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Visualization of frequencies traveling through water

This is the final team project for our flow visualization course. In this project, we set out to visualize the propagation of waves through a liquid medium. We tried various fluids, including non-Newtonian Oobleck, but we settled on water as it represented what we wanted to show the best. Chris Leong was my project partner for this project and took photos for this project, while I held the apparatus.

The setup used in this visual was simply a ladle full of water over a speaker playing at 80 Hz, with the camera above shooting downward as demonstrated in Figure 1. This visualization is patterns appearing in moving water created by waves. These standing waves are created by the resonance of the sound waves. When we setup our experiment, we only had a speaker that had large divots where the sound comes, and we had to use a ladle to get the surface to touch directly to the container we held the water in to get a strong enough effect. This was static overtime, given the same pressure applied over time. Different frequencies yielded varying results as well; however, this image was taken with 80 Hz. For this, I decided to calculate the Reynolds number. Using the frequency as a model for the displacement, we can find what the maximum velocity is and calculate a rough Reynolds number from there. We take the

displacement as a function of the frequency, then we take the derivative finding the velocity. Then I estimated the amplitude to be roughly 0.001m and the wavelength to be 0.01m. This gives a Reynolds number of 5027. This just means that inertia is more important to visuality than viscosity. According to John Stewart Reid in his article "Cymatics Research – Physics of Sound" he details what sound is and what is looks like stating " Sound in air is the transfer of periodic movements between adjacent colliding atoms or molecules. This sonic energy typically expands away from the site of the collisions as a spherical or bubble-shaped emanation, the surface of which is in a state of radial oscillation." This explains the spherical shapes we see in the visual. Another component of this is resonance, this is important to this effect as explained by Journey of Curiosity " If we are to hold the variables of the medium constant, and now vibrate it through a series of different frequencies, the medium will react due to its 'resonant modes' (a wave whose frequency matches one of the mediums natural frequencies of vibration) and create standing waves (standing wave modes arise from the combination of reflection and interference such that the reflected waves interfere constructively with the incident waves)".

$$x(t) = A\sin(2\pi ft)$$

$$u(t) = 2\pi fA\cos(2\pi ft)$$

$$U\max = 2\pi fA$$

$$Re = \frac{\rho UL}{\mu}$$

$$Re = \frac{\rho 2\pi fAL}{\mu}$$

$$Re = \frac{1000\left(\frac{kg}{m^3}\right)2\pi(80hz)(0.001m)(0.01m)}{0.001(Pa \cdot s)} = 5027$$

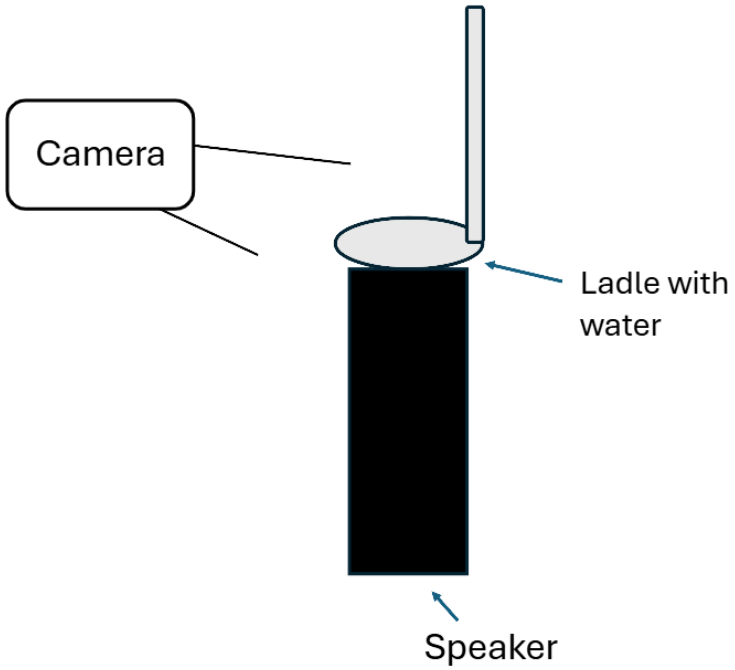

Figure 1: Diagram of setup

We used a simple set up and simply photographed the phenomenon as it was visible with the naked eye. We used tap water and a standard kitchen ladle. This was shot in a well-lit open room. No flash or extra lighting was used.

We took an image as a close up, we zoomed the camera in as far as we could to get more detail in the photo. The water was about 3 inches from the camera, shot at ISO 5000, 1/400 and f 4.5. We wanted the field of view to be just wide enough to capture the flow but fuzzy around the edges, because we wanted to maximize what we could do with the photo,

even though I chose to crop until those features weren't very prominent. This was shot on a Sony A7II , the lens was a Tamron 17 – 28, a digital camera. Our original image was 6000 by 4000 pixels and the final image was 2019 by 963 pixels. The photo was first color adjusted, then cropped down, to focus the image on the subject. The image was made black and white to take some distracting reflections away and define the ripples better.

This image reveals the beauty of sound and waves in general. I enjoy how the image has such a raw feeling, and I feel like I accomplished my goal for this photo, in making the photo look more like art than I usually do. I feel like physics is revealed and are very vivid. I fulfilled my intent with this photo. I feel like we could have gotten a better speaker that was easier to work with and we could have cycled through different frequences to get a better result.

Works Cited

"The Physics of Sound." *Cymascope*, 9 Apr. 2022, cymascope.com/the-physics-of-sound/.

"What Is Cymatics? Science of Visible Sound Explained." *Journey of Curiosity*, journeyofcuriosity.net/pages/what-is-cymatics-how-to-explained?srsltid=AYCX9vLXectbxjn10-4CVdF-PPUegjtBuMo2cL7vinWiKwXNMZIsbzjO. Accessed 20 Nov. 2026.

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