SEMINAR ANNOUNCEMENT

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
Faculty of Engineering
Website: https://www.eng.nus.edu.sg/ece/

Area: Microelectronic Technologies & Devices

Host: Assoc Prof Mansoor Bin Abdul Jalil

TOPIC	:	**Topoelectrical circuits - Weyl semimetals on the circuit board**
SPEAKER	:	**Mr S M Rafi-Ul-Islam** **Graduate student, ECE Dept, NUS**
DATE	:	**12 May 2020, Tuesday**
TIME	:	**3pm to 4pm**
WEBINAR	:	**https://us04web.zoom.us/j/71817185558** **Meeting ID: 718 1718 5558**

ABSTRACT

Weyl semimetals (WSMs) are a recent addition to the family of topological materials, and the physical realization of different types of WSMs and its heterojunction are challenging. In this work, we demonstrate a simple and effective method to design and realize various WSM states in a three-dimensional periodic circuit lattice known as “topoelectrical circuits”, composed of passive electric circuit elements such as inductors and capacitors (LC). The experimental accessibility of such LC circuits offers a ready platform for the realization of not only various WSM phases but also for exploring transport properties in topological systems. The characteristics of such LC circuits are described by the circuit admittance matrices, which is mathematically related to the Hamiltonian of the quantum tight-binding model. The system can be switched between the Type-I and Type-II WSM phases simply by an appropriate choice of inductive or capacitive coupling between certain nodes [1]. A peculiar phase with a flat admittance band emerges at the transition between the Type-I and Type-II Weyl phases. The resonant impedance readout can be used to classify the Type-I and Type-II WSM states. Moreover, we investigate the transmission across WSM heterojunctions, consisting of a Type-I WSM source to a drain in the Type-II or intermediary Type- III WSM phase. For transport from a Type-I WSM source to a Type-II WSM drain, valley-independent (dependent) energy flux transmission occurs when the tilt and transmission directions are perpendicular (parallel) to each other [2]. Furthermore, “anti-Klein” tunneling occurs between a Type-I source and Type-III drain where the transmission is totally suppressed for certain valleys at normal incidence [3]. Therefore, in comparison to the material and other platforms, TE circuits are offer flexibility and accessibility in terms of experimental realization. They can also be more readily adjusted to realize a variety of topological phases.

[1] Rafi-Ul-Islam, S.M., Siu, Z.B., Sun, C. and Jalil, M.B., 2020. Realization of Weyl semimetal phases in topoelectrical circuits. *New Journal of Physics*, *22*(2), p.023025.

[2] Rafi-Ul-Islam, S.M., Siu, Z.B. and Jalil, M.B., 2020. Topoelectrical circuit realization of a Weyl semimetal heterojunction. *Communications Physics*, *3*(1), pp.1-11.

[3] Rafi-Ul-Islam, S.M., Siu, Z.B. and Jalil, M.B., 2020. Anti-Klein tunneling in topoelectrical Weyl semimetal circuits. *Applied Physics Letters*, *116*(11), p.111904.

BIOGRAPHY

S. M. Rafi-Ul-Islam received his B.Sc. degree in Electrical and Electronic Engineering from the Bangladesh University of Engineering and Technology (BUET) in 2014. He is currently working towards his Ph.D. degree in the Electrical and Computer Engineering Department at the National University of Singapore. His research interests include theoretical analysis, computer modelling and circuit design of the topoelectrical (TE) circuits and link them to the transport of TE circuits, also modelling unconventional Hamiltonians, i.e. higher-order topological insulators, non-reciprocal systems, non-linear systems and non-Hermitian systems.