Get Wet Report

Alex Zinman
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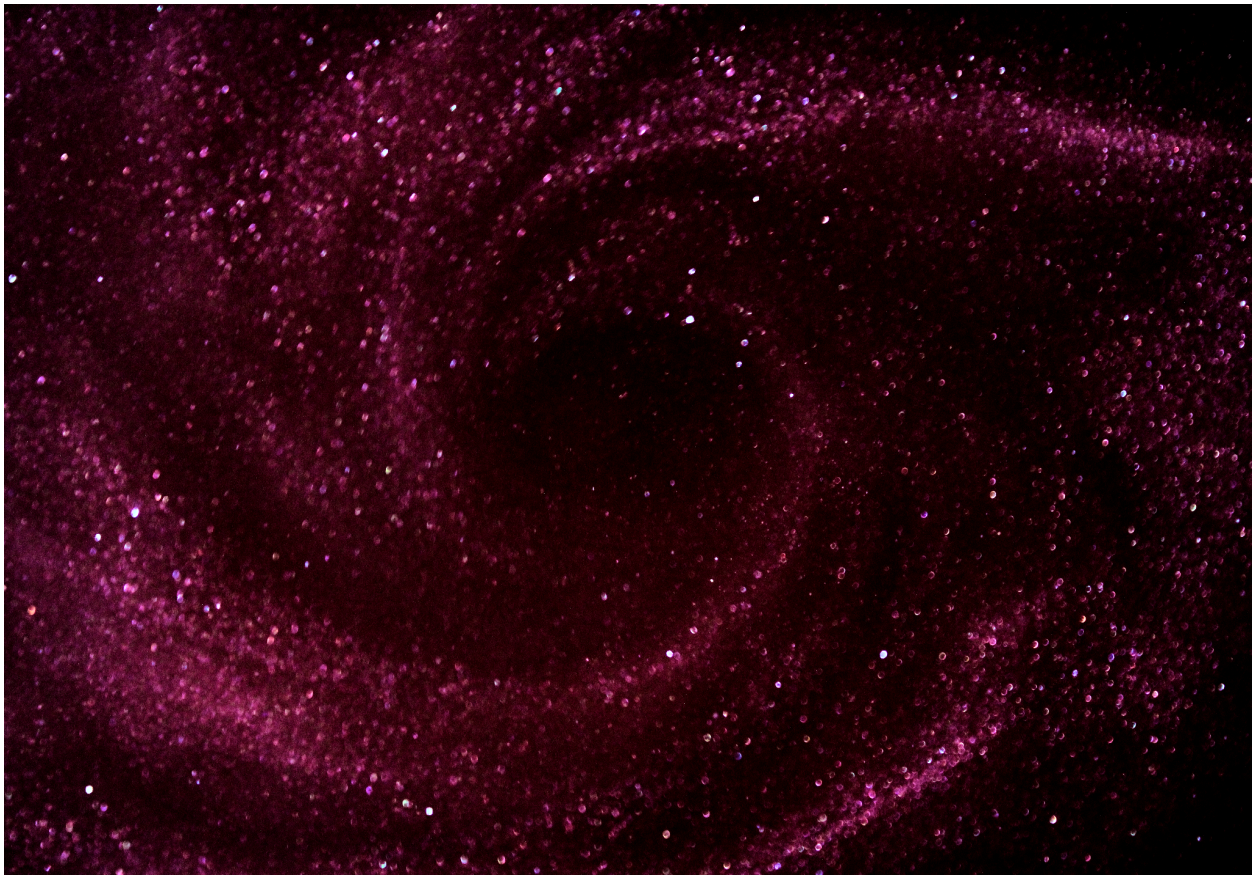

Figure 1. Final Image of Vortex Formed by Stirring Shimmery Water in a Container

Background

This image was created for the first visualization assignment of the Flow Visualization course: Get Wet. The image is a snapshot of shimmery water after being stirred with a spoon. The intent of this image was to visualize how the metallic shimmer in the water reflected the fluid flow when disturbed. The main phenomenon I intended to show was a vortex in the water. Initially, I was taking images from the side of the container to visualize how the pigment moved around in the water. I changed my tactic and intention halfway through my experiment, moving on to photographing how the shimmery edible glitter highlighted the fluid flow, specifically a vortex created by swirling a spoon in the water. The final setup involved stirring the water and edible glitter mixture to keep the pigment evenly distributed and taking continuous pictures of the top of the fluid after removing the spoon.

Fluid Physics

The flow apparatus used in this experiment is a container with 4 walls and a bottom, filled with water mixed with the edible glitter to create a heterogeneous mixture, and stirred with a metal tablespoon as seen in *Figure 2*.

