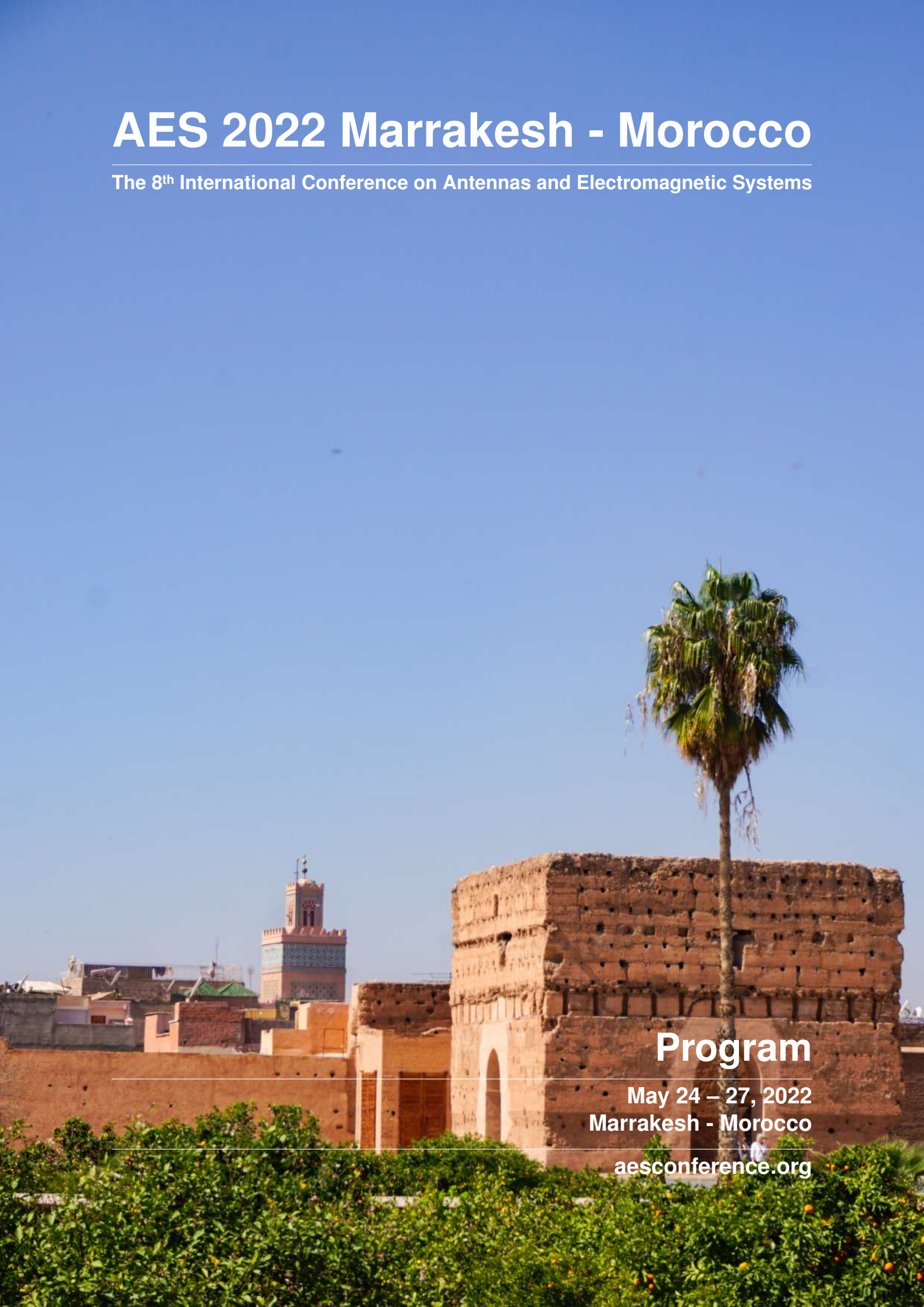
AES 2022 Marrakesh - Morocco

The 8th International Conference on Antennas and Electromagnetic Systems



Program

May 24 – 27, 2022
Marrakesh - Morocco

aesconference.org

AES 2022 Marrakesh - Morocco

The 8th International Conference on Antennas and Electromagnetic Systems

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Edited by

Said Zouhdi | Paris-Saclay University, France

CONTENTS

ABOUT AES

The International Conference on Antennas and Electromagnetic Systems (AES) serves as an international multidisciplinary forum for deliberations on recent advances and developments in all aspects of Antennas, Electromagnetics, Propagation, and Measurements. Of special interest are : :

- Antenna theory and design ;
- Active, adaptive and reconfigurable antennas ;
- Array antennas ;
- Broadband and multi-band antennas ;
- Antennas for wireless power transmission and harvesting ;
- Millimeter/Terahertz and nano-optical antennas ;
- MIMO, antenna diversity, smart and signal processing antennas ;
- Electromagnetic theory ;
- Computational and numerical techniques ;
- Optimization techniques ;
- Nonlinear electromagnetics ;
- Metamaterials, metasurfaces, FSS and EBG ;
- Photonics and plasmonics ;
- Quantum optics ;
- Propagation theory ;
- 5G propagation ;
- Propagation and remote sensing in complex and random media ;
- Millimeter/terahertz and UWB propagation ;
- Propagation in biological tissues ;
- Antenna and propagation measurement techniques ;
- Material characterization and non-destructive testing ;
- EMI/EMC/PIM chambers, instrumentation, and measurements.

Additionally, through its unique from-Conference-to-Journal-Publication concept, AES offers a rare opportunity for authors to submit papers to Advanced Electromagnetic (AEM) journal and then be considered for publication.

The conference program typically features an excursion program and a banquet.

Following a now well-established tradition AES takes place in unique locations around the world.

Year	Organizers	Venue
2018	Said Zouhdi	Western Mediteranean Cruise
2017	Junsuk Rho, Said Zouhdi	Incheon, Korea
2016	Enrique Márquez Segura, Eva Rajo-Iglesias, Said Zouhdi	Torremolinos (Malaga), Spain
2014	Lingling Sun, Ke Wu, Said Zouhdi	Hangzhou, China
2013	Hamid M. K. Al-Naimiy, Said Zouhdi	Sharjah-Dubai, United Arab Emirates
2012	Xavier Begaud, Said Zouhdi	Paris, France

AES 2022 ORGANIZATION

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Paris–Saclay University, France

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PLENARY SPEAKERS

Goutam Chattopadhyay

NASA-Jet Propulsion Laboratory, USA

Microwave Antennas and Systems for Space Applications

Goutam Chattopadhyay is a Senior Scientist at the NASA's Jet Propulsion Laboratory, California Institute of Technology, a Visiting Professor at the Division of Physics, Mathematics, and Astronomy at the California Institute of Technology, Pasadena, USA. He received the Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech), Pasadena, in 2000. He is a Fellow of IEEE (USA) and IETE (India) and an IEEE Distinguished Lecturer.

His research interests include microwave, millimeter-wave, and terahertz receiver systems and radars, and development of space instruments for the search for life beyond Earth.

He has more than 350 publications in international journals and conferences and holds more than twenty patents. He also received more than 35 NASA technical achievement and new technology invention awards. He received the IEEE Region-6 Engineer of the Year Award in 2018, Distinguished Alumni Award from the Indian Institute of Engineering Science and Technology (IIEST), India in 2017. He was the recipient of the best journal paper award in 2020 and 2013 by IEEE Transactions on Terahertz Science and Technology, best paper award for antenna design and applications at the European Antennas and Propagation conference (EuCAP) in 2017, and IETE Prof. S. N. Mitra Memorial Award in 2014.

Stefano Maci

University of Siena, Italy

From the second to the third generation of metasurface antennas

Stefano Maci received the Laurea Degree cum Laude at University of Florence in 87 and from '97 is a Professor at the University of Siena. His research interest includes high-frequency and beam representation methods, computational electromagnetics, large phased arrays, planar antennas, reflector antennas and feeds, metamaterials and metasurfaces. Since 2000 he was member the Technical Advisory Board of 12 international conferences, member of the Review Board of 6 International Journals. He organized 25 special sessions in international conferences, and he held 10 short courses in the IEEE Antennas and Propagation Society (AP-S) Symposia about metamaterials, antennas and computational electromagnetics. In 2004-2007 he was WP leader of the Antenna Center of Excellence (ACE, FP6-EU) and in 2007-2010 he was International Coordinator of a 24-institution consortium of a Marie Curie Action (FP6). He has been Principal Investigator from 2010 of 6 cooperative projects financed by European Space Agency. In 2004 he was the founder of the European School of Antennas (ESoA), a post graduate school that presently comprises 34 courses on Antennas, Propagation, Electromagnetic Theory, and Computational Electromagnetics and 150 teachers coming from 15 countries. Since 2004 is the Director of ESoA.

Professor Maci is IEEE Fellow since 2004, he has been a former member of the AdCom of IEEE Antennas and Propagation Society (AP-S), associate editor of AP-Transaction, Chair of the Award Committee of IEEE AP-S, and member of the Board of Directors of the European Association on Antennas and Propagation (EurAAP). From 2008 to 2015 he has been Director of the PhD program in Information Engineering and Mathematics of University of Siena, and from 2013 to 2015 he was member of the National Italian Committee for Qualification to Professor. He has been former member of the Antennas and Propagation Executive Board of the Institution of Engineering and Technology (IET, UK). He is presently the director of the consortium FORESEEN, presently involving 48 European Institutions, and principal investigator of the Future Emerging Technology project "Nanoarchitectronics" of the 8th EU Framework program. He was co-founder of 2 Spin-off Company. He is a Distinguished Lecturer of the IEEE Antennas and Propagation Society (AP-S), and recipient of the EurAAP Award in 2014, of the IEEE Shelkunoff Transaction Prize 2015, and of the Chen-To Tai Distinguished Educator award 2016. In 2020 will be TPC Chair of the METAMATERIAL conference. In the last ten years he has been invited 25 times as key-note speaker in international conferences. The research activity of Professor Maci is documented in 150 papers published in international journals, (among which 100 on IEEE journals), 10 book chapters, and about 400 papers in proceedings of international. These papers have received around 6800 citations with h index 41.

Marta Martínez-Vázquez

Renesas Electronics Europe, Germany

The challenge of simulation in modern antenna design

Marta Martínez-Vázquez was born in Santiago de Compostela, Spain, in 1973. She obtained her MSc. and PhD. degrees in Telecommunication Engineering from the Universidad Politécnica de Valencia, Spain, in 1997 and 2003, respectively. In 2000 she joined the Antennas and EM Modelling department of IMST GmbH in Germany. She is now with Renesas Electronics (Germany). Her research interests include the design and applications of antennas for mobile devices, array antennas , sensors, and RF systems.

Dr. Martínez-Vázquez is currently a member of the IEEE AP-S Education Committee and the IEEE AP-S Distinguished Lecturers Committee. She is a former vice-chair of the European Association of Antennas and Propagation (EurAAP) and a former member of the Administrative Committee of the IEEE Antennas & Propagation Society. She has served as a Distinguished Lecturer for the IEEE AP-S. She has been the chair of the COST IC1102 Action “Versatile, Integrated and Signal-aware Technologies for Antennas (VISTA) and the vice-chair of the COST IC0603 Action “Antenna Sensors and Systems for Information Society Technologies.” Previously, she was a member of the Executive Board of the ACE (Antennas Centre of Excellence) Network of Excellence and the leader of its small antennas activity.

She is currently a feature Editors of the IEEE Antennas & Propagation Magazine and an Associate Editor of the IET Microwaves, Antennas & Propagation Journal. She has over 90 publications, including books, book chapters, journal and conference papers and patents. Dr. Martínez-Vázquez has been awarded the 2004 Best Ph.D. award of the Universidad Politécnica de Valencia and the 2013 IEEE AP-S Lot Shafai Mid-Career Distinguished Achievement Award.

Yahya Rahmat-Samii

University of California - Los Angeles, USA

From EBG's to Meta-Surfaces and Beyond : Recent Developments and Novel Engineering Applications

Yahya Rahmat-Samii is a Distinguished Professor, a holder of the Northrop-Grumman Chair in electromagnetics, a member of the U.S. National Academy of Engineering (NAE), a Foreign Member of the Chinese Academy of Engineering (CAE) and the Royal Flemish Academy of Belgium for Science and the Arts, the winner of the 2011 IEEE Electromagnetics Field Award, and the Former Chairman of the Electrical Engineering Department, University of California at Los Angeles (UCLA), Los Angeles, CA, USA. He was a Senior Research Scientist with the Caltech/NASA's Jet Propulsion Laboratory. He has authored or coauthored more than 1100 technical journal and conference papers and has written over 36 book chapters and six books and is the holder many patents. He has more than 20 cover-page IEEE publication articles.

Prof. Rahmat-Samii is a fellow of IEEE, AMTA, ACES, EMA, and URSI. He was a recipient of the Henry Booker Award from URSI, in 1984, which is given triennially to the most outstanding young radio scientist in North America, the Best Application Paper Prize Award (Wheeler Award) of the IEEE Transactions on Antennas and Propagation in 1992 and 1995, the University of Illinois ECE Distinguished Alumni Award in 1999, the IEEE Third Millennium Medal and the AMTA Distinguished Achievement Award in 2000. In 2001, he received an Honorary Doctorate Causa from the University of Santiago de Compostela, Spain. He received the 2002 Technical Excellence Award from JPL, the 2005 URSI Booker Gold Medal presented at the URSI General Assembly, the 2007 IEEE Chen- To Tai Distinguished Educator Award, the 2009 Distinguished Achievement Award of the IEEE Antennas and Propagation Society, the 2010 UCLA School of Engineering Lockheed Martin Excellence in Teaching Award, and the 2011 campus-wide UCLA Distinguished Teaching Award. He was also a recipient of the Distinguished Engineering Educator Award from The Engineers Council in 2015, the John Kraus Antenna Award of the IEEE Antennas and Propagation Society and the NASA Group Achievement Award in 2016, the ACES Computational Electromagnetics Award and the IEEE Antennas and Propagation S. A. Schelkunoff Best Transactions Prize Paper Award in 2017. Rahmat-Samii was the recipient of the prestigious Ellis Island Medal of Honor in 2019. The medals are awarded annually to a group of distinguished U.S. citizens who exemplify a life dedicated to community service. These are individuals who preserve and celebrate the history, traditions, and values of their ancestry while exemplifying the values of the American way of life and are dedicated to creating a better world. Among the receipts of this honor are seven US presidents to name the few. He is listed in Who's Who in America, Who's Who in Frontiers of Science and Technology and Who's Who in Engineering. He has been a plenary and millennium session speaker at numerous national and international symposia. He has been the organizer and presenter of many successful short courses worldwide. Many of his students have won major theses and conference paper awards.

He has had pioneering research contributions in diverse areas of electromagnetics, antennas, measurements and diagnostics techniques, numerical and asymptotic methods, satellite and personal communications, human/antenna interactions, RFID and implanted antennas in medical applications, frequency-selective surfaces, electromagnetic band-gap and meta-material structures, applications of the genetic algorithms and particle swarm optimizations. He is the designer of the IEEE Antennas and Propagation Society logo which is displayed on all IEEE AP-S publications. He was the 1995 President of the IEEE Antennas and Propagation Society and 2009–2011 President of the United States National Committee (USNC) of the International Union of Radio Science (URSI). He has also served as an IEEE Distinguished Lecturer presenting lectures internationally.

David R. Smith

Duke University, USA

Large Aperture Metasurface Antennas to Enable Rapid-Revisit, Satellite-Based Synthetic Aperture Radar

David R. Smith is the James B. Duke Distinguished Professor of the Electrical and Computer Engineering Department at Duke University, where he also serves as Director for the Center for Metamaterial and Integrated Plasmonics. Dr. Smith is also the Founding Director of the Metamaterials Commercialization Center at Intellectual Ventures in Bellevue, Washington. Dr. Smith received his Ph.D. in 1994 in Physics from UCSD. Dr. Smith's research interests include the theory, simulation and characterization of unique electromagnetic structures, including photonic crystals, metamaterials and plasmonic nanostructures. Smith and his colleagues demonstrated the first left-handed (or negative index) metamaterial at microwave frequencies in 2000, and also demonstrated a metamaterial "invisibility cloak" in 2006. In 2005, Dr. Smith was part of a five-member team that received the Descartes Research Prize, awarded by the European Union, for their contributions to metamaterials and other novel electromagnetic materials. In 2006, Dr. Smith was selected as one of the "Scientific American 50." Since 2009, Dr. Smith has continually been named a "Citation Laureate" by ISI Web of Knowledge for having among the most number of highly cited papers in the field of Physics. Dr. Smith is a co-recipient of the McGroddy Prize for New Materials, awarded by the American Physical Society, for "the discovery of metamaterials" (2013). In 2016, Dr. Smith was elected to the National Academy of Inventors. Dr. Smith has recently been active in transitioning metamaterial concepts for commercialization, being a co-founder of Evolv Technology, Echodyne Corporation, Pivotal Commware, and advisor to Kymeta Corporation—all companies devoted to developing metamaterial products.

KEYNOTE SPEAKERS

Federico Capasso

Harvard University, USA

Structured light and dark

Wenshan Cai

Georgia Institute of Technology, USA

Field- and Carrier-Enabled Nonlinear Nanophotonics

Christophe Couteau

University of Technology of Troyes (UTT), France

Quantum photonics using nanodiamonds and integrated optics

Christophe Craeye

Université catholique de Louvain, Belgium

Integral equations for metasurface design

Juan Sebastian Gomez Diaz

University of California, Davis, USA

Non-reciprocal phased-array antenna systems

Mona Jarrahi

University of California Los Angeles, USA

Plasmonic heterodyne terahertz receivers with quantum-level sensitivity at room temperature

Panagiotis Kosmas

Kings' College London, UK & Meta Materials Europe SA, Athens, Greece

Microwave Imaging for Medical Diagnostics

Masaya Notomi

NTT Basic Research Labs., Japan

Generating topological states with non-Hermitcity and symmetry breaking

Eva Rajo-Iglesias

University Carlos III of Madrid, Spain

Gap Waveguide Technology using Periodic Structures with Higher Symmetries

Junsuk Rho

Pohang University of Science and Technology (POSTECH), Korea

Intelligent inverse design in nanophotonics using deep-learning

Kaushik Sengupta

Princeton University, USA

Terahertz Chip-Scale Systems

CONFERENCE TUTORIALS

AES 2022 will initiate a series of technical tutorials instructed by world-leading experts on various topics of interest to the AES community. Tutorials are intended to provide a high quality learning experience to conference attendees.

Tutorials & Instructors

Prof. Qammer H. Abbasi

University of Glasgow, UK

Tuesday 24th May

15:00 - 16:00 — Auditorium I

Machine learning enabled wearables for plants and humans at nano scale

Advancement in nanotechnology has made it possible to manufacture sensors, circuits and devices measuring only nano-meters in size. This development is creating an extraordinary opportunity to observe, interact, and optimize physical systems from the very bottom. Wireless communication and networking at nanoscale, however, faces new challenges not encountered in conventional sensor networks. For example, nanoscale antenna calls for wireless communication in the Terahertz band, which encounters new path loss d noise phenomena posing significant challenges for many target applications of such networking. Nanoscale computing and communication is a new and rapidly growing field of research promoting collaboration between wireless networking, nanotechnology, and other fundamental disciplines. However, the research is in its early stages to realize communication and networking at the nanoscale. Currently, there is no definitive standard that provides guidelines and regulation for nanoscale communication and networking. This motivates this proposal to shed light on and promote this area of research and foster.

The objective of this tutorial is to present the opportunities, challenges, and recent advancements of this new and growing inter-disciplinary field explicitly in healthcare and agricultural technology domains using terahertz frequencies.

Prof. Stefano Maci

University of Siena, Italy

Thursday 26th July

15:00 - 16:00 — Auditorium I

Guidance and Radiation of Metasurface-Waves

Metasurfaces constitute a class of thin metamaterials, which can be used from microwave to optical frequencies to create new electromagnetic engineering devices. At microwave frequencies, they are obtained by a dense periodic texture of small elements printed on a grounded slab. Changing the dimension of the elements, being the sub-wavelength 2D-periodicity equal, gives the visual effect of a pixelated image and the electromagnetic effect of a modulation of the equivalent local reactance. The modulated metasurface reactance (MMR) so obtained is able to transform surface or guided waves into different wavefield configurations with required properties. The MMR allows a local modification of the dispersion equation and, at constant operating frequency, of the local wavevector. Therefore, a metasurface modulation permits addressing the propagation path of a surface wave, according with a generalized Fermat principle, as happen in ray-field propagation in inhomogeneous solid medium. This may serve for designing lenses or point-source driven beam-forming networks. When the MMR exhibits a periodic modulation along the SW wavevector, the wave propagation is accompanied by leakage ; i.e., a surface wave is transformed into a leaky-wave, and the structure itself becomes an extremely flat antenna. In every case, introducing asymmetry in the pixel allows for a polarization control. In this tutorial, the basic wave mechanisms will be reviewed showing several antenna applications.

