Simulation of Antenna Arrays: Part 5 – Predicting the radiation pattern of antenna arrays

Now that the radiation patterns of an array of antennas can be predicted, this blog will demonstrate how to use the approach we have developed to predict the typical use of an antenna array for steering the radiation pattern to follow specific, predefined paths.

Array Steering

An array is typically designed to have maximum directivity using the broadside radiation pattern, i.e. at an azimuth angle $\varphi = 90^{\text{o}}$ for an array along the x −axis. The maximum of the array factor $A(\theta, \varphi)$ is obtained when the digital wavenumber is zero:

$$\psi = kd\cos\varphi = 0$$

We can "electronically" rotate, or steer the array pattern towards some other direction, say ϕ_0, without rotating it. The corresponding digital wavenumber at the desired viewing direction will be:

$$\psi_0 = kd\cos\phi_0$$

Such steering operations can be achieved using wavenumber translation in ψ −space be replacing the broadside pattern $A(\psi)$ by the translated pattern $A(\psi - \psi_0)$. The translated variable is then defined as:

$$\psi' = \psi - \psi_0 = kd(cos\varphi - cos\phi_0)$$

This equation can also be written in terms of the linear phase progression parameter α:

$$\psi' = kdcos\varphi + \alpha$$

where the array phase progression parameter is given by:

$$\alpha = -kdcos\phi_0 = -2\pi\frac{d}{\lambda}cos\phi_0$$

For a linear array of 15 half-wavelength dipoles arranged along the x −axis, we want to steer the broadside pattern by an angle ϕ_0. For the sake of convenience, we can parametrize the steering angle and array phase progression as shown below:

