Ripple Tank

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What is a Ripple Tank?

Today, we'll be using a ripple tank to demonstrate a few properties of waves. They're very simple, and consist of a few parts:

- Water Pool: A shallow pool of water with glass underneath.
- Lamp: A lamp from above allows us to see the wave shadows.
- Mirror & Projection Screen: for the light to hit.
- Wave Source: Either a point or linear source
- Power Source: Controls the way that the wave source moves

Our ripple tank also has a strobe that allows us to create a stationary image of the waves by matching the strobe frequency to the wave frequency. Thus, the waves are in the same position each time they are illuminated.

Linear Source: Basics

We can use a flat bar to form a linear wave. The ripple tank's power source pushes air through the hose periodically, moving the bar.

Review: what should happen when we increase the frequency that the source moves?

- Wave Frequency?
- Wavelength?
- Period?

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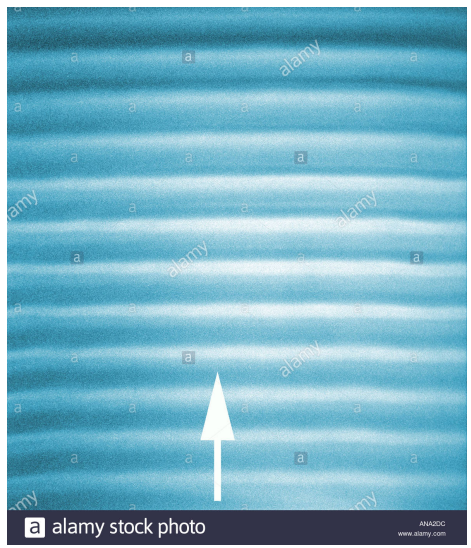

Figure: Linear waves in a ripple tank

Linear Source: Reflection

If we add a flat object into the water, we can see waves reflect off of it.

- What should the resulting pattern look like?
- Where will we see constructive interference?
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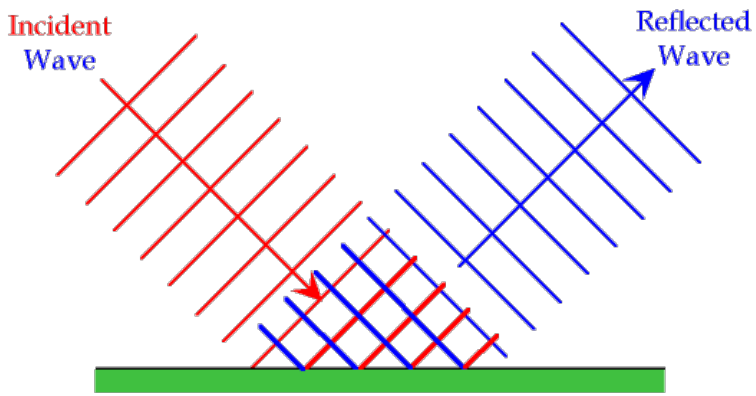

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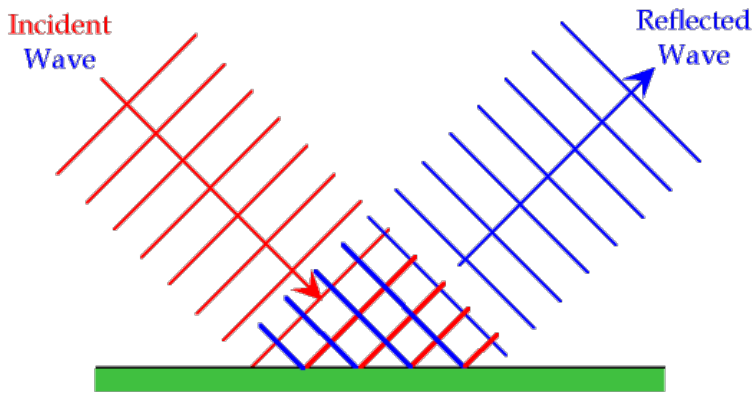