AES 2022 VENUE

AES 20122 will be held at

Kenzi Rose Garden Hotel
Avenue President Kennedy
Marrakesh, Morocco

GENERAL INFORMATION

Registration

Registered participants may pick up their conference material at the registration desk which will be located at the Conference Center of the Kenzi Rose Garden Hotel :

• Monday, May 23 (15 :00 - 18 :00)
• Tuesday, May 24 (7 :30 - 17 :30)

Conference Dinner and Horse (Fantasia) Show

Venue : Chez Ali Restaurant
Price : €50 (first come, first served basis)
Schedule : Thursday, May 26 at 20 :00.

Free Shuttle bus service will be provided between the Conference Hotel and Chez Ali Restaurant.
Pick-up time : 19 :30 at Kenzi Rose Garden Hotel.

GUIDELINES FOR ORAL PRESENTERS

IN-PERSON ORAL PRESENTATIONS

Each session room is equipped with a stationary computer connected to a LCD projector. Presenters must load their presentation files in advance onto the session computer. Technician personnel will be available to assist you.

Scheduled time slots for oral presentations are 15 mn for regular, 20 mn for invited presentations, 30 mn for keynote talks and 35 mn for plenary talks, including questions and discussions. Presenters are required to report to their session room and to their session Chair at least 15 minutes prior to the start of their session.

The session chair must be present in the session room at least 15 minutes before the start of the session and must strictly observe the starting time and time limit of each paper.

ON-LINE ORAL PRESENTATIONS

On-line oral presenters at AES 2022 will be required to submit a pre-recorded presentation (regular : 15-minutes duration, invited : 12-minutes, keynote : 30-minutes and plenary : 35-minutes) which will be made available to view by the participants up to four weeks after the conference.

All speakers have the possibility to give their talk **live** in the allotted time specified in the technical program. At the time of the presentation, the session chairperson will allow the speaker to share their computer screen with the audience (the pre-recording will be used as a backup in case of a no-show or technical difficulty). Speakers also have the option to have their **pre-recorded** presentation played during the live session. **However, all authors, no matter what format they select (live or on replay) should submit a pre-recorded presentation by the deadline of April 25th**.

For both live or on-demand presentations, a 5-minute Question and Answer (Q&A) session will follow each presentation. At least one of the paper's authors must be online to answer questions after the talk.

Detailed instructions on the on-line oral presentations will be made available on the conference website.

GUIDELINES FOR POSTER PRESENTERS

IN-PERSON POSTER PRESENTATIONS

Presenters are requested to stand by their posters during their session. One poster board, A0 size (118.9 x 84.1 cm), in portrait orientation, will be available for each poster. Pins or thumbtacks are provided to mount your posters on the board. All presenters are required to mount their papers 30mn before the session and remove them at the end of their sessions. Posters must prepared using the standard AES poster template (available on the conference website).

ON-LINE POSTER PRESENTATIONS

Poster presenters will be required to submit a poster in **digital format**. Questions can be posted at any time via special chat channels. During the conference, there will be poster sessions scheduled over different time zones where poster presenters will discuss their posters with the attendees via video conferencing. Additional information on on-line poster presentations will be made available on the conference website.

TECHNICAL PROGRAM

Monday 23rd May, 2022

Registration

Lobby

15:00 - 18:00

Tuesday 24th May, 2022

Registration

Lobby

07:30 - 17:30

Opening Address

Auditorium I

08:45 - 09:00

09:00 - 10:10 — Auditorium I

Session 1A1

Plenary Session I

09:00 : Plenary talk

Large Aperture Metasurface Antennas to Enable Rapid-Revisit, Satellite-Based Synthetic Aperture Radar

David R. Smith[1], **Michael Boyarsky**[1], **Milton Perque**[2], **Tom Driscoll**[3], **Russell Hannigan**[4]
[1]*Duke University (USA),* [2]*Metacept Corporation (USA),* [3]*Echodyne Corporation (USA),* [4]*Xplore Corporation (USA)*

We present the case for waveguide-fed, metasurface apertures as spaceborne antennas for synthetic aperture radar (SAR) imaging. Remote surveillance of earth has gained increasing relevance, both for military as well as commercial purposes. Low- and mid-frequency microwaves have the advantage of penetrating clouds and possibly other obstructions, enabling the capability to persistently monitor terrestrial targets. However, wide-scale coverage over large portions of the earth requires a significantly large constellation of satellites, each equipped with an appropriate SAR system operating in either a monostatic mode or cooperating with other satellites in a multstatic mode. The SAR antenna must have a suitably large aperture to produce a reasonable beam profile; must have minimal DC power requirements; must be efficient, preferably without active heat management; should be able to steer over a wide angular range electronically; should be low-cost; and should have minimal weight and profile. These and many other similar requirements motivate the use of metasurface apertures, which can be designed to satisfy all of these requirements due to their simplified architecture. With recent advances in launch capabilities rapidly driving down the costs and complexity of satellite deployment, a high-performance, low-profile, and low-cost SAR antenna is the key component to enable an appropriately sized constellation for earth observation. Such a constellation could achieve rapid revisit times, allowing the same target to be imaged at radio frequencies over intervals of tens of minutes or fewer. Given the cost per square meter and relative performance of the metasurface aperture, we believe metasurface apertures will play a pivotal role in future satellite-based SAR systems.

09:35 : Plenary talk

Are We Alone? NASA Technologies to Find Life Beyond Earth and Answers to Other Science Questions

Goutam Chattopadhyay
NASA-Jet Propulsion Laboratory (USA)

Fundamental science questions drives the selection of NASA missions. We develop instruments to make measurements that can answer those science questions. In this presentation, we will present an overview of the state of the art instruments that we are currently developing and layout the details of the science questions they will try to answer.

Coffee Break

Session 1P1

Poster session I

10:10 - 10:50

Pedro Falcão, Custodio Peixeiro
University of Lisbon (Portugal)

The implementation of a wideband printed monopole antenna near a metallic shield is presented. A wearable antenna system application to probe the electromagnetic field, with frequency in the range 0.7-3.5 GHz (5:1 bandwidth), incident on a professional user is envisaged. A lossy foam layer is used between the shield and the antenna to absorb the shield reflection and avoid narrowing the bandwidth.

Mac Cartier, Rahul Sreekumar, Elisa Pantoja, Mircea R. Stan
University of Virginia (USA)

Fractal antennas allow for the design of Ultrawide-band(UWB) antennas with a reduced footprint, we present anovel technique for generating antenna geometries which extend the Koch snowflake to angles other than 60 degrees.This is achieved by generating a Koch curve of an arbi-trary indentation angle and then circumscribing the curve about the origin. Using our method, we achieve a 36 per-cent footprint area reduction compared to a traditional Koch snowflake antenna with a center frequency of 4.1 GHz.

P3: A fast hybrid approach to model roughness effects for 2D the tropospheric maritime long-range propagation *On-line*
Thomas Bonnafont[1], Othmane Benhmammouch[2], Ali Khenchaf[1]
[1] *ENSTA Bretagne (France),* [2] *International University of Casablanca (Morocco)*

This paper studies the long-range tropospheric electromagnetic wave propagation over the sea. An asymptotic model based on the parabolic wave equation is considered. This latter is solved using a fast and memory-efficient wavelet-based method. The roughness effects of the sea are introduced through a hybrid approach. Numerical experiments (in X-band) are provided to highlight the advantages of the wavelet-based method in the context of maritime propagation.

Youness Zaarour[1], Fatima Zahrae El Arroud[1], Rafiq El Alami[1], Hafid Griguer[1], M'Hamed Drissi[2]
[1] *Mohammed VI Polytechnic University (Morocco),* [2] *INSA Rennes (France)*

Noninvasive sensor of plant that measure leaf concentration water is purposed. It is based on a microstrip structure where the loaded layer is represented by a mathematical model. The leaf is represented with the cellulose Cole-Debye model, that includes freshwater molecules which are simulated with different size to characterize the turgescence and plasmolysis behavior. The concept is validated and compared to Cole-Debye model for different situation of stress leaf, represented by an equivalent dielectric cell over the sensor.

Attilio Zilli[1], Andrea Locatelli[2], Davide Rocco[2], Luca Carletti[2], Paolo Biagioni[1], Lamberto Duo[1], Xiaofei Wu[3], Swen Grossmann[3], Carlo Gigli[4], Giuseppe Marino[4], Giuseppe Leo[4], Costantino De Angelis[2], Bert Hecht[3], Michele Celebrano[1], Marco Finazzi[1]
[1] *Politecnico di Milano (Italy),* [2] *University of Brescia (Italy),* [3] *University of Wurzburg (Germany),* [4] *Université de Paris (France)*

Nanostructures can be exploited to enhance nonlinear optical processes via the strong light confinement by their resonant modes. The dependence of these modes on the geometry and material composition offers ample opportunities for tailoring the optical response of the system. I report about sum-frequency generation (SFG) by individual dielectric and plasmonic nanocylinders, pumped by two pulsed beams with different photon energies. A rich size- and polarization-dependent behavior is observed, disclosing strategies to manipulate the nonlinear properties of nanoscale systems

Xin Dai, Kwai-Man Luk
City University of Hong Kong (China)

A wide band low profile magneto-electric (ME) dipole working in millimeter wave band is presented in this

paper. Different from conventional ME dipoles using the vertical wall as magnetic dipoles, the proposed antenna's magnetic dipole is composed of the aperture between the patches of the electric dipole. As a result, the profile of the ME dipole can be much lower than conventional ones. The proposed ME dipole antenna is fed through the ground slot by the substrate integrated coaxial line (SICL), which can significantly enhance the backside lobe performance. A simulated impedance bandwidth of 48.5 % (26-42 GHz) and a gain up to 9 dBi can be achieved with a profile of about 0.12 λ0. Additionally, symmetric radiation patterns with back lobe lower than -23 dB over the operating band can be obtained. With the advantage of wide working band, low profile and low backside radiation, the proposed antenna would a good candidate for millimeter wave antenna in package (AiP) applications.

Abinash Gaya, Mohd Haizal Jamaluddin
Universiti Teknologi Malaysia (Malaysia)

A ring slot fed ultra-wide band Dielectric Resonator Antenna (DRA) has been designed here which can be used for band 30 (23GHz-28GHz) of 5G applications .The simulated gain of the antenna is 6.42dBi with radiation efficiency of 93 percentage .A circular aperture has been made on the ground plane which excites the DRA with the wide aperture .The simulated bandwidth of the antenna is 6.2GHz(24.6 GHz -30.8GHz) .

10:50 - 12:35 — Auditorium I

Session 1A2
Millimeter/Terahertz and nano-optical antennas

10:50 : Keynote talk
Gap Waveguide Technology using Periodic Structures with Higher Symmetries
Eva Rajo-Iglesias
University Carlos III of Madrid (Spain)

In this work, the use of holes instead of pins for the implementation of the groove version is presented. The periodic structure based on the use of holes requires the glide symmetrical disposition of the unit cell to provide a complete and wide stopband for the parallel plate modes. Design guidelines for this version will be detailed and the advantages in terms of manufacturing will be discussed together with the limitations when compared to the use of pins. Some examples of designed antennas and components in the millimeter wave band using this approach will be presented in the talk.

11:20 : Invited talk
Generation of high-quality tunable terahertz vortices based on difference frequency generation
Katsuhiko Miyamoto, Takashige Omatsu
Chiba University (Japan)

We demonstrate a high-quality tunable terahertz (THz) vortices generation based on difference frequency generation in combination with Gaussian and vortex modes.

11:40 : Invited talk
Phase control of THz-wave in multi-port waveguide structure coupled with bull's-eye antenna
Seigo Ohno
Tohoku University (Japan)

We have analytically and numerically investigated phase control feature of terahertz wave in a waveguide structure coupled with a bull's-eye antenna via polarization state of the wave incident to the bull's-eye antenna. In this presentation, we will introduce the theoretical extension to the multiport waveguide aligned in parallel nearby the tiny hole of the bull's-eye antenna and show some numerical results.

Qing Le Zhang, Bao Jie Chen, Kam Man Shum, Chi Hou Chan
City University of Hong Kong (China)

We present a planar terahertz goubau-line antenna with endfire radiation based on the substrate mode in this paper. As the antenna substrate thickness increases, the goubau line can excite the substrate mode and

thus the truncated substrate will work as an antenna to generate endfire radiation. The proposed antenna operates from 325 GHz to 430 GHz on a 300 μm thick quartz substrate, and achieves the endfire radiation with 9.5-10.85 dBi gain.

12:15 : Invited talk
Ultrabroadband terahertz pulses from a Ge:Au photoconductive emitter *On-line*
Abhishek Singh[1], Alexej Pashkin[1], Stephan Winnerl[1], Malte Welsch[1], Cornelius Beckh[2], Philipp Sulzer[2], Alfred Leitenstorfer[2], Manfred Helm[1], Harald Schneider[1]
[1] *Helmholtz-Zentrum Dresden-Rossendorf (Germany),* [2] *University of Konstanz (Germany)*

Using gold-implantated germanium, where the carrier lifetime is shortened by more than three orders of magnitude, we have demonstrated a broadband photoconductive THz emitter compatible with modelocked fiber lasers operating at wavelengths of 1.1 and 1.55 um and pulse repetition rates up to 20 MHz. The emitted THz spectrum spans up to 70 THz. This approach opens up a prospect for manufacturing of compact, high-bandwidth THz photonic devices compatible with Si CMOS technology.

10:50 - 12:30 — Auditorium II

Session 1A3
Optics and photonics

10:50 : Invited talk
Shapeshifting diffractive optical elements *On-line*
Antonio Ambrosio
Istituto Italiano di Tecnologia (Italy)

We have proved that it is possible to realize optical elements with theory-matching efficiency and practical use, reconfigurable on demand right where and when needed. I will present diffraction optical elements with efficiency equal to the theoretical efficiency, realized by direct structuring of the surface of a photosensitive polymer, avoiding any further development step.

11:10 : Invited talk
Laser scanners with rotational Risley prisms: A graphical method to determine and study exact scan patterns
Virgil-Florin Duma[1], Alexandru-Lucian Dimb[2]
[1] *Aurel Vlaicu University of Arad (Romania),* [2] *Polytechnic University of Timisoara (Romania)*

We report on a novel, graphical method, using a 3D mechanical design program, CATIA V5R20, to obtain and analyze exact scan patterns or a pair of rotational Risley prisms - in comparison to other scanning modalities, produced by the most common galvanometer laser scanners.

11:30 : Invited talk
Giant Pockels Effect in Thin Film Barium Titanate for Reconfigurable Photonics *On-line*
Aaron Danner
National University of Singapore (Singapore)

In this talk I will introduce the barium titanate photonics platform. The Pockels effect is what enables GHz-level switching speeds in optical modulators and switches, so materials which exhibit strong Pockels coefficients are advantageous as they maximize light-matter interaction. Using pulse laser deposition, we have grown single crystal barium titanate on various low index substrates and measured an r-parameter over 600 pm/V. We then experimentally demonstrated polarization modulation.

11:50 : Invited talk
High-Speed Fiber-Wireless-Fiber Bridge System for Fixed Wireless Link in Millimeter-Wave Band Using Photonic Technology *On-line*
Dat Pham
National Institute of Information and Communication Technology (NICT) (Japan)

We present photonics-enabled technologies to realize high-speed fiber-wireless-fiber bridge systems in the millimeter-wave band, including a photonics-enabled receiver and an all-photonic receiver. In the former method, the millimeter-wave signal is down-converted to the microwave band before being converted to the optical signal for further transmission using an optically generated local oscillator signal. In the latter method, the millimeter-wave signal is directly converted to the optical domain without any frequency conversion using a broadband optical modulator.

12:10 : Invited talk
Optical Fiber Sensors and Their Applications
Perry Shum, Huanhuan Liu, Jinna Chen
Southern University of Science and Technology (SUSTech) (China)

Several novel fiber-based sensors and technologies developed are presented here, including fiber Bragg grating (FBG) based sensors, photonic crystal fiber (PCF) based sensors, specialty fiber-based sensors and distributed fiber sensing systems.

10:50 - 12:25 — Auditorium III

Session 1A4

Advanced numerical and theoretical tools

Organized by: Kofi Edee

Chaired by: Kofi Edee

10:50 : Invited talk
Casimir interaction on gratings
Brahim Guizal, Mauro Antezza
Université de Montpellier (France)

We will discuss some recent numerical results on the Casimir interaction between metallic gratings. These findings pave the way to the design of a contactless quantum vacuum torsional spring, and sensors with possi- ble relevance to micro and nanomechanical devices.

11:10 : Invited talk
Full-vectorial polynomial modal method for circular waveguides. Application to reflection and diffraction at the end of radially inhomogeous cylinders.
Gerard Granet
Université Clermont Auvergne (France)

We develop a modal method for radially inhomogeneous waveguides. The formulation is derived with the two transverse components of the magnetic field. The algebraic eigensystem is solved by using Tchebycheff polynomials and a tau method.

11:30 : Invited talk
The polariton laser ridge: an exception to the rule
Christelle Brimont[1], Hassen Souissi[1], M. Gromovyi[2], T. Gueye[1], L. Doyennette[1], D. D. Solnyshkov[3], G. Malpuech[3], E. Cambril[2], S. Bouchoule[2], B. Alloing[4], S. Rennesson[4], F. Semond[4], J. Zuniga-Pérez[4], T. Guillet[1]
[1] *Université de Montpellier (France),* [2] *Université Paris-Saclay (France),* [3] *Université Clermont Auvergne (France),* [4] *CRHEA-CNRS (France)*

We present an experimental study of a laser with a ridge waveguide geometry, allowing to show that the polariton laser effect can be observed only by imposing a pumping section of only 15 % of the total length of the cavity. A good quantitative agreement between experimental results and simulationsis obtained. We explain how a ridge polariton laser is different from a conventional laser.

11:50 : Invited talk

A direct and an inverse domain decomposition method applied to Fourier modal method: simulation of large scale device response

Kofi Edee, Gerard Granet, Françoise Paladian, Pierre Bonnet
Institut Pascal (France)

A parallel spectral modal method is introduced for the frequency-domain Maxwell's equations. The method is applied to compute electromagnetic field through a large- scale surface, using the Aperiodic Fourier Modal Method (AFMM). In the proposed domain decomposition methods, a large-size surface is squared onto sub-cells. The spectrum of the electromagnetic field component on each sub-cell may be simulated, locally with a coast that is not dependent on the number of the sub-cells, making it suitable for parallel computing.

Imane Massaoudi, Pierre Bonnet
Université Clermont Auvergne (France)

Numerical co-simulation methods are increasingly used to solve complex electromagnetic compatibility problems. For the time-dependent Maxwell-Equations, these approaches may exchange information and simulation results for each temporal iteration. In this paper, we propose an asynchronous temporal co-simulation method. The approach is illustrated on a transmission lines network. The results obtained are validated with the global simulation.

Lunch

12:30 - 14:00

14:00 - 15:10 — Auditorium I

Session 1A5

Metamaterials and metasurfaces

14:00 : Keynote talk

Integral equations for metasurface design

Christophe Craeye, Modeste Bodehou, Jean Cavillot, Denis Tihon
Université Catholique de Louvain (Belgium)

Among the different ways to solve Maxwell's equations, integral-equation approaches are probably offering the most physical insight. They allow the prediction of surface waves and their transformation into leaky waves. We will explain how integral equations can be turned into a direct design tool, beyond traditional field analysis. This allows the design of metasurfaces with prescribed radiation patterns, as well as the creation of multi-beam metasurfaces. Such a perspective on numerical methods may also serve other fields of engineering.

14:30 : Invited talk

Plasmonic and metamaterial devices based on highly doped semiconductors for infrared applications

Emmanuel Centeno[1], Rafik Smaali[1], Fernando Gonzalez Posada Flores[2], Laurent Cerutti[2], Antoine Moreau[1], Fatima Omeis[1], Thierry Taliercio[2]
[1] *Université Clermont Auvergne (France),* [2] *Montpellier University (France)*

Highly doped semiconductors are ideal materials to realize plasmonic and metamaterial based systems operating from the infrared to the THz frequencies. In this work, we show that nano-antennas, hyperbolic metamaterials and epsilon-near-zero metasurfaces can be designed which such materials. These systems are demonstrated to enhance light matter interactions and can be applied for infrared spectroscopy.

