GET WET

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In the very real and tangible world that humans occupy, interaction with fluids is essential. For the most part, however, fluids mean most to us when they are interacting with solid bodies. Our diaphragms expand and contract to inhale and exhale air when we breathe, our arms and legs push against water when we swim, and beverages are directed down the esophagus when we drink. This image is intended to demonstrate that the interaction of a fluid with a solid is not always straightforward.

The image was captured in the bottom of a small cast iron frying pan. The intent was to visualize the vapor barrier that forms when a fluid contacts a very hot surface and boils off so vigorously that the fluid 'floats' on a bed of its own vapor. This is known as the Leidenfrost effect. In this image, the fluid used was water, for safety and ease of availability and cleanup.

A small camping stove was used to heat the frying pan thoroughly. The camera was placed on a tripod, above the pan. (See sketch for details.) It is important to note if recreating this picture, that steam from the pan may fog the lens of the camera almost instantly. Water is then poured, using a bottle or similar container, into the superheated pan from above. At this stage it is helpful to have a camera that can take multiple frames per second. Otherwise, the timing must be correct to capture the impact of the water with the pan. The size of the water stream in this image is approximately ¼ inch in diameter. The water was poured from a height of one foot, making the free stream velocity approximately 8 feet per second. The resulting Reynolds number of the stream is approximately 15.5. There are no features in this image that require a very fine spatial resolution. However, the time resolution is much more impressive – less than 1 pixel can be traversed by the average speed items in the image. This is calculated off of a velocity of 192 inches / sec, $1/2000^{th}$ sec exposure, a 3 inch wide frame, and 1291 pixels / inch.

In order to capture this image with the best depth of field possible, and with the most natural light, it had to be taken in direct sunlight. Therefore, the camping stove and pan were set up between noon and one P.M. outside, in order to maximize available light. The camera was placed opposite the water stream from the sun, to both emphasize the fluid depth, and to capture enough light to stop down the aperture. Although direct sunlight was used, there was still not enough available light to use an extreme aperture value, resulting in at most, medium depths of field.

The equipment used was a Nikon D200 SLR, with a 60mm f/2.8 micro Nikkor lens, capturing 3872 pixels in width, and 2592 pixels in height. The distance from lens to the stream was 6 inches. At this distance, the image is approximately 3 inches wide. (See scale image for detail.) The ISO was rated at 400, and the aperture was nearly wide-open at f/3.5. This is counter-intuitive to the previous statement of attempting a large depth of field, but under the conditions, the better images were taken with fast shutter speeds, this image being taken at $1/2000^{th}$ of a second. There have been no digital alterations to this image.

The image reveals the intense vaporization of water, which it was intended to do. However, the image would contain more usable information if the camera could be placed level with the heated surface. A recommendation in the future would be to use a flat plate, angled slightly down from the camera lens. An additional recommendation would be to find a heat source that can sustain a high rate of heat transfer. This will allow for longer windows of photo opportunities between trials. Also, a high-speed video camera would capture the beauty in the motion of the water without losing the

informational value. Finally, the next best way to image this vapor barrier would be to quench a piece of metal in a 'fish tank' and image it from the side.

What I like most about the image, however, is the way that violence is desensitized in the image. Since violence is defined as a strong impulse over a short time, and we have eliminated the time aspect in a still image, we have an image that captures a violent action without the impact of being a rapid event. More importantly, however, is that we have captured an image that humans rarely see. In addition to being rarely seen, this type of flow is rarely seen in detail, and for any amount of time. This makes the image take on a certain alien quality that is intriguing to the human eye.

REFERENCES

Walker, Jearl. "Boiling and the Leidenfrost Effect." 02 May 2000. Cleveland State University. 23 Sept. 2007 <http://www.wiley.com/college/phy/halliday320005/pdf/leidenfrost_essay.pdf>.