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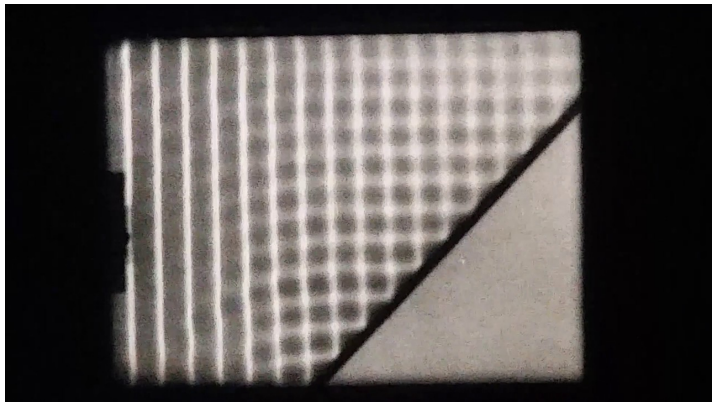

Figure: Linear Wave Reflection in a Ripple Tank

Linear Source: Reflection w/ Parabola

What if we use a parabolic reflector instead of a flat one? What effect will be created? Remember that waves will reflect *across the normal*.

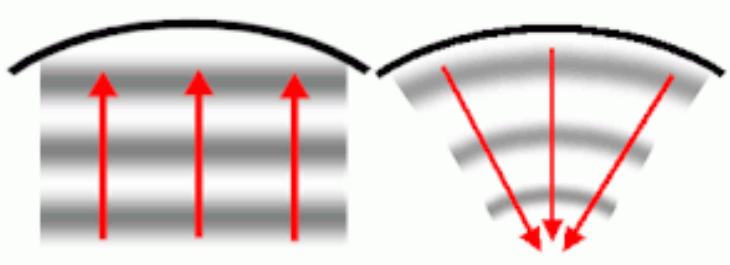

Figure: When waves reflect off of a parabola, they are focused into a single point.

Figure: Linear waves reflect off a parabola to form radial waves.

Diffraction: Review

Diffraction occurs when a wave encounters an object or a slit.

Figure: Diffraction of water waves through a narrow opening in the shoreline

Diffraction: Huygens-Fresnel Principle

This behavior is described by the Huygens-Fresnel Principle, which treats each point in the wave as a single spherical wave, whose interference causes the linear wave we see.

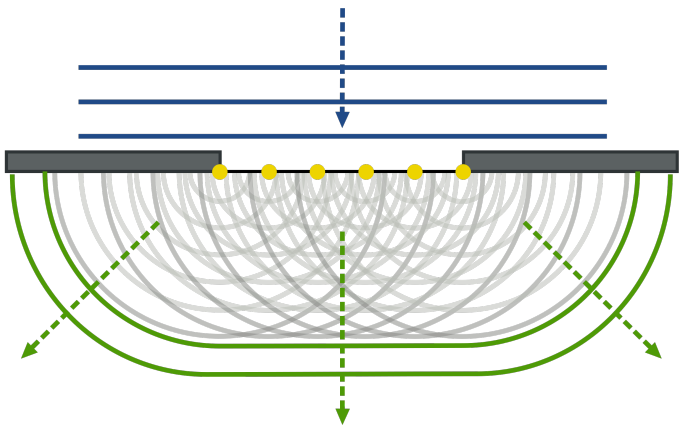

Figure: Diffraction through a narrow opening as described by Huygen-Fresnel.

