Circular Polarization

In a **circularly polarized** EM wave, the electric field at any point has a constant magnitude but its direction rotates in the plane perpendicular to the direction of propagation. Imagine the electric field vector rotating, with its tip tracing out a circle. According to the convention used in optics, if you are looking at the wave coming toward you and the electric field vector rotates clockwise, it is *right circularly polarized*; if it rotates counterclockwise it is *left circularly polarized*.

A circularly polarized wave is the superposition of waves polarized along perpendicular axes that have the same amplitude and frequency and are 90° out of phase. Suppose that at some point the electric fields due to two waves traveling along the z-axis are $E_x = E_m \cos \omega t$ and $E_y = E_m \sin \omega t$. At any time the magnitude of the electric field is E_m:

$$E = \sqrt{E_x^2 + E_y^2} = \sqrt{E_m^2 \cos^2 \omega t + E_m^2 \sin^2 \omega t} = E_m \sqrt{\cos^2 \omega t + \sin^2 \omega t} = E_m$$

At a time t the electric field makes an angle θ with respect to the $+x$-axis, where

$$\theta = \tan^{-1} \frac{E_y}{E_x} = \tan^{-1} \left(\frac{E_m \sin \omega t}{E_m \cos \omega t} \right) = \omega t$$

Thus, the electric field vector rotates with constant angular velocity ω.