Flat nonlinear optics: efficient frequency conversion in gradient nonlinear metasurfaces

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The recent emergence of “flat” optical components has been spurred by the development of metasurfaces that provide control over the phase of scattered fields at subwavelength scales [1]. Extending such a paradigm to the nonlinear optical case could lead to analogs in the nonlinear domain, where efficient frequency mixing occurs in deeply subwavelength volumes (free of the cumbersome phase-matching constraints of bulk nonlinear materials) with control over the wavefront of the nonlinearly generated beam. However, such an extension faces two important challenges, as in order to practically realize this goal, it is required to achieve both a high nonlinear conversion efficiency and sub-diffractive phase control over sub-wavelength structures. Recently, we reported metasurfaces with giant nonlinear response based on coupling plasmonic resonators to intersubband transitions within multi-quantum well (MQW) semiconductor heterostructures for mid-infrared second-harmonic generation [2]. We recently extended this paradigm by experimentally demonstrating second harmonic metasurfaces with a record high nonlinear optical response of 1.2x106 pm/V [3] and attaining continuous phase control over the giant second harmonic response from such metasurfaces via the Pancharatnam-Berry method [4]. The practical impact of the nonlinear metasurfaces proposed here may be extended to a variety of fields, including THz generation and frequency up-conversion for detection.

**Biography:** Mikhail Belkin received his BS in Physics and Mathematics from Moscow Institute of Physics and Technology in 1998 and PhD degree in Physics from the University of California at Berkeley in 2004. In 2004-2008 he worked in Prof. Federico Capasso group in the Harvard School of Engineering and Applied Sciences. In the Fall of 2008 he joined the faculty of the ECE department of the University of Texas at Austin, where he is currently an Associate Professor and General Motors Foundation Centennial Teaching Fellow. Dr. Belkin’s research interests are in the field of mid-infrared and THz photonics and nonlinear optics. His recent recognitions include the 2015 Friedrich Wilhelm Bessel Research Award from the Humboldt Foundation, 2014 Tour Speaker award from the Society for Applied Spectroscopy, the NSF CAREER Award, the DARPA Young Faculty Award, and the AFOSR Young Investigator Program Award. Dr. Belkin is the Fellow of the OSA and the Senior Member of IEEE.

**References:**

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