Finite difference operators as a preconditioner in phase contrast tomography

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In computed tomography, phase contrast imaging can lead to higher contrast reconstructions than classical absorption based CT for certain materials, e.g. soft tissue. Differential phase contrast tomography (DPC) is based on measurements of the small angular deviations in the wave front. These measurements can be linked to the derivative of the intensity measurements used in absorption based computed tomography.

Using this knowledge, it is possible to reformulate the reconstruction methods from classical CT for the DPC problem. Analytically, this results in a FBP algorithm with a special complex filter. Algebraically however, the linear system $Ax = b$ for absorption based tomography, changes to $DAx = b$ for some finite difference operator D. This leads to a regularization problem of the form

$$\min_{x\in\mathbb{R}^n} \left\{ \|b - DAx\|_2^2 + \lambda \|x\|_2^2 \right\}. \tag{1}$$

In this talk we will discuss how different finite difference operators affect the reconstruction. More specifically, we will look at a forward and a central difference scheme as well as a combination of both. We will also show how the generalized Arnoldi-Tikhonov method can be modified for non-square matrices in order to solve (1).