Implicit X-ray speckle-based phase and dark field imaging

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Bio:

Dr Pavlov currently works at University of Canterbury (Christchurch, New Zealand). He also holds Adjunct positions at Monash University (Australia) and University of New England (Australia). Dr Pavlov has made contributions to the development and application of novel theoretical and computational approaches to 2D, 3D and 4D image reconstruction and structure characterisation in application to X-ray imaging and diffraction. These approaches were successfully used in experiments at numerous laboratory and synchrotron radiation sources (Photon Factory, Japan; SPring-8, Japan; ELETTRA, Italy; ESRF, France; Australian Synchrotron). In particular, Dr Pavlov has developed new theoretical approaches in diffraction tomography, deterministic coherent diffractive imaging, phase-contrast imaging/tomography and extended the statistical dynamical X-ray diffraction theory to multilayer structures and nanostructures.

Abstract text for online and/or printed programs (Enter 100-150 word abstracts suitable for early release. If accepted, this abstract text will be published prior to the meeting in online or printed programs promoting the conference.):

We have developed a means for simultaneous 3D reconstructions of the projected thickness and dark-field (SAXS) information of a single-material object using two mask positions, under the assumption of illumination by spatially random x-ray speckles. This dark-field signal allows one to obtain information about sub-pixel size features in low-density objects. This phase-contrast imaging method implicitly rather than explicitly tracks speckles, and utilises an extended version of our recently published methods (Pavlov et al. (2020) J. Opt. **22**(12): 125604; Pavlov et al. (2020) Phys. Rev. Appl. **13**(5): 054023). Our new approach is based on a Fokker–Planck description of paraxial x-ray optics (Paganin and Morgan (2019) Sci. Rep. **9**(1): 17537; Morgan and Paganin (2019) Sci. Rep. **9**(1): 17465). The method is applied to experimental CT data collected at a synchrotron.

Abstract text for technical review purposes (Enter 250-word abstract for technical review. Abstract should contain enough detail to clearly convey the approach and the results of the research. If accepted, it may be published and made available at the meeting.):

We have developed a rapid deterministic means for simultaneous 3D reconstructions of the projected thickness and dark-field (SAXS) information of a single-material object, using two transverse mask positions, under the assumption of illumination by spatially random x-ray speckles. This dark-field signal allows one to obtain information about sub-pixel size features in low-density objects. This phase-contrast imaging method implicitly rather than explicitly tracks speckles, and utilises an extended version of our recently published methods (Pavlov et al. (2020) J. Opt. **22**(12): 125604; Pavlov et al. (2020) Phys. Rev. Appl. **13**(5): 054023). Our new approach is based on a Fokker–Planck description of paraxial x-ray optics (Paganin and Morgan (2019) Sci. Rep. **9**(1): 17537; Morgan and Paganin (2019) Sci. Rep. **9**(1): 17465). This Fokker-Planck model considers the X-ray energy flow, downstream of the sample, to be composed of (i) a coherent part associated with the attenuating and refracting aspects of the sample, together with (ii) a diffuse component that is related to the presence of unresolved micro-structure within the sample. The method is computationally rapid since it is based on a simple closed-form solution to the inverse problem of speckle-based phase and dark field imaging, as well as exhibiting good stability with respect to noise in the input images. The method is applied to experimental x-ray CT data collected at a synchrotron.

Topics:

Alternative to conventional attenuation-based tomography.

Keywords:

Speckle-based imaging

Phase-contrast imaging

Dark-field tomography