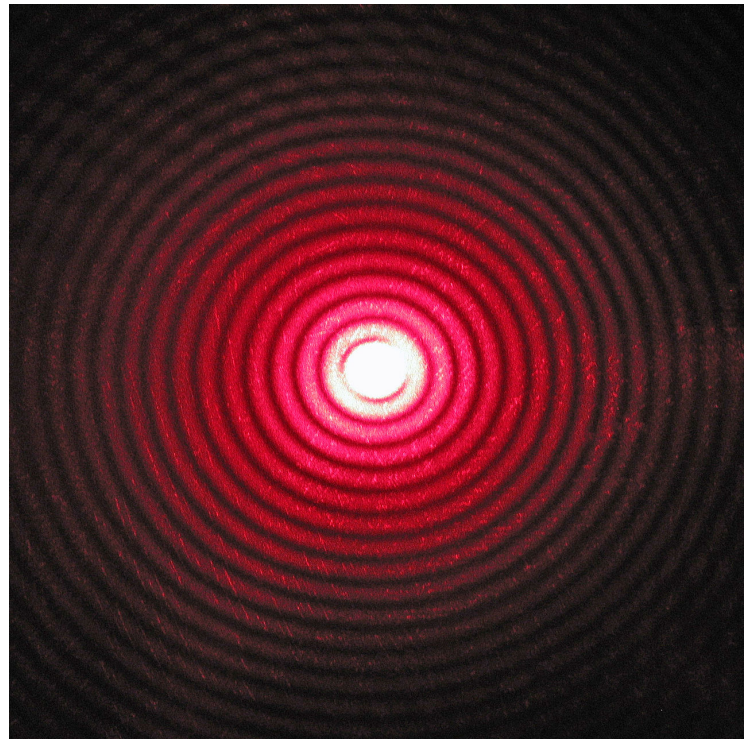

Figure: Diffraction pattern of a laser beam after passing through a small hole.

Linear Source: Diffraction

We can create diffraction by adding a small object or slits into the water.

We'll first add a small rectangle to the water pool.

- What do we expect to see in its shadow?

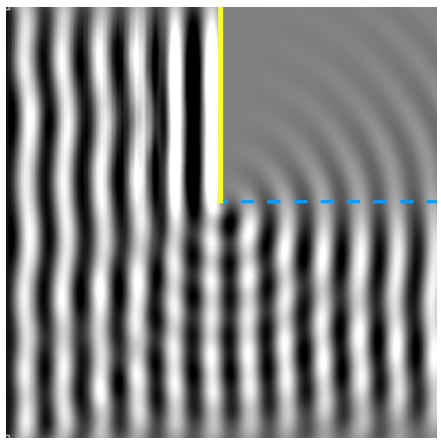

Figure: The effect of diffraction on plane waves after being blocked by an object.

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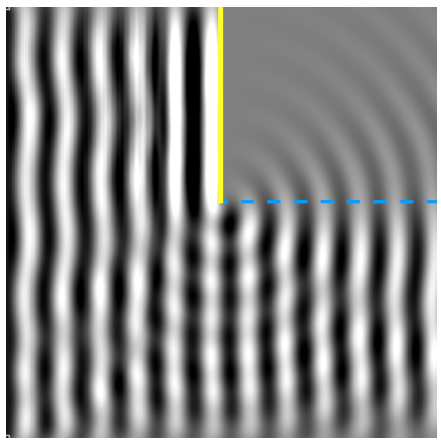

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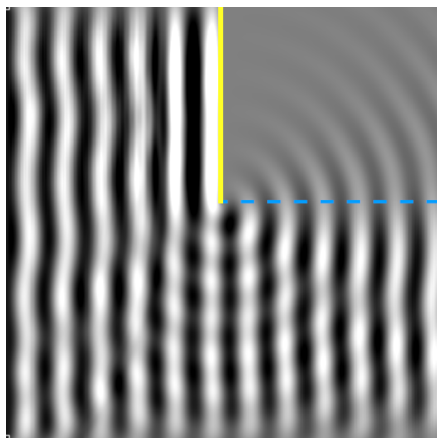

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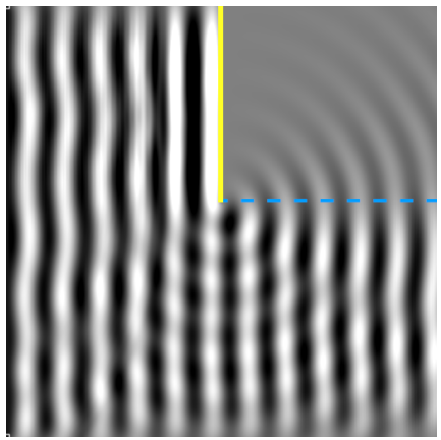

