SOUND WAVES-BEATS

What would you hear (detect) if two sound waves of slightly* different frequencies arrived at your ear at the same time.

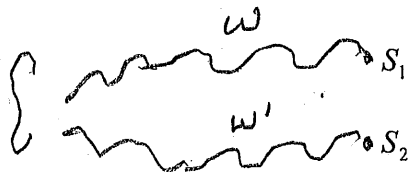
Let us put detector at $x = 0$ and have two waves

$$S_1 = S_m Sin(kx + wt)$$

$$\frac{w}{k} = V_s = \frac{w'}{k'}$$

$$S_2 = S_m Sin(k'x + w't)$$

$x = 0$



Ear

Superpose S_1 and S_2 at $x = 0$

$$S = S_m(Sinwt) + S_m Sin(w't)$$

$$= 2S_m Cos(\frac{w - w'}{2})t \cos(\frac{w + w'}{2})t$$

* $(w - w') << w$ $\quad [(f' - f) << f]$ so $\frac{w + w'}{2} \approx w$

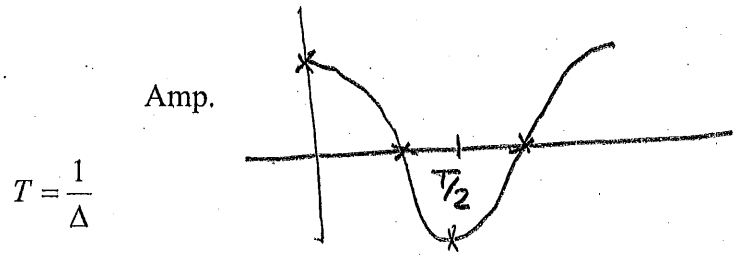
$$S = 2SinCos[2\pi(\frac{f - f'}{2})t]Sinwt$$

So you perceive a wave of frequency f whose amplitude varies as

$$Cos\frac{2\pi(f - f')}{2}t$$

or at a frequency $\Delta = (\frac{f - f'}{2})$

That is if you plot amplitude as a function of t you get:



Note that in one period there are two maxima and two zeros so you will detect

$$f_B = | f - f' |$$

as the number of Beats when both sounds arrive together, you hear one frequency, but its amplitude has $| f - f' |$ maxima and $| f - f' |$ zeros every second.

The two bars in the Demo had frequencies $f = 440Hz$ and $f' = 445Hz$ you heard $440Hz$ and five zeros/maxima per second.