METAMATERIALS CONGRESS

meta morphose VIRTUAL INSTITUTE

ADVANCED SCIENCE RESEARCH CENTER
THE GRADUATE CENTER
CITY UNIVERSITY OF NEW YORK

CUNY THE CITY UNIVERSITY OF NEW YORK

20th International Congress on Artificial Materials for Novel Wave Phenomena | New York City, 2026

METAMATERIALS 2026

August 31–September 5

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Artificial Materials for Novel Wave Phenomena

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Contents

Message from the General Chair

Dear Colleagues and Friends,

It is my great pleasure to welcome you to Metamaterials 2026 in New York City!

Over the past two decades, metamaterials have evolved from a scientific concept into a vibrant and transformative field, influencing disciplines ranging from electromagnetics and optics to communications, sensing, energy, quantum technologies, and beyond. Today, the pace of discovery and innovation continues to accelerate, driven by new theoretical insights, advanced fabrication capabilities, artificial intelligence, and interdisciplinary collaboration. We are fortunate to be part of a truly dynamic and thriving community.

Metamaterials 2026 brings together leading researchers, innovators, students, industry professionals, and newcomers from around the world to share the latest advances and discuss emerging technologies and opportunities. Now in its 20th edition, the conference provides a unique forum for presenting cutting-edge research, exchanging ideas, fostering new partnerships, and exploring future directions that will shape science and technology for years to come.

The conference program, expertly assembled by the Program Committee under the leadership of Prof. Ewold Verhagen, features distinguished plenary speakers, invited and contributed presentations across five technical tracks, special symposia, a vibrant poster session, and numerous networking opportunities designed to stimulate discussion and inspire new collaborations across academia, industry, and government laboratories.

It is particularly exciting for me, as Past President of Metamorphose, to welcome Metamaterials for the first time outside Europe and in North America. As many of you may recall, we embarked on this adventure in 2020 and 2021, but the conference had to be held online because of the pandemic. Six years later, we are finally able to welcome our broad international community to New York City. It is especially meaningful that this milestone coincides with the 20th edition of the conference. I still fondly remember attending the first edition in Rome as a graduate student, and I am deeply honored to help host the conference in New York twenty years later. I would like to thank the Metamorphose leadership, especially Prof. Alessio Monti and Prof. Filiberto Bilotti, for their support of this endeavor, as well as all members of the Local Organizing Com-

mittee, who have worked tirelessly to prepare this exciting event.

On behalf of the Organizing Committee, I extend my sincere gratitude to all authors, speakers, sponsors, exhibitors, reviewers, session organizers, and volunteers whose dedication and contributions make this conference possible. Most importantly, I thank all participants for being part of this international community and for helping advance the frontiers of metamaterials research.

I hope that Metamaterials 2026 will be scientifically rewarding, professionally enriching, and personally enjoyable for all of you. I wish you a successful conference and a pleasant stay in New York City, and I look forward to the stimulating discussions, new collaborations, and exciting discoveries that lie ahead.

Welcome to Metamaterials 2026!

Andrea Alù, General Chair, Metamaterials 2026; Past President of the Virtual Institute for Artificial Electromagnetic Materials and Metamaterials (METAMORPHOSE VI)

Message from the President

Welcome to *Metamaterials 2026*, the *20th International Congress on Artificial Materials for Novel Wave Phenomena*, held in the dynamic and exciting city of New York, New York, USA. It is a pleasure and an honor for me to welcome all of you from around the world – as we gather once again to discuss the progress and continued evolution of our beloved field of metamaterials.

Over the past three decades, metamaterials have transformed from a bold scientific vision into a vibrant and far-reaching research discipline. Today, the field continues to inspire fundamental discoveries while enabling new technologies across electromagnetics, photonics, acoustics, mechanics, quantum science, information processing, energy, biomedical engineering, and many other areas. This remarkable growth reflects not only the creativity of individual researchers but also the strength of the international community built on collaboration, openness, and the free exchange of ideas.

The scientific program assembled for this 20th anniversary conference reflects both the growth of our field and the exciting directions that are forthcoming. Throughout the week, you will have the opportunity to engage with outstanding plenary and invited presentations, contributed papers and poster presentations, lively discussions, and the exchange of new ideas that often become the seeds for future collaborations and breakthroughs. The accompanying Doctoral School continues our longstanding commitment to educating and inspiring the next generation of scientists and technologists who will shape the future of metamaterials.

On behalf of the METAMORPHOSE Virtual Institute, I extend my sincere appreciation and gratitude to everyone whose dedication has made this conference possible. I thank the local organizing committee, the Technical Program Committee, the Steering Committee, the Scientific Advisory Board, our sponsors and partners, the reviewers for their careful evaluations, the plenary and invited speakers for sharing their expertise, the Doctoral School instructors for mentoring our young researchers, and, most importantly, all authors and participants whose scientific contributions form the heart of this congress.

It is a privilege for me to serve as President of the METAMORPHOSE Virtual Institute and to witness the continued growth, vitality, and international impact

of our community. As we celebrate the twentieth edition of this conference, we also look toward the future with optimism, excitement, and confidence that the discoveries and collaborations emerging from this meeting will continue to advance science, technology, and society.

I wish you an exciting, productive, and enjoyable week in New York City. May your time here lead to stimulating discussions, new collaborations, lasting friendships, and exciting ideas that will shape the next chapter of our field.

Enjoy the conference!

Nader Engheta, President of the Virtual Institute for Artificial Electromagnetic Materials and Metamaterials (METAMORPHOSE VI AISBL)

Message from the Technical Program Committee Chair

On behalf of the Technical Program Committee, it is my great pleasure to welcome you to Metamaterials 2026. This 20th edition of the International Congress on Artificial Materials for Novel Wave Phenomena brings together an exciting breadth of research that illustrates just how vibrant our field is, and how the vision of metamaterials continues to inspire new science in ever-expanding directions – from quantum and topological wave phenomena to time-varying and programmable systems, and from meta-optics and physical computing to acoustics, mechanics, thermal science, biophysics, and wireless technologies.

We are delighted that so many of you are joining us in New York from all over the world, contributing to a diverse program that brings together different communities, approaches, and generations of researchers. It includes five plenary lectures by renowned pioneers who continue to lead our field into new territory: Silvia Vignolini, Romain Fleury, Michal Lipson, Peter McMahon, and Teri Odom. The technical program includes more than 200 invited and contributed talks in 60 parallel sessions over the four conference days. Together, they highlight not only the remarkable scientific breadth of the field, but also the diversity of the researchers who are shaping its future. The program includes three thematic Special Sessions, devoted to electromagnetic information theory for programmable metamaterials, programmable mechanics and instabilities, and new frontiers of sound. In addition, a special session organized with the American Physical Society and the editors of the Physical Review journals showcases selected recent works from Physical Review. Continuing a successful initiative from last year, we have again given posters a prominent place in the program. Four dedicated poster sessions are held immediately after lunch, providing ample opportunity for discussion and discovering exciting new work.

A program of this scope is only possible through the efforts of a great many people. I would first like to thank all authors for submitting their most exciting work, and all reviewers for carefully evaluating the contributions. We are grateful for the advice and experience of the Steering Committee and of previous edition's Technical Program Committee chairs, the Special Session organizers, and the Physical Review editors and APS as well as all other sponsors for their support. I want to particularly thank the members of the Technical

Program and Program Formation Committees, whose collective effort has produced a program so rich that I have found myself wishing I could attend several parallel sessions at once.

Special thanks go to Mirko Barbuto and Alessio Monti for their invaluable support in countless organizational matters, Stefano Vellucci for carefully and swiftly editing the program, the General Chair Andrea Alù and the entire local organizing committee for their tremendous work, enthusiasm, and support throughout the past year.

I look forward to stimulating days of science, discussion, and connections in Manhattan, and wish you all an inspiring and enjoyable Metamaterials'2026.

Ewold Verhagen, Chair, Technical Program Committee

Organizers

METAMORPHOSE VI

The Virtual Institute for Artificial Electromagnetic Materials and Metamaterials, in short the ”METAMORPHOSE VI AISBL”, is a non-profit International Association, whose purposes are the research, the study, and the promotion of artificial electromagnetic materials and metamaterials. The Association has been established in 2007 by the partners of the FP-6 Network of Excellence ”METAMaterials ORganized for radio, millimeter wave, and PHOtonic Superlattice Engineering” - METAMORPHOSE NoE - funded by the European Commission in 2004-2008. The METAMORPHOSE VI is an active network integrating, managing, and coordinating several research and spreading activities in the field of Artificial Electromagnetic Materials and Metamaterials. In order to achieve its purposes, the METAMORPHOSE VI AISBL pursues the following activities:

- Integrate, manage, coordinate, and monitor research projects in the field of Artificial Electromagnetic Materials and Metamaterials
- Spread excellence in this field, in particular, by organizing scientific conferences and creating specialized journals in this field
- Create and manage research programmes in this field
- Activate and manage training programmes (including PhD and training programmes for students and industrial partners)
- Provide information on Artificial Electromagnetic Materials and Metamaterials
- Transfer new technology in this field to the Industry
- Offer advice and services related to Artificial Electromagnetic Materials and Metamaterials to industries, producers, distributors, potential users, service suppliers in Europe and worldwide. Among the other activities, the Association owns and organizes the Metamaterials Congress Series and the Doctoral Programmes on Metamaterials. (metamorphose-vi.org)

Advanced Science Research Center

The Advanced Science Research Center at City University of New York is a premier New York City research institution. Its mission is to break down barriers between scientific disciplines and foster university-wide collaborative research that yields breakthroughs in five core areas: Photonics, Nanoscience, Structural Biology, Neuroscience, and Environmental Sciences. The ASRC operates as the nucleus of a university-wide science enterprise, fostering an integrated research network that brings together faculty, students, and postdoctoral researchers from The Graduate Center and CUNY's colleges across the five boroughs.

In its striking 200,000-square-foot building, the ASRC's core facilities house some of the most advanced scientific instrumentation in the region, including state-of-the-art nuclear magnetic resonance spectrometers, a data analytics center featuring a large-scale visualization wall, a rooftop observatory and an anechoic test chamber capable of measuring electromagnetic radiation across the 1–110 GHz frequency range.

Among its flagship research programs, the Photonics Initiative has established CUNY as an internationally recognized center for the science and engineering of light–matter interactions. Directed by Prof. Andrea Alù, the Initiative brings together expertise in metamaterials, nanophotonics, wave physics, quantum photonics, imaging, sensing, and optical communications, providing a vibrant environment for both fundamental discoveries and technological innovation.

City University of New York

The City University of New York (CUNY) is the public university system of New York City. Founded in 1847 as the Free Academy of the City of New York, it traces its origins to the first free public institution of higher education in the United States. Established on the principle that advanced education should be accessible to talented students regardless of social or economic background, CUNY has played a central role in the intellectual, scientific, and cultural life of New York City for nearly two centuries.

Today, CUNY comprises 26 campuses distributed across the five boroughs, including 11 senior colleges, 7 community colleges, and 8 graduate and profes-

sional schools. Together, these institutions educate more than 275,000 students and form the nation's largest urban public university system.

Through its colleges, graduate programs, and research centers, CUNY advances research across a broad range of disciplines while educating generations of scholars, innovators, entrepreneurs, and public leaders. Its faculty and alumni include thirteen Nobel Prize winners, twenty-four MacArthur Fellows, and numerous distinguished figures in academia, industry, government, and the arts.

Committees

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Student Paper Competition

Selected Finalists (alphabetical order)

- **Klaas De Kinder**, *Dispersion-Mediated Novel Space-Time Modes*
- **Isabella Giovannelli**, *Tuning Chirped Pulses in Non-Hermitian Scattering Systems via Complex Time Delay*
- **David Moreno Gallego de la Sacristana**, *Wavefront-Tailored Extraordinary Optical Transmission with Babinet Nonlocal Metasurfaces*
- **Mia Morrell**, *Emergence of a Continuous Time Crystal from Classical Wave–Matter Interactions*
- **Xiao Zhang**, *Frequency Sorting with Lorentzian Time-Metamaterials*

Final Competition

The Student Paper Competition final will take place on **September 1**, in parallel with the conference poster session.
As previously communicated, in addition to presenting their papers during the regular technical sessions, all finalists are required to prepare a poster and discuss their work with the members of the Award Committee during the final session.The members of the Award Committee will interact with the students during the poster presentation and will elect the winner.

Awarding Ceremony

The winner of the Best Student Paper Competition will be announced during the Congress Closing Ceremony.

Awards

First Prize	Award certificate and cash prize of $300
Second Prize	Award certificate and cash prize of $200
Third Prize	Award certificate and cash prize of $100

Physical Review Journals Symposium and Awards

Physical Review Journals Symposium

The conference organizers and the editors of *Physical Review* invite you to a Special Session, dedicated to a few selected works published recently in the *Physical Review* journals, within and beyond the traditional domain of metamaterials research.

Physical Review Journals Awards

The Organizers are very proud to announce the **2026 Best Paper Awards** and **2026 Best Poster Award**, sponsored by APS Physics.
The Best Paper Awards have been created to recognize the scientific quality of research in three different domains (Applied/Theory/Experiments) whereas the Best Poster Award is not related to a specific domain.

All papers/posters presented at the conference, except for invited and plenary contributions, are eligible. The winners will be announced during the conference closing ceremony and consist of an APS branded certificate and a **US$ 250** cash prize.

ACS Photonics Poster Competition

The Organizers are pleased to announce that **ACS Photonics** will sponsor a **Poster Competition** dedicated to **Photonics contributions** presented at the conference.
All poster presentations related to Photonics are eligible for the competition. The winners will be announced during the conference closing ceremony and will receive:

First Prize:	US$ 350 cash prize + Certificate
Second Prize:	US$ 250 cash prize + Certificate
Third Prize:	US$ 150 cash prize + Certificate

Royal Society of Chemistry Poster Awards

The Organizers are pleased to announce the Royal Society of Chemistry (RSC) will sponsor two poster awards at Metamaterials 2026:

- The Nanoscale Horizons Prize
- The Nanoscale and Nanoscale Advances Prize

Both awards will be presented during the closing ceremony and will include:

- RSC branded certificate
- £200 RSC book voucher
- Free RSC membership for 1 year

Technical Presentation by GenISys

From Design to Device: What Metasurface and Nanophotonic Fabrication Actually Requires

GenISys, Inc.

Technical presentation held by Dr. Kaustubh Vyas, Assistant Director, North America, on GenISys, a leading provider of software solutions for nanofabrication, specializing in e-beam lithography data preparation, proximity effect correction, and optical lithography simulation and OPC.

Location

Proshansky Auditorium

Monday, August 31
13:00–13:30

Panel on Funding Opportunities for Metamaterials Research

Army Research Office (ARO)
Office of Naval Research (ONR)

Interactive discussion on research funding opportunities with program managers from the Army Research Office and Office of Naval Research.

Panelists

Tania Paskova (Army Research Office)
James Joseph (Army Research Office)
Joe Qiu (Army Research Office)
Antti Makinen (Office of Naval Research)

Location

Proshansky Auditorium

Tuesday, September 1
12:30–14:00

Meet-and-Greet with American Physical Society Editors

American Physical Society

Meet the editors of the American Physical Society journals, discuss your research, learn about the publication process, and receive advice on preparing and submitting manuscripts.

Location

Proshansky Auditorium

Wednesday, September 2
12:30–14:00

Practical Information

General Venue Information

Venue location

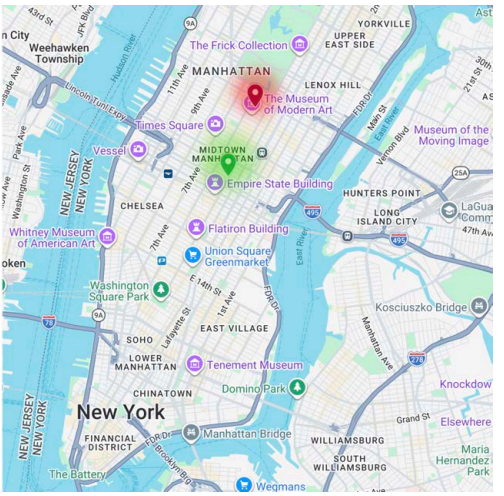
The conference will take place at the CUNY Graduate Center directly across from the iconic Empire State Building in the heart of Midtown Manhattan.

Conference sessions, lunches and welcome drinks:

CUNY Graduate Center
365 5th Ave
New York

Conference banquet
Wednesday at 18:30

Fogo de Chão
40 W 53rd St.
New York



The map indicates the CUNY Graduate Center (green pin), the conference dinner venue (red pin), and some of Midtown Manhattan's most iconic attractions within easy walking distance, including Times Square, the Museum of Modern Art, the Empire State Building, and the Vessel at Hudson Yards.

CUNY Graduate Center

The CUNY Graduate Center, the venue for Metamaterials'2026, is housed in the historic B. Altman Building on Fifth Avenue. Originally opened in 1905 as the flagship store of the renowned B. Altman & Company, the building is an elegant example of Italian Renaissance Revival architecture and has long been a prominent landmark in the heart of Midtown Manhattan. Following

an extensive restoration and adaptive reuse, the building was transformed for contemporary use while preserving many of its original architectural features. Today, its combination of historic elegance and modern facilities provides a unique setting for conferences and cultural gatherings. Most conference activities take place on the **Concourse Level** and the **First Floor** of the CUNY Graduate Center. All floors are accessible via elevators, and all restrooms are equipped for accessibility.

Main Entrance

Enter the CUNY Graduate Center through the main building entrance at 365 Fifth Avenue. The northernmost doors on Fifth Avenue are automated and ramp accessible. Both stairs and a ramp provide access to the building.

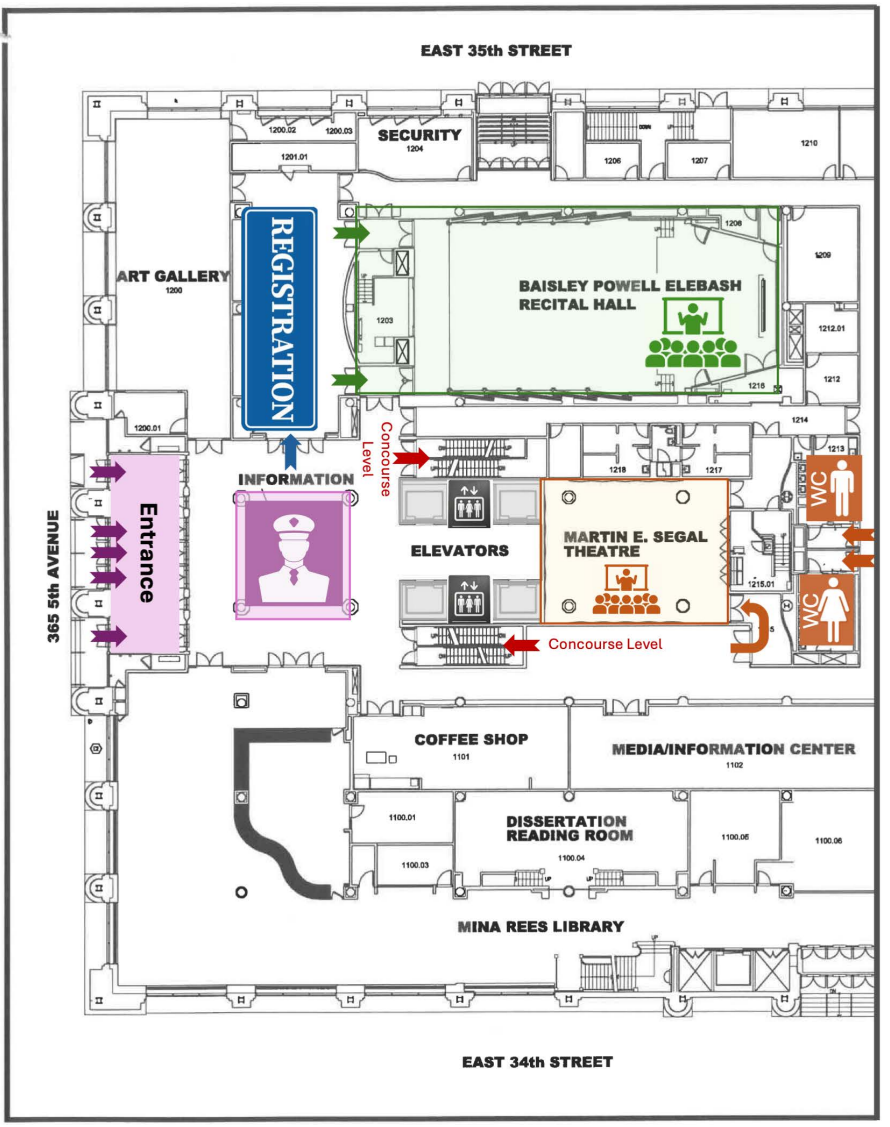
First Floor

The first floor provides access to the Registration Desk, Elebash Recital Hall, and the Martin E. Segal Theatre. Elevators and stairs provide access to the concourse level.

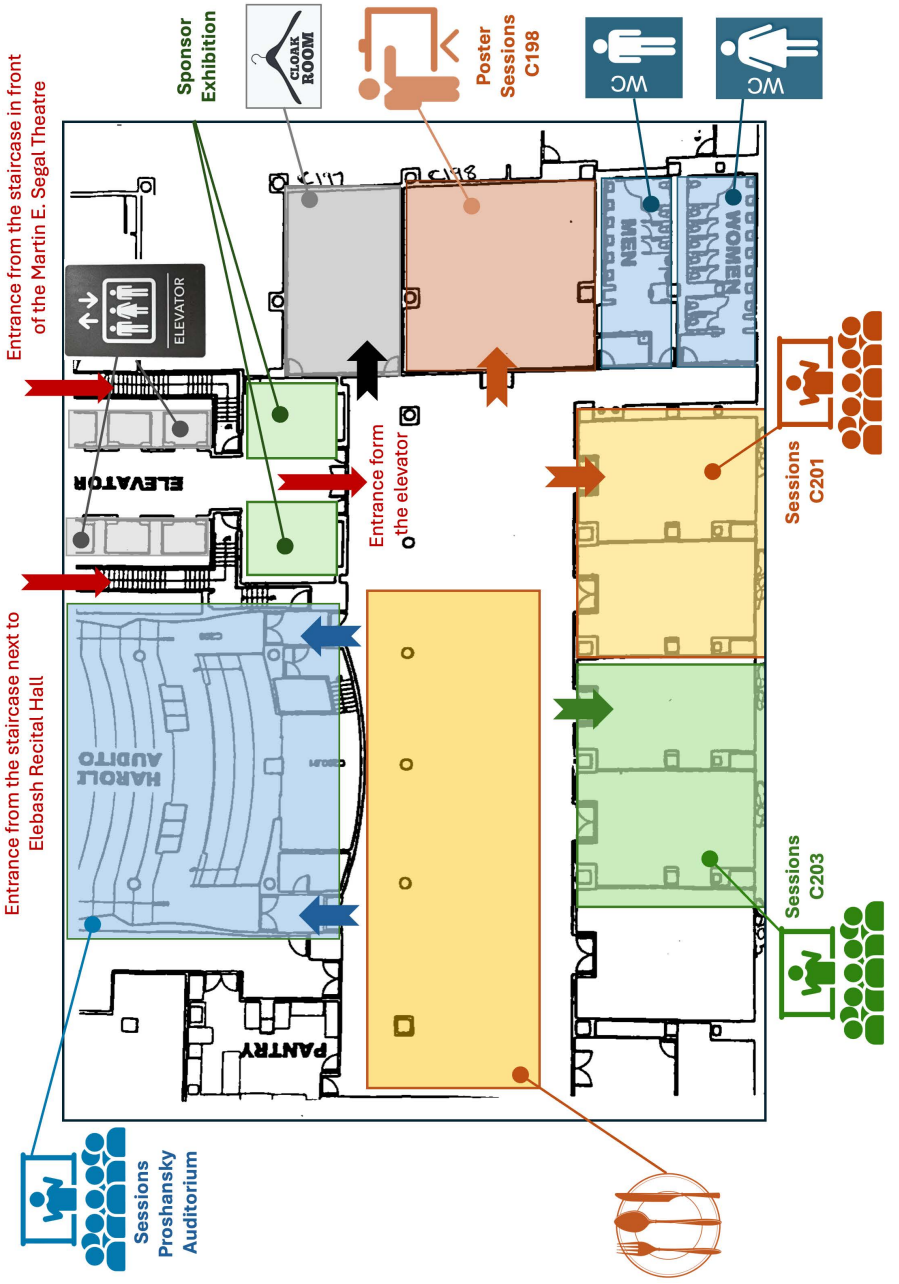
Concourse Level

The concourse level houses the Proshansky Auditorium, the concourse lobby and foyer, and meeting rooms C197, C198, and C201–C205.

First Floor Plan



Concourse Level



Plenary sessions

The conference plenary lectures will be held in the spacious **Proshansky Auditorium**, located on the concourse level of the CUNY Graduate Center. Equipped with modern audiovisual facilities, comfortable seating, and full accessibility, the auditorium provides an ideal setting for the conference's main scientific program.

Parallel sessions and posters

Location
Parallel sessions will be held in the **Elebash Recital Hall** and the **Martin E. Segal Theatre** on the first floor of the CUNY Graduate Center, as well as in the **Proshansky Auditorium** and Rooms **C201** and **C203** on the **Concourse Level**. Poster sessions will take place in Room **C198** on the **Concourse Level**.

Speaker instructions
Each presentation room is equipped with a Windows laptop, projector, and presentation remote. Speakers are encouraged to bring their presentation on a USB-A flash drive in either Microsoft PowerPoint or Adobe PDF format and to upload and test it on the presentation laptop in their assigned room well before the session begins, or at the latest during the preceding break. To avoid unexpected compatibility issues, we recommend verifying that the presentation displays correctly and that any embedded media play properly on the room laptop. If you prefer to use your own laptop, please inform the session chair before the session begins and allow sufficient time to ensure compatibility with the audiovisual equipment. Presenters are also kindly requested to introduce themselves to the session chair before the start of the session and to leave sufficient time for questions at the end of their talk (approximately 5 minutes for invited talks and 3 minutes for contributed talks).

Poster presenters
Posters can be put up in the **concourse level** room C198 at the start of the day and should be removed by the end of the last session of the day. Poster boards are 115×160 (width × height in cm), taking A0 format in portrait orientation. Poster boards are numbered. Please pick the board associated with your poster number as listed in the abstract book.

Registration Desk and Cloakroom

The registration desk is located in the **first-floor lobby of the Elebash Recital Hall**, immediately accessible upon entering the CUNY Graduate Center. Con-

ference participants may collect their name badges and conference materials here. The registration desk will be staffed daily during the hours indicated in the conference program. For security purposes, participants are kindly requested to wear or carry their conference badge while in the building. Those who do not have their badge with them may be asked to present a valid photo ID to security personnel to gain access to the conference venue.

A **cloakroom** will be available in Room **C197** on the **Concourse Level** throughout the conference for the convenience of participants.

Sponsor sessions and exhibitions

Sponsor exhibition booths are located on the Concourse Level. A **Physical Review Special Session** will be held in Room C203 on Wednesday at 10:30 AM. In addition, a **Meet-and-Greet with American Physical Society Editors** is scheduled for Wednesday at 12:30 PM in the Proshansky Auditorium.

Coffee breaks, lunch and lounge areas

Coffee breaks and lunch will be served on the **Concourse Level** of the CUNY Graduate Center in a standing buffet format, providing ample opportunities for informal discussions and networking among conference participants.

Welcome Reception

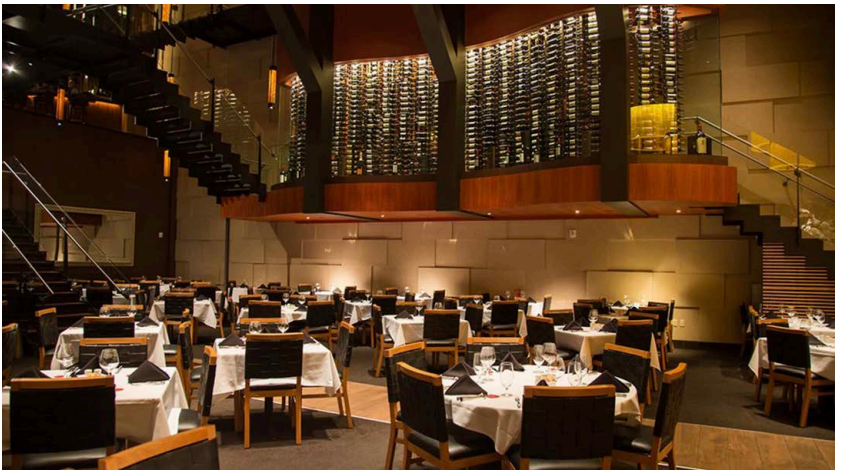
The Welcome Reception will be held in the **Dining Commons** on the eighth floor of the CUNY Graduate Center. This spacious glass-domed venue offers panoramic views of the Manhattan skyline, including the iconic Empire State Building, providing a welcoming setting for participants to meet, reconnect with colleagues, and enjoy music and informal discussions at the start of the conference.

Proceedings

The proceedings of Metamaterials 2026 are uploaded online.
Please visit the link:

https://congress.metamorphose-vi.org/proceedings2026.zip

Conference Dinner



The official conference dinner will be held at **Fogo de Chão**, a renowned Brazilian steakhouse located in the heart of Midtown Manhattan at **40 West 53rd Street**. The dinner offers an excellent opportunity to continue scientific discussions, reconnect with colleagues, and enjoy an informal evening in a welcoming atmosphere.
A wide selection of dishes, including **vegetarian options**, will be available to accommodate different dietary preferences.

Date:	Wednesday, September 2, 2026
Time:	19:00
Venue:	Fogo de Chão
Address:	40 West 53rd Street, New York, NY

Getting There

- **On foot:** Approximately a 20-minute walk north along Fifth Avenue to 53rd Street.
- **By subway:** From **34 St–Herald Sq**, take the uptown **B** or **D** train to **7 Av**, the **F** train to **5 Av/53 St**, or the **M** train to **57 St**.

Social Activity in Brooklyn

Tuesday, September 1, 2026 – 7:00 p.m.

All Metamaterials 2026 attendees are invited to join an informal social evening in Brooklyn following Tuesday's conference sessions.

Participants will travel together on a scenic ride on the public ferry from Manhattan (32nd street) to Brooklyn. After arriving, there will be the chance to split in smaller groups for dinner on your own, and enjoy a walk across the Brooklyn Bridge.

Please note that this is an informal group activity and does not include a guided tour. The conference will be able to provide ferry tickets for up to 100 participants on a first-come, first-served basis.

A sign-up sheet will be available at the conference registration desk. The meeting point, ferry departure time, and additional logistical details will be announced onsite.

Dinner and any other personal expenses will not be covered by the conference for this activity.

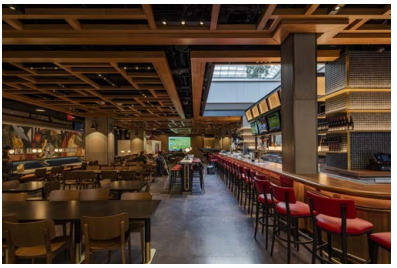
Nearby Restaurants

Looking for a change of scene during the breaks? The neighborhood surrounding the CUNY Graduate Center in Midtown Manhattan is home to numerous food halls, cafés, and restaurants, all within a short walk. Whether you're looking for a quick snack, a relaxed meal, a place to unwind between sessions, or simply an opportunity to explore the neighborhood during your stay, you'll find plenty of excellent options nearby.

Food Gallery 32

Approx. 5-minute walk

A popular Koreatown food hall featuring Korean cuisine, Asian specialties, desserts, and quick lunch options.



Moynihan Food Hall

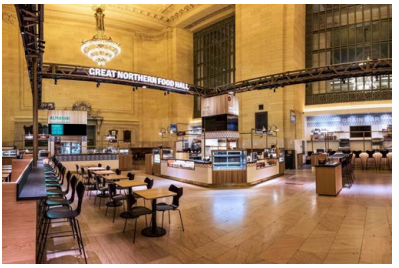
Approx. 12-minute walk

Located adjacent to Penn Station, offering numerous cafés, restaurants, and grab-and-go lunch choices.

Shaver Hall

Approx. 5-minute walk

A modern food hall with a diverse collection of restaurants, cafés, and comfortable communal seating.



Grand Central Dining

Approx. 15-minute walk

The Dining Concourse at Grand Central Terminal features cafés, restaurants, and specialty food vendors.

Wi-Fi

Complimentary wireless internet access is available throughout the CUNY Graduate Center. Conference participants are encouraged to connect to the **GCguest** wireless network, which provides convenient internet access for visitors. After selecting the network, a web page will open requesting an email address and acceptance of the terms of service before connecting.

