MULTIPLE-SHOT SCATTER CORRECTION FOR TOMOGRAPHIC MICROSCOPY OF AMPLITUDE/PHASE-CONTRAST SAMPLES

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Unlike conventional X-ray imaging, in optical tomographic microscopy the propagation of radiation is no longer along straight lines, because the refraction and diffraction effects can play an essential role. In this situation the use of the same Radon-based algorithms leads to low resolution and strong artifacts in the image, or even makes the reconstruction impossible. In this paper we analyze a new reconstruction algorithm based on approximate propagators describing the high-frequency radiation scattered by amplitude/phase-contrast samples.

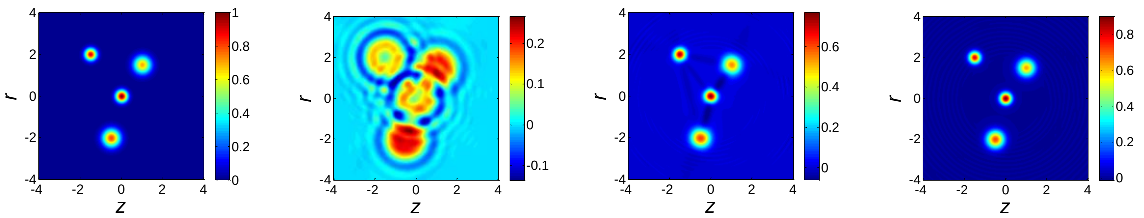

Figure 1. A synthetic phase-contrast phantom, and the results of wavefield inversion based on (i) naïve kinematic model, (ii) Born approximation, and (iii) multiple-shot scatter correction algorithm (from left to right).

We assume that the wave propagation is governed by a standard parabolic wave equation (PWE). It is shown that an approximate solution of PWE can be expressed in terms of a propagation operator that transforms (the complex exponential of) a linogram of the illuminated object into a set of its diffraction patterns [1]. Since the propagation operator is easily invertible, a computational multiple-shot scatter correction may be successfully performed, in order to realize a projective/tomographic imaging of forward-scattering structures.

When the rotation of the object is allowed, either parallel- or fan-beam projection can be easily extracted from the linogram for each rotation angle (all of them constituting collectively a sinogram); this reduces the reconstruction process to the conventional Radon-based computed tomography. For a sufficiently large aperture synthesized in the measurement process, the reconstruction of the object is of high quality and is characterized by good resolution, whereas the use of the naïve kinematic model results in an essentially blurred image. The results of simulations (see Fig. 1) show a rather good resolution of reconstructed images well beyond the weak scattering regime [2]. In contrast to many known lensless imaging techniques suitable for reconstructing only thin samples, our method allows for imaging extended objects.

[1] G. Samelsohn, "High-frequency directed wave propagators: A path integral derivation" *IEEE Trans. Antennas Propagat.* **61**, 5637-5648 (2013).

[2] G. Samelsohn, "Transmission tomography of forward-scattering structures" *J. Opt. Soc. Am. A* **33**, 1181-1192 (2016).