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MCEN 4228
2/8/2010

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The original intent for this image was to investigate how light is distorted through a stream of water due to refraction. However after further examination of the image and the physics behind it I realized that there was something that was much more interesting going on. The purpose of this photo quickly changed to investigating the complexities of surface effects on free falling fluids.

In order to produce this fluid flow I took a 1-gallon open pitcher and filled it with water at room temperature and then proceeded to pour it out at varying flow rates. The most interesting results were achieved at much higher flow rates. In the photo that I have selected had a flow rate of around 1 gallon for 5 seconds so about 0.2 gallons per second. In the original photo we can see that scale of the event as it occurs over a 3-4 foot vertical span, however in the edited photo we are looking at an isolated portion of the image that is only about 8-10inches in length. A basic schematic of the set up is shown below in Diagram 1. This portion of the image that has been captured occurs immediately after the water has left the pitcher and before the stream begins to break up into water droplets. This phenomenon is called the Plateau-Rayleigh instability, which is also an examination of the effects of surface tension.

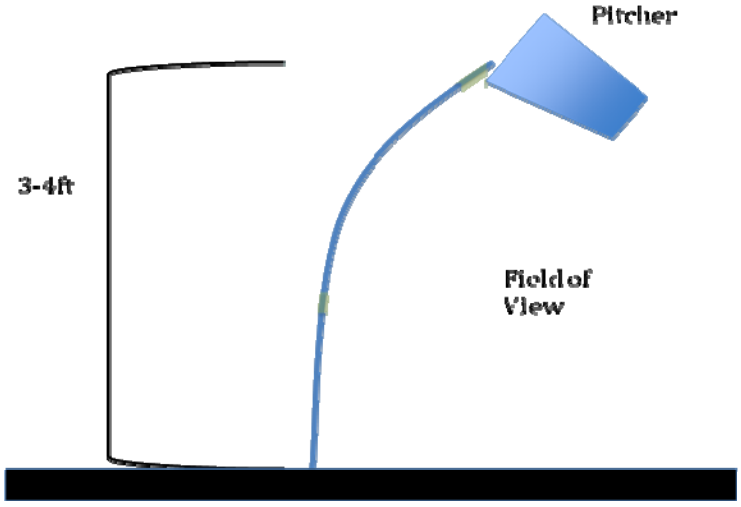

Diagram 1: Apparatus

Surface tension is caused by the increased attraction between molecules that occur at the exposed surface. Within the central portions of the liquid the molecules are attracted to one another evenly with intermolecular forces, so each molecule feels the same effect from each of its neighbors. However on an exposed surface of the liquid the molecule does not have equal forces acting on them. As shown in the diagram below the molecule on the surface is pulled inward and to the sides causing a tension like force to develop. The exposed molecules experience stronger attractive forces to each of their neighboring molecules generating the surface tension. This it is a phenomena that allows for liquids to stay together without being in a container. For example water droplets are a product of this effect as well as free streams as shown in selected photo.

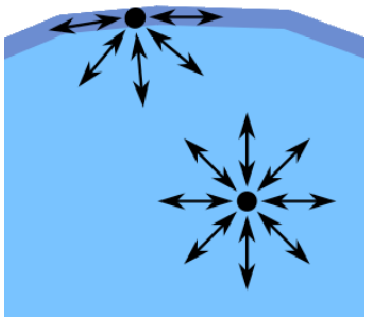

Diagram 2: Surface Tension

The Plateau-Rayleigh instability is caused by slight variation within these surface tension forces. Regardless of how smooth the stream is to start with minor defects or slight variations in the surface of the stream will cause it to develop a sinusoidal shape and eventually form individual droplets. This sinusoidal shape can be seen in the photo, along with the true complexity of this phenomenon. We can see that there are two distinct sinusoidal shapes, one that travels parallel to the page and another that seems to go into the page. This is part of the Plateau-Rayleigh instability, as these two sinusoidal shapes develop they interfere with each other and eventually cause the stream to break up into droplets when the surface tension forces are over come. As described above it is surface tension in the liquid itself that allows for the steam to be developed in such a manner.

In order to capture this photo I made several adjustments to the Digital Canon Powershot camera. One of the key adjustments that I made was to alter the aperture to f/3.5, which allowed for a greater depth of field. This allowed the camera to get the stream to be in focus as well as the brick background behind the stream. The down side to doing this is that the stream has some motion blur at the bottom portion of the photo. In order to capture the whole stream the camera was held about 3 feet away from the stream and with help form a partner I was able to take the picture while they poured the water out at various rates. The photo that is show has a flow rate of about 0.2 gallons/second. This image was also captured under natural lighting conditions. The basic principal behind generating this image is very simple, however producing the appropriately sized stream and correct lighting conditions are difficult. I am not sure if I could achieve the same results given that natural lighting was used.

The original purpose of the photo was to investigate the refractive properties of water in a free stream. That is why the geometric background was selected, as I wanted to compare the repeating pattern that the bricks offered to that of the portion that was distorted through the stream. In addition the brick background provided a 'scale' or markers in which the features of the steam could be measured and compared to one another.

The original photo was taken into Photoshop to enhance the contrasting features of the background and also was cropped to focus on a smaller portion of the event. The original photo was 2112x2816 and was resized to 624x1776. The narrow width enhances what is happening within the fluid as the viewer is more focused on the stream and not the background. In addition it allows for the view to better understand what is happening in the image at first glance. Also within Photoshop the contrast of the image was altered using the level-curve adjustment. This was done to better highlight/define the fluid flow. By adjusting the levels we can see the difference in the before and after photos below.

Original Modified

When looking at the original image there is not very much detail in the fluid mechanics or the beauty that exists within this stream. However after modification we can see more details into what is happening. Although this image does not show how this fluid phenomena is formed or what is the cause for the sinusoidal curves within the stream. I feel that the physics within the flow are shown but in not enough detail. I think that if this photo was to be taken with a much higher quality camera and a more skilled photographer then more the physics would be shown through the clearer quality of the image. However in summary I am very impressed with my image, as I have not had a lot of experience with cameras or taking detailed images of complex motion.

Sources:

1. http://en.wikipedia.org/wiki/Surface_tension
2. "Surface Tension." *Test Page for Apache Installation*. Web. 07 Feb. 2010. <http://hyperphysics.phy-astr.gsu.edu/Hbase/surten.html>.
3. Röntzsch, Lars. "3D lattice kinetic Monte Carlo simulation." Web. 7 Feb. 2010. http://www.roentzsch.org/Rayleigh/

Diagram 2:
http://upload.wikimedia.org/wikipedia/commons/f/f9/WassermoleküleInTröpfchen.svg