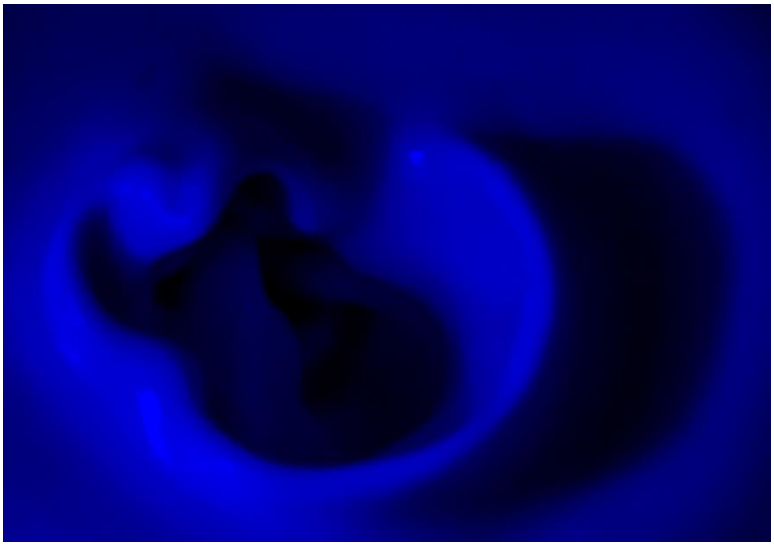

IMPINGING JET ON LUMINESCENT NON-NEWTONIAN FLUID

TEAM FIRST

Cyron Completo | ATLS 4151 | 2/19/18 – 3/7/18
Photography assistant: Sung Moon
Equipment contributed by: Galen Melchert

Context

This image was taken for the Team First project and was taken by Cyron Completo with assistance from Sung Moon. The intention was to capture the cavitation effect from blowing air into oobleck, a non-Newtonian fluid created from corn starch and water, illuminated with a black light. Several trials were done to get an image that captured the layered cavitation effect, however those trials were either framed incorrectly or had too much motion blur. Sung helped by using a handheld air duster, expelling air into the oobleck using the pump of the duster and by holding the black light. He pumped the duster several times as Cyron attempted to photograph the effect at just the right moment. Galen contributed the duster as well as his camera.

FLOW DISCUSSION

The flow is of a slight air jet impinging on a non-Newtonian fluid. The air is being expelled from a duster perpendicular to the surface of the fluid. The nozzle of the duster is roughly 0.16 cm^2 in diameter. There is about 0.5 liters of the fluid stored in a clear container that is 10 cm x 10 cm x 15 cm in dimension.

The fluid appears this way because of the force exerted by the air jet, fluid tension, work done by the force of the jet, gravity, and the normal force of the container holding the fluid.

To replicate this flow, you must use a single 7-watt LED black light connected to a wall outlet as a source of lighting. You must create the fluid by mixing a tonic water with corn starch at a ratio of 1:2. The tonic water contains quinine, which is luminescent when illuminated with a black light. The fluid must be stored in a container as specified above. The black light must be held at about 15 centimeters away from the container, at approximately the same height as the lip of the container. The lightbulb must be uncovered and must be pointing downward, towards the floor, while parallel with the container and perpendicular to the surface of the fluid. The photographer must take the photo at precisely the moment that the air impinges on the fluid, as the fluid is quick to regain stability.

VISUALIZATION TECHNIQUE

The visualization technique is using a black light to bring out the luminescence of quinine in a non-Newtonian fluid. The cornstarch within the fluid is from a 16-ounce container of Argo corn starch, making use of 12-ounces of corn starch for the project. The LED black light is from Felt Electric and is a non-dimmable LED 7-watt black light bulb. The fluid was mixed with 6 ounces of water and 12 ounces of corn starch.

The lighting of the scene was exclusively handled by the LED black light bulb. To replicate the lighting, you must find a room that has very little to no lighting and use the bulb to light the scene. The camera flash was not used at all, and manual focus mode was engaged to prevent the usage of the focus light.

PHOTOGRAPHIC TECHNIQUE

The field of view was roughly 7 cm^2 to capture the impact region as well as to provide information about the surrounding, stable fluid. The fluid was about 0.6 meters away from the lens to focus on the object at a reasonable distance for the focal length. The focal length was 50 mm as a nice balance between focus, depth of field, and lens distortion. The camera itself was a digital camera, a Sony ILCE-5100, which spit out an image of 3645 x 2548 pixels in dimension. In terms of exposure, the photo was taken at 1/800 sec at f/3.5 with ISO 1000 to capture the fluid motion quickly, without much motion blur, while taking in as much light as possible. Before submitting the final version, I imported the photo in Adobe Lightroom to adjust the exposure. The image was slightly underexposed at the time of capture, so I adjusted the exposure in Lightroom to make the image easier to view while leaving the flow physics intact.

CLOSING REMARKS

The image shows that a non-Newtonian fluid would appear to "open up" rather than splatter when a jet of air is being pushed into it. I like that the flow looks almost organic, like an ear. The fluid physics are shown well and improve upon my understanding on how various fluids of varying density would interact. How can I improve this image? Some other students told me of the presence of motion blur but I am unable to detect the blur in this image.

I fulfilled my intent with this image: to interact with oobleck in various ways and to create an image that enhances my understanding of non-Newtonian fluid flow. I would like to improve the lighting in this scene, as the monotone blue color created by the black light is slightly unsettling – an emotion that I did not intend to convey. For the future, I hope to create a slow motion video showing the same non-Newtonian fluid interacting in various ways.