Announcing the Final Examination of Sabin Regmi for the degree of Doctor of Philosophy in Physics

Date: 17 November 2022
Time: 3:00 p.m.
Room: PSB 160
Dissertation title: Observation of novel phases of quantum matter beyond topological insulator.

Abstract:

Owing to their unique electronic properties, intriguing novel phenomena, and potential quantum device applications, quantum materials with non-trivial band structure have enticed a bulk of research works over the last two decades. The experimental discovery of the three-dimensional topological insulators (TIs) - bulk insulators with surface conduction via spin-polarized electrons - kicked off the flurry of research interest towards such materials, resulting in the discovery of new topological phases of matter beyond TI. Topological semimetallic phase in Dirac, Weyl, and nodal-line semimetals is an example, where the classification depends on the dimensionality, degeneracy, and symmetry protection of the bulk band crossing. The field of topology has also been extended to materials possessing non-trivial states at/along lower dimensional regions of the crystals, such as higher order topological insulators.

In this dissertation, we investigated the electronic structure of quantum materials beyond TIs, especially lanthanide-based and/or correlated systems, by utilizing angle-resolved photoemission spectroscopy supported by first-principles calculations and transport measurements. Our work on a Europium-based antiferromagnet highlights this material as a promising ground to study the interplay of different kinds of topological orders including higher-order topology with magnetism. The electronic structure below the antiferromagnetic transition shows splitting of the linearly dispersing bands near the Fermi level. Another study on rare-earth based semimetals shows the presence of multiple nodal-lines that remain gapless even in the presence of the spin-orbit coupling. Kagome systems have been getting attention in the study of interplay among topology, geometry, magnetism, and electronic correlation in quantum materials. We studied a van der Waals breathing kagome semimetal and observed flat and weakly dispersing bands that are sensitive to light polarization and originate from the breathing kagome geometry. Charge density wave (CDW) order in quantum materials remains an important topic of study given its co-existence or competence with superconductivity and magnetic ordering. Our study in a Gadolinium-based van der Waals material shows the presence of a momentum dependent CDW gap and the presence of antiferromagnetic ordering that could prove important to study the interaction of CDW and magnetic orders in this material. Overall, the works under this dissertation reveal the electronic properties in quantum systems that range from insulator to metals/semimetals and from topological insulator to topological semimetals, kagome semiconductor, and CDW material.

Outline of Studies:
Major: Physics

Educational Career:
M. S. Tribhuvan University, Nepal, 2015
B. S. Tribhuvan University, Nepal, 2011

Committee in Charge:
Dr. Madhab Neupane (Chair)
Dr. Talat S. Rahman
Dr. Yasuyuki Nakajima
Dr. Alexei Fedorov, Lawrence Berkeley National Laboratory (External Committee Member)

Approved for distribution by Dr. Madhab Neupane, Committee Chair, on October 31, 2022.

The public is welcome to attend.