Light Microscopy
Problem Set 4

Alejandra Zegarra, Walter Müller
Based on an invention of Jan Becker, Polina Feldmann and Rainer Heintzmann
and, of course, to our beloved ℝené ℝichter.

December 10, 2017

Please hand in the solutions of this problem set next lecture on the 18th of December 2017.

10 2D Imaging

Calculate analytically the 4 different basic imaging functions for coherent and incoherent imaging. Consider a 4f system with a real circular pupil (Figure 1) and Fresnel approximation.

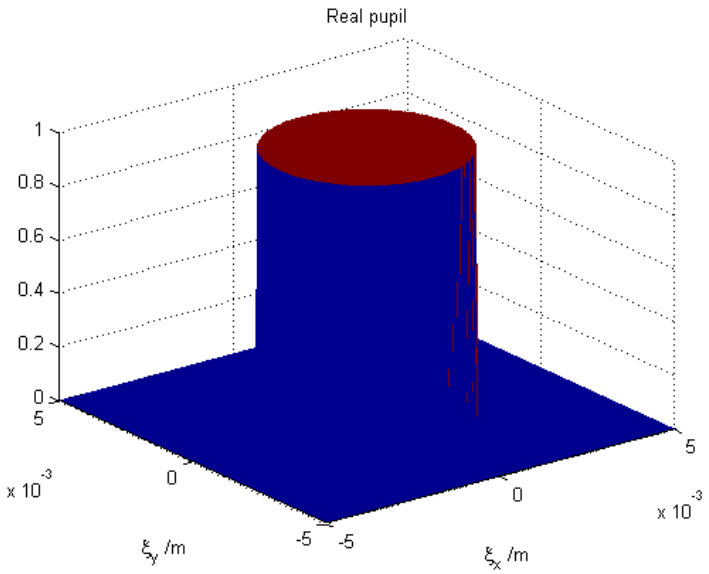

Figure 1: Circular aperture.

Follow the lecture script to calculate:

a) the CTF (Figure 2),

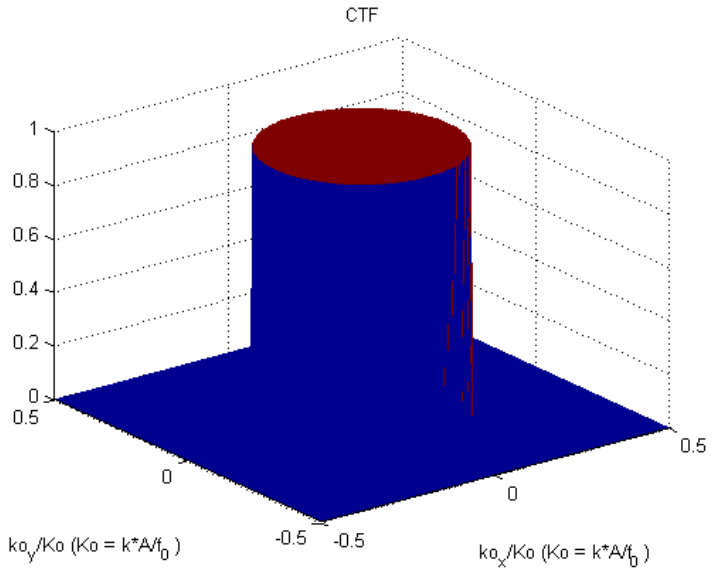

Figure 2: Circular aperture.

