

Final Report for ONR project ‘Fifteenth International Congress on Artificial Materials for Novel Wave Phenomena – Metamaterials 2021’

ONR grant No. N00014-20-1-2524

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The ONR grant No. N00014-20-1-2524 has been used to support the Fifteenth International Congress on Artificial Materials for Novel Wave Phenomena – Metamaterials 2021, in particular to support the participation of 150 students to both the Conference and the Doctoral School. The period of performance spanned across the time period from April 15, 2020 to April 14, 2022. In the following, we describe the main achievements enabled by this grant and the success of this conference in bringing together scientists from different countries and backgrounds to discuss science.

Conference Locations:

- **Initially expected to be onsite at The City University of New York from August 2-7, 2021, the Congress has been moved to an online format in the week of September 20-25, 2021 because of the worldwide sanitary situation and related travel restrictions.**

Meeting/Conference Web Site:

<https://congress2021.metamorphose-vi.org/>

Overview of Conference:

The Congress, comprise a Conference and a Doctoral School, was held over six days from September 20-25, 2021. The program of the Conference featured 4 plenary 1-h talks, 110+ invited 30-minute talks, 195+ regular 15-minute talks organized in 48 oral sessions and 12 special sessions. In addition, the program included five poster sessions. The Conference had 591 attendees and 308 registered presenters from 43 different countries.

The Doctoral School featured six plenary lectures given by well-recognized experts of the field and it has been attended by more than 180 students.

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14. ABSTRACT The Congress followed the success of Metamaterials 2007-2020 and continues the traditions of the highly successful series of International Conferences on Complex Media and Metamaterials (Bianisotropics) and Rome International Workshops on Metamaterials and Special Materials for Electromagnetic Applications and Telecommunications. The Congress main objective was to provide a unique topical forum to share the latest results of the metamaterials research and bring together the engineering, physics, applied mathematics and material science communities working on artificial materials and their applications in electromagnetism/optics, acoustics/mechanics, transport, and multi-physics. The Doctoral School offered a unique opportunity to students and young researchers to meet pioneers and leading experts in light scattering at the extreme and get exposure to the latest advancements in this burgeoning research field. The Congress, comprise a Conference and a Doctoral School, was held over six days from September 20-25, 2021. The program of the Conference featured 4 plenary 1-h talks, 110+ invited 30-minute talks, 195+ regular 15-minute talks organized in 48 oral sessions and 12 special sessions. In addition, the program included five poster sessions. The Conference had 591 attendees and 308 registered presenters from 43 different countries. The Doctoral School featured six plenary lectures given by well-recognized experts of the field and it has been attended by more than 180 students.			





15th International Congress on Artificial Materials for Novel Wave Phenomena

Metamaterials 2021

New York, USA, 2 – 7 August, 2021

The Fifteenth International Congress on Artificial Materials for Novel Wave Phenomena – *Metamaterials 2021*, will comprise a **4-day Conference (2–5 August)**, and a **2-day Doctoral School (6–7 August)**. Co-organized by the *METAMORPHOSE VI AISBL* (<https://www.metamorphose-vi.org>) and The City University of New York (CUNY), this Congress follows the success of *Metamaterials 2007-2020* and continues the traditions of the highly successful series of *International Conferences on Complex Media and Metamaterials (Bianisotropics)* and *Rome International Workshops on Metamaterials and Special Materials for Electromagnetic Applications and Telecommunications*. The Congress will provide a unique topical forum to share the latest results of the metamaterials research. It will bring together the engineering, physics, applied mathematics and material science communities working on artificial materials and their applications in electromagnetism/optics, acoustics/mechanics, transport, and multi-physics.

Please be informed that if the sanitary situation will not allow holding the Congress in New York, it will run in an online format in a later week tentatively scheduled for September 20-25, 2021.

<p style="text-align: center;">Paper Submission</p> <p>Papers should be 2-3 pages long and contain an abstract, a brief conclusion, and a main body where technical content and novelty of the work are clearly presented. Papers should be submitted as camera-ready PDF files to the website: https://congress.metamorphose-vi.org</p> <p>Authors are requested to use the template provided on the Congress website when preparing their submission. Authors of accepted and presented papers will be given the option of publishing their work in <i>IEEE Xplore</i> subject to the manuscript compliance with the format and copyright requirements.</p>	<p style="text-align: center;">Topics</p> <p><i>Potential topics include but are not limited to:</i></p> <ul style="list-style-type: none"> • Physics of complex electromagnetic materials • Analytical and numerical modelling of metamaterials and metasurfaces • Homogenization and effective medium models • Fabrication and experimental characterization of metamaterials • Nonlinear, tunable, reconfigurable, and programmable metamaterials and metasurfaces • Time-space modulated structures • Active and absorption-free metamaterials • Chiral and bianisotropic composites • Metamaterials with extreme parameters • Quantum and superconducting metamaterials • Carbon nanotubes, graphene and other 2D materials • Nonreciprocal and topological metamaterials • Multiscale metamaterials • Plasmonics • Photonic crystals and EBG structures • Antenna and absorber applications of metamaterials • RF and microwave metamaterials: design, properties, applications • Metamaterials for 5G applications • Millimeter wave/THz metamaterials and applications • Optical metamaterials and their applications • Acoustic metamaterials • Mechanical and elastic metamaterials • Metamaterials for nanoelectronics, nanophotonics and nanoantennas • Metamaterials for control of heat flow and radiation • Metamaterials for quantum electronics • Metamaterials for sensing • Metamaterials in naval and aeronautic applications • Biological and biomedical applications of metamaterials • Super-resolution and near-field imaging: effects and devices • Transformational electromagnetics, elastodynamics, hydrodynamics and thermodynamics • Advances in cloaking and invisibility • Metamaterials in education
<p style="text-align: center;">Committees</p> <p style="text-align: center;">General Chair Andrea Alù, USA</p> <p style="text-align: center;">Technical Program Committee Chair Carsten Rockstuhl, Germany</p> <p style="text-align: center;">Steering Committee Chair Alessio Monti, Italy</p> <p style="text-align: center;">Local Organizing Committee Andrea Alù (Chair) Diana Strickland Leah Abraha Alex Krasnok (PhD school Chair) Younes Radi (PhD school Chair)</p>	<p style="text-align: center;">Doctoral School on Metamaterials</p> <p>A course of the <i>European School on Metamaterials</i> operated by the <i>METAMORPHOSE VI</i> will be held in conjunction with the Congress (6-7 August 2021). The theme of the course is still under consideration and will be announced soon in the website. For more information visit the website: https://school.metamorphose-vi.org/</p>
<p style="text-align: center;">Contact</p> <p style="text-align: center;">contact@metamorphose-vi.org</p>	<p style="text-align: center;">Submission deadline</p> <p style="text-align: center;">7 March 2021</p>







