行波与驻波

> Notes for MIT-18.002

We will start with a very down-to-earth equation. $y = \frac{1}{3}x$ .We can see this is a line through origin with slope $1/3$. Suppose wo want this line to move with a speed of 6 meters per second in the plus x direction.

All we have to do is to replace x in that equation by $x - 6t$. That tells us if we want something to move with a speed v in the x plus direction, then all we have to do in our equations is to replace x by $x - vt$, vice versa.

Now, we are going to change to something that is real wave.

We have equation below.

$$y = 2\sin 3x$$

That is a wave, not moving. And λ -- the wavelength is $2\pi/3$. The wave number $k = \frac{2\pi}{\lambda} = 3$ is the coefficient in front of x.

Now we want to have this wave move. We want to have a travelling wave. We want to have it move with 6 meters per second in the plus x direction. So the recipe is now very simple, all we have to do is replace this x by $x - 6t$.

$$y = 2\sin 3(x - 6t)$$

And if we look at this equation, And you plot a little bit later in time than t_0. This equation holds all the characteristics of the oscillation. It holds **the amplitude, the wavelength, the speed and the direction**.

We can also make a travelling wave with a rotating wheel. Detail in the video.

Let's move on to the standing wave. Suppose we have a wave travelling with plus x direction called y_1

$$y_1 = y_0 \sin(kx - \omega t)$$

And notice now, we have all the symbols that we are familiar with.

And another identical wave but travelling with the opposite direction.

$$y_2 = y_0 \sin(kx + \omega t)$$

And so if this is a string, the net result is the sum of the two. So we have to add them up.

$$y = y_1 + y_2$$

So we have to do some trigonometric manipulation

$$\boxed{y = 2y_0 \sin kx \cos \omega t}$$

And this is very different from a travelling wave.

Nowhere will you see $kx - \omega t$ anymore. All the timing information is now separate from the spatial information. And so what does a standing wave looks like? There will be some stationary point that will never move -- **nodes**. Nothing is going in the horizontal line, just going up and down, up and down except these nodes.

Can we make a standing wave? Yes we can. A standing wave can be made by shaking or rotating a string. Detail in the video.

You need to watch the video. That's truly amazing, especially for the latter part with instructor illustrate the principle of instruments and other knowledge.