

Lecture-2

Example: Equiangular spiral antenna

This is one geometrical configuration whose surface can be described by angles.

Specify $f(\theta)$ /derivative of $f(\theta)$:

$$\frac{df}{d\theta} = f'(\theta) = A\delta\left(\frac{\pi}{2} - \theta\right)$$

A: a constant, δ : Dirac delta function

So,

$$r \Big|_{\theta=\pi/2} = \rho = \begin{cases} Ae^{a\phi} = \rho_0 e^{a(\phi-\phi_0)} & \theta = \pi/2 \\ 0 & \text{elsewhere} \end{cases} \quad (4.8)$$

where $A = \rho_0 e^{-a\phi_0}$

In terms of λ ,

$$\rho = \frac{\rho}{\lambda} = \frac{A}{\lambda} e^{a\phi} = Ae^{a[\phi - \ln(\lambda)/a]} = Ae^{a(\phi - \phi_1)}$$

where $\phi_1 = \frac{1}{a} \ln(\lambda)$

Alternatively,

$$\phi = \frac{1}{a} \ln\left(\frac{\rho}{A}\right) = \tan\psi \ln\left(\frac{\rho}{A}\right) = \tan\psi (\ln\rho - \ln A)$$

where $1/a$: rate of expansion of the spiral, ψ : angle between the radial distance ρ and the tangent of the spiral .

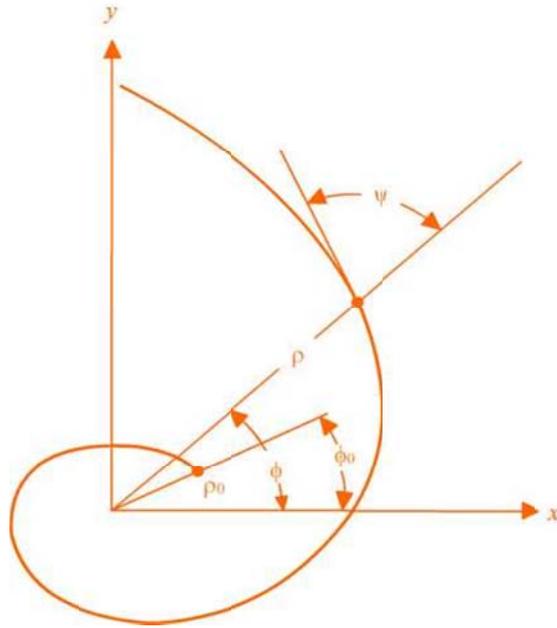


Fig 4.2. Single spiral

The total L of the spiral can be calculated by:

$$L = \int_{\rho_0}^{\rho_1} \left[\rho^2 \left(\frac{d\phi}{d\rho} \right)^2 + 1 \right]^{1/2} d\rho$$

$$\Rightarrow L = (\rho_1 - \rho_0) \sqrt{1 + \frac{1}{a^2}}$$

ρ_0, ρ_1 : inner and outer radii of the spiral.

Various geometrical arrangement of the spiral have been used to form different antenna systems as shown in Fig.4.3.

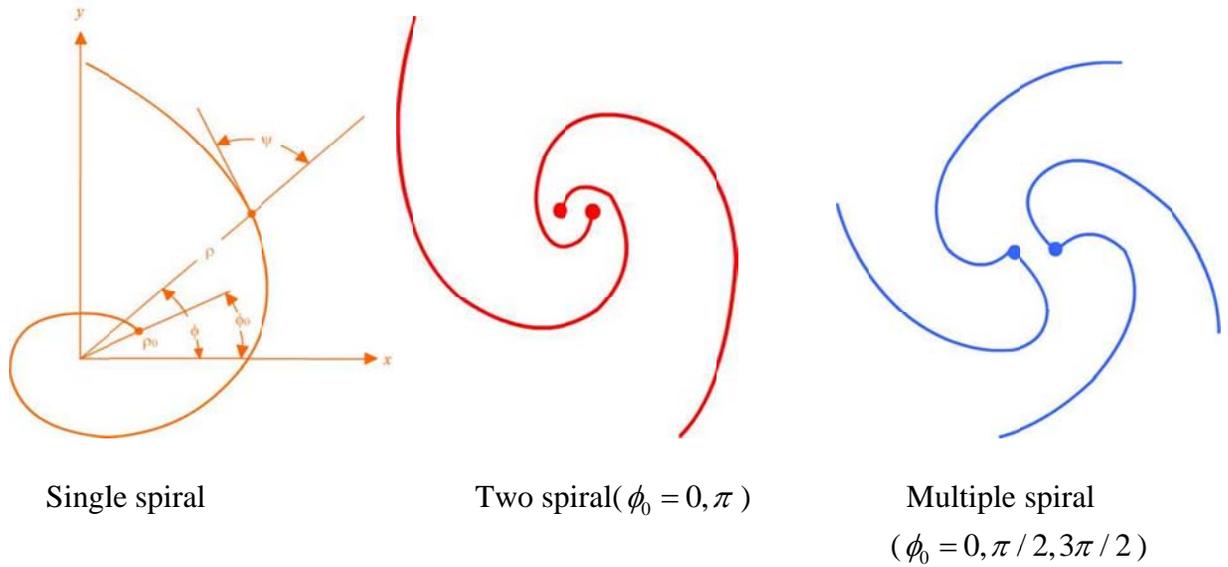


Fig.4.3. spiral wire antenna

This analytical formulation can be extended to create two different antennas. One antenna would consist of two metallic arms suspended in free-space [Fig. 4.4(a)] and the other of a spiraling slot on a large conducting plane [Fig. 4.4(b)]. Both these antenna are tapered to provide better matching termination.

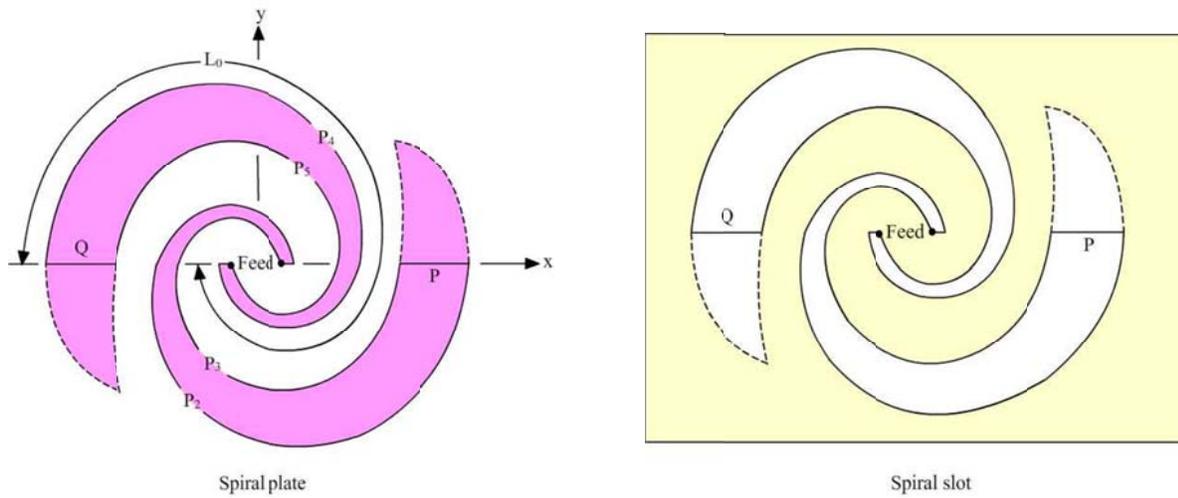


Fig.4.4. Spiral plate and slot antenna