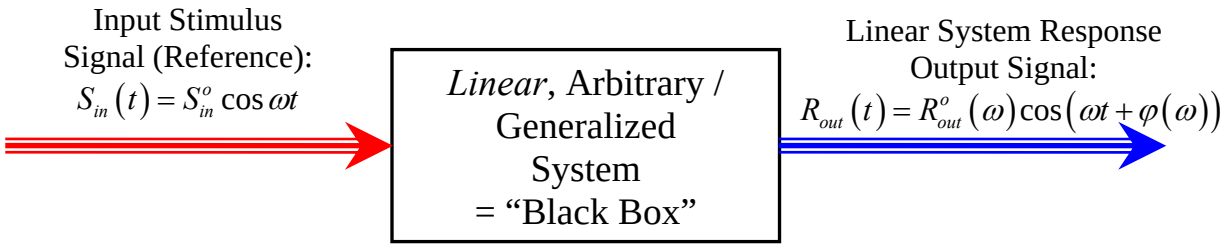
Complex Sound Fields

What is a *Complex* Quantity?

In *any* situation involving wave phenomena, if interference effects are manifest, *e.g.* two (or more) waves {*n.b.* diffraction – a *scattering* process – is also a type of wave interference – wave *self*-interference}, then a well-defined phase relation between waves associated with such phenomena exists, which in general is time-dependent, but could also be stationary in time in certain situations.

There are also {many} situations in which a periodic/harmonic (*i.e.* single frequency) ***input*** stimulus – *i.e.* a harmonic ***reference*** signal $S_{in}(t) = S_{in}^{o} \cos \omega t$ is ***input*** to a ***system*** { = a "black box"} which in turn outputs a {***linear***} ***response*** signal which, in general may have a ***non-trivial*** (*e.g.* frequency-dependent) ***amplitude* .and. *phase*** relation ***relative*** to the input reference signal $R_{out}(t) = R_{out}^{o}(\omega)\cos\left(\omega t + \varphi(\omega)\right)$, which we show schematically in the figure below:



Mathematically, we can use ***complex variables*** as a convenient way to describe the underlying physics associated with such phenomena. We don't *have to* use complex variables/complex notation to do this, but it turns out that in many situations it is very convenient/handy to do so!

In acoustics, since we have already talked about/discussed various situations exhibiting wave interference, we're thus already familiar with many examples of complex sounds – we simply haven't discussed them using complex variables/complex notation. One simple acoustics example is the situation where a sine-wave generator at frequency f is used to drive an identical pair of loudspeakers situated a lateral distance d away from each other – destructive/constructive interference effects between the sine-wave sounds coming from the two loudspeakers can clearly be heard *e.g.* walking on a line parallel to the line joining the two loudspeakers, as shown in the figure below: