Nonlinear Optics Based on Dielectric Metasurfaces

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Abstract: Dielectric nanostructures can enable strong light manipulation with low-loss. Given the relatively low refractive index of dielectric materials at optical frequencies, achieving strong optical resonances in dielectric nanostructures is crucial in realizing practical dielectric metadevices. In the nonlinear regime, dielectric architectures exhibiting high quality (Q) factor resonances can facilitate enhanced nonlinearities. In this work, we study the dielectric nanostructures supporting optical resonances associated with the bound states in the continuum (BICs) for enhanced nonlinearities. First, we show that, by designing the quasi-BIC resonances, second harmonic generation (SHG) from an asymmetric lithium niobate (LN) metasurface can be largely boosted. Second, leveraging the large Kerr nonlinearity of silicon, we investigate a planar Si metasurface which supports high Q-factor guided mode resonances (GMRs) for tunable chiroptical response at near-infrared wavelengths. Last, exploiting the momentum-space polarization vortices observed in photonic structures, we investigate the nonlinear optical vortex generation from Si photonic crystal slabs. Our work indicates that the exploitation of the high-Q resonances associated with BICs can greatly facilitated the development of nonlinear dielectric metadevices.