Participants affiliated with the CUNY Graduate Center may alternatively use the secure **GCcommunity** network with their institutional credentials.

Transportation

Getting to Midtown Manhattan from the Airports

New York City is served by three major airports: John F. Kennedy International Airport (JFK), LaGuardia Airport (LGA), and Newark Liberty International Airport (EWR). The conference venue, the CUNY Graduate Center, is conveniently located in Midtown Manhattan and is easily accessible by public transportation, taxi, or rideshare services.

John F. Kennedy International Airport (JFK)

- **AirTrain + Subway (Budget Option)**
  Take the JFK AirTrain to Jamaica Station, then transfer to the **E** subway line toward Manhattan. Exit at **34 St–Penn Station** or **42 St–Port Authority**.
  Time: 50–70 minutes *Cost:* approximately $12.
- **AirTrain + Long Island Rail Road (Fastest Rail Option)**
  Take the AirTrain to Jamaica Station and transfer to the Long Island Rail Road (LIRR) for service to Grand Central Terminal or Penn Station.
  Time: 35–45 minutes *Cost:* approximately $14–16.
- **Taxi or Rideshare**
  Yellow taxis and rideshare services provide direct transportation to Midtown Manhattan.
  Time: 45–75 minutes (traffic dependent) *Cost:* approximately $70–90, excluding tolls and gratuity.

LaGuardia Airport (LGA)

- **Q70 Shuttle Bus + Subway**
  Take the free Q70 LaGuardia Link bus to Jackson Heights–Roosevelt Avenue and transfer to the subway for Midtown Manhattan. The F train stops at 34 St–Herald Square, only a short walk from the conference venue.
  Time: 40–50 minutes *Cost:* approximately $3.
- **Taxi or Rideshare**
  A convenient direct option to Midtown Manhattan.
  Time: 20–40 minutes *Cost:* approximately $35–50.

Newark Liberty International Airport (EWR)

- **AirTrain + NJ Transit**
  Take the Newark AirTrain to Newark Liberty Airport Station and transfer

to an NJ Transit train to New York Penn Station.
Time: 45–60 minutes *Cost:* approximately $16–18.

- **Taxi or Rideshare**
  Direct service to Midtown Manhattan.
  Time: 45–60 minutes *Cost:* approximately $70–100.

For up-to-date information on airport transportation and public transit, please consult:

- MTA Airport Guide:

- JFK AirTrain:

- Newark AirTrain:

Navigating New York City

New York City's extensive public transportation network makes it easy to travel throughout Manhattan and the surrounding boroughs. We strongly recommend using **Google Maps** for navigation, as it provides accurate, real-time information on subway and bus services, estimated travel times, and service disruptions. It is particularly useful for identifying the correct subway lines and station exits. The official **MTA app** is also a helpful resource for transit updates and planning your journey.
New York City's subway and bus network is operated by the Metropolitan Transportation Authority (MTA). The traditional MetroCard has largely been replaced by the **OMNY** (One Metro New York) contactless payment system, allowing passengers to simply "tap and go" using:

- Contactless credit or debit cards,
- Smartphones (Apple Pay, Google Pay, etc.),
- Smart watches and other compatible wearable devices.
- **Standard fare:** approximately $3.00 for a single subway or local bus ride.
- **Fare capping:** after 12 paid trips within a seven-day period using the same payment method, additional rides during that period are free.
- **Free transfers:** transfers between subway and local bus services are included for up to two hours after the initial tap.

Useful transit resources:

- OMNY: `https://omny.info`
- MTA Trip Planning and Service Information: `https://new.mta.info`
- Subway Map: `https://www.mta.info/map/5256`
- Bus Map: `https://www.mta.info/map/5391`

Scan for MTA subway and bus maps.

What to do in New York City

Statue of Liberty

The Statue of Liberty, one of the world's most iconic landmarks, was a gift from France to the United States and was dedicated in 1886 as a symbol of freedom, democracy, and friendship between the two nations. Standing proudly at the entrance to New York Harbor, it welcomed millions of immigrants arriving in America and has since become a universal emblem of hope, opportunity, and the enduring spirit of liberty. Access to the Statue of Liberty is by ferry departing from Battery Park. Visitors are strongly encouraged to reserve Pedestal or Crown tickets several months in advance through Statue City Cruises (https://www.statuecitycruises.com), the official ferry operator. From the conference venue, Battery Park can be reached in approximately 30 minutes via the downtown 1, 4, 5, R, or W subway lines to Bowling Green. Standard ferry tickets start at around $20 per person.

Central Park

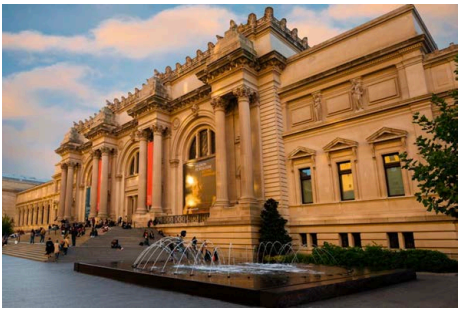
Central Park is the largest and most famous urban park in New York City, spanning 843 acres in the heart of Manhattan. Designed by Frederick Law Olmsted and Calvert Vaux, the park opened in 1858 as the first major landscaped public park in the United States. Created to provide a natural retreat from the rapidly growing city, it features picturesque lakes, woodlands, gardens, and iconic landmarks. Today, Central Park is one of the world's most visited urban parks and a beloved symbol of New York City's culture, recreation, and natural beauty. For the latest information on seasonal routes, maps, and activities, please visit City Cruises New York (https://www.centralparknyc.org/). From the conference venue, the departure point can be reached by a pleasant 30-minute walk along Fifth Avenue—a New

York landmark in its own right—or by taking the uptown N, R, or W subway lines to 5 Av/59 St, with a travel time of approximately 20 minutes.

Brooklyn Bridge

The Brooklyn Bridge, one of New York City's most iconic landmarks, was completed in 1883 as the world's longest suspension bridge of its time, connecting Manhattan and Brooklyn across the East River. Designed by John Augustus Roebling and completed under the leadership of his son, Washington Roebling, with crucial contributions from Emily Warren Roebling, the bridge was a remarkable engineering achievement of the 19th century. Today, with its distinctive Gothic-style towers and sweeping views of the New York skyline, the Brooklyn Bridge remains a symbol of innovation, resilience, and the enduring spirit of the city. A walk across the Brooklyn Bridge offers some of the most spectacular views of the Manhattan skyline and New York Harbor. For the best experience, we recommend crossing from Brooklyn to Manhattan. From the conference venue, the bridge can be reached by taking the downtown F train to York Street or the downtown A or C train to High Street, with a travel time of approximately 30–40 minutes.

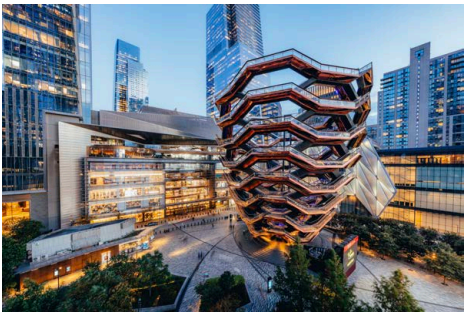
The Metropolitan Museum of Art



The Metropolitan Museum of Art (The Met) is one of the world's largest and most renowned art museums, housing a collection that spans more than 5,000 years of human history and culture. Founded in 1870 and located along the eastern edge of Central Park, the museum features masterpieces from ancient civilizations to modern times, including works by renowned European, American, Asian, African, and Islamic artists. With its iconic architecture and extraordinary collections, The Met offers visitors an unparalleled journey through the artistic and cultural heritage of humanity. From the conference venue, the museum can be reached by taking the uptown 6 subway line

from Grand Central to 77 St, with a travel time of approximately 30 minutes. General admission is approximately $30 per person.

The High Line, Little Island & Hudson Yards



New York's revitalized West Side is home to some of the city's most distinctive and innovative attractions, combining award-winning urban design with vibrant cultural and recreational spaces. Explore Little Island, an imaginative park built on sculptural piers above the Hudson River, offering landscaped gardens, walking paths, performance venues, and spectacular waterfront views. Continue along the High Line, the celebrated elevated greenway transformed from a historic freight railway into one of New York's most beloved public spaces, featuring art installations, gardens, and unique perspectives of the city. The route naturally leads to Hudson Yards, Manhattan's newest neighborhood development, where visitors can admire the iconic Vessel, discover the acclaimed arts and performance center The Shed, and enjoy a vibrant mix of shops, restaurants, and public plazas. Together, these landmarks showcase New York City's unique blend of history, architecture, culture, and urban innovation, while offering some of the finest views of the Hudson River and the Manhattan skyline. From the conference venue, the area can be reached by taking the downtown A, C, or E subway lines to 14 St–8 Av, followed by a short walk west. Total travel time is approximately 30 minutes.

The American Museum of Natural History

The American Museum of Natural History (AMNH) is one of the world's premier scientific and cultural institutions, dedicated to exploring the history of our planet and the universe. Founded in 1869 and located beside Central Park, the museum is renowned for its spectacular dinosaur fossils, the iconic blue whale

suspended in the Milstein Hall of Ocean Life, and its extensive collections spanning astronomy, geology, anthropology, and biodiversity. The museum is also home to the renowned Rose Center for Earth and Space, whose striking architecture and immersive exhibits explore the origins of the cosmos and humanity's place within it. Through its world-class exhibitions and pioneering research, the AMNH offers visitors a fascinating journey through the natural world, the evolution of life, and the mysteries of the universe.

From the conference venue, the museum can be reached by taking the uptown B subway line to 81 St, with a travel time of approximately 20 minutes. General admission is approximately $40 per person.

Observation Decks: Manhattan from Above

No visit to New York City is complete without experiencing its breathtaking skyline from above. The city's iconic observation decks offer spectacular panoramic views of Manhattan, each providing a unique perspective on the city. For ticket information, opening hours, and visitor details, please consult the official websites listed below.

Top of the Rock — Unobstructed views of the Empire State Building and Central Park. Official website: Rockefeller Center.

SUMMIT One Vanderbilt — An immersive multi-sensory experience with mirrored spaces and glass floors. Official website: SUMMIT One Vanderbilt.

Edge — The highest outdoor sky deck in the Western Hemisphere, featuring a glass floor. Official website: Edge NYC.

Empire State Building Observatory — A classic Art Deco landmark with iconic skyline views. Official website: Empire State Building.

One World Observatory — Located atop One World Trade Center, offering 360-degree city views. Official website: One World Observatory.

Times Square

Times Square is the vibrant heart of New York City and one of the world's most recognizable landmarks. Located at the intersection of Broadway and Seventh Avenue, it is famous for its dazzling digital billboards, Broadway theaters, bustling atmosphere, and the iconic New Year's Eve Ball Drop celebration. Known as "The Crossroads of the World," Times Square attracts millions of visitors each year and offers a unique blend of entertainment, shopping, dining, and street performances. Whether by day or illuminated at night, it captures the energy and excitement that define New York City. From the conference venue, Times Square can be reached on foot in approximately 20 minutes or by taking the 7 subway line to Times Sq–42 St. The area is freely accessible and can be enjoyed at any time of day, although the illuminated skyline is particularly spectacular after dark.

More to Explore

New York City offers an endless variety of cultural events, museums, performances, dining, and seasonal activities. For up-to-date information on attractions and events throughout the city, please visit `https://www.nyctourism.com/`.

Scan for New York City Tourism Information

Useful Contacts

CUNY Graduate Center (Venue)	(+1) 212 817 7000
Public transportation(MTA)	https://new.mta.info/
NYC Yellow Cabs	https://www.nyc.gov/site/tlc/businesses/yellow-cab.page
Emergency services (Police, Fire, EMS)	911
Non-emergency city services	311
Nearest hospital: Bellevue Hospital	(+1) 212 562 5555
Local organizers	labraha@gc.cuny.edu (+ 1) 212 413 3261

Photonics Initiative
CUNY Advanced Science Research Center
85 St. Nicholas Terrace
New York, NY 10031, USA.

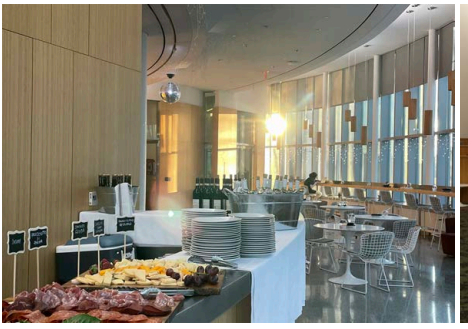
CUNY Graduate Center
365 Fifth Avenue
New York, NY 10016, USA.

Doctoral School

Metaphotonics for Engineering Light–Matter Interaction

September 4–5, 2026

CUNY Advanced Science Research Center



School Program

Time	Program / Speaker	Topic
Friday, September 4		
9:30 am–10:30 am	**Talk 1** Xiaoqin (Elaine) Li *UT Austin*	Optics of moiré materials
10:30 am–11:00 am	**Discussion / Break**	
11:00 am–12:00 pm	**Talk 2** Igal Brener *Sandia National Laboratories*	Nonlinear and quantum metasurfaces
12:00 pm–12:30 pm	**Discussion**	
12:30 pm–1:30 pm	**Lunch**	
1:30 pm–2:30 pm	**Talk 3** Paloma Arroyo Huidobro *Universidad Autónoma de Madrid*	Time-varying nanophotonics
2:30 pm–3:00 pm	**Discussion**	
3:00 pm–4:30 pm	**Hands-on Activity** Vitali Kozolov *CUNY ASRC*	Time-dependent scattering: Applications in RFID and radar invisibility cloaking
Saturday, September 5		
9:30 am–10:30 am	**Talk 4** Jun Kono *Rice University*	Cavity strong coupling
10:30 am–11:00 am	**Discussion / Break**	
11:00 am–12:00 pm	**Talk 5** Timur Shegai *Chalmers University of Technology*	2D material-based metasurfaces
12:00 pm–12:30 pm	**Discussion**	
12:30 pm–1:30 pm	**Lunch**	
1:30 pm–2:30 pm	**Talk 6** Gabriele Grosso *CUNY*	Quantum emitters in low-dimensional materials
2:30 pm–3:00 pm	**Discussion**	
3:00 pm–4:30 pm	**Hands-on Activity** Vitali Kozolov *CUNY ASRC*	Time-dependent scattering: Applications in RFID and radar invisibility cloaking

School Dinner

Baylander Steel Beach

Friday, September 4, 2026 | 6:00–9:00 pm

Baylander began its service life in 1968 as harbor utility craft YFU-79 during the Vietnam War. One of 16 Skilak-class lighters purchased by the U.S. Navy, it was used to transport personnel and materials throughout the delta regions. In 1986, it was converted into a helicopter landing trainer and renamed Baylander HLT after its home port in Pensacola Bay.

Over the following 25 years, more than 122,000 landings took place on board, allowing members of the U.S. armed services and allied nations to train for aircraft-carrier landings on a moving ship at sea. After being sold at auction in 2012, Baylander was purchased by the Trenk Family Foundation. Today, it is docked on the Hudson River at the 125th Street West Harlem Piers Park.

Join us for dinner, conversation, and Hudson River views aboard this historic vessel.

Conference Program

Scan for the Latest Conference Program

Conference App

iOS App

Android App

Scan the QR code to download the conference app and stay up to date throughout the event.

Session matrix, Monday, August 31

	Proshansky Auditorium	Elebash Recital Hall	Martin E. Segal Theatre	C201	C203
08:00	Registration				
09:00	Opening ceremony				
09:30	Plenary session I — Silvia Vignolini Bio-inspired self-assembled chiral architecture for optics and plasmonics				
10:30	Coffee break				
11:00 - 12:30	Inverse design and machine learning for photonic systems	Supercon-ducting and cavity-engineered quantum meta materials	Material- and thermally tunable meta structures	Nonlinear meta surfaces and lasing	Fundamen-tals of dispersive time-varying media
12:30	Lunch break and Poster session I (C198) **Technical presentation by GenIsys** (Proshansky Auditorium)—13:00-13:30				
14:00 - 15:30	Light-matter interactions in time-varying meta materials	Analytical EM theory and wave-matter interactions	Meta materials with extreme parameters and broken symmetries	Bistability, diffraction & reconfig-urable meta surfaces	Meta surfaces for beam control and intelligent radio environments
15:30	Coffee break				
16:00 - 18:00	Special session: Electromag-netic information theory for (pro-grammable) meta materials	Topological waves and meta materials	Chiral, anisotropic and nonlocal meta materials	Time-modulated RF meta surfaces	2D and van der Waals meta surfaces
18:00	Welcome reception				

The venue opens for registration at 08:00 and closes at 21:00.
All delegates are welcome to the reception, which offers drinks and light snacks

Session matrix, Tuesday, September 1

	Proshansky Auditorium	Elebash Recital Hall	Martin E. Segal Theatre	C201	C203
09:00	Plenary session II — Romain Fleury Shaping wave momentum and information in complex media				
10:00	Coffee break				
10:30 - 12:30	Novel phenomena in synthetic dimensions	Polaritons and strong light-matter effects	Sensing and metrology 1	Time-varying antennas and scatterers	Special session: Pro-grammable mechanics and instabilities
12:30	Lunch break and Poster session II (C198) **Panel on funding opportunities for metamaterials research** (Proshansky Auditorium) Tania Paskova, James Joseph, Joe Qiu (Army Research Office) Antti Makinen (Office of Naval Research)				
14:00 - 15:30	Meta materials with ultrafast modulation	Novel phenomena and synthetic motion	Quantum and topological photonics	Optical effects in nano photonic setups	Meta structures and meta-optics for advanced antenna systems
15:30	Coffee break				
16:00 - 17:30	Physical platforms for analog computing	Nonlinear plasmonics and hybrid interactions	Time crystals	Active, reconfig-urable, and non reciprocal meta surfaces	Emergent phenomena in non-Hermitian and non reciprocal systems
17:30	Plenary session III — Michal Lipson Engineering photonic matter: From silicon photonics to synthetic dimensions				

The venue opens at 08:00 and closes after the plenary at 19:00

Session matrix, Wednesday, September 2

	Proshansky Auditorium	Elebash Recital Hall	Martin E. Segal Theatre	C201	C203
09:00	Plenary session IV — Peter McMahon Programmable waveguide metamaterials for linear and nonlinear optics				
10:00	Coffee break				
10:30 - 12:30	Thermal meta materials and meta surfaces	Sensing and metrology 2	Sensing and wave control in acoustic and mechanical meta materials	Smart electromagnetic environments and intelligent meta surfaces for wireless communications	Physical Review special session
12:30	Lunch break and Poster session III (C198) **Meet-and-greet with American Physical Society editors** (Proshansky Auditorium)				
14:00 - 15:30	Fabrication and experimental characterization of meta structures I	Non-Hermitian wave dynamics and scattering	Physics of artificial materials for novel and extreme phenomena I	Active, quantum & emerging platforms	Metasurface modeling, simulation, and design
15:30	Coffee break				
16:00 - 17:30	Meta-optics for computing and imaging	Geometry and band engineering in artificial wave systems	Metasurface engineering for absorbing and radiating structures	Advanced scattering phenomena in complex electromagnetic systems	Quantum emitters and Purcell enhancement
17:30	Break before social dinner				
18:30	Social dinner				

The venue opens at 08:00 and closes after the sessions end at 18:30.
Ticketed dinner guests are welcome at Fogo de Chão at 19:00

Session matrix, Thursday, September 3

	Proshansky Auditorium	Elebash Recital Hall	Martin E. Segal Theatre	C201	C203
09:00 - 10:00	Time-varying media and synthetic motion	Nano photonic meta devices	Scattering and disorder	Meta optics for classification and feature extraction	Physics of artificial materials for novel and extreme phenomena II
10:00	Coffee break				
10:30 - 12:30	Photonic operations with optical meta surfaces	Reconfig-urable and program mable meta surfaces for wave control	Breaking reciprocity: Physics and technolo-gies of wave isolation	Tunable, nonlinear, and temporal meta structures for photonics	Special session: New frontiers of sound
12:30	Lunch break and Poster session IV (C198)				
14:00 - 15:30	Meta materials for biophysics and biomedicine	Physical and neuro morphic computing	2D, hyperbolic and spatio-temporal nano photonics	Fabrication and experi-mental characteri-zation of meta structures II	Advanced antenna architectures and broadband radiation techniques
15:30	Coffee break				
16:00	Plenary session V — Teri W. Odom Unconventional photonic nanocavity lattices for light-matter interactions				
17:00	Closing ceremony				

The venue opens at 08:00 and closes after the Closing Ceremony at 19:00.

Plenary Session I

Monday 09:30 - 10:30

Chairperson: Ewold Verhagen

Bio-Inspired Self-Assembled Chiral Architecture for Optics and Plasmonics

Silvia Vignolini

Max Planck for Colloids and Interfaces, Germany

Chirality transfer across length scales is an intriguing and universal phenomenon. Both in nature and in materials science, complex architectures composed of bio-based chiral building blocks are responsible for unique optical responses from bright and vivid colourations to extremely large dichroism. When it comes to working with naturally derived chiral building blocks, however, the challenge lies in understanding how the properties of individual building blocks relate to the emergent features of large-scale architectures and structures. Our research addresses this gap by investigating the origins of mesophase chirality in bio-derived particles such as cellulose and chitin nanocrystal suspensions. Through a combination of quantitative morphological analysis of individual nanoparticles, final architecture, and their assemblies, we showcase the functionality of such chiral materials in the context of optical materials, including plasmonic ones, also providing examples of how such materials can be produced at scale.

Location: Proshansky Auditorium (Concourse Level)

Plenary Session II

Tuesday 09:00 - 10:00

Chairperson: Andrea Alù

Shaping Wave Momentum and Information in Complex Media

Romain Fleury

École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Optimization in wave physics is central to many applications: focusing electromagnetic energy to a specific location in a complex medium, for example, can be performed optimally using methods known as wavefront shaping1. Conceptually, such problems are quadratic optimization problems, which can often be solved exactly and implemented efficiently provided a sufficiently good model of the system is known. There are, however, two important cases in which the optimization of waves is particularly hard: (i) when multiple objectives or constraints have to be satisfied, or (ii) when they involve non-linearity and many parameters to optimize. In this talk, we will present our experimental research on wave-based optimization in these two challenging regimes. In a first part,

we will focus on the problem of optimally moving objects in a complex environment. The goal is to shape waves in order to optimize the radiation force or torque exerted on one or several objects, possibly under constraints. We will demonstrate how hard it is, for example, to move two objects simultaneously along desired directions, while a third one is maintained in a trap. To solve such problems, we will introduce a method called wave-momentum shaping, and demonstrate it in two very different experiments. The first experiment will focus on demonstrating the core of the theory in a quasi-lossless regime. We will report the controlled translation and rotation of macroscopic objects using sound, in both spatially and temporally-varying backgrounds. The second experiment will significantly extend the method, by involving microscopic objects in lossy microfluidic channels, and moving them by shaping the electromagnetic force density around them. Both regimes, lossy and lossless, can be mapped to one another by an equivalence principle, allowing us to optimize the force from either scattering or conductance fluctuations, measured at the ports of the system. In a second part, we will focus on non-linear wave-based

optimization problems involving many parameters, known as scattering neural networks. Like digital neural networks, scattering neural networks can be trained to perform non-linear inference or regression tasks, however their analog nature challenges their training and practical implementation. We will discuss our recent experimental advances in training free-field optical systems to perform non-linear optimization problems, demonstrating a stable optical neural network with millions of trained optical weights. Such systems perform classification or regression on optical images, and can be used as optical preprocessors to replace energy-hungry digital modules in vision models.

Location: Proshansky Auditorium (Concourse Level)

Plenary Session III

Tuesday 17:30 - 18:30

Chairperson: Diana Strickland

Engineering Photonic Matter: From Silicon Photonics to Synthetic Dimensions

Michal Lipson

Columbia University, USA

Over the last two decades, integrated photonics evolved from a technology platform for optical communications into a powerful framework for engineering artificial photonic materials. By controlling geometry, dimensionality, topology, and increasingly the temporal evolution of optical systems, photonic chips can now realize behaviors that have no counterpart in conventional optical media.In this talk, I will describe this evolution through examples spanning silicon photonics, dispersion engineering, nonlinear photonics, inverse-designed structures, synthetic dimensions, and spatiotemporally modulated systems. These advances reveal a transition from building individual photonic devices toward creating programmable optical materials whose properties emerge from engineered interactions among many optical states. I will discuss how this perspective opens new opportunities at the intersection of metamaterials, condensed-matter physics, and integrated photonics, and may ultimately enable a new generation of photonic technologies for communications, sensing, computing, and quantum information processing.

Location: Proshansky Auditorium (Concourse Level)

Plenary Session IV

Wednesday 09:00 - 10:00

Chairperson: Gabriele Grosso

Programmable Waveguide Metamaterials for Linear and Nonlinear Optics

Peter McMahon

Cornell University, USA

I will present our group's work on making programmable photonic metamaterials. After incorporating a photoconductor into a device containing a waveguide, it is possible to arbitrarily change the waveguide's refractive index as a function of space, by shining an optical pattern onto the photoconductor from above. The scheme relies on the waveguide having a strong second-order nonlinear susceptibility, such as in lithium niobate. I will explain the working principle and present several examples of applications of our programmable linear metamaterial, spanning optical computing through communications. I will also show how we have applied the same approach to creating waveguide metamaterials for nonlinear optics, demonstrating spatial and spectral control of second-harmonic generation, and other nonlinear processes. Our work combines some of the benefits of metamaterials – the ability to create new or better functions – with some of the benefits of programmability – the ability to change function.

Location: Proshansky Auditorium (Concourse Level)

Plenary Session V

Thursday 16:00 - 17:00

Chairperson: Nader Engheta

Unconventional Photonic Nanocavity Lattices for Light-Matter Interactions

Teri W. Odom

Northwestern University, USA

Optical chirality from spin angular momentum and orbital angular momentum offers exciting prospects to manipulate light. These characteristics are driving the next advances in communication, encryption, and sensing. This talk will describe how to design unconventional optical cavities based on plasmonic nanoparticle lattices. First, we will discuss two-dimensional architectures based on global control of lattice symmetry and local tuning of unit cell shapes. Second, we will examine strong light-matter interactions of these cavities coupled to colloidal semiconducting gain materials. Finally, we will describe coherent polariton emission and prospects for room-temperature chiral polaritonics and flat-band lasing.

Location: Proshansky Auditorium (Concourse Level)

Parallel Sessions

Oral Sessions (Monday Morning)

Inverse Design and Machine Learning for Photonic Systems

Chairperson(s): Paloma A. Huidobro, Antonio Ambrosio

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
11:00 - 11:30	Alexandra Boltasseva	Machine-Learning-Empowered On-Chip Quantum Photonics: From Emitter Control to Integration and Quantum Measurements
11:30 - 12:00	Haejun Chung	Inverse Design in Meta-Optics: From Time-Domain Adjoint Optimizations to Diffusion Models
12:00 - 12:30	Carsten Rockstuhl	Model- and Data-Driven Inverse Design of Scattering Nanophotonic Systems

Superconducting and Cavity-Engineered Quantum Metamaterials

Chairperson(s): Aitzol Garcia, P James Schuck

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
11:00 - 11:30	Tatiana Webb	Cavity-Altered Superconductivity
11:30 - 12:00	Bo Zhen	Superconducting Nonlinear Metamaterials
12:00 - 12:15	Amin Hakimi	Terahertz Amplification and Lasing with Cavity Loading Two-Dimensional Materials with Berry Curvature Dipole
12:15 - 12:30	Rodrigo P. Câmara	Time-Crystal Phases and Spin Ordering in Isotropic Kramers Qubits

Material- and Thermally Tunable Metastructures

Chairperson(s): Pai-Yen Chen, Sander Mann

Room: Martin E. Segal Theatre

Time	1st Author (Presenter)	Title
11:00 - 11:30	Alessio Monti	Plasma-Enabled Metasurfaces and Metagratings for Reconfigurable Microwave Systems
11:30 - 12:00	Ana Díaz-Rubio	Reconfigurable Bianisotropic Metasurface for Dynamic Control of Asymmetric Absorption

Continued from Previous Page:Material- and Thermally Tunable Metastructures

Chairperson(s): Pai-Yen Chen, Sander Mann **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
12:00 - 12:30	Filiz Yesilkoy	Thermally-Tuned Metasurfaces for Mid-Infrared Molecular Spectroscopy and Strong Light–Matter Coupling

Nonlinear Metasurfaces and Lasing

Chairperson(s): Alexander Khanikaev **Room: C201**

Time	1st Author (Presenter)	Title
11:00 - 11:30	Siying Peng	Continuous-Wave Chiral Exciton-Polariton Lasers Across the Visible and Infrared
11:30 - 11:45	Ziyu Wang	Giant Second Harmonic Generation from Notched Lithium Niobate Waveguide Arrays
11:45 - 12:00	Hooman Barati Sedeh	Overcoming the Efficiency–Wavefront Trade-Off in Nonlinear Meta-Optics
12:00 - 12:15	Pietro Baldin	Photo-Induced Band Unfolding in a Heterostructure Metasurface for Ultrafast Diffraction Management
12:15 - 12:30	Sedigheh Esfahani	Optically Driven Faraday Effect in Nonlinear Media

Fundamentals of Dispersive Time-Varying Media

Chairperson(s): Yarden Mazor, Ariel Epstein **Room: C203**

Time	1st Author (Presenter)	Title
11:00 - 11:30	Francesco Monticone	Space-Time Nonlocal Metamaterials
11:30 - 12:00	Dimitrios Sounas	Metric Structure of Time-Varying Media
12:00 - 12:15	Klaas De Kinder	Dispersion-Mediated Novel Space-Time Modes
12:15 - 12:30	Antonio Ganfornina-Andrades	Multi-Domain Analysis of Generalized Time-Varying Drude Media with Ultrafast Dynamic Carriers and Lossy Modulation.

11:00 - 12:30 Oral Sessions (Monday Morning)
Proshansky
Auditorium

Inverse Design and Machine Learning for Photonic Systems

Chairperson(s): Paloma A. Huidobro, Antonio Ambrosio

11:00 - 11:30 **Machine-Learning-Empowered On-Chip Quantum Photonics: From Emitter Control to Integration and Quantum Measurements** (Invited talk)
Alexandra Boltasseva[1], Yuheng Chen[2], Demid Sychev[1], Peigang Chen[1], Vaishnavi Iyer[1], Pranshu Maan[1], Alexander Kildishev[1], Vladimir Shalaev[1] *— [1] Purdue, United States [2] Purdue, United States*
Scalable quantum photonics demands advanced, multi-targeted optimization of emitters, resonators, couplers, waveguides and other elements of on-chip circuitry, as well as control elements under realistic conditions such as noise and fabrication constraints. Machine learning (ML) provides a unifying framework both for navigating high-dimensional photonic design spaces and for speeding up quantum measurements as well as for forecasting the temporal dynamics of quantum emitters' behavior that is critical for coherence control. In silicon nitride (SiN)–compatible photonic integrated circuits, generative and surrogate-based inverse design enables rapid co-optimization of waveguides, resonators, and emitter–circuit interfaces, supporting multiplexed architectures and manufacturable layouts. ML also enables anticipatory mitigation of decoherence: models trained on sparse spectral measurements can predict spectral diffusion and dephasing trajectories of solid-state emitters, allowing feed-forward stabilization and improved photon indistinguishability across devices. Complementing these ML-enabled capabilities, adjoint topology optimization of couplers between hexagonal boron nitride (hBN) room-temperature single-photon sources and SiN waveguides enables fabrication-aware, position-robust interfaces that mitigate modal mismatch and achieve high simulated coupling efficiencies. Together, decoherence-aware ML design and prediction, SiN-integrated emitters and circuitry, and robust emitter–waveguide coupling define a viable path toward stable, scalable quantum photonic systems.

11:30 - 12:00 **Inverse Design in Meta-Optics: From Time-Domain Adjoint Optimizations to Diffusion Models** (Invited talk)
Haejun Chung *— Hanyang University, Korea (South)*
This talk demonstrates recent advances in meta-optics inverse design, emphasizing a Nyquist-sampled time-domain adjoint framework that drastically re-

duces FDTD memory while preserving gradient accuracy for broadband metalens optimization. It also introduces physics-guided diffusion models as a scalable, fabrication-aware nanophotonic design method.