14:50 : Invited talk

Conformable metasurface patches for mm-waves holographic applications

Jianling Xiao[1], Simon Horsley[2], Robert I. Hunter[1], Sebastian A. Schulz[1], Graham Smith[1], Duncan A. Robertson[1], Andrea Di Falco[1]
[1] *University of St Andrews (United Kingdom),* [2] *University of Exeter (United Kingdom)*

We present our work on the design, fabrication and characterisation of conformable metasurface patches in

the mm-wave range for holographic applications.

15:00 - 16:00 — Auditorium I

Session 1A6
Conference Tutorials I

15:00 : Tutorial
Machine learning enabled wearables for plants and humans at nano scale
Qammer H. Abbasi
University of Glasgow (UK)

The objective of this tutorial is to present the opportunities, challenges, and recent advancements of this new and growing inter-disciplinary field explicitly in healthcare and agricultural technology domains using terahertz frequencies.

14:00 - 15:55 — Auditorium II

Session 1A7
Nanophotonics, plasmonics and quantum optics

14:00 : Invited talk
Large scale metasurfaces: from plasmonics to photon harvesting in 2D semiconductor layers *On-line*
Maria Caterina Giordano[1], Matteo Gardella[1], Matteo Barelli[1], Giorgio Zambito[1], Giulio Ferrando[1], Pham Duy Long[2], Nguyen Si Hieu[2], Francesco Buatier de Mongeot[1]
[1] *Universita di Genova (Italy),* [2] *Vietnam Academy of Science and Technology (Vietnam)*

The nanofabrication of large-area metasurfaces with tunable optoelectronic response is crucial in many fields from plasmonics to energy conversion. Here the engineering of self-organized plasmonic antennas will be demonstrated, showing their performances in photo-degradation of polluting molecules. In parallel, the capability to strongly couple light to large-area 2D semiconductor layers will be shown. Thanks to nanoscale re-shaping of the interface to form flat-optics nanogratings superior photon harvesting performances can be achieved with strong impact in photonics and energy conversion.

Senglee Foo
Huawei Technologies (Canada)

Tightly-coupled dipole arrays (TCDA) have been developed based on current-sheet periodic structure to achieve ultra-broadband impedance performance with wide scanning capability. This paper presents an alternative ultra-broadband periodic array using continuous magneto-electric (ME) currents, which can be implemented using radiating slots and horizontal monopoles. The proposed ME array is scalable from sub-6GHz to millimeter-wave and has the advantage of much simpler feed structure and does not require extremely small capacitive gap between radiating elements.

14:35 : Invited talk
Plasmonic-based Photothermal Conversion
Jérôme Plain
Université de Technologie de Troyes (France)

Numerous applications are based on the capability of plasmonic nanoparticles to locally increase the temperature. These are two main issues: the first one is the choice of the materials and the second one is the way to locally characterize the temperature enhancement. In this presentation, we will address these two issues.

14:55 : Invited talk

Universal light encoders: artificial intelligence hardware for light processing components and integrated systems
A. B. Lopez, F. Getman, M. Makarenko, Q. Wang, A. Fratalocchi
KAUST (Saudi Arabia)

In this invited talk, I will review our recent theoretical and experimental results in the field of Universal Light Encoders (ULE) artificial intelligence (AI) hardware for a new class of flexible ultra-flat components (thickness $textless$ 100nm) for high efficiency (close to unitary) vectorial control of light These devices are supported by a layer of “physical” neural network units in suitably engineered optical nanoresonators.

15:15 : Invited talk
Electromagnetic Vortices: Properties and Applications
Andrei Afanasev
George Washington University (USA)

Vortex states of electromagnetic fields, or twisted photons, were shown experimentally to modify angular momentum selection rules when absorbed by atoms.

15:35 : Invited talk
Shaping light in space and time: chip-scale atomic clocks to twisted light pulses
Amit Agrawal
National Institute of Standards and Technology (USA)

We demonstrate the versatility of dielectric metasurfaces to (i) shape the temporal evolution of ultrafast optical pulses, and (ii) discuss their applications towards creating integrated photonic interfaces with quantum systems.

14:00 - 15:00 — Auditorium III

Session 1A8

Advanced numerical and theoretical tools

Organized by: Kofi Edee

Chaired by: Kofi Edee

14:00 : Invited talk
Efficient computation of EM scattering from a dielectric cylinder covered with graphene strips
Brahim Guizal, Youssef Jeyar, Mauro Antezza
Université de Montpellier (France)

We present a numerical approach for the solution of EM scattering from a dielectric cylinder partially covered with graphene. It is based on Fourier-Bessel expansions inside and outside the cylinder. We apply the ad-hoc boundary conditions in the presence of graphene but due to the singular nature of the electric field at the ends of graphene, we introduce auxiliary boundary conditions. The result is a very simple and very efficient method allowing the study of diffraction from such structures.

14:20 : Invited talk
Convergence acceleration for the numerical solution of Maxwell’s equations by processing edge singularities of the electromagnetic field
Igor Semenikhin
Russian Academy of Sciences (Russia)

The methodology for accelerating the convergence of numerical methods for solving Maxwell’s equations in the frequency domain by taking into account the behavior of the electromagnetic field near the geometric edges of wedge-shaped structures is presented. Several algorithms for incorporating treatment of singularities into methods for solving Maxwell’s equations in two-dimensional structures by the examples of the analytical modal method and the spectral element method are discussed.

14:40 : Invited talk

Graphene surface magneto-plasmons excited through a magnetostatic biased graphene-strip grating : Semi analytical Approach *On-line*

Maha Ben Rhouma[1], **Kofi Edee**[2], **Brahim Guizal**[3]
[1] *CEA Saclay (France),* [2] *Universite Clermont Auvergne (France),* [3] *CNRS-Universite de Montpellier (France)*

We present an accurate and simple semi analytical model for investigating the magneto-plasmonic response of a 1D subwavelength graphene strip grating under an external static magnetic field when the graphene is considered as an anisotropic layer with atomic thickness. It is based on an effective medium approach (EMA) and a rigorous phase correction. The proposed model is numerically validated and evaluated by comparing the results with those obtained from the PMM method and from methods published in the litterature.

14:50 - 15:40 — Auditorium III

Session 1A9

Scattering and diffraction

Alexander Powell, Alastair Hibbins, Roy Sambles
University of Exeter (United Kingdom)

Superscattering, whereby a subwavelength object is designed to support multiple orthogonal resonances at the same frequency, can vastly enhance the interaction of electromagnetic radiation with small objects, and has applications in diverse fields such as antenna-design, sensing and optoelectronics. However, experimentally demonstrating superscattering is extremely difficult, requiring complex fabrication processes. We demonstrate that superscattering in the microwave regime can be achieved rather simply through the careful structuring of a high-index dielectric sphere, which can be fabricated via additive manufacturing.

Tsirinantenaina A. Rafalimanana[1], **Gerard Granet**[2], **Karyl Danielson Ranirіharinosy**[1]
[1] *Université de Fianarantsoa (Madagascar),* [2] *Université Clermont Auvergne (France)*

We present a new semi-analytical formulation for diffraction by structured cylinders. A pseudo-spectral modal method is used to solve the Maxwell equations written in curvilinear coordinates. The program is compared with the numerical results obtained with finite element method using Comsol Multiphysics.

15:20 : Invited talk

Limits on Electromagnetic Scattering

Pengning Chao[1], **Benjamin Strekha**[1], **Rodrick K. Defo**[1], **Sean Molesky**[2], **Alejandro W. Rodriguez**[1]
[1] *Princeton University (USA),* [2] *Polytechnique Montreal (Canada)*

While improvements in nanofabrication and computational methods have driven dramatic progress in expanding the range of achievable optical characteristics, they have also greatly increased design complexity. These developments have led to heightened relevance for the study of fundamental limits on optical response. Here, we review recent progress in our understanding of these limits with special focus on an emerging theoretical framework that combines computational optimization with conservation laws to yield physical limits capturing all relevant wave effects.

Coffee Break

Session 1P2

Poster session II

16:00 - 16:30

Shahin Salarian, Dariush Mirshekar
University of Essex (United Kingdom)

Microstrip patch antenna have been designed for satellite simulator system for transceiver antenna. The

transmitter antenna is designed for the uplink at 14.25 GHz and receiver antenna is designed for the downlink at 11.45 GHz. The transmitter and receiver antennas are designed on a single substrate with microstrip transmission feedline on two sides for each frequency band. Simulation results reveal a broadband structure for reflection, with a gain of 7 dB and high efficiency.

Fatima Omeis[1], Rafik Smaali[2], Aubry Marin[2], Audrey Potdevin[2], Francois Réveret[2], Emmanuel Centeno[2], Elena Silaeva[1], Yves Jourlin[1], Geneviève Chadeyron[2], Michel Langlet[3]
[1] *Université Jean Monnet (France),* [2] *Université Clermont Auverge (France),* [3] *Université Grenoble Alpes (France)*

White Light Emitting Diodes (WLEDs) with improved light emission in the red region are highly desired for many applications especially for obtaining warm illumination. In this work, we provide an experimental and theoretical study for a grating structure composed of ZnO nanowires (NWs) that proves to boost and directionally extract the visible and red light emission. The experimental results are compared with a theoretical and numerical model to understand this unique optical behavior.

Abdolreza Divsalar, Shahin Salarian, Dariush Mirshekar-Syahkal
University of Essex (United Kingdom)

A novel mm-wave periodic filter structure has been proposed based on a new design approach. The filter performs at 60 GHz with 3.5GHz bandwidth. The structure composed of periodic Microstrip stubs on BL037 Liquid Crystal substrate. Changing the bias voltage of LC provides a tunability from 58.5 to 62 GHz, while maintains the fractional bandwidth around 5 %. In addition, the effect of a different LC substrate has been investigated which provides similar behavior with a wider tuning distance.

Einstom Llego Engay, Dewang Huo, Radu Malureanu, Ada-Ioana Bunea, Andrei Lavrinenko
Technical University of Denmark (Denmark)

A bifunctional metasurface was fabricated to facilitate quantitative phase imaging. The silicon-based metasurface is made of elliptical nanopillars and acts as a polarization splitter allowing for the recording of two images, where one is shifted from the other. The two images were then used in an iterative calculation to retrieve the phase information of technical samples like lenses.

P5: On the propagation of surface plasmon polaritons at the interface of low-dimensional acoustic metamaterials *On-line*

Tatjana Gric[1], Edik Rafailov[2]
[1] *Vilnius Tech (Lithuania),* [2] *Aston University (United Kingdom)*

Acoustic metamaterials and phononic crystals possess a wide variety of exceptional physical features. Dispersion properties of surface waves propagating at the interface between a nanocomposite made of a semiconductor inclusions systematically distributed in a transparent matrix and low-dimensional acoustic metamaterial, constructed by an array of nanowires implanted in a host material are investigated. We observed propagation of surface plasmon polaritons. It is demonstrated that one may dramatically modify properties of the system by tuning the geometry of inclusions.

Fatima Khoutar[1], Mariem Aznabet[1], Hung Luyen[2], Otman E. Mrabet[1], Nader Behdad[2]
[1] *Abdelmalek Essaadi University (Morocco),* [2] *University of Wisconsin-Madison (USA)*

This paper presents a single-metallic-layer, near-to-zero-index metasurface as a superstrate for an antenna to achieve gain enhancement and circular polarization. The proposed metasurface comprises an array of SRRs rotated and aligned diagonally to provide linear-to-circular polarization conversion when placed above a linearly polarized patch antenna. Simulated and measured results show that the proposed antenna system has a 3-dB axial ratio bandwidth of 200 MHz, exhibits a RHCP with a good cross polarization level, and achieves a 6-dB gain enhancement.

Saida Ibnyaich, Samira Chabaa, Layla Wakrim, Abdessalam El Yassini, Moha M'rabet Hassani, Abdelouheb Zeroual
Cadi Ayyad University (Morocco)

A New, compact, slotted partial ground plane, microstrip patch antenna developed for use in Ultrawide-band application is studied in this paper. The antenna has an electrical small dimensions with a good gain, a notable efficiency and a wide impedance bandwidth. Which make this antenna a good candidate for ultawide-band wireless communication, microwave imaging and radar applications as well.

16:30 - 18:20 — Auditorium I

Session 1A10
Millimeter/Terahertz and nano-optical antennas

16:30 : Invited talk
Conformal leaky-wave antennas for terahertz wireless links
Hichem Guerboukha, Rabi Shrestha, Joshua Neronha, Zhaoji Fang, Daniel Mittleman
Brown University (USA)

We explore the performance of curved leaky-wave antennas in the terahertz range. We identify two distinct regimes in whichthe far-field emission pattern varies relative to that of a planar antenna. We show that a curved multi-aperture leaky-waveantenna can be used for agile far-field beam forming, and demonstrate high-gain wireless links at gigabit-per-second data ratewith low bit error rate, in multiple directions simultaneously. This work lays the foundation for the implementation of terahertzleaky-wave structures in conformal geometries.

16:50 : Invited talk
The physics of optical patch antennas
Antoine Moreau
Université Clermont Auvergne (France)

In the last ten years, optical patch antennas have emerged as a platform allowing for a complete control of light – from huge Purcell enhancement to wavefront control. We review here the rich physics of these antennas, ranging from plasmonic slowdown of light to the impact of nonlocality on the optical response and show that a "gap-plasmon opticsçan be established, bringing a full and thorough understanding of such structures.

17:10 : Invited talk
Status and progress of millimeter-wave GaN transistors for next generation high-power radar systems
Kathia Harrouche, Sri Saran Vankatachalam, Elodie Carneiro, François Grandpierron, Farid Medjdoub
CNRS-IEMN (France)

With the development of wireless communication such as 5G or SATCOM, the need and requirements for millimeter-wave compact solid-state high power amplification has significantly increased. In this presentation, we will discuss some potential device design enabling to properly operate in the millimeter-wave range under high drain bias $textgreater$ 20 V with high performance.

17:30 : Invited talk
LTCC-Integrated Antennas for mmWave Applications
Ammar Kouki
École de Technologie Supérieure (Canada)

In this talk, the successful use of LTCC technology for the design of two novel LTCC-integrated antennas will be presented. The first design consists of a fully integrated, single fabrication, dielectric resonator antenna array operating between 27 and 31 GHz. The second design consists of a horn antenna that is vertically integrated in a thick multi-layer LTCC substrate designed for operation between 50 and 75 GHz with a WR15 feed.

17:50 : Keynote talk
Nonreciprocal Phased-Array Antenna Systems *On-line*
J. Sebastian Gomez
University of California (USA)

This talk describes the concept and experimental demonstration of nonreciprocal phased-array antennas able to exhibit (i) an independent control of their transmission and reception patterns at the same operation frequency, and (ii) nonreciprocity at the polarization level, i.e., transmit with one polarization but receive with the opposite handedness. The proposed approach can be applied to develop efficient nonreciprocal phased-array antennas across the electromagnetic spectrum and find broad applications in wireless communication and polarimetric radar and sensing systems.

16:30 - 18:40 — Auditorium II

Session 1A11
Electromagnetic theory

16:30 : Invited talk
Exact Inductance of Straight Round Wires
Hubert Anton Aebischer
LEGIC Identsystems AG (Switzerland)

This paper presents exact integral representations for the partial inductance of straight round wires in the low-frequency limit, the high-frequency limit, and at arbitrary frequency with skin effect. They are suitable for numerical integration and thus ideal for testing the accuracy of electromagnetics (EM) software on problems with curved boundaries. Further, these integrals allow the exact calculation of the inductance of circularly cylindrical vias.

16:50 : Invited talk
Single-layer representation of the field scattered by a collection of objects
Anthony Gourdin[1], **Didier Felbacq**[2]
[1] *(France),* [2] *Montpellier University (France)*

We provide a new representation of the field based on a single-layer integral. The potential has support on an arbitrary line enclosing the scatterers and can be used in a fast multipole algorithm. The results are presented in the bidimensionnal case for simplicity.

17:10 : Invited talk
Reflection and transmission coefficients at plane interfaces between transformation-optics media
Mircea Giloan
Babes-Bolyai University (Romania)

The reflection and transmission phenomena occurring at the plane interface between two transformation-optics media are analyzed. In order to compute the reflection and transmission coefficients the wave vectors and the polarizations of the incident, reflected and transmitted waves are described inside the anisotropic and inhomogeneous media at the interface plane. The reflection and transmission coefficients are derived in terms of the coordinate transformations which are describing the transformation-optics media.

17:30 : Invited talk
GSTC formulation for Maxwell's equations
Agnes Maurel[1], **Nicolas Lebbe**[1], **Kim Pham**[2]
[1] *Université de Paris (France),* [2] *Université Paris-Saclay (France)*

We revisit the classical zero-thickness Generalized Sheet Transition Conditions (GSTCs) which are a key tool for efficiently designing metafilms able to control the flow of light in a desired way.

17:50 : Invited talk
Symmetry protected and accidental bound states in the continuum in photonic-crystal structures, studied by the resonant-state expansion
Sam Neale, Egor Muljarov
Cardiff University (United Kingdom)

We apply the resonant-state expansion (RSE), a novel rigorous theoretical method in electrodynamics, to planar photonic-crystal structures, to study their eigenmodes, and in particular bound states in the continuum (BICs). Using the high efficiency of the RSE, we investigate the mode evolution with changes to the geometrical and material parameters of the system. Increasing the amplitude of the periodic modulation of the permittivity, we demonstrate formation of symmetry protected and accidental BICs in photonic-crystal structures and study their properties.

James Capers[1], **Stephen Boyes**[2], **Alastair Hibbins**[1], **Simon Horsley**[1]
[1] *University of Exeter (United Kingdom),* [2] *DSTL Porton Down (United Kingdom)*

We derive a simple and efficient method for designing wave–shaping materials composed of dipole scatterers.

We apply our theory to design aperiodic metasurfaces that re-structure the radiation from a dipole emitter in many ways. Our proposed technique is relevant to designing metamaterials for a wide class of applications, and has the key benefit of including all interactions within the system of scatterers. Additionally, we develop a clear physical interpretation of the optimised structure, by extracting 'eigen-polarizabilities' of the system.

Robert L. Gardner
Georgia Tech Research Institute (USA)

The electromagnetics community has paid a great deal of attention to field coupling to transmission lines. The transmission line models may be complex, but these models usually have linear terminations. Simulating the coupling of fields into real systems requires the application of active terminations. Such a model can be expanded to understand how energy stored in a target system can be applied to make that system fail.

16:30 - 18:15 — Auditorium III

Session 1A12
Nanophotonics, plasmonics and quantum optics

16:30 : Invited talk
Towards single-shot far-field multipole retrieval using novel integrated detectors
Johannes Butow, Jorg Eismann, Peter Banzer
Max Planck Institute for the Science of Light (Germany)

Controlled excitation and measurement of multipoles in nanoscatterers is an important task of increasing interest in nano-optics and nano-metrology. Here, we discuss the implementation of a far-field approach for the retrieval of multipolar contributions to particle scattering. We utilize a novel integrated detector capable of measuring spatial phase, polarization and intensity information. We introduce the multipole retrieval scheme and discuss the main building-blocks of the novel detector, paving the way towards intriguing applications in nano-metrology, microscopy and imaging.

16:50 : Invited talk
Magnetoplasmonic nanocavities for the enhanced magnetic control of light polarization via hybridization with dark plasmons *On-line*
Paolo Vavassori[1], Andrey Chuvilin[1], Alberto Lopez-Ortega[2], Nicoló Maccaferri[3], Mario Zapata-Herrera[4], Matteo Pancaldi[5]
[1] *CIC nanoGUNE BRTA (Spain),* [2] *Universidad Pública de Navarra (Spain),* [3] *University of (Luxembourg),* [4] *Materials Physics Center (Spain),* [5] *Elettra Synchrotron Trieste (Italy)*

Enhancing magneto-optical effects is crucial for size reduction of key photonic devices based on non-reciprocal propagation of light and to enable active nanophotonics. Here, we disclose an approach that exploits multipolar Fano resonances excitable in symmetry broken magnetoplasmonic nanocavities and arising from the hybridization of dark plasmons with dipolar plasmonic resonances to achieve an unprecedented amplification of magneto-optical activity.

17:10 : Invited talk
Surface Enhanced Visible Absorption of Dye Molecules in the Near-Field of Gold Nano-Antennas
Zouheir Sekkat
University Mohammed V (Morocco)

Surface enhanced absorption was clearly reported to occur in the infrared region of the spectrum of light. In this presentation, we show that it also occurs in the visible region of the spectrum by using a dye, i.e. an azo-dye, which exhibits a good light absorption in that region, and gold nanoparticles, which act as plasmonic nanoantennas, when the azo-dyes and the nanoparticles are incorporated in the bulk of solid films of polymer.

