Structured illumination microscopy for live-cell super-resolution imaging

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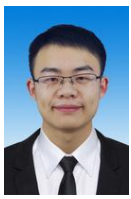
Structured illumination microscopy (SIM) has been widely applied in live-cell super-resolution imaging due to its advantages such as high photon efficiency and compatibility with regular fluorescent proteins. However, the quality of SIM super-resolution images heavily depends on the numerical reconstruction algorithms. The estimation of illumination parameters is crucial for accurate image reconstruction, as even minor errors in parameter estimation may introduce severe reconstruction artifacts. Moreover, SIM typically requires at least nine raw frames per reconstruction, limiting imaging speed and increasing phototoxicity—challenges for long-term dynamic live-cell observation. To address these challenges, we have conducted a series of studies focused on efficient illumination parameter estimation and super-resolution reconstruction with reduced frame numbers. We propose the principal component analysis (PCA)-based method for structured illumination parameter estimation, along with the spatiotemporal multiplexing approaches for efficient super-resolution reconstruction. These techniques enable fast, adaptive compensation of illumination parameters under complex, low signal-to-noise conditions, and achieve minimally invasive, high spatiotemporal resolution imaging of fine subcellular structures in living cells.



Short Bio:

Jiaming Qian received his Ph.D. in Optical Engineering from Nanjing University of Science and Technology (NJUST), Chian. He is a Postdoctoral fellow of NJUST, China.