# Group Delay and Phase Delay (1A)

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# Beat Signal

**Very similar frequency signals**

1.1 Hz $\cos(2\pi*1.1*t)$

0.9 Hz $\cos(2\pi*0.9*t)$

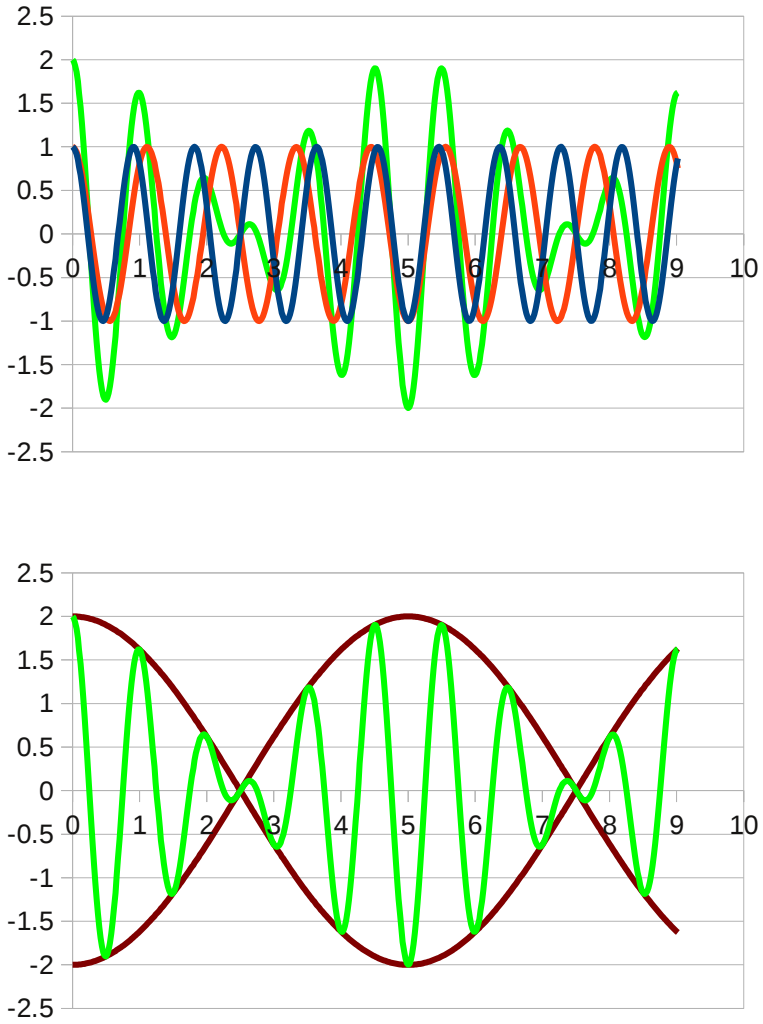
$$\cos(2\pi*1.1*t)+\cos(2\pi*0.9*t)$$

$$=\cos\left(2\pi*\frac{(1.1-0.9)}{2}*t\right)\cdot\cos\left(2\pi*\frac{(1.1+0.9)}{2}*t\right)$$

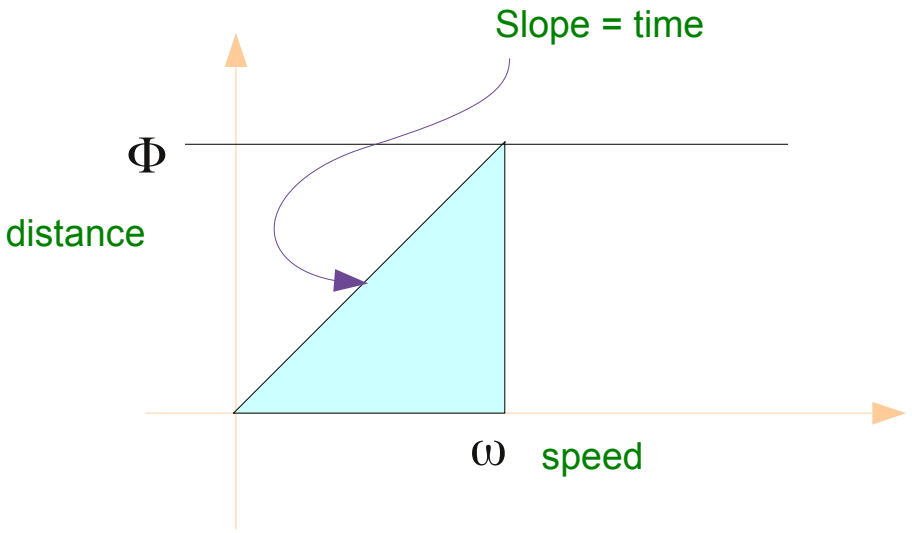
$$=\cos(2\pi*0.1*t)\cdot\cos(2\pi*1.0*t)$$

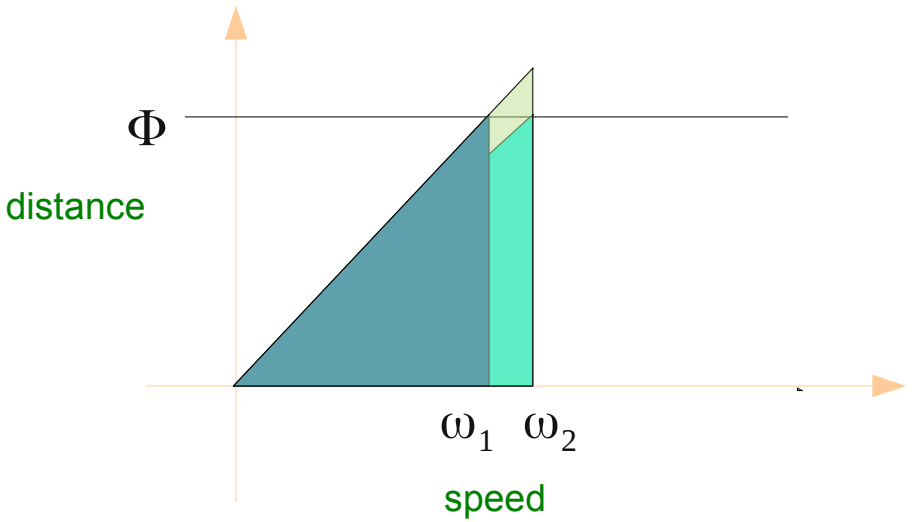
Slow moving envelop

Fast moving carrier



# Angle and Angular Speed



## References

[1] http://en.wikipedia.org/
[2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003
[3] A “graphical interpretation” of the DFT and FFT, by Steve Mann