

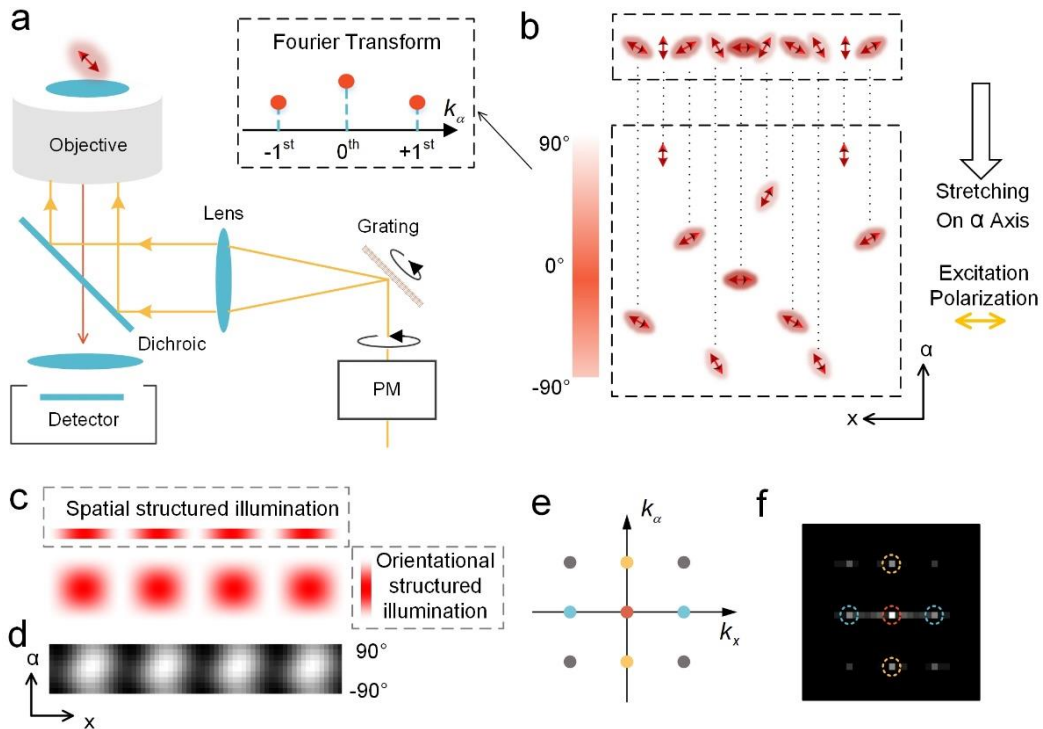
STRUCTURED ILLUMINATION IN SPATIO-ANGULAR HYPERSPACE

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With three directions of the interference fringes, Structured Illumination Microscopy (SIM) doubles the spatial resolution compared to wide field imaging. The polarization of interferometric lasers should be perpendicular to the plane of laser beams (s-polarized) for a high modulation factor. Hence SIM requires polarization modulation of the lasers, which influences the fluorescence signal of the dipoles. Here we interpret the specimen in spatio-angular hyperspace, providing a universal framework to model polarization in imaging. A circularly polarized light excites the dipoles with uniform illumination in spatio-angular hyperspace, while a linearly polarized light leads to structured illumination. Furthermore, the s-polarized structured illumination brings 2D spatio-angular illumination pattern, generating spatial harmonics, angular harmonics, and spatio-angular harmonics. We developed polarized SIM (pSIM) with spatial and angular harmonics solved and reassembled, which achieves both super-resolution intensity imaging and orientation measurement of the fluorescent dipoles.

We applied pSIM on both commercial systems (GE OMX-SR, Nikon N-SIM) and a home-built system with a spatial light modulator to generate interferometric patterns (SLM-SIM), with 2D-SIM, 3D-SIM, or TIRF-SIM imaging modality. For the first time, pSIM reveals the “side-by-side” organization the actin filaments in the “actin ring” structure of Membrane-associated Periodic Structure (MPS) in hippocampal neurons.



[1] K. Zhanghao, X. Chen, W. Liu, et al. “Structure Illumination in Spatial-Oriental Hyperspace”, arXiv:1712.05092v3.