

Fall 2018 Colloquium

Department of Physics & Astronomy, TAMU-Commerce

Oct 4, Thursday, 4-5 PM in Science Building 127

(coffee and cookies will be served at 3:50 PM)

Optical Physics and Nano-Physics

Active Optical Metasurfaces and Zero-index Materials for Emerging Nanophotonic Applications

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Dr. Howard Lee is currently Assistant Professor in the Department of Physics at Baylor University and IQSE Fellow and visiting professor in the Institute for Quantum Science and Engineering (IQSE) at Texas A&M. He was a Postdoctoral Fellow at the Department of Applied Physics and Materials Science at Caltech, working with Prof. Harry Atwater in active plasmonics/metasurfaces. He received his PhD in Physics from the Max Planck Institute for the Science of Light in Germany in 2012 under the supervision of Prof. Philip Russell (2015 President of OSA). His current research focuses active plasmonics/metasurfaces, linear and nonlinear zero-index optics, quantum biophotonics and Raman/CARS spectroscopy, “meta”-fiber optics for advanced imaging and spectroscopy, and hybrid photonic-plasmonic on-chip optical devices. His work on nano-optics and plasmonics has led to publications in various journals, such as Science, Nano Letters, Advanced Materials, and Optics Letters as well as 30 invited talks and 70 conference papers. Dr. Lee is a recipient of 2018 NSF CAREER Award, 2017 DARPA Young Faculty Award, 2017 APS Robert S. Hyer Award, 2018 OSA Ambassador, 2018 Baylor Young Investigator Development Award, 2016 Baylor Proposal Development Award, and 2012 Croucher Postdoctoral Fellowship. His group has awarded for external grants with total amount of ~ \$3M in the first three years at Baylor University. More information about Dr. Lee’s research can be found at <https://www.baylor.edu/physics/index.php?id=925932>

Abstract

Controlling the flow of light is fundamental to optical applications. With the recent advances in nanofabrication capabilities and new theoretical concepts, ground breaking platforms for the nanoscale manipulation of light have been demonstrated in recent years. These include metasurface and epsilon-near-zero (ENZ) materials and structures, which offer unique optical

features such as sub-wavelength field confinement, unusual optical nonlinear/quantum properties and advanced wavefront shaping.

This talk will review our research efforts on tunable meta/ENZ-optics for developing novel optical imaging, sensing, and communication applications. I will present our recent development on the use of gate-tunable materials, transparent conducting oxides, to demonstrate an electrically tunable metasurfaces that can tune the optical phase and amplitude for ultrathin beam steering devices [1]. In addition, a broadband, field-effect tunable, and ultrathin ENZ perfect absorber enabled by the excitation of ENZ modes will be discussed [2,3]. Finally, I will present our study on “meta”-optical fiber by integrating metasurfaces and zero-index materials with optical fibers to develop novel and ultracompact in-fiber optical devices such as an optical fiber metalens [4,5]. These advanced “meta”-optical fibers open the path to revolutionary in-fiber optical imaging and communication devices [6].

References:

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2. A. Anopchenko, L. Tao, C. Arndt, H. W. Lee, “Field-effect tunable and broadband Epsilon-near-zero perfect absorbers with deep subwavelength thickness,” *ACS Photonics* **5**, 2631 (2018).
3. A. Anopchenko, S. Gurung, L. Tao, C. Arndt, H. W. Lee, “Atomic Layer Deposition of Ultra-thin and smooth Al-doped ZnO for Zero-Index Photonics”, *Materials Research Express*, **5**, 014012 (2018).
4. K. Minn, A. Anopchenko, J. Yang, H. W. Lee, “Excitation of epsilon-near-zero resonance in ultra-thin indium tin oxide shell embedded nanostructured optical fiber,” *Nature Scientific Reports* **8**, 2342 (2018).
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6. G. K. L. Wong, M. S. Kang, H. W. Lee, F. Biancalana, C. Conti, T. Weiss and P. St.J. Russell, “Orbital angular momentum resonances in helically twisted photonic crystal fiber,” *Science* **337**, 446-449 (2012)