Data Processing School :: Exercise 45

Source directory	/data/lofarschool/data/exercise 45
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Context

This exercise will demonstrate how some simple Python commands can help visualize how a single polarization of the LOFAR low band antennae responds to electromagnetic radiation.

Prerequisite

Basic python.

Description

This exercise describes two functions you can use in this exercise to visualize the LOFAR LBA beam. The beam model is an analytic solution to how a single polarization of the LBA (e.g., "x") sees electromagnetic radiation from the sky. This model only applies to a single polarization that is rotated 45 degrees relative to local north. For the x+y sensitivity, imagine rotating the sensitivity pattern of x by 90 degrees and adding it to the original pattern.

The exercise consists of two functions that can plot either one or a set of slices through the beam.

1. "show_azimuth" requires as input the observing frequency and an azimuth value. It then plots a slice through the beam at that frequency and azimuth (from horizon to zenith). Azimuth=0deg is due north and increases to the east.
2. "show_elevation" is the same, but plots a slice through the beam at a given elevation, starting from azimuth zero through 360 degrees.

Both functions can take one input value of azimuth or elevation. They can also take lists of multiple azimuths and elevations. A list in python is defined with square brackets, e.g., "[10., 50.]".

Files & Directories

The following files are found in the exercise directory:

1. `coordinates_mod.py` – A Python script the does coordinate conversion. Not used directly.
2. `exercise.py` – A Python script that defines a few functions for plotting the beam amplitude.
3. `inputs` – A directory for associated files and libraries. Not used directly.
4. `inputs_old` – An old inputs directory. Not used directly.
5. `lofar_beams.py` – A Python script that reads in the LOFAR LBA beam model. Not used directly in the exercise, but could be fun for experimentation.
6. `README.txt` – File that introduces the exercise and problems.

Step-by-step instructions

Use these functions to answer the following questions.

1. Imagine a cell phone tower that is 50m tall and located 50km away to the east. How much will the x-dipole signal be reduced by the beam sensitivity at 30. and 80. MHz?
2. What is the elevation of the x-dipole half-power point for frequency = 30 MHz and azimuth = 0., pi/8, pi/4, 3pi/8, pi/2, pi?
3. How is the x-dipole beam pattern is symmetric in azimuth? How often does it repeat itself in a full 360 degrees? How often would the x+y dipole pattern repeat in 360 degrees?
4. Estimate the most that the x+y beam amplitude changes with azimuth at 30 and at 80 MHz?
5. At what frequency between 30-80 MHz does the x+y beam have the least structure (most smooth)?

Example outputs

Here is are quick exapmles of how you can run the two functions:

```
# first, run python interactively and import the script.
> ipython -pylab
>>> import exercise
```

```
# this shows an azimuth slice through the beam at 30 MHz toward the east.
>>> exercise.show_azimuth(30e6,90.)
```

```
# this shows three elevation slices through the beam at 80 MHz.
>>> exercise.show_elevation(80e6,[10.,30.,50.])
```