12:00 - 12:30 **Model- and Data-Driven Inverse Design of Scattering Nanophotonic Systems** (Invited talk)
Carsten Rockstuhl[1], Nigar Asadova[1], Jan David Fischbach[1], Kaoutar Boussaoud[1], Frank Tristram[1], Jörg Meyer[1], Renaud Vallée[2], Dmytro Vovchuk[3], Anton Kharchevskii[4], Pavel Ginzburg[4], Yannick Augenstein[5]
— *[1] Karlsruhe Institute of Technology, Germany [2] University of Bordeaux, France [3] Tel Aviv University and Riga Technical University, Isreal and Latvia [4] Tel Aviv University, Isreal [5] Flexcompute Inc, USA*
We present our advances on the model- and data-driven inverse design of photonic materials described within a scattering framework. The model-driven approach is based on an automatic differentiation of a code for the forward problem. The data-driven approach leverages a newly established data repository for T-matrices to train neural networks.

11:00 - 12:30 Oral Sessions (Monday Morning)
Elebash
Recital Hall

Superconducting and Cavity-Engineered Quantum Metamaterials

Chairperson(s): Aitzol Garcia, P James Schuck

11:00 - 11:30 **Cavity-Altered Superconductivity** (Invited talk)
Tatiana Webb — *City College of New York, USA*
Is it feasible to alter the ground state properties of a material by engineering its electromagnetic environment? Inspired by theoretical predictions, including works by many speakers of this exciting workshop, experimental realizations of such cavity-controlled properties without optical excitation are beginning to emerge. Our team devised and implemented a novel platform to realize cavity-altered materials. Single crystals of hyperbolic van der Waals (vdW) compounds provide a resonant electromagnetic environment with enhanced density of photonic states and prominent mode confinement. We inter-faced hexagonal boron nitride (hBN) with the molecular superconductor κ-(BEDT-TTF)2Cu[N(CN)2]Br (κ-ET). The frequencies of infrared (IR) hyperbolic modes of hBN match the IR-active carbon-carbon stretching molecular resonance of κ-ET im-plicated in superconductivity. Meissner effect measurements via magnetic force microscopy demonstrate a strong suppression of superfluid density near the hBN/κ-ET interface. Our work highlights the potential of dark cavities devoid of external photons for engineering electronic ground state properties of complex quantum materials. I.Keren, T.Webb et al. Nature 650, 864 (2026).

11:30 - 12:00 **Superconducting Nonlinear Metamaterials** (Invited talk)
Bo Zhen — *University of Pennsylvania, USA*
In this talk, I will present our recent progress in developing a theoretical framework for predicting nonlinear susceptibilities in superconducting meta-atoms and metamaterials.

12:00 - 12:15 **Terahertz Amplification and Lasing with Cavity Loading Two-Dimensional Materials with Berry Curvature Dipole**
Amin Hakimi[1], J. Sebastian Gomez-Diaz[2], Filippo Capolino[1] — *[1] University of California Irvine, USA [2] University of California Davis, USA*
Low-symmetry two-dimensional materials exhibiting Berry curvature dipoles can generate terahertz optical gain under DC bias. We introduce a compact cavity platform that enhances light–matter interactions, enabling bias-controlled, chiral, and polarization-selective terahertz amplification and lasing driven by non-Hermitian electro-optic effects.

12:15 - 12:30 **Time-Crystal Phases and Spin Ordering in Isotropic Kramers Qubits**

Rodrigo P. Câmara[1], Tatiana G. Rappoport[2], Andrea Alù[3], Mauro Antezza[4], Mário G. Silveirinha[1] — *[1] Universidade de Lisboa and Instituto de Telecomunicações, Portugal [2] Centro Brasileiro de Pesquisas Físicas, Brazil [3] Photonics Initiative ASRC and Physics Program GC, City University of New York, USA [4] Laboratoire Charles Coulomb, Université de Montpellier, France*

We demonstrate that isotropic, experimentally accessible Kramers qubits coupled to structured plasmonic environments can exhibit spin ordering rooted in spontaneous time-reversal symmetry breaking, previously linked to qubit anisotropy. A nonlinear Bloch equation governs the spin dynamics, enabling time-crystal states and mono- or bistable configurations. Higher-order multistability is topologically forbidden.

11:00 - 12:30 Oral Sessions (Monday Morning)
Martin E.
Segal Theatre

Material- and Thermally Tunable Metastructures

Chairperson(s): Pai-Yen Chen, Sander Mann

11:00 - 11:30 **Plasma-Enabled Metasurfaces and Metagratings for Reconfigurable Microwave Systems** (Invited talk)
Alessio Monti[1], Mohammad Alijani[1], Mirko Barbuto[2], Mohammed Tawqeer[3], Stefano Vellucci[4], Alessandro Toscano[1], Filiberto Bilotti[1] — *[1] Roma Tre University, Italy [2] Roma Tre University & Metamorphose-VI, Italy [3] Roma Tre University, Italy [4] Niccolò Cusano University & Metamorphose-VI, Italy*
Plasma discharges offer a unique opportunity to implement reconfigurable metastructures at microwave frequencies. Unlike conventional solid-state tuning approaches, plasma behaves as a dispersive electromagnetic material whose constitutive parameters can be continuously controlled through electrical excitation. In this contribution, we examine plasma as a competitive platform for reconfigurable metastructures and establish a unified framework for their design. We summarize key theoretical and experimental results obtained in our recent investigations, including analytical modeling of canonical plasma inclusions and electromagnetic retrieval of non-uniform plasma parameters. Their implications for the design of plasma-based metasurfaces and metagratings integrated with antenna systems are outlined. The presented framework supports the view of plasma as a viable and physically robust building block for adaptive radiating structures.

11:30 - 12:00 **Reconfigurable Bianisotropic Metasurface for Dynamic Control of Asymmetric Absorption** (Extended oral)
Pau Hostalet-Vicent[1], Luis Manuel Máñez-Espina[1], Manuel Selles-Armendia[1], Koen Schouteden[2], Jean-Pierre Locquet[2], Maria Seo[2], Teresa Mengual-Chulia[1], Pablo Sanchis[1], Ana Díaz-Rubio[1] — *[1] Universitat Politècnica de València, Spain [2] KU Leuven, Belgium*
In this work, we develop a reconfigurable infrared metasurface based on the phase-change material VO_2, whose optical response is dynamically controlled by temperature. By exploiting the insulator–metal transition of VO_2, we engineer the bianisotropic response of the metasurface and tailor the absorption mechanisms in its two crystalline states. We demonstrate temperature-dependent control of absorption asymmetry: in one phase, the structure exhibits a fully symmetric absorption profile, whereas in the other it displays pronounced asymmetry. The proposed concept is supported by comprehensive

numerical simulations and validated through experimental fabrication and optical characterization.

12:00 - 12:30 **Thermally-tuned Metasurfaces for Mid-Infrared Molecular Spectroscopy and Strong Light–Matter Coupling** (Invited talk)
Filiz Yesilkoy — *University of Wisconsin - Madison, USA*
Thermally tunable, free-standing silicon metasurfaces that support high-Q bound states in the continuum enable dynamically reconfigurable mid-infrared spectroscopy in transmission mode. Continuous resonance tuning enhances molecular fingerprint detection and facilitates vibrational strong coupling, providing a scalable platform for compact biochemical sensors and actively programmable light–matter interactions.

11:00 - 12:30 Oral Sessions (Monday Morning)
C201

Nonlinear Metasurfaces and Lasing

Chairperson(s): Alexander Khanikaev

11:00 - 11:30 **Continuous-Wave Chiral Exciton-Polariton Lasers Across the Visible and Infrared** (Invited talk)
Siying Peng — *Westlake University, China*
By exploiting strong light-matter coupling in chiral 2D perovskites, we demonstrate room-temperature, continuous-wave circularly polarized lasing across visible and infrared spectra.

11:30 - 11:45 **Giant Second Harmonic Generation from Notched Lithium Niobate Waveguide Arrays**
Ziyu Wang, Ruwen Peng, Mu Wang — *Nanjing University, China*
Achieving efficient second-harmonic generation in compact lithium niobate metastructures remains challenging due to the limited mode overlap and weak field confinement in subwavelength geometries. Here we present a viable design strategy for LN metastructures that enables robust and efficient second-harmonic generation (SHG). The designed structure consists of periodically notched LN waveguide arrays that support guided-mode resonances (GMRs). Benefiting from significant near-field enhancement within large mode volumes at resonance, a maximum SHG conversion efficiency of $\eta = 2.71 \times 10^{-3}$ is achieved at a peak power density of 3.83 GW/cm², representing a 3,000-fold enhancement compared with an unstructured LN film of the same thickness. These results provide new insights into the future design of integrated and high-efficiency nonlinear optical devices.

11:45 - 12:00 **Overcoming the Efficiency–Wavefront Trade-Off in Nonlinear Meta-Optics**
Hooman Barati Sedeh[1], Yuruo Zheng[1], Jiaren Tan[1], Luca Carletti[2], Maria Antonietta Vicenti[2], Ivan Kravchenko[3], Michael Scalora[2], Natalia Litchinitser[1] — *[1] Duke University, USA [2] University of Brescia, Italy [3] Oak Ridge National Laboratory, USA*
Nonlinear frequency conversion in compact platforms has long been limited by phase matching constraints and reduced interaction lengths. Metasurfaces offer a promising path forward by confining light into subwavelength resonant structures, enhancing nonlinear interactions in ultrathin devices. Yet the field of nonlinear meta-optics faces a persistent dilemma: nonlocal metasurfaces deliver high efficiency but little wavefront flexibility, while local designs provide phase control at the cost of poor conversion efficiency.

In this work, we tackle this challenge from two directions. We first introduce a single-layer nonlocal platform that harnesses symmetry breaking and resonant Pancharatnam–Berry phase control to achieve efficient nonlinear holography. We then demonstrate a bilayer nonlocal metasurface that enables independent nonlinear wavefront shaping from optically decoupled layers.

12:00 - 12:15 **Photo-Induced Band Unfolding in a Heterostructure Metasurface for Ultrafast Diffraction Management**
Pietro Baldin — *Politecnico di Milano, Italy*
Nonlocal metasurfaces driven by femtosecond optical pulses offer unprecedented opportunities for ultrafast dynamic control of light at the nanoscale. The strong field enhancements associated with nonlocal resonances can lead to efficient modulation of the optical response of the metasurface on ultrafast timescales. Here, we present a theoretical investigation on photo-induced band unfolding, and demonstrate how to leverage this transient symmetry breaking in a heterostructure metasurface for ultrafast diffraction management.

12:15 - 12:30 **Optically Driven Faraday Effect in Nonlinear Media**
Sedigheh Esfahani, Andrea Alù — *Advanced Science Research Center, City University of New York, USA*
The Faraday effect is a well-known nonreciprocal phenomenon in which a magnetic bias rotates the polarization of light in magneto-optical media by breaking time-reversal symmetry. However, magneto-optical materials are typically lossy, bulky and difficult to integrate into photonic platforms, motivating the search for magnet-free nonreciprocity. Here, we investigate the realization of an all-optical mechanism for nonreciprocal polarization rotation by leveraging Kerr nonlinearity in isotropic media. In this approach, two circularly polarized optical pumps with opposite handedness and slight frequency detuning generate a beating optical bias that breaks the degeneracy between the orthogonal polarization components of a linearly polarized probe. A Fabry-Perot resonator is designed to support two pump modes and a probe mode together with its sidebands. The nonlinear interactions inside the cavity are analyzed using full-wave numerical simulations, which confirm the emergence of a nonreciprocal Faraday-like rotation reaching up to one degree. Unlike previous magnet-free approaches, the proposed mechanism does not rely on material resonances, phase-matching conditions or coherence between the pumps and the probe, thus, provides a promising route toward compact, integrable, all-optical nonreciprocal photonic devices.

11:00 - 12:30 Oral Sessions (Monday Morning)
C203

Fundamentals of Dispersive Time-Varying Media

Chairperson(s): Yarden Mazor, Ariel Epstein

11:00 - 11:30 **Space-Time Nonlocal Metamaterials** (Invited talk)
Francesco Monticone — *Cornell University, USA*
In this talk, I will present new results on extreme electromagnetic effects enabled by the interplay of time modulation, frequency dispersion (temporal nonlocality), and spatial dispersion (spatial nonlocality), including the emergence of infinite "momentum bandgaps" in nonlocal photonic time crystals and new opportunities for on-demand, efficient, broadband wave transformations.

11:30 - 12:00 **Metric Structure of Time-Varying Media** (Invited talk)
Dimitrios Sounas — *Wayne State University, USA*
We present an analysis that reveals the presence of a metric in time-varying media. Starting from Maxwell equations, we show that any model for the evolution dynamics of time-varying media, such as coupled-mode theory, must always involve a metric that embodies the stored energy of the system. This metric is essential to satisfy scattering-matrix pseudo-unitarity in time-varying media. In contrast, in time-invariant systems, such a metric can always be factored into the system's state vector. This fact reveals a fundamental difference of time-varying media from time-invariant media, with implications on understating their behavior and developing accurate models of their responses.

12:00 - 12:15 **Dispersion-Mediated Novel Space-Time Modes**
Klaas De Kinder, Christophe Caloz — *KU Leuven, Belgium*
Space-time varying systems offer unprecedented control over wave scattering. Yet, most related studies assume nondispersive materials. Here, we develop a general framework for scattering at space-time interfaces between dispersive media. Discarding forbidden frequency transitions and applying the theory to Drude and Lorentz media, we uncover an exotic family of dispersion-mediated space-time modes that may enable novel concepts and applications.

12:15 - 12:30 **Multi-Domain Analysis of Generalized Time-Varying Drude Media with Ultrafast Dynamic Carriers and Lossy Modulation.**
Antonio Ganfornina-Andrades[1], Juan Enrique Vázquez-Lozano[1], Simon Horsley[2], Íñigo Liberal[1] — *[1] Public University of Navarre, Spain [2] University of Exeter, United Kingdom*
We present a generalized time-varying Drude model in which carrier density, effective mass, and collision rate evolve in time. The multi-domain permittivity

reveals non-adiabatic and loss-driven effects, including temporal blurring, selective gating/anti-gating, and low-frequency reshaping. By extending current frameworks, this model may offer a tool for designing and fitting experiments.

Oral Sessions (Monday Afternoon 1)

Light-Matter Interactions in Time-Varying Metamaterials

Chairperson(s): Francesco Monticone, Filiz Yesilkoy

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
14:00 - 14:30	Mordechai (Moti) Segev	Light-Matter Interactions in Time-Varying Media
14:30 - 15:00	Paloma Arroyo Huidobro	Light-Matter Interactions in Time-Varying Nanophotonic Media
15:00 - 15:30	Emanuele Galiffi	Coherent Energy Manipulation in Classical and Quantum Time-Metamaterials

Analytical EM Theory and Wave-Matter Interactions

Chairperson(s): Lin Wu

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
14:00 - 14:30	David Smith	Electromagnetics and Equivalent Circuits of Waveguide Fed Metamaterial Elements
14:30 - 14:45	Vitali Kozlov	Spectral Density Analysis of Linear Momentum Transfer between Transient Plane Waves and Metamaterials
14:45 - 15:00	Lukas Jelinek	Principal Limitations of Polarizability
15:00 - 15:15	Michael Havrilla	Depolarizing Dyads of a Spherical Bianisotropic Gyrotropic Medium
15:15 - 15:30	Santi Concetto Pavone	Rigorous Electromagnetic Field Modeling of Cylindrical-Waveguide Fed Confined Plasma in a Metallic Cylindrical Cavity for Plasma Energy Transfer Applications

Metamaterials with Extreme Parameters and Broken Symmetries

Chairperson(s): Tiago Morgado

Room: Martin E. Segal Theatre

Time	1st Author (Presenter)	Title
14:00 - 14:30	Che Ting Chan	Using Conical Dispersion to Realize Zero Index Media

Continued from Previous Page: Metamaterials with Extreme Parameters and Broken Symmetries

Chairperson(s): Tiago Morgado **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
14:30 - 15:00	Pai-Yen Chen	Non-Hermitian EMNZ Medium with Low Loss
15:00 - 15:15	Ioannis Katsantonis	Exploiting Non-Hermitian Metasurfaces to Enhance Chiral Sensitivity
15:15 - 15:30	Pietro Brugnolo	Bound States in the Continuum In Metasurface Cavities

Bistability, Diffraction & Reconfigurable Metasurfaces

Chairperson(s): Jorik Van De Groep, Yang Zhao **Room: C201**

Time	1st Author (Presenter)	Title
14:00 - 14:15	Leonardo Salvini	Exploring Symmetry-Breaking Nonlinear Cavity Structures for Enhanced Optical Limiter Performance
14:15 - 14:30	Viktoriia Babicheva	Transition Metal Dichalcogenide Nanoantennas for Tailored Quantum Emission
14:30 - 14:45	Matthew Belzer	Reconfigurable Directional Asymmetry of Photon Pair Emission in Bilayer Metasurfaces
14:45 - 15:15	Ariel Epstein	Bistable Diffraction in Nonlinear Metagratings
15:15 - 15:30	Govert Neijts	Continuous-Wave Optical Bistability of a Quasi-Bound State in the Continuum in a Metasurface

Metasurfaces for Beam Control and Intelligent Radio Environments

Chairperson(s): Alessio Monti, Hiroki Wakatsuchi **Room: C203**

Time	1st Author (Presenter)	Title
14:00 - 14:30	George Eleftheriades	Advances on Metasurfaces and Metastructures for Beamsteering and Beamshaping Applications
14:30 - 15:00	Tie Jun Cui	Space-Time-Coding Strategies for Rapid and Robust Diagnostics of Reconfigurable Intelligent Surfaces

Continued from Previous Page: Metasurfaces for Beam Control and Intelligent Radio Environments

Chairperson(s): Alessio Monti, Hiroki Wakatsuchi **Room: C203**

Time	1st Author (Presenter)	Title
15:00 - 15:15	Ilir Gashi	Semi-Analytic Framework for the Modeling and Design of Reconfigurable Intelligent Surfaces
15:15 - 15:30	Joaquin Garcia-Fernandez	Single and Multiple Control Metasurface Antennas Based on TE Surface Waves

14:00 - 15:30 Oral Sessions (Monday Afternoon 1)
Proshansky
Auditorium

Light-Matter Interactions in Time-Varying Metamaterials

Chairperson(s): Francesco Monticone, Filiz Yesilkoy

14:00 - 14:30 **Light-Matter Interactions in Time-Varying Media** (Invited talk)
Mordechai (Moti) Segev — *Technion - Israel Institute of Technology, Israel*
Recent theoretical and experimental progress on light-matter interactions in time-varying media, and in Photonic Time-Crystals specifically, will be presented, including results on nonlinear frequency conversion and on interaction with atoms and with free electrons.

14:30 - 15:00 **Light-Matter Interactions in Time-Varying Nanophotonic Media** (Invited talk)
Paloma Arroyo Huidobro — *Universidad Autónoma de Madrid and IFIMAC, Spain*
Light-matter interactions in time-modulated, frequency-dispersive, structured media can be drastically distinct from those in static media. We discuss the joint effect of dispersion and time-dependence on the scattering properties of nanostructures, their interaction with dipolar sources -that can become sinks-, and the existence of conservation laws in these time-dependent systems. We also introduce a quantum framework that incorporates dispersion and losses, as well as time modulation in a non-perturbative way. Our theory shows that both gain and loss must be accounted for to properly define the local density of states in time-varying media.

15:00 - 15:30 **Coherent Energy Manipulation in Classical and Quantum Time-Metamaterials** (Invited talk)
Emanuele Galiffi — *University of Texas at Austin, USA*
Time-varying metamaterials break energy and frequency conservation, unlocking novel wave control paradigms. We show how interferometric tailoring of wave-matter energy exchanges enables tunable gain, loss, and pulse shaping at temporal interfaces and in Floquet media, opening routes to efficient frequency conversion and Hong–Ou–Mandel–type correlations from classical light.

14:00 - 15:30 Oral Sessions (Monday Afternoon 1)
Elebash
Recital Hall

Analytical EM Theory and Wave-Matter Interactions

Chairperson(s): Lin Wu

14:00 - 14:30 **Electromagnetics and Equivalent Circuits of Waveguide Fed Metamaterial Elements** (Invited talk)
David Smith — *Duke University, USA*
We present an analysis of the electromagnetic properties of waveguide-fed metamaterial elements. we show that a circuit model can be derived for resonant metamaterial elements, extending the results of a previous approach that considered non-resonant slot-like apertures. The model provides a simple, analytical expression that accurately captures the scattering characteristics of waveguide-fed metamaterial elements, and can be easily adapted to the co-integration of lumped components. We anticipate the approach can also be applied to advanced apertures, such as those incorporating gain.

14:30 - 14:45 **Spectral Density Analysis of Linear Momentum Transfer between Transient Plane Waves and Metamaterials**
Vitali Kozlov, Ali Droby, Andrea Alu — *ASRC CUNY, USA*
We introduce a rigorous theoretical framework to calculate the total linear momentum transferred to arbitrarily-shaped scatterers by temporally-modulated electromagnetic plane waves. Unlike the traditional time-averaged harmonic analysis based on the Maxwell stress tensor, our approach utilizes the correlations of electromagnetic fields and the resulting momentum spectral density. We derive a fundamental relation that preserves the delicate balance between absorbed and scattered-field contributions to the total momentum, revealing that the Abraham force does not contribute to total momentum transfer. Our result assumes nothing about the material or geometric makeup of the scattering object, which can be active, nonlinear, bianisotropic and even time-dependent (including geometric deformations and material modulation). We use this theoretical framework to prove that drag (pulling) forces using complex frequency excitations cannot provide overall negative pull, since the total momentum transfer across the entire duration of the input signal must be positive. Finally, we demonstrate the ability to use this formalism to analytically derive the quasi-steady state instantaneous force on a passive particle, demonstrating a transient pulling force under complex frequency wave excitation.

14:45 - 15:00 **Principal Limitations of Polarizability**
Lukas Jelinek, Miloslav Capek — *CTU FEE Prague, Czech Republic*
A computation method for obtaining the principal limitations (fundamental bounds) of the polarizability tensor components of electrically small scatterers is developed. The tightness of the limit is discussed by comparing it with the known design of a magnetic metamaterial particle.

15:00 - 15:15 **Depolarizing Dyads of a Spherical Bianisotropic Gyrotropic Medium**
Michael Havrilla — *Air Force Institute of Technology, USA*
A scalar potential formulation for a spherical bianisotropic gyrotropic medium containing sources is developed. The analysis leads to two coupled Helmholtz-like equations having hybrid TE and TM field structure relative to the radial direction. Expected depolarizing dyads are identified which physically arise due to radial currents. Unexpected depolarizing dyads also occur from transverse currents. It is shown the unexpected depolarizing dyads are removable, leading to a mathematically and physically consistent theory.

15:15 - 15:30 **Rigorous Electromagnetic Field Modeling of Cylindrical-Waveguide Fed Confined Plasma in a Metallic Cylindrical Cavity for Plasma Energy Transfer Applications**
Santi Concetto Pavone[1], Luigi Celona[2], Gino Sorbello[1] — *[1] University of Catania, Italy [2] Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN-LNS), Italy*
This paper introduces an analytical model of the electromagnetic interaction between a plasma confined in a cylindrical cavity and a circular waveguide. Under appropriate assumptions, closed-form field solutions are obtained, offering insight into energy transfer mechanisms and the parameters that govern efficient cavity–plasma coupling.

14:00 - 15:30 Oral Sessions (Monday Afternoon 1)
Martin E.
Segal Theatre

Metamaterials with Extreme Parameters and Broken Symmetries

Chairperson(s): Tiago Morgado

14:00 - 14:30 **Using Conical Dispersion to Realize Zero Index Media** (Invited talk)
Che Ting Chan — *Hong Kong University of Science and Technology, Hong Kong*
We will discuss the creation of a Dirac point and linear dispersion in photonic band structure at the Brillouin zone center by breaking time reversal symmetry, resulting in an effective medium with zero refractive index. Such gyromagnetic zero index media have topological implications for both near field and far field wave behavior.

14:30 - 15:00 **Non-Hermitian EMNZ Medium with Low Loss** (Invited talk)
Pai-Yen Chen — *University of Illinois Chicago, USA*
We present a wideband and lossless epsilon-and-mu-near-zero (EMNZ) metamaterials based on a composite structure consisting of dielectrics and non-Hermitian photonic structures (i.e., PT-symmetric metasurfaces). We also discuss the concept and practical implementation of this EMNZ metamaterials (e.g., zero-delay teleportation, supercoupling, and directive emission) in different spectral ranges.

15:00 - 15:15 **Exploiting Non-Hermitian Metasurfaces to Enhance Chiral Sensitivity**
Ioannis Katsantonis, Maria Kafesaki — *FORTH and University of Crete, Greece*
We show that resonant non-Hermitian metasurfaces provide a novel route to chiral sensing, enabling the detection of extremely small quantities of chiral samples and the discrimination between different enantiomers through circular dichroism measurements.

15:15 - 15:30 **Bound States in the Continuum In Metasurface Cavities**
Pietro Brugnolo[1], Rasmus Elkjær Jacobsen[2], Samel Arslanagic´[2], Mats Gustafsson[1] — *[1] Lund University, Sweden [2] Technical University of Denmark, Denmark*
Bound states in the continuum are localized waves that remain perfectly confined despite existing within a spectrum of radiating modes. We propose a method for determining the conditions under which bound states in the continuum emerge in metasurface cavities, formulated in terms of scalar electric

surface impedance and scalar magnetic surface admittance. Full-wave simulations of two toroidal metasurface cavities are reported, illustrating the formation of single-mode quasi-bound states in the continuum and highlighting effectiveness and simplicity of the proposed approach.

14:00 - 15:30 Oral Sessions (Monday Afternoon 1)
C201

Bistability, Diffraction & Reconfigurable Metasurfaces

Chairperson(s): Jorik Van De Groep, Yang Zhao

14:00 - 14:15 **Exploring Symmetry-Breaking Nonlinear Cavity Structures for Enhanced Optical Limiter Performance**

Leonardo Salvini[1], Rodion Kononchuk[1], Andrey Chabanov[1], Igor Anisimov[2], Ilya Vitebskiy[2], Federico Tommasi[3], Wenyu Du[4], Stefano Cavalieri[3], Diederik Wiersma[5], Francesco Riboli[6] — *[1] University of Texas at San Antonio, USA [2] Air Force Research Lab., USA [3] Università di Firenze, Italy [4] CNR, Italy [5] European Laboratory for Nonlinear Spectroscopy (LENS), Università di Firenze, Istituto Nazionale di Ricerca Metrologica (INRiM), Italy [6] CNR, European Laboratory for Nonlinear Spectroscopy (LENS), Italy*

We present an investigation of passive optical limiters (OLs) that utilize symmetry breaking of reflectionless scattering modes at exceptional points of degeneracy in nonlinear coupled-cavity systems. In our study, we analyze how structural parameters, including intercavity coupling strength and external losses, influence key performance metrics of these devices. Through numerical simulations and optical measurements, we demonstrate that tuning these parameters can effectively optimize the limiting threshold and operational bandwidth of the OLs. Furthermore, we show that increasing the fraction of nonlinear cavities enhances device performance in the nonlinear, broken-symmetry regime, resulting in a faster suppression of transmission. These findings indicate a pathway for developing compact, self-activating OLs with wide bandwidths and rapid response times, with critical applications in protecting sensors and vision systems from laser damage.

14:15 - 14:30 **Transition Metal Dichalcogenide Nanoantennas for Tailored Quantum Emission**

Li Liu, Julien Werzowa, Atsu Atitsogbui, Raphael Landau, Viktoriia Babicheva — *University of New Mexico, USA*

We examine quantum emitters integrated with resonant van der Waals nanoantennas and metasurfaces to characterize nanoscale light–matter interactions. The enhancement is assessed in the weak-coupling regime, whereas strong coupling is analyzed through coherent emitter–antenna dynamics and entanglement, being linked to tunable emission and integrated quantum photonic functionalities.

14:30 - 14:45 **Reconfigurable Directional Asymmetry of Photon Pair Emission in Bilayer Metasurfaces**
Matthew Belzer, Michele Cotrufo — *University of Rochester, USA*
Metasurfaces are a promising platform to enhance Spontaneous Parametric Down Conversion (SPDC). However, most devices in literature cannot control the generated photon pairs' emission direction. We numerically demonstrate a bilayer metasurface that has tunable directional asymmetry in its photon pair emission, in addition to boosting SPDC efficiency via resonant enhancement.

14:45 - 15:15 **Bistable Diffraction in Nonlinear Metagratings** (Invited talk)
Naama Cohen Levi, Ariel Epstein — *Technion - Israel Institute of Technology, Israel*
We introduce an analytical synthesis method for nonlinear metagratings (MGs) exhibiting bistable diffraction, potentially enabling wireless beam switching through mild signal strength modulation. The framework, validated with full-wave simulations, identifies design parameters and guidelines for controlling hysteresis behavior, using Kerr-type nonlinear capacitive loads as meta-atoms. Important extensions to realistic varactor based implementations and transmissive beam manipulation nonlinear MGs are presented, forming a solid, physically insightful, framework for incorporating this appealing class of complex media in practical microwave applications.

15:15 - 15:30 **Continuous-Wave Optical Bistability of a Quasi-Bound State in the Continuum in a Metasurface**
Govert Neijts, Femius Koenderink, Ewold Verhagen, Said Rahimzadeh-Kalaleh Rodriguez — *AMOLF, Netherlands*
Here, we demonstrate continuous-wave optical bistability in a silicon metasurface using symmetry-broken quasi-bound states in the continuum. High-Q resonances provide strong field confinement, enabling thermo-optic feedback. We show that symmetry breaking enables systematic tuning of the nonlinear switching thresholds, establishing dielectric metasurfaces as a platform for continuous-wave nonlinear functionalities.

14:00 - 15:30 Oral Sessions (Monday Afternoon 1)
C203

Metasurfaces for Beam Control and Intelligent Radio Environments

Chairperson(s): Alessio Monti, Hiroki Wakatsuchi

14:00 - 14:30 **Advances on Metasurfaces and Metastructures for Beam-steering and Beamshaping Applications** (Invited talk)
George Eleftheriades — *Dept. of Electrical and Computer Engineering, Canada*
Recent advances in metasurfaces and metastructures will be presented for achieving electromagnetic wave beam-steering and beam-shaping in the far zone.

14:30 - 15:00 **Space-Time-Coding Strategies for Rapid and Robust Diagnostics of Reconfigurable Intelligent Surfaces** (Invited talk)
Yi Ning Zheng[1], Xiao Qing Chen[1], Lei Zhang[1], Marco Rossi[2], Giuseppe Castaldi[2], Shuo Liu[1], Vincenzo Galdi[2], Tie Jun Cui[1] — *[1] Southeast University, China [2] University of Sannio, Italy*
We propose a diagnostic framework for reconfigurable intelligent surfaces (RISs) utilizing space-time-coding (STC) modulation. By implementing non-uniform frequency and orthogonal coding modulation strategies, the operational status of individual elements is mapped to distinct spectral harmonics or code channels. Experiments on 1-bit RIS prototypes confirm that these methods enable rapid and accurate fault localization via simple spectrum analysis, offering a scalable solution without computationally intensive algorithms or iterative measurements.

15:00 - 15:15 **Semi-Analytic Framework for the Modeling and Design of Reconfigurable Intelligent Surfaces**
Ilir Gashi, Matteo Albani — *University of Siena, Italy*
This work develops a semi-analytic formulation for the scattering analysis of infinite Reconfigurable Intelligent Surfaces (RIS) modeled as periodic arrays of reactive-loaded antennas. Using Floquet modal decomposition and discrete Fourier transforms, the approach enables calculation of reflection coefficients under both uniform and periodic loading. The framework extracts scattering parameters from single-cell simulations and supports design of RIS-based reflectors with controllable phase profiles. Validation against full-wave CST simulations for an 8-element dipole array demonstrates excellent agreement and successful excitation of desired Floquet modes through both local approximation and optimization-based methods.

15:15 - 15:30 **Single and Multiple Control Metasurface Antennas Based on TE Surface Waves**

Joaquin Garcia-Fernandez, Enrica Martini, Stefano Maci — *University of Siena, Italy*

This investigation proposes two reconfigurable metasurface antennas (MTSs), based on varactor diodes, for controlling the radiation of transverse electric (TE) surface waves (SWs). The proposed implementations, namely the Multiple-Control MTS and the Single-Control MTS, are characterized by low power consumption, simplified biasing schemes, and reduced control complexity. The realization of reconfigurable TE channels, capable of operating over a frequency band centered at $f = 5.9$ GHz and enabled by varactor diodes, is discussed. Full-wave simulations demonstrate a broad range of achievable propagation constant values through the varactors, along with versatile control of the leaky-wave (LW) aperture field. These features make the proposed MTSs attractive candidates for integration within a combined TE/TM channel architecture for dual-polarized systems, as beam scanning can also be achieved using these structures over a competitive operational bandwidth.