Shiva Hayati Raad, Zahra Atlasbaf
Tarbiat Modares University (Iran)

Graphene-coated spherical particles are used as optical dimers/trimers. Assembling various particles enhan-

ces their performance due to the hybridization of plasmons. To obtain a quantitative insight into the performance, the modified Mie-Lorenz coefficients for a single layer spherical shell is used to obtain the polarizability of it. Unlike single spherical particles, the optical response in dimers is polarization and angle-dependent. By introducing asymmetry to the dimer i.e., designing a heterodimer, the performance is further improved for higher incident angles.

Oleksandr Buchnev[1], **Alexandr Belosludtsev**[2], **Victor Reshetnyak**[3], **Dean R. Evans**[4], **Vassili A. Fedotov**[1]
[1] *University of Southampton (United Kingdom),* [2] *Center for Physical Sciences and Technology (Lituania),* [3] *Taras Shevchenko National University of Kyiv (Ukraine),* [4] *Air Force Research Laboratory (USA)*

We demonstrate experimentally that Tamm plasmons can be supported by a dielectric mirror interfaced with a metasurface, a discontinuous thin metal film periodically patterned on the sub-wavelength scale. Not only do Tamm plasmons survive the nano-patterning of the metal film, but they also become sensitive to external perturbations, as a result. In particular, by depositing a nematic liquid crystal on the outer side of the metasurface we were able to red-shift a Tamm plasmon by 35 nm.

Pedro Mendes Ruiz[1], **Xavier Begaud**[2], **François Magne**[3], **Etienne Leder**[1]
[1] *Bowen ERTE-ETSA (France),* [2] *Télécom Paris (France),* [3] *When-AB (France)*

This work presents the design of a linear array of microstrip rectangular patch antennas with a cosecant squared elevation radiation pattern. This linear array is one of the elements of a passive radar using signals from 4G base stations for UAV detection. The array is designed to operate from 2.62 GHz to 2.69 GHz.

Wednesday 25th May, 2022

8:30 - 10:30 — Auditorium I

Session 2A1
Nanophotonics, plasmonics and quantum optics

08:30 : Keynote talk
Field- and Carrier-Enabled Nonlinear Nanophotonics
Wenshan Cai
Georgia Institute of Technology (USA)

The active manipulation of optical properties via external stimuli and the nonlinear wave-mixing of light with controlled means are among compelling research directions in nanophotonics. In this talk, we explore active and nonlinear plasmonic metamaterials by leveraging the field-induced disruption of the inversion symmetry for second-order optical processes, and exploiting the hot-carrier-induced perturbation in structured optical media for ultrafast all-optical modulation and nonlinear signal generation.

09:00 : Invited talk
Electromagnetic Asymmetry Enhanced Second-Harmonic Generation in a Symmetry-Broken Plasmonic Nanocavity
Dangyuan Lei
City University of Hong Kong (China)

Plasmonic particle-on-film nanocavities, comprising metal nanoparticles closely separated from a thin metal film by a nanometric dielectric gap, support hybridized plasmon modes with extremely small mode volume and strongly enhanced local field. In this talk, I will discuss a new mechanism for second-harmonic generation (SHG) enhancement in single symmetry-broken plasmonic nanocavities, i.e., the light-induced electromagnetic asymmetry.

Yi Huang[1], **Xiyuan Cao**[1], **Xiaowei Lu**[1], **Jiang Peng**[1], **Jin Yi**[2], **Aimin Wu**[1]
[1] *Chinese Academy of Sciences (China),* [2] *Zhejiang University (China)*

Reduced SrTiO3 (r-STO) with large Seebeck coefficient is promising for high-performance photothermoelectric (PTE) photodetector. However the response time of bulk r-STO photodetector is on second scale. Here we use subwavelength nanophotonic structures to enhance light absorption and decrease the response time of r-STO PTE photodetector to microsecond scale in long-wavelength infrared (LWIR) region. Moreover, with arranged Au disk array of different radius, we obtain an ultrabroadband absorber whose bandwidth covers the whole LWIR range with more than 60 % absorption.

Andrea Mancini[1], **Christopher R. Gubbin**[2], **Rodrigo Berte**[1], **Alberto Politi**[2], **Yi Li**[3], **Simone De Liberato**[2], **Stefan A. Maier**[1]
[1] *LMU Munich (Germany),* [2] *University of Southampton (United Kingdom),* [3] *Southern University of Science and Technology (China)*

Surface Phonon Polaritons (SPhPs) can be excited in the Reststrahlen band of polar dielectrics where the dielectric function is negative. Antennas supporting SPhPs are an alternative to plasmonic resonators in the infrared, due to their reduced losses and higher field confinement. We investigate the near-field response of arrays of Silicon Carbide antennas by means of scattering scanning near field microscopy. Knowledge of the near-field response is needed for many applications requiring coupling of the antennas to other elements.

09:50 : Invited talk
Towards efficient detection and spectroscopy of photons emitted by Er3+ ions in silicon
Attilio Zilli[1], **Michele Castriotta**[1], **Michele Celebrano**[1], **Giorgio Ferrari**[1], **Lamberto Duo**[1], **Marco Finazzi**[1], **Enrico Prati**[2]
[1] *Politecnico di Milano (Italy),* [2] *Consiglio Nazionale delle Ricerche (Italy)*

We develop a highly sensitive apparatus for efficient room temperature detection of the emission by Er3+ ions

co-implanted with oxygen atoms in a Si substrate. Our setup proves to be capable of detecting a lower bound value for the emission intensity of about 104 photons/s, corresponding to an ion surface concentrations down to 1012 cm-2. Yet, the open challenge we aim here is to retrieve the spectroscopic fingerprint of Er3+ with high resolution at these low concentrations.

10:10 : Invited talk
Temporal dynamic of strongly coupled epsilon-near-zero media
Mehdi H. Ebrahim[1], Andrea Marini[2], Nathaniel Kinsey[3], Jacob B. Khurgin[4], Lucia Caspani[5], Marcello Ferrera[6], Vladimir M. Shalaev[7], Alexandra Boltasseva[7], Daniele Faccio[1], Matteo Clerici[1]
[1] University of Glasgow (United Kingdom), [2] University of L'Aquila (Italy), [3] Virginia Commonwealth University (USA), [4] Johns Hopkins University (USA), [5] University of Strathclyde (United Kingdom), [6] Heriot-Watt University (United Kingdom), [7] Purdue University (USA)

We shall present an overview of our recent investigations into the time-dependent effects observed in transparent conductive oxides photoexcited at the epsilon near zero point. We will then discuss the role of the epsilon-near-zero mode in establishing the temporal dynamics in strongly coupled plasmonic systems.

8:30 - 10:30 — Metamaterials and metasurfaces

Session 2A2

GEN205

08:30 : Invited talk
Simultaneously photonic and phononic metamaterials *On-line*
Oliver B. Wright[1], Motonobu Tomoda[1], Osamu Matsuda[1], Ting Zhang[2], Tetsuya Ueda[3]
[1] Hokkaido University (Japan), [2] Nanjing University of Information Science and Technology (China), [3] Kyoto Institute of Technology (Japan)

Metamaterials have been primarily studied in electromagnetics and acoustics to date. In the fields of photonic and phononic crystals, structures simultaneously exhibiting both optical and acoustic—so-called phoXonic—properties—have been proposed, but this has not been done for metamaterials. Here we propose the concept of a phoxonic metamaterial, and demonstrate a working design in the GHz electromagnetic and kHz acoustic range that can simultaneously exhibit negative electromagnetic refraction at the same time as negative acoustic refraction.

08:50 : Invited talk
Nano-fabrication based Electromagnetic Devices with Cross-wavelength Wide Range Applications
Su Xu[1], Fu-Yan Dong[1], Wen-Rui Guo[2], Wen-Ming Su[2], Hongsheng Chen[3], Hong-Bo Sun[1]
[1] Jilin University (China), [2] Chinese Academy of Sciences (China), [3] Zhejiang University (China)

Metamaterials have been widely studied in last decades. Here we present our recent progress on metamaterials and integrated metadevices that exhibits multiple functions over cross-wavelength wide ranges, including absorbers, selective emitters and cloaks. Based on nano-fabrication techniques, multilevel geometrical profiles can be achieved in practice. We will talk about our design recipe on how to realize cross-wavelength meta-devices with divergent functions as well.

09:10 : Invited talk
Generation of tunable order Bessel beams with cascaded metasurfaces *On-line*
Yan Zhang[1], Guocui Wang[1], Bin Hu[2], Xinke Wang[1]
[1] Capital Normal University (China), [2] Beijing Institute of Technology (China)

A variorder Bessel beam generator is experimentally demonstrated with two metasurface devices. Two cascading metasurfaces are employed to generate Bessel beams in the terahertz range. The order of generated Bessel beam can be turned by rotating the metasurface. The order of the Bessel beam is changed from zero-order to fourth-order when the rotation angle of metasuface components from 20 degrees to 80 degrees.

09:30 : Invited talk
Non-Hermitian THz metasurfaces based ultra-sensitive sensing *On-line*

Teun-Teun Kim, Soojeong Beak, Hosub Lim, Sang Hyun Park, Bumki Min
University of Ulsan (Korea)

Since the sensitivity around EPs is significantly enhanced, Non-Hermitian photonics has become an emerging research area that has been extensively studied in different spectral regions using various optical systems. Here, we demonstrate sensing of amyloid-beta (Aβ) protein, a well-known precursor for Alzheimer's disease by an abrupt phase transition near an exceptional point in non-Hermitian¬ metasurfaces.

09:50 : Invited talk
Development of Three-Dimensional Fabrication Technologies Using Laser Processing and 3D Printing for Terahertz Optics Production *On-line*
Kuniaki Konishi
The University of Tokyo (Japan)

Lithography techniques conventionally used to make artifical strucutres can only make quasi-two-dimensional structures. We are developing new technologies which makes it possible to produce a three-dimensional artificial structure with a resolution of several tens of micrometers smaller than the wavelength of the THz wave. In this talk, I introduce the development of three-dimensional artificial structures for THz wave control fabricated by using laser processing and 3D printing technologies.

10:10 : Invited talk
Recent progress in the frequency selective metasurfaces in mid infrared wavelength *On-line*
Yoshiaki Nishijima, Naoki To
Yokohama National University (Japan)

Here we summarized the recent progress of plasmonic meta surfaces in mid infrared wavelength region. The experimentally measured optical properties were com- pared with simulations by Finite difference time-domain calculations. Also, we demonstrate applications of these structures for the plasmonic IR-light sources and detec- tors.and another sensing devices.

8:30 - 09:25 — Auditorium III

Session 2A3
Measurement and Characterization Techniques

08:30 : Invited talk
Real-time measurement system using multi-wavelength THz-wave parametric generation and detection
Kosuke Murate, Kodo Kawase
Nagoya University (Japan)

In this study, we achieved real-time identification of reagents using combination of machine learning and simultaneous generation and detection of multiwavelength terahertz (THz) waves by injection seeded terahertz wave parametric generator (is-TPG).

Alireza Kazemipour, Johannes Hoffmann, Michael Wollensack, Daniel Stalder, Juerg Ruefenacht, Markus Zeier
Federal Institute of Metrology (METAS) (Switzerland)

In-waveguide measurements are usually challenging at THz frequencies because of dimensional restrictions. Corrugated horn antenna is studied to show its capabilities (and limits) as WG to free-space mode convertor. Results are presented in terms of energy transfer to an open-surface detector and TEM propagation mode on-and-near the antenna aperture. This paper shows the feasibility of using such antennas in 75-110GHz and 500-750GHz bands for power measurement and material characterization with the estimation of systematic and random errors.

09:05 : Invited talk
Biological Effects of Radiations and Telecommunications

Sara Liyuba Vesely[1], **Alessandro Alberto Vesely**[2], **Sibilla Renata Dolci**[3], **Caterina Alessandra Dolci**[4], **Marco Emilio Vesely**[2]
[1] *ITB-CNR (Italy),* [2] *TANA (Italy),* [3] *UNIMI-VESPA (Italy),* [4] *UNIMI (Italy)*

Accepting that the Sun doesn't foster life just by heating, it can be asked if telecommunications technologies can possibly contribute to the endeavor of clarifying the borderline between beneficial and harmful effects of radiation in a more effective way than by dosimetry.

9:25 - 10:40 — Auditorium III

Session 2A4
Antenna theory and design

09:25 : Invited talk
Design and Fabrication of ceramic-based antennas
Wenzhong Lu, Xiao Chuan Wang, Yi Hui Lou
Huazhong University of Science and Technology (China)

With the rapid development of modern wireless communication systems, ceramic antennas have received increasing attention due to their miniaturization, high durability, high power capacity and high sensitivity. we presented a novel method for realizing flat Luneburg lenses for antenna applications. The method we described includes ceramic Stereolithography, metamaterial structure and optical coordinate transformation. We experimentally validate our design methodology by fabricating and characterizing a flat Luneburg lenses whose operation frequency is at Ku-band (12-18GHz) with antenna gains of 18dBi.

09:45 : Invited talk
Recent Advances in Conformal Transmitarrays
Peiyuan Qin, Y. Jay Guo
University of Technology Sydney (Australia)

This talk will give an overview of research on conformal transmitarrays conducted in University of Technology Sydney, Australia. More specifically, it includes our latest progress in high efficiency conformal transmitarrays and multi-beam conformal transmitarrays.

10:05 : Invited talk
Reconfigurable Intelligent Surfaces for Future Wireless Communication
Qammer H. Abbasi
University of Glasgow (United Kingdom)

A novel idea of a smart reflector that is gaining a lot of interest is the Reconfigurable Intelligent Surface (RIS) which operates by reflecting the waves in the same way as a backscattering device. It consists of planar, low cost, nearly passive elements that would smartly manipulate EM waves in specific directions. In this talk, I will discuss about the work on this topic in our group and different testbeds and their results.

Abinash Gaya, Mohd Haizal Jamaluddin
Universiti Teknologi Malaysia (Malaysia)

A microstrip line coupled probe fed Rectangular Dielectric resonator antenna has been proposed here with wideband width for millimeter wave 5G applications. The designed antenna generates circular polarization with wideimpedance bandwidth (26.84GHz -23.30GHz) of 13.61 % centered at 26GHz. A conformal strip is used over the Dielectric resonator to drive the distributed fields. A microstrip line is placed close to the probe where the coupling occurs. The simulated gain of the antenna is 5.83dBi .

Coffee Break

Session 2P1

Poster session III

10:30 - 11:00

Xin Dai, Kwai-Man Luk
City University of Hong Kong (China)

A wide band low profile magneto-electric (ME) dipole working in millimeter wave band is presented in this paper. Different from conventional ME dipoles using the vertical wall as magnetic dipoles, the proposed antenna's magnetic dipole is composed of the aperture between the patches of the electric dipole. As a result, the profile of the ME dipole can be much lower than conventional ones. The proposed ME dipole antenna is fed through the ground slot by the substrate integrated coaxial line (SICL), which can significantly enhance the backside lobe performance. A simulated impedance bandwidth of 48.5 % (26-42 GHz) and a gain up to 9 dBi can be achieved with a profile of about 0.12 $\lambda 0$. Additionally, symmetric radiation patterns with back lobe lower than -23 dB over the operating band can be obtained. With the advantage of wide working band, low profile and low backside radiation, the proposed antenna would a good candidate for millimeter wave antenna in package (AiP) applications.

Abinash Gaya, Mohd Haizal Jamaluddin
Universiti Teknologi Malaysia (Malaysia)

A ring slot fed ultra-wide band Dielectric Resonator Antenna (DRA) has been designed here which can be used for band 30 (23GHz-28GHz) of 5G applications .The simulated gain of the antenna is 6.42dBi with radiation efficiency of 93 percentage .A circular aperture has been made on the ground plane which excites the DRA with the wide aperture .The simulated bandwidth of the antenna is 6.2GHz(24.6 GHz -30.8GHz) .

N. Suguna[1], S. Revathi[1], Ch. Murali Krishna[2]
[1] VIT University (India), [2] PDPM IIIT Design and Manufacturing (India)

Four element Aspen modeled MIMO antenna printed on Rogers RT Duroid 5880™ substrate and its compact size is 20mm x 23mm. The proposed antenna produce operating bandwidth of 23.66GHz (4.12 to 27.78GHz) and FBW is 148.33 %. Proposed antenna has isolation greater than -20dB in the operating SWB and VSWR is less than threshold value 2 in the obtained SWB range. Peak gains at selected frequencies 4.8GHz, 8GHz, 14.1GHz, 16.2GHz and 23.6GHz are 3.16dBi, 5.19dBi, 5.82dBi, 5.13dBi and 6.98dBi respectively.

Noaman Naseer, Suleyman Kamaci, Burak Guçluoğlu, Birsen Saka
Hacettepe University (Turkey)

In this research, a square unit cell for X-band reflectarray on molded silicone substrate is investigated for phase curve characteristics. The square patch is simulated in CST and unit cell analysis is done by using the waveguide method. Three different unit cells with copper, conductive textile, and conductive ink are fabricated and tested for return loss and phase characteristics and results are compared with a simulated one.

Abdelhakim Adli, Marta Cabedo-Fabrés, Miguel Ferrando Bataller
Universitat Politècnica de València (Spain)

This paper presents a Planar Inverted-F Antenna (PIFA) design for a smartwatch application, optimized to operate on the 2.4 GHz Bluetooth frequency band, on the proximity of the human forearm. . By a multi-layer substrate, half air half rubber we obtain a return loss of -20 dB is obtained at 2.4 GHz, and an efficiency of -5 dB, which represents a good efficiency taking into account the effect of the human forearm.

Hind Kantas, My Abdelkader Youssefi, Ahmed Mouhsen, Rachid Dakir
Hassan I University (Morocco)

Advances in digital electronics and circuit integration have led to miniature and more efficient systems with low energy consumption. However, conventional battery power supply techniques remain difficult to envisage in some applications because they are limited in autonomy and require periodic replacement. In order to make these systems more energy independent and increase battery life, electromagnetic energy recovery

systems called Rectenna.[a]re a very interesting alternative, they capture this energy and convert it into useful continuous power

Asma Oubellouch, My Abdelkader Youssefi, Ahmed Mouhsen, Rachid Dakir
Hassan I University (Morocco)

Wireless local area networks WLANs are facing a challenge due to the need for higher transmission rates higher capacity and better quality of service MIMO technology has become increasingly important in terms of performance for wireless communication systems This work consists of a detailed analysis of the Alamouti system and the usefulness of diversity and its exploitation in a WIFI system This suggestion improves the performance of the WLAN system using Alamouti scheme

11:00 - 12:30 — Auditorium I

Session 2A5
Nanophotonics, plasmonics and quantum optics

11:00 : Keynote talk
Plasmonic Heterodyne Terahertz Receivers with Quantum-Level, Sensitivity at Room Temperature
Mona Jarrahi
UCLA (USA)

We introduce a terahertz receiver that uses plasmonic photomixing for frequency downconversion to offer quantum-level sensitivities at room temperature for the first time. Frequency downconversion is achieved by mixing terahertz radiation and a heterodyning optical beam with a terahertz beat frequency in a plasmonics-enhanced semiconductor active region. With a versatile design capable of broadband spectrometry, over a 0.1-5 THz bandwidth, we demonstrate receiver sensitivities down to 3 times the quantum-limit at room temperature.

11:30 : Invited talk
Dynamically Tuneable Conducting Polymer Nanooptics *On-line*
Magnus Jonsson
Linkoping University (Sweden)

I will present our recent research showing that organic conducting polymers can be used as a new type of materials for dynamically tuneable nanooptics, including chemically and electrically controlled plasmonic nanoantennas

11:50 : Invited talk
Optoinduced magnetization from the spin and orbital angular momenta of light
Vahe Karakhanyan, Clément Eustache, Yannick Lefier, Thierry Grosjean
University of Bourgogne - Franche-Comté (France)

We provide a spin and orbital angular momentum representation of the inverse Faraday effect in a metal. We analytically show the role of the spin and orbital angular momenta of light, as well as the spin-orbit interaction (SOI), in the generation of an optoinduced magnetization. We also show that resonances in plasmonic nanoantennas enhance and confine the IFE, thereby leading to static magnetic fields directly applicable in a vast application domain including all-optical magnetization switching and spin-wave excitation.

12:10 : Invited talk
Scalable and efficient photonic designs using disordered metamaterial nanounits
Ekmel Ozbay
Bilkent University (Turkey)

We explored the material and architecture requirements for the realization of light perfect absorption using these metamaterial designs from ultraviolet (UV) to far-infrared (FIR) wavelength regimes. This, in turn, opens up the opportunity of the practical application of these perfect absorbers in large scale dimensions. We adopted these lithography-free techniques in many applications including photoelectrochemical water splitting,

photodetection, light emission, sensing, filtering and thermal camouflage.