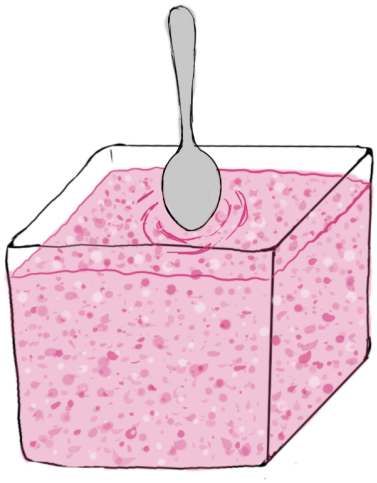

Figure 2. Sketch of Flow Apparatus

The vorticity in the fluid defines a vortex and is often associated with fluid rotation along a centerline. By swirling the spoon in the water, turbulent flow was created on the surface,

creating the ridges seen in the vortex. The Vortex itself is created by a no-slip condition on the walls, where the friction creates zero velocity along the walls. When the spoon stirs the water in the center of the container, the water starts to separate from the spoon due to centrifugal force. Due to gravity, the water begins to slide down a ramp created by the forces. The fluid motion is described by its velocity $\mathbf{u} = u\mathbf{i} + v\mathbf{j} + w\mathbf{k}$, where u represents the velocity component in the x-direction, v represents the velocity component in the y-direction, and w represents the velocity component in the z-direction. The fluid vorticity is $\omega = \nabla \times \mathbf{u}$ also known as the gradient of **u.** As observed in *Figure 1*, the "bumpy" parts of the vortex that look like folds are due to the waves made on the surface by moving the spoon. These waves then get sucked into the vortex which creates the effect which can be seen by the darker and lighter sections that can be seen swirling into the center.

Visualization Technique

The visualization techniques used to capture the final image (*Figure 1*) are easy to replicate. The setup involved a clear container filled with 4 cups of water and ½ tbs of CAKECRAFT edible rose gold glitter dust, shown below in *Figure 3*. This heterogeneous mixture was then stirred throughout the photographic process to maintain the dispersion of glitter in the water. This setup was done early evening, so I used a combination of natural lighting and the flash from an iPhone 15 pro held above and to the side of the container. After this, the vortex was created by swirling the spoon in the liquid in a circular motion repeatedly and then pulling the spoon straight out.

Figure 3. CAKECRAFT Edible Rose Gold Glitter Dust

Photographic Technique

The image was taken on a Canon EOS 2000D (also known as the Canon EOS Rebel T7) at a distance of 6.5” above the top of the container. The lens used was a Canon zoom lens with an 18-55mm focal length, 1:3.5-5.6 aperture, and a thread diameter of 58mm. The original picture (*Figure 4*) was 6000 x 4000 pixels and was cropped to 5502 x 3827 pixels (*Figure 1*) which allowed the center of the vortex to be centered in the image.

