Light Science & Applications

Dehydration of plant cells shoves nuclei rotation allowing for 3D phase-contrast tomography

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Abstract: Single-cell phase-contrast tomography promises to become decisive for studying 3D intracellular structures in biology. It involves probing cells with light at wide angles, which unfortunately requires complex systems. Here we show an intriguing concept based on an inherent natural process for plants biology, i.e., dehydration, allowing us to easily obtain 3D-tomography of onion-epidermal cells' nuclei. In fact, the loss of water reduces the turgor pressure and we recognize it induces significant rotation of cells' nuclei. Thanks to the holographic focusing flexibility and an ad-hoc angles' tracking algorithm, we combine different phase-contrast views of the nuclei to retrieve their 3D refractive index distribution. Nucleolus identification capability and a strategy for measuring morphology, dry mass, biovolume, and refractive index statistics are reported and discussed. This new concept could revolutionize the investigation in plant biology by enabling dynamic 3D quantitative and label-free analysis at sub-nuclear level using a conventional holographic setup.