Oral Sessions (Monday Afternoon 2)

Special Session: Electromagnetic Information Theory for (Programmable) Metamaterials

Proshansky

Chairperson(s): Philipp Del Hougne, Owen Miller **Room: Auditorium**

Time	1st Author (Presenter)	Title
16:00 - 16:30	David Miller	Self-Configuring Processing of Multiwavelength and Partially Coherent Light
16:30 - 17:00	Philipp Del Hougne	Progress Toward a Universal Wave-Control Framework and an Electromagnetic Information Theory for Reconfigurable Microwave Systems
17:00 - 17:20	Alessio Amaolo	Communicating Through Waves: How Many Optical Channels Can a Photonic Device Support?
17:20 - 17:40	Nicholas Behrens	Interpreting and Designing Hybrid Meta-Optical-Electronic Computing Systems Through an Information-Theoretic Approach
17:40 - 18:00	Owen Miller	Round-Table Discussion: Electromagnetic Information Theory for Metamaterials

Topological Waves and Metamaterials

Elebash

Chairperson(s): Mordechai Segev **Room: Recital Hall**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Alexander Khanikaev	Spectrally-Robust Freeform Topological Photonic Vortex Resonators
16:30 - 16:45	Paloma Huidobro	From Subluminal to Superluminal Interface States in Space-Time Photonic Crystals
16:45 - 17:15	Aitzol Garcia-Etxarri	3D Topological Photonics: 3D Chern Photonic Insulators and Electromagnetic Axions
17:15 - 17:30	Ilia Kuk	Existence and Localization of Hybrid Surface Waves at a Hyperbolic Material-Topological Insulator Interface

Chiral, Anisotropic and Nonlocal Metamaterials

Chairperson(s): Emanuele Galiffi **Martin E.**
Room: Segal Theatre

Time	1st Author (Presenter)	Title
16:00 - 16:30	Yang Zhao	Deciphering Chirality via Super-Resolution Near-Field Chiral Absorption
16:30 - 17:00	Yarden Mazor	Theory, Symmetries and Applications of Knot-Particle Metasurfaces: From Matched Polarization Rotation to Broadband Absorption
17:00 - 17:15	Tiago Morgado	Asymmetric Negative Refraction in Nonlocal Double-Wire Metamaterials with Loss Asymmetry
17:15 - 17:30	Alexander Zhuravlev	All Angle Unitary-Transmissive Meta-Atoms for Angle-Dependent Phase Gradient Metasurfaces: Toward Scan Range Extenders
17:30 - 18:00	Lin Wu	Chiral Metasurfaces with Rotational Symmetry for All-To-Circular Nonlinear Upconversion

Time-Modulated RF Metasurfaces

Chairperson(s): Dimitrios Sounas, Douglas Werner **Room: C201**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Hiroki Wakatsuchi	Passive Ultrafast Time-Varying Metasurfaces
16:30 - 16:45	Filippo Pepe	Multifrequency Beam Control on Curved Surfaces via Space-Time Coding Modulation
16:45 - 17:00	Genma Suematsu	Design of Time-Varying Reflection Characteristics of Waveform-Selective Metasurfaces via Coupled-Mode Theory
17:00 - 17:15	Zhe Zhang	Performance Bound of Integrated Floquet Circulator Based on Switched Resonators
17:15 - 17:30	Eisuke Omori	Reconfigurable Intelligent Surfaces Enabling Passive High-Speed Switching
17:30 - 18:00	Filiberto Bilotti	Space-Time Modulated Metasurfaces for Advanced Communication and Radar Systems

2D and van der Waals Metasurfaces

Chairperson(s): Alexandra Boltasseva **Room: C203**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Antonio Ambrosio	Hyperbolic Dispersion and Polaritons in the van der Waals Crystal $MoOCl_2$
16:30 - 17:00	Jorik Van De Groep	Exciton Resonance Tuning in Dynamic 2D Metasurfaces
17:00 - 17:30	P James Schuck	3R-Stacked Transition Metal Dichalcogenide Nonlocal Metasurfaces for Efficient Second-Harmonic and Quantum Light Generation

16:00 - 18:00 Oral Sessions (Monday Afternoon 2)
Proshansky
Auditorium

Special Session: Electromagnetic Information Theory for (Programmable) Metamaterials

Chairperson(s): Philipp Del Hougne, Owen Miller

16:00 - 16:30 **Self-Configuring Processing of Multiwavelength and Partially Coherent Light** (Invited oral)
David Miller — *Stanford University, USA*
Programmable and self-configuring Mach-Zehnder interferometer meshes, previously exploited for processing coherent spatial modes, now can make programmable and self-configuring complex and multilayer spectral filters and, for the first time, can separate partially coherent light into its fundamental mutually orthogonal and mutually incoherent components, opening new opportunities in optical processing.

16:30 - 17:00 **Progress Toward a Universal Wave-Control Framework and an Electromagnetic Information Theory for Reconfigurable Microwave Systems** (Invited oral)
Philipp Del Hougne — *CNRS, IETR - Univ Rennes, France*
Reconfigurable microwave systems such as dynamic metasurface antennas (DMAs) or reconfigurable intelligent surfaces (RISs) emerge as a technological enabler of next-generation wireless communications, sensing, and wave-domain computing. Despite many theoretical works and some antenna-level prototypes, system-level experiments notoriously struggle with model-reality mismatch due to fabrication inaccuracies and/or unknown system details. In-software optimization of the configuration of an experimental prototype to achieve a desired functionality, or determining fundamental limits to the achievable functionalities of a given prototype, remains difficult. In this talk, I will present an update on our recent efforts to establish a four-step universal framework for controlling waves in such reconfigurable microwave systems. First, we formulate a physics-consistent system model. Second, we experimentally estimate its parameters to minimize model-reality mismatch. Third, we perform in-software model-based optimization of the system configuration to approximate a desired transfer function. Fourth, we derive fundamental model-based bounds on achievable functionalities. Along the way, I will also discuss some ideas for maximizing wave-domain flexibility with enhanced mutual coupling, non-local programmability, and time-modulation of tunable components.

17:00 - 17:20 **Communicating Through Waves: How Many Optical Channels Can a Photonic Device Support?** (Invited oral)
Alessio Amaolo, Alejandro Rodriguez — *Princeton University, USA*
We present a general method to bound the singular values (channel amplitudes) of the scattering matrix of arbitrarily structured linear photonic systems. This decomposition provides a convenient approach to investigate maximal optical control of information-theoretic quantities (Shannon capacity, Fisher information, imaging limits) and power quantities (density of states enhancements, heat transfer). As an illustration of the framework, we compute ordered channel bounds for problems relating to communication through waveguides and metasurfaces, planewave detection, and radiative heat transfer.

17:20 - 17:40 **Interpreting and Designing Hybrid Meta-Optical-Electronic Computing Systems Through an Information-Theoretic Approach**
Nicholas Behrens, Francesco Monticone — *Cornell University, USA*
We utilize an information-theoretic perspective to analyze and design hybrid optical-electronic computing systems. Specifically, we reveal that well-designed linear meta-optical pre-processing elements reshape the input data distribution to improve performance on the task, similar to linear discriminant analysis. We also show that image recognition performance can be recovered after using (imperfect) nonlocal optics for space compression.

17:40 - 18:00 **Round-Table Discussion: Electromagnetic Information Theory for Metamaterials**
Owen Miller[1], Philipp Del Hougne[2], David Miller[3],Francesco Monticone[4],Marco Di Renzo[5] — *[1] Yale University, USA [2] CNRS, Univ Rennes, France, [3] Stanford University, USA, [4] Cornell University, USA, [5] Paris-Saclay University – CNRS and CentraleSupelec, France*

16:00 - 18:00 Oral Sessions (Monday Afternoon 2)
Elebash
Recital Hall

Topological Waves and Metamaterials

Chairperson(s): Mordechai Segev

16:00 - 16:30 **Spectrally-Robust Freeform Topological Photonic Vortex Resonators** (Invited talk)
Alexander Khanikaev[1], Yuma Kawaguchi[2], Daria Smirnova[3], Filipp Komissarenko[4], Daria Kafeeva[5], Svetlana Kiriushechkina[5], Jeffery Allen[6], Monica Allen[6], Andrea Alu[7] — *[1] University of Central Florida, USA [2] City College of New York, USA [3] The Australian National University, Australia [4] University of Central Florida, United States [5] City College of New York, United States [6] Air Force Research Laboratory, Munitions Directorate, Eglin AFB, United States [7] Photonics Initiative, Advanced Science Research Center, City University of New York, United States*
Topological concepts have been at the forefront of materials research in recent years, driving a revolution in our understanding of the response of quantum materials and enabling new ways to manipulate light and sound in topological metamaterials. Topological defects and topological boundaries of different dimensions have driven a paradigm shift in photonics, where topological photonic crystals and metamaterials can be engineered to create one-way flow of energy robust to defects or to control such flows with synthetic degrees of freedom along topological domain walls. More recently, topological point singularities encoded into photonic structures have been shown to enable confinement of optical modes with the topologically nontrivial nature of the cavity imprinted into the vorticity of optical far fields. Here we demonstrate that the two latter concepts - domain wall and point singularities - can be unified into an even more powerful tool to enable arbitrarily shaped resonant cavities of any dimension supporting spectrally stable “zero-energy” modes. We experimentally confirm that such modes, whose existence is guaranteed by topological principles, allow an unprecedented degree of control over the optical field, which appears to have no phase modulation across space, can have any desirable radiation pattern, and enables spectral stability regardless of shape or length.

16:30 - 16:45 **From Subluminal to Superluminal Interface States in Space-Time Photonic Crystals**
Alejandro Caballero, Thomas F. Allard, Paloma A. Huidobro — *Universidad Autónoma de Madrid, Departamento de Física Teórica de la Materia Condensada (IFIMAC), Spain*

We show that space-time symmetries persist in crystals with travelling-wave modulations whose velocities can be either lower (subluminal) or higher (superluminal) than the speed of light, which enable the study of their topological properties and the prediction of spatiotemporal interface states.

16:45 - 17:15 **3D Topological Photonics: 3D Chern Photonic Insulators and Electromagnetic Axions** (Invited talk)

Aitzol Garcia-Etxarri — *Donostia International Physics Center, Spain*

Inspired by the discoveries of topological phenomenain solid state systems, the study of topology in the propagation of light in photonic crystals has been the subject of much recent attention. Among all topological states of matter, time-reversal symmetry (TRS) broken topological materials, such as Chern insulators have been a particular focus due to their topologically protected unidirectional edge states with non-reciprocal propagation properties. In these systems, scattering processes from one boundary state into another are strongly suppressed, due to decoupling of counter-propagating 1D chiral edge channels. In this contribution, we will firstly introduce a general strategy to design 3D Chern insulating cubic photonic crystals in a weakly TRS broken environment with orientable and arbitrarily large Chern vectors. [1] Secondly, will show how these designs can be used to build photonic axion insulators. [2] Such a 3D topological photonic crystal exhibits extraordinary properties such as half-quantized surface effects and unidirectional chiral hinge states that propagate exclusively along the edges. These chiral hinge states form intricate networks that enable light to travel without loss or interference, even when obstacles are present. This breakthrough offers a deeper understanding of exotic particles and paves the way for practical applications in quantum computing, advanced sensors or in the development of axion-like particle detectors such as axion dark matter particles [3].

17:15 - 17:30 **Existence and Localization of Hybrid Surface Waves at a Hyperbolic Material-Topological Insulator Interface**

Ilia Kuk, Ildar Gabitov — *The University of Arizona, USA*

We study localized electromagnetic surface waves at the interface between a uniaxial hyperbolic material and an isotropic topological insulator. The topological magnetoelectric coupling hybridizes TE and TM polarizations through modified boundary conditions. Analytical dispersion relations are derived for two relevant orientations of the optical axis: tangential to the interface and orthogonal to the propagation direction, and normal to the interface. We identify the corresponding existence domains and analyze localization through penetration depths into both media. The results reveal finite spectral windows of surface-wave propagation separated by forbidden frequency intervals, as well as frequency ranges where the mode loses surface character due to diverging

penetration depth.

16:00 - 18:00 Oral Sessions (Monday Afternoon 2)
Martin E.
Segal Theatre

Chiral, Anisotropic and Nonlocal Metamaterials

Chairperson(s): Emanuele Galiffi

16:00 - 16:30 **Deciphering Chirality via Super-Resolution Near-Field Chiral Absorption** (Invited talk)
Yang Zhao, Seongmin Im — *University of Illinois Urbana Champaign, USA*
I will present a decoupled optical nanoscopy platform that enables direct imaging of nanoscale thermal distributions generated by off-resonant nanostructures. By separating optical force and photothermal contributions, this instrumentation provides high-fidelity characterization of nanomaterial properties without thermal cross-talk. The approach is particularly applicable for probing chiral macromolecular assemblies, where local optical chirality is associated with optical absorption and chirality transfer effects. I will discuss recent advances that improve measurement fidelity, capture ultrafast thermomechanical dynamics, and achieve enhanced spatial resolution beyond conventional scanning probe approaches.

16:30 - 17:00 **Theory, Symmetries and Applications of Knot-Particle Metasurfaces: From Matched Polarization Rotation to Broadband Absorption** (Invited talk)
Nadav Goshen, Yarden Mazor — *Tel-Aviv University, School of Electrical and Computer Engineering, Israel*
Metasurfaces based on toroidal and flattened wire knot elements enable unique control of electromagnetic waves. We show how their topology enables polarization rotation and chiral effects. We discuss practical design considerations, modeling, and propose extensions for applications such as selective absorption and beam steering.

17:00 - 17:15 **Asymmetric Negative Refraction in Nonlocal Double-Wire Metamaterials with Loss Asymmetry**
Tiago Morgado[1], Sylvain Lannebère[1], Enrico Renzi[2], Andrea Alù[2], Mário Silveirinha[3] — *[1] Instituto de Telecomunicações and Department of Electrical Engineering, University of Coimbra, Portugal [2] Photonics Initiative, Advanced Science Research Center, and Physics Program, The Graduate Center, City University of New York, USA, USA [3] University of Lisbon–Instituto Superior Técnico and Instituto de Telecomunicações, Portugal*
We demonstrate that heterogeneous double-wire metamaterials—comprising two dissimilar and nonconnected wire arrays—enable loss-asymmetric hy-

perbolic dispersion and strongly asymmetric negative refraction. Due to their strongly nonlocal response and engineered microstructure, these systems support two independent propagation channels with unequal losses. Free-space waves incident at opposite angles preferentially excite different channels, rendering the system inherently angularly selective. As a result, strongly asymmetric negative refraction—characterized by pronounced angular asymmetry in transmission and absorption—emerges in these fully reciprocal metamaterials across microwave to infrared frequencies.

17:15 - 17:30 **All Angle Unitary-Transmissive Meta-Atoms for Angle-Dependent Phase Gradient Metasurfaces: Toward Scan Range Extenders**
Alexander Zhuravlev[1], Amit Shaham[2], Ariel Epstein[2] — *[1] ITMO University, Russia [2] Technion - Israel Institute of Technology, Israel*
We present the synthesis of meta-atoms featuring angle-dependent transmission phase and all angle reflectionless behaviour. Utilizing the generalized sheet transition conditions, we demonstrate that meta-atoms characterized by a finite anisotropic magnetic surface susceptibility component $\chi_{mm}^{xz} \neq 0$ can achieve antisymmetric transmission phase with respect to the angle of incidence – which always crosses zero under normal incidence – maintaining unitary transmission. As a physical implementation of such meta-atoms, we propose a configuration of two tilted loops with capacitive loads. Numerical simulations confirm that adjusting the lumped capacitors within these loops allows for control of the χ_{mm}^{xz} value; increase in the former leads to a higher phase shift experienced by the obliquely incident wave. Beyond physical insights, the proposed meta-atom can potentially be used as a building block of multi-angular metasurfaces: beam expanders, multiplexers, and devices for scan-range extension of phased arrays.

17:30 - 18:00 **Chiral Metasurfaces with Rotational Symmetry for All-To-Circular Nonlinear Upconversion** (Invited talk)
Lin Wu — *Singapore University of Technology and Design (SUTD), Singapore*
Chiral metasurfaces enable symmetry-controlled light–matter interactions, but combining strong chirality with rotational symmetry in nonlinear optics remains challenging. We develop a framework for all-to-circular upconversion using maximally chiral quasi-BICs and symmetry-enforced selection rules, demonstrated in bilayer and planar metasurfaces, with scaling laws guiding compact circularly polarized harmonic generation.

16:00 - 18:00 Oral Sessions (Monday Afternoon 2)
C201

Time-modulated RF metasurfaces

Chairperson(s): Dimitrios Sounas, Douglas Werner

16:00 - 16:30 **Passive Ultrafast Time-Varying Metasurfaces** (Invited talk)
Hiroki Wakatsuchi — *Nagoya Institute of Technology, Japan*
We report circuit-loaded subwavelength structures referred to as waveform-selective metasurfaces that enable passive time-varying electromagnetic responses even at a fixed carrier frequency without any control electronics or an external direct-current (DC) supply. Although these structures provide a high degree of freedom for temporal wave control, the transition speed of the electromagnetic state is limited by the nature of the embedded circuits. Thus, this talk introduces another type of time-varying metasurface that offers ultrafast switchable electromagnetic responses without external DC supply. We show that these structures can be integrated into a range of applications, including communications, imaging, and sensing.

16:30 - 16:45 **Multifrequency Beam Control on Curved Surfaces via Space-Time Coding Modulation**
Filippo Pepe[1], Lei Zhang[2], Yi Ning Zheng[2], Xiao Qing Chen[2], Ivan Iudice[3], Giuseppe Castaldi[1], Marco Di Renzo[4], Tie Jun Cui[2], Vincenzo Galdi[1] — *[1] University of Sannio, Italy [2] Southeast University, China [3] Italian Aerospace Research Centre (CIRA), Italy [4] Université Paris-Saclay, CNRS, CentraleSupélec, France*
We introduce space-time coding conformal metasurfaces for dynamic electromagnetic wave control on curved surfaces. Using a semi-analytical model and hybrid synthesis, we achieve multifrequency beam steering and shaping. X-band experiments demonstrate anomalous reflection, beam splitting, and diffuse scattering across distinct harmonic orders.

16:45 - 17:00 **Design of Time-Varying Reflection Characteristics of Waveform-Selective Metasurfaces via Coupled-Mode Theory**
Genma Suematsu, Yuki Kunitomo, Atsuko Nagata, Eisuke Omori, Hiroki Wakatsuchi — *Nagoya Institute of Technology, Japan*
In this study, we present a coupled mode theory framework for designing waveform-selective metasurfaces with time-dependent reflection characteristics. In addition, we demonstrate a waveform-selective rooftop cloak as a proof-of-concept application.

17:00 - 17:15 **Performance Bound of Integrated Floquet Circulator Based on Switched Resonators**

Zhe Zhang, Romain Fleury — *École Polytechnique Fédérale de Lausanne EPFL, Switzerland*
Magnet-free circulators based on switched resonators can operate at modulation frequencies far below the signal carrier, overcoming the fundamental scaling bottleneck of switched-capacitor schemes. We develop an analytical framework that yields closed-form performance bounds on the transmission–isolation trade-off, validated by experiment, offering a scalable route toward mmWave and sub-THz integrated nonreciprocal components.

17:15 - 17:30 **Reconfigurable Intelligent Surfaces Enabling Passive High-Speed Switching**
Eisuke Omori[1], Atsuko Nagata[1], Shinya Sugiura[2], Hiroki Wakatsuchi[1] — *[1] Department of Electrical and Electronic Engineering, Nagoya Institute of Technology, Japan [2] Institute of Industrial Science, The University of Tokyo, Japan*
We proposed a new type of wave-selective metasurfaces composed of the switching component and applied them to reconfigurable intelligent surfaces. In particular, this study evaluates the numerical and experimental switching responses.

17:30 - 18:00 **Space-Time Modulated Metasurfaces for Advanced Communication and Radar Systems** (Invited talk)
Filiberto Bilotti[1], Mirko Barbuto[1], Alessio Monti[2], Davide Ramaccia[1], Alessandro Toscano[1], Stefano Vellucci[1] — *[1] Roma Tre University, Italy [2] ROMA TRE University, Italy*
We present the main results of our recent studies on space–time modulated and reconfigurable metasurfaces for communication and radar systems, highlighting physical-layer processing enabled by digital coding and control. By acting directly on analogue electromagnetic signals, we show that the use of the metasurface-aided signal processing paradigm (i.e. hardware-based manipulation of signals using space-time modulated metasurfaces) allows reducing latency, hardware complexity, and power consumption compared to conventional digital-signal-processing-based architectures. In particular, we demonstrate radar functions, such as frequency conversion, Doppler compensation, direction-of-arrival estimation, false-target generation, RCS manipulation, harmonic generation, and propose a new paradigm of smart antennas (stand-alone radiators and antenna arrays) characterized by advanced beam shaping/steering capabilities.

16:00 - 18:00 Oral Sessions (Monday Afternoon 2)
C203

2D and van der Waals Metasurfaces

Chairperson(s): Alexandra Boltasseva

16:00 - 16:30 **Hyperbolic Dispersion and Polaritons in the van der Waals Crystal $MoOCl_2$** (Invited talk)
Antonio Ambrosio — *Istituto Italiano di Tecnologia, Italy*
Hyperbolic media enable extreme control of electromagnetic waves due to their anisotropic dielectric response, supporting highly confined and directional optical modes. Here we investigate the nanophotonic properties of the layered van der Waals crystal $MoOCl_2$, recently identified as a natural hyperbolic material in the visible spectral range.

16:30 - 17:00 **Exciton Resonance Tuning in Dynamic 2D Metasurfaces** (Invited talk)
Jorik Van De Groep — *University of Amsterdam, Netherlands*
In this presentation, I will discuss two recent examples of how the unique tunability of exciton resonances in monolayer 2D semiconductors can be leveraged to achieve dynamic nanophotonic devices: (i) selective beam steering with an atomically thin binary blazed grating; (ii) amplitude modulation with a hybrid-2D metasurface through strong coupling.

17:00 - 17:30 **3R-Stacked Transition Metal Dichalcogenide Nonlocal Metasurfaces for Efficient Second-Harmonic and Quantum Light Generation** (Invited talk)
P James Schuck[1], Zhi Hao Peng[1], Michele Cotrufo[2], Ding Xu[1], Sander Mann[3], Siyuan Qiu[1], Dn Basov[1], Milan Delor[1], Andrea Alù[4], Chiara Trovatello[5]
— *[1] Columbia University, USA [2] University of Rochester, USA [3] University of Amsterdam, The Netherlands [4] City University of New York, USA [5] Politecnico di Milano, Italy*
By leveraging metasurfaces and 3R-stacked MoS_2 crystals, we achieve 140× second-harmonic generation enhancement compared with unpatterned 3R-MoS_2 flakes with the same thickness, enabling single-pass second-harmonic conversion efficiencies of 10^{-4} over only 160-nm-thick metastructures at relevant telecom wavelengths.

Oral Sessions (Tuesday Morning)

Novel Phenomena in Synthetic Dimensions

Proshansky
Chairperson(s): Mario Silveirinha **Room: Auditorium**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Alexander Gaeta	Quantum Photonics in the Synthetic Frequency Dimension
11:00 - 11:30	Philippe St-Jean	Exponentially-Enhanced Sensing with a Frequency-Encoded Bosonic Kitaev Chain
11:30 - 11:45	Jonas Himmel	Photonic Emulation of Hyperbolic Spacetime Dynamics
11:45 - 12:00	Hadiseh Nasari	Observation of Penrose-Zel'dovich Super-Radiance and Angular-Momentum Bandgaps in a Floquet-Rotating Space-Time Crystal
12:00 - 12:30	Baile Zhang	Critical Topological Phase Transition

Polaritons and Strong Light-Matter Effects

Elebash
Chairperson(s): Marcello Ferrera **Room: Recital Hall**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Junichiro Kono	Cavity-Dressed Quantum Matter
11:00 - 11:30	Jaime Gomez Rivas	Exciton–Polariton Condensation in Bound States in the Continuum of Plasmonic and Dielectric Metasurfaces
11:30 - 11:45	Giacomo Venturi	Magneto-Optical Switch with Tunable Hyperbolic Polaritons in a 2D Magnet
11:45 - 12:00	Omid Poordashtban	Graphene-Integrated Metasurface for Full 2π Mid-Infrared Phase Modulation via GMR-Plasmon Strong Coupling
12:00 - 12:15	Julia Holland	Acoustoplasmonic Metasurfaces for Optically Tunable Acoustic Wavefront Shaping
12:15 - 12:30	Alexey Krasavin	Active Plasmonics at Single Nanocavity Level: Electrically-Driven Modulation of Excitonic Strong Coupling and Electroluminescence

Sensing and Metrology 1

Chairperson(s): Femius Koenderink, Natalia Litchinitser **Room: Segal Theatre** **Martin E.**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Luat Vuong	Large-Area Polarimetric Encoders: Compressed Sensing and Waveguiding with Silica Hollow Spheres
11:00 - 11:30	Okan Yurduseven	Metasurface-Driven Compressive Electromagnetic Imaging and Sensing
11:30 - 11:45	Hamza Saeed	A Compact Passive RF Metamaterial Resonator for In-Situ Structural Health Monitoring of Mortar
11:45 - 12:00	Niccolo Scalise Pantuso	Complex Mass Distribution Recognition at the Microscale Enabled by Rainbow Trapping in Piezoelectric Metamaterials
12:00 - 12:30	Nasim Mohammadi Estakhri	Molding Electromagnetic Waves in Near Field: From Ultrathin Metasurfaces to Electromagnetically Thick Metastructures

Time-Varying Antennas and Scatterers

Chairperson(s): Silvio Hrabar, Luca Stefanini **Room: C201**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Gengbo Wu	Space-Time Metasurface Antennas: Concept, Design and Applications
11:00 - 11:30	Sergei Tretyakov	Feedback-Based Autonomous Programmable Meta-atoms
11:30 - 11:45	Mario Junior Mencagli	Temporal Modulation for Dispersion-Free Impedance Matching
11:45 - 12:00	Miguel Verde Ruiz	Scattering Properties of Time-Varying Frequency-Dispersive Nanoparticles
12:00 - 12:30	Ioannis Katsantonis	Engineering the Scattering Response of Cylindrical Scatterers through Time-Modulation

Special Session: Programmable Mechanics and Instabilities
Chairperson(s): Lucia Stein-Montalvo, Muamer Kadic **Room: C203**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Muamer Kadic	Nonreciprocal Topological Kink-Wave Propagation in Mechanical Metamaterials
11:00 - 11:30	Fani Derveni	Imperfection-Insensitive Plate-Lattice Metamaterials: Programming Stability Through Geometry
11:30 - 12:00	Lucia Stein-Montalvo	Shape-Shifting Kiri-Origami Metamaterials for Adaptive Cities

10:30 - 12:30 Oral Sessions (Tuesday Morning)
Proshansky
Auditorium

Novel Phenomena in Synthetic Dimensions

Chairperson(s): Mario Silveirinha

10:30 - 11:00 **Quantum Photonics in the Synthetic Frequency Dimension** (Invited talk)
Alexander Gaeta — *Columbia University, USA*

11:00 - 11:30 **Exponentially-Enhanced Sensing with a Frequency-Encoded Bosonic Kitaev Chain** (Invited talk)
Philippe St-Jean[1], Paul-Édouard Blanchard[1], Alexander Mcdonald[2] — *[1] Université de Montréal, Canada [2] Université de Sherbrooke, Canada*
We experimentally realize a bosonic Kitaev chain by encoding the corresponding Hamiltonian in the resonant modes of a frequency comb. We harness the inherent nonreciprocal propagation of light in frequency space to detect a small microwave tone with a signal-to-noise ratio that scales exponentially with system size.

11:30 - 11:45 **Photonic Emulation of Hyperbolic Spacetime Dynamics**
Jonas Himmel[1], Coraline Bacq[2], Krishna C. Maurya[2], Max Ehrhardt[3], Matthias Heinrich[1], Tom A.W. Wolterink[1], Pablo Basteiro[2], Rathindra N. Das[4], René Meyer[2], Tobias Huber-Loyola[5], Andreas Pfenning[2], Sven Höfling[2], Johanna Erdmenger[2], Alexander Szameit[1] — *[1] University of Rostock, Germany [2] Julius-Maximilians-Universität Würzburg, Germany [3] McGill University, Canada [4] Julius-Maximilians-Universität Würzburg, Weizmann Institute of Science, Massachusetts Institute of Technology, Germany, Israel, USA [5] Julius-Maximilians-Universität Würzburg, Karlsruhe Institute of Technology, Germany*
We report the first experimental emulation of fermionic wave packet dynamics in Lorentzian AdS spacetime using a photonic platform, thereby establishing an experimental route to directly probing dynamical bulk phenomena underlying holographic duality, and provide a scalable platform for exploring nonequilibrium quantum field dynamics in curved spacetimes.

11:45 - 12:00 **Observation of Penrose-Zel'dovich Super-Radiance and Angular-Momentum Bandgaps in a Floquet-Rotating Space-Time Crystal**
Hadiseh Nasari[1], Hady Moussa[1], Yoshiaki Kasahara[2], Arno Thielens[1], Andrea Alù[1] — *[1] City University of New York, USA [2] City University of New York, The University of Texas at Austin, USA*

By leveraging rotating patterns of space–time modulation that enable ultrafast rotation-like dynamics, here, we present unequivocal experimental evidence of access to the regime of extreme rotational Doppler shift and electromagnetic Zel'dovich amplification, in alignment with expectations for operation within the angular momentum gap of a time-like crystal.

12:00 - 12:30 **Critical Topological Phase Transition** (Invited talk)
Baile Zhang — *Nanyang Technological University, Singapore*
Criticality and topology are both organizing principles of phase transitions. Using an acoustic metamaterial platform, we experimentally demonstrate a unifying scenario: a critical topological phase transition in which topology remains well defined and becomes operative within the critical regime.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
Elebash
Recital Hall

Polaritons and Strong Light-Matter Effects

Chairperson(s): Marcello Ferrera

10:30 - 11:00 **Cavity-Dressed Quantum Matter** (Invited talk)
Junichiro Kono — *Rice University, USA*
There is a growing realization that a material's fundamental properties can be radically transformed by placing it in an optical cavity. Within these confined spaces, the quantum vacuum fields surrounding the material can trigger non-intuitive modifications of electronic states. This process, driven by ultrastrong vacuum–matter coupling (USC), produces "vacuum-dressed" materials with entirely novel physical properties.

11:00 - 11:30 **Exciton–Polariton Condensation in Bound States in the Continuum of Plasmonic and Dielectric Metasurfaces** (Invited talk)
Jaime Gomez Rivas — *Eindhoven University of Technology, Netherlands*
We report exciton–polariton condensation in organic molecules strongly coupled to symmetry-protected bound states in the continuum (BICs) supported by dielectric and plasmonic metasurfaces. Condensation occurs in BICs with different modal characteristics. Remarkably, the thresholds are comparable for Ag and Si metasurfaces, despite the intrinsic losses of the plasmonic system.

11:30 - 11:45 **Magneto-Optical Switch with Tunable Hyperbolic Polaritons in a 2D Magnet**
Giacomo Venturi[1], Wei Wang[1], Emroz Khan[1], Lin Jing[1], Vinod Menon[2], Andrea Alù[1] — *[1] Photonics Initiative, Advanced Science Research Center, City University of New York, USA [2] Department of Physics, City College of New York, USA*
We demonstrate a magneto-optical switch using tunable hyperbolic exciton-polaritons in CrSBr. Below 130 K, external magnetic fields trigger a topological transition in the polariton dispersion. Using nanostructured gratings for far-field excitation, we achieve significant optical modulation, establishing a platform for reconfigurable sub-diffractional devices and integrated photonic circuits.

11:45 - 12:00 **Graphene-Integrated Metasurface for Full 2π Mid-Infrared Phase Modulation via GMR-Plasmon Strong Coupling**
Omid Poordashtban, Mohammad Mojtaba Sadafi, Hossein Mosallaei — *Northeastern University, United States*

2π phase modulation with uniform reflectance remains a key challenge in tunable metasurface design. We propose and numerically demonstrate a mid-infrared metasurface that achieves continuous 2π phase modulation at λ = 7.41 μm under TM polarization by engineering a coupling between an over-coupled guided-mode resonance (GMR) and a graphene plasmonic (GP) mode. Electrically tuning the graphene Fermi level shifts the GP resonance across the fixed GMR frequency, inducing strong mode hybridization and phase repulsion while preserving uniform reflectance throughout the tuning range. The over-coupled GMR design ensures that hybridization redistributes the phase rather than suppressing amplitude, resulting in a near-circular trajectory of the reflection coefficient in the complex plane. The moderate-Q nature of the GMR reduces inter-pixel cross-talk, and combined with an inverse-design optimization framework enables effective beam steering and arbitrary wavefront shaping in the mid-infrared.

