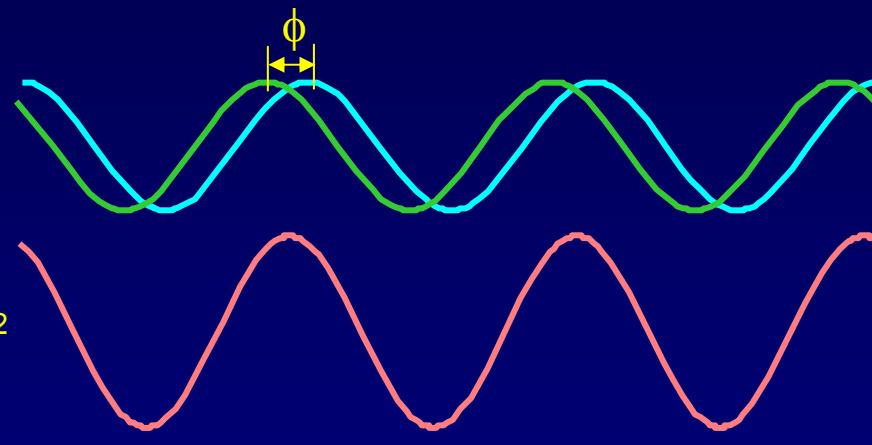# Adding Sine Waves with Different Phases

Suppose we have two sinusoidal waves with the same A_1, ω, and k: $y_1 = A_1 \cos(kx - \omega t)$ and $y_2 = A_1 \cos(kx - \omega t + \phi)$
One starts at phase ϕ after the other:

Spatial dependence of 2 waves at t = 0:

Resultant wave: $y = y_1 + y_2$

Use this trig identity: $A_1\left(\cos\alpha + \cos\beta\right) = 2A_1 \cos\left(\dfrac{\beta - \alpha}{2}\right)\cos\left(\dfrac{\beta + \alpha}{2}\right)$

$y_1 + y_2$ $(\phi/2)$ $(kx - \omega t + \phi/2)$

$$y = \underbrace{2A_1 \cos(\phi/2)}_{\text{Amplitude}}\ \underbrace{\cos(kx - \omega t + \phi/2)}_{\text{Oscillation}}$$