PURDUE UNIVERSITY

Birck Nanotechnology Center

Non-reciprocal photonics with optomechanical resonator systems

Professor Gaurav Bahl

Friday, August 3rd
9:00am
MRGN 121

Time-reversal symmetry is a property shared by wave phenomena in linear stationary media. However, broken time-reversal symmetry is required for synthesizing nonreciprocal devices like optical isolators, circulators, and gyrators. Magnetic fields can enable such nonreciprocal behavior for electromagnetic waves, but this method does not conveniently translate to the chip-scale or to the acoustic domain, compelling us to search for nonmagnetic solutions. We have adopted a unique approach to address this challenge through the use of co-localized interacting modes of light and sound in resonator systems. The acousto-optical physics within these systems enable fundamental experiments having analogies to condensed matter phenomena, including phonon laser action, cooling, and electromagnetically induced transparency. This talk will describe our experimental efforts to exploit the momentum conservation rules intrinsic to light-sound interactions for producing strong nonreciprocal behavior. We have demonstrated that such systems can be used to produce complete optical isolation with low loss over a very compact footprint [3]. Our results also reveal that chiral effects are pervasive throughout the phononic and photonic physical layers of these systems, for instance, showing that chirality can be dynamically imparted to phonon transport to suppress disorder-induced backscattering.

Dr. Gaurav Bahl is an Assistant Professor of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign, and is an Affiliate in the Department of Electrical and Computer Engineering. He received his PhD and MS degrees in Electrical Engineering from Stanford University in 2010 and 2008, and the BEng degree from McMaster University in 2005. Dr. Bahl has pioneered the development of optomechanical excitation and cooling using Brillouin scattering in ultra-high-Q resonators. His group is also exploring the use of optomechanics for extremely high-throughput sensing of single micro/nanoparticles suspended in fluids. Most recently, his group has been investigating nonreciprocal optomechanical interactions, and mechanisms by which chiral transport of photons and phonons can be optomechanically induced. His work on Brillouin cooling and opto-mechanofluidic sensing has been featured twice in the December special issues of OSA Optics & Photonics News (2012 and 2013). He is a recipient of the AFOSR Young Investigator Award in 2015, the ONR Director of Research Early Career Grant in 2016, and was elevated to Senior Member of the IEEE in 2016.

PURDUE UNIVERSITY Discovery Park