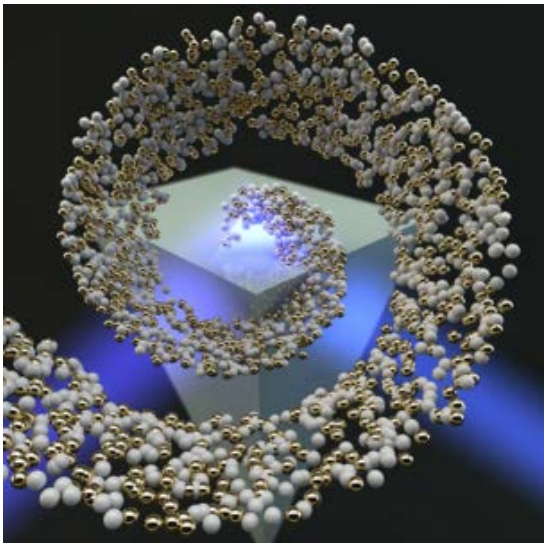
ECE 695: Topological Photonics

Instructor: Prof. Zubin Jacob (zjacob@purdue.edu)

Fall 2018

Tue-Thu: 4:30pm – 5:45pm, EE 234



Exciting research trends in the fields of topological electronic materials have motivated a unique set of closely related phenomena in photonics and phononics. This course will introduce graduate students to foundational ideas such as Pancharatnam-Berry Phase, Chern number, topological surface states, spin-momentum locking and quantum spin hall effect. These phenomena will be covered with themes cross-cutting the fields of electronics, photonics and phononics thus making it appealing to a broad audience.

Applications: Throughout the course, quantum and thermal engineering applications will be stressed. These include quantum communications, quantum gates, quantum memories, robust on-chip photonic-routing, spin-sensing, single photon detectors, ultralow threshold lasing, etc.

Pre-requisite: The necessary background in quantum mechanics can be developed along the way and the course assumes very little in-depth knowledge. However, it is useful to have a strong understanding of wave physics (eg: Classical Electromagnetism).

Topic 1: Parity and time-reversal symmetry for fermions and bosons

Topic 2: Introduction to spin and orbital angular momentum for fermions and bosons

Topic 3: Topological quantization vs. second quantization

Topic 4: Graphene as a model system for topological phase, Introduction to Geometric Phase and Chern number

Topic 5: Dirac equation and Topological edge states

Topic 6: Quantum and topological phase transitions, Quantum magnets

Topic 7: Integer Quantum Hall Effect, Quantum Spin Hall Effect, Topological Insulators in 2D and 3D, Weyl semi-metals

Topic 8: Selected experiments on topological phases of matter

Course notes: Slides and/or hand-written notes will be provided for each lecture