Abstract:
In many applications of wireless communications, radar, sonar, and biomedical imaging, it is desired to separate a signal of interest in the presence of interference and noise using measurements from multiple sensor elements. When exact knowledge of the signal signature vector is available, adaptive beamformers provide high spatial resolution and good interference rejection. However, in most situations, the signature vector is not perfectly known due to factors such as multi-path, local scattering, random fluctuations in the propagation medium, array calibration errors, etc. Differences between the presumed signature and the actual signature result in signal suppression and poor interference rejection.

In this talk, we derive two multi-rank generalizations of the MVDR beamformer, namely matched direction beamformers and matched subspace beamformers, for scenarios where the signal signature lies in a known linear subspace but the orientation of the signal in the subspace is otherwise unknown. The unknown orientation may be fixed for a sequence of experimental realizations, in which case the signal has a rank-1 covariance matrix, or it may be random over realizations, in which case the signal covariance is multi-rank. We show that eigenvalues of an error covariance matrix play a key role in resolving signals of interest. As we will see, signals with rank-1 covariances are resolved by the dominant eigenvalues of the error covariance matrix (matched direction beamforming) while signals with multi-rank covariances are resolved by the subdominant eigenvalues (matched subspace beamforming). Consequently, the beamformers we advocate may be viewed as eigenvalue beamformers. But more importantly, it is eigenvalues of an error covariance matrix that matter- not eigenvalues of measurement covariance matrices.