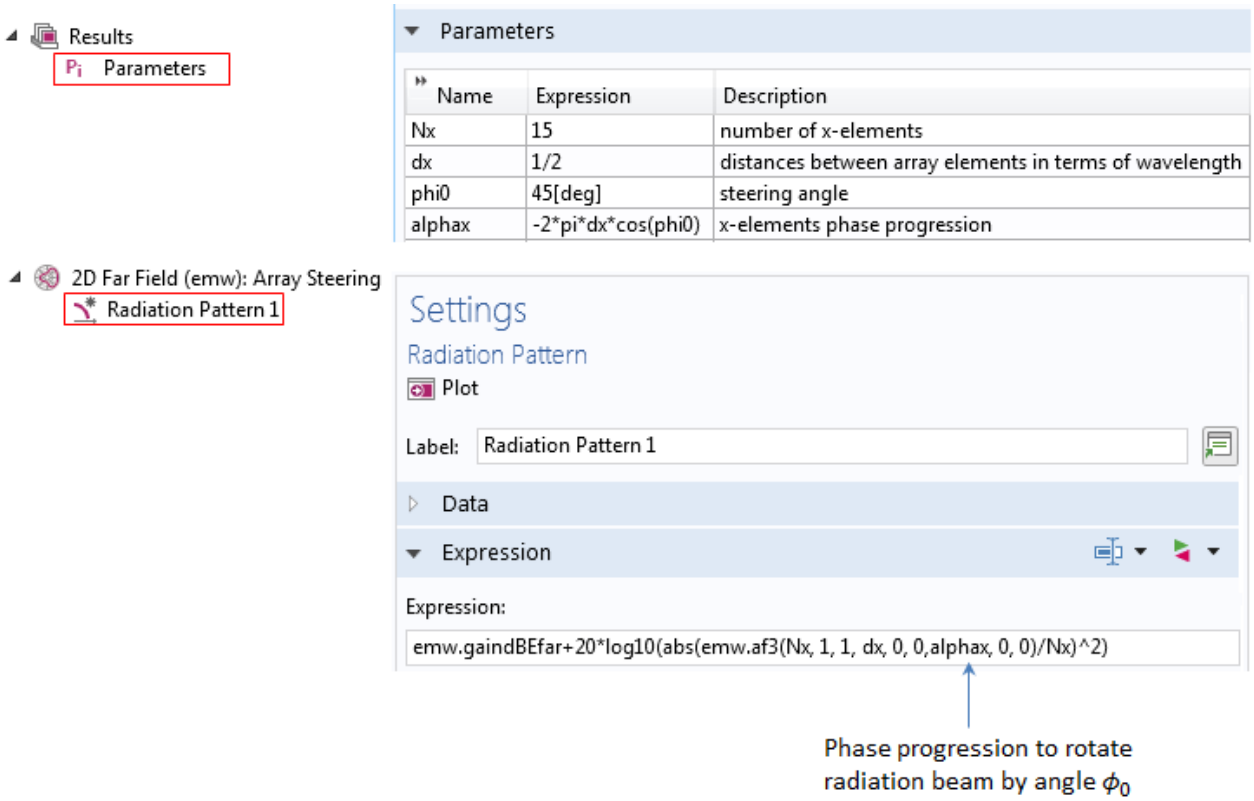

Figure 15: Setup windows for array phase progression and expression for the power gain radiation pattern

Figure 16 illustrates the effect of translation of the digital wavenumber on the corresponding rotation of the angular pattern for a 15-element half-wavelength uniform dipole array with $d_x = \lambda/2$.

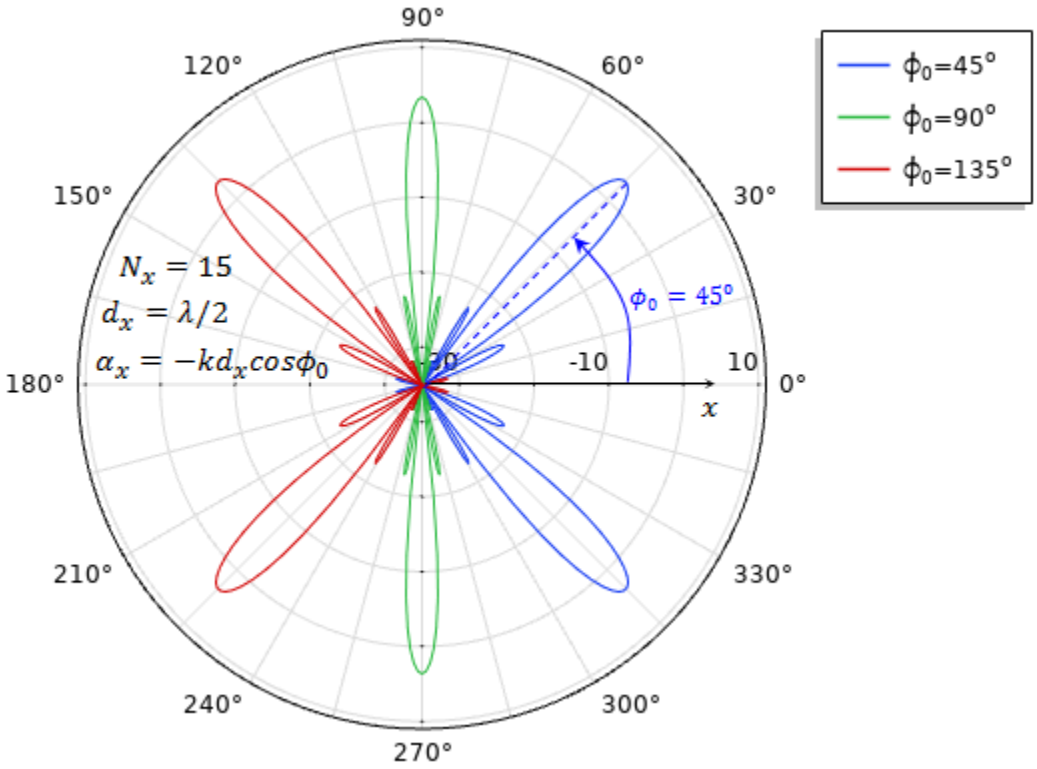

Figure 16: Array steering by translation in digital wavenumber space

Please see animation below this pdf.

References

1. Constantine A. Balanis, *Antenna Theory: Analysis and Design*, John Wiley &Sons, New Jersey, 2005 (third edition).

2. Sofocles J. Organdies, *Electromagnetic Waves and Antennas*, Rutgers University, https://www.ece.rutgers.edu/~orfanidi/ewa/ewa-2up.pdf