12:00 - 12:15 **Acoustoplasmonic Metasurfaces for Optically Tunable Acoustic Wavefront Shaping**
Julia Holland, George Zipitis, Claire Kim, Nicholas Boechler, Lisa Poulikakos — *UCSD, USA*
Acoustoplasmonic metasurfaces comprise plasmonic nanoparticles which demonstrate enhanced polarization-sensitive absorption, which are leveraged to excite acoustic waves. We analytically and numerically examine this coupling of optical, thermoelastic, and acoustic mechanisms, and furthermore implement optimization algorithms for intelligent metasurface design. We finally turn our attention towards experimental realization of these studies.

12:15 - 12:30 **Active Plasmonics at Single Nanocavity Level: Electrically-Driven Modulation of Excitonic Strong Coupling and Electroluminescence**
Alexey Krasavin[1], Junsheng Zheng[2], Ruoxue Yang[2], Zhenxin Wang[2], Yuanjia Feng[2], Longhua Tang[2], Linjun Li[2], Xin Guo[2], Daoxin Dai[2], Limin Tong[2], Pan Wang[2], Anatoly Zayats[1] — *[1] King's College London, United Kingdom [2] Zhejiang University, China*
Ability to enhance and dynamically control light-matter interactions at the nanoscale plays a pivotal role in the development of nanophotonics. Utilizing ultra-confined optical fields, ultra-strong electric fields and two-dimensional semiconductors inside electrically-driven single-crystal plasmonic nanocavities, we demonstrate active control of excitonic strong coupling and electroluminescence at the single nanocavity level.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
Martin E.
Segal Theatre

Sensing and Metrology 1

Chairperson(s): Femius Koenderink, Natalia Litchinitser

10:30 - 11:00 **Large-Area Polarimetric Encoders: Compressed Sensing and Waveguiding with Silica Hollow Spheres** (Invited talk)
Luat Vuong, Altai Perry, Lydia Tsai, Jared Salary, Zepeng Cai, Yadong Yin, Tahmid Shahriar — *UC Riverside, USA*
Large-area silica hollow-spheres in photonic crystal films show a strong polarimetric response and offer an affordable, scalable, and versatile platform for new hybrid optical neural network technologies. Here we highlight results with compressive sensing and waveguiding towards applications with simple machine learning for high-speed transparent cameras.

11:00 - 11:30 **Metasurface-Driven Compressive Electromagnetic Imaging and Sensing** (Invited talk)
Okan Yurduseven — *Queen's University Belfast, United Kingdom*
We present the concept of coded-metasurface antennas as an enabling technology for compressive electromagnetic imaging and sensing applications. The coded-metasurface concept is used to synthesize spatio-temporally varying field patterns to probe and encode the channel information. It is shown that coded-metasurfaces can play a significant role in addressing some of the drawbacks associated with conventional electromagnetic imaging and sensing architectures, from simplifying the physical hardware layer to drastically reducing the number of measurements. We present and validate different modulation techniques as applied to coded-metasurfaces for a number of use case scenarios, including wireless communications, through-wall imaging, and security-screening as well as different near-field and far-field wave phenomena.

11:30 - 11:45 **A Compact Passive RF Metamaterial Resonator for In-Situ Structural Health Monitoring of Mortar**
Hamza Saeed, Tayfun Nesimoglu, Abdullah Ekinci, Cumali Sabah — *Middle East Technical University - Northern Cyprus Campus, Turkey*
This study presents a compact, embedded RF metamaterial resonator for real-time monitoring of cement mortar hydration and damage. The S-shaped resonator, made on FR-4 and sealed in PET film, was placed inside a 150 mm mortar cube and monitored using a vector network analyzer during early hardening, water curing, and compression to failure. Changes in resonant frequency,

quality factor, and minimum reflection were correlated with microstructural evolution and mechanical response. Results show high sensitivity to early-age hydration, clear curing trends over time, and distinct signatures during elastic and peak-stress stages, without affecting mortar strength.

11:45 - 12:00 **Complex Mass Distribution Recognition at the Microscale Enabled by Rainbow Trapping in Piezoelectric Metamaterials**
Niccolo Scalise Pantuso, Tommaso Maggioli, Samuel Quaresima, Cristian Cassella — *Northeastern University, USA*
We introduce a new class of piezoelectric metamaterial-based microelectromechanical systems (MEMS) that leverages topological physics to recognize complex microscale mass distributions. Unlike conventional resonant sensors, these devices support multiple topological interface states localized at different positions and frequencies, providing a spatially distributed but compact sensing framework.

12:00 - 12:30 **Molding Electromagnetic Waves in Near Field: From Ultrathin Metasurfaces to Electromagnetically Thick Metastructures** (Invited talk)
Nasim Mohammadi Estakhri — *Chapman University, USA*
We explore the possibility of using material and structural symmetries to create versatile platforms for reflectionless funneling and to route, concentrate, and sculpt electromagnetic wave as it propagates through designer metastructures.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
C201

Time-Varying Antennas and Scatterers

Chairperson(s): Silvio Hrabar, Luca Stefanini

10:30 - 11:00 **Space-time Metasurface Antennas: Concept, Design and Applications** (Invited talk)
Gengbo Wu — *City University of Hong Kong, Hong Kong*
While the global commercialization of the fifth-generation (5G) wireless communications is gradually taking off, there is already significant interest in the next generation of wireless communications. 6G scheduled to be launched in 2030, will provide a Tbps data rate, microsecond latency, and almost unlimited bandwidth to the connectivity of numerous mobile and intelligent networks. Antennas and metasurfaces are ubiquitous and indispensable components to generate and manipulate electromagnetic (EM) waves. In this talk, I will share the development and design of the space-time-coding metasurface antenna that can control all fundamental properties of EM waves, including amplitude, phase, polarization, frequency, and momentum. The space-time-coding metasurface antenna can further facilitate information manipulation, which can fundamentally simplify the architecture of information transmitter systems. The unparalleled wave and information manipulation capabilities of the metasurface antenna will spark a surge of applications from next-generation wireless systems, cognitive sensing to imaging.

11:00 - 11:30 **Feedback-Based Autonomous Programmable Meta-Atoms** (Invited talk)
M. S. Mirmoosa[1], G. Ptitcyn[2], S. Hrabar[3], S. Tretyakov[4] — *[1] University of Eastern Finland, Finland [2] University of Pennsylvania, USA [3] University of Zagreb, Croatia [4] Aalto University, Finland*
Media link(s): In this talk we will present and discuss a concept of completely autonomous and programmable meta-atoms for arbitrary control of reflection and transmission of current-voltage or field waves. The idea is based on the use of time-modulated elements (like varactors or varistors) whose modulation rule is determined by the instantaneous values of the local voltages or fields at the position of the meta-atom.

11:30 - 11:45 **Temporal Modulation for Dispersion-Free Impedance Matching**
Mario Junior Mencagli[1], Dimitrios Sounas[2] — *[1] University of Delaware, USA [2] Wayne State University, USA*
Impedance matching enables efficient power transfer but is fundamentally limited in bandwidth by the Bode–Fano bound for passive time-invariant

networks. By introducing aperiodic temporal modulation of a capacitor, this limit can be surpassed while preserving the temporal shape of the transmitted signal, enabling broadband operation in resonant devices.

11:45 - 12:00 **Scattering Properties of Time-Varying Frequency-Dispersive Nanoparticles**
Miguel Verde Ruiz[1], Thomas Allard[1], David Globosits[2], Stefan Rotter[2], Paloma Arroyo Huidobro[1] — *[1] Universidad Autónoma de Madrid, Spain [2] Vienna University of Technology, Vienna*
We analyze the optical response of frequency-dispersive particles whose permittivity is modulated in time. We focus on the symmetries and conserved quantities of the scatterer and demonstrate that the Floquet scattering matrix of this frequency-dispersive system is pseudounitary in the absence of material losses.

12:00 - 12:30 **Engineering the Scattering Response of Cylindrical Scatterers Through Time-Modulation** (Invited talk)
Jiaruo Yan[1], Ioannis Katsantonis[2], M. Mostafa[3], Viktar Asadchy[3], Maria Kafesaki[4] — *[1] FORTH, Greece [2] FORTH, Greece [3] Aalto University, Finland [4] FORTH and Univ. of Crete, Greece*
Using a Floquet–Mie formulation, we investigate electromagnetic scattering from a dielectric cylinder with periodically time-modulated permittivity. We show that temporal modulation induces parametric resonances linked to the intrinsic Mie modes and enables pronounced, tunable reshaping of the far-field radiation. Our results position time-modulated cylinders as promising meta-atoms for dynamically tunable metamaterials and metasurfaces.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
C203

Special Session: Programmable Mechanics and Instabilities

Chairperson(s): Lucia Stein-Montalvo, Muamer Kadic

10:30 - 11:00 **Nonreciprocal Topological Kink-Wave Propagation in Mechanical Metamaterials** (Invited talk)
Muamer Kadic — *Université Marie et Louis Pasteur, SUPMICROTECH, France*
In this presentation, we show how to establish bifurcation-induced nonreciprocity as a fully nonlinear route to topological-like mechanical functionality. This approach enables robust wave transport without magnetic fields, gyroscopes, or linear band topology.

11:00 - 11:30 **Imperfection-Insensitive Plate-Lattice Metamaterials: Programming Stability Through Geometry** (Invited talk)
Fani Derveni — *Cornell University, USA*
Plate-lattice mechanical metamaterials offer exceptional stiffness-to-weight performance but remain limited by fabrication-induced imperfections and buckling. This invited talk presents a mechanics-based perspective showing how geometric design enables robust post-buckling behavior and programmable stability, opening pathways toward reliable and scalable metastructures. Media link(s): Related publication:
https://doi.org/10.1016/j.eml.2021.101510

11:30 - 12:00 **Shape-Shifting Kiri-Origami Metamaterials for Adaptive Cities** (Invited talk)
Lucia Stein-Montalvo — *Northwestern University, USA*
Kirigami and origami — the arts of cutting and folding — offer a route to mechanical metamaterials with large, programmable shape change. This talk explores how these and other shape-shifting structures can interact with e.g. airflow, light, and sound, enabling a class of climate-adaptive structures for a more self-regulating built environment.

Oral Sessions (Tuesday Afternoon 1)

Metamaterials with Ultrafast Modulation

Proshansky
Room: Auditorium

Chairperson(s): Hui Cao, Hui-Hsin Hsiao

Time	1st Author (Presenter)	Title
14:00 - 14:30	Marcello Ferrera	Light–Matter Interaction in Near-Zero-Index Time-Varying Media
14:30 - 15:00	Vladimir Shalaev	Quantum Photonics and Space-Time Metamaterials
15:00 - 15:15	Romain Tirole	Sub-Cycle Optical Modulation of InAs Towards Time Reflection
15:15 - 15:30	Ohad Segal	About Time: Observation of Time-Reflections at Optical Frequencies

Novel Phenomena and Synthetic Motion

Elebash
Room: Recital Hall

Chairperson(s): Sergei Tretyakov, Tsampikos Kottos

Time	1st Author (Presenter)	Title
14:00 - 14:30	Riccardo Sapienza	Superluminal Motion and Gain-loss Control from Time-varying Metamaterials
14:30 - 14:45	Jaime E. Sustaeta-Osuna	Fluctuational Quantum Electrodynamics of Dispersive Time-Varying Media
14:45 - 15:00	Zeki Hayran	Information-Optimal Temporal States in Dispersive Time-Varying Media
15:00 - 15:15	Kayla Cecil	Flexural Wave Reflections from Time Modulated Impedance Boundaries
15:15 - 15:30	Xiao Zhang	Frequency Sorting with Lorentzian Time-Metamaterials

Quantum and Topological Photonics

Martin E.
Room: Segal Theatre

Chairperson(s): Christos Argyropoulos

Time	1st Author (Presenter)	Title
14:00 - 14:30	Avik Dutt	Entangled Frequency Combs, Strong Squeezing and Non-Hermiticity in Frequency-Encoded Synthetic Dimensions

Continued from Previous Page: Quantum and Topological Photonics

Chairperson(s): Christos Argyropoulos **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
14:30 - 15:00	Albert Polman	Optical Metasurfaces Controlling Quantum Electron Wavepackets
15:00 - 15:15	Jonas Himmel	Hidden Symmetries in Quantum Photonic Systems
15:15 - 15:30	Frieder Lindel	Close Encounters Between Periodic Light and Periodic Arrays of Quantum Emitters

Optical Effects in Nanophotonic Setups

Chairperson(s): Jaime Gomez Rivas, Ioannis Katsantonis **Room: C201**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Daniel Wasserman	Infrared Metaplasmonics
14:30 - 14:45	Charly Bolhuis	The Local Density of Optical States in Absorbing Inhomogeneous Media
14:45 - 15:00	Seongmin Im	Exploring the Origin of Photothermal Force with Super-resolution Optical Force Mapping of Nanoscale Photothermal Effects
15:00 - 15:15	Emanuele D. Cadeddu	Uniform Hemispherical Illumination from a Light-Emitting Concave Metalens
15:15 - 15:30	Mathieu Mivelle	Ultrafast Opto-Magnetism: Unlocking the Unconventional Inverse Faraday Effect

Metastructures and Meta-Optics for Advanced Antenna Systems

Chairperson(s): Okan Yurduseven, Nasim Mohammadi Estakhri **Room: C203**

Time	1st Author (Presenter)	Title
14:00 - 14:30	David González Ovejero	Folded Meta-Optics for Compact, High-Gain Sub-Terahertz Antennas
14:30 - 14:45	Junsoo Kim	M-type Ferrite Based Multi-Functional Metasurface for LEO Satellite Communication
14:45 - 15:00	Dmytro Vovchuk	Radar QR Codes Based on Phase-Gradient Metasurfaces

Continued from Previous Page: Metastructures and Meta-Optics for Advanced Antenna Systems

Chairperson(s): Okan Yurduseven, Nasim Mohammadi Estakhri **Room: C203**

Time	1st Author (Presenter)	Title
15:00 - 15:15	Tyler Burns	Binary-Coerced Multiphysics Topology Optimization for Manufacturable Dielectric Metamaterials
15:15 - 15:30	Adam Pander	Increasing Data Transmission Rates of Beamforming Metasurfaces in 300-GHz-Band Wireless Communication Using Dynamic Focus Metalens

14:00 - 15:30 Oral Sessions (Tuesday Afternoon 1)
Proshansky
Auditorium

Metamaterials with Ultrafast Modulation

Chairperson(s): Hui Cao, Hui-Hsin Hsiao

14:00 - 14:30 **Light–Matter Interaction in Near-Zero-Index Time-Varying Media** (Invited talk)
Marcello Ferrera — *Heriot-Watt University, United Kingdom*
Transparent conducting oxides operated near their crossover wavelength exhibit a low refractive index over a broad spectral window with strongly enhanced optical nonlinearities. In this regime, refractive-index changes approaching unity occur within tens of femtoseconds, enabling a near-ideal time-varying optical medium for ultrafast control of photon energy and momentum.

14:30 - 15:00 **Quantum Photonics and Space-Time Metamaterials** (Invited talk)
Vladimir Shalaev — *Purdue University, USA*
In this talk we first discuss quantum photonic integrated circuitry (qPIC) based on the recently discovered single-photon emitters in silicon nitride and the avalanche-enhanced optical modulation in silicon at single-photon intensities. Then, we show that transparent conducting oxides (TCOs) operating in the near-zero index (NZI) regime can provide strong single-light-cycle modulation, enabling novel optical phenomena in such extreme time-varying media, including photonic time crystals and 4D space-time metamaterials

15:00 - 15:15 **Sub-Cycle Optical Modulation of InAs towards Time Reflection**
Romain Tirole[1], Michele Guizzardi[1], Sofia Sechi[1], Myles B. T. Osenton[1], Mingze He[1], Enrico M. Renzi[1], Alexander Ware[2], Dan Wasserman[2], Andrea Alù[1] — *[1] The Advanced Science Research Center, CUNY, USA [2] The University of Texas at Austin, USA*
The observation of time-reflection at optical frequencies has so far eluded the photonics community. Here, we demonstrate all-optical sub-cycle modulation of Indium Arsenide, measuring high levels of time-refraction for low pump intensities, and discuss experimental techniques bringing us closer to a first demonstration of time-reflection in the optical regime.

15:15 - 15:30 **About Time: Observation of Time-Reflections at Optical Frequencies**

Ohad Segal[1], Noa Konforty[1], Oded Schiller[1], Maxwell J. Tolchin[2], Jon-Paul Maria[2], Yonatan Plotnik[1], Mordechai Segev[1] — *[1] Technion - Israel Institute of Technology, Israel [2] Pennsylvania State University, United States of America*

When a wave encounters a large abrupt change in the electromagnetic properties of the medium, it splits into time-reflected and time-refracted waves. Observing time-reflection requires order-unity refractive index variations occurring within less than a single cycle. Here, we report the first observation of time-reflection at optical frequencies.

14:00 - 15:30 Oral Sessions (Tuesday Afternoon 1)
Elebash
Recital Hall

Novel Phenomena and Synthetic Motion

Chairperson(s): Sergei Tretyakov, Tsampikos Kottos

14:00 - 14:30 **Superluminal Motion and Gain-Loss Control from Time-varying Metamaterials** (Invited talk)
Riccardo Sapienza — *Imperial College London, United Kingdom*
Metamaterials have revolutionised the way we control light transport and generation. Yet, to date, they rely on static and passive architectures, only redistributing incident wave energy - for example a metalens that focuses light or a cloak that makes an object invisible. The next frontier lies in extending this control to the space-time domain, enabling waves to coherently interact with synthetically moving modulations. Here, I report the experimental observation of light scattering from optical modulations propagating faster than the speed of light [1], alongside coherent perfect absorption [2] — two phenomena that open a pathway to more complex spatio-temporal optical dynamics. I further present time-resolved measurements of the modulation profile in Indium Tin Oxide, uncovering ultrafast, non-monotonic dynamics [3] that give rise to strong time-varying optical effects. These are initial steps towards next-generation active metamaterials capable of manipulating light beyond the constraints of conventional, time-invariant designs.

14:30 - 14:45 **Fluctuational Quantum Electrodynamics of Dispersive Time-Varying Media**
Jaime E. Sustaeta-Osuna, Thomas F. Allard, Francisco J. García-Vidal, Paloma A. Huidobro — *Universidad Autónoma de Madrid, Spain*
We present a theory of fluctuational quantum electrodynamics of dispersive time-varying media. Crucially, our new framework accounts for the dispersion and losses of the time-modulated medium and furthermore, treats the temporal modulation in an exact manner, without relying on perturbative method.

14:45 - 15:00 **Information-Optimal Temporal States in Dispersive Time-Varying Media**
Zeki Hayran, John B. Pendry — *Imperial College London, United Kingdom*
We introduce information-optimal temporal states for probing localized events in dispersive time-varying media by maximizing Fisher information under energy and measurement constraints. For a modulated slab, the optimal probe outperforms optimized Gaussians and can precede the event, revealing the central role of temporal memory in waveform design.

15:00 - 15:15 **Flexural Wave Reflections from Time Modulated Impedance Boundaries**

Kayla Cecil[1], Benjamin M. Goldsberry[2], Michael R. Haberman[3] — *[1] The University of Texas at Austin, Walker Department of Mechanical Engineering, Applied Research Laboratories, USA [2] The University of Texas at Austin, Applied Research Laboratories, USA [3] University of Texas at Austin, Walker Department of Mechanical Engineering, Applied Research Laboratories , USA*

This study analyzes flexural wave reflections from time-modulated impedance boundaries using a semi-analytical framework based on Euler–Bernoulli beam theory. By modeling boundaries as temporally modulated spring elements, we derive expressions for reflected waves and explore how time-varying boundary conditions can enable advanced elastic wave control.

15:15 - 15:30 **Frequency Sorting with Lorentzian Time-Metamaterials**

Xiao Zhang[1], Luca Stefanini[1], Emanuele Galiffi[2], Andrea Alù[1] — *[1] Photonics Initiative, Advanced Science Research Center, City University of New York, USA [2] Chandra Family Department of Electrical and Computer Engineering, University of Texas at Austin, USA*

In this work, we theoretically propose that a Lorentzian temporal slab can serve as an ideal frequency sorter which separates the waves of different frequency components into different directions. We also demonstrate that the frequency sorter can operate at any momentum and incoming wave ratios by adjusting the controlling parameters.

14:00 - 15:30 Oral Sessions (Tuesday Afternoon 1)
Martin E.
Segal Theatre

Quantum and Topological Photonics

Chairperson(s): Christos Argyropoulos

14:00 - 14:30 **Entangled Frequency Combs, Strong Squeezing and Non-Hermiticity in Frequency-Encoded Synthetic Dimensions** (Invited talk)
Avik Dutt, Yichen Shen, Sashank Kaushik Sridhar, Rohith Srikanth, Antoine Henry — *University of Maryland, College Park, USA*
The frequency degree of freedom of photons provides a versatile substrate for generating and manipulating novel electromagnetic states, including quantum states such as squeezed and entangled light. Here, we discuss how a comb of such entangled states can be generated using the frequency modes of a high-quality-factor microresonator through four-wave mixing nonlinearities. These quantum microcombs exhibit strong spectrally tunable squeezing across a wide frequency span exceeding 11 THz (100 nm). The same substrate also can be engineered to realize artificial lattice "materials" out of light, by coupling frequency modes to form synthetic dimensions. Our experiments on such frequency synthetic dimensions allow for direct probing of wave phenomena such as the non-Hermitian skin effect in 1D and 2D, both in real-space and momentum space. We conclude with perspectives for classical and quantum information processing using frequency-encoded synthetic dimensions.

14:30 - 15:00 **Optical Metasurfaces Controlling Quantum Electron Wavepackets** (Invited talk)
Albert Polman — *AMOLF, Netherlands*
We show how a strong laser-induced near field generated at a silicon metasurface dresses a 10 keV electron in a quantum-coherent superposition state, where the metasurface geometry controls the shape of the propagating electron wavepacket in space and time.

15:00 - 15:15 **Hidden Symmetries in Quantum Photonic Systems**
Jonas Himmel[1], Max Ehrhardt[2], Matthias Heinrich[1], Sebastian Weidemann[1], Tom A.W. Wolterink[1], Malte Röntgen[3], Peter Schmelcher[4], Alexander Szameit[1] — *[1] University of Rostock, Germany [2] McGill University, Canada [3] Eastern Institute for Advanced Study, China [4] University of Hamburg, Germany*
We study the impact of hidden symmetries on the dynamics of quantum photonic systems. We experimentally observe high-fidelity state transfer between latent-symmetric sites and suppression of two-photon coincidences between

so-called singlet sites. We find that the introduction of multiphoton states and their (in)distinguishability can induce latent symmetries in asymmetric systems.

15:15 - 15:30 **Close Encounters Between Periodic Light and Periodic Arrays of Quantum Emitters**
Frieder Lindel[1], Carlos J. Sánchez Martínez[2], Johannes Feist[2], Francisco J. García-Vidal[2] — *[1] ETH Zürich, Switzerland [2] Universidad Autónoma de Madrid, Spain*
We introduce a cavity quantum electrodynamics platform where collective excitations of periodic quantum-emitter arrays strongly couple to the light modes of metasurfaces, giving rise to what we name crystal polaritons. We show that interactions between them can lead to a strong nonlinear response for extremely low polariton densities.

14:00 - 15:30 Oral Sessions (Tuesday Afternoon 1)
C201

Optical Effects in Nanophotonic Setups

Chairperson(s): Jaime Gomez Rivas, Ioannis Katsantonis

14:00 - 14:30 **Infrared Metaplasmonics** (Invited talk)
Zarko Sakotic[1], Noah Mansfield[1], Divya Hungund[1], Monica Allen[2], Jeffery Allen[2], Daniel Wasserman[1] — *[1] UNIVERSITY OF TEXAS AT AUSTIN, USA [2] Air Force Research Laboratory, Munitions Directorate, Eglin AFB, USA*
We demonstrate that the plasmonic response of noble metals can be extended well into the mid-infrared wavelength range by means of geometric dilution. By keeping minimum feature dimensions larger than the mean free path of electrons in noble metals but dramatically reducing the metal fill factor, mode confinement of $\lambda_0/35$ and greater can be achieved in thin noble metal films. We show that not only do such materials offer strongly enhanced light-matter interaction at long wavelengths, but the lithographic control of plasmonic response opens the door to novel elliptical, hyperbolic, and canalized plasmonic modes.

14:30 - 14:45 **The Local Density of Optical States in Absorbing Inhomogeneous Media**
Charly Bolhuis, Sander Mann — *University of Amsterdam, Netherlands*
The amount of power radiated by a source depends on its electromagnetic environment, captured by the local density of optical states (LDOS). However, conventional methods to calculate the LDOS yield divergences for sources embedded in inhomogeneous media. To overcome this limitation, we present a generalized expression that fully regularizes the problem and enables the calculation of the LDOS in arbitrary electromagnetic environments, including boundaries, loss, and gain.

14:45 - 15:00 **Exploring the Origin of Photothermal Force with Super-resolution Optical Force Mapping of Nanoscale Photothermal Effects**
Seongmin Im, Wei Hong, Gayatri Chandran, Xing Wang, Yang Zhao — *University of Illinois at Urbana-Champaign, USA*
We employ decoupled optical force nanoscopy combined with phase-informed decomposition to disentangle the photothermal force from mixed optical forces, thereby elucidating its physical origin. The chiroptical photothermal response of a chiral gold nanoparticle was observed under the illumination with opposite circularly polarized light. We also demonstrate that our system possesses a temperature sensitivity of 0.1 K. Building upon our decoupled optical force nanoscopy, we anticipate that the high-resolution photothermal

measurements under ambient conditions provide a broad range of characterizing nanophotonic and semiconductor devices.

15:00 - 15:15 **Uniform Hemispherical Illumination from a Light-Emitting Concave Metalens**
Emanuele D. Cadeddu[1], Wesley Mills[2], Paolo Pintus[1], Steve. P. Denbaars[2], Shuji Nakamura[2], Francesco Quochi[1], Jon A. Shuller[2], Prasad P. Iyer[3] — *[1] Department of Physics, University of Cagliari, Italy [2] Department of Electrical and Computer Engineering, University of California Santa Barbara, USA [3] Center for Integrated Nanotechnologies, Sandia National Laboratories, Albuquerque, NM, USA*
We demonstrate uniform hemispherical illumination from a concave metalens composed of GaN nanopillars with embedded InGaN quantum wells. A quadratic spatial phase profile (NA ≈ 1.4) creates a virtual point source that directs emitted light to fill the total internal reflection cone within the high-index substrate, coupling it uniformly into the free-space hemisphere. Fourier-plane imaging reveals 10–30% azimuthal and up to 15% zenithal uniformity enhancement over unpatterned thin films of equivalent area.

15:15 - 15:30 **Ultrafast Opto-Magnetism: Unlocking the Unconventional Inverse Faraday Effect**
Mathieu Mivelle — *CNRS, Sorbonne université, INSP, France*
We experimentally probe the ultrafast dynamics of the nanoscale Inverse Faraday Effect to demonstrate unconventional magneto-optical responses. Using time-resolved MOKE, we characterize magnetization optically induced by linear polarization in plasmonic nanorods. Furthermore, we investigate chiral nanostructures generating magnetization exclusively under specific circular polarizations. These direct experimental validations pave the way for novel all-optical spintronic devices.

14:00 - 15:30 Oral Sessions (Tuesday Afternoon 1)
C203

Metastructures and Meta-Optics for Advanced Antenna Systems

Chairperson(s): Okan Yurduseven, Nasim Mohammadi Estakhri

14:00 - 14:30 **Folded Meta-Optics for Compact, High-Gain Sub-Terahertz Antennas** (Invited talk)
David González Ovejero[1], Tomas Thuroczy[2], Malo Robin[2], Xavier Morvan[2], Olivier De Sagazan[2], Ronan Sauleau[2] — *[1] CNRS, France [2] Université de Rennes, France*
This manuscript presents a folded planar lens antenna, also referred to as a folded transmitarray, featuring an integrated subreflector based on Gregorian optics. Unlike conventional folded flat lenses, which typically require a polarization-rotating surface, the proposed antenna retains the fabrication simplicity of a standard non-folded planar lens while achieving a nearly threefold reduction in profile. The subreflector profile is derived in closed form using geometrical optics, resulting in an elliptical ring-like focus, which is realized as a planar reflectarray. Both the reflectarray and the planar lens aperture are implemented using the same three-metal-layer stack, supported by two dielectric substrates.

14:30 - 14:45 **M-type Ferrite based Multi-Functional Metasurface for LEO Satellite Communication**
Junsoo Kim[1], Nohgyeom Ha[2], Soohyun Kim[1], Seongun Choi[1], Byeongjin Park[3], Sukjin Kwon[3], Horim Lee[3], Mikyung Lim[4], Yunho Kim[5], Garam Kim[6], Sangkil Kim[1] — *[1] Pusan National University, Korea (South) [2] Hanwha Systems, Korea (South) [3] Korea Institute of Materials Science, Korea (South) [4] Chung-Ang University, Korea (South) [5] Seoul National University, Korea (South) [6] Purdue University, The United States of America*
This paper proposes M-type ferrite based multi functional metasurface for LEO satellite communication. The proposed metasurface enables independent control of reflection at 17.5 GHz, transmission from 28 to 30 GHz, and absorption from 34 to 40 GHz within a single low profile platform.

14:45 - 15:00 **Radar QR Codes Based on Phase-Gradient Metasurfaces**
Dmytro Vovchuk[1], Assaf Stav[2], Konstantin Grotov[2], Mykola Khobzei[1], Vladyslav Tkach[1], Vjaceslavs Bobrovs[3], Pavel Ginzburg[4] — *[1] Riga Tecnical University, Latvia [2] Tel Aviv University, Israel [3] Riga Tecnical University, Tkach [4] Israel, Tel Aviv University*

Passive identification of objects using radar is of growing interest for automotive and autonomous systems operating at millimeter-wave frequencies. In this work, we introduce radar-readable QR codes implemented using engineered metasurfaces with frequency-dependent reflection phase gradients. When interrogated by an FMCW radar, the metasurface dispersion induces an artificial shift in the detected range, enabling information encoding without active transmission or onboard power. We develop the theoretical framework linking reflection phase dispersion to virtual range displacement, design and fabricate PCB-based metasurface pixels operating in the 76–81 GHz automotive band, and experimentally validate the concept in an anechoic chamber. Multiple QR-like patterns are demonstrated and successfully decoded. To assess scalability and robustness, convolutional neural networks are trained on augmented datasets, achieving reliable classification at moderate SNR levels. The proposed radar QR codes provide a pathway toward passive, infrastructure-independent identification for future autonomous mobility.

15:00 - 15:15 **Binary-Coerced Multiphysics Topology Optimization for Manufacturable Dielectric Metamaterials**
Tyler Burns, Andy Huynh, Sawyer Campbell, Pingjuan Werner, Douglas Werner — *The Pennsylvania State University, USA*
This work presents a fabrication-oriented multiphysics topology optimization framework that transforms continuous adjoint-designed dielectric metamaterials into manufacturable binary meta-structures. By combining electromagnetic adjoint and mechanical SIMP gradients with a converging coercion operator, the method achieves simultaneous gain enhancement and structural robustness in additively manufacturable dielectric devices.

15:15 - 15:30 **Increasing Data Transmission Rates of Beamforming Metasurfaces in 300-Ghz-Band Wireless Communication Using Dynamic Focus Metalens**
Adam Pander, Dasiuke Kitayama, Hibiki Kagami, Haruka Matsunaga, Hiroyuki Takahashi — *NTT Device Technology Labs, NTT, Inc., Japan*
This study presents a 300-GHz-band reconfigurable metalens combined with beamforming gradient metasurfaces (beam steering angles: 0°, 18°, 30°, and 38°). Near E field and data transmission links were evaluated in relation to the dynamic operation of the metalens, showing a significant boost in the received power and achieving data rates above 100 Gb/s.

