Utilizing Coherent Diffractive Imaging Techniques with Partially Coherent Sources.

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Coherent Diffractive Imaging utilizes iterative schemes to invert a far-field diffraction pattern to recover the exit surface wave of the sample that gives rise to the pattern. These schemes make several assumptions about the nature of the experiment in order to successfully reconstruct an image of the object. One important assumption is that the illuminating radiation is fully coherent. While this is a good assumption for laser light, when using X-ray sources the degree of coherence achievable using current sources is limited. The success of several Coherent Diffractive Imaging experiments using X-rays suggests that while full coherence is not necessary[1], a relatively high level of coherence is. This can be a limiting factor.

Theoretical considerations imply that it may be possible to overcome the detrimental effects partial coherence can have on the reconstruction algorithms. By introducing significant phase curvature in the wave incident on the sample, one can effectively force the partially coherent far-field diffraction pattern to approach the fully-coherent pattern as curvature is increased[2]. The phase structure in the illuminating field also has the effect of increasing the stability of the reconstruction algorithms[3].

An alternative approach is to work with the known coherence function of the illuminating field. If the beam can be appropriately characterized[4], it should be possible to utilize this information to prepare an iterative scheme that can reconstruct an object's exit surface wave from its measured partially coherent far-field diffraction pattern.

We present a theoretical basis for the observation that curvature helps ameliorate the negative effects of partial coherence, along with the results of a coherent diffractive imaging experiment demonstrating the benefits of wavefront curvature even in the presence of relatively low levels of coherence. Also presented is a framework for building the partial coherence of the beam into an iterative scheme, with preliminary simulations of an elementary experimental setup.

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