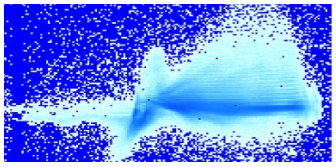

COHERENCE 2024
11th International Conference
on Phase Retrieval
and Coherent Scattering

MAX IV

Contribution ID: **19** Type: **Invited speaker**

Intrinsic speckle-tracking for rapid retrieval of a sample's attenuation, phase shift, and diffusive dark-field images

Wednesday, 19 June 2024 14:05 (30 minutes)

Speckle-based X-ray imaging (SBXI) [1, 2] is a technique that utilises random speckle modulations imprinted into an X-ray wavefront to retrieve multimodal sample information. Here, the term "multimodal" is used in the sense that SBXI can recover information regarding a sample's X-ray attenuation, refraction, and diffusion information – three complementary signals. Requiring only a piece of sandpaper in the experimental set-up as a mask, SBXI is an appealing technique for use in a broad range of applications. Furthermore, the signal-retrieving algorithm we have developed—Multimodal Intrinsic Speckle-Tracking (MIST) [3]—makes SXBI even more appealing as it is computationally rapid yet still capable of retrieving high-quality images of the sample. Transverse speckle shifts and speckle blurring are associated with the recovered phase-shift and diffuse dark-field (DDF) signals, respectively. MIST analyses these speckle changes by considering local energy conservation for each speckle in the SBXI regime, wherein, the Fokker-Planck equation for paraxial X-ray imaging [4, 5] is combined with the geometric flow formalism for SBXI [6]. There are various iterations of the MIST algorithm [3, 7, 8, 9], with each increasing in generality by reducing the number of sample requirements. In all the published MIST approaches, the multimodal inverse problem is solved by linearising the associated Fokker-Planck equation and deriving analytical or least-square solutions for the multimodal signals. Within this presentation, a general overview of the currently published MIST approaches will be provided. This will cover the mathematical techniques utilised in solving the Fokker-Planck inverse problem, as well as the underlying assumptions. Retrieved signals from various samples imaged using a synchrotron SBXI technique will be shown. The closing section of the presentation will discuss ongoing research avenues.

[1] Bérujon, S. et al. Phys. Rev. Lett. 108(15), 158102 (2012)
[2] Morgan, K.S. et al. Appl. Phys. Lett. 100(12), 124102 (2012)
[3] Pavlov, K.M. et al. J. Opt. 22(12), 125604 (2020)
[4] Paganin, D.M and Morgan, K.S. Sci. Rep. 9(1), 17537 (2019)
[5] Morgan, K.S. and Paganin, D.M. Sci. Rep. 9(1), 17465 (2019)
[6] Paganin, D.M. et al. Phys. Rev. A, 98(5), 053813 (2018)
[7] Alloo, S.J. et al. J. Med. Imaging 9(3), 031502 (2022)
[8] Pavlov, K.M. et al. Phys. Rev. A, 104(5), 053505 (2021)
[9] Alloo, S.J. et al. Sci. Rep. 13(1), 5424 (2023)

Primary authors: ALLOO, Samantha (School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand. School of Physics and Astronomy, Monash University, Victoria, Australia.); Prof. PAGANIN , David (School of Physics and Astronomy, Monash University, Victoria, Australia); Prof. MORGAN, Kaye (School of Physics and Astronomy, Monash University, Victoria, Australia); Dr PAVLOV, Konstantin (School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand. School of Physics and Astronomy, Monash University, Victoria, Australia. School of Science and Technology, University of New England, Armidale, Australia.)

Presenter: ALLOO, Samantha (School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand. School of Physics and Astronomy, Monash University, Victoria, Australia.)

Session Classification: Novel microscopies