IEEE MTT-S / AP-S CHAPTER

Central and Southern Italy

Distinguished Lecturer Program

Speaker: Prof. Karu Esselle, MacQuarie University, Sidney, Australia

Many names, many advantages – Are resonant cavity antennas the killer planar space-saving approach to get 15-25 dBi gain?

September 5th, 2017, at 11:00 Sala multimediale Dipartimento di Ingegneria, Sezione Elettronica Applicata

Università Roma Tre
Dipartimento di Ingegneria
Dottorato in Elettronica Applicata
Via Vito Volterra 62, Roma, Italy

Welcome and Introduction: Prof. G. Schettini, Prof. L. Tarricone

IEEE

IEEE MTT-S / AP-S CHAPTER

Central and Southern Italy

MTT-S

UNIVERSITÀ DEGLI STUDI ROMA TRE

Università Roma Tre
Dipartimento di Ingegneria
Dottorato in Elettronica Applicata
Via Vito Volterra 62, Roma, Italy

Abstract

No other antenna concept has more names. At present these antennas are known as Fabry-Perot cavity resonator antennas, Partial Reflector Surface (PRS) based antennas, Electromagnetic Band Gap (EBG) Resonator antennas (ERAs) and Two-Dimensional Leaky-Wave Antennas, and more names are forthcoming. Yet they all have more or less the same configuration consisting of a resonant cavity, formed between a partially reflecting superstructure and a fully reflecting (ground) plane. The resonant cavity is excited by a small feed antenna. Hence, they are referred to as resonant cavity antennas (RCAs) in this presentation. Since the concept of using a "partially reflecting sheet array" superstructure to significantly enhance the directivity was disclosed by Trentini in 1956, it has been an attractive concept to several antenna researchers for several reasons, including its theoretical elegance, relationships to other well-researched area such as leaky-waves, EBG, frequency selective surfaces and metasurfaces, and practical advantages as a low-cost simple way to achieve high-gain (15-25 dBi) from an efficient planar antenna without an array, which requires a feed network. The RCA concept is one of the main beneficiaries of the surge of research on electromagnetic periodic structures in the last decade, first inspired by EBG and then to some extent by metamaterials. As a result, RCAs gained a tremendous improvement in performance in the last 10 years, in addition to other advantages such as size reduction.

Lecture Prof. Karu Esselle September 5th, 2017, at 11:00 Sala multimediale Dipartimento di Ingegneria,

Università Roma Tre
Dipartimento di Ingegneria
Dottorato in Elettronica Applicata
Via Vito Volterra 62, Roma, Italy

As an example, achieving 10% gain bandwidth from such an antenna with a PSS was a major breakthrough in 2006 but now there are prototypes with gain bandwidths greater than 50%. Until recently most RCAs required an area in the range of 25-100 square wavelengths but the latest extremely wideband RCAs are very compact, requiring only 1.5-2 square wavelengths at the lowest operating frequency. Once limited to a select group of researchers, these advantages have attracted many new researchers to RCA research domain, and the list is growing fast, as demonstrated by the diversity of authors in recent RCA publications. RCAs have already replaced other types of antennas, for example as feeds for reflectors. Have they become the killer planar alternative to 3D antennas such as horns and small reflectors? If not, what needs to be done to reach that stage?

This presentation will take the audience through historical achievements of RCA technology, giving emphasis to breakthroughs in the last 10 years. Special attention is given to methods that led to aforementioned bandwidth enhancement and area reduction, dramatic improvement of gain-bandwidth product and unprecedented gain-bandwidth product per unit area demonstrated by RCAs, both theoretically and experimentally. Several choices of superstructures are discussed.

These superstructures include all dielectric superstrates with axial permittivity gradients and transverse permittivity gradients and printed superstructures also known as PSSs or metasurfaces.

Lecture Prof. Karu Esselle September 5th, 2017, at 11:00 Sala multimediale Dipartimento di Ingegneria,

IEEE MTT-S / AP-S CHAPTER

Central and Southern Italy

Università Roma Tre
Dipartimento di Ingegneria
Dottorato in Elettronica Applicata
Via Vito Volterra 62, Roma, Italy

Due to ultra-compactness of modern designs and edge radiation becoming a significant player in the principle of operation, different optimisation methods and strategies have been developed to replace previous unit-cell based methods, which were only suitable for previous larger RCAs.
In particular, optimisation of RCAs using automated optimisation methods, including evolutionary algorithms such as Genetic algorithms and Particle Swarm algorithms as well as statistical optimisation algorithms, is described, illustrating the improvements that have been achieved from such optimisations by the speaker’s team and others. Taking one step back, methods of designing phase correction structures (PCS) to enhance near-field phase uniformity, and hence far-field directivity, of conventional larger RCAs are presented, highlighting physical reasons for the phase non-uniformity. Both printed (metasurface-type) PCSs and all-dielectric PCSs are included in this discussion.

The presentation will conclude with yet unresolved issues, which could be addressed in future research.

Lecture Prof. Karu Esselle September 5th, 2017, at 11:00 Sala multimediale Dipartimento di Ingegneria,