11:00 - 12:35 — Auditorium II

Session 2A6
Electromagnetics and materials

11:00 : Invited talk
Integrated microresonator frequency comb source for massive-parallel optical communication
Takasumi Tanabe, Soma Kogure, Shun Fujii
Keio University (Japan)

We demonstrated ultra-dense wavelength-division multiplexing (WDM) data transmission using an intensity modulation and direct detection (IM-DD) scheme. We discuss the feasibility of SiN and MgF2 microresonators for WDM applications regarding output power, bandwidth, and required pumping power. In addition, we discuss that IM-DD communication is relevant to the next-generation optical communication that requires ultra-low latency.

11:20 : Invited talk
Towards Robust Optical Data Processing with Photonic Integrated Circuits
Jian Wang
Huazhong University of Science and Technology (China)

In this talk, we review recent advances in robust optical data processing using silicon PICs: 1) On-chip reconfigurable optical full-field manipulation for grooming photonic signal processor (reconfigurable optical add/drop multiplexer, filter), 2) On-chip mesh-structure-enabled programmable multi-task photonic signal processor (filter, delay, router, switch), 3) On-chip multi-dimensional (mode, polarization, wavelength) selective switch, 4) On-chip intelligent mode switching in fiber-chip-fiber communication systems.

11:40 : Invited talk
Towards far-field multipole retrieval with a reconfigurable photonic integrated circuit
Johannes Butow, Jorg Eismann, Varun Sharma, Dorian Braandmuler, Peter Banzer
University of Graz (Austria)

Controlled excitation and measurement of multipoles in nanoscatterers is an important task of increasing interest in nano-optics and nano-metrology. Here, we discuss the implementation of a far-field approach for the retrieval of multipolar contributions to particle scattering. We utilize a reconfigurable photonic integrated circuit capable of measuring spatial phase, polarization and intensity information. We introduce the multipole retrieval scheme and discuss the main concepts of this novel detector, paving the way towards intriguing applications in nano-metrology, microscopy and imaging.

Vivek Chaudhary[1], Petr Neugebauer[2], Omar Mounkachi[3], Salma Lahbabi[4], Abdelouahed Elfatimy[1]
[1] Mohammed VI Polytechnic University (Morocco), [2] Brno University of Technology (Czech Republic), [3] Mohammed V University (Morocco), [4] University Hassan II (Morocco)

Herein, we present the enormous capabilities of the most recent rediscovered 2D material named black phosphorous (BP). It offers a solution for several technological limitations that appears in conventional 2D materials such as transition metal dichalcogenides/oxides etc. In the present work, we have demonstrated the electronic and optoelectronic properties of BP via realizing field effect transistors.

12:15 : Invited talk
Engineering of the extremely high Q factor in two subwavelength dielectric disks
Evgeny Bulgakov, Konstantin Pichugin, Almas Sadreev
Kirensky Institute of Physics (Russia)

We study a ways to achieve extremely high-Q factor in two subwavelength dielectric coaxial disks through destructive interference ofleaking resonant modes of each disk. By two-parametric avoided crossing, the aspect ratio and distance between disks we manage to enhance the Q-factor by two orders.

11:00 - 11:40 — Auditorium III

Session 2A7
Metamaterials and metasurfaces

11:00 : Invited talk
Multiphysics simulations for phase change material based nanophotonics
Dmitry Chigrin
RWTH Aachen University (Germany)

The growing demand on reconfigurability in neuromorphic computing, quantum computing and microwave photonics is attracting increasing attention towards design and optimization of active integrated photonic components. Phase change materials are materials in which phase transitions can be induced quickly and reversibly, resulting in pronounced changes of their physical properties. In this presentation we report on recent developments and applications of a multiphysics description of phase change material based nanophotonic systems.

11:20 : Invited talk
Manipulating Circularly Polarized Optical Radiation with Functional Metasurfaces
Fei Ding
University of Southern Denmark (Denmark)

Metasurfaces have the potential to emerge as essential components for classical and nonclassical optical fields. In this talk, I will first present two examples on how to use metasurfaces to design quarter-wave plates that can not only allow broadband circular-to-linear polarization conversion but also generate vector vortex beams or function as a versatile beam splitter. After that, I will talk about a conceptually new approach to the room-temperature generation of circularly polarized, well-collimated single photons.

12:00 - 12:40 — Auditorium III

Session 2A8
Millimeter/terahertz and UWB propagation

12:00 : Invited talk
Non-linear THz studies at the TeraFERMI beamline
Andrea Perucchi
Elettra - Sincrotrone Trieste (Italy)

The THz fields are used to achieve THz control of matter and to push materials well into their nonlinear regime. THz nonlinearities are particularly pronounced in Dirac materials, because of their non-conventional band-structure properties. We report here on the THz nonlinear electrodynamics of the topological insulator Bi2Se3 and on layered black phosphorus, thus highlighting the role of band dispersion in shaping the nonlinear properties.

12:20 : Invited talk
A Terahertz Polarization Splitter Using a Hybrid Plasmonic Waveguide *On-line*
Jun Shibayama, Arata Yamamoto, Junji Yamauchi, Hisamatsu Nakano
Hosei University (Japan)

We investigate a waveguide-based polarization splitter in the terahertz (THz) region, in which a hybrid plasmonic waveguide and a dielectric waveguide are placed in parallel. The eigenmode analysis of each waveguide shows that the phase matching condition is satisfied for the quasi-TE mode and not for the quasi-TM mode, leading to a TM-pass polarizer. The device length is also predicted with the analysis of the supermode of the parallel waveguide.

Lunch

12:30 - 14:00

14:00 - 16:00 — Auditorium I

Session 2A9

Metamaterials and metasurfaces

14:00 : Keynote talk
Software-defined reconfigurable metasurfaces for programmable wireless environments
14:00 : Invited talk
Software-defined reconfigurable metasurfaces for programmable wireless environments
Maria Kafesaki, O. Tsilipakos, Ch. Liaskos
Foundation for Research and Technology Hellas (Greece)

Programmable reconfigurable metasurfaces are expected to constitute a key element in the future programmable wireless environments. Here we discuss the design and fabrication of a programmable, reconfigurable and multifunctional metasurface able to operate as all-angle perfect absorber, beam steering and beam focusing device, accounting also for all aspects imposed by the programmability incorporation.

14:20 : Invited talk
Optomechanics of ultra thin photonic metasurfaces *On-line*
Ognjen Ilic
University of Minnesota (USA)

We show how the ability of metasurfaces to steer and bend light can be harnessed to shape optomechanical forces. We discuss the potential of metasurfaces as ideal platforms for optomechanics because of their large-area and lightweight form. Such metasurface control of optical forces could lead to novel approaches to optical levitation and propulsion at the macro scale.

14:40 : Invited talk
Detecting Spatially Incoherent Illumination with Metallic Metasurfaces
Thomas Frank, Oleksandr Buchnev, Tamsin Cookson, Malgosia Kaczmarek, Pavlos Lagoudakis, Vassili A. Fedotov
University of Southampton (United Kingdom)

We report on a discovery that homogeneous metallic non-diffracting metamaterials of a certain type respond differently to spatially coherent and incoherent illumination, enabling robust speckle-free discrimination between different degrees of coherence. The effect has no direct analogue in natural optical materials and may find applications in compact metadevices enhancing imaging, vision, detection, communication and metrology.

15:00 : Invited talk
Generalized Snell-Descartes laws for metasurfaces made by scatterers
Emmanuel Rousseau, Didier Felbacq
Université de Montpellier (France)

This talk will discuss the relevance of the generalized laws of reflection and refraction for metasurfaces. We discuss in detail their derivation starting from questioning the original proof. We discuss diffractive metasurfaces made of scatter- ers. We conclude that generalized Snell-Descartes laws can be defined but differ from the ones reported in the literature.

15:20 : Invited talk
Forward and Inverse Design of Electromagnetic Metasurfaces
Willie John Padilla, Simiao Ren, Jordan M. Malof
Duke University (USA)

The demonstration of exotic electromagnetic metasurfaces has benefited from the advance of computational

electromagnetic simulations and the continued maturation of nanolithography. Recently, deep learning has shown a unmatched ability for the forward and inverse design of electromagnetic metasurfaces. I will overview this exciting and rapidly expanding area of research, highlighting novel examples and provide an outlook.

15:40 : Invited talk
Breaking the limit of emission suppression in low contrast 3D media
Meraj E. Mustafa[1], Lukas Maiwald[1], Soumyadeep Saha[1], Mikhail S. Sidorenko[2], Ruslan R. Yafyasov[2], Mikhail V. Rybin[2], Manfred Eich[2], Alexander Y. Petrov[1]
[1] *Hamburg University of Technology (Germany),* [2] *ITMO University (Russia)*

Light emission can be significantly suppressed in 3D photonic crystals at the frequency of a photonic band gap but a refractive index contrast above 1.8 is needed. We present 3D quasiperiodic structures that can significantly reduce the density of states even at lower index contrasts. The suppression of 10 dB is demonstrated in simulations with refractive index contrast of 1.4. A refractive index contrast of 1.6 is investigated experimentally in microwave regime.

14:00 - 16:05 — Auditorium II

Session 2A10
Electromagnetics and materials

14:00 : Invited talk
Full-Wave Optimization and Design of Nanoparticle Arrays for Various Nano-Optical Applications
Ozgur Ergul
Middle East Technical University (Turkey)

Rigorous optimization and design of nanoparticle arrays for diverse nano-optical applications, such as coupling, beamshaping, and focusing, using a full-wave optimization environment are presented. An implementation of MLFMA, which is developed for accurate and efficient computations of plasmonic interactions in three-dimensional structures, is integrated into a module of genetic algorithms to perform reliable optimization trials and to reach optimal designs for desired electromagnetic characteristics.

14:20 : Invited talk
Accurate and Efficient Analysis of the Electromagnetic Scattering from a thin disk *On-line*
Mario Lucido
University of Cassino and Southern Lazio (Italy)

In this paper, the analysis of the scattering from a thin disk is formulated as a set of one-dimensional integral equations in the vector Hankel transform domain. Galerkin method with a complete set of orthogonal eigenfunctions of the static part of the integral operator, reconstructing the physical behavior of the fields, as expansion basis, leads to fast converging Fredholm second-kind matrix equations.

Mohammed Kanjaa, Otman El Mrabet, Mohsine Khalladdi
Abdelmalek Essaadi University (Morocco)

A transmission line method (TLM)algorithm is proposedfor electromagnetic (EM) wave propagation in biologicaltissues with the Cole-Cole dispersion Model. A linear behaviorof the polarization current during the time step is assumed.The polarization current density is approached usingLagrange extrapolation polynomial, and the fractionalderivation is obtained according to Riemann definition. Reflectioncoefficients at an air/muscle interfaces simulated ina 1-D domain are found in good agreement with those obtainedfrom the analytic model.

Zoltan Sztranyovszky, Wolfgang Langbein, Egor A. Muljarov
Cardiff University (United Kingdom)

We present an accurate first order perturbation theory for the electromagnetic eigenmodes of a resonator, which is based on the spectral representation of the Green's dyadic. We show that when the resonator boundary is deformed, higher-order terms of the standard perturbation series can contribute to the eigenmode frequencies in first-order in the deformation depth. This is a consequence of the vectorial nature of the elec-

tromagnetic field and the infinite degeneracy of static modes of the resonator.

15:10 : Invited talk
Coupling Between Surface Acoustic Waves and Localized Plasmons in Pillared Phononic Crystals
On-line

Bahram Djafari Rouhani[1], **Noual Adnane**[2], **Rock Akiki**[1], **Yan Pennec**[1], **El Houssaine El Boudouti**[2]
[1] *University of Lille (France),* [2] *Université Mohamed Premier (Morocco)*

We present a theoretical study of the interaction between surface (Sezawa) acoustic waves propagating at the surface of a multilayer structure supporting Au pillars with the metal-insulator-metal (MIM) type plasmons localized between each pillar and a Au film underneath. The strength of the coupling is evaluated from the modulation of plasmonic properties by the acoustic waves. The highest coupling rates are obtained for a compressional mode of the pillars and for some of the propagating Sezawa modes.

Youness Akazzim[1], **Lluis Jofre Roca**[2], **Otman EL Mrabet**[1]
[1] *Abdelmalek Essaadi University (Morocco),* [2] *Technical University of Catalonia (Spain)*

In this paper, we present a cylindrical microwave imaging system based on a multi-frequency bi-focusing (MFBF) imaging technique using Extended Gap Ridge Horn antenna (EGRH) probe for medical applications. The proposed probe antenna is designed to operate between 0.5 GHz to 1 GHz and filled with a high permittivity material to have an impedance match to the human body. This system has been successfully simulated using CST Microwave studio

15:45 : Invited talk
Transverse-Magnetic Wave Propagation in a Plane Waveguide Filled with Anisotropic Kerr Medium: Essentially Nonlinear Guided Regime

Dmitry Valovik
Penza State University (Russia)

Propagation of electromagnetic waves in a waveguide filled with anisotropic Kerr medium is considered. The nonlinearity involves two non-negative parameters. If both parameters are zeros, then one arrives at a linear problem that has a finite number of eigenwaves. If the first parameter is positive and the second one is nonnegative, then the nonlinear problem has infinitely many solutions, only a finite number of these solutions have linear counterparts. This predicts existence of an essentially nonlinear guided regime.

14:00 - 16:05 — Auditorium III

Session 2A11
Nanophotonics, plasmonics and quantum optics

14:00 : Invited talk
Integrated single photons sources based on tapered optical nanofibers

Alberto Bramati
Sorbonne Université (France)

We present the optical and quantum properties of highly efficient perovskite nanocubes and discuss our strategy towards a compact integrated single photon source.

14:20 : Invited talk
Heterogenously integrated Gallium phosphide optomechanical oscillator on Soi waveguides

Robert Horvath[1], **Giuseppe Modica**[2], **Inès Ghorbel**[2], **Grégoire Beaudoin**[2], **Konstantinos Pantzas**[2], **Isabelle Sagnes**[2], **Aude Martin**[2], **Alfredo de Rossi**[3], **Sylvain Combrié**[3], **Rémy Braive**[2]
[1] *CNRS-C2N (France),* [2] *C2N - CNRS (France),* [3] *(France)*

We present a one dimensional photonic crystal, made of GaP, as an optomechanical oscillator with low phase noise heterogenously integrated on Silicon-on-Insulator circuitry. The mechanical oscillation at 3.35 GHz is directly imprinted on the optical carrier. An external opto electronic feedback loop with time-delay is constructed to further stabilize the oscillation. We achieved a phase noise of -111dBc/Hz at 100 kHz offset

frequency with sub-Hz linewidth of 0.67 Hz.

Daniil A. Shilkin[1], Dmitry N. Gulkin[1], Anna A. Popkova[1], Vsevolod I. Avilkin[1], Dmitry V. Obydennov[1], Kestutis Kurselis[2], Denis M. Zhigunov[3], Boris I. Afinogenov[1], Evgeny V. Lyubin[1], Vladimir O. Bessonov[1], Boris N. Chichkov[2], Andrey A. Fedyanin[1]
[1] *Lomonosov Moscow State University (Russia),* [2] *Leibniz University Hannover (Germany),* [3] *Skolkovo Institute of Science and Technology (Russia)*

Femtosecond laser printing allows the creation of spherical nanoparticles on a wide range of substrates. Here we apply this technique to fabricate Mie-resonant color-routing nanoantennas. First, we place single silicon particles on a dielectric multilayer and demonstrate color-selective directional excitation of Bloch surface waves. Second, we create asymmetric dimers of silicon nanospheres that provide color-selective directional scattering of evanescent waves. Our results highlight the potential of laser printing as an advanced fabrication technique for integrated optics.

14:55 : Large-area self-assembly of anisotropic Palladium nanostructures for SERS applications *On-line*
Mohammad Navvabpour[1], Pierre Michel Adam[1], Safi Jradi[1], Suzanna Akil[2]
[1] ***University of Technology of Troyes (France),*** [2] ***University of Lorraine (France)***

Here, we report for the first time a facile one-step fabrication route of anisotropic palladium nanoparticles (Pd NPs) with high SERS performance by polymer self-assembly.

15:10 : Invited talk
Floquet Topological Electromagnetics
Harish Krishnaswamy
Columbia University (USA)

In this paper, we unveil a new route to photonic Floquet TIs, based on quasi-electrostatic wave propagation in switched capacitor networks. This approach enables the first experimental demonstration of a non-reciprocal Floquet TI for electromagnetic waves, additionally offering an ultra-broad topological bandgap, spanning from DC up to GHz frequencies, within a deeply sub-wavelength form factor in a chip-scale integrated CMOS implementation.

15:30 : Invited talk
Plasmonic nanoantennas and their applications *On-line*
Pierre Berini
***University of Ottawa** (Canada)*

We review recent work on plasmonic nanoantennas and their applications in nonlinear optics and in optoelectronics.

Dmitry V. Obydennov[1], Daniil A. Shilkin[1], Ekaterina I. Elyas[1], Vitaly V. Yaroshenko[2], Oleg S. Kudryavtsev[3], Dmitry A. Zuev[2], Evgeny V. Lyubin[1], Evgeny A. Ekimov[3], Igor I. Vlasov[3], Andrey A. Fedyanin[1]
[1] ***Lomonosov Moscow State University (Russia),*** [2] ***ITMO University (Russia),*** [3] ***Russian Academy of Sciences (Russia)***

The size of the hosting particle affects the spontaneous light emission of embedded emitters. Here we study submicron-sized diamond particles containing silicon-vacancy color centers. We measure size-dependent scattering spectra, fluorescence emission rate, and Raman scattering intensity. Obtained results are found to agree with our calculations and demonstrate the potential of Mie resonances in nanoantennas design.

Coffee Break

Session 2P2

Poster session IV

16:00 - 16:30

Ameen Abdelrahman[1], Fouad Erchiqui[1], Mourad Nedil[1], Mohamed Siaj[2], Brahim Aissa[2]

[1] *UQAT (Canada),* [2] *UQAM (Canada)*

In this work, the preparation and the physical evaluation of a series of miscible 0.2 M solutions in 50/50 volume ratios were addressed. A total of 5 solutions comprised of plain electrolyte/ graphene, plain electrolyte / graphene-ethylene Glycol, plain electrolyte/ graphene-poly-ethylene glycol, plain electrolyte/ graphene-glycerol, and plain electrolyte/ Graphene-Polyethylenimine. Were assembled with Ag, and copper nanoparticles. The physical properties were studied by electrochemical impedance spectroscopy, solution conductivity calculations, and viscosity and flexibility measurements, particle size distribution analyses. Surface morphology characterizations were done by transmission electron microscopy. A comparative approach of the physical properties between the fives solutions serves as a guide to select the most appropriate fluid applicable to the upcoming device.

Imad Adjali, Benoit Poussot, Shermila Mostarshedi, Jean-Marc Laheurte
Université Gustave Eiffel (France)

A statistical analysis of the matching properties of a dipole surrounded by thin and thick randomly distributed loaded dipoles is presented. The input impedance and input reflection coefficient of the driven dipole is obtained by using the IEMF method and validated by NEC and measurements. The cumulative distributed functions are presented for different dipole densities and the mismatch of a surrounded thin or thick dipole is studied for different surrounding loads.

Siham Benkouda[1], **Abdelkrim Gadda**[1], **Ahmed Mahamdi**[1], **Sami Bedra**[2]
[1] *University of Mentouri Brothers - Constantine 1 (Algeria),* [2] *University of Batna (Algeria)*

In this work, we are interested to predicted the resonant characteristics of superconducting thin film microstrip resonator. Galerkin's procedure in the vector Fourier transform domain in conjunction with Gorter-Casimir's theorem of two fluids and the London brothers equations have been used for the numerical computation of the resonant frequency and the bandwidth of a rectangular patch superconductor. In order to minimize the computing time, a neural approach based on artificial neural networks is introduced into the modeling process.

Siham Benkouda[1], **Ahmed Mahamdi**[1], **Sami Bedra**[2]
[1] *University of Mentouri Brothers - Constantine 1 (Algeria),* [2] *University of Batna (Algeria)*

Modeling of equilateral triangular patch antenna on suspended and single substrate is presented in this paper. A neurospectral approach is used to compute the resonant frequency of the triangular antenna for the fundamental mode as well as for higher order modes. We show that the use of the neurospectral approach in the analysis of microstrip antennas is a promising fast and accurate technique.