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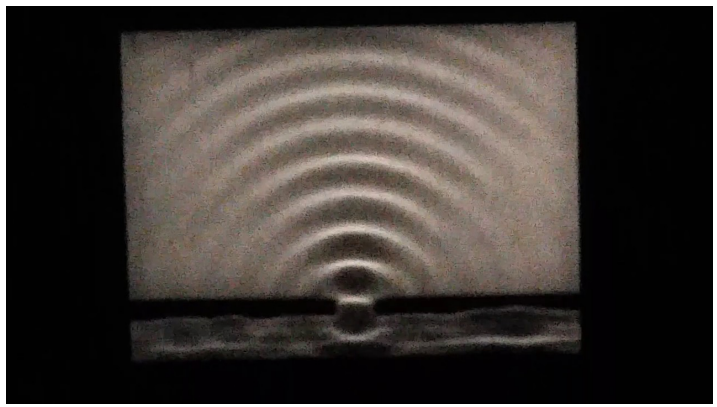

Figure: Diffraction through a narrow slit.

- What if we use several slits?

Review: Refraction

Refraction occurs when a wave passes from one medium to another, causing it to change speed.

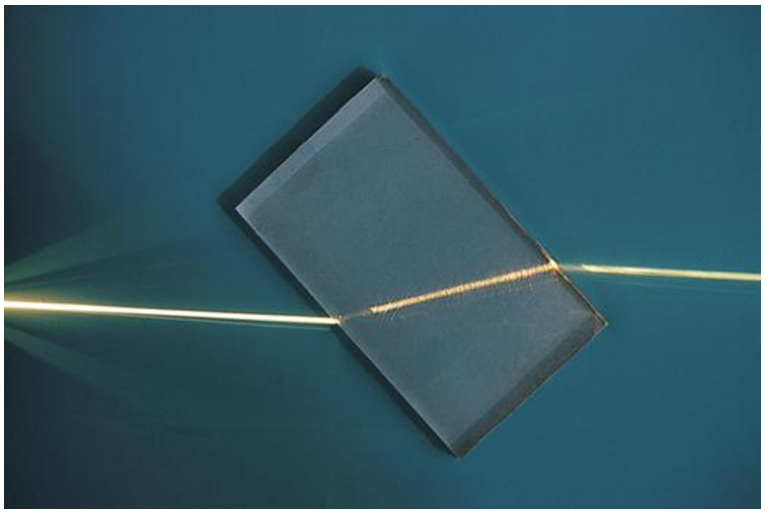

Figure: Light refracting through a piece of plastic. The speed of light is different in plastic than in air, so the beam bends.

Figure: The difference in the speed of light in water and air causes the pencil to appear split due to refraction.

Review: Refraction

Refraction causes waves to bend *towards the normal* when they encounter a medium in which they travel slower, and away from the normal when encountering a medium in which they travel faster.

