Muddy Waters

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Group Image 3

When two laminar streams of liquid collide in mid-air, the cohesion between the liquid's molecules causes the two streams to pull together after the collision while the liquid's momentum keeps droplets moving along the initial trajectory. Some of the water flies out, and some is pulled in creating an interesting formation resembling a fish skeleton, hence the name "fishbone instability."

Ryan Coyle, Adam Sokol, and I used plastic bottles with holes punched in the caps and straws inserted through the holes to create streams of water. A plastic bucket full of water with red and blue dye served as the source from which the bottles were filled. This bucket was placed below the bottles to catch falling water. With one person holding each bottle and one manning the camera, we tried a variety of techniques to get the fishbone instability including aiming the straws directly at one another and letting the water fall, having one bottle fire upward and one downward, and changing the angle at which the bottles fired relative to the camera. In the end, it turned out that having one person fire both bottles simultaneously yielded the best results. This is because two people have a harder time maintaining timing and aim. We also realized that it was hard to maintain a fishbone shape once the stream was established. It was during the initial impact that the streams produced a fishbone-like structure. Once we noted this, water was fired at regular intervals in short bursts with the camera snapping photos in sync.

The camera used for this photo is a Canon EOS REBEL T2i. The camera was placed on the floor approximately two feet above the ground, slightly below the water bottles, to best capture the fishbone instability. Since the water was moving so quickly, an exposure time of 1/3200 second was used. This mandated the use of a high sensitivity ISO-800 despite having the sun as the light only source. No exposure bias was used. The hardest part was establishing and maintaining proper focus as the streams would often move relative to the camera and the depth of field was really short. The focal length was 50mm.

This image shows the cohesive effects between water molecules, commonly known as surface tension. Despite having relatively consistent flows, the streams were not laminar or uniform enough to form a well-defined fishbone structure. Further research revealed that most clear fishbone structures are commonly created using jets of viscoelastic fluid instead of water, but that is harder to obtain and cannot be used as leisurely.

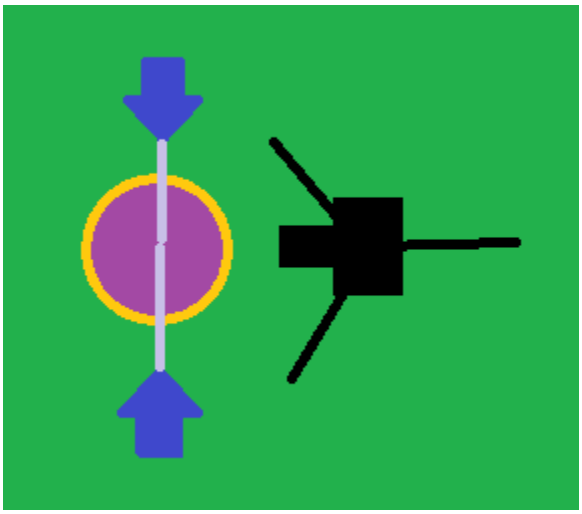
Appendix

Ideal Fishbone Structure

Courtesy of Massachusetts Institute of Technology

An ideal fishbone structure created using viscoelastic fluid.

Photographic Setup



The setup of the camera and water bottles over the bucket of water.

Original Image

The unedited image.