Seminar October 30th, 2024

Advances in Photonics, Radar and Telecommunications Systems

UNIVERSIDAD DE GRANADA

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Sala de Usos Múltiples, CITIC UGR, Granada, Spain

Link: https://meet.google.com/nnh-asjf-tii

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11:30-12:00 *“Non-Foster Circuits, Stabilization and Temporal Modulations”* Presenter: Antonio Alex-Amor University of Pennsylvania – SEAS, Philadelphia, USA	12:00-12:30 *“UAV-Mounted GPR-SAR Systems: a Key Technology for Detecting Buried Explosive Threats”* Presenter: María García-Fernández Queen’s University Belfast – ECIT, Belfast, UK
12:30-13:00 *“Smart Metasurfaces for Advanced Wireless Communication Devices in Millimeter-Wave Bands”* Presenter: Miguel Beruete Universidad Pública de Navarra – TERALAB, Pamplona, Spain	13:00-13:30 *“Chiral Gain Photonics”* Presenter: Mário Silveirinha University of Lisbon – IST, Lisbon, Portugal

Non-Foster Circuits, Stabilization and Temporal Modulations

Antonio Alex-Amor

University of Pennsylvania – SEAS
Philadelphia, USA

Foster's reactance theorem states that the reactance of a passive component should monotonically increase with frequency. This is the case of conventional passive inductors and capacitors we work with on a daily basis. Nonetheless, there is a class of electronic and optical components that do not fulfill Foster's theorem, the so-called non-Foster elements.

Non-Foster networks are active systems that are not limited by passivity constraints (Bode-Fano and Carlin-LaRosa bounds). Thus, non-Foster circuits are highly-demanded in electrical engineering and telecommunications, for instance, to vastly increase the bandwidth characteristics of matching networks in antennas. Unfortunately, like many active systems, non-Foster circuits face severe stability problems.

In this talk, we will show how temporal modulations can be conveniently used to stabilize non-Foster circuits. As an example, we will present the stabilization of an $L(t)C$ resonator formed by a time-varying inductor $L(t)$ and a negative capacitor $C < 0$. This work is framed within the emerging field of space-time metamaterials.

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UAV-Mounted GPR-SAR Systems: a Key Technology for Detecting Buried Explosive Threats

María García-Fernández

Queen's University Belfast – ECIT
Belfast, UK

Radar technology plays an important role in our daily lives with applications ranging from security screening for ensuring the safety of the public to structural health monitoring to name a few. In the field of subsurface sensing, Ground Penetrating Radar (GPR) is a key technology for detecting buried explosive threats, such as landmines and Improvised Explosive Devices (IEDs).

The talk will be focused on GPR systems mounted on board Unmanned Aerial Vehicles (UAVs), leveraging the Synthetic Aperture Radar (SAR) paradigm to provide high-resolution radar images of the subsurface. This kind of systems brings together the advantages of UAVs (e.g., enabling the inspection of difficult-to-access areas without interacting with the soil) and the capability of radar systems to detect buried targets.

In this talk, several prototypes of UAV-mounted GPR-SAR systems tested in realistic scenarios will be presented, showing their success to detect buried threats in realistic scenarios. The current challenges and future trends of this technology will be also discussed.

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Smart Metasurfaces for Advanced Wireless Communication Devices in Millimeter-Wave Bands

Miguel Beruete

Univ. Pública de Navarra – TERALAB
Pamplona, Spain

In this talk, I will discuss the development and application of smart metasurfaces designed to enhance wireless communication devices operating in millimeter-wave bands. These advanced devices enable unprecedented levels of control over electromagnetic waves, facilitating the design of compact and efficient solutions tailored for future wireless communication systems.

I will explore various topics within the realm of metasurfaces, including holographic principles, dynamic reconfiguration, and vortex beam generation, all aimed at increasing the capacity and performance of wireless systems. Overall, this presentation will highlight the transformative potential of smart metasurfaces in advancing wireless communication technology.

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Chiral Gain Photonics

Mário Silveirinha

University of Lisbon – IST
Lisbon, Portugal

I will discuss our research on distributed transistor-metamaterials, emphasizing a unique non-Hermitian electro-optic effect arising from the Berry curvature dipole [1-3]. This effect leads to active or dissipative responses controlled by the field polarization handedness, opening avenues for advanced, nonreciprocal terahertz devices with chiral gain.

[1] S. Lannebère, D. E. Fernandes, T. A. Morgado, M. G. Silveirinha, "Nonreciprocal and non-Hermitian material response inspired by semiconductor transistors", Phys. Rev. Lett., 128, 013902, 2022.

[2] T. G. Rappoport, T. A. Morgado, S. Lannebère, M. G. Silveirinha, "Engineering transistor-like optical gain in two-dimensional materials with Berry curvature dipoles", Phys. Rev. Lett., 130, 076901, 2023.

[3] T. A. Morgado, T. G. Rappoport, S. S. Tsirkin, S. Lannebère, I. Souza, M. G. Silveirinha, "Non-Hermitian Linear Electrooptic Effect in 3D materials", arXiv:2401.13764

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