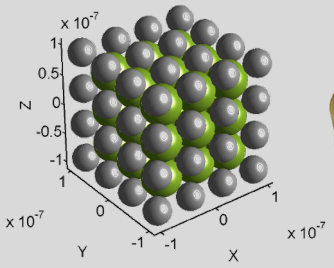
PhD Course on

METAMATERIALS AND METASURFACES

PhD Program in Information Engineering and Science
University of Siena, Palazzo S Niccolò, Aula video conferenze
May 27-31 2013



Prof. M. Albani
Università di Siena - Dipartimento di Ingegneria dell'Informazione e Scienze Matematiche

Prof. S. Maci
Università di Siena - Dipartimento di Ingegneria dell'Informazione e Scienze Matematiche

Dr Marco Sabbadini
European Space Agency, ESA ESTEC, The Netherland

Abstract

Metamaterials are artificial materials engineered to have properties that may not be found in nature. They are constituted of elements small in terms of a wavelength realized by conventional materials such as metals or dielectrics, arranged in periodic patterns to obtain a certain average constitutive electric and magnetic parameters. Metasurfaces constitute a class of thin Metamaterials characterized by average boundary conditions. Objective of the course is to give basic background, mathematical and numerical tools, physical insight, and a view on the engineering application at the state of the art about Metamaterial and Metasurfaces at both microwave and optical regimes.

Syllabus

I – Metamaterials (MTM)	II – Metasurfaces (MTS)	III – Mathematical and Numerical EM Tools
Background • Microwave MTM • Optical MTM • DNG and ENZ • 1D, 2D, 3D MTM • Application Review	**Background** • Microwave MTS and EBG • Optical MTS and EBG • MTS for Antennas • MTS for BFN • Application review	**Background** • Floquet Theorem • Transverse Resonance • 2D and 3D Periodic BC • Surface waves (SW) • Leaky Waves (LW)
Microwave MTM • Multisurface MTM • DNG and ENZ • Tx line (1D) materials • EBG • Chiral materials • Reciprocity issues	**Microwave MTS** • Isotropic metasurfaces • Anysotropic metasurfaces • Polarisation control • Bounded waves on MTS • Unbounded waves on MTS • Implementation of MTS	**Dispersion in MTS and MTM** • Dispersion for MTS • Dispersion for MTM • Phase and Group velocity • **k** and Poynting vectors
Optical MTM • Self-assembled MTM • Fabbrication routes • Loss compensation • Bottom up MTM	**Optical MTS** • Plasmonic Materials • Plasmonic waves • Graphene • Applications	**Transformation Optics** • Non-orthogonal Transformation • Covariant and contravariant sets • MTM transformations • MTS transformation • Applications (cloaking, lenses)
Retrieval of constituent parameters • Multi-surface MTM • Nanostructured MTM	**MTS design and applications** • Conjugate matching method • MetaLenses • Metahorns • MTS Antennas	**Numerical EM analysis** • MoM, Mode Matching • ABCD matrices • Floquet-Bloch analysis • Spatial and spectral modelling • SWE expansions for MM

Course Schedule

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
9:00-10:45	**SM**	Background MTM	**MA**	Optical MTM	**SM**	Dispersion in MTS and MTM	**MS**	MTS Design	**SM**	Retrieval
11:00-12:45	**SM**	Background MTS	**MA**	Optical MTM	**SM**	Dispersion in MTS and MTM	**SM**	Numerical EM analysis	**SM**	Transformation Optics
Lunch										
14:30-16:00	**SM**	Microwave MTM	**MA**	Optical MTS	**SM**	MTS Design	**MS**	Numerical EM analysis	**SM**	Transformation Optics
16:15-17:45	**SM**	Microwave MTS	**SM**	Math Background	**MS**	MTS Design	**MA**	Retrieval	Exam	

MA: Matteo Albani; **MS**: Marco Sabbadini; **SM**: Stefano Maci