Oral Sessions (Tuesday Afternoon 2)

Physical Platforms for Analog Computing

Chairperson(s): Baile Zhang, Philippe St-Jean

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
16:00 - 16:30	Hui Cao	Optical Kernel Machine with Programmable Nonlinearity
16:30 - 17:00	Nikolay Zheludev	NanoMechanical vs Electronic Computers

Nonlinear Plasmonics and Hybrid Interactions

Chairperson(s): Albert Polman, Daniel Wasserman

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
16:00 - 16:30	Junsuk Rho	Sustainable Manufacturing of Optical Metasurfaces with Engineered Optical Materials
16:30 - 17:00	Hui-Hsin Hsiao	Strong Coupling in Hybrid Metasurfaces for Enhanced Nonlinear Signal Conversion
17:00 - 17:15	Romain Tirole	Floquet Control of Surface Plasmons through Hybrid Resonances in $MoOCl_2$
17:15 - 17:30	Sedigheh Esfahani	Ultrafast Switching and Power Limiting with Nonreciprocal Intersubband Polaritonic Metasurfaces

Time Crystals

Chairperson(s): Vladimir Shalaev, Riccardo Sapienza

Room: Martin E. Segal Theatre

Time	1st Author (Presenter)	Title
16:00 - 16:30	Mario Silveirinha	Superluminal Spacetime Crystals Induced by Anomalous Velocity Modulation
16:30 - 16:45	Sahitya Singh	Observation of a Passive Photonic Time Crystal in an On-chip Transmission-Line Metamaterial
16:45 - 17:00	Mohammadreza Salehi	Nonlocal Photonic Time Crystals: Infinite Momentum Bandgaps with Minimal Modulation Speed and Strength
17:00 - 17:15	Thomas F. Allard	Controlling Light-Matter Interaction Through a Frequency-Dispersive Photonic Time Crystal

Continued from Previous Page: Time Crystals

Chairperson(s): Vladimir Shalaev, Riccardo Sapienza **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
17:15 - 17:30	Evgeniy Narimanov	Carrier Drift Modulation and Lossless Hyperbolic Time Crystals

Active, Reconfigurable, and Nonreciprocal Metasurfaces

Chairperson(s): David González Ovejero **Room: C201**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Silvio Hrabar	Switching-Based Active Impedances for Highly Efficient Meta-structures and Antennas
16:30 - 16:45	Sadi Ayhan	Metasurface-Enabled Subsecond mmWave Photonic Limiter: Spatiotemporal Switching Dynamics
16:45 - 17:00	Darin Nozina	Nonreciprocal Broadband Huygens Radiator - Preliminary Experimental Verification
17:00 - 17:15	Stefano Vellucci	Dual-Angle Multi-Objective Design of a Reconfigurable Phase-Gradient Metasurface for Wide-Angle Scanning of Sparse Arrays
17:15 - 17:30	Feiyu Shan	Toward Nonlocal Programmable Metasurfaces for Multiuser Orthogonal Beamforming

Emergent Phenomena in Non-Hermitian and Nonreciprocal Systems

Chairperson(s): Avik Dutt **Room: C203**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Tsampikos Kottos	Guiding Waves in Nonlinear Media via In-Situ Physical Adjoint Propagation
16:30 - 16:45	Vassos Achilleos	Wave Acceleration and Non-Hermitian Jump in Nonreciprocal Lattices
16:45 - 17:00	Mia Morrell	Emergence of a Continuous Time Crystal from Classical Wave-Matter Interactions
17:00 - 17:15	Nadav Shaibe	Probing Non-Hermitian Scattering Using The Generalized Wigner-Smith Operator
17:15 - 17:30	Isabella Giovannelli	Tuning Chirped Pulses in Non-Hermitian Scattering Systems via Complex Time Delay

16:00 - 17:30 Oral Sessions (Tuesday Afternoon 2)
Proshansky
Auditorium

Physical Platforms for Analog Computing

Chairperson(s): Baile Zhang, Philippe St-Jean

16:00 - 16:30 **Optical Kernel Machine with Programmable Nonlinearity** (Invited talk)
Hui Cao — *Yale University, USA*
We introduce a low-power optical kernel machine based on structural nonlinearity. By tuning the order of nonlinearity, we vary the kernel sensitivity and information capacity. We optimize the nonlinearity to approximate parity functions from first to fifth order for binary inputs.

16:30 - 17:00 **NanoMechanical vs Electronic Computers** (Invited talk)
Nikolay Zheludev[1], Raskatla Venugopal[1], Jinxiang Li[2], Giorgio Adamo[1], Kevin Macdonald[1] — *[1] University of Southampton, United Kingdom [2] Nanyanag Technological University, Singapore*
Digital mechanical computers (e.g. bacus) dominated well into the twentieth century before being displaced by electronic machines. The decisive advantage of electronics was their transition to the nanoscale. Can nano-mechanical computers also be scaled to the nanoscale and compete with electronic architectures? We report the timetron as a central building block for mechanical computation based on the concept of a time crystal, which can be switched with femtojoule-scale energies and sustained with only a few femtowatts of optical power.

16:00 - 17:30 Oral Sessions (Tuesday Afternoon 2)
Elebash
Recital Hall

Nonlinear Plasmonics and Hybrid Interactions

Chairperson(s): Albert Polman, Daniel Wasserman

16:00 - 16:30 **Sustainable Manufacturing of Optical Metasurfaces with Engineered Optical Materials** (Invited talk)
Junsuk Rho — *POSTECH, Korea (South)*
In this talk, I will discuss the recent progress of imaging, sensing, and display applications with mass-producible optical metalenses (visible, near-infrared). The basic principle, experimental demonstration, and scalable manufacturing methodologies will be presented.

16:30 - 17:00 **Strong Coupling in Hybrid Metasurfaces for Enhanced Nonlinear Signal Conversion** (Invited talk)
Hui-Hsin Hsiao — *National Taiwan University, Taiwan*
We investigated the integration of various types of metasurfaces with epsilon-near-zero materials to enhance nonlinear optical signals. Both coupled-mode theory and near-field analysis of the hybridized modes were employed to examine the strong coupling effect and the symmetry relationship of the electric fields at the fundamental wave and up-conversion frequencies.

17:00 - 17:15 **Floquet Control of Surface Plasmons Through Hybrid Resonances in $MoOCl_2$**
Romain Tirole[1], Giacomo Venturi[1], Emroz Khan[1], Lin Jing[1], Lin Nan[2], Nicola Melchioni[2], Andrea Mancini[2], Antonio Ambrosio[2], Andrea Alù[1] — *[1] The Advanced Science Research Center, CUNY, USA [2] Centre for Nano Science and Technology, Fondazione Istituto Italiano di Tecnologia, Italy*
The emergence of $MoOCl_2$ is offering new avenues to circumvent the limit of losses in plasmonics. We report a hybridization of plasmonic and waveguide modes within the material leading to high-Q surface plasmons. Surprisingly, we find in pump-probe experiments that optical pumping leads to an increase in the propagation length.

17:15 - 17:30 **Ultrafast Switching and Power Limiting with Nonreciprocal Intersubband Polaritonic Metasurfaces**
Sedigheh Esfahani[1], Sander Mann[2], Andrea Alù[1] — *[1] Advanced Science Research Center, City University of New York, USA [2] University of Amsterdam, The Netherlands*
Optical power limiting and ultrafast switching are essential for protecting sensitive photonic systems from high-intensity radiation in advanced optical

technologies. Recent progress in nanophotonics has highlighted intersubband polaritonic metasurfaces as a powerful platform for achieving exceptionally strong and ultrafast nonlinear optical responses through the coupling of resonant nanostructures with multi-quantum-well transitions. These systems have demonstrated high-contrast optical limiting, but existing designs are fundamentally reciprocal and therefore cannot provide direction-dependent protection or asymmetric signal routing. Here we show that nonreciprocal ultrafast power limiting can be achieved in transmission using engineered intersubband polaritonic metasurfaces that combine strong nonlinear saturation with structural asymmetry. This approach opens new opportunities for on-chip optical protection, asymmetric signal processing, and advanced nonlinear functionalities in next-generation photonic systems.

16:00 - 17:30 Oral Sessions (Tuesday Afternoon 2)
Martin E.
Segal Theatre

Time Crystals

Chairperson(s): Vladimir Shalaev, Riccardo Sapienza

16:00 - 16:30 **Superluminal Spacetime Crystals Induced by Anomalous Velocity Modulation** (Invited talk)
Filipa Prudencio[1], Mario Silveirinha[2] — *[1] University of Lisbon and Instituto Universitário de Lisboa, Portugal [2] University of Lisbon, Portugal*
We propose that quantum geometry in topological materials provides intrinsic ultrafast spatiotemporal modulation. In optically pumped Weyl semimetals, anomalous-velocity feedback yields optical-frequency spacetime crystals, enabling unidirectional subgap light and ENZ parametric plasmon emission.

16:30 - 16:45 **Observation of a Passive Photonic Time Crystal in an On-chip Transmission-Line Metamaterial**
Sahitya Singh, Andrea Alù — *ASRC, City University of New York, USA*
Here, we experimentally demonstrate momentum bandgaps arising in a passive photonic time crystal by leveraging time interfaces driven by commutated switching networks. We implement a passive PTC using an on-chip switched transmission-line-metamaterial in 65nm CMOS technology. This platform enables observation of passive PTCs that realize momentum selectivity without supporting parametric amplification.

16:45 - 17:00 **Nonlocal Photonic Time Crystals: Infinite Momentum Bandgaps with Minimal Modulation Speed and Strength**
Mohammadreza Salehi, Francesco Monticone — *Cornell University, USA*
Momentum bandgaps in photonic time crystals have drawn significant theoretical interest but limited experimental progress due to the need for high modulation speed and strength. We show that the speed constraint stems from the Manley–Rowe relations governing conventional modulation schemes. Modulating the plasma frequency of a Lorentz-dispersive material overcomes this limit, and adding a tailored spatial nonlocality enables infinite momentum bandgaps at arbitrarily low modulation speeds and strengths.

17:00 - 17:15 **Controlling Light-Matter Interaction Through a Frequency-Dispersive Photonic Time Crystal**
Thomas F. Allard[1], Jaime E. Sustaeta-Osuna[1], Francisco J. Garcia-Vidal[2], Paloma A. Huidobro[2] — *[1] Universidad Autonoma de Madrid, Spain [2] Universidad Autónoma de Madrid, Spain*

We investigate the interaction between a dipolar emitter and a dispersive photonic time crystal. By leveraging dispersion, we unveil the possibility of converting dipole emission into dipole absorption without relying on momentum gaps and while operating in the system's stable regime.

17:15 - 17:30 **Carrier Drift Modulation and Lossless Hyperbolic Time Crystals**

Evgeniy Narimanov[1], Boris Shapiro[2] — *[1] Purdue University, USA [2] Technion, Israel*

Carrier Drift Modulation provides an ultrafast mechanism for inducing transient anisotropy in isotropic conductors, enabling hyperbolic dispersion and the formation of hyperbolic photonic time crystals. The same modulation supplies parametric gain that compensates intrinsic losses, offering a practical route to lossless hyperbolic media using existing semiconductor platforms. Media link(s): See preprint https://arxiv.org/pdf/2601.00547

16:00 - 17:30 Oral Sessions (Tuesday Afternoon 2)
C201

Active, Reconfigurable, and Nonreciprocal Metasurfaces

Chairperson(s): David González Ovejero

16:00 - 16:30 **Switching-Based Active Impedances for Highly Efficient Meta-structures and Antennas** (Invited talk)
Srdan Milic, Darin Nozina, Ana Kovacic, Silvio Hrabar — *University of Zagreb, Croatia*
In this contribution, we review new approaches that involve transferring highly efficient switching circuits, commonly used in power electronics, into the field of active meta-structures and antennas. This generalization may lead to highly efficient broadband RF positive impedance inverters (gyrators), and negative impedance converters or inverters. Finally, we discuss technological constraints such as maximum operating efficiency and power handling, and highlight future research directions.

16:30 - 16:45 **Metasurface-Enabled Subsecond mmWave Photonic Limiter: Spatiotemporal Switching Dynamics**
Sadi Ayhan[1], Andrey Chabanov[1], Igor Anisimov[2], Carl Pfeiffer[2], Vladimir Vasilyev[2], Ilya Vitebskiy[2] — *[1] The University of Texas at San Antonio, USA [2] Air Force Research Laboratory, USA*
We present a metasurface-enabled mmWave photonic limiter that preserves low insertion loss in normal operation while rapidly rejecting high-power interference. Subsecond activation is achieved by accelerating the thermally driven VO2 insulator-to-metal transition in a multilayer resonant stack using an ITO nanolayer and a subwavelength gold bow-tie antenna array to concentrate fields and localize heating, enabling fast switching in 120 ms.

16:45 - 17:00 **Nonreciprocal Broadband Huygens Radiator - Preliminary Experimental Verification**
Darin Nozina, Srdjan Milic, Silvio Hrabar — *University of Zagreb, Croatia*
This contribution presents a simple experimental prototype of a gyrator-based Huygens radiator operating in the HF band (3 MHz–30 MHz) and reports preliminary results indicating extremely broad bandwidth and inherent nonreciprocal behavior.

17:00 - 17:15 **Dual-Angle Multi-Objective Design of a Reconfigurable Phase-Gradient Metasurface for Wide-Angle Scanning of Sparse Arrays**

Stefano Vellucci[1], Alessio Monti[2], Mirko Barbuto[3], Alessandro Toscano[2], Filiberto Bilotti[2] — *[1] Niccolò Cusano University, Italy [2] ROMA TRE University, Italy [3] ROMA TRE University, Iatly*

A reconfigurable transmissive metasurface superstrate for wide-angle scanning of sparse antenna arrays is presented. The structure operates in two states: a refracting configuration that redirects a 30° radiated beam toward 60°, enabling radiation beyond the conventional grating-lobe free region, and a transparent configuration that preserves broadside radiation. The design combines an analytical microwave-network synthesis with a multi-objective full-wave optimization.

17:15 - 17:30 **Toward Nonlocal Programmable Metasurfaces for Multiuser Orthogonal Beamforming**

Feiyu Shan, Hao Luo, Ahmed Alkhateeb, Georgios Trichopoulos — *Arizona State University, USA*

A circuit-based metasurface with nonlocality and reconfigurability is proposed for multiuser orthogonal beamforming for multiple-input-multiple-output (MIMO) wireless communications. The metasurface features a low-profile structure, aimed for the application of satellite communications in the millimeter wave frequency bands.

16:00 - 17:30 Oral Sessions (Tuesday Afternoon 2)
C203

Emergent Phenomena in Non-Hermitian and Nonreciprocal Systems

Chairperson(s): Avik Dutt

16:00 - 16:30 **Guiding Waves in Nonlinear Media via In-Situ Physical Adjoint Propagation** (Extended oral)
Tsampikos Kottos[1], John Guillamon[1], William Tuxbury[1], Zheming Li[2], Lucas Fernandez-Alcazar[1], Owen Miller[3], Zin Lin[4] — *[1] Wesleyan University, USA [2] Wesleyan University, United States [3] Yale University, USA [4] Virginia Tech, USA*
We demonstrate real-time wave control in nonlinear multi-resonant environments using time- and energy- efficient nonlinear adjoint optimization schemes. By exploiting nonlinear multipath scattering, small in-situ perturbations are amplified, enabling targeted channel emission, coherent perfect absorption and asymmetric transport. Our approach is applicable to in-door wireless technologies, imaging, power electronic and optical neural networks.

16:30 - 16:45 **Wave Acceleration and Non-Hermitian Jump in Nonreciprocal Lattices**
Vassos Achilleos[1], Sayan Jana[2], Bertin Manda[2], Dimitri Frantzeskakis[3], Lea Sirota[4] — *[1] CNRS LAUM, France [2] School of Mechanical Engineering, Tel Aviv University, Tel Aviv 69978, Israel [3] Department of Physics, National and Kapodistrian University of Athens, Athens 15784, Greece [4] School of Mechanical Engineering, Tel Aviv University, Tel Aviv 69978, Israels*
We analytically and numerically study wavepacket dynamics in a Hatano–Nelson type lattice. Using a continuum approximation, we derive closed-form expressions revealing three dynamical stages — acceleration, deceleration, and uniform motion — alongside a disorder-free non-Hermitian jump driven by momentum-dependent amplitude growth.

16:45 - 17:00 **Emergence of a Continuous Time Crystal From Classical Wave-Matter Interactions**
Mia Morrell, David Grier — *NYU, USA*
An acoustic standing wave creates an array of potential energy wells for subwavelength-scale objects. Trapped particles interact by exchanging scattered waves. Unless the particles have identical scattering properties, their wave-mediated interactions are nonreciprocal. Nonreciprocity enables pairs of mismatched particles to harvest energy from the wave to sustain steady-state oscillations despite viscous drag and the absence of periodic driving. We show in

theory and experiment that this emergent steady state breaks spatiotemporal symmetry in a way that distinguishes it as a classical time crystal.

17:00 - 17:15 **Probing Non-Hermitian Scattering Using The Generalized Wigner-Smith Operator**
Nadav Shaibe, Jared Erb, Steven Anlage — *University of Maryland, USA*
In this work, we present an experimental investigation of the generalized Wigner–Smith operator in non-Hermitian scattering systems. The resulting generalized response shares many features with complex time delay. For systems where multi-frequency measurements are not easily done, the generalized operator could be a powerful tool for system characterization.

17:15 - 17:30 **Tuning Chirped Pulses in Non-Hermitian Scattering Systems via Complex Time Delay**
Isabella Giovannelli, Steven Anlage, Thomas Antonsen — *University of Maryland, USA*
Complex time delay (CTD) describes how long a wave lingers in a dispersive non-Hermitian scattering system. Here we demonstrate a connection between CTD and the temporal/spectral properties of a chirped Gaussian pulse, which can then be used to create a chirped pulse with broadband zero time delay.

Oral Sessions (Wednesday Morning)

Thermal Metamaterials and Metasurfaces

Proshansky

Chairperson(s): Adam Overvig, Harry Atwater **Room: Auditorium**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Harry A. Atwater	Metastructures to Harness Spatial Coherence of Thermal and Luminescence Radiation
11:00 - 11:15	Konstantinos Delimaris	Tunable Near-Field Radiative Heat Transfer and Large Thermal Rectification with Hyperbolic Metasurfaces
11:15 - 11:30	Ewold Verhagen	Chiral Thermal Fluctuations and Enhanced Refrigeration in Nonreciprocal Nanomechanical Resonator Networks
11:30 - 12:00	Sander Mann	Thermal and Spontaneous Emission from Complex, Nonreciprocal, and Time-varying Metamaterials
12:00 - 12:30	Mauro Antezza	Kapitza-Like Modulation of Near-Field Radiative Heat Transfer

Sensing and Metrology 2

Elebash

Chairperson(s): Giuseppe Strangi **Room: Recital Hall**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Femius Koenderink	Fano-Resonant Fourier Scatterometry for Metrology - A View Through the Lens of Fisher Information
11:00 - 11:15	Thomas Grant	Mapping of Fisher Information Flow in Optical Metrology
11:15 - 11:30	Aleksandra Szymanska	Enhancing Plasmonic Metasurface Performance via Nanogap Engineering
11:30 - 12:00	Natalia Litchinitser	Non-Contact Hyperlens for Diffraction-Unlimited Imaging
12:00 - 12:15	Tamara Amro	Orientation-Locked Birefringent Spherulite for Dual Magnetic and pH Sensing
12:15 - 12:30	Alexander Stoychev	Increasing Sensitivity with a Self-Oscillating Meta-Atom

Sensing and Wave Control in Acoustic and Mechanical Metamaterials

Chairperson(s): Muamer Kadic, Fani Derveni **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Michael R. Haberman	Dynamics of Coupled Elastic Systems with Spatiotemporally Modulated Interface Conditions
11:00 - 11:15	Geon Lee	Omnidirectional Elastic Metalens for Directional Vibration Sensing
11:15 - 11:30	Zhenwei Xu	Synchronization-Enabled Information Flow in Acoustic Metamaterials
11:30 - 11:45	Osama Bilal	Harnessing Temporal Interfaces for Time Lensing and Classical Analogues of Dynamic Quantum Phase Transitions for Phonons
11:45 - 12:00	Xihai Ni	A Nonreciprocal Re-Entrant Honeycomb with a Two-Step Design Strategy Exhibit Enhanced Mechanical Properties
12:00 - 12:30	Giacomo Oliveri	An Underwater Acoustic Metamaterial Skin for Improved Distributed Acoustic Sensing

Smart Electromagnetic Environments and Intelligent Metasurfaces for Wireless Communications

Chairperson(s): Enrica Martini, Yi Ning Zheng **Room: C201**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Andrea Massa	EMS-Engineering for Smart Electromagnetic Environments
11:00 - 11:30	Marco Di Renzo	Physical Neural Networks for Wireless Communications
11:30 - 11:45	Sravan Kumar Reddy Vuyyuru	Beyond-Diagonal Metasurfaces for Non-Local Scattering Synthesis
11:45 - 12:15	Vincenzo Galdi	Space-Time Coding Metasurfaces for Smart Radio Environments
12:15 - 12:30	Francisco Cuesta	Virtual Aperture for Small-Antenna Gadgets based on Textile Metasurfaces

Physical Review Special Session
Chairperson(s): Jerry Dadap **Room: C203**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Bolei Deng	Mechanical Metamaterials as Computing Bodies: From Topological Braiding to Trainable Sensing Intelligence
11:00 - 11:30	Stefano Martiniani	Engineering Disorder for Photonic Function
11:30 - 12:00	Yair Shokef	Combinatorial Design of Floppy Modes and Frustrated Loops in Metamaterials
12:00 - 12:30	Linxiao Zhu	Strong Nonreciprocal Thermal Emission Epsilon-Near-Zero Metamaterials

10:30 - 12:30 Oral Sessions (Wednesday Morning)
Proshansky
Auditorium

Thermal Metamaterials and Metasurfaces

Chairperson(s): Adam Overvig, Harry Atwater

10:30 - 11:00 **Metastructures to Harness Spatial Coherence of Thermal and Luminescence Radiation** (Invited talk)
Harry A. Atwater — *California Institute of Technology, USA*
Achieving highly directive and spatially coherent thermal and luminescent radiation across broad spectral ranges remains a central challenge in photonics, particularly because conventional approaches to directional thermal emission often rely on narrowband resonances or polarization-specific mechanisms. Recent demonstrations of broadband directional emission based on Berreman modes have shown promising performance, yet their operation is fundamentally restricted to transverse-magnetic polarization, limiting their broader applicability

11:00 - 11:15 **Tunable Near-Field Radiative Heat Transfer and Large Thermal Rectification with Hyperbolic Metasurfaces**
Konstantinos Delimaris, Andrea Alù — *Photonics Initiative, Advanced Science Research Center, City University of New York, New York, NY, 10031, USA, Physics Program, The Graduate Center, City University of New York, New York, NY, 10026, USA, USA*
We investigate near-field radiative heat transfer mediated by surface modes in engineered hyperbolic sheets. We show that Lorentzian hyperbolic metasurfaces may provide extreme control over near-field thermal heat transfer. By tailoring the resonance bandwidth, detuning and shear anisotropy of the two sheets, we achieve highly super-Planckian heat flux and strong thermal rectification. Our results identify hyperbolic shear metasurfaces as a versatile platform for tunable nanoscale thermal management.

11:15 - 11:30 **Chiral Thermal Fluctuations and Enhanced Refrigeration in Nonreciprocal Nanomechanical Resonator Networks**
Jesse Slim[1], Javier Del Pino[2], Sander Mann[3], Ewold Verhagen[4] — *[1] University of Queensland, Australia [2] Universidad Autónoma de Madrid, Spain [3] University of Amsterdam, Netherlands [4] AMOLF, Netherlands*
We experimentally investigate how nonreciprocity affects thermodynamic performance in laser-controlled nanomechanical resonator networks. Synthetic magnetic flux through time-modulated optical fields enable controlled coupling and frequency-conversion cooling. Phase-resolved fluctuation correla-

tions reveal chiral, flux-tunable heat currents and energy redistribution. In the strong-coupling regime, broken time-reversal symmetry enhances refrigeration of a hot mode.

11:30 - 12:00 **Thermal and Spontaneous Emission from Complex, Nonreciprocal, and Time-varying Metamaterials** (Invited talk)
Sander Mann — *University of Amsterdam, Netherlands*
Thermal radiation and spontaneous emission emanate from fluctuations in dissipative materials. It is well known that such radiation can be manipulated in novel and unintuitive ways in advanced metamaterial environments, but modeling remains challenging. First, we discuss calculation of the spontaneous emission rate or LDOS in dissipative materials. We then present fundamental relationships between the emission and absorption in complex, nonreciprocal, and time-varying materials, and discuss resulting fundamental bounds.

12:00 - 12:30 **Kapitza-Like Modulation of Near-Field Radiative Heat Transfer** (Invited talk)
Mauro Antezza — *University of Montpellier and CNRS, France*
We demonstrate a Kapitza-like mechanism in near-field radiative heat transfer: rapid modulation of a flux-controlling parameter generates a quadratic correction to slow thermal dynamics. This produces measurable temperature shifts and modified effective conductances, enabling active stabilization and control of nanoscale radiative heat flow.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
Elebash
Recital Hall

Sensing and Metrology 2

Chairperson(s): Giuseppe Strangi

10:30 - 11:00 **Fano-Resonant Fourier Scatterometry for Metrology - A View Through the Lens of Fisher Information** (Invited talk)
Femius Koenderink — *AMOLF, Netherlands*
We explore metasurface scattering motifs to tackle as main question: how can you realize a maximally informative scattering structure and experiment to report on deeply subwavelength dimensional or positional parameters such as structure placements, relative alignment and shape of nanoobjects. This is of main importance for the semiconductor industry, where the need is to quantify the lithography process. That industry currently uses optical scatterometry on gratings printed inbetween actual devices as a telltale proxy. I will show examples where we perform dark-field angle-resolved scatterometry on Fano-resonant structures, addressing how you objectively measure and optimize information content through design of geometry, input wavefront, mode structure and choice of observable.

11:00 - 11:15 **Mapping of Fisher Information Flow in Optical Metrology**
Thomas Grant[1], James Williamson[2], Huanli Zhou[1], Hadyn Martin[2], Andrew Henning[2], Kevin Macdonald[1], Xiangqian Jiang[2], Nikolay Zheludev[1] — *[1] University of Southampton, United Kingdom [2] University of Huddersfield, United Kingdom*
We report the first spatial mapping of Fisher information flow in an optical position metrology experiment with a nanoscale target, revealing the flow's topological structure, including singularities, vortices, and regions of information backflow.

11:15 - 11:30 **Enhancing Plasmonic Metasurface Performance via Nanogap Engineering**
Aleksandra Szymanska, Andrzej Kudelski, Agata Królikowska — *University of Warsaw, Poland*
A plasmonic metasurface based on Core-Shell-Like Nanostructures (CSLNs) enables precise nanogap engineering over macroscopic areas. Using a scalable modified nanosphere lithography approach, large arrays of CSLNs with nanogaps down to the single-nanometer regime were fabricated, exhibiting a core–shell-like optical response with multiple tunable plasmonic resonances spanning from the ultraviolet to the near-infrared. We demonstrate

that nanogap-induced electromagnetic field enhancement governs both the optical and sensing performance, enabling highly sensitive and reproducible molecular detection, experimentally validated by surface-enhanced Raman scattering (SERS) spectroscopy.

11:30 - 12:00 **Non-Contact Hyperlens for Diffraction-Unlimited Imaging** (Invited talk)
Jiaren Tan[1], Yuruo Zheng[1], Hooman Barati Sedeh[1], Wenhao Li[1], Tianboyu Xu[2], Viktor A. Podolskiy[3], Natalia M. Litchinitser[1] — *[1] Duke University, USA [2] Intel Corporation, USA [3] University of Massachusetts Lowell, USA*
We present a flat-object-plane hyperlens that enables non-contact super-resolution imaging by directly projecting subwavelength information into the far field. Unlike earlier-generation curved, contact-based hyperlenses, our design combines a planar multilayer section that converts evanescent waves into propagating modes with a surrounding cylindrical region that magnifies subwavelength features. The device is based on a silver/titanium pentoxide multilayer hyperbolic metamaterial operating in the Type I regime. Positioned 20 nm above the object, it preserves high spatial frequency information without direct sample contact. Experimental measurements of subwavelength objects demonstrate far-field resolution beyond the diffraction limit. This approach provides a practical pathway toward diffraction-unlimited projection imaging compatible with planar microscopy and nanophotonic platforms.

12:00 - 12:15 **Orientation-Locked Birefringent Spherulite for Dual Magnetic and pH Sensing**
Tamara Amro — *Hebrew university, Israel*

12:15 - 12:30 **Increasing Sensitivity with a Self-Oscillating Meta-Atom**
Alexander Stoychev[1], Ulrich Kuhl[2], Nicolas Noiray[1] — *[1] ETH Zurich, Switzerland [2] Université Côte d'Azur, France*
We introduce a nonlinear sensing protocol based on synchronization of self-oscillating meta-atoms. We propose an alternative observable, the coherent spectral weight at the injection frequency, and show that it exhibits a threshold singularity with enhanced scaling compared to conventional frequency-splitting around square root degeneracies, including exceptional points. A toy acoustic experiment confirms three orders of magnitude enhancement in system response.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
Martin E.
Segal Theatre

Sensing and Wave Control in Acoustic and Mechanical Metamaterials

Chairperson(s): Muamer Kadic, Fani Derveni

10:30 - 11:00 **Dynamics of Coupled Elastic Systems with Spatiotemporally Modulated Interface Conditions** (Invited talk)
Michael R. Haberman, Benjamin M. Goldsberry — *The University of Texas at Austin, USA*
This work presents a coupled mode theory that describes wave phenomena and vibrations of coupled elastic systems for which the interface conditions are modulated as a function of space and time. We demonstrate the use of spatiotemporal modulation to couple modes, with applications focused on resonance control.

11:00 - 11:15 **Omnidirectional Elastic Metalens for Directional Vibration Sensing**
Geon Lee, Junsuk Rho — *Pohang University of Science and Technology, Korea (South)*
Quadratic-phase elastic metasurface with thickness-graded plate segments delivers diffraction-limited wide-angle focusing and maps incident momentum to laterally shifted foci. Integrated piezoelectric harvesting converts flexural-wave energy into self-powered robust vibration sensing.

11:15 - 11:30 **Synchronization-Enabled Information Flow in Acoustic Metamaterials**
Zhenwei Xu[1], Ulrich Kuhl[2], Nicolas Noiray[1] — *[1] ETH Zurich, Switzerland [2] Université Côte d'Azur, CNRS, Institut de Physique de Nice (INPHYNI), France*
We study synchronization-based information transmission through nonlinear scattering on a limit-cycle meta-atom. Information is encoded as a slow frequency variation of an incident carrier wave. A phase-reduced stochastic model shows when this variation is preserved (phase locked) versus degraded (noise-driven phase slips). The resulting criterion relates the locking potential barrier to the effective phase diffusion inherited from oscillator noise.

11:30 - 11:45 **Harnessing Temporal Interfaces for Time Lensing and Classical Analogues of Dynamic Quantum Phase Transitions for Phonons**
Osama Bilal, Mahmoud Samak — *University of Connecticut, USA*

A temporal interface is a sudden change in the properties of the media hosting a propagating wave. Supported by experiments, we present a comprehensive theoretical framework demonstrating how temporal interfaces govern wavenumber and frequency composition. We further harness our framework to demonstrate a phononic time lens, and a classical analogue of dynamical quantum phase transitions. Media link(s): https://arxiv.org/abs/2601.08866

11:45 - 12:00 **A Nonreciprocal Re-Entrant Honeycomb with a Two-Step Design Strategy Exhibit Enhanced Mechanical Properties**

Xihai Ni, Qiang Gao — *Southeast University, China*

As one of the common structures in negative Poisson's ratio structures, the re-entrant honeycomb has been widely studied for its excellent negative Poisson's ratio and energy absorption capabilities. However, the traditional re-entrant honeycomb often exhibits low plateau stress and instability during compression, which limits its practical application. Therefore, in this paper, we propose a two-step design strategy for the rotation nonreciprocal enhanced re-entrant honeycomb (RNERH). The proposed design strategy yields a novel honeycomb with dual plateau stress and two dominant deformation modes. By adjusting the two design strategies, multiple adjustments to the different plateau stresses and plateau densification points of the structure are achieved, further revealing the influence of the two design strategies on the load transfer path of the structure. Additionally, we also investigate the relationship between the energy absorption capacity of the structure and the two deformation modes. The results show that the rotation angle θ2 can control the first plateau of the structure, and the optimal value is 35° for the overall energy absorption capacity of the structure. The relationship between l2 and the diagonal strut is the main factor affecting the second plateau of the structure, with the optimal parameter being 52mm. Through this two-step design strategy, the mechanical performance of the re-entrant structure is enhanced, and it also guides the design method of negative Poisson's ratio structures. This further compensates for the performance deficiencies of negative Poisson's ratio structures and promotes their practical application.