Congress flyer

Organizing Committee: Andrea Alù, CUNY; Diana Strickland, CUNY; Leah Abraha, CUNY; Alex Krasnok, CUNY; Younes Radi, CUNY.

Congress Aim: The Congress followed the success of *Metamaterials 2007-2020* and continues the traditions of the highly successful series of *International Conferences on Complex Media and Metamaterials (Bianisotropics)* and *Rome International Workshops on Metamaterials and Special Materials for Electromagnetic Applications and*

Telecommunications. The Congress main objective was to provide a unique topical forum to share the latest results of the metamaterials research and bring together the engineering, physics, applied mathematics and material science communities working on artificial materials and their applications in electromagnetism/optics, acoustics/mechanics, transport, and multi-physics.

The Doctoral School offered a unique opportunity to students and young researchers to meet pioneers and leading experts in light scattering at the extreme and get exposure to the latest advancements in this burgeoning research field.

	Friday, 24 September	Saturday, 25 September			
09:00 - 10:30	<i>Sergei Tretyakov</i> Perfect Absorption, Coherent and Virtual Perfect Absorption	<i>Alex Khanikaev</i> Topological Effects in Photonics: Introduction to the Area			
10:30 - 11:00	Break and online discussion with the speaker		S. Tretyakov	T. Kottos	A. Khanikaev
11:00 - 12:30	<i>Andrey Bogdanov</i> Embedded Eigenstates	<i>Tsampikos Kottos</i> Exceptional Points and PT - Symmetric Structures			
12:30 - 13:00	Break and online discussion/Q&A with the speaker		A. Bogdanov	F. Monticone	M. Khajavikhan
13:00 - 14:30	<i>Francesco Monticone</i> Scattering by Finite Objects: Theory, Extreme Effects, and Fundamental Bounds	<i>Mercedeh Khajavikhan</i> Topological Effects in Photonics: Applications			

Program and pictures of the speakers of the Doctoral School that has been held right after the Conference on September 24-25, 2021.

Spirit of the Conference and Scientific Program: The Metamaterials Congress series is convened annually by the METAMORPHOSE Virtual Institute since 2007 and is recognized as a prime and high-quality scientific event for the whole metamaterial community. Since its first edition, in fact, the Congress has continuously evolved and established itself as the leading and natural forum for a broad class of scientists working on the design and applications of artificial materials in different fields.

The Congress was originally planned to be on-site in New York. However, the ongoing concerns and uncertainties caused by the pandemic pushed us to opt for a fully virtual event. The format change has been announced in March 2021 and its aim was to ensure the Community to stay together while protecting the health and safety of our participants. The extraordinary participation to the Congress confirmed the need of the Community to keep enhancing ideas and research results despite the challenges of the current time.

Organizers: The conference was co-organized by the METAMORPHOSE VI AISBL, a non-for-profit International Association, whose purposes are the research, the study and the promotion of artificial electromagnetic materials and metamaterials, and The City University of New York (CUNY).

Expenditures of funds supplied by the Office of Naval Research:

The total record of expenditures on this grant was for \$20,000.00, generously supported by the Office of Naval Research. This funding was used to support the registration fees

(both for the Conference and the School) for 150 students. The student grants have been assigned after a public call distributed through the Congress website and mailing list: <https://congress2021.metamorphose-vi.org/index.php/onr-and-nsf-student-grant>, through a competitive process that considered the student's financial needs and the submitted work that the student would be able to present.

Conference Sponsors:

American Physical Society (APS)
Meta Materials Inc. (“META®”)
IOP Publishing
New Journal of Physics
Wiley
Laser & Photonics Review
Office of Naval Research
National Science Foundation

The conference program can be found at the link: [Conference Program.](#)

The doctoral school program can be found at the link: [Doctoral School Program.](#)

Presentation Data:

Plenary Invited Presentations: 4
Invited Presentations: 112
Contributed oral Presentations: 196
Poster Presentations: 18



Prof. Alù speaking at the opening session of the Fifteenth International Congress on Artificial Materials for Novel Wave Phenomena – Metamaterials 2021.



Some of plenary speakers (above: Prof. Mark L. Brongersma, Stanford University, and Prof. Alexandra Boltasseva, Purdue University; below on the left: Prof. Sebastian Huber, Institut für Theoretische Physik) during their talk. Below on the right: Prof. Carsten Rockstuhl, Karlsruhe Institute of Technology, Chair of the Technical Program Committee of the Conference.



Pictures of the session chairs involved in Metamaterials 2021. Chairs have been corresponding with presenters to finalize the program, will guide the discussion around the presentations, and run the technical side of the show. They have been really coordinating and orchestrating the whole conference alongside the organizers.