State Key Laboratory of Terahertz and Millimeter Waves
香港城市大學 City University of Hong Kong

IEEE (HK) Section
AP/MTT

Seminar On

IEEE Antennas and Propagation Society Distinguished Lecture
Fundamental quantity and equations for electromagnetics from classical to quantum
Prof. Eng Leong Tan
Nanyang Technological University, Singapore

Date : **10 July 2026 (Friday)**

Time : **11:00 am – 12:00 nn**

Venue : **Room 15-202, 15/F, State Key Laboratory of Terahertz and Millimeter Waves, Lau Ming Wai Academic Building, City University of Hong Kong**

Abstract

It has been more than 160 years since Maxwell presented his equations of electromagnetics (EM) in 1864. Today, these equations have been written in our familiar beautiful form, in terms of fields (E and B) typically and potentials (A and phi) occasionally. However, since Maxwell-Hertz-Heaviside era, there have been longstanding dilemma to use either fields or potentials (or both) for EM, and for the potentials, which gauge condition should be imposed, e.g. Lorenz gauge, Coulomb gauge, etc. The present talk will introduce new gauge-invariant physical quantity of field-impulses for new fundamental equations of electromagnetics. Unlike the potentials that are gauge-dependent and may not be physical nor causal, the field-impulses are like fields being gauge-independent, physically real, causal and measurable. Using single wave equation in terms of electric field-impulse can provide the complete description of all electromagnetics. The electric field-impulse is the single physical quantity that can unify not only electrodynamics but also electrostatics and magnetostatics, which otherwise remain independent and left separated all this while. It can completely embed all fields and potentials attributed to static, dynamic, steady or nonsteady charge and/or current distributions. The field-impulses facilitate the development of finite-difference time-domain (FDTD) method for EM simulatons, even including electrostatics (recall that traditional Yee's FDTD has no static charge which calls for Poisson/Laplace equation!). Moreover, unlike the fields that under-describe quantum-EM, the field-impulse can explain the Aharonov-Bohm (AB) effect and appear naturally in Schrodinger equation. The field-impulses not only resolve the century-old field-potential/gauge dilemma, but also aptly describe quantum-EM interactions. They constitute the fundamental physical quantities that are promising for replacing fields, potentials, and ultimately Maxwell equations from classical to quantum. Theoretical formulation and efficient computation with fundamental implicit schemes of FDTD methods will be presented. Several mobile apps for technology-enhanced-learning of electromagnetics and transmission line circuits will also be demonstrated if time permits.

Biography

Eng Leong Tan (SM'06) received the B.Eng. (Electrical) degree with first class honors from the University of Malaya, Malaysia, and the Ph.D. degree in Electrical Engineering from Nanyang Technological University (NTU), Singapore. From 1999 to 2002, he was with Institute for Infocomm Research, Singapore and since 2002, he has been with the School of Electrical & Electronic Engineering, NTU. His research interests include computational electromagnetics (CEM), multi-physics (including quantum, acoustics, thermal), RF/microwave circuit and antenna design. He has published more than 150 journal papers and presented more than 100 conference papers. He and his students received numerous paper and project awards/prizes including: 2019 Ulrich L. Rohde Innovative Conference Paper Award on Computational Techniques in Electromagnetics, First Prize in 2014 IEEE Region 10 Student Paper Contest, First Prize in 2014 IEEE MTT-S Student Design Contest on Apps for Microwave Theory and Techniques, First Prize in 2013 IEEE AP-S Antenna Design Contest, etc. He was the recipient of the IEEE AP-S Donald G. Dudley Jr. Undergraduate Teaching Award with citation: "For excellence in teaching, student mentoring, and the development of mobile technologies and computational methods for electromagnetics education." He has been actively involved in organizing many conferences and workshops, including General Chair of PIERS 2017 Singapore, TPC Chair of ICCEM 2020, APCAP 2018 (Auckland) and 2015 (Bali), as well as TPC Chair of IEEE APS/URSI 2021. He is a Fellow of ASEAN Academy of Engineering and Technology, and a Fellow* of the Electromagnetics Academy in recognition of distinguished contributions to "Computational electromagnetics and education". He has been appointed as the IEEE AP-S Distinguished Lecturer for 2025-2027 and MTT-S Speaker for TC-1 Field Theory and Computational EM Committee Speakers Bureau. He is also a member of the AP-S TC-5 Electromagnetics and Fundamentals Committee.

***** ALL ARE WELCOME *****

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