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

Backscattering-Protected Waveguide by Using Duality

Professor Stefano Maci
University of Siena, Siena, Italy

Date : **26 May 2025 (Monday)**

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

Topological edge modes have garnered significant attention for their ability to support robust, backscattering-immune wave propagation. While traditionally associated with non-reciprocal systems, recent advances have extended these concepts to reciprocal media through the implementation of parity-time-duality (PTD) symmetry. A waveguide exhibiting PTD symmetry features a cross-section where geometric inversion along a specific axis results in dual (complementary) boundary conditions. This symmetry ensures immunity to backscattering caused by discontinuities or sharp corners, provided these perturbations also respect the PTD condition. Several structural implementations, though not always explicitly labelled under PTD symmetry, have demonstrated these principles. A central component in these designs is the use of metasurfaces to engineer the necessary boundary conditions. Early configurations employed complementary reactance surfaces to sustain a so-called line wave at their interface. An alternative architecture was introduced, consisting of a parallel-plate waveguide (PPW) where each side employs dual boundary conditions—typically realized using perfect electric conductor (PEC) and perfect magnetic conductor (PMC) surfaces. This configuration enforces PTD symmetry and supports only the desired edge mode, thus achieving propagation protected by backscattering. The implementation of PMC boundaries was enabled by metasurfaces, particularly high-impedance mushroom-type electromagnetic bandgap (EBG) structures, providing an effective PMC response. Experimental demonstrations confirmed the viability and robustness of this approach. In the presentation, several practical devices based on PTD-symmetric principles are showcased, highlighting the versatility of the concept. These include compact and reconfigurable components such as directional couplers, mode converters, and waveguide bends, all benefiting from the inherent robustness and low-loss characteristics offered by PTD-symmetric waveguides.

Biography

Stefano MACI is a Professor at the University of Siena (UNISI). Since 2000, he has been P.I. of 10 research projects funded by the European Union (EU) and by the European Space Agency (ESA). He is a Fellow of IEEE since 2004. In 2004 he founded the European School of Antennas (ESoA), a PhD school that presently comprises 35 courses on Antennas, Propagation, and Electromagnetic Theory, and 200 teachers, among them 20 IEEE Fellow. He has been advisor of 40 PhD students. He has been former member of IEEE Antennas and Propagation Society (AP-S) AdCom, the Chair of the Award Committee of the IEEE AP-S, member of the AP Executive Board of IET (UK), Distinguished Lecturer of IEEE and of EurAAP. He was recipient of several prizes and awards, among which the EurAAP Award 2014, the Chen-To Tai Distinguished Educator award 2016, of the Shelkunoff Transaction Prize in 2015, and of the URSI Dellinger Gold Medal in 2020. He is presently Director of ESoA. He has been TPC Chair of the METAMATERIAL 2020 and and General Chair of EuCAP 2023. He was the president of the IEEE Antennas and Propagation Society 2023. In the last ten years he has been invited 60 times as key-note speaker in international conferences. His research activity is documented in 200 papers published in international journals, (among which 100 on IEEE journals), 10 book chapters, and about 450 papers in proceedings of international conferences.

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

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