

We consider the problem of estimating the covariance of  $X$  from measurements of the form  $y_i = A_i x_i + \varepsilon_i$  (for  $i = 1, \dots, n$ ) where  $x_i$  are i.i.d. unobserved samples of  $X$ ,  $A_i$  are given linear operators, and  $\varepsilon_i$  represent noise. Our estimator is constructed efficiently via a simple linear inversion using conjugate gradient performed after eigenvalue shrinkage motivated by the spike model in high dimensional PCA. Applications to 2D image denoising and 3D structure classification in single particle cryo-EM will be discussed.