12:00 - 12:30 **An Underwater Acoustic Metamaterial Skin for Improved Distributed Acoustic Sensing** (Invited talk)

Giacomo Oliveri, Giorgio Gottardi, Mohammad Abdul Hannan, Lucia Graziani, Andrea Massa — *ELEDIA@UniTN - DICAM, University of Trento, Italy*

Distributed Acoustic Sensing (DAS) using optical fibers enables long-range detection of underwater acoustic signals but suffers from reduced sensitivity for sources located directly above the fiber due to predominantly transverse wave coupling. This limitation could be addressed by integrating DAS with an Under-

water Acoustic Metamaterial Skin (UAMS), which can redirect incident acoustic waves to induce measurable axial strain via engineered wave phase gradients. An initial architectural design for a UAMS-enhanced DAS system is proposed, outlining the development of thin meta-atoms capable of precise underwater phase control to improve sensitivity for zenith-located sources.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
C201

Smart Electromagnetic Environments and Intelligent Metasurfaces for Wireless Communications

Chairperson(s): Enrica Martini, Yi Ning Zheng

10:30 - 11:00 **EMS-Engineering for Smart Electromagnetic Environments** (Invited talk)
Andrea Massa, Giacomo Oliveri, Giorgio Gottardi — *ELEDIA@UniTN - DICAM, University of Trento, Italy*
The Smart Electromagnetic Environment (SEME) paradigm has emerged over the past decade as a key evolution trend in modern wireless system design, enabling the shaping of electromagnetic wave propagation to meet network performance requirements. This vision has stimulated the exploration of novel scenarios and design principles based on smart electromagnetic (EM) entities, including electromagnetic skins (EMSs). EMSs are passive, two-dimensional engineered surfaces capable of modifying wave propagation in indoor and outdoor environments through static or adaptive surface current control. Their relevance within SEME stems from advanced wave-manipulation capabilities (such as nonconventional reflection and beam steering) usually achieved via local tuning of the meta-atom EM response. Recent advances have further expanded EMS potential by addressing fundamental limitations, including the development of optically transparent and low-cost implementations suitable for seamless integration into existing structures, or their customization to integrated sensing and communications scenarios. This paper surveys recent progress in EMS engineering for SEME applications, focusing on state-of-the-art design methodologies and implementation strategies for next-generation wireless systems.

11:00 - 11:30 **Physical Neural Networks for Wireless Communications** (Invited talk)
Marco Di Renzo — *Paris-Saclay University – CNRS and CentraleSupelec, France*
In this talk, we introduce wave-domain processing enabled by reconfigurable metasurfaces with the aim to redesign the physical layer of wireless communications. We will discuss the motivations, enabling technologies and our recent contributions in this emerging field of research.

11:30 - 11:45 **Beyond-Diagonal Metasurfaces for Non-Local Scattering Synthesis**

Sravan Kumar Reddy Vuyyuru[1], Francisco S. Cuesta[1], Viktar S. Asadchy[1], Sergei A. Tretyakov[1], Do-Hoon Kwon[2] — *[1] Aalto University, Finland [2] University of Massachusetts Amherst, United States of America*
Realizations of advanced electromagnetic functionalities in metasurfaces, based on strong non-local behavior, require fine subwavelength structuring, leading to practical complexities. We propose an alternative co-simulation design framework based on a coupling load network that eliminates this constraint by combining simple uniform arrays with tunable cascaded load networks.

11:45 - 12:15 **Space-Time Coding Metasurfaces for Smart Radio Environments** (Invited talk)
Lei Zhang[1], Tie Jun Cui[1], Vincenzo Galdi[2] — *[1] Southeast University, China [2] University of Sannio, Italy*
Space-time coding metasurfaces enable programmable control of electromagnetic waves through joint spatial and temporal modulation, supporting harmonic generation, nonreciprocity, and waveform shaping. This talk reviews recent advances, highlighting smart propagation environments, integrated sensing and communications, conformal implementations, and reliability strategies for scalable, multifunctional intelligent surfaces.

12:15 - 12:30 **Virtual Aperture for Small-Antenna Gadgets Based on Textile Metasurfaces**
Francisco Cuesta[1], Xianghui Qiu[2], Mohammad M. Asgari[1], Shuai Yuan[1], Sergei Tretyakov[1], Xuchen Wang[2], Viktar Asadchy[1] — *[1] Aalto University, Finland [2] Harbin Engineering University, China*
In this talk, we propose clothes-embedded metasurfaces that convert incident-to-surface waves to focus into a device's antenna located near the garment, boosting device connectivity by exploiting the larger textile area. The metasurface design consist of a loaded-wire metasurface topology, impedance matrix from numerical Green's function values, and load optimization through multi-population genetic algorithm.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
C203

Physical Review Special Session

Chairperson(s): Jerry Dadap

10:30 - 11:00 **Mechanical Metamaterials as Computing Bodies: From Topological Braiding to Trainable Sensing Intelligence** (Invited talk)
Bolei Deng[1], Liyuan Chen[2], Matthew Fuertes[1], Kyungmi Na[1], Yifei Li[3], Xinyi Yang[1] — *[1] Georgia Institute of Technology, USA [2] Harvard University, USA [3] Massachusetts Institute of Technology, USA*
Mechanical metamaterials are often designed to control stiffness, waves, deformation, or stability, but their dynamics can also serve as a form of physical computation. In the first part of this talk, I will discuss our recent work on topological computation by non-Abelian braiding in classical metamaterials. We realize a mechanical analog of the one-dimensional Kitaev chain, in which tunable couplings support classical Majorana zero modes. By developing braiding protocols for arbitrary pairs of modes, the system reproduces braid-group statistics, implements single-qubit Clifford operations in a classical setting, and remains robust to mechanical defects through topological protection. This example shows how geometry and dynamics can encode computational operations directly in the material body. I will then use this result as a bridge to a broader question: beyond designing a material to perform a prescribed computation, can we train the intelligence of the body itself? In the second half of my talk, I will introduce a systematic way to train the intelligence of mechanical metamaterials, focusing on a specific capability of the material body: sensing. We call this capability sensing intelligence. We show that the geometry of a metamaterial body can be optimized to reshape external stimuli into internal signals that are easier for a neural network to interpret. Rather than hand-designing this physical preprocessing, we let the neural network train its own body for sensing by backpropagating the sensing loss to the body's design parameters through differentiable simulation. Across numerical and experimental sensing scenarios, the optimized body improves sensing accuracy by up to fivefold, accelerates neural-network training, and reduces the number of required electronic sensors by nearly an order of magnitude. Together, these studies point toward a broader framework of physical intelligence, where materials are not passive substrates for sensing and computation, but trainable partners of the brain.

11:00 - 11:30 **Engineering Disorder for Photonic Function** (Extended oral)
Stefano Martiniani — *New York University, USA*
Not all material properties can be realized with periodic structures. Correlated disordered media can achieve transport properties unattainable in crystals,

such as isotropic photonic bandgaps. I will present gyromorphs, a new class of functional disordered materials combining liquid-like translational disorder with quasi-long-range rotational order, induced by a ring of delta peaks in their structure factor. We predict that gyromorphs outperform all known isotropic photonic bandgap materials, opening a path to fine control over optical properties in non-crystalline media.

11:30 - 12:00 **Combinatorial Design of Floppy Modes and Frustrated Loops in Metamaterials** (Invited talk)
Yair Shokef[1], Wenfeng Liu[2], Tomer A. Sigalov[1], Corentin Coulais[2] — *[1] Tel Aviv University, Israel [2] Universiteit van Amsterdam, Netherlands*
Metamaterials are a promising platform for a range of applications, from shock absorption to mechanical computing. These functionalities typically rely on floppy modes or mechanically frustrated loops, both of which are difficult to design. In particular, how to design multiple modes or loops with target deformations remains an open problem. We introduce a combinatorial approach that allows to create an arbitrarily large number of floppy modes and frustrated loops. The design freedom of the mode shapes enables to easily introduce kinematic incompatibility to turn them into frustrated loops. We demonstrate that floppy modes can be sequentially buckled by using a specific instance of elastoplastic buckling. We utilize our combinatorial floppy chains and frustrated loops to achieve matrix-vector multiplication in materia. Our findings bring about new principles for the design and use of floppiness and frustration in soft matter and metamaterials.

12:00 - 12:30 **Strong Nonreciprocal Thermal Emission Epsilon-Near-Zero Metamaterials** (Invited talk)
Linxiao Zhu — *Pennsylvania State University, USA*
Light emission and absorption are typically constrained by the reciprocal relation of emissivity and absorptivity, as stated in the Kirchhoff's law of thermal radiation. I will discuss our observation of strong nonreciprocal emission in a magneto-optical epsilon-near-zero metamaterial, points to new opportunities for heat flux control, energy harvesting, and sensing.

Oral Sessions (Wednesday Afternoon 1)

Fabrication and Experimental Characterization of Metastructures I

Proshansky

Chairperson(s): Jelena Vučković, Christos Argyropoulos **Room: Auditorium**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Christos Argyropoulos	Nonlinear and Quantum Plasmonic Metasurfaces to Realize Nanophotonic Functionalities Beyond Natural Materials
14:30 - 15:00	Jelena Vučković	Inverse Design and Demonstration of High Performance Integrated Classical and Quantum Photonics
15:00 - 15:15	David Moreno Gallego De La Sacristana	Wavefront-Tailored Extraordinary Optical Transmission with Babinet Nonlocal Metasurfaces
15:15 - 15:30	Melanie Choca	Plasma-Enhanced Chemical Vapor Deposition (PECVD) SiO_2 Spacers Enabling Planarized Stacking of Metasurfaces on Patterned Topography

Non-Hermitian Wave Dynamics and Scattering

Elebash

Chairperson(s): Vincenzo Galdi, Jason Valentine **Room: Recital Hall**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Jack Harris	Using the Non-Hermitian Berry Phase to Generate Useful Amplification
14:30 - 15:00	Steven Anlage	Utilizing Complex Time Delay to Recover Complex Scattering Parameters From Intensity Measurements
15:00 - 15:30	Filippo Capolino	Near Cubic-Root Oscillation Frequency Sensitivity of Steady-State Saturable Nonlinear Coupled Oscillators at an Exceptional Point Degeneracy

Physics of Artificial Materials for Novel and Extreme Phenomena I

Martin E.

Chairperson(s): Yakir Hadad **Room: Segal Theatre**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Giuseppe Strangi	Engineering Fano Resonances via Thin Film Nanophotonics
14:30 - 15:00	Samel Arslanagic	Particle-Based Systems and Metasurfaces for Enhanced Radiation, Scattering and Localization of Electromagnetic Fields
15:00 - 15:15	Roee Geva	Homogenized Wideband P.T.D-Symmetric Thin Scatterers at Low Frequencies
15:15 - 15:30	Myles Osenton	Experimental Demonstration of Negative Refraction with Complex Frequency Waves

Active, Quantum & Emerging Platforms

Chairperson(s): Mikael Rechtsman, Maiken Mikkelsen **Room: C201**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Alex Schuchinsky	Passive Intermodulation in Junctions of Conductors with Rough Surfaces
14:30 - 15:00	Howard Lee	Active and Nonlinear Zero-Index and Meta-Photonics
15:00 - 15:30	Chiara Trovatello	Ultracompact Nonlinear Platforms Based on van der Waals Semiconductors for Classical and Quantum States of Light

Metasurface Modeling, Simulation, and Design

Chairperson(s): Stefano Maci, David Smith **Room: C203**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Enrica Martini	Semianalytical Modeling of Periodic Spatially Dispersive Metasurfaces
14:30 - 14:45	Luis Manuel Máñez-Espina	Modeling and Designing of Reciprocal and Non-Reciprocal Bianisotropic Metasurfaces with Strong Mode Hybridization
14:45 - 15:00	Ryan Strohman	Efficient Simulation of Space-Time Metasurfaces with Frequency Domain Solvers and Multimodal Network Theory

Continued from Previous Page: Metasurface Modeling, Simulation, and Design

Chairperson(s): Stefano Maci, David Smith **Room: C203**

Time	1st Author (Presenter)	Title
15:00 - 15:15	Mustafa Yucel	Generalized Invisibility for Metasurfaces in Asymmetric Media
15:15 - 15:30	Federica Anfuso	Near-Field Bending Beam Control via Ray-Caustic Synthesis for Focused Propagation Around Obstacles

14:00 - 15:30 Oral Sessions (Wednesday Afternoon 1)
Proshansky
Auditorium

Fabrication and Experimental Characterization of Metastructures I

Chairperson(s): Jelena Vučković, Christos Argyropoulos

14:00 - 14:30 **Nonlinear and Quantum Plasmonic Metasurfaces to Realize Nanophotonic Functionalities Beyond Natural Materials** (Invited talk)
Christos Argyropoulos — *The Pennsylvania State University, USA*
We demonstrate compact nonlinear and quantum plasmonic metasurfaces to efficiently generate second harmonic response from surface nonlinearities and control quantum single photon-photon interactions. Our findings demonstrate that ultrathin plasmonic metasurfaces can have potential applications in integrated nonlinear and quantum photonic systems.

14:30 - 15:00 **Inverse Design and Demonstration of High Performance Integrated Classical and Quantum Photonics** (Invited talk)
Jelena Vučković — *Stanford University, USA*
We describe our photonic inverse design approach, and show how it can be employed to design high performance integrated photonics for applications including optical interconnects and quantum technologies. While we demonstrated inverse designed structures a variety of materials ranging from silicon, to silicon carbide, diamond, and titanium:sapphire, we also show that silicon inverse designs can be fabricated in commercial foundries where they experimentally outperform photonics PDK.

15:00 - 15:15 **Wavefront-Tailored Extraordinary Optical Transmission with Babinet Nonlocal Metasurfaces**
David Moreno Gallego De La Sacristana[1], Yoshiaki Kasahara[2], Andrea Alù[2] — *[1] Polytechnic University of Valencia, Spain [2] Photonics Initiative, Advanced Science Research Center, United States*
We demonstrate a nonlocal metasurface that simultaneously achieves extraordinary optical transmission (EOT) and full 2π phase control of the transmitted wavefront for circular polarizations. By applying Babinet's principle to a metasurface governed by a quasi-bound-state-in-the-continuum supporting geometric phase control, the supported high-Q resonance is mapped onto a complementary transmissive aperture geometry patterned on freestanding copper foil. The EOT phenomenon is mainly controlled by the aperture shape, while their rotation encodes an arbitrary geometric phase across the aperture without impacting the high-Q resonance. We demonstrate anomalous refraction at

19.5 GHz with a simulated EOT factor of 6 and experimentally measured EOT factor of 3, validated by free-space near-field measurements.

15:15 - 15:30 **Plasma-Enhanced Chemical Vapor Deposition (PECVD) SiO_2 Spacers Enabling Planarized Stacking of Metasurfaces on Patterned Topography**

Melanie Choca[1], Federico De Luca[2], Samantha Roberts[2], Andrea Alu[2], Viktoriia Rutckaia[2] — *[1] The City College of New York, USA [2] Advanced Science Research Center CUNY, USA*

Monolithic metasurface stacking can miniaturize and add functionality to planar optics, but fabrication is limited by spacer non-planarity and incomplete gap filling on patterned surfaces. We study PECVD SiO_2 spacers, identify a planarization thickness and a void-formation regime for narrow gaps, and find little sensitivity to pattern density. As a demonstration, three-layer stacks preserve the combined resonance spectrum with a modest spectral shift, establishing a practical spacer process window for robust multilayer integration.

14:00 - 15:30 Oral Sessions (Wednesday Afternoon 1)
Elebash
Recital Hall

Non-Hermitian Wave Dynamics and Scattering

Chairperson(s): Vincenzo Galdi, Jason Valentine

14:00 - 14:30 **Using the Non-Hermitian Berry Phase to Generate Useful Amplification** (Invited talk)
Jack Harris — *Yale University, USA*
We have developed a novel form of amplification based on the non-Hermitian Berry phase. We describe its physical origin, and its demonstration in an optomechanical platform.

14:30 - 15:00 **Utilizing Complex Time Delay to Recover Complex Scattering Parameters From Intensity Measurements** (Invited talk)
Nadav Shaibe[1], Isabella Giovannelli[1], Jared Erb[1], Steven Anlage[2] — *[1] University of Maryland, USA [2] University of Maryland, United States*
Wigner–Smith time delay becomes a complex quantity when applied to non-Hermitian systems with sub-unitary scattering matrices, and is directly connected to the poles and zeros of the scattering matrix. This complex generalization of time delay also applies to other quantities, including single elements of the scattering matrix, such as the reflection coefficient, or transmission coefficient between two scattering channels. We introduce a procedure utilizing complex time delay through which phase information, up to an overall constant, can be recovered from scalar reflection or transmission intensity data. We demonstrate the process with experimental data on a chaotic microwave scattering system, although the results apply to all forms of wave scattering.

15:00 - 15:30 **Near Cubic-Root Oscillation Frequency Sensitivity of Steady-State Saturable Nonlinear Coupled Oscillators at an Exceptional Point Degeneracy** (Invited talk)
Benjamin Bradshaw, Filippo Capolino — *University of California, Irvine, USA*
We study two coupled resonators, one with saturable gain, one with loss, exhibiting multiple steady-state exceptional points. Near a third-order SS-EPD, oscillation frequency shows cubic-root sensitivity to perturbations. Optimal sensing occurs in the weakly coupled regime, enhancing response near this non-Hermitian degeneracy.

14:00 - 15:30 Oral Sessions (Wednesday Afternoon 1)
Martin E.
Segal Theatre

Physics of Artificial Materials for Novel and Extreme Phenomena I

Chairperson(s): Yakir Hadad

14:00 - 14:30 **Engineering Fano Resonances via Thin Film Nanophotonics** (Invited talk)
Giuseppe Strangi — *CASE WESTERN RESERVE UNIVERSITY, USA*
This presentation examines the physics of metal–dielectric thin films supporting Fano resonances. Interference between discrete and continuum modes in nanocavities reveals coupled oscillator behavior, producing semi transparent states where identical wavelengths are coherently partitioned between transmission and reflection.

14:30 - 15:00 **Particle-Based Systems and Metasurfaces for Enhanced Radiation, Scattering and Localization of Electromagnetic Fields** (Invited talk)
Samel Arslanagic[1], Rasmus Jacobsen[1], Richard Ziolkowski[2] — *[1] Technical University of Denmark, Denmark [2] University of Arizona, US*
Our ability to effectively tailor wave-matter interactions is of great practical importance with profound impact on societally important applications. Recently, notable efforts in the field of metamaterials have led to a range of functional devices, as well as remarkable physics enabling effective wave-matter interactions. Much of the attention was devoted to structures composed of single resonators and metasurfaces that support highly directive radiating and scattering responses, but also to platforms capable of localizing the fields through the excitation of bound states in the continuum. In this presentation, we review our recent and current efforts within super-directive lens antennas surpassing the known super-directivity bounds, and a wide scope of realistic and curvilinear metasurface cavities with both passive and active, electric and magnetic surface impedances, that enable enhanced and directional scattering, but also high field localizations inside the respective cavities.

15:00 - 15:15 **Homogenized Wideband P.T.D-Symmetric Thin Scatterers at Low Frequencies**
Roee Geva[1], Mário Silveirinha[2], Raphael Kastner[1] — *[1] Tel Aviv University, Israel [2] University of Lisbon, Portugal*
P.T.D-symmetric systems are known to exhibit non-reflections into certain controlled modes. Realization of such systems, however, may pose significant

technological challenges due to the need to synthesize magnetic or electric-magnetic materials with prescribed constitutive parameters over a wide frequency range. As long as the technology is not fully available, it is suggested to make use of media that approximate the desired behavior at the low frequency regime. A homogenization procedure for a realizable medium, presented below, provides a significant simplification for the design process. Results are backed by full wave simulations.

15:15 - 15:30 **Experimental Demonstration of Negative Refraction with Complex Frequency Waves**

Myles Osenton[1], Wei Wang[2], Vitali Kozlov[2], Andrea Alù[2] — *[1] University of British Columbia; City University of New York, Canada [2] City University of New York, United States*

We present experimental demonstration of negative refraction using parity-time (PT) symmetric structures. We fabricated two passive metasurfaces and synthetically excited it with a complex-frequency signal, enabling tuning of virtual gain to achieve the PT-symmetry requirement. By measuring the transmission coefficient, negative phase accumulation as a function of frequency is observed.

14:00 - 15:30 Oral Sessions (Wednesday Afternoon 1)
C201

Active, Quantum & Emerging Platforms

Chairperson(s): Mikael Rechtsman, Maiken Mikkelsen

14:00 - 14:30 **Passive Intermodulation in Junctions of Conductors with Rough Surfaces** (Invited talk)
Alex Schuchinsky — *University of Liverpool, United Kingdom*
Passive intermodulation (PIM) of rough conductors is studied as multiphysics effect. The main sources of RF signal distortions include the charge tunnelling, heat flow and mechanical deformations. The tunnelling effect is the fastest nonlinear process. The mechanical deformations and heat distribution are slower, but they are coupled to the charge tunnelling. The nonlinear analysis of PIM is performed for the conductor junctions and contacts of surfaces, deformed by the applied contact pressure. The explicit relations and their approximations are obtained for the PIM products in the contact joints of the compressed contact asperities.

14:30 - 15:00 **Active and Nonlinear Zero-Index and Meta-Photonics** (Invited talk)
Howard Lee, Jin Yan, Quynh Dang, David Dang, Aleksei Anopchenko, Christopher Gonzalez, Stuart Love, Andrew Palmer, Yucheng Jin, Yuechen Liu, Leo Zheng, Meena Salib, Michael Father, Massee Akbar, Teo Reyes, Jiatong Wan, Harvey Lin, Hayden Hunziker — *University of California, Irvine, USA*
I will discuss our recent development on conducting oxide and metallic nitride epsilon-near-zero materials in planar and optical fiber platforms. I will present the observation of abnormal nonlinear temporal dynamic of hot electrons and enhanced optical nonlinearity in AZO and ITO ENZ thin films under different pump fluences and excitation angles using a degenerate pump-probe spectroscopy technique. I will then discuss the development of 2D ITO ENZ materials via liquid metal printing technique and their electrically tunable properties. Finally, I will discuss the first experimental integration of ENZ materials and metasurfaces with optical fibers for efficient excitation of ENZ mode and advanced wavefront shaping.

15:00 - 15:30 **Ultracompact Nonlinear Platforms Based on van der Waals Semiconductors for Classical and Quantum States of Light** (Invited talk)
Chiara Trovatello — *Politecnico di Milano, Italy*
Here we design and realize ultrathin periodically-poled structures and metasurfaces using highly nonlinear van der Waals semiconductors (3R-MoS_2) to

demonstrate phase-matched and mode-matched nonlinear optical processes, respectively. By overcoming size-efficiency trade-offs, these ultracompact platforms enable efficient frequency conversion and entangled photon generation over microscopic pathlengths for on-chip photonic applications.

14:00 - 15:30 Oral Sessions (Wednesday Afternoon 1)
C203

Metasurface Modeling, Simulation, and Design

Chairperson(s): Stefano Maci, David Smith

14:00 - 14:30 **Semianalytical Modeling of Periodic Spatially Dispersive Metasurfaces** (Invited talk)
Serena Assefa Asfaw[1], David Gonzalez-Ovejero[2], Enrica Martini[3] — *[1] University of Siena, Italy [2] CNRS, France [3] University of Siena,*
In this work, we analyze the impact of spatial dispersion in homogenized metasurface models and propose a general analysis methodology that incorporates spatial dispersion while preserving model simplicity and computational efficiency. The proposed framework is validated through numerical studies of metasurfaces implemented with different technologies, demonstrating improved predictive capability.

14:30 - 14:45 **Modeling and Designing of Reciprocal and Non-Reciprocal Bianisotropic Metasurfaces with Strong Mode Hybridization**
Luis Manuel Máñez-Espina[1], Bahman Amrahi[2], Viktar Asadchy[2], Ana Díaz-Rubio[1] — *[1] Universitat Politècnica de València, Spain [2] Aalto University, Finland*
Bimodal interferometry in photonic integrated waveguides relies on structures supporting at least two modes to connect input and output channels. We present an ultrashort bimodal interferometer integrated into a photonic waveguide by embedding a multilayer hyperbolic metamaterial within a subwavelength gap between two dielectric waveguides. Media link(s): Optics Letters https://doi.org/10.1364/OL.535004.

14:45 - 15:00 **Efficient Simulation of Space-Time Metasurfaces with Frequency Domain Solvers and Multimodal Network Theory**
Ryan Strohman, Anthony Grbic — *University of Michigan, USA*
A technique is presented for calculating the electromagnetic fields scattered and guided by spatially discrete, traveling-wave modulated metasurfaces under time-harmonic plane wave illumination. The technique uses multimodal network theory and the network parameters of the metasurface's unit cell extracted using fullwave simulation. The technique is validated through commercial fullwave-circuit co-simulation.

15:00 - 15:15 **Generalized Invisibility for Metasurfaces in Asymmetric Media**
Mustafa Yucel, Karim Achouri — *EPFL, Switzerland*

Using GSTC, we derive analytical invisibility conditions for metasurfaces that achieve reflectionless, phase-preserving transmission, including oblique incidence, bianisotropy, and asymmetric media. Closed-form co-polarized susceptibility relations are obtained and validated with full-wave simulations.

15:15 - 15:30 **Near-Field Bending Beam Control via Ray-Caustic Synthesis for Focused Propagation Around Obstacles**
Federica Anfuso[1], Ahsan Ullah Khan[2], Gino Sorbello[1], Santi Concetto Pavone[2] — *[1] University of Catania, Italy [2] University of Catania, Italy*
A novel technique for shaping curved electromagnetic beams in the near field is presented, using distributed ray-caustics. The proposed method enables the synthesis of beams that propagate along arbitrarily prescribed trajectories, allowing controlled bending around known obstacles while preserving localized focusing features. Numerical simulations validate the proposed approach.

Oral Sessions (Wednesday Afternoon 2)

Meta-optics for Computing and Imaging

Chairperson(s): Mario Junior Mencagli

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
16:00 - 16:30	Owen Miller	Design and (Information) Theory for Many-Mode Grating Couplers
16:30 - 17:00	Jason Valentine	Meta-Optics for Edge Computing Applications

Geometry and Band Engineering in Artificial Wave Systems

Chairperson(s): Jack Harris, Romain Fleury

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
16:00 - 16:30	Adam Overvig	Geometric Phases in Nonlocal Metasurfaces and Custom Cavities
16:30 - 16:45	Arghyadeep Pal	Coupled Dirac Doublets in Babinet-Complementary Hexagonal Patch–Mesh Bilayers
16:45 - 17:00	Frank Scheffold	Transport Regimes in Hyperuniform Photonic Materials
17:00 - 17:30	Mikael Rechtsman	Aspects of Wave Transport in Hyperuniform Photonic Systems

Metasurface Engineering for Absorbing and Radiating Structures

Chairperson(s): Giacomo Oliveri, Alex Schuchinsky

Room: Martin E. Segal Theatre

Time	1st Author (Presenter)	Title
16:00 - 16:30	Yakir Hadad	Absorption Bounds on Complex Surfaces
16:30 - 17:00	Stefano Maci	Dual Surface-Wave Excitation and Leaky-Wave Balance in Self-Dual Metasurfaces
17:00 - 17:15	Omer Sade	Semianalytical Synthesis of Metagrating-Inspired Wideband Fabrication-Ready Printed-Circuit-Board (PCB) Salisbury Absorbers

Continued from Previous Page: Metasurface Engineering for Absorbing and Radiating Structures

Chairperson(s): Giacomo Oliveri, Alex Schuchinsky **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
17:15 - 17:30	Yanwen Chen	Dual Matched Fabry–Perot Structures for Shaping Wide Flat-Top Radiation Patterns in All Azimuthal Directions

Advanced Scattering Phenomena in Complex Electromagnetic Systems

Chairperson(s): Sead Arslanagic, Steven Anlage **Room: C201**

Time	1st Author (Presenter)	Title
16:00 - 16:15	Hao He	Coherent Control of Complex Frequency Wave Scattering via Complex Spectra
16:15 - 16:30	Vitali Kozlov	Experimental Demonstration of Zero Forward Scattering with Complex Frequency Excitations
16:30 - 16:45	Dmytro Vovchuk	Time-Modulated Scatterer for Micro-Doppler Radar Deception
16:45 - 17:00	Clément Ferise	Broadband Transmission Enhancement in Mirror-Symmetric Disordered Systems
17:00 - 17:15	Tycho Van Velden	Reconfigurable Polarization Conversion Metasurface for Radar Cross Section Control in X-Band
17:15 - 17:30	Tristan Nerson	Multi-Objective Tweezers in Scattering Media via Generalized Wigner-Smith Matrices

Quantum Emitters and Purcell Enhancement

Chairperson(s): Mauro Antezza, Chiara Trovatello **Room: C203**

Time	1st Author (Presenter)	Title
16:00 - 16:30	Gabriele Grosso	Hybrid Quantum Defects in Wide Bandgap Nitrides for Integrated Quantum Photonics
16:30 - 17:00	Maiken Mikkelsen	Tailoring Local Fields for Ultrafast Single Photon Sources
17:00 - 17:15	R. Margoth Cordova-Castro	Purcell-Enhanced Emission at the Single-Molecule Level
17:15 - 17:30	Mathieu Mivelle	Optical Magnetic-Field-Gated Criticality in Photon Avalanching Quantum Processes

16:00 - 17:30 Oral Sessions (Wednesday Afternoon 2)
Proshansky
Auditorium

Meta-Optics for Computing and Imaging

Chairperson(s): Mario Junior Mencagli

16:00 - 16:30 **Design and (Information) Theory for Many-Mode Grating Couplers** (Invited talk)
Owen Miller, Nazar Pyvovar, Hao Li, Yaxi Liu — *Yale University, USA*
To couple free-space modes on chip, the key challenge is not enhancing coupling rates, but rather avoiding unwanted couplings. We propose a pathway towards high-efficiency coupling of hundreds or thousands of modes. Furthermore, we describe information-theoretic considerations that call for a unique variation of grating coupler functionality.

16:30 - 17:00 **Meta-Optics for Edge Computing Applications** (Invited talk)
Brandon Swartz, Rahul Shah, Yuechen Yang, Yuankai Huo, Jason Valentine — *Vanderbilt University, USA*
This talk will focus on the use of meta-optics for implementing computation for edge sensors, serving to off-load computational operations from digital processing platforms focused on spatial and spectral pattern recognition.

16:00 - 17:30 Oral Sessions (Wednesday Afternoon 2)
Elebash
Recital Hall

Geometry and Band Engineering in Artificial Wave Systems

Chairperson(s): Jack Harris, Romain Fleury

16:00 - 16:30 **Geometric Phases in Nonlocal Metasurfaces and Custom Cavities** (Invited talk)
Adam Overvig — *Stevens Institute of Technology, USA*
Geometric phases have expanded the capabilities of optical devices to control both the spatial and momentum properties of light. We explore recent advances of both the detour phase and Pancharatnam's phase to control light in nonlocal metasurfaces and cavities.

16:30 - 16:45 **Coupled Dirac Doublets in Babinet-Complementary Hexagonal Patch–Mesh Bilayers**
Arghyadeep Pal, Federico Giusti, Stefano Maci — *University of Siena, Italy*
We study a hexagonal bilayer formed by a PEC patch-island lattice and its ex-act Babinet-complementary percolating mesh (hexagonal aperture) lattice. Using the C3v little group at the K point, we identify the symmetry-enforced Dirac doublet in each layer and show that exact complementarity does not guarantee identical dispersions in a three-dimensional eigenmode environment. Finally, we develop a minimal two-band-per-layer coupled-Dirac model with detuning and interlayer hybridization to interpret the stacked bilayer dispersion and gap opening.

16:45 - 17:00 **Transport Regimes in Hyperuniform Photonic Materials**
Frank Scheffold, Luis Salvador Froufe Perez, Francisco Hernandez Alejandre — *University of Fribourg, Switzerland*
Disordered stealthy hyperuniform (SHU) dielectric slabs exhibit diffusive, localized, and bandgap transport regimes. Here we present numerical results based on large-scale finite- difference time-domain (FDTD) simulations, analyzing both the total transmission coefficient and the transverse spreading of a focused beam at the output plane. At frequencies far from the bandgap, rapid expansion of the intensity profile toward the slab edges indicates diffusive trans- port. In contrast, strong transverse confinement near the gap signals the presence of Anderson localization, Lifshitz tail states, or a photonic bandgap. These results establish beam-spreading analysis as a practical and versatile diagnostic tool for complex photonic materials, applicable to both numerical and experimental systems.

