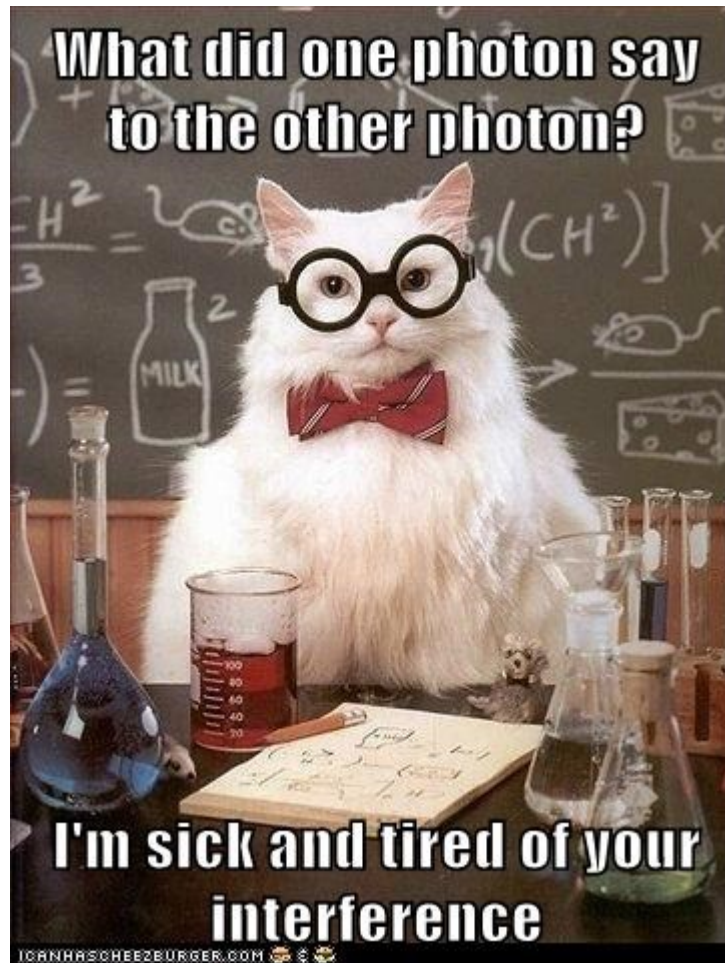


# Interference

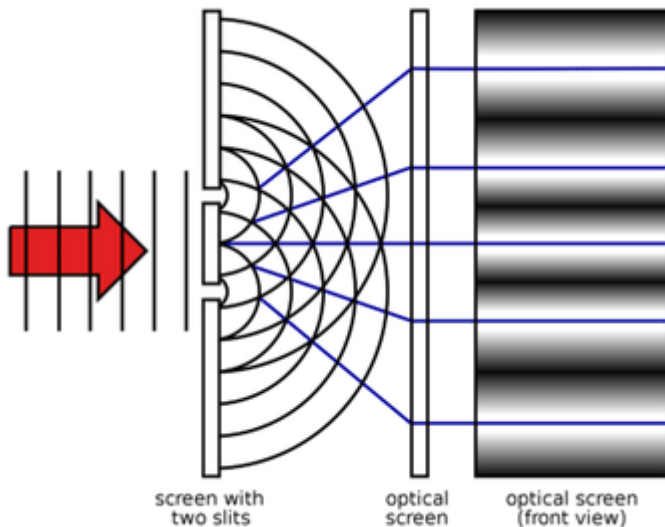


**Wave interference is a result of the Law of Superposition:**

When two or more waves meet at a point, the resultant wave has an amplitude that is the sum of the displacements of each wave. This results in constructive and destructive interference.

# Interference Pattern:

When waves interfere, they produce an interference pattern  
 A **simple** example is produced by a wave passing through 2 slits.



$$\lambda = \frac{xd}{nL}$$

$\lambda$  is the wavelength (m)  
 $x$  is the distance from central fringe  
 $d$  is the distance between slits  
 $n$  is the fringe order  
 $L$  is the distance from slits to screen (m)

Some easy examples before we discuss the absolutely mind bending results of the 'simple' 2 slit experiment.

