Holographic Methods for Surface Crystallography

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A hologram stores information about the amplitude and phase of a wave in an interference pattern with a known reference wave. The unknown wave may be recovered through a process known as reconstruction. It has been suggested that many diffraction patterns, e.g. those formed by photoelectrons, or low energy backscattered electrons may be capable of a holographic interpretation, and computer reconstruction algorithms were proposed to recover the 3D structure of atoms surrounding an atomic source of a (spherical) reference wave. A major limitation of all these methods is that, due to the decay of the reference wave with the inverse of the distance from the source, the reconstructed image contains information only about atoms rather close to the source. In the case of surface crystallography, a more useful direct method would be one capable of recovering the entire contents of a large surface unit cell. We will describe in this talk an alternative holographic interpretation of x-ray and electron diffraction patterns from surfaces which accomplishes this task by taking as the reference wave the delocalized one scattered by the entire bulk substrate and show some results from applications to surface x-ray diffraction (SXRD) [1] and low energy electron diffraction (LEED) [2].

[1] Lyman P.F., Shneerson V.L., Fung R., Harder R.J., Lu E.D., Parihar S.S., Saldin D.K., *Phys. Rev. B*, 2005, **74**, 081402(R0). [2] Saldin D.K, Seubert A., Heinz K., *Phys. Rev.Lett.*, 2002, **88**, 115507.

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