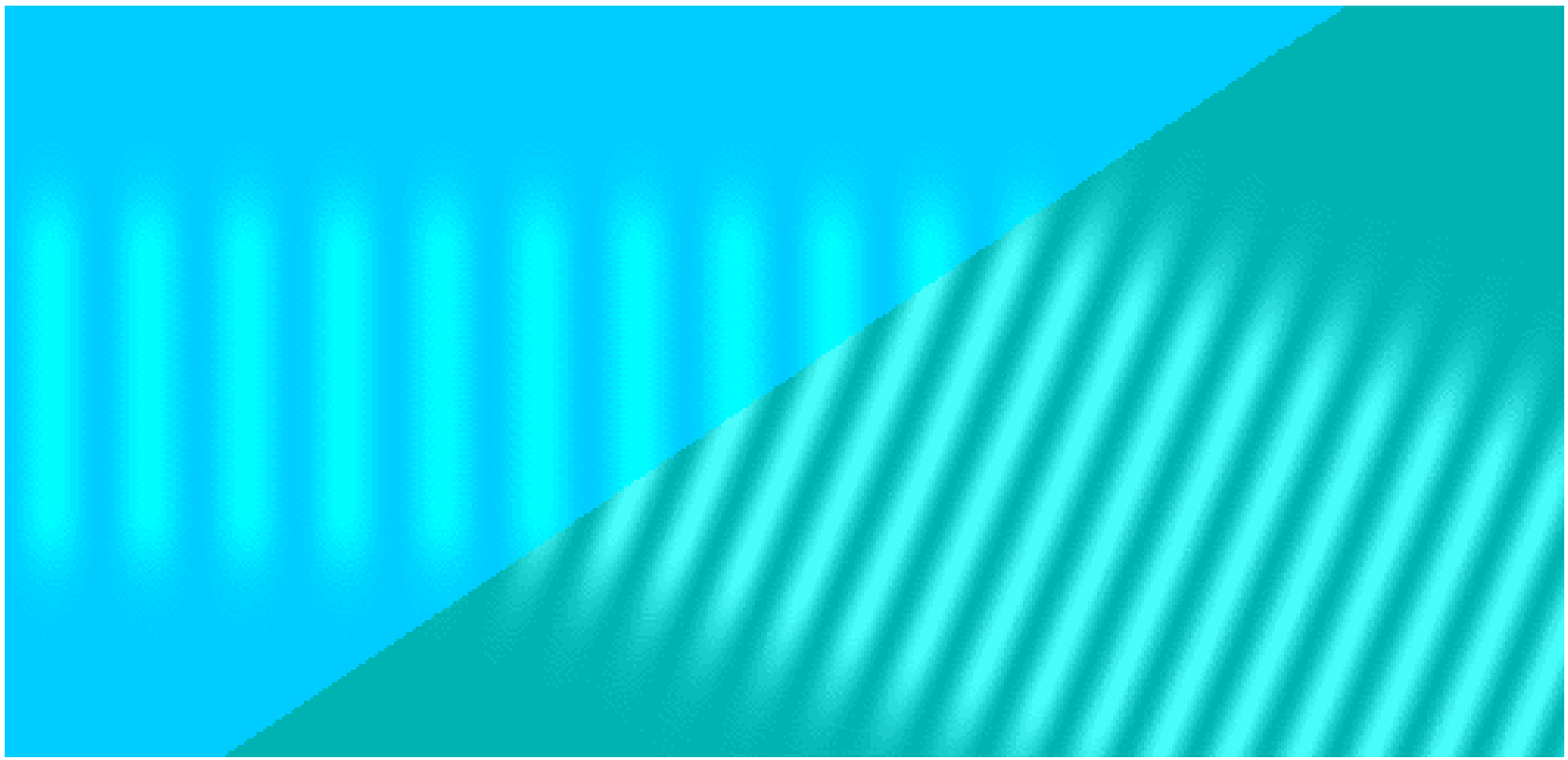

Figure: Waves travel slower in the new medium and thus must bend to stay connected.

Example: The Beach

Water travels slower in shallow water, so waves refract to be perpendicular to the beach as they approach the shore.

Figure: Refraction affecting waves on the beach

Linear Source: Refraction

We can add a piece of glass to the bottom of the water pool, making the pool shallower.

- What do we expect to see as the water passes over the shallower area?
- When they move from the shallow area back into the deeper area?