Ozgur Eris, Gokhan Karaova, Ozgur Ergul
Middle East Technical University (Turkey)

A novel formulation involving a combination of potential and field formulations is presented for stable analyses of closed conductors with various sizes and discretizations.

Tarek Fortaki[1], **Siham Benkouda**[2], **Ahmed Mahamdi**[2], **Sami Bedra**[1]
[1] *University of Batna (Algeria),* [2] *University of Mentouri Brothers - Constantine 1 (Algeria)*

In this work, the cavity model for simple rectangular microstrip antenna is extended with some modifications to performing the resonant characteristics of the antenna. The cavity model in conjunction with the genetic algorithm is using for the design of rectangular microstrip antenna. Furthermore, the results present in this paper, are comparing with those presented elsewhere. Finally the effect of the different parameters of the rectangular antenna on the resonant characteristics is also investigated for fundamental and higher order modes.

Salah Belkhiri[1], **Fethi Ben Mebarek**[2], **Mohamed Lotfi Khene**[2]
[1] *University of M'Sila (Algeria),* [2] *University of Biskra (Algeria)*

The performance of superconducting current limiters associating the short-circuit phenomenon depends on the structure of the superconducting material envisaged and on the way of inserting it into the electrical network. In this paper, we present some numerical results of the magnetic behavior of superconducting fault current limiters (SFCLs). To describe the relationship between the electric field and the current density inside the thin-film superconductor.

16:30 - 18:55 — Auditorium I

Session 2A12
Nanophotonics, plasmonics and quantum optics

16:30 : Invited talk
Building Uncooled Infrared Camera based on One Atom Thick Graphene
Debashis Chanda
University of Central Florida (USA)

One atom thick graphene offers an alternative mechanism bypassing material bandgap restriction. Further, the ability of carrier concentration modulation on graphene via external voltage offers dynamic spectral selectivity for color night vision/sensing.

16:50 : Invited talk
Excitation and Modulation of Surface Plasmon Polaritons at PN++ Junctions
Dentcho Angelov Genov[1], Rajkumar Vinnakota[1], Zuoming Dong[2], Andrew Briggs[2], Leland Nordin[2], Seth Bank[2], Daniel Wasserman[2]
[1] Louisiana Tech University (USA), [2] University of Texas at Austin (USA)

We present excitation and active modulation of Surface Plasmon Polaritons (SPPs) at degenerately doped PN++- junction based on lattice matched Indium Gallium Arsenide. The device is experimentally characterized, showing far-field voltage assisted reflectivity modulation for mid-IR wavelengths. Numerical simulations of the device have confirmed the experimental findings and predict data rates of up to 1Gbits/s. Decreeing the device physical dimensions can lead to data rates in excess of 50Gbits/s, thus providing a new pathway toward fast plasmotronic devices.

17:10 : Invited talk
Photothermal effects in nanostructures: from ultrafast optical symmetry breaking to extreme heat dissipation *On-line*
Alessandro Alabastri
Rice University (USA)

I will show how this phenomenon leads to a space-dependent out-of-equilibrium hot carrier population that breaks the optical symmetry of otherwise symmetrical nanostructures. The resulting asymmetric hot-carrier time dynamics can be exploited to manipulate light-matter interaction in the ultrafast regime. Electron-phonon scattering eventually induces heating, and I will show how properly designed large scale ultrathin ($\sim$250nm) metasurfaces allow extremely large ($\sim$GW/m3) and broadband ($\sim$90 $\%$ of solar spectrum) dissipated power densities.

17:30 : Keynote talk
Metaoptics for Active Photonics *On-line*
Federico Capasso
Harvard University (USA)

Metaoptics offer unique opportunities for light control through dispersion engineering and optical nonlinearities. Here we demonstrate ultrashort pulse shaping with metasurfaces and new schemes for spatial light modulation and Gigahertz speed transmission modulation based on Mie resonances and on organic layers with giant electrooptic coefficient.

18:00 : Invited talk
Inverse Design of Plasmonic Nano-Antenna
Zhou Zeng, Prabhukumar Venuthurumilli, Xianfan Xu
Purdue University (USA)

We develop a new method for inverse design of plasmonic nano-antennas. We demonstrate the accuracy of this method for a plasmonic antenna used for heat-assisted magnetic recording (HAMR). We also use non-linear material interpolation to counter the non-physical field amplification, and filtering-and-projection regularization to ensure manufacturability of the design. Successful design of a plasmonic aperture to produce an electric field as small as 60 nm x 30 nm is presented.

18:20 : Invited talk
Enhanced Harmonic Generation and Broadband Upconversion from Nonlinearly Coupled Semiconductor and Metal Nanoparticle Films
Nathan Spear, Kent Hallman, Emil Hernandez-Pagan, Janet Macdonald, Richard Haglund
Vanderbilt University (USA)

A heterostructure comprising CuS and Au nanoparticle films separated by insulating ligands exhibits enhanced second- and third-harmonic generation and a broadband upconversion spectrum, when excited by femtosecond laser pulses at 1050 nm near the localized surface plasmon resonance of CuS.

José Gabriel Gaxiola Luna, Peter Halevi
National Institute of Astrophysics, Optics and Electronics (Mexico)

We study a temporal photonic crystal with square profile ofpermittivity and permeability. The continuity of the D(t)and B(t) fields across the time discontinuities facilitates theKronig-Penney methodology, leading to an analytic photonicband structure (PBS). It is periodic in frequency andexhibits k bands separated by k-gaps, but for equal modulationsthe PBS is composed of straight lines without k-gaps.The field D(t) displays the Bloch-Floquet behavior.

16:30 - 18:50 — Auditorium II

Session 2A13
Metamaterials and metasurfaces

16:30 : Invited talk
Dragging and amplifying light with space-time metamaterials
P. A. Huidobro[1], M. G. Silveirinha[1], E. Galiffi[2], J. B. Pendry[2]
[1] *University of Lisbon (Portugal),* [2] *Imperial College London (United Kingdom)*

In this talk I will consider space-time metamaterials of travelling-wave type and introduce the theory of homogenisation of these modulated media.

16:50 : Invited talk
Water-based metamaterials for advanced microwave control and sensing
Rasmus E. Jacobsen[1], Alex Krasnok[2], Andrea Alu[2], Samel Arslanagic[1], Andrei V. Lavrinenko[1]
[1] *Technical University of Denmark (Denmark),* [2] *City University of New York (USA)*

In the talk I review different water-based devices for microwave control and sensing. Among the effective implementation of water-based elements there are examples of metasurfaces, absorbers, dielectric resonance antennas, radio-frequency components and structures with a so-called bound state in the continuum as a sensor.

17:10 : Invited talk
Tunable Carbon-Based Nanomaterials for THz Applications *On-line*
Aleksandra Przewloka[1], Nikolaos Xenidis[2], Serguei Smirnov[2], Aleksandra Krajewska[1], Piotr Drozdz[1], Dmitri Lioubtchenko[1]
[1] *CENTERA Laboratories (Poland),* [2] *KTH Royal Institute of Technology (Sweden)*

In this work single-walled carbon nanotube tuning properties are studied for phase shifting applications. The dielectric rod waveguide with loaded carbon nanomaterials was experimentally studied in ultra-wide frequency band of 0.1-0.5 THz.

17:30 : Invited talk
Nonlinear Nanomechanical Photonic Metamaterials *On-line*
Kevin F. MacDonald, Jinxiang Li, Dimitrios Papas, Jun-Yu Ou, Eric Plum, Nikolay I. Zheludev
University of Southampton (United Kingdom)

By harnessing mechanical and optical resonances in tandem one can enhance the magnitude of

actuation and optical response in dynamically reconfigurable nanostructures driven by microwatt optical signals and low-intensity acoustic vibrations. We review recent work on structures exhibiting profound opto-mechanical nonlinearity and bistability.

17:50 : Invited talk
Fabrication of Large-Area Metal Oxide Infrared Metasurfaces
Kai Sun[1], Callum Wheeler[1], Evangelos Vassos[2], Alex Feresidis[2], C. H. de Groot[1], Otto L. Muskens[1]
[1] *University of Southampton (United Kingdom),* [2] *University of Birmingham (United Kingdom)*

We present recent developments for the fabrication of functional metasurfaces in the mid- and long-wave infrared using 200mm wafer scale nanofabrication techniques. Our results include deep-UV scanner lithography of multi-band metasurfaces with tailored reflectivities in the two atmospheric windows. Also we will show recent results on smart radiative cooling metasurfaces based on atomic layer deposition of W:VO2.

18:10 : Invited talk
Fast Scattering Matrix Computation for Complex Media and Metasurfaces *On-line*
Ho-Chun Lin, Zeyu Wang, Chia Wei Hsu
University of Southern California (USA)

We use the Schur complement and partial factorization to compute the scattering matrices of large-scale complex optical systems and large-area metasurfaces, achieving orders-of-magnitude speed-up and reduced memory usage over existing methods.

18:30 : Invited talk
Modeling of Spatially Dispersive Quadrupolar Metasurfaces
Karim Achouri, Ville Tiukuvaara, Olivier J. F. Martin
EPFL (Switzerland)

Metasurfaces are typically modeled using boundary conditions restricted to dipolar responses. While generally effective, this modeling approach suffers in the case of large incidence angles. This work is expected to be useful for designing spatial analog optical signal processing metasurfaces for incident beams with large angular spectra.

16:30 - 18:10 — Auditorium III

Session 2A14
Propagation and scattering

Aihua Wood[1], Ryan Wood[2], Matthew Charnley[3]
[1] *Air Force Institute of Technology (USA),* [2] *Harvard University (USA),* [3] *Rutgers University (USA)*

This paper explores the through-the-wall inverse scattering problem via machine learning. The reconstruction method seeks to discover the shape, location, and type of hidden objects behind simulated walls. We use radar frequency (RF) sources and receivers placed outside the room to generate observation data with objects randomly placed inside the room.

Zaynab Guerraou[1], Ali Khenchaf[1], Fabrice Comblet[1], Phillipe Morgand[2], Phillipe Pouliguen[3], Florent Jangal[3]
[1] *ENSTA Bretagne (France),* [2] *Centre d'Ingénierie des Systèmes en Télécommunications en Electro-Magnétisme et Electronique (France),* [3] *Agence de l'Innovation de Défense (AID) (France)*

In the recent years, small UAVs have become accessible for military, commercial and leisure activities. This comes with an increasing apprehension concerning their hazardous and illicit misuses. Radar systems have proved good capabilities for UAV surveillance, but small target detection still remains challenging and subject to active research. In this perspective, the present work deals with clutter mitigation and small target detection using phased-array radar and adaptive processing.

17:00 : Invited talk
A Stochastic Ray-Based Model for UAV-to-Ground Radio Channels in Built-Up Environments
Claude Oestges
UCLouvain (Belgium)

A stochastic ray-based model is applied to model the UAV to-ground radio channel in urban areas. The modelingmethod relies on simple input data, such as input distributionparameters (e.g. mean building height, building heightvariance). The physical part of the model being based onray-tracing, it is also applicable over very wide parameterranges at a very low computation time thanks to a precalculationprocedure.

Amina Bendaoudi, Z. Mahdjoub
University of Sidi Bel Abbès (Algeria)

In this paper, we propose a novel technique which consists in implementing a periodic network based on a model of a C-shaped Split Ring Resonator on the square slots of radiating rectangular patch antenna. This technique for improving frequency characteristics and miniaturizing the geometric dimension of the 5G application. The results of the simulation have proved that the proposed technique has an excellent radiation efficiency, compared to the reference patch antenna.

Hocine Anis Belaid, Shermila Mostarshedi, Benoit Poussot, Jean-Marc Laheurte
Université Gustave Eiffel (France)

This paper deals with the problem of near ground wave propagation, and in particular with the assessment of the region in which the near-ground wave becomes the dominant component. The critical distances are estimated as a function of the link parameters in the case of dipole antennas.

17:50 : Invited talk
Topological charge and orbital angular momentum of asymmetric vortex laser beams
Alexey Kovalev, Victor Kotlyar, Sergey Stafeev
Samara National Research University (Russia)

Some types of asymmetric light fields with optical vortices are considered as well as their properties: asymmetric diffraction-free Bessel modes and their superpositions, asymmetric paraxial Laguerre-Gaussian and Bessel-Gaussian beams, as well as vortex Hermite-Gaussian beams. Explicit expressions are derived to describe freespace propagation of these fields along with their topological charge and orbital angular momentum. Stability of these quantities to some types of distortions is studied.

18:10 - 18:50 — Auditorium III

Session 2A15
Mm-wave, THz, and quasi-optical antenna measurements

18:10 : Invited talk
RF cold tests of open mm-wave metallic accelerating structures
Giuseppe Torrisi[1], Ornella Leonardi[1], Giorgio Sebastiano Mauro[1], Luigi Celona[1], Gino Sorbello[1], Bruno Spataro[2], Luigi Faillace[3], Valery Dolgashev[4]
[1] *Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN-LNS) (Italy),* [2] *Istituto Nazionale di Fisica Nucleare - Laboratori nazionali di Frascati (Italy),* [3] *Istituto Nazionale di Fisica Nucleare - Sezione di Milano (Italy),* [4] *SLAC National Accelerator Laboratory (Italy)*

This paper describes the design and the low-power RF tests of an open mm-wave metallic accelerating structure. We used the numerical codes CST Microwave Studio and ANSYS HFSS in order to optimize the gap size and position that could introduce several and undesired field perturbation. A 3-cells standing wave structure at 93 GHz was fabricated and the S-parameters have been measured in excellent agreement with simulations.

18:30 : Invited talk

Subsoil Electromagnetic Attenuation Measurements Using Underground Antennas

Abdul Salam, Usman Raza, Tahir Mehmood Khan
Purdue University (USA)

In this paper, electromagnetic attenuation measurements are presented using subsurface antennas in different soils. The results are reported for input parameters of communication range and center frequency. These results provide useful insights into soil communications medium for Agricultural IoT based underground wireless communication system design.

Thursday 26th May, 2022

08:30 - 09:40 — Auditorium I

Session 3A1

Plenary Session II

08:30 : Plenary talk
The Next Generation of Metasurface Antennas
Stefano Maci
University of Siena (Italy)

Today we are facing a transition to the third generation of MTS antennas, where MTSs change boundary conditions in space and time, opening new perspectives in 5G communications and beyond. In this presentation, the evolution of MTS antennas is described, with new ideas and examples on future communication scenarios. Fig. 1 presents a roadmap and some pictures of prototypes presented in the talk.

09:05 : Plenary talk
Electromagnetic Skyrmions of Free Space
Nikitas Papsimakis, Yijie Shen, Nikolay I. Zheludev
University of Southampton (United Kingdom)

In this talk we overview recent progress in toroidal electrodynamics including generation and detection of toroidal pulses, the study of their space-time .[en]tanglement.[a]nd isodiffraction behaviour and light-matter interactions involving anapoles. We will report on the unique supertoroidal pulses, propagating skyrmionic formations of electromagnetic fields that can be non-diffracting and exhibit superoscillatory behavior.

Coffee Break

Session 3P1

Poster session V

9:40 - 10:10

Amit Magdum, Mallikarjun Erramshetty, Ravi Prasad K. Jagannath
National Institute of Technology Goa (India)

This paper presents an efficient reconstruction algorithm based on the exponential filtering of singular values for two dimensional scattering objects in microwave imaging. This approach is used with a linear, transverse magnetic polarized model of Born's approximation for the solution of ill-posed problems. Various examples of synthetic as well as experimental data set are considered to demonstrate the accuracyof the algorithm. Reconstruction results show that this algorithm out performs the standard Tikhonov regularization approach.

Chen Ding, Kwai-Man Luk
City University of Hong Kong (China)

A novel rotation-free far-field gain measurement method of linearly-polarized (LP) antennas using artificial anisotropic polarizers (AAP) is proposed in this paper. No rotation to antenna feed is required during the measurement. Measurements for a rectangular linearly-polarized horn operating between 50 to 67 GHz have been conducted for verification at different E-plane angles. The measurement method is useful for gain measurements of linearly-polarized antennas especially at millimeter-wave and terahertz range.

Eduardo Alvear-Cabezon[1], Emmanuel Centeno[1], Rafik Smaali[1], Fernando Gonzalez-Posada[2], Stephane Blin[2], Thierry Taliercio[2]
[1] ***Université Clermont Auvergne (France),*** [2] ***Montpellier University (France)***

We theoretically and experimentally study the THz electromagnetic properties of an undoped-InAs slab whose permittivity is optically modified by a photo-generation process. We show a high modulation of the THz transmission up to 90 % from 0.75 to 10 THz at very low pump fluence in the continuous wave regime. We also demonstrate a high-speed transmission modulation rate up to 2 MHz range with a modulated pump.

Garima Joshi, R. Vijaya
Indian Institute of Technology (India)

We have proposed a THz range, multi-band, metasurface-integrated Fabry- Perot cavity antenna. The perforated single layer metasurface provides 40 % wide stop bandwidth and it is used as superstrate. The metasurface integrated antenna resonates at the frequencies of 180.0 GHz, 189.46 GHz, 199.02 GHz and 208.82 GHz. The maximum peak gain of 13 dBi is at 189.46 GHz among the four bands. Nearly 5 % of gain enhancement is achieved in all four bands after loading the metasurface on the antenna.

Stamatios Amanatiadis[1], Vasileios Salonikios[1], Michalis Nitas[1], Theodoros Zygiridis[2], Nikolaos Kantartzis[1], Traianos Yioultsis[1]
[1] ***Aristotle University of Thessaloniki (Greece),*** [2] ***University of Western Macedonia (Greece)***

The plane wave scattering on graphene micro-disks is investigated numerically in the present work. Initially, the propagation properties of the supported surface waves on the 2D material are studied theoretically. Then, the plasmonic resonant frequencies of a circular graphene scatterer are identified via the broadband analysis of the absorption cross-section. Finally, the radar cross-section of the same setup is examined, indicating that the resonant frequencies are optimal for forward propagation, thus enabling the effective beam manipulation.

Sara Liyuba Vesely[1], Sibilla Renata Dolci[2], Alessandro Alberto Vesely[3], Marco Emilio Vesely[3], Caterina Alessandra Dolci[2]
[1] ***ITB-CNR (Italy),*** [2] ***UNIMI-VESPA (Italy),*** [3] ***TANA (Italy)***

We review Einstein's law of photochemical equivalence inthe context of the radiation hypothesis. He attempted to explain the involved energetics by exploiting thermodynamics at the molecular level. Quantum mechanics incorporated Einstein's seminal result in the same way as it incorporated Mendeleev's periodic table of the elements. Despite its richness in new physics and the considerable influence it exerted on the photochemical approach, photochemical equivalence didn't prove as fruitful for chemistry as had the discovery of organic chemistry.

Marina Moskaleva, Daria Raschetova, Dmitry Valovik, Ekaterina Zarembo
Penza State University (Russia)

In this report we study symmetric guided electromagnetic waves propagating in a plane anisotropic dielectric waveguide. The waveguide has either infinitely conducting walls or open interfaces. In the latter case the waveguide is located between two half-spaces with constant scalar permittivities. The permittivity of the waveguide is given by a real diagonal tensor, the permeability is a constant scalar quantity. The dispersion equation is found and studied. Numerical results are presented.

10:10 - 12:30 — Auditorium I

Session 3A2

Nanophotonics, plasmonics and quantum optics

10:10 : Invited talk
Controlling the PT Symmetry of Non-Hermitian Graphene Dirac Plasmons and its Application to Terahertz Lasers

Taiichi Otsuji
Tohoku University (Japan)

We present new ideas on the operating principle and device structure of graphene plasmonic laser transistors based on controlling the PT symmetry of graphene Dirac plasmons with high radiation intensity and ultrafast modulation capability operating at room temperature in the THz frequency band.

10:30 : Invited talk
Light induced exotic chiral surface reliefs in azo-polymers
Takashige Omatsu
Chiba University (Japan)

We review the formation of exotic chiral surface reliefs of azo-polymers by irradiation of structured light beams with optical angular momentum, that is orbital and spin angular momentum. Such chiral surface relief will be applied to be advanced chiral metasurfaces.

10:50 : Invited talk
2D Transition Metal Dichalcogenides for Tunable Optronics and Ultra-Thin Flat Optics
Meng Zhao, Zeng Wang, Steve Qingyuang Wu, Jinghua Teng
*A*STAR (Singapore)*

In this talk, I will introduce photonsieves and flat lenses made from MoS2 by exploring the strong excitonic absorption for high efficiency large angle of view hologram and sub-diffraction limit imaging,, the observation of strong oscillator strength in interlayer excitons in WS2/HfS2 heterostructure and its application in room temperature operation high sensitivity mid-IR photodetection, and the electrostatically tunable plasmonic responses in near IR range from solution processed atomically thin NbSe2.

