Ferrofluid Motion: A Team Second Report

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Filmed with assistance from Galen Melchert, Sung Moon, Kevin Oh, and Hanwen Zhao.

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This video was filmed as a submission to the Team Second project with Cyron Completo, Galen Melchert, Sung Moon, Kevin Oh, and Hanwen Zhao all working on visualizing ferrofluid in various ways. The intent of this video is to show the ways ferrofluid interacts with magnetic forces while sandwiched between two glass sheets. The glass sheets also helped portray the Saffman-Taylor instability (viscous fingering) from when a fluid is released from the weight of one solid pushing against the normal force of another solid. Galen Melchert assisted by moving a magnet underneath the bottom glass sheet, Sung Moon helped by holding onto an edge of the top glass sheet, Kevin Oh helped by holding onto the opposite edge of the top glass sheet, and Hanwen Zhao contributed his lighting equipment.

# Flow Discussion

The basic flow portrayed is a ferrofluid induced into the Saffman-Taylor instability resulting from the gradual release of weight of a solid object on top of the fluid placed on a parallel object (in this case, both objects are glass sheets). Furthermore, the flow exhibits the unique property of actively interacting with a magnetic field from a magnet underneath the bottom sheet. The ferrofluid is attracted to the magnet, so it appears to be moving with the magnet. In order to repeat this flow for a similar result, about one fluid ounce of ferrofluid must be poured on a glass sheet with a sheet of paper underneath said sheet. Another glass sheet must be placed on top of the fluid. As for lighting, place a lamp approximately 1 meter away from the apparatus.

## Visualization Technique

The visualization technique makes use of no other flows outside of the ferrofluid itself. The only lighting comes from a lamp placed approximately 1 meter away from the flow apparatus.

## Film Technique

 I used an LG G6 phone to film this flow interaction. The focal length was approximately 4.03 mm (average) in order to frame the flow interactions without including the edges of the glass sheet, the aperture was f/1.8 in order to capture as much light as possible while keeping the depth of field shallow to focus on the flow itself, the distance from the object to the lens was about half a meter in order to keep a suitable distance for the depth of field, the camera was digital: with a resolution of 1920 x 1080 pixels, the ISO was about 150 in order to reduce graininess, and the video was post-processed to add stabilization.

## What the image reveals

The image reveals the properties of the Saffman-Taylor Instability, or viscous fingering, when weight is removed from a fluid as well as portraying how ferrofluid interacts with a small magnet. I like that the ferrofluid branches out in the beginning and how I chose to follow the ferrofluid’s interaction with the magnet as the magnet moves underneath the bottom glass sheet. The fluid physics are shown well, but could be shown better if I had chosen to show the equipment that I used. I definitely fulfilled my intent with this short video, but it could be developed further by adding a satisfying outro making use of the ferrofluid in another manner.