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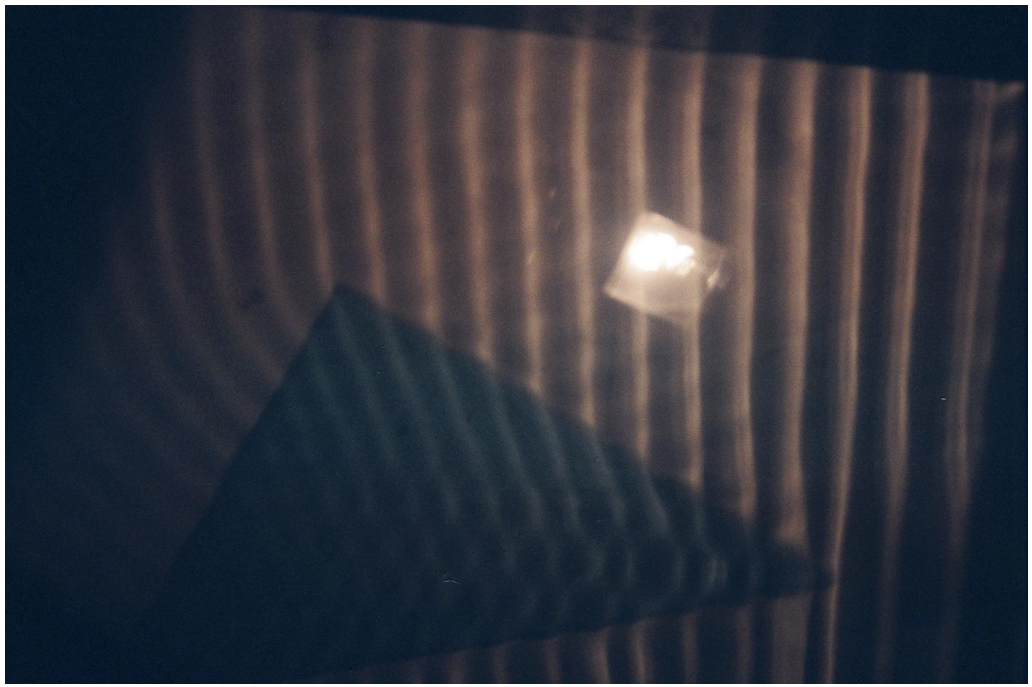

Figure: Refraction over a glass piece in a ripple tank

Point Source

Rather than a plane wave, we can create a radial wave by using a single point as our wave source rather than a bar. What will this look like?

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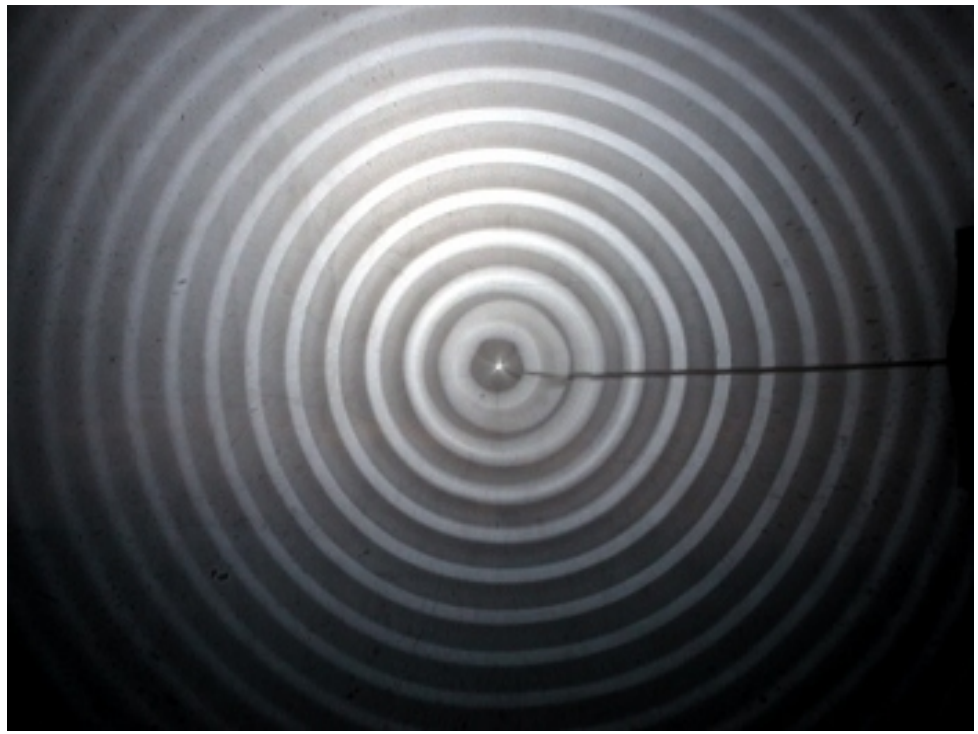

Figure: Waves propogating radially from a point source in a ripple tank.

