Optogenetics and Wave front shaping

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Abstract

The combination of light microscopy and optogenetics offers the possibility to control activation and inhibition of neuronal activity enabling the analysis of well-defined neuronal population within intact neuronal circuits and systems. Interestingly, optogenetics has already permitted to address key biological questions with relatively simple illumination methods using widefield visible light illumination. However, some limitations in the specificity of genetic targeting and the intricate morphology of the brain make it challenging to, for example, individuate subsets of genetically identical interconnected cells, or to establish the role of specific
spatiotemporal excitatory patterns in guiding animal behavior. To reach such degree of specificity, more sophisticated illumination methods are required.
Here I will present a series of new methods recently developed in my group for highresolution single and two photon optogenetics based on the temporal control of ultrafast pulses for axial localization of the illumination volume and on either digital holography or the generalized phase contrast method for lateral light patterning. Exemplary experiment showing two-photon activation of ChR2 in brain slices will be showed.
Finally I will present some recent results demonstrating optogenetics activation with near single cell resolution in freely behaving animals by performing holographic light patterning trough a recently developed fiberscope.

Keywords: optogenetics, neuronal activity

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