A TUTORIAL ON ADAPTIVE OPTICS FOR DYNAMIC ABERRATION CORRECTION IN MICROSCOPY

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Adaptive optics is a promising technology for improving resolution and contrast in a broad range of microscopy imaging modalities. In this tutorial, we will focus specifically on the use of adaptive optics for dynamic correction of aberrations, both specimen-induced and instrument. We will set out the core principles that underlie the design and operation of adaptive optics systems, discuss practical aspects of implementation and the current state-of-the-art.

We will review some of the current wavefront correction technologies available, including deformable mirrors and spatial-light modulator technologies, asking what are the important physical characteristics and properties, the key parameters for devices and how these translate into practical capabilities and, as often, limitations in an adaptive optics correction system. Some of the more successful approaches to controlling wavefront correctors will be covered including those based on wavefront-sensing and on image-based optimisation, and different control strategies. We will discuss the key operation principles and practical implementation, what factors influence the choice of approach, how one should choose appropriate parameters to optimize the chances of success and will point out some common pitfalls and misconceptions.

We will look at what can be achieved with the current state-of-the-art, how this relates to the promise of the technology and discuss some of the key challenges both technological and fundamental.