17:00 - 17:30 **Aspects of Wave Transport in Hyperuniform Photonic Systems** (Invited talk)

Mikael Rechtsman — *Penn State, USA*

Hyperuniform systems are those whose density fluctuations scale more slowly than the volume of the system. This implies that the spectral density of such a pattern goes to zero at small momentum. Periodic crystals and quasicrystals are hyperuniform, as are disordered systems, provided the disorder is highly correlated. The problem of wave transport through hyperuniform systems is notoriously difficult to address in numerical simulations because of the extremely large system sizes required to establish definitive results. Here, I will present our analytical results on Lifshitz tails in the hyperuniform disordered Anderson model [1]; this addresses the question of the nature of the band gap in such systems, and to what extent hyperuniformity leads to greater band gaps. I will also present our experimental results on large two-dimensional photonic crystals with added stealthy-hyperuniform disorder [2], capturing the "stealthiness transition" and demonstrating both the presence of multiple scattering and the interplay with the non-Hermiticity that is necessarily present as a result of the radiative leakage. [1] Karcher, J. F., Gopalakrishnan, S. & Rechtsman, M. C. Effect of hyperuniform disorder on band gaps. Phys. Rev. B 110, 174205 (2024). [2] Barsukova, M. et al. Stealthy-hyperuniform wave dynamics in two-dimensional photonic crystals. Preprint at https://arxiv.org/abs/2507.05253 (2025).

16:00 - 17:30 Oral Sessions (Wednesday Afternoon 2)
Martin E.
Segal Theatre

Metasurface Engineering for Absorbing and Radiating Structures

Chairperson(s): Giacomo Oliveri, Alex Schuchinsky

16:00 - 16:30 **Absorption Bounds on Complex Surfaces** (Invited talk)
Amir Shlivinski[1], Yoav Kriman[2], Tomer Eini[2], Yakir Hadad[2] — *[1] Ben Gurion University, Israel [2] Tel Aviv University, Israel*
Wave absorbers, notably Dallenbach layers, underpin antennas, EMC, and RCS reduction. Classical Rozanov bounds assume plane waves. We generalize thickness–bandwidth limits to broadband spatial spectra and curved surfaces, enabling further realistic absorber design.

16:30 - 17:00 **Dual Surface-Wave Excitation and Leaky-Wave Balance in Self-Dual Metasurfaces** (Invited talk)
Marcel Bouchez[1], David Gonzalez-Ovejero[2], Stefano Maci[3] — *[1] University of Rennes, France [2] University of Rennes, CNRS, France [3] University of Siena, Italia*
Self-dual metasurfaces support degenerate TE and TM surface waves under a duality impedance condition. Radial modulation enables broadside radiation with independent polarization control via balanced Huygens excitation. We derive the exact electric–magnetic moment ratio and analytically balance leakage constants, providing a framework for efficient dual-polarized metasurface antennas.

17:00 - 17:15 **Semianalytical Synthesis of Metagrating-Inspired Wideband Fabrication-Ready Printed-Circuit-Board (PCB) Salisbury Absorbers**
Omer Sade, Ariel Epstein — *Technion - Israel Institute of Technology, Israel*
We present a semianalytical scheme for the design of realistic Salisbury screens capable of wideband absorption. Building upon the concept of metagratings (MGs), we utilize associated rigorous analytical models and follow the guidelines recently proposed by Nayani et al. (Nat. Commun., vol. 16, 2025) to synthesize printed-circuit-board (PCB) MG absorbers with enhanced bandwidth. The proposed method, validated via full-wave simulations, yields fabrication-ready layouts for Salisbury screens with improved frequency response, while offering analytical insights on the relation between concrete degrees of freedom in detailed PCB absorber designs and the path to increase their performance in light of the Rozanov bound.

17:15 - 17:30 **Dual Matched Fabry–Perot Structures for Shaping Wide Flat-Top Radiation Patterns in All Azimuthal Directions**
Yanwen Chen, Stefano Maci — *University of Siena, Italy*
An azimuthally isotropic wide flat-top embedded element gain pattern (EEGP) is ideal for improving the embedded element efficiency (EEE) in dense array configurations. Conventional Fabry–Perot (FP) resonant antennas, typically produce radiation patterns with asymmetry between the E- and H-planes due to polarization-dependent resonance behavior. In this work, a FP structure composed of electromagnetically matched dual media is proposed. By employing media with equal relative permittivity and permeability, the FP resonance becomes polarization independent. As a result, the structure produces a far-field power pattern that is isotropic with respect to the azimuthal angle, enabling the realization of a wide flat-top EEGP suitable for high-EEE dense array applications.

16:00 - 17:30 Oral Sessions (Wednesday Afternoon 2)
C201

Advanced Scattering Phenomena in Complex Electromagnetic Systems

Chairperson(s): Sead Arslanagic, Steven Anlage

16:00 - 16:15 **Coherent Control of Complex Frequency Wave Scattering via Complex Spectra**

Hao He, Ali H. Alhulaymi, Nazar Pyvovar, Ali Ghorashi, A. Douglas Stone — *Department of Applied Physics, Yale University, USA*

The scattering matrix imposes constraints on input-output relations in linear wave systems. By introducing additional constraints, scattering processes can be formulated as non-Hermitian eigenvalue problems with discrete complex eigenfrequencies, known as critically constrained scattering modes (CCONs). It is now well understood that these complex frequencies can be excited transiently, focusing on either resonances or zeros of the scattering matrix. Recently other complex eigenspectra have been studied for coherent control of scattering, e.g. for reflectionless excitation and more constrained problems such as routing, when they are tuned to the real axis. Here we demonstrate that coherent control such as wave routing can be achieved even for complex eigenfrequencies via transient (complex frequency) excitation. Our results establish CCONs as a general framework for manipulating temporally structured waveforms in generic resonant systems.

16:15 - 16:30 **Experimental Demonstration of Zero Forward Scattering with Complex Frequency Excitations**

Vitali Kozlov, Wei Wang, Seunghwi Kim, Arno Thielens, Andrea Alu — *ASRC CUNY, USA*

The optical theorem dictates that the forward scattering of an object is proportional to its total extinction. Consequently, for passive objects illuminated by continuous waves, zero forward scattering implies complete transparency - no scattering and no absorption. While active materials have been proposed to suppress shadows while maintaining scattering in other directions, they suffer from inherent instabilities. Here, we experimentally demonstrate shadowless forward scattering from a macroscopic high-index dielectric sphere by exciting it with a complex-frequency (CF) wave. By tailoring the temporal decay of the incident pulse to mimic the response of a gain medium (virtual gain), we achieve a 26 dB suppression of forward scattering compared to standard continuous-wave excitation, without using any active materials.

16:30 - 16:45 **Time-Modulated Scatterer for Micro-Doppler Radar Deception**

Dmytro Vovchuk[1], Vitali Kozlov[2], Andrey Sheleg[3], Konstantin Boiko[3], Vladyslav Tkach[1], Mykola Khobzei[1], Ronel Melnitsky[3], Aviel Glam[4], Amir Boag[3], Pavel Ginzburg[3] — *[1] Riga Tecnical University, Latvia [2] City University of New York, USA [3] Tel Aviv University, Israel [4] Rafael Advanced Defense Systems Ltd, Israel*

Micro-Doppler signatures play a central role in radar-based target recognition, as they arise from motion-induced electromagnetic scattering and encode information about the internal dynamics of observed objects. Despite the impressive performance of modern machine learning algorithms in target classification, such systems remain vulnerable to deceptive manipulation through deliberately engineered temporal modulation of the backscattered fields. In this work, we outline the physical foundations of passive micro-Doppler deception and experimentally demonstrate the ability to camouflage a drone as a helicopter from the perspective of an interrogating radar, while preserving complete radio silence. The proposed approach enables the realization of compact, low-cost, and low-power devices that can, for example, cause a flock of birds to be perceived as a swarm of drones by radar-based sensing platforms. The concept is naturally suited for implementation using passive time-dependent metasurfaces.

16:45 - 17:00 **Broadband Transmission Enhancement in Mirror-Symmetric Disordered Systems**

Clément Ferise[1], Zhazira Zhumabay[2], Vincent Pagneux[3], Stefan Rotter[4], Matthieu Davy[2] — *[1] EPFL - Laboratory of Wave Engineering, Switzerland [2] Université de Rennes, CNRS, IETR - UMR 6164, Rennes, France [3] Laboratoire d'Acoustique de l'Université du Mans, CNRS UMR 6613, Le Mans, France [4] Institute for Theoretical Physics, Vienna University of Technology (TU Wien), Vienna, Austria*

In this talk, we present a framework for achieving bandpass filtering and broadband perfect wave transmission in complex systems by optimizing symmetric disordered media via inverse design. We show that leveraging symmetry of complex media reduces the optimization's complexity enabling the incorporation of additional constraints in the parameter space. Numerical simulations based on the coupled dipole approximation are validated experimentally in a multimode microwave waveguide with dielectric and metallic scatterers.

17:00 - 17:15 **Reconfigurable Polarization Conversion Metasurface for Radar Cross Section Control in X-Band**

Tycho Van Velden[1], Giuseppe Labate[2], Gabriele Federico[3], Giampiero Gerini[4] — *[1] Eindhoven University Of Technology, Netherlands Organisation*

for Applied Scientific Research, Netherlands [2] Netherlands Organisation for Applied Scientific Research, Netherlands [3] Eindhoven University Of Technology, Netherlands [4] Netherlands Organisation for Applied Scientific Research, Eindhoven University Of Technology,
This work proposes a novel design for a reconfigurable polarization-conversion metasurface operating for adaptive radar cross section (RCS) control in the X-Band. This func- tionality is achieved through unit cells that can be independently configured as either opposite phase polarization conversion (PC) or as two oppositely phased Artificial Magnetic Conductors (AMC). Simulation results demonstrate a 10 dB reduction in RCS of nearly full X-Band. Practi- cal constraints related to the control mechanism and manufacturability are also considered, and their impact on the metasurface design is briefly discussed.

17:15 - 17:30 **Multi-Objective Tweezers in Scattering Media via Generalized Wigner-Smith Matrices**
Tristan Nerson[1], Jakob Hüpfl[2], Clément Ferise[1], David Globosits[2], Marlene Hudler[2], Matthieu Malléjac[3], Stefan Rotter[2], Romain Fleury[1] — *[1] École Polytechnique Fédérale de Lausanne (EPFL) - Laboratory of Wave Engineering, Switzerland [2] Institute for Theoretical Physics, Vienna University of Technology (TU Wien), Austria [3] Univ. Bordeaux, CNRS, Bordeaux INP, I2M, UMR 5295, Arts et Metiers Institute of Technology, France*
Radiation forces enable contactless acoustic/electromagnetic manipulation, but multiple scattering makes robust control – especially of several objects with competing goals – hard. We map force objectives to Hermitian operators built from the scattering matrix: eigenstates give optimal single-object actuation, while multi-object problems yield Pareto fronts and exact trade-off bounds, echoing incompatible quantum observables. Media link(s): See our arXiv preprint: arxiv.org/abs/2511.22279

16:00 - 17:30 Oral Sessions (Wednesday Afternoon 2)
C203

Quantum Emitters and Purcell Enhancement

Chairperson(s): Mauro Antezza, Chiara Trovatello

16:00 - 16:30 **Hybrid Quantum Defects in Wide Bandgap Nitrides for Integrated Quantum Photonics** (Invited talk)
Saifa Amin[1], Aidan Jimenez[1], Enrique Mejia[1], Yifeng Cao[2], Martino Silvetti[3], Andrea Biondini[3], Marco Govoni[3], Jonathan Pelliciari[2], Gabriele Grosso[1] — *[1] CUNY Advanced Science Research Center, USA [2] Brookhaven National Laboratory, USA [3] University of Modena and Reggio Emilia, Italy*
Hybrid quantum defects in wide-bandgap nitrides enable tunable single-photon emission through nonlocal donor–acceptor recombination coupled to molecular vibronic modes. We establish a microscopic framework linking vibronic structure, spectral variability, and nonlocal recombination processes, providing design principles for spectrally programmable quantum light sources compatible with integrated nanophotonic and metamaterial platforms.

16:30 - 17:00 **Tailoring Local Fields for Ultrafast Single Photon Sources** (Invited talk)
Maiken Mikkelsen — *Duke University, USA*
Local electromagnetic fields can be strongly modified using artificially structured materials, in particular cavities with small gaps between two metal interfaces can support extreme local field enhancements. Using this, we demonstrate picosecond single photon emission from SiVs in diamond and Purcell factors greater than 10,000 for single colloidal quantum dots emitting in the telecom band at 1550 nm.

17:00 - 17:15 **Purcell-Enhanced Emission at the Single-Molecule Level**
R. Margoth Cordova-Castro[1], Robert Boyd[2] — *[1] University of Ottawa, Canada [2] University of Rochester, USA*
In this work, we have introduced a novel platform and a methodology to precisely control and investigate spontaneous emission lifetimes at the nanoscale. Our technique enables detailed observation of light-matter interactions beyond the diffraction limit, facilitating molecular localization with nanometric precision, and allowing for single-molecule-level interrogation and ultra-precise nano-positioning analysis. Our approach reveals unprecedented, high non-averaged Purcell factors, demonstrating significant potential for quantum applications and sensing technologies. Media link(s): Controlling light-matter interactions at scales smaller than the diffraction limit at the single photon level is a critical challenge to advancing quantum technologies and sensing

applications. Single-molecule nanophononics is an emerging field offering exciting opportunities to investigate light-matter interactions at the emitter level with nanometer-scale resolution. We proposed a non-invasive methodology, capable of temporally and spatially correlating enhanced molecular single-emitter properties coupled to a novel material platform that enables precise engineering of spontaneous emission. This platform is based on free-standing hollow plasmonic nanocones arranged in a square lattice, uniformly scalable to the centimeter scale while maintaining unitary cell geometry. Exhibits diverse and tunable light-matter interaction enhancement properties in function of the out-of-plane illumination angle. Significantly increasing the local density of states (LDOS) in a manner that depends on both emitter position and dipole orientation, offering extreme position sensitivity within the 3D electromagnetic landscape. The strong changes in the emission of molecular single emitters along the 3D nanofields in the metamaterial, leads to billions of Purcell-enhanced single emitters integrated into a single nanodevice. We measured the LDOS modification along the 3D fields with nano precision and single emitter level. Implementing a non-scanning widefield method combining far-field single-molecule super-resolution microscopy, with time correlation single photon counting (TCSPC), we probe molecule per molecule enhanced quantum light-matter interactions. These unique properties offer an exceptionally sensitive platform for molecular sensing and the detection of small vectorial field variations with resolution surpassing the diffraction limit. By leveraging these plasmonic nanostructures and our method for measuring single-molecule Purcell-enhanced nano-resolved maps, we enable fine-tuned control of light-matter interactions. Obtaining fast single-photon sources at room temperature, provides a powerful tool for quantum applications at the single-emitter level. Our results heralds advances in technologies limited by resolution, single-photon efficiency, sensitive detection, scalability, low-density sensing, and vectorial field mapping.

17:15 - 17:30 **Optical Magnetic-Field-Gated Criticality in Photon Avalanching Quantum Processes**

Mathieu Mivelle — *CNRS, Sorbonne université, INSP, France*

We report the active gating of photon avalanching via the optical magnetic field. By modulating the magnetic ignition in thulium ions, we decouple the threshold from cooperativity, achieving a record non-linearity (s=62). This establishes the magnetic field as a key lever for collective quantum dynamics and adaptive neuromorphic photonics.

Oral Sessions (Thursday Morning 1)

Time-Varying Media and Synthetic Motion

Chairperson(s): Viktar Asadchy, Anthony Grbic

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
09:00 - 09:30	Nader Engheta	From Vibrational Resonance to Vibrational Electromagnetics via Metastructures
09:30 - 09:45	Kyan Louisia	Can Physical Motion Be Synthetically Reproduced?
09:45 - 10:00	Grigorii Ptitcyn	DC Bias and Travelling-Wave Modulations: Illusion of the Permittivity Response

Nanophotonic Metadevices

Chairperson(s): Marina Leite, Maria Csete

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
09:00 - 09:30	Tingyi Gu	Low Loss Silicon Photonic Metasystem for Mode Control, Wide-Field Imaging and Parallel Signal Processing
09:30 - 09:45	Eleni Perivolari	Single-Shot Cm-Scale Plasmonic Nanogaps for Trace Detection of Chemical Compounds
09:45 - 10:00	Donghyun Kim	Angle-Robust Color Routers Enabled by Optical Structural Similarity Constraints

Scattering and Disorder

Chairperson(s): Arthur Yaghjian, Raphael Kastner

Room: Martin E. Segal Theatre

Time	1st Author (Presenter)	Title
09:00 - 09:30	Cheng Guo	Joint Control and Probability Distribution of Coherent Wave Transport
09:30 - 09:45	Aaron Shih	Spectral Design of Disordered Photonic Metamaterials
09:45 - 10:00	Carlo Forestiere	Mie Scattering Analog Circuit Emulator

Metaoptics for Classification and Feature Extraction
Chairperson(s): Junichiro Kono, Lisa Poulikakos **Room: C201**

Time	1st Author (Presenter)	Title
09:00 - 09:30	Elena Goi	Nanoprinted Neural Networks for High-Content and High-Throughput Classification
09:30 - 09:45	Bernardo Dias	All-Optical Tunable Analog Computation Using 2D Materials
09:45 - 10:00	Prachi Thureja	Multifunctional Nonlocal Metasurfaces for Optical Feature Extraction

Physics of Artificial Materials for Novel and Extreme Phenomena II
Chairperson(s): Ana Díaz-Rubio, Iñigo Liberal **Room: C203**

Time	1st Author (Presenter)	Title
09:00 - 09:30	Younes Radi	Passive Non-Foster Microwave Systems Approaching Fundamental Limits
09:30 - 09:45	Luca Stefanini	Plasma Temporal Slabs Achieve Full Time Reversal
09:45 - 10:00	Shuai S. A. Yuan	Synthesizing Arbitrary Tunable Nonreciprocal Devices via a Programmable Chaotic Cavity

09:00 - 10:00 Oral Sessions (Thursday Morning 1)
Proshansky
Auditorium

Time-Varying Media and Synthetic Motion

Chairperson(s): Viktar Asadchy, Anthony Grbic

09:00 - 09:30 **From Vibrational Resonance to Vibrational Electromagnetics via Metastructures** (Invited talk)
Nader Engheta — *University of Pennsylvania, USA*
The fields of Vibrational Mechanics and Vibrational Resonance were born after Kapitza's explanation of the stability of the inverted pendulum. Inspired by these concepts, we have been exploring how approaches from these fields can introduce novel and interesting phenomena into the field of metamaterials. In this talk, I present an overview of our recent findings in "Vibrational Electromagnetics" through a series of investigations of wave-matter interaction in certain metastructures, including specially designed inhomogeneous metamaterials, non-Foster structures, non-Hermitian metastructures, structured diffusion, and manipulated optical rays, among others. I discuss some of the physical insights into our findings and also forecast future possibilities in this field

09:30 - 09:45 **Can Physical Motion Be Synthetically Reproduced?**
Kyan Louisia, Francisco J. Rodríguez-Fortuño — *King's College London, United Kingdom*
Advances in space–time modulated metamaterials have enabled synthetic motion, partially reproducing electro- magnetic signatures of moving objects without physical displacement. We evaluate how faithfully synthetic motion reproduces genuine motion using Galilean and Lorentz modulation protocols. By analysing wave scattering properties and hybrid motion (both real and synthetic motion simultaneously), we identify which dynamical effects are reproduced and which remain intrinsically tied to true physical motion.

09:45 - 10:00 **DC Bias and Travelling-Wave Modulations: Illusion of the Permittivity Response**
Grigorii Ptitcyn[1], Diego Martinez Solis[2], Mohammad Sajjad Mirmoosa[3], Nader Engheta[1] — *[1] University of Pennsylvania, United States [2] University of Vigo, Spain [3] University of Eastern, Finland*
Materials with unusual optical properties enable advanced control of light but are often rare or difficult to realize. We introduce a dynamic framework in which programmed DC-biased space-time modulations of material parameters reproduce the response of otherwise readily accessible media.

09:00 - 10:00 Oral Sessions (Thursday Morning 1)
Elebash
Recital Hall

Nanophotonic Metadevices

Chairperson(s): Marina Leite, Maria Csete

09:00 - 09:30 **Low Loss Silicon Photonic Metasystem for Mode Control, Wide-Field Imaging and Parallel Signal Processing** (Invited talk)
Tingyi Gu — *University of Delaware, USA*
The advancement of metamaterials reveals the potential of nanophotonics in applications across disciplines. We explored a new topology for photonic integrated circuits for the control of non-Hermicity, nonreciprocity, mathematical convolution, and hyperspectral image classification. The advanced electromagnetic engineering promises to fundamentally reshape the design concepts of system-on-chip technology.

09:30 - 09:45 **Single-Shot Cm-Scale Plasmonic Nanogaps for Trace Detection of Chemical Compounds**
Eleni Perivolari, Enkui Lian, John Demello — *Norwegian University of Science and Technology, Norway*
Here, we report a rapid, single-shot interference lithography strategy for the fabrication of wafer-scale, highly ordered metallic nanogap arrays with nanoscale precision. The resulting structures exhibit uniform sub-10 nm gap features across centimeter scales, yielding dense plasmonic hotspots. To assess optical performance, the arrays were employed as surface-enhanced Raman spectroscopy (SERS) substrates using a self-assembled monolayer of biphenyl-4-thiol as a standard Raman reporter. The substrates demonstrate strong Raman enhancement, confirming efficient electromagnetic field localization and high device reliability, ideal for trace detection of chemicals via SERS and various vibrational spectroscopies.

09:45 - 10:00 **Angle-Robust Color Routers Enabled by Optical Structural Similarity Constraints**
Donghyun Kim, Chanik Kang, Kyungmin Kim, Haejun Chung — *Hanyang University, Republic of Korea*
Nanophotonic color routers suffer severe performance degradation under oblique illumination. We introduce Optical Structural Similarity (OSS), a constraint integrated into adjoint-based topology optimization to enforce geometric continuity between angle-specific unit cells. OSS significantly suppresses stitching errors, enabling angle-robust color routing across the entire image sensor.

09:00 - 10:00 Oral Sessions (Thursday Morning 1)
Martin E.
Segal Theatre

Scattering and Disorder

Chairperson(s): Arthur Yaghjian, Raphael Kastner

09:00 - 09:30 **Joint Control and Probability Distribution of Coherent Wave Transport** (Invited talk)
Cheng Guo, Shiyu Li, Yunrui Wang — *The University of Texas at Austin, USA*
We address two key problems in the coherent control of wave transport: the joint control of multiple observables and the probability distribution of random wave transport in arbitrary media.

09:30 - 09:45 **Spectral Design of Disordered Photonic Metamaterials**
Aaron Shih — *University of Fribourg, Switzerland*
We create disordered structures exhibiting specific spectral features, from stealthy hyperuniformity to completely new structures, “gyromorphs”, that exhibit rotational order alongside translational disorder. Using direct laser writing, we fabricate these structures as polymer nanolattices and report their optical properties in the near infrared range. Preliminary data suggests a photonic bandgap in gyromorphs on par with that of stealthy hyperuniformity in low refractive index material.

09:45 - 10:00 **Mie Scattering Analog Circuit Emulator**
Carlo Forestiere[1], Emanuele Corsaro[1], Marco Balato[1], Carlo Petrarca[1], Giovanni Miano[1], Andrea Alù[2] — *[1] University of Naples, Italy [2] City University of New York, USA*
We introduce and experimentally validate an analog circuit emulator of Mie scattering. The emulator adopts a modular architecture: excitation conditions are specified by generators and filters, whereas distinct networks of resistors, capacitors, and inductors capture material dispersion and radiative properties.

09:00 - 10:00 Oral Sessions (Thursday Morning 1)
C201

Metaoptics for Classification and Feature Extraction

Chairperson(s): Junichiro Kono, Lisa Poulikakos

09:00 - 09:30 **Nanoprinted Neural Networks for High-Content and High-Throughput Classification** (Invited talk)
Elena Goi — *FS University Jena, Germany*
We present nanoprinted diffractive neural networks fabricated by two-photon nanolithography and show their potential in the context of high-content and high-throughput classifiers for imaging flow cytometry. These optical neural networks perform high-speed classification of objects at visible wavelengths, highlighting the potential of integrated optofluidic machine-learning systems.

09:30 - 09:45 **All-Optical Tunable Analog Computation Using 2D Materials**
Bernardo Dias[1], Romain Tirole[2], Michele Guizzardi[2], Andrea Cordaro[3], Albert Polman[3], Andrea Alù[2], Jorik Van De Groep[1] — *[1] University of Amsterdam, Netherlands [2] City University of New York, United States of America [3] AMOLF, Netherlands*
We demonstrate optically tunable edge detection by integrating a dielectric metasurface with multilayer 2D materials exhibiting strong photo-induced refractive index modulation. By applying an external pump laser, we dynamically switch the edge-detection functionality on and off. This approach provides a reconfigurable, all-optical platform for high-speed image processing.

09:45 - 10:00 **Multifunctional Nonlocal Metasurfaces for Optical Feature Extraction**
Prachi Thureja[1], Mehdi Kiani[1], Lin Jing[1], Shaban Sulejman[2], Ann Roberts[2], Andrea Alù[1] — *[1] City University of New York, USA [2] The University of Melbourne, Australia*
We demonstrate a passive dispersion-engineered nonlocal metasurface for wavelength-selective spatial-frequency filtering, enabling low-pass circle detection with a tunable numerical aperture and high-pass edge detection. Experiments show up to 3-fold SNR enhancement for circles, clear edge enhancement and improved classification accuracy of objects using a single-layer convolutional neural network.

09:00 - 10:00 Oral Sessions (Thursday Morning 1)
C203

Physics of Artificial Materials for Novel and Extreme Phenomena II

Chairperson(s): Ana Díaz-Rubio, Iñigo Liberal

09:00 - 09:30 **Passive Non-Foster Microwave Systems Approaching Fundamental Limits** (Invited talk)
Younes Radi — *Syracuse University, USA*
We will present a unified perspective on how deliberately tailored dispersion can be used to create absorbing layers (dielectric and magnetic) with unprecedented bandwidth-to-thickness ratios. We will further show how closely related ideas can enable compact, on-chip realizations of negative reactive behavior that are typically associated with active or stability-limited circuits.

09:30 - 09:45 **Plasma Temporal Slabs Achieve Full Time Reversal**
Luca Stefanini, Akshaj Arora, Nikita Nefedkin, Andrea Alù — *CUNY-Advanced Science Research Center, USA*
In this study, we demonstrate that full time-reversal can be achieved in a spatially symmetric homogeneous medium by exploiting the unique wave-matter interactions in plasma temporal slabs. We show that, while conventional non-dispersive time-interfaces are constrained by a physical bound on the time reflection efficiency due to momentum conservation, a dispersive plasma medium allows breaking this limit by introducing mechanical momentum exchanges as a new degree of freedom. By utilizing a Lagrangian formalism, we reveal that, by preserving the inertia of carriers at a time-interface, rather than their time derivative, triggers a kickback effect that enables the time-reflected wave to exceed the time-transmitted wave, up to canceling time-transmission and fully reverting the wave without violating total momentum conservation. We validate our analytical predictions through a microwave experiment involving a time-varying metamaterial transmission line, where we successfully measure time-reflections greater than time-transmission. Our findings prove that mechanical momentum exchanges are an essential ingredient for achieving full time-reversal, offering new playgrounds for broadband phase conjugation and distortion compensation for applications in imaging and telecommunications.

09:45 - 10:00 **Synthesizing Arbitrary Tunable Nonreciprocal Devices via a Programmable Chaotic Cavity**
Shuai S. A. Yuan[1], Viktar Asadchy[1], Philipp Del Hougne[2] — *[1] Aalto University, Finland [2] Aalto University & Univ Rennes, Finland & France*

we demonstrate a programmable chaotic cavity platform capable of realizing arbitrary frequency-agile nonreciprocal functionalities. Fixed magnetically self-biased ferrites inside the cavity provide intrinsic time-reversal symmetry breaking, while tunable reciprocal port terminations enable boundary programmability. As an example, a two-port isolator functionality is realized by optimizing the load reflection phases.Near-unity forward transmission and isolation exceeding 110 dB are achieved, with the possibility for continuous shift of the operating frequency in the relative spectral range of 15%. The proposed platform is capable of realizing reconfigurable, arbitrary passive nonreciprocal multiport devices.

Oral Sessions (Thursday Morning 2)

Photonic Operations with Optical Metasurfaces

Proshansky

Chairperson(s): Femius Koenderink **Room: Auditorium**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Nanfang Yu	Optical Neural Interface: Integrating Metasurfaces and CMOS Imagers for Lensless Neuron Localization
11:00 - 11:15	Miao Chen	Assembling and Modeling Cascading Disordered Optical Metasurfaces
11:15 - 11:30	Kaizad Rustomji	Virtual Absorption and Energy Storage-Release Mechanism in Metasurfaces
11:30 - 12:00	Lisa Poulikakos	Nature-Inspired Photonic Surfaces for Next-Generation Imaging and Diagnostics
12:00 - 12:15	Ian Hammond	Topology-Optimized Metasurfaces for Distributed 3d Anisotropic Raman Emission
12:15 - 12:30	Mehmet Atıf Durmuş	Nonlocal 2D Excitonic Metasurfaces for Active Wavefront Manipulation

Reconfigurable and Programmable Metasurfaces for Wave Control

Elebash

Chairperson(s): Agnese Mazzinghi, Eva Rajo-Iglesias **Room: Recital Hall**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Mirko Barbuto	Twisted Cascaded Metasurfaces for Vortex Generation and Sensing
11:00 - 11:30	Gennady Shvets	Generation and Enhancement of Persistent Nanoscale Magnetization in All-Dielectric Metasurfaces by Optically Injected and Localized Free Carriers
11:30 - 11:45	Amir Khajevandi	Programmable Metamaterials via Boundary-Condition Tuning
11:45 - 12:00	Ali Alhulaymi	Controlling Wave Propagation with a Minimal Number of Tunable Elements
12:00 - 12:15	Mattia Sartore	Reconfigurable Microwave Metasurfaces for Miniaturized and Tunable Electric Space Propulsion Systems

Breaking Reciprocity: Physics and Technologies of Wave Isolation

Chairperson(s): Younes Radi, Clara Wanjura **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Gaurav Bahl	Spatiotemporal Approaches to Achieving Gyration in Integrated Devices
11:00 - 11:15	Shuai S. A. Yuan	A Passive Polarization-Independent Microwave Metasurface Isolator
11:15 - 11:45	Viktar Asadchy	Synthetic Motion: A Path to Passive Bias-Free Optical Nonreciprocity
11:45 - 12:00	Xinxin Guo	Non-Reciprocal Communication with Signal Amplification Through a Compact Acoustic Circulator
12:00 - 12:15	Anna Tasolamprou	Nonreciprocity in a Metasurface Formed by Magnetically Biased Plasmonic Cylinders
12:15 - 12:30	Balázs Bánhelyi	Optimized Metamaterial Multilayers for Faraday Rotation Isolators

Tunable, Nonlinear, and Temporal Metastructures for Photonics

Chairperson(s): Giampiero Gerini, Yoshiaki Kasahara **Room: C201**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Ali Ghorashi	Coated Scatterers for Tunable Coherent Perfect Absorption
11:00 - 11:30	Marina Leite	Soft-Lattice Semiconductors as a Platform for Switchable Photonics
11:30 - 11:45	Felix Wong	Optical Cavities with Largely Tunable Q-Factors based on Resonant Metasurfaces
11:45 - 12:00	Mohammad Mojtaba Sadafi	Dynamic Light Scattering from Dispersive Time-Varying Metasurfaces: A Causal Floquet–Bloch Approach
12:00 - 12:15	Michael De Oliveira	Optically Programmed Nonlinear Computing in a Thin Nonlinear Film
12:15 - 12:30	Joseph Stones	Optical Eigenpulses in Ultra-Fast Time-Modulated ITO as a Temporal Metamaterial

Special Session New Frontiers of Sound
Chairperson(s): Pierre A Deymier **Room: C203**

Time	1st Author (Presenter)	Title
10:30 - 11:00	Pierre A Deymier	Harnessing Topological Acoustics for Applications: Geometric Phase Computing, Engineering and Sensing
11:00 - 11:30	Bingxu Luo	Geometric Phase Sensing on Natural Environments Using Seismic Waves
11:30 - 12:00	Wataru Takeda	Reconfigurable Non-Volatile Phononic Devices Using Phase-Change Materials
12:00 - 12:30	Pierre A Deymier	Topological Acoustic Metamaterials Application to Phase Computing with Exponential Scaling

10:30 - 12:30 Oral Sessions (Thursday Morning 2)
Proshansky
Auditorium

Photonic Operations with Optical Metasurfaces

Chairperson(s): Femius Koenderink

10:30 - 11:00 **Optical Neural Interface: Integrating Metasurfaces and CMOS Imagers for Lensless Neuron Localization** (Invited talk)
Nanfang Yu — *Columbia University, USA*
Optical neural interfaces offer a promising avenue for monitoring and stimulating neuronal activity with high spatiotemporal resolution. This talk presents two highly integrated devices that combine optical metasurfaces with CMOS imaging technology for precise neuron localization. The first system, a "needle" device, enables the probing of deep brain neural circuits while significantly minimizing tissue displacement compared to