Subdiffraction Confinement of Light in Dielectric Cavities

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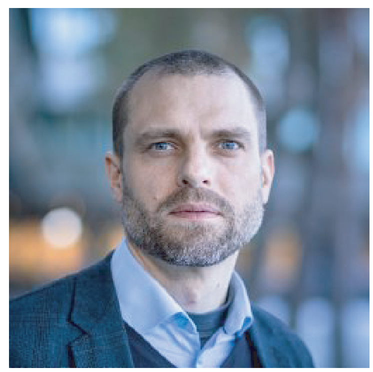
Abstract— Photonic nanocavities play a central role in optics and cavity quantum electrodynamics due to their ability to enhance light-matter interaction enabled by high quality factors and small mode volumes [1]. A common statement in the literature is that the mode volume of dielectric cavities cannot be reduced below the diffraction limit, but theoretical works [2] have shown that the diffraction limit does not apply to cavities. However, the first experimental demonstration [3] of subdiffraction confinement of light appeared only recently due to the extreme nanofabrication requirements. It has been predicted [4] that such miniaturized cavities may increase the light-matter interaction to a level where a single photon in the cavity can lead to measurable nonlinear quantum optics, but this requires parting with conventional fabrication methods. The most recent developments include the combination of self-assembly with scalable silicon photonics [5], which opens entirely new perspectives for ultrasmall dielectric nanophotonics in a regime where the only limiting factor is structural disorder [6]. In my presentation, I will outline the latest developments and the prospects for applications in this new research field.



Søren Stobbe received his PhD from the Technical University of Denmark (DTU) in 2009. After stays at the California Institute of Technology and the Niels Bohr Institute, he returned in 2018 to DTU where is a full professor of photonic nanotechnology. His group combines silicon photonics with nanoelectromechanical devices and extreme-resolution lithography and spans across nanocavities, topological insulators, and integrated photonics. In his recent paper, "Self-assembled photonic cavities with atomic-scale confinement," published in Nature in December 2023, his group demonstrated a new fabrication method that combines the scalability of planar technology with the resolution of self-assembly. This allowed demonstrating waveguide-coupled dielectric cavities with mode volumes 100x times below the diffraction limit while at the same time exhibiting quality factors 100x above the upper limit for plasmonics. Prof. Stobbe has published multiple papers in Nature, Science, Reviews of Modern Physics, Nature Nanotechnology, Nature Photonics, Nature Physics, Nature Communications, and Physical Review Letters.

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