# Estimating defocus and astigmatism of the optical transfer function by frequency scaling

Stanislav Budzinskiy

Lomonosov Moscow State University

### My eye



Figure 1: Fundus

#### Defocus



(a) Image

(b) Spectrum

Figure 2: Fundus image corrupted by defocus.

i = o \* PSF,  $OTF = \mathcal{F}[PSF]$ 

- Need to estimate the PSF ( $\sim$  the value of defocus).
- Radially average the spectrum to increase SNR.
- Fit radially averaged power spectrum and/or its zeros to estimate defocus.
- Deconvolution.

#### Astigmatism and defocus



(a) Only defocus

(b) Astigmatism and defocus

Figure 3: OTF for different aberrations.

How to increase SNR when astigmatism is there?

## Nonlinear scaling to circularize



Figure 4: Turning ellipses into circles.

This required some classical analysis: special functions (Bessel and cylinder), zeros of special functions, asymptotics...