b) the CSF (Figure 3),

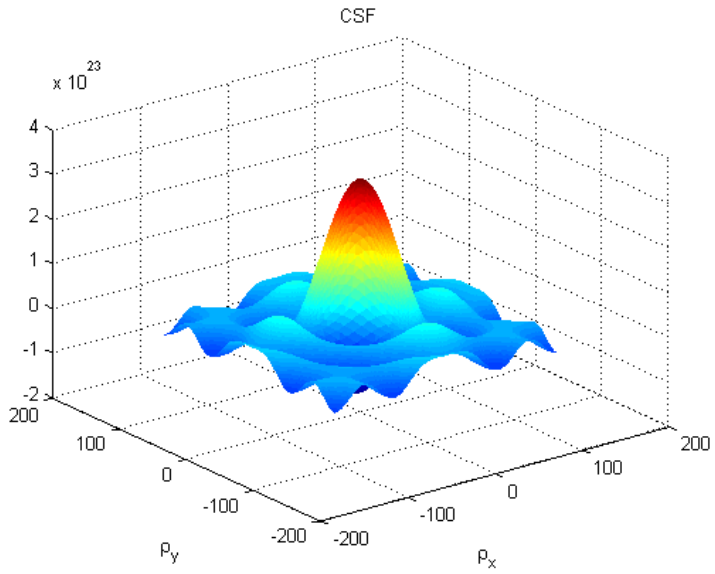

Figure 3: Coherent Transfer Function

c) the PSF (Figure 4),

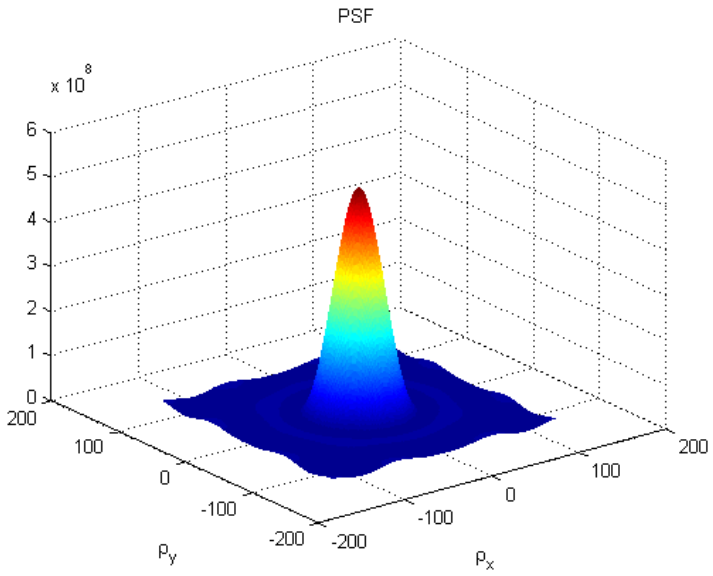

Figure 4: Circular aperture.

d) and the OTF (Figure 5). Calculate this function as the autocorrelation of the CTF.

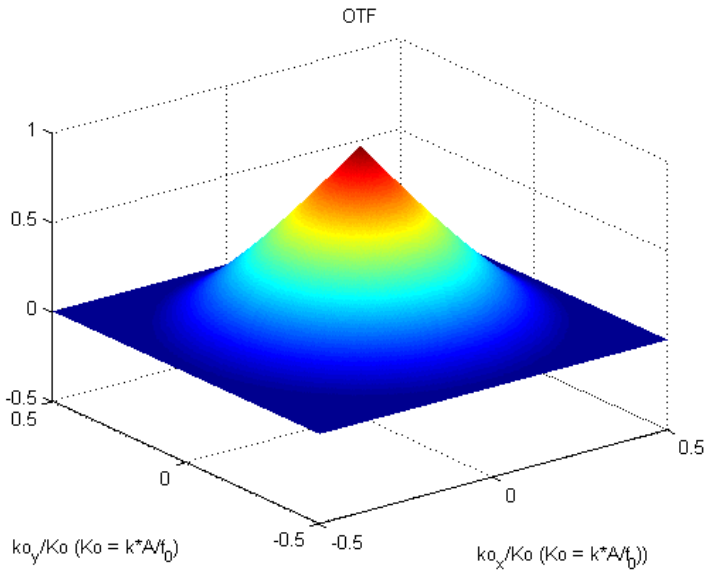

Figure 5: Circular aperture.

11 Basic imaging functions

Following the previous example and modifying the Matlab code `IncoherentImagingMAT.m` calculate numerically the CSF, PSF, CTF and OTF of the following apertures. Show the graphs obtained.

a) Annular pupil (the JB Aperture).

$$P_{JB}(\vec{\xi}) = \begin{cases} 1, & r_i \leq |\vec{\xi}| \leq r_e \\ 0, & elsewhere \end{cases} \tag{1}$$

with $\int\limits_{\xi<r_e} d\xi = 2 \int\limits_{\xi<r_i} d\xi$.

b) Gaussian Pupil. Hint: Since the support of this function is infinite, you should multiply your Gaussian times the circular aperture to restrict the frequencies.