Contribution ID: **10** Type: **Invited**

Move contrast X-ray imaging and its applications in complex systems

Thursday, March 16, 2023 3:25 PM (30 minutes)

A complex system is usually reflected in several aspects, such as multiple chemical components, entangled spatial structure, aeolotropic relative motion between components, chemical reactions, etc. Extracting the spatial-temporal evolution process of the target component in such a complex system puts forward higher requirements on the spatial resolution, temporal resolution, imaging depth and the invasiveness of the system. For dynamic complex systems with relative motion between components, a method called move contrast X-ray imaging (MCXI) is introduced, which utilized the different temporal modulation of the incident light field by different moving components to separately image components with different motion modes. Compared with the usual X-ray absorption contrast and phase contrast, move contrast can solve the problem of overlapping of structural information in transmission image caused by high X-ray penetration, and has higher sensitivity and contrast-to-noise ratio for weak signals.

MCXI has been applied in several disparate research fields. In medical radiography, MCXI can reduce the dose of iodic contrast medium to only 10%, while maintaining sufficient signal strength (F.X. Wang et. el., IUCrJ (2020). 7). In the aspect of plant physiology, MCXI can be used to observe water refilling along microvessels in leaves and thick opaque plant stems resorting to no contrast agents. In electrolytic reactions, transport routes of clustered ions can be depicted with MCXI, which may provide significant support for further electric field research.

In conclusion, owing to the character of high sensitivity and contrast-to-noise ratio for weak signals, MCXI is a promising imaging method in dynamic complex systems of many research fields, where in-vivo and in-operando experiments are in urgent need.

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Session Classification: Methods

Track Classification: Methods