The fractional Fourier transform as a simulation tool for lens-based X-ray microscopy - DTU Orbit (20/10/2019)

The fractional Fourier transform (FrFT) is introduced as a tool for numerical simulations of X-ray wavefront propagation. By removing the strict sampling requirements encountered in typical Fourier optics, simulations using the FrFT can be carried out with much decreased detail, allowing, for example, on-line simulation during experiments. Moreover, the additive index property of the FrFT allows the propagation through multiple optical components to be simulated in a single step, which is particularly useful for compound refractive lenses (CRLs). It is shown that it is possible to model the attenuation from the entire CRL using one or two effective apertures without loss of accuracy, greatly accelerating simulations involving CRLs. To demonstrate the applicability and accuracy of the FrFT, the imaging resolution of a CRL-based imaging system is estimated, and the FrFT approach is shown to be significantly more precise than comparable approaches using geometrical optics. Secondly, it is shown that extensive FrFT simulations of complex systems involving coherence and/or nonmonochromatic sources can be carried out in minutes. Specifically, the chromatic aberrations as a function of source bandwidth are estimated, and it is found that the geometric optics greatly overestimates the aberration for energy bandwidths of around 1%.

General information
Publication status: Published
Organisations: Department of Physics, Neutrons and X-rays for Materials Physics, European Synchrotron Radiation Facility
Corresponding author: Poulsen, H. F.
Contributors: Pedersen, A. F., Simons, H., Detlefs, C., Poulsen, H. F.
Number of pages: 12
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Journal of Synchrotron Radiation
Volume: 25
Issue number: 3
ISSN (Print): 0909-0495

Ratings:
BFI (2018): BFI-level 1
Scopus rating (2018): CiteScore 2.68 SJR 1.415 SNIP 1.266
Web of Science (2018): Impact factor 2.452

Web of Science (2018): Indexed yes
Original language: English
Keywords: Wavefront propagation, Compound refractive lenses, X-ray microscopy

Electronic versions:
Untitled.pdf

DOIs: 10.1107/S1600577518003028

Source: FindIt
Source ID: 2398569062
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review