11:10 : Invited talk
Dipole-Dipole Coupling Mediated by Lattice Resonances
Alejandro Manjavacas
IO-CSIC (Spain)

Ordered arrays of metallic nanostructures support collective modes known as lattice resonances, which give rise to very strong and spectrally narrow optical responses. Here, we show that, thanks to their collective nature, the lattice resonances of a periodic array of metallic nanoparticles can mediate an efficient long-range coupling between two dipole emitters placed near the array.

11:30 : Keynote talk
Quantum photonics using nanodiamonds and integrated optics
Christophe Couteau
University of Technology of Troyes UTT (France)

We will present our recent work on integrated quantum photonics based on a hybrid system made of colour centres in nanodiamonds and single photons within a common optical bus. This platform is a first step towards scalability for quantum communications. Ultimately, we aim to achieve entanglement via the interaction between two nodes thanks to a common photonics waveguide. We will present how we plan to control the positioning of nanodiamonds as well as the quantum optics properties of such emitters.

Madiha Amrani[1], Soufyane Khattou[1], Adnane Noual[1], Abdelkader Mouadili[2], El Houssaine El Boudouti[1], Bahram Djafari-Rouhani[3]
[1] *Université Mohammed I (Morocco),* [2] *Université Hassan II (Morocco),* [3] *Université de Lille (France)*

We give both analytically and numerically a demonstration of the possibility to realize a simple plasmonic demultiplexer based on Fano and electromagnetic induced transparency resonances. The demultiplexer consists in a waveguide with an input line and two output lines. Each output line contains two stubs placed at two different positions. We derive the expressions for a selective transfer of a single propagating mode through one line keeping the other line unaffected. The analytical results are confirmed by numerical simulations.

Ouadiaa Barrou[1], Abdelkebir El Amri[1], Abdelati Reha[2]

[1] *Hassan II University of Casablanca (Morocco),* [2] *Laboratoire d'Innovation en Management et en Ingénierie pour l'Entreprise (Morocco)*

In order to use a patch array antenna in various telecommunications applications, its miniaturization and high gain are very important parameters. The antenna miniaturization allows its integration in small embedded systems and its gain allows increasing its range. Several techniques are used to achieve this goal. Our work aims to miniaturize and improve the performance of a circular patch array antenna through the combination of DGS and KOCH Snowflake Fractal technologies.

10:10 - 12:30 — Auditorium II

Session 3A3
Metamaterials and metasurfaces

10:10 : Invited talk
Tunable Infrared Metasurface based on VO2 for Anti-Counterfeiting and Adaptive Radiative Cooling
Junichi Takahara
Osaka University (Japan)

We demonstrate tunable infrared metasurface by utilizing metal-insulator transition material of VO2. Switching optical property between dielectric and negative dielectric opens new functionality of metasurface such as anti-counterfeiting and adaptive radiative cooling in wide range of spectra from near- to mid-IR range.

10:30 : Spectral tuning of SPP reflection by quasi-symmetric metal nano-block arrays *On-line*
Naoki Ichiji, Atsusi Kubo
University of Tsukuba (Japan)

We investigate the spectral tuning of the SPP wave packets by quasi-symmetric arrays composed of metal blocks with two different structural lengths. The FDTD simulations showed a resonance phenomenon in the gap between the blocks when the two blocks have different lengths in the longitudinal direction. Furthermore, the resonance of the gap resulted in a significant spectral modulation of the reflected SPP wave that depended on the structural length and positional relationship of the blocks.

10:45 : Invited talk
Radiation control with exceptional points in non-Hermitian plasmonic systems *On-line*
Yuto Moritake
Tokyo Institute of Technology (Japan)

In this paper, we introduce our research based on the singular eigenstates in EP. The first is formation of circular polarization eigenstates and the second is formation of Huygens dipoles at EPs. The studies introduced in this paper provide new photonic functionalities caused by the singular eigenstates at EP in NH systems.

11:05 : Invited talk
Manipulating the Polarization of Electromagnetic Waves via Metastructures
Ruwen Peng, Mu Wang
Nanjing University (China)

In this work, we present our recent work on manipulating the polarization of electromagnetic waves with metastructures. The investigations provide some guidelines to control the polarization of electromagnetic waves at subwavelength scale.

Junichi Takahara, Kazusa Kawashima, Rongyang Xu
Osaka University (Japan)

A perfect absorber (PA) is a key device for low-carbon society in future since PA mutually converts energy between heat and light. In this talk, I talk about all-dielectric PSs based on Si metasurfaces. In contrast to conventional plasmonic PAs, they are designed in different way by degenerate critical

coupling (DCC) for visible and infrared region. We propose various novel structures of a Mie resonator supporting not only electric and magnetic dipoles but also quadrupoles to achieve DCC condition.

David Hähnel, Jens Forstner, Viktor Myroshnychenko
Paderborn University (Germany)

We present the design and optimization of all-dielectric nonlinear metasurfaces using a simple sampling method combined with Monte Carlo simulation and demonstrate that the use of sophisticated optimization methods is not necessary. We apply this approach for the optimization of metasurface composed of silicon disks, which operates as a third harmonic beam deflector at a defined angle. Our results demonstrate a significant enhancement of radiated third harmonic intensity in the first diffraction order compared to that reported in literature.

11:55 : Invited talk
Bismuth-based Metamaterials: Fundamentals and Applications *On-line*
Johann Toudert, Rosalia Serna
CSIC (Spain)

Bismuth shows outstanding optical properties, including a metal-like response in the ultraviolet-visible and a dielectric character with giant refractive index in the infrared. We explain how this enables bismuth-based metamaterials to show a remarkable optical response over these spectral regions. Such response can be tuned in a static way by suitable metamaterial design and in a dynamic way by harnessing the solid-liquid transition of bismuth. We discuss the application of such metamaterials to information technology, energy harvesting and sensing.

Yuriy Sirenko[1], Kostyantyn Sirenko[1], Nataliya Yashina[1], Gerard Granet[2]
[1] *National Academy of Sciences of Ukraine (Ukraine),* [2] *Université de Clermont-Ferrand (France)*

The synthesis problem of 2-D photonic crystals of finite thickness providing the ultra-wide stopbands for the plane incident waves is solved on the base of EAC-method (method of exact absorbing conditions).

10:10 - 12:25 — Auditorium III

Session 3A4
Millimeter/Terahertz and nano-optical antennas

10:10 : Invited talk
Recent Progress in Millimeter-Wave Mobile Handset Array Antennas for 5G Applications
Shuai Zhang
Aalborg University (Denmark)

Millimeter-wave mobile terminal antenna arrays are implemented in 5G cellular communication systems. However, due to the small phone space and the user mobility, handset arrays should have large spatial coverage, dual-polarization, integratable with sub 6G phone antennas, small shadowing effects from the user and so on. This paper reviews some recent progress in millimeter-wave handset antennas aiming at solving these problems.

10:30 : Invited talk
THz transmission for fixed wireless services under severe weather conditions
Tetsuya Kawanishi
Waseda University (Japan)

Terahertz band systems are expected to be a means of achieving short-range, high-speed communications. However, there are concerns about the effects of rain attenuation and wind-induced vibration, and ensuring performance in adverse weather conditions is an issue. In this presentation, a link budget model of terahertz band fixed wireless systems under storm conditions will be presented and the feasibility of a highly stable system will be discussed.

10:50 : Invited talk
Novel resonant-tunneling-diode terahertz oscillators and applications
Safumi Suzuki
Tokyo Institute of Technology (Japan)

The recent progress in resonant-tunneling diode (RTD) THz oscillators and applications is reviewed. For high-frequency and high output power, RTD oscillators integrated with cylindrical and rectangular cavities have been developed. Structure simplified RTD oscillators for easy device fabrication and good uniformity were proposed and fabricated. This simple structure has an extensibility for large-scale array, active metamaterial, and beam forming function. Novel THz radar systems using RTD oscillators were proposed, and a precise distance measurement and a three-dimensional imaging were demonstrated.

11:10 : Invited talk
Base Station and User Equipment Antennas for 60-GHz-Band Near-Field Wireless Communication System: GATE
Takashi Tomura, Jiro Hirokawa
Tokyo Institute of Technology (Japan)

This paper presents base station and user equipment antennas for a 60-GHz-band near-field wireless communication system: gigabit access transponder equipment (GATE). The GATE uses electrically large antennas for base stations to provide a uniform field distribution and low interference between adjacent links.

Ch. Murali Krishna[1], N. Suguna[2], S. Revathi[2]
[1] PDPM IIIT Design and Manufacturing (India), [2] VIT University (India)

In this paper, novel approach tri - element Multiple - Input Multiple - Output (MIMO) terahertz (THz) antenna is designed to cover wide band characteristics from 2.44 - 3.09THz for medical, short - indoor and THz applications. The proposed MIMO antenna is designed on quartz glass dielectric material within compact size of 120μm x 60μm, offers of wide impedance bandwidth (IBW) of 0.65THz, isolation less than -25dB, peak gain 6.82dB and high radiation efficiency of 92 - 98 %. The MIMO antenna parameters are envelope correlation coefficient (ECC), diversity gain (DG), total active reflection coefficient (TARC), channel capacity loss (CCL) and mean effective gain (MEG) are within acceptable limits

11:45 : Invited talk
Gain and Efficiency Enhancement of mm-Wave On-Chip Antennas Through Artificial Magnetic Conductors
Atif Shamim
KAUST (Saudi Arabia)

This talk describes AMC design steps in an on-chip environment and shows how it can be used to boost AoC radiation performance. Further, it also shows innovative techniques for AMC thickness reduction to make it more suitable with the traditional CMOS stack-ups.

12:05 : Invited talk
Non Conventional Reflectarray and Transmitarray Configurations for Next Generation Applications
Paola Pirinolo
Politecnico di Torino (Italy)

Reflectarrays (RAs) and transmitarrays (TAs) represent an efficient alternative to reflectors and arrays as high-gain antennas, since they posses nice features making them potentially suitable for several different applications. In view of these, some non-conventional, dielectric-only RA and TA configurations are here discussed.

Lunch

12:30 - 14:00

14:00 - 14:45 — Auditorium I

Session 3A5

Millimeter/Terahertz and nano-optical antennas

14:00 : Keynote talk
Terahertz Chip-Scale Systems
Kaushik Sengupta
Princeton University (USA)

In this talk, we will discuss how new design approaches crosscutting circuits/EM/systems partitions, to open new possibilities in enabling programmability and adaptability in these THz chip technologies including programmable chip-scale THz sensors, THz metasurfaces and spatio-temporal control of THz fields for physical layer security, and how these can enable new applications in sensing, imaging, security and localization.

Jacqueline Damas[1], Niels Neumann[2], Klaus Wolf[2], Dirk Plettemeier[2]
[1] ***University of Dar es Salaam Tanzania (Tanzania),*** [2] ***TU Dresden (Germany)***

A planar antenna array on the RF substrate increases the level of system integration and lowers the manufacturing cost for such systems. In this paper, the authors present the design and fabrication of a planar 2$imes$2 antenna arrayfor a 60 GHz Radio-over-Fiber (RoF) wireless system. The antenna is radiating at broadside and excited by microstrip line. For the measurement with RF probes on a wafer prober, a microstrip-to-coplanar waveguide transition is added. The measured gain of the antenna is 6 dBi and the matching is better than -20 dB at 60 GHz. The measurement and simulation results of gain and input return loss match very well at the resonance frequency.

15:00 - 16:00 — Auditorium I

Session 3A6

Conference Tutorials II

15:00 : Tutorial
Guidance and Radiation of Metasurface-Waves
Stefano Maci
University of Siena (Italy)

Metasurfaces constitute a class of thin metamaterials, which can be used from microwave to optical frequencies to create new electromagnetic engineering devices. At microwave frequencies, they are obtained by a dense periodic texture of small elements printed on a grounded slab. Changing the dimension of the elements, being the sub-wavelength 2D-periodicity equal, gives the visual effect of a pixelated image and the electromagnetic effect of a modulation of the equivalent local reactance. The modulated metasurface reactance (MMR) so obtained is able to transform surface or guided waves into different wavefield configurations with required properties. The MMR allows a local modification of the dispersion equation and, at constant operating frequency, of the local wavevector. Therefore, a metasurface modulation permits addressing the propagation path of a surface wave, according with a generalized Fermat principle, as happen in ray-field propagation in inhomogeneous solid medium. This may serve for designing lenses or point-source driven beam-forming networks. When the MMR exhibits a periodic modulation along the SW wavevector, the wave propagation is accompanied by leakage; i.e., a surface wave is transformed into a leaky-wave, and the structure itself becomes an extremely flat antenna. In every case, introducing asymmetry in the pixel allows for a polarization control. In this tutorial, the basic wave mechanisms will be reviewed showing several antenna applications.

14:00 - 15:55 — Auditorium II

Session 3A7

Metamaterials and metasurfaces

14:00 : Invited talk

Engineering bound states in the continuum through dipolar metaatoms: from microwaves to the visible

Diego R. Abujetas[1], Juan J. Saenz[2], Jose A. Sanchez-Gil[1]
[1] *CSIC (Spain),* [2] *Donostia International Physics Center (Spain)*

We explore the emergence of bound states in the continuum (BICs) in metasurfaces consisting of dipolar meta-atoms. To this end, we derive a coupled dipole theoretical formulation to describe the optical properties of a periodic array consisting of one (or several) electric or magnetic dipoles per unit cell. We exploit this general formulation to investigate robust symmetry-protected BICs through different mechanisms in various kinds of arrays of interest throughout the electromagnetic spectrum.

14:20 : Invited talk

Subwavelength waveguide arrays for spatial phase manipulation of microwaves

Dominic Palm, Marco Rahm
Technische Universität Kaiserslautern (Germany)

We design, fabricate and experimentally test waveguide arrays with subwavelength width and periodicity to manipulate the spatial phase of microwaves. The electromagnetic performance of the waveguide arrays is optimized by use of a particle swarm algorithm.

Hassan Chreim[1], Mohamad Majed[2], Mohamad Rammal[2], Quentin Solanes[3], Jimmy Autier[3], Hussein Abou Taam[4], Bernard Jecko[5]
[1] *Dassault Systemes (France),* [2] *ITHPP (France),* [3] *University of Limoges (France),* [4] *Lebanese University (Lebanon),* [5] *XLIM LAB (France)*

This paper deals with 2 methods, allowing to fous the radiated field of the radiated field of an ARMA, for electronic war application. The field strenghening is obtained without having to increase the input power. It can be done through simple bending of the antenna or applying a specific phase law.

Safia Jaouad[1], Mariam Aznabet[2], Otman EL Mrabet[1], Mohsine Khalladi[2]
[1] *University of Abdelmalek Essaadi (Morocco),* [2] *University of Wisconsin-Madison (USA)*

In this paper, a meta-surface is developed as an effective solution for reducing mutual coupling between two adjacent antennas. The meta-surface comprises an array of omega shape resonators placed above two closely antennas. The simulated results show a 24 dB reduction in coupling when placing meta-surface over two adjacent antennas separated by a spacing of 1/5 wavelength at frequency of 2.85 GHz. Furthermore, the gain of antenna arrays with the meta-surface is also improved by 3dB.

Kim Pham[1], Agnès Maurel[2]
[1] *ENSTA Paris (France),* [2] *ESPCI (France)*

We study the scattering of waves by a single row of resonant inclusions, of the Mie type. An effective model based on matched asymptotic analyzed is used to account for the small thickness of the array. Hence, instead of the effective bulk parameters, we end up with interface parameters entering in jump conditions for the electromagnetic fields, among these parameters, one is frequency dependent and encapsulates the resonant behav- ior of the inclusions.

Ozgur Eris
Middle East Technical University (Turkey)

We present computational design and analysis of near-zero-index (NZI) shell structures, which can provide directional radiation characteristics when excited by isotropic sources. Alternative strategies are used to create symmetric and asymmetric beams, such as geometric shaping of internal cavities, applying curvatures on outer surfaces, using pyramidal textures to suppress undesired beams, and selecting suitable material properties. The results show that, with well-designed geometric parameters, quite successful radiation patterns can be obtained with relatively simple NZI shells.

15:40 : **Exact, Feasible and Practical Cloaks for Static and Quasistatic Magnetic Fields** *On-line*
Alvar Sanchez
Universitat Autonoma de Barcelona (Spain)

Here we review how cloaks for dc and low-ac magnetic fields have been theoretically proposed and experimentally demonstrated using different approaches. They range from exact cloaks for uniform dc fields to actual cloaks being used in future particle accelerators. We also present how the cloak of static and quasistatic magnetic fields by metamaterials can be realized in very simplified situations, including the case of using only a single homogeneous and isotropic material.

14:00 - 15:55 — Auditorium III

Session 3A8
Nanophotonics, plasmonics and quantum optics

14:00 : Invited talk
Emergent PT symmetry and quantum fluctuations in a double-quantum-dot circuit QED set-up *On-line*
Archak Purkayastha[1], Manas Kulkarni[2], Yogesh Joglekar[3]
[1] ***Trinity College Dublin (Ireland),*** [2] ***Tata Institute of Fundamental Research (India),*** [3] ***Indiana University Purdue University Indianapolis (IUPUI) (USA)***

Open classical and quantum systems with effective parity-time (PT) symmetry have shown tremendous promise foradvances in lasers, sensing, and non-reciprocal devices.However, the microscopic origin of such effective, non-Hermitian models is not well under-stood. In this work, bymicroscopically modelling a double-quantum-dot-circuit-QED set-up that is realizable in state-of-the-art experi-ments, we show that a non-Hermitian Hamiltonian emergesnaturally, which can be controllably tuned to observe bothPT -transition, as well as the effect of quantum fluctuations.

14:20 : Invited talk
Quantum dynamics in structured photonic fields
Jonas Wätzel, Jamal Berakdar
Martin-Luther-Universität Halle-Wittenberg (Germany)

Phase- and polarization-textured laser pulses have been realized in a wide range of frequencies spanning the XUV to the THz regimes. This contribution presents few examples on how to use these pulses or combination thereof to induce new types of optical quantum transitions and/or laser-dressed states. For instance, it is found that electronic toroidal states can be triggered and controlled on the picosecond time scale using polarization-structured THz vector beams.

14:40 : Invited talk
Riesz-projection based simulation and analysis of resonant photonic devices and machine-learning based parameter optimization
Fridtjof Betz[1], Felix Binkowski[1], Matthias Plock[1], Lilli Kuen[1], Phillip Manley[2], Philipp-Immanuel Schneider[2], Martin Hammerschmidt[2], Lin Zschiedrich[2], Sven Burger[1]
[1] ***Zuse Institute Berlin (Germany),*** [2] ***JCMwave GmbH (Germany)***

We present Riesz projection based methods relying on contour integration for efficiently computing quasi-normal modes and modal expansions of near-field and far-field physical quantities. We use a finite-element method based implementation of these methods for the analysis of nanophotonic resonators for quantumoptics applications. We use Bayesian optimization methods for finding best geometry parameters yielding, e.g., resonators with maximized quality factor.

15:00 : Invited talk
Tunable Mie resonances in silicon nanostructures probed with electron energy-loss spectroscopy
Soren Raza
Technical University of Denmark (Denmark)

In this talk, I will present results on thermo-optic and electromechanical tuning of optical Mie resonan-

ces in high-refractive-index silicon nanostructures. Using in situ electron energy-loss spectroscopy, we show that the high thermo-optic coefficient of silicon enables tuning between the near field of Mie resonances supported by silicon nanoparticles in the visible. We also demonstrate an electromechanical platform composed of a silicon nanobeam dimer to electrically tune the optical response.

15:20 : Invited talk

Photoluminescence enhancement of the near-IR light from Ge(Si) QDs embedded in Si Mie nanosidks

Viktoriia Rutckaia[1], Mihail Petrov[2], Vadim Talalaev[1], Frank Heyroth[1], Dominik Schulze[1], Alexey Novikov[3], Mikhail Schaleev[3], Joerg Schilling[1]
[1] *Martin-Luther University of Halle-Wittenberg (Germany),* [2] *ITMO University (Russia),* [3] *Russian Academy of Science (Russia)*

We investigate optical properties of Ge(Si) QDs by steady-state and time-resolved micro-photoluminescence. Their 1.3-1.5 um broad emission is attractive for telecomm applications. We discuss mechanisms of photoluminescence enhancement considering embedding QDs in resonant nanodisks. We show that the Mie resonances of the disks govern the enhancement of the photoluminescence due to a good spatial overlap of the emitter position with the localized electric field. Using time-resolved measurements we confirm the impact of the Purcell effect on QD emission rate.