Light of  $\lambda = 300 \text{ nm}$  passes through two slits, 2 mm apart. If an interference pattern forms on a screen 4 m away, what is the distance between the central fringe and fringe order 2?

$$\lambda = \frac{xd}{nL}$$

$$300 \times 10^{-9} = \frac{x \cdot 2 \times 10^{-3}}{2(4)}$$

$$x = \frac{4(2)(300 \times 10^{-9})}{2 \times 10^{-3}}$$

$$x = \frac{1200 \times 10^{-6}}{2}$$

$$= 1.2 \times 10^{-3} \quad 1.2 \text{ mm}$$

The distance between the central fringe and the order 4 fringe is 0.5 mm. If the  $\lambda$  of the light is 450 nm, and the screen is 5 m from the slits, how far apart are the slits?

$$\lambda = \frac{xd}{nL}$$

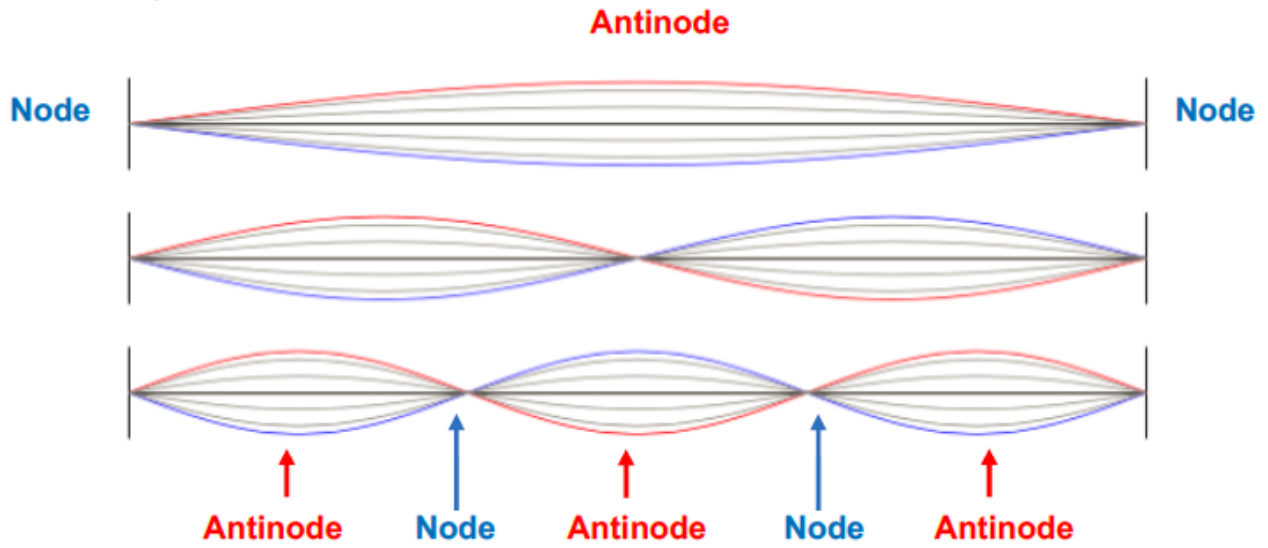
$$450 \times 10^{-9} = \frac{0.5 \times 10^{-3} d}{4(5)}$$

