Quantum Imaging with X-rays

Ralf Roehlsberger

Deutsches Elektronen-Synchrotron (DESY), 22607 Hamburg, Germany

ralf.roehlsberger@desy.de

Accelerator-driven free-electron lasers (FEL) have opened new avenues for high-resolution structure determination that go beyond conventional X-ray crystallography [1-3]. While these techniques rely on coherent scattering, incoherence due to wavefront distortions or incoherent fluorescence emission - often the predominant scattering mechanism - is generally considered a detrimental effect. Here we show that methods from quantum imaging, i.e., exploiting higher order intensity correlations, can be used to image the full 1D, 2D and even 3D arrangement of sources that scatter incoherent X-ray radiation [4-8]. We discuss a number of properties of the new incoherent diffraction imaging method that are conceptually superior to those of conventional coherent X-ray structure determination and point out that current FELs are ideally suited for the implementation of this approach [7]. We also present an experimental demonstration in the soft X-ray domain, where we use higher-order intensity correlations to achieve higher fidelities in the image reconstruction and potentially a sub-Abbe resolution [8].

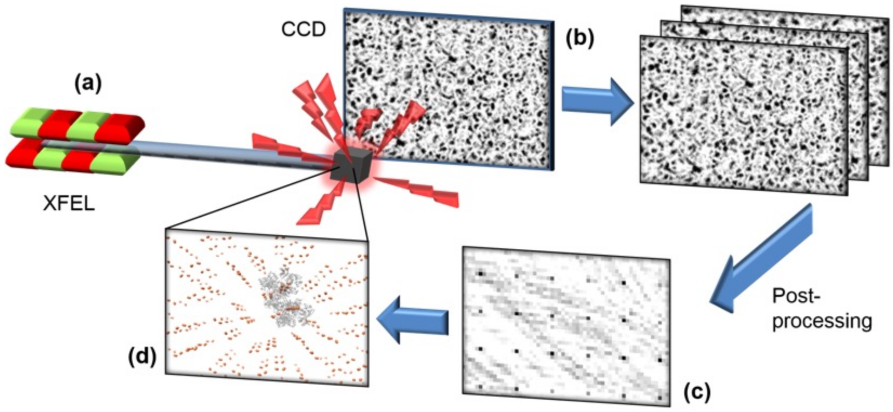

Illustration of incoherent diffraction imaging: A large number of snapshots of incoherent X-rays emitted by a 3D source arrangement is recorded by a CCD; the intensity correlations of each snapshot are determined individually; averaging over many snapshots leads to a pattern that yields the initial 3D distribution of the sources [7].

References

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