2.3 Microscopy: Exercises

Lecture 8: More Coherence & Image formation

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1. Coherence

a) Name two perfectly coherent and incoherent light sources!

b) At what distance from two coherent sources (distance to the closest source, λ = 500 nm) that are 300nm apart does an observer have to be to experience constructive and destructive interference (calculate for first order, n=1)?

c) Where is the first minimum of the Airy pattern on a screen 1 cm behind a 1-dimensional slit of width 2000 nm with light from a source of λ = 500 nm?
Note: The original version of this problem contained an error.

d) Young‘s Double Pinhole Interferometer: Sketch the dependency of the coherence area, as well as the relative change of the coherence parameter (normalization to distance 0) for an incoherent light source (diameter 1mm, λ = 500 nm) on the distance to the detector. What is the main observation?

2. Image formation part 1 – The Convolution Theorem

The convolution theorem is an important tool in theoretical treatment of microscopic problems, which has come up a few times in the lecture. In brief, it states that the Fourier transform of the product of two functions is equivalent to the convolution of the Fourier transforms of the functions.

Show that

$$\mathscr{F}(w \cdot v) = \mathscr{F}(w) \otimes \mathscr{F}(v),$$

where $\mathscr{F}(w(x)) = W(k)$ denotes the Fourier transform and $W(k) \otimes V(k) = \int_{-\infty}^{\infty} W(\xi) \cdot V(k-\xi) d\xi$ is the convolution of W and V.