$$\frac{450 \times 10^{-9}(20)}{0.5 \times 10^{-3}} = d$$

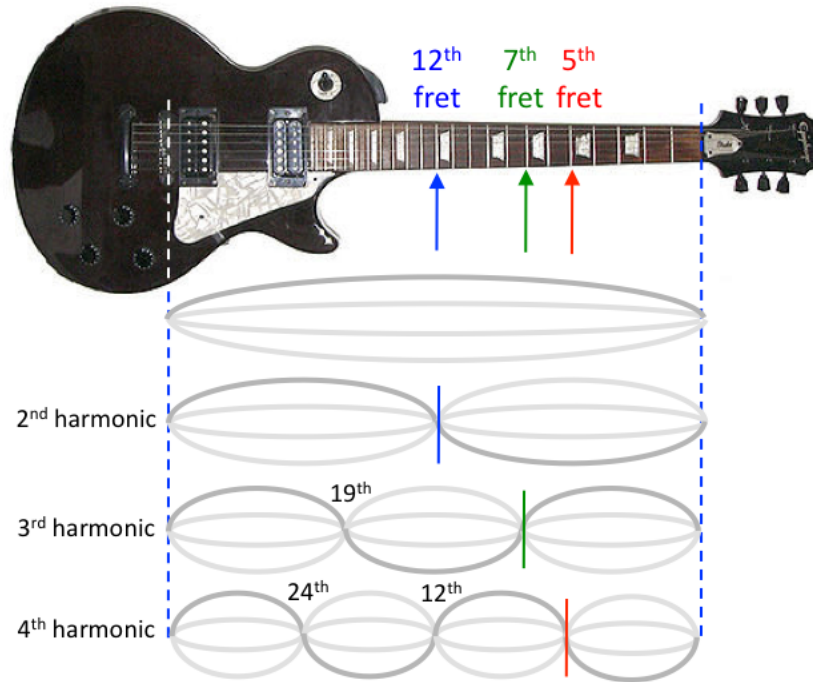
$$0.018 \text{ m} = d$$

$$1.8 \text{ cm} = d$$

Standing waves:

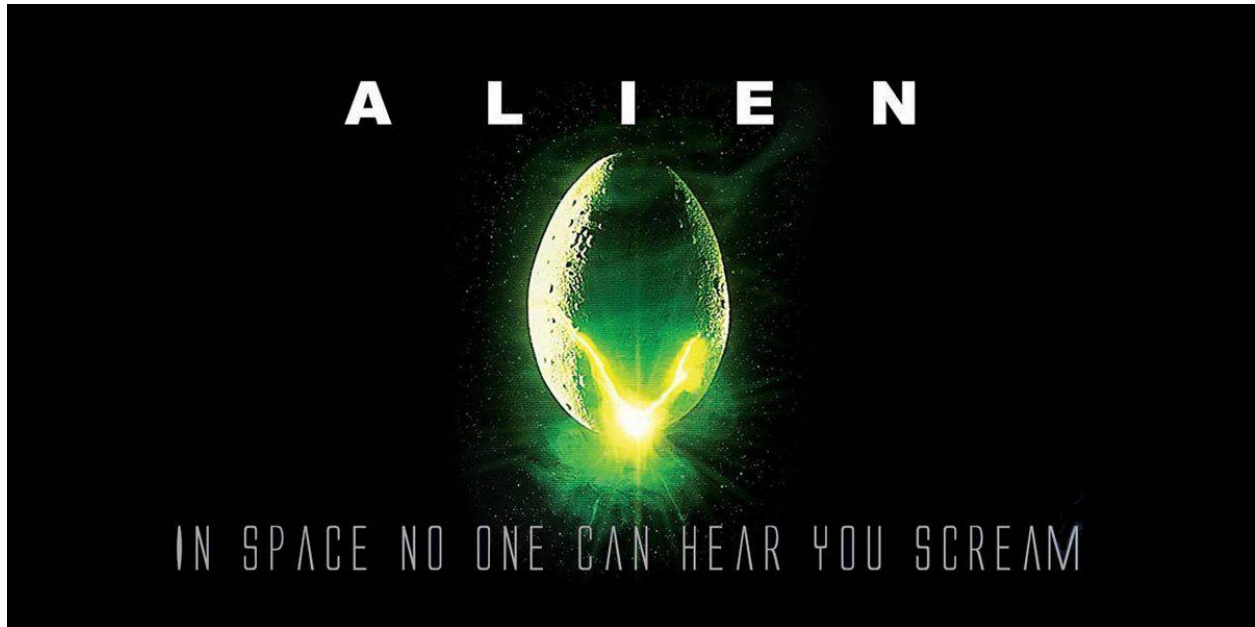


## Harmonics on a Guitar



## Back to the 2 slit experiment:

A bit of background:



These waves need to travel on something...

Combine this with the fact that light is a wave...



So, how does the light from the Sun get to Earth?

Big problem...

It was theorized that space was made of a material that could transmit light - called 'aether'.

They set about to find it...

Enter the (imo) most important null result in experimentation, the Michelson/Morley interferometer.

*In that basement Michelson and Morley carefully set up a brick foundation for a circular iron trough which held a pool of mercury. On that they floated a wooden doughnut which supported a five-foot square sandstone block. To the block Michelson and Morley fixed their mirrors, lenses, and lamp. The instrument was set up so that a single light beam would be divided into two portions, each traveling thirty-six feet, but one at right angles to the other for most of the journey. At the end the two beams coincided in the viewer's eyepiece.*

They found - nothing. The speed of light is the same in all directions. There was no aether medium for the light waves to travel on. (this comes up a lot in relativity!)

This was the dawn of:

## Wave/particle duality

Light is a wave.

Light is a particle.

We call the particle of light a photon.

Let's watch a video on what happens when you shoot particles of light through 2 slits.