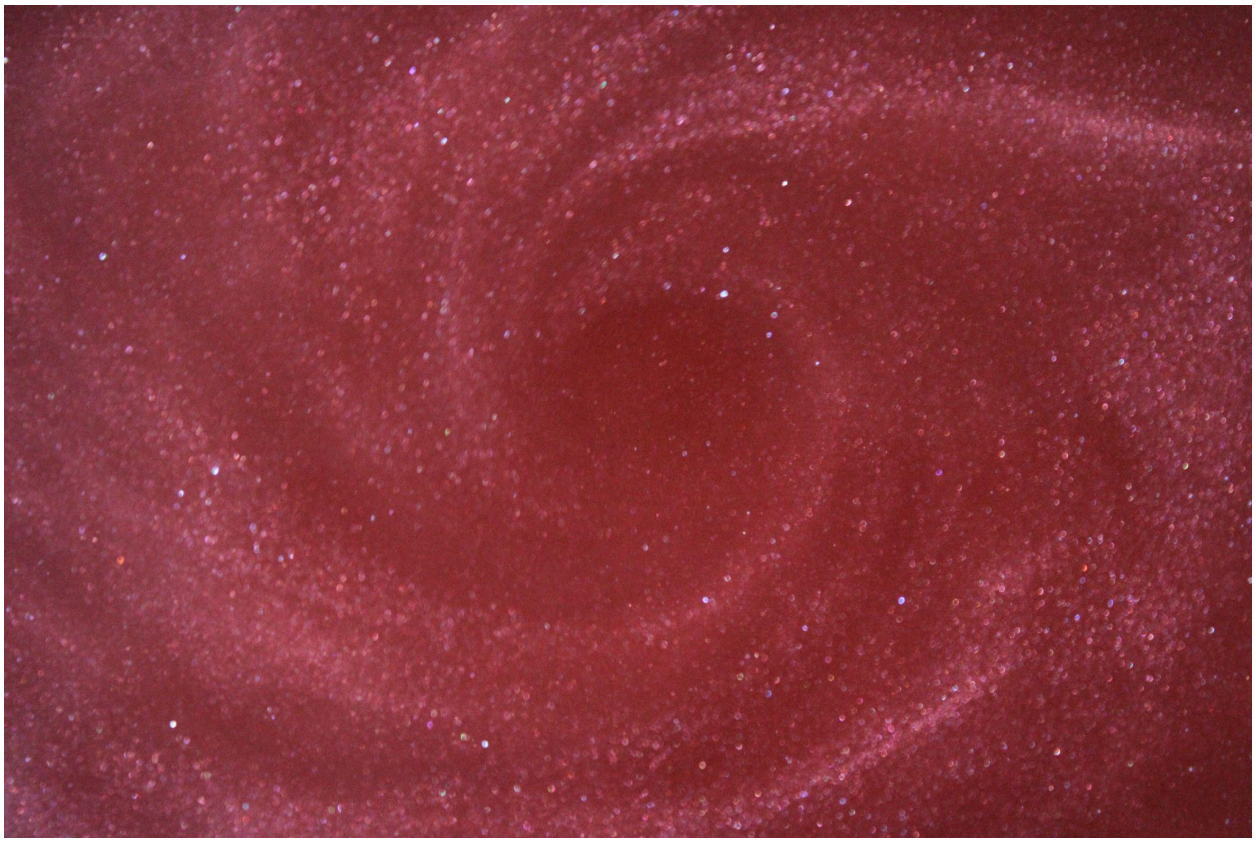

Figure 4. Original Image of Vortex Formed by Stirring Shimmery Water in a Container

The photo was taken with a 3200 ISO, a focal length of 48 mm, an aperture of *f*5.6, and a 1/125s shutter speed. The image was post-processed to intensify the colors and create a more visible distinction between the vortex and the waves being sucked into it. To do this the following adjustments were made: brilliance -0.10, exposure 0.05, highlights 0.15, shadow -0.15, brightness 0.10, contrast 0.15, black point 0.10, saturation 0.05, vibrance 0.50, cast -0.52, (white balance - temp/tint) temp 4,361K, definition amount 0.25, (sharpen) intensity 0.81, (sharpen)

edges 0.22, and (sharpen) falloff 0.69. The RGB curve was also adjusted as seen below in *Figure 5*.

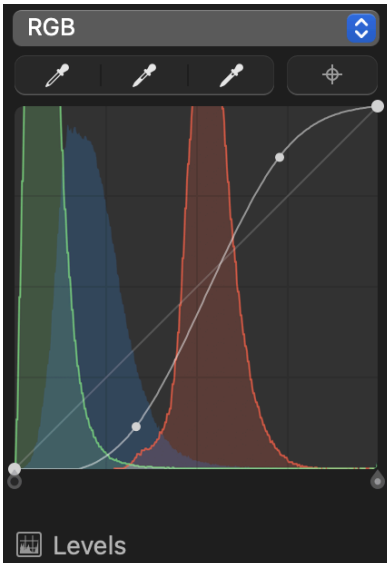

Figure 5. RGB Curve for Edited Image in Figure 1

Conclusion

This image beautifully captures the intriguing dynamics of a vortex, a phenomenon often observed in everyday moments such as stirring a cup of coffee. By adjusting the colors and contrast of the image, I was able to emphasize the way the fluid folded into the vortex. In the future, I should use a tripod to reduce camera shake and employ better lighting techniques to minimize reflections from the edible glitter, which causes the photo to appear blurry. Moving forward, I'm curious about how to further refine the depiction of the vortex to increase its definition even before editing. Exploring different methods of vortex creation, along with experimenting with various containers, could yield unique visual effects. This could offer fresh perspectives and provide an even sharper contrast, improving the overall impact of the photograph.

References

Vortex Dynamics, math.unm.edu/~nitsche/pubs/2006EMP.pdf. Accessed 24 Sept. 2024.

Stoker. “Vortex Physics Explained: Bernoulli’s Principle & Beaker Resistance.” *Physics Forums: Science Discussion, Homework Help, Articles*, Physics Forums: Science Discussion, Homework Help, Articles, 14 June 2015, www.physicsforums.com/threads/vortex-physics-explained-bernoullis-principle-beaker-resistance.818952/.