

## Optical diffraction tomography of weakly scattering objects

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Observing objects by scattered light is attractive as it offers high signal levels and in principle unlimited observation time. Scattered light provides a source for high contrast imaging using Nomarski differential interference contrast (DIC) or phase contrast microscopy. Furthermore the scattered light contains quantitative information of the scattering source itself.

Performing tomographic reconstructions of a scattering object is generally a very complex mathematical problem when diffraction effects have to be taken into account. However, under the assumption that the object is only weakly scattering, an analytical approximation can be derived: the first order Born approximation yields a linear relationship between the scattered field and a subset of the object's Fourier transform [1].

We present a microscopy technique that can reconstruct an estimate of the 3D scattering density from a weakly scattering sample like a biological cell. Using the first order Born approximation we derive a reconstruction scheme that is entirely based in real space and notably simpler than comparable tomographic reconstruction algorithms [2].

Our experimental system uses a common path interferometric detection scheme to decode the complex amplitude of the scattered wave. Under rotating illumination, multiple illumination directions are incoherently added on a single image. Three-dimensional data is acquired using z-stepping of the objective.

Experimental data of human cheek cells and HeLa cancer cells are presented that are in good agreement with the first order Born approximation.

[1] E. Wolf, "Three-dimensional structure determination of semi-transparent objects from holographic data," *Optics Communications*, **1**, 153-156 (1969)

[2] R. Fiolka, K. Wicker, R. Heintzmann, A. Stemmer, "Simplified approach to diffraction tomography in optical microscopy," *Optics Express*, **17**, 12407-12417 (2009)

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