Problem 6

From the non-adaptive power spectrum estimate, there appears to be 3 distinct signals of interest impinging on the array at {-61.5, 43.8, and 53.5} degrees. It can be expected to have the MVDR power spectrum estimate be more precise than the non-adaptive estimate; however, the MVDR power spectrum estimate shows 6 signals at {-61.5, -16.5, 40.5, 45.4, 95.3, and 112.7} degrees, but at very low power levels (almost 290dB below the non-adaptive estimate). This huge discrepancy is due to the autocorrelation matrix R being very ill-conditioned (condition number of 1.34e18).

By using forward/backward averaging, the condition number of the R matrix (denoted Rfb) is decreased by orders of magnitude, to 9823. The corresponding MVDR (denoted by the green Rfb line in the plot) has well defined peaks at {-57.4, -42.4, -17.7, 18.3, 43.0, and 58.0} degrees.

Diagonal loading of the original R matrix (to make the matrix more well-conditioned, in particular condition number = 1312) shows a smoother response (shown in purple) than the unloaded (original R) matrix, but the effect of the dominant diagonal is to smooth out the response; thus, only 4 peaks are seen at {-59.8, -18.3, 43.0, and 49.6} degrees.

Diagonal loading of the Rfb (forward-backward averaged) autocorrelation matrix again “smoothed out” the spectral response of the original Rfb MVDR; the peaks were higher (denoted by the yellow line) and had identical angular locations, but almost hid the unique peaks at -57/-42 degrees and 43/58 degrees. A lower diagonal loading value would likely prevent the blending of the peaks more.

Overall, the signals at -60, -18, 43 and 50 degrees (corresponding to the associated eigenvectors of the 4 dominant eigenvalues) showed up in all the power spectrums, with the exception of the non-adaptive spectrum, which didn’t have enough resolution to identify the two peaks at 43 and 50 degrees.