Leonardo Midolo
University of Copenhagen (Denmark)

Deterministic sources of single photons are key elements for quantum information processing, simulation, and computing. I will present a photonic integrated circuit based on dual-mode waveguides for the resonant excitation of two self-assembled InAs quantum dots, paving the way to the integration of multiple sources on a chip. Our plug-and-play waveguide-based source can generate streams of pure and indistinguishable single photons on-demand, so that a planar platform for quantum photonic integrated circuits can be realized.

Coffee Break

Session 3P2

Poster session VI

16:00 - 16:30

Mohamed Karim Laoufi, Slimane Mekaoui, Mohamed Lamine Tounsi
USTHB University (Algeria)

In this paper, a new multi-standard filter with four resonance frequencies is proposed for radio-mobile including GSM/4G LTE, WLAN and 5 G applications. The design and synthesis is resolved using a new formulation of the FDTD method. The metal finite conductivity and thickness are rigorously taken into account. The FDTD computed results are in good agreement with simulated data obtained with CST electromagnetic tool.

Sarosh Ahmad[1], Shuvra Barua[2], Ayesha Akram[3], Bilal Manzoor[4]
[1] *University Faisalabad (GCUF) (Pakistan),* [2] *Ahsanullah University of Science and Technology (AUST) (Bangladesh),* [3] *University of Lahore (Pakistan),* [4] *University of Engineering and Technology (UET) (Pakistan)*

This study presents an Industrial, Scientific, and Medical (ISM) band at 915 MHz. There are four slotted resonators in this patch, which are installed on a flexible Roger Duroid RT5880 substrate with a typical 0.254 mm thickness. The suggested antenna's overall dimensions are 7mm x 7mm x 0.254 mm, and it spans a frequency range of 800 MHz to 1 GHz (200 MHz) under the skin tissue.

Oscar Gomez[1], Florence Nadal[2], Benoit Poussot[2], Pascale Jardin[2], Geneviève Baudoin[2]
[1] *PTU Microwave (Luxembourg),* [2] *Université Gustave Eiffel (France)*

Multiple-Input Multiple-Output (MIMO) radars with colocated antennas have been shown to have higher resolution and better accuracy in target localization than standard phased-array radars. However,

due to the proximity of the antenna elements, direct coupling between the transmitters and the receivers (crosstalk) may exist and degrade in the narrowband case the performance of some detection techniques, such as the Generalized Likelihood Ratio Test (GLRT) based one. This paper presents a crosstalk reduction technique for MIMO radar.

Burak Demirdogen, Erkan Afacan
Gazi University (Turkey)

In this research, the effect of the different transmit antennas on the equipment was compared between 30-100MHz under the RS103 test described in MIL-STD-461G standard. First, dummy equipment under test (EUT) was designed consisting of two metallic structures connected each other with a two-meter-long shielded cable. Second, a digital thermometer was used as a EUT to perform RS103 test by using biconical and E-field generator to improve the comprehensibleness of susceptibility.

16:30 - 17:05 — Auditorium I

Session 3A9

Plenary Session III

16:30 : Plenary talk
From EBG's to Meta-Surfaces and Beyond: Recent Developments and Novel Engineering Applications
Yahya Rahmat-Samii
University of California Los Angeles (USA)

This plenary talk will review the development of various electromagnetic meta-structures, as well as the state-of-the-art concepts, designs and manufacturing techniques including Fused Deposition Modeling (FDM), Stereolithography (SLA), Direct Metal Laser Sintering (DMLS), Inkjet printing and Charge-Programmed Multi-material 3D Printing. Furthermore, a wealth of practical examples will be presented to illustrate promising applications of these intriguing concepts.

Break

17:05 - 17:15

17:15 - 18:40 — Auditorium I

Session 3A10

Imaging, inverse scattering and remote sensing

17:15 : Keynote talk
Microwave Imaging for Medical Diagnostics
Panagiotis Kosmas
King's College London, (United Kingdom)

The talk will briefly introduce the principles of medical microwave imaging (MWI) and then review recent progress from Dr Kosmas' team on the development and validation of this technique for brain imaging. This will include a study on the impact of using a metasurface to enhance signal penetration as well as a comparison of two-dimensional and three-dimensional tomographic approaches.

17:45 : Invited talk
Microwave imaging for real-world applications: from system design to experimental validation
Lorenzo Crocco
CNR-IREA (Italy)

In this communication, two microwave imaging devices to tackle real-world applications are presented. The first one is a device to monitor patients affected by brain stroke in the postacute stage, the second is a device for monitoring packaged food along the production line. The two devices share a common approach to the system development, as they are both designed taking into account the specific constraints imposed by the relevant scenarios and exploiting a rigorous design methodology.

18:05 : Invited talk
Electromagnetic and Geophysical models to estimate wind speed from Sentinel 1 radar images - C band
Ali Khenchaf
ENSTA Bretagne (France)

SAR (Synthetic Aperture Radar) systems are commonly used to observe the globe, and in particular the sea surface, since they can offer high spatial resolution data. To exploit SAR data, a description of the relationship between electromagnetic backscatter and the sea surface is essential. Thus, it is possible to use empirical (geophysical) or EM models. In this paper, we investigated and presented models for sea surface radar backscatter calculations and then used to estimate wind speed from Sentinel-1 images.

Ibrahim Akduman, Aleksandar Janjic
Istanbul Technical University (Turkey)

In this paper it will be presented a new microwave measurement configuration for the breast cancer imaging. The system consists of 36 modified Vivaldi antennas located circularly in an alumina matching medium. The operating frequency of the system is 0.4-8Ghz. The imaging system is clinically tested with 322 patients and now in the process of medical certification. During the talk the clinical results will be presented as well.

17:15 - 18:40 — Auditorium II

Session 3A11
Antenna theory and design

17:15 : Invited talk
Dielectric Nanoantennas for Versatile Light Control
Yuebing Zheng
The University of Texas at Austin (USA)

We apply silicon nanoparticles to achieve directional light scattering, directional emission of two-dimensional transition metal dichalcogenides (2D TMDs), and room-temperature near-intrinsic exciton linewidth in 2D TMDs. Hydrogenated amorphous and core-shell nanoparticles are synthesized to suppress optical loss and enable broadband directional scattering. A modified Mie theory for dipole-sphere hybrid systems is developed, along with numerical simulations, to instruct the optimal antenna design. We extend the theory to study a chiral emitter coupled with a silicon nanosphere.

Abdelfatah M. Ahmed[1], Siddig Tawer Kafi[1], Aida A. Salama[2]
[1] *Al-Neelain University (Sudan),* [2] *Azhar University (Egypt)*

This work aimed to investigate the effects of radiation from telecom antennas on rats kidneys .ninety six male rats were exposed to three radiation levels,.Eight rats from each group were examined after six and twelve weeks. The resultsc shown clear different in all investigated parameters. We concluded that exposure to tower radiation can cause several dameges on rats kidneys .

17:50 : Invited talk
Characteristic Modes for the design of compact radiators on complex platforms
Simone Genovesi[1], Francesco Alessio Dicandia[2]
[1] *University of Pisa (Italy),* [2] *Greenwaves (Italy)*

The placement of a communication system on a three-dimensional platform always poses a series of problems that the antenna designer has to solve or mitigate for guarantee the desired functional operability. Among the several challenges, the need of compact and conformal radiators is one of the hardest tasks to accomplish, especially if working on objects whose dimensions are comparable to the wavelength of interest. The solution to this problem can be pursued by using the Characteristic Mode Analysis.

Mohamed El Khamlichi[1], Alejandro Alvarez Melcon[2], Mohamed-Ali Ennasar[3], Otman EL Mrabet[1], Juan Hinojosa[2]
[1] *Abdelmalek Essaadi University (Morocco),* [2] *Universidad Politécnica de Cartagena (Spain),* [3] *National Higher School of IT (ENSIAS) (Morocco)*

This paper presents a novel low-cost and flexible passive RFID tag antenna for blood monitoring and tracking, which is in great demand by e-healthcare applications. The tag antenna consists of two compact symmetrical capacitive structures and works at the ultra-high frequency (UHF) European band (865 MHz-868 MHz). Measurement results show that the proposed design has a read range of 2.2 m, which is 4.4 times higher than commercial RFID tag antennas.

Aiman Mughal, Jithin Mudakkarappilli Sudersanan, Shermila Mostarshedi, Benoit Poussot, Jean-Marc Laheurte
Université Gustave Eiffel (France)

Mono-static radar cross section (RCS) is estimated for a set of randomly distributed loaded thin dipoles. The RCS calculation is performed using two techniques based on the total backscattered field and the radar equation. Different dipole configurations and complex load impedances are studied in order to highlight the RCS distortion. Numerical Electromagnetics Code (NEC) simulator is used for the computations.

17:15 - 18:25 — Auditorium III

Session 3A12
Instrumentation, and measurements

17:15 : Invited talk
Giant Magnetoimpedance Microwires for Sensor Applications
Arkady Zhukov, Paula Corte-Leon, Lorena Gonzalez-Legarreta, Mihail Ipatov, Juan Maria Blanco, Valentina Zhukova
Universidad del Pais Vasco (Spain)

The influence of post-processing (annealing and stress-annealing) on the Giant magnetoimpedance (GMI) effect in thin magnetic microwires is reviewed. High GMI effect has been observed in Co-rich magnetic microwires with vanishing magnetostriction coefficient. Post-processing including annealing or stress-annealing at adequate conditions allows further improvement of GMI effect in Co-rich magnetic microwires.

17:35 : Invited talk
Assessment of Electromagnetic Field Threats to a Military Airport
D. V. Giri[1], F. M. Tesche[2]
[1] *University of New Mexico (USA),* [2] *EMConsultant (USA)*

A recent area of concern is how to insure the continued functioning of critical elements of societal infrastructure amid increasing forms of terrorist activities. One new threat is the use of an HPEM source to create intentional electromagnetic interference (IEMI). This threat involves deliberately illuminating a facility or sub-system with a sufficiently intense EM field, to cause an interruption in the normal operation of the facility's electrical equipment.

Daniel Bourreau, Alain Péden
IMT Atlantique (France)

This paper presents the implementation of free space Sparameter measurement setups in the Ka, W and J bands. The complex permittivity is extracted without any specific processing on the S-parameters from 26 up to 330 GHz. The comparison between the measured and simulated four Sparameters (magnitude and phase) shows very good agreement and validates the test benches as well as the calibration procedure.

Youness Zaarour[1], Mohammed Ali Ennasar[2], Otman El Mrabet[2], Hafid Griguer[1], M'Hamed Drissi[3]
[1] ***Mohammed VI Polytechnic University (Morocco),*** [2] ***University of Abdelmalek Essaadi (Morocco),*** [3] ***INSA Rennes (France)***

The proposed compact sensor is based on a Split Square Resonator (SRR) to improve the detection. The dimensions of the SRR have been chosen to provide a mutual coupling with a high sensitivity. The material under test (MUT) is placed in the near-field region of the sensor. This design exhibits a high sensitivity close to 58 % as the relative permittivity of MUT's changes from 1 to 10. The proposed sensor can measure the permeability and losses.

Conference Dinner and Horse (Fantasia) Show

Departure by bus from Kenzi Rose Garden Hotel at 19:30

19:30 - 23:30

Friday 27th May, 2022

9:00 - 09:35 — Auditorium I

Session 4A1
Plenary

09:00 : Plenary talk
The challenge of EM simulation for the design of automotive radar frontends
Marta Martinez-Vazquez
Renesas Electronics Europe GmbH (Germany)

This presentation analyses the trends for automotive radar systems, including high-definition imaging and new sensor architectures. The focus will be on RF performance and its impacts on the frontend design. Design bottlenecks like the interface between the MMIC and the radar board, electromagnetic interference or the effect of the casing and the fascia will be discussed.

Coffee Break
09:35 - 10:00

10:00 - 11:40 — Auditorium I

Session 4A2
Broadband and multi-band antennas

10:00 : Invited talk
Design of a Compact Dual-Circular-Polarized Cavity-Backed Spiral Antenna
Ivan Bailon-Ballesteros[1], Kerlos Atia Abdalmalak[1], Ahmed El Yousfi[1], Vicente Gonzalez-Posadas[2], Daniel Segovia-Vargas[1]
[1] Carlos III University of Madrid (Spain), [2] Polytechnic University of Madrid (Spain)

In this paper, a dual-circular-polarized antenna is presented. The compactness of the design is the greatest contributionof this work, achieving dual circular polarizationwith a single antenna. The design is based on a four-armspiral with differential feeding to achieve the desired polarization. The antenna achieves a bandwidth of 60 % (from 4 to 7.5 GHz) for an axial ratio below 3 dB, return losses below-8 dB and isolation below -30 dB. Symmetric radiationpattern with gain higher than 7 dB is obtained.

10:20 : Invited talk
A New Microstrip Sierpinski Carpet Antenna Using a Circular Pattern With Improved Performance
Abdelhakim Moutaouakil[1], Younes Jabrane[1], Abdelati Reha[2], Abdelaziz Koumina[1]
[1] Cadi Ayyad University (Morocco), [2] Laboratoire d'Innovation en Management et en Ingénierie pour l'Entreprise (Morocco)

In this work, we present the two first iterations design of the Sierpinski carpet fractal antenna by using a circular pattern. The proposed antenna is printed on FR4 substrate with a dielectric constant of 4.4. At the second iteration, the studied antenna has a multiband behavior with four resonant frequencies with a good impedance matching. The simulated results performed by CADFEKO a Method of Moments (MoM) based Solver and measurement using Vector Network Analyzer are in good agreement.

10:40 : Wideband Design and Optimization of Reflectarray Antennas *On-line*

Manuel Arrebola, Daniel R. Prado, Marcos R. Pino
Universidad de Oviedo (Spain)

This paper describes a technique for the design and optimization of wideband reflectarrays based on the generalized intersection approach and a direct layout optimization using a method of moments based on local periodicity. Results for two very large dual-linear reflectarrays for direct-to-home applications are provided and discussed. The first is a reflectarray working in a 15 % bandwidth with European coverage. The second antenna provides coverage to South America in two frequency bands with very tight requirements.

Henna Farheen[1], Lok-Yee Yan[2], Till Leuteritz[2], Siqi Qiao[2], Florian Spreyer[1], Christian Schlickriede[1], Viktor Quiring[1], Christof Eigner[1], Thomas Zentgraf[1], Stefan Linden[2], Jens Forstner[1], Viktor Myroshnychenko[1]
[1] *Paderborn University (Germany),* [2] *Universität Bonn (Germany)*

We show the numerical and experimental realization of broadband optical traveling-wave antennas made from low-loss dielectric materials which exhibit highly directive patterns. The high directivity is a result of the interplay between two dominant TE- and leaky-modes present in the antenna director. These antennas possess near unity radiation efficiency at the operational wavelength of 780nm, maintaining a broad bandwidth. We envision that our all-dielectric approach demonstrates a new class of antennas that are excellent candidates for optical-communication and sensing.

Ali Houssein Harmouch
Lebanese University (Lebanon)

Small Ultra-Wideband Efficient Antennas are of great importance and have many applications in the wireless market, that requires from these antenna structures to be able to perform at all desired subbands starting from LTE (780MHz) up to WiMAX applications (5.5 GHz) with a good level of radiation efficiency and dimensions not exceeding 150mm*100mm*10mm. Simulation results using CST software suite have shown a clear enhancement in the bandwidth (6:1), and radiation efficiency (Gain = 5dB in average).

Muhammad Junaid Mughal, Adnan Iftikhar, Muhammad Farhan Shafique, Sarib Azaz Gondal, Umer Farooq, Adnan Fida, Bilal Ijaz
COMSATS University (Pakistan)

A band reject broadband antenna with bandwidthof 8.82 GHz operating in the Ku-band realized in multilayerconfiguration is proposed in this paper. The band rejection hasbeen achieved by introducing Split Ring Resonators (SRRs).The multilayer topology adopted in this paper has resulted inan overall antenna size of 22 x 12 x 2:285 mm3. Such topology allows an additional benefit of loading the middle layer with SRRs to reject a specific frequency.

10:00 - 11:15 — Auditorium II

Session 4A3

Electromagnetics and materials

10:00 : Invited talk
3D printed microrobots controlled by light - Towards environmental and biomedical applications
Ada-Ioana Bunea, Einstom Engay, Alexandre Emmanuel Wetzel, Rafael Taboryski
Technical University of Denmark (Denmark)

Microrobots are rapidly developing as a valuable solution for performing microscale tasks, among which they seem particularly promising for biomedical and environmental applications. Two-photon polymerization enables the fabrication of microstructures with complex shapes, while focused laser beams allow for precise manipulation of such 3D printed objects. Whereas several challenges have yet to be overcome before microrobots can perform in the real world, many interesting laboratory applications have already been demonstrated, while others are being explored.

10:20 : Invited talk
Dirac cones in SOI photonic crystal slabs: dispersion relation, reflection spectra, selection rules, and non-Hermiticity
Yuanzhao Yao, Naoki Ikeda, Takashi Kuroda, Takaaki Mano, Hiromi Koyama, Yoshimasa Sugimoto, Kazuaki Sakoda
National Institute for Materials Science (Japan)

We materialized the mid-IR Dirac-cone dispersion relation with photonic crystal slabs fabricated in SOI wafers. Their dispersion relation, which was measured by angle-resolved reflection spectroscopy with our home-made high-resolution apparatus, agreed well with its numerical calculation and the selection rules derived by the k-p perturbation theory. We also evidenced the distortion of the Dirac cones caused by the non-Hermiticity by the numerical calculation of the dispersion relation and the reflection spectra.

10:40 : Invited talk
Tomographic Ground Penetrating Radar: Comparison of Various Image Configurations
Mallikarjun Erramshetty
National Institute of Technology Goa (India)

This paper presents tomographic detection of dielectric and conducting objects buried beneath earth subsurface. Three tomographic image configurations are considered: Bistatic, Singleview-multistatic, Multiview-multistatic configurations. The reconstruction capabilities of each are studied by considering numerical examples. The effect of erroneous assumption on the background medium is investigated. Truncated singular value decomposition (TSVD) is used for the inverse solution. The study also show the effect of truncation number in TSVD on output result.

Ying Yang, Kun-Shan Chen
Guilin University of Technology (China)

This paper examines the Brewster effect of incoherent scattering from a lossy inhomogeneous rough surface with vertical dielectric profile. Numerical results show that the Brewster angle gradually moves to the large incident angle with an increase of the background dielectric constant and of the surface root mean squared (rms)height. The angular dependence of reflection coefficients, both the level and the trend, is slightly affected by the correlation length. The scattering strength is much more sensitive tothe rmsheight than to the correlation length.

10:00 - 10:50 — Auditorium III

Session 4A4
Antenna theory and design

10:00 : Invited talk
Advances in the theory of Characteristic Modes
Miguel Ferrando-Bataller, Marta Cabedo-Fabrés, Eva Antonino-Daviu
Universitat Politecnica de Valencia (Spain)

The Characteristic Mode Theory was developed by Professor Roger F. Harrington and his collaborators, relating currents in the radiating structure to the associated modal fields. It has been extensively developed following the paper published by the authors of this communication, revisiting the theory and applying it to the analysis of planar antennas. The latest advances in cubesat, planar lens structures, antennas for MIMO applications for 5G applications and metamaterials are presented.

Abdenasser Lamkaddem[1], Abdenacer Es-Salhi[2], Ahmed El Yousfi[1], Kerlos Atia Abdalmalak[1], Vicente Gonzalez Posadas[3], Daniel Segovia Vargas[1]
[1] *Carlos III University of Madrid (Spain),* [2] *Mohammed I University (Morocco),* [3] *Polytechnic University of Madrid (Spain)*

This paper presents the development of a dual-band antenna working in the Industrial, Scientific, and

Medical (ISM) band (902 - 928 MHz, 2.4 - 2.5 GHz). The proposed antenna is compact, has a frequency-independent response between the lowest and the highest frequency, has a small size of 6 x 6 x 2.54 mm3. This design does not use any via or defected ground plane making the antenna very useful for this kind of application.

10:35 : Polarization Reconfigurable Patch Antenna with Ground Slots for Sub-6GHz Applications *On-line*
Manpreet Kaur, Hari Shankar Singh, Mayank Agarwal
***Thapar Institute of Engineering and Technology** (India)*

A polarization reconfigurable patch antenna truncated at the corners has been presented in this paper. The proposed antenna is covering the sub-6GHz band (4.8-5GHz). In order to achieve reconfigurability, D-shaped slots have been cut in the ground plane and PIN diodes are inserted in each slot. The antenna is capable of switching between two polarization states i.e. linear polarization and circular polarization. Moreover, 3D radiation pattern of the design is also shown in order to check the pattern stability.

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