2011

Get Wet

Boris
LEMATTRE
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The purpose of this project is to make a picture of fluids that both emphasizes a phenomenon and is beautiful. I personally wanted to show in this assignment the Worthington effect, named by the scientist who first studied the shape a droplet could have when impacting a surface. I think droplets are among the most beautiful phenomena, entirely created by the nature.

I will first discuss briefly the history of droplet photography. Then I will explain the technique used for this assignment to finally explain what occurs on the pictures submitted.

I. History of droplet

Droplet pictures are relatively recent, as photography techniques were not enough developed to capture the very brief instant the droplet impacts a surface. First official studies of this phenomenon were carried out in the late 1800's by an English physics teacher named A. M. Worthington. He usually used sketches to show what occurred during the impact, due to the lack of high-speed photography technology.

However, with the help of other scientists, he was able to take pictures of droplets. In the early 1900's, he published a book, *A study of splashes*[1]. It was the first time a book on this subject was published. It allowed seeing and understanding the different stages a droplet takes when falling, and what happens when the droplet impacts a surface.

Physics phenomena are multiple and complex. The one I wanted to emphasize here can be described as follows: when a droplet impacts a liquid surface, it creates a "crater", result of the droplet breaking the surface of the liquid. After the crater being created, it has to be filled with the liquid. So, the liquid rushes into the hole so fast that the liquid splashes outside the surface, creating a column of liquid. The top of the column has enough energy to create other droplets, as it is shown in the picture below. It is called the Worthington effect.

Figure 1: Worthington effect

[1] Worthington, A. M. *A Study of Splashes*. New York; Mac Millan, 1963

II. Technique used

Taking a picture of a droplet is a matter of timing, luminosity, focus, and in some way chance. Many techniques can be used, in which the droplet and the picture are synchronized electronically. But I chose an easier one: a droplet falling from a tap. Basically, the equipment used is:

- ✓ Camera and flash
- ✓ Tripod
- ✓ Tap
- ✓ Container
- ✓ Toothbrush

After filling the container with water, I regulated the tap to obtain a regular fall of water droplets. This regularity is important to know when to take the picture. To focus on the area where the phenomenon would occur, I used a toothbrush, since it is difficult to focus on a moving object. I placed the toothbrush exactly where the droplets fell, so the focus was adapted to the restricted area of the phenomenon.

The light is essential in a high-speed droplet picture, since the daylight is usually too weak to have a good luminosity for the short time of the phenomenon. So I used the flash of my camera. As I did not have another flash to prevent light from impacting directly the scene, I used a tissue I put on the flash, to low its intensity. Moreover, as I took the picture at an angle of about 20~30 degrees from the scene, I put a sheet of paper behind the container. Thus, the flash reflected from the paper to the scene. That why the light seems to come from behind. Changing the backdrop gives different colors of the picture. I tried several backdrops, like a red one, orange, yellow, purple and blue. I chose the blue one since I thought it was the most beautiful, but the other colors could have been presented too.

Once the installation was set, I just had to take the pictures, and hope to take it at the right time. As I used the flash, I settled an ISO400, and an exposure time of 1/400s. I changed these parameters as the pictures were taken, since I started with a longer exposure time and a higher ISO, but the pictures were not really clean.

I took at least 100 pictures before to have correct results. Once I was satisfied by the type of picture, I just changed the backdrop. After that only I chose the picture I preferred. I only changed the contrast with the software Gimp, and erased the little droplets outside the center of the picture, to allow one's eyes to focus only on the center of the picture. Indeed, I did not really change the picture, I just improved it.

III. Physics phenomenon

Even if I wanted at first to show the Worthington phenomenon, I did not submit the classic picture with the column and the droplet "ejected" on the top of it, and that for several reasons. First, it is of course because this picture was the most beautiful. Secondly, it is because the technique I used was not really adapted to show this effect. Indeed, the tap released droplet too big, and most of the time there was several droplets. So the other droplets interfered with the first droplet impacting on the water, and the results were usually different from the classic "one column", as you can see on the picture below:

Figure 2: Droplets interfering with the Worthington effect

However, the picture I submitted is interesting yet. You can see the crater formed by the fall of the first droplet, and two other droplets coming to fall in this kind of "black hole". The blue color reminds me of the universe, and the light reflecting into the droplets makes them like stars falling in a black hole, or blue pearls in the abyss of the ocean.

Moreover, this picture is interesting because you see the first droplet breaking the surface tension. It is like a diver, who jumps from a high point. He has to put his hands first before entering the water, to break the surface tension, and then his body can go smoothly into the water. So, in the picture, the other droplets would normally impact the liquid more smoothly than the first one.

You can also see the circular ripples due to the fall of the droplet. Impacting the water, the first droplet breaks its surface. The energy generated is transmitted gradually in the form of waves going circularly from the impact point to the outside.