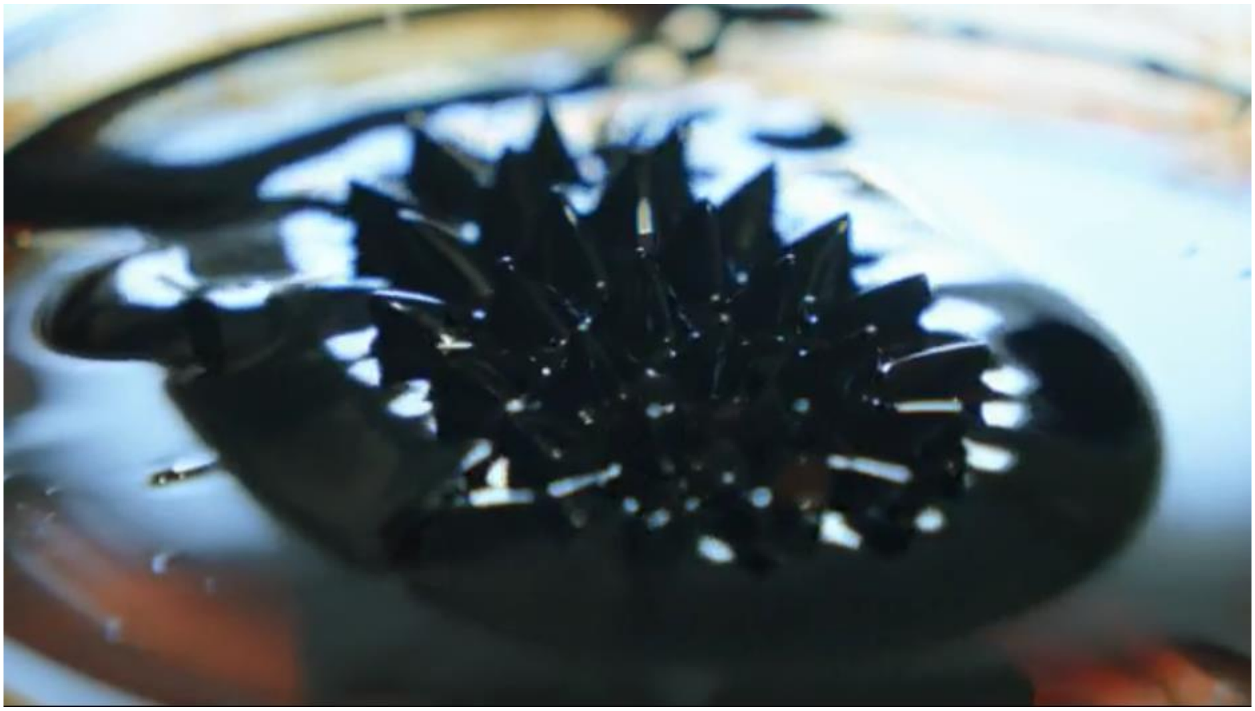
Cade Haley
FILM 4200

<u>**Team First Report – Ferrofluids and Watercolor**</u>



Purpose of the image

When looking for subjects to shoot in this assignment, our team decided on the use of ferrofluid, and optionally experiment with the flow of dry ice vapors over ferrofluid. In this video I found that I was able to capture ferrofluid flows and motion that would be best represented in video through the swirling of the mixture and alterations in the strength of the magnetic field. In combination with the placement of the background light and use of watercolors squirted on top of the mixture, I felt that I was able to accurately portray the strange nature of the ferrofluid flow, its reaction to varying levels of magnetism, and how it interacts with watercolors placed on top.

Flow demonstrated

In this video, we can see the effects of normal field instability, which causes the disturbance pattern seen when a magnet is placed underneath. The height of the sinusoidal blobs in the ferrofluid become taller and higher frequency as the magnet gets closer, keeping the material suspended due to Brownian motion. Alterations in static equilibria is represented by the equations for <u>magnetostatic potential</u> $\nabla^2\Phi_1 = \nabla^2\Phi_2 = 0;$ alongside the magnetically augmented Young-Laplace equation $-N_g h + N_m\{\chi_0(\eta \cdot \nabla\Phi_2)^2 + (\nabla\Phi_2)^2\} + 2H = K,$ where N_8 is the gravitational Bond number, N_m is the magnetic Bond number, h and η represent the interface elevation and normal unit vector, H is local mean curvature, x_0 is magnetic susceptibility, and K is the reference pressure constant.[i]

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Additionally, the effect of the suspension of the watercolor on top of the ferrofluid is likely due to the surface tension of the surfactant that composes the ferrofluid, with the watercolors having a lower material density. Dots of watercolor are formed when the watercolor becomes trapped in one of the ferrofluid's local minima, and surface tension connecting the watercolor blobs to other watercolor blobs is broken when a peak is formed.

Materials Used

The materials used consist primarily of a Blackmagic Pocket Cinema Camera with a Lumix G Vario 12-35mm lens used to shoot the flow visualization, a table, petri dishes (about 6 cm in diameter), a magnetite magnet on a baking tray, and ferrofluid (consisting of a surfactant such as vegetable oil, and iron filings). The window light seen in the background had no filter on it whatsoever, which created a well-defined square of light in the image, adding to the element of contrast and strong backlighting in the image. The process of shooting the image required suspending a plate of glass about 8 cm above a table surface by placing 2 equal-thickness Styrofoam blocks on each end of the glass and moving the magnet around under the glass.

Photo technique

By using the strong backlighting of the sky reflection in this image, our group could make use of the illusion of having the ferrofluid move on its own without any perturbing of the petri dish. Use of shallow depth of field was another intentional element, shooting at an f-stop of f2, a framerate of 30 and a shutter speed of 1/60. In conjunction with an ISO setting of 1600, the exposure of the image made for a satisfactory result. Finally, I color graded and edited the footage in Blackmagic Resolve.

Honorable mention videos:



[i] G., Boudouvis A. "Normal field instability and patterns in pools of ferrofluid." Journal of Magnetism and Magnetic Materials. August 19, 2002. Accessed March 06, 2018. https://www.sciencedirect.com/science/article/pii/0304885387900576.