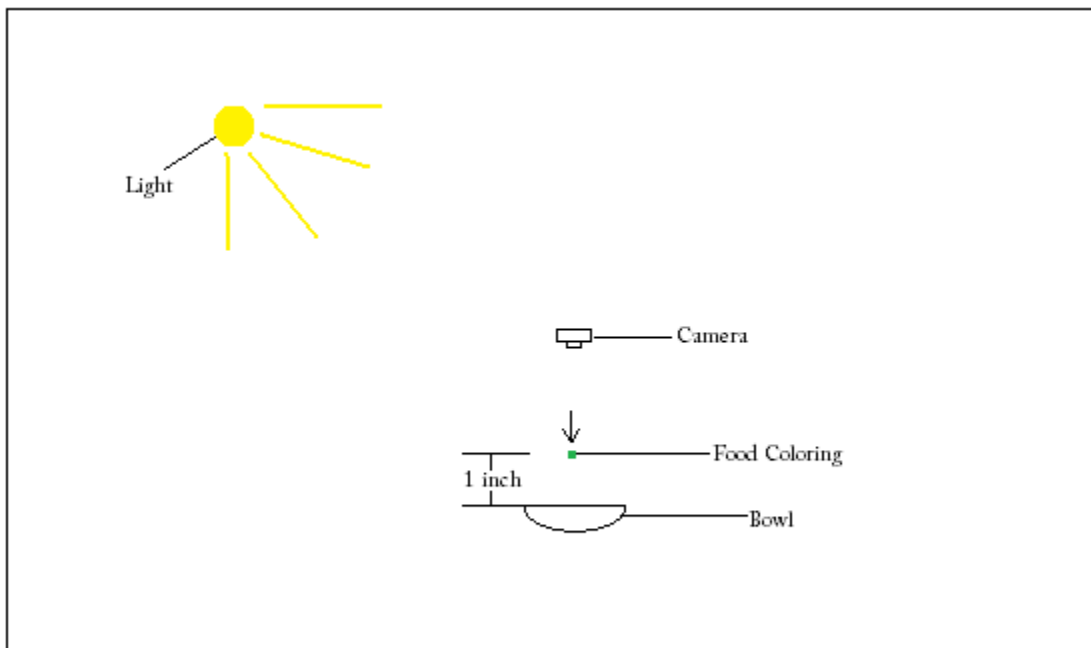


Figure 1. Setup

The type of flow phenomenon that arises from this situation is known as Rayleigh-Taylor instability. In this case, the phenomenon occurs from the higher density food coloring being on top of the lighter density water, which creates an instability. As gravity pushes the denser food coloring down through the water, interesting flow patterns emerge. As the denser fluid sinks deeper into the less dense fluid, instabilities arise that are known as Rayleigh-Taylor fingers. They move downward in this situation and also have been termed 'dimples'. The drop of food

coloring has an estimated Reynolds Number of 1410 the moment that it enters the water, which suggests that the initial flow through the water is laminar. After five seconds, enough interference had developed in an area of approximately 6" by 5" to create an intriguing image. The exposure time was only .072 seconds, so the flow did not move enough during exposure to make a noticeable impact on the image.

In order to create the image, I used a white bowl approximately eight inches in diameter at the top of the bowl and filled it with approximately two inches of water. A single drop of green food coloring was dropped into the center of the bowl from approximately an inch above the water. The picture was taken from around one foot above the bowl focusing on the point where the food coloring impacted the water. Around five seconds passed between the time the food coloring impacted the water and the picture was taken. This was necessary to allow the flow to develop. The light source was from a 60 Watt light bulb positioned around five feet above the bowl but several feet off to the side, so as to eliminate any reflection of the bulb in the water when viewed from above. No flash was used to obtain the image.

The apparatus used to capture the image was a 5.2 mega pixel Fujifilm FinePix A350 digital camera. The final image had a pixel width of  $X=1348$  and a pixel height of  $Y=1382$ , while the original image had a pixel width of  $X=2592$  and a pixel height of 1944. The focal length of the lens was 5.8 mm. The field of view was approximately 6" by 5". The distance between the object and the lens was approximately 12". The aperture was set to  $f/2.8$ . The shutter speed was set to  $5/69^{\text{th}}$  of a second. The ISO was set to 100. The image was manipulated using both iPhoto and Photoshop. In iPhoto, the tint and exposure were slightly adjusted. Also, the retouch effect was used to eliminate a few white spots in the background of the image. In Photoshop, the clone stamp was used to further eliminate the white spots in the background. The image was then cropped in Photoshop.

## Conclusion

In the image, the "dimples", or Rayleigh-Taylor fingers can be easily identified. They are the circles that have formed mainly around the edges of the dye. I like the way that the image portrays the dimples from a top view. The image does not show the depth of the dimples formed in the picture, which could provide more understanding of the physics occurring in the situation. Overall, I really enjoyed my image. A higher quality camera could have captured a better picture, but I think that my image sufficiently demonstrates the physics in the situation. An additional picture at a side view would have helped more in visualizing the situation.

## References

[http://en.wikipedia.org/wiki/Rayleigh-Taylor\\_instability](http://en.wikipedia.org/wiki/Rayleigh-Taylor_instability), 12/11/08. Wikipedia. 2/1/09

[http://en.wikipedia.org/wiki/Reynolds\\_number](http://en.wikipedia.org/wiki/Reynolds_number), 1/30/09. Wikipedia. 2/1/09