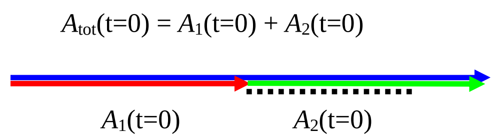
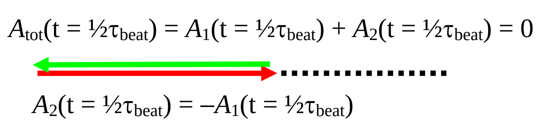
Human beings perceive/hear beats in a rather peculiar manner – when the two (or more) individual frequencies are quite close together, i.e. $f_1 \sim f_2$, and in fact so close together such that their frequency difference, $\Delta f = f_{beat} = | f_1 - f_2|$ is less than the so-called ***critical band*** for human hearing (typically ~ 90 Hz for frequencies in the human voice range (~ 100 *Hz* – 1 *KHz*)). We humans don't perceive the individual frequencies as separate, rather, we perceive/hear only a single frequency, as the (~ log-weighted intensity) average of the frequencies present. For two signals with equal amplitudes/equal sound intensities having $f_1 \sim f_2$ with $\Delta f = f_{beat} = | f_1 - f_2|$ less than the critical band, the perceived average frequency is simply $< f > = ½(f_1 + f_2)$. What we humans hear as beats in this situation is so-called amplitude modulation of a sound wave consisting of a single average frequency $< f > = ½(f_1 + f_2)$, much like someone rhythmically turning the volume control of an amplifier up and down at a frequency of $\Delta f = f_{beat} = | f_1 - f_2|$, or equivalently, a beat period of $\tau_{beat} = 1/f_{beat} = 1/| f_1 - f_2|$.

In terms of the phasor diagram, as time progresses, the individual amplitudes $A_1(t)$ and $A_2(t)$ actually precess at (angular) rates of $\omega_1 = 2\pi f_1$ and $\omega_2 = 2\pi f_2$ radians per second respectively, completing one revolution in the phasor diagram, for each cycle/each period of $\tau_1 = 2\pi/\omega_1 = 1/f_1$ and $\tau_2 = 2\pi/\omega_2 = 1/f_2$, respectively. If at time $t = 0$ the two phasors are precisely in phase with each other (i.e. with initial relative phase $\Delta\varphi_{21} = 0.0$), then the resultant/total amplitude $A_{tot}(t = 0) = A_1(t = 0) + A_2(t = 0)$ will be as shown in the figure below.



As time progresses, if $\omega_1 \neq \omega_2$, (phasor 1 with angular frequency $\omega_1 = 2\pi f_1 = 2*1000\pi = 2000\pi$ radians/sec and $\omega_2 = 2\pi f_2 = 2*980\pi = 1960\pi$ radians/sec in our example above) phasor 1, with higher angular frequency will precess more rapidly than phasor 2 (by the difference in angular frequencies, $\Delta\omega = (\omega_1 - \omega_2) = (2000\pi - 1960\pi) = 40\pi$ radians/second). Thus, as time increases, phasor 1 will ***lead*** phasor 2; eventually (at time $t = ½\tau_{beat} = 0.025 = 1/40^{th}$ sec in our above example) phasor 2 will be exactly $\Delta\varphi = \pi$ radians, or 180 degrees behind in phase relative to phasor 1. Phasor 1 at time $t = ½\tau_{beat} = 0.025$ sec $= 1/40^{th}$ sec will be oriented exactly as it was at time t = 0.0 (having precessed exactly $N_1 = \omega_1 t/2\pi = 2\pi f_1 t/2\pi = f_1 t = 25.0$ revolutions in this time period), however phasor 2 will be pointing in the opposite direction at this instant in time (having precessed only $N_2 = \omega_2 t/2\pi = 2\pi f_2 t/2\pi = f_2 t = 24.5$ revolutions in this same time period), and thus the total amplitude $A_{tot}(t = ½\tau_{beat}) = A_1(t = ½\tau_{beat}) + A_2(t = ½\tau_{beat})$ will be precisely zero (if the magnitudes of the two individual amplitudes are precisely equal to each other), or minimal (if the magnitudes of the two individual amplitudes are not precisely equal to each other), as shown in the figure below.



As time progresses further, phasor 2 will continue to lag farther and farther behind, and eventually (at time $t = \tau_{beat} = 0.050$ sec $= 1/20^{th}$ sec in our above example) phasor 2, having precessed through $N_2 = 49.0$ revolutions will now be exactly $\Delta\varphi = 2\pi$ radians, or 360 degrees (or