

Recovering Phase and Correlations from X-ray Fields

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The development of x-ray free-electron lasers promises the acquisition of diffraction data from very small crystals, or even single molecules. Recent work has demonstrated the reconstruction of such non-crystallographic specimens from diffraction data, although the uniqueness of the reconstruction cannot be guaranteed. Successful unique real-space phase recovery methods, such as the transport of intensity approach, have been demonstrated and successfully applied but have hitherto been thought to fail in the far-field limit.

In this talk we consider the real-space ideas in the context of the diffraction of fields containing phase curvature, which we term astigmatic fields. We show that astigmatic diffraction patterns allow *unique* recovery of structural information from diffracted intensities in reciprocal space. We demonstrate an algorithm that allows the phase to be recovered uniquely and reliably.

We then go on to consider the next level of complexity, which is the recovery of the correlations in the wavefield. We outline a technique by which complete coherence information may be recovered from a beam and we present some experimental results recently obtained at the Advanced Photon Source.