

# Iteration-Free Approaches to Solving Large Antenna and Scattering Problems

G. Vecchi<sup>1</sup> and Stefano Maci<sup>2</sup> and Raj Mittra<sup>3</sup>

<sup>1</sup>Torino Polytechnic, <sup>2</sup>Univ. of Sienna and <sup>3</sup>Raj Mittra

## 1- Frequency-domain, MoM-based approaches

### 1.1 Introduction [GV, 20']

- Integral Equation Formulation (IE), Method-of-Moments (MoM) discretization; Basis function issue (regularity, shape-conforming)
- Green's function for planar stratified media: an overview
- Key numerical issues and limitations
- Reduction of complexity: (1) quest for a sparse matrix and the rules of the game (conditioning)
- Reduction of the complexity: (2) reducing the number of unknowns (how?)

### 1.2 Multi-scale aggregate functions [2h 30', GV+SM]

- The multiscale concept (GV)
- Edge singularities in basis functions (TICRA results) (SM)
- Compression and super-compression routes: overview (GV)
- Aggregate Basis Function approach
  - o Synthetic Functions (SFX), (GV)
  - o PO based basis function and fast evaluation of associated fields (SM)
  - o The transmission line Green's functions method (TLGF) method (SM)
  - o Minimum number of basis functions (degrees of freedom of the problem)
  - o The Truncated Floquet-Wave (TFW) MoM approach (SM)
  - o Edge singularities in basis functions (TICRA results) (SM)

### 1.3 Examples [45 min]

- Planar array analysis (SM-GV)
- Truncated EBG materials (SM)
- Installation of large arrays on a board of complex platform (AR(RAY))<sup>2</sup> (SM)
- Radiation from antennas on-board a satellite (GV)
- Reconstruction of the complex environment from measurements (SATIMO results) (SM-GV)

### 1.4 Characteristic Basis Functions (CBF) in the Context of MoM (1h 30 min) (RM)

- Introduction to Characteristic Basis Function Method (CBFM)
- Generation of initial CBFs using either PO (no matrix solution) or sparse L-U decompositions
- Application of SVD to generate new CBFs
- Reduced Matrix Generation
- Multiple Incident Angle and Multiple Frequency analysis using a single set of CBFs
- Comparison with Fast Multipole Method (FMM)

## **2- Time domain CBF for large Complex Inhomogeneous Structures (1h 30 min)**

- Characteristic Basis Function in the Context of FDTD
- Problem Localization and CB Generation Using a windowed illumination in the FDTD
- Synthesis of Solution of a Large Problems from the Subdomain Solutions
- Solution of very Large Problems involving  $10^{10}$  unknowns (or more) using the CBFDTD on parallel platforms using Parallel and Serial-parallel approaches
- Seamless hybridization with asymptotic methods
- Examples: Large Planar Arrays; FSS radomes, Large Arrays covered with FSS radomes with dissimilar periods; Conformal Arrays on Curved Surfaces; EMI/EMC problems including penetration of High Power Signals inside buildings; Interaction between two large antennas mounted on a complex structure, *e.g.*, a ship or an aircraft.