9.5: Amplitude Modulation

So far, we've mostly considered simple sinusoidal waves with fixed amplitudes. However, the general solution to the wave equation allows for many more interesting wave shapes. An important, and often encountered one is where the wave itself is used as the medium, by changing the amplitude over time:

$$u(x,t) = A(x,t)\cos(kx-\omega t) \tag{9.5.1}$$

The wave now consists of two waves: the carrier wave, which travels with the **phase velocity** $v_w = \frac{\omega}{k}$, and the envelope, which travels with the **group velocity** v_g. An illustration of a modulated wave is shown in Figure $9.5.1$. In the common case that the group velocity is independent of the wavelength of the carrier wave, we can rewrite 9.5.1 to reflect the fact that the amplitude is now also a wave, with speed v_g:

$$u(x,t) = A\left(x-v_{\mathrm{g}}t\right)\cos(kx-\omega t) \tag{9.5.2}$$

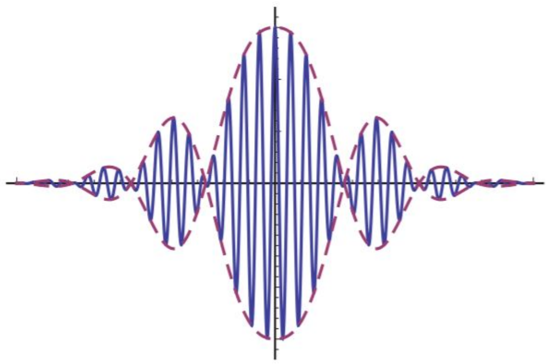

Figure $9.5.1$: Amplitude-modulated wave. The amplitude of the carrier wave (blue, traveling at phase velocity $v_{\mathrm{w}} = \omega/k$) is changed over time, resulting in an envelope (red) which travels at the lower group velocity v_g.