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Title

Utilizing Geometry and Topology for Designing On-Chip Quantum Hyperentanglement Photonic Infrastructure

Speaker

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Date and Time

16th June, 2021 | 7:00 PM IST

Meeting Link

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About the Speaker

Ritesh Agarwal is a Professor in the Department of Materials Science and Engineering at the University of Pennsylvania. He earned his undergraduate degree from the Indian Institute of Technology, Kanpur in 1996, and a master's degree from the University of Chicago. He received his PhD in physical chemistry from the University of California at Berkeley in 2001 researching ultrafast liquid and protein solvation and photosynthesis via multiple-pulse coherent nonlinear optical techniques. After completing his PhD., Ritesh was a postdoctoral fellow at Harvard where he studied the photonic properties of semiconductor nanowires.

His current research interests include structural, chemical, optical and electronic properties of low-dimensional systems and development of new probes to study complex phases of natural and engineered materials. Ritesh is the recipient of the NSF CAREER award in 2007, NIH Director's New Innovator Award in 2010 and the SPIE Nanoengineering Pioneer Award in 2014. In 2017, he became the director of a Multi-University Research Initiative on Phase Change Materials for Photonics, leading a team of six PIs from five universities. He was elected as a Fellow of the Optical Society of America in 2020.

Abstract

Spin (SAM, intrinsic) and orbital angular momentum (OAM, extrinsic) degrees of freedom (DOF) characterize the chiral nature of light. The interplay between SAM and OAM DOFs has recently sparked significant interest leading to discovery of new physics in both classical and quantum optics [1]. These findings and potential applications call for the manipulation of not only individual SAM and OAM scalar states as two separable DOFs, but also the quantum entanglement between photons in both DOFs enabled by non-separable spin-orbit vectorial states, enabling the hyperentanglement with a higher channel capacity and enhanced security. To enable this emerging field of quantum hyperentanglement would require development of miniaturized on-chip photonic devices for robust generation, transport and detection of entangled photon states involving coupled SAM and OAM DOFs. Development of on-chip chiral photonic devices however requires fundamental investigations of momentum space geometry and topology of materials to engineer specific spin-orbit interactions to control and detect the vectorial states of photons. We will discuss some recent developments in our laboratory [2-5] towards the development of tunable microchip lasers that produce different SAM-OAM states and photodetectors utilizing Weyl semimetals that are sensitive to SAM-OAM states. The direct transduction of photocurrents mapped to unique SAM-OAM coupled states is engineered via nonlocal light-matter interactions that cannot be described within the electric-dipole approximation and also requires a theoretical description accounting for the topology of electronic bands and also light (OAM states). We will also describe our efforts towards assembling topological photonic and polaritonic waveguides that can route signals based on spin (or pseudospin) degree of freedom. Either by protecting or breaking certain symmetries in (meta)materials, prospects of designing new photonic materials and devices will be discussed that can enable a new generation of classical and quantum photonic devices that can encode, manipulate, transmit and sense information encoded in SAM-OAM modes of light.

References

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