Point Source: Reflection off Flat Surface

We can once again add a flat surface to the tank to see the effect of reflection. What should happen in this case?

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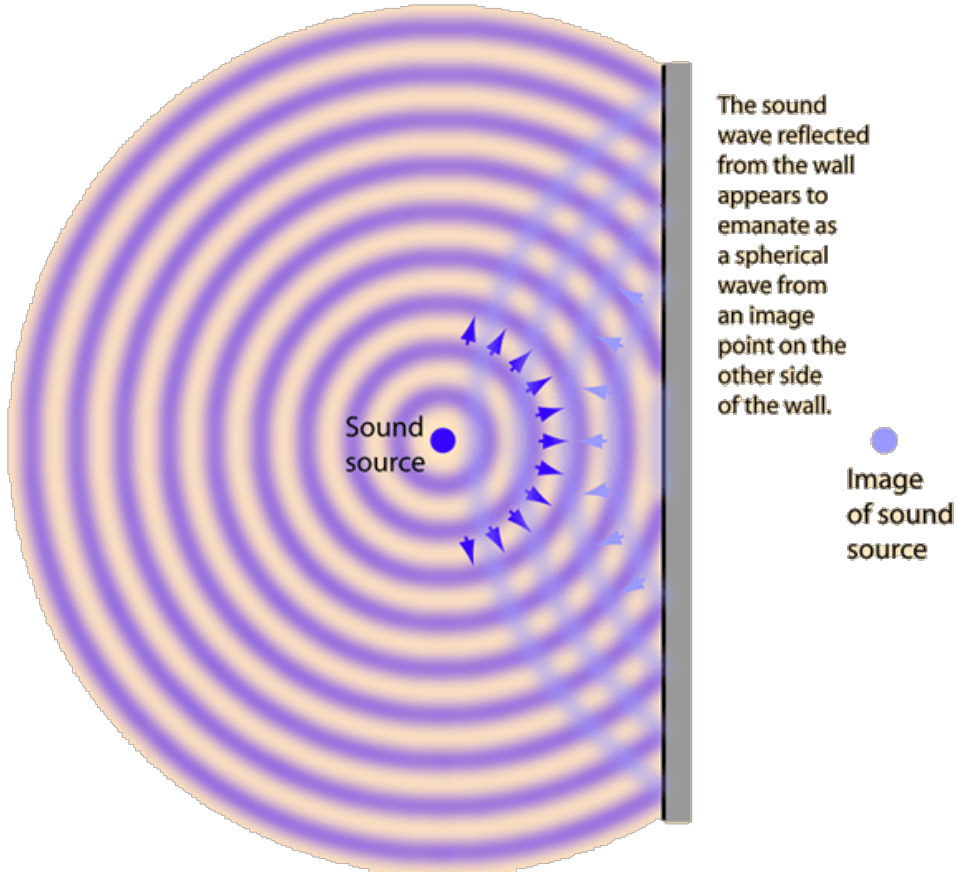

Figure: Radial waves reflecting off a flat surface

Point Source: Reflection off Parabola

Placing a parabola into the water, what should the reflected waves look like?

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This is hard to see in the ripple tank, unfortunately, but if we place the wave source at the focal point, they should reflect to form plane waves.

Two Point Sources: Interference

We can add a second point source to see the interference that results. What pattern will be created when the waves overlap?

Point Source: Diffraction

Let's follow the same steps as above to see what happens with diffraction.

Try it

Does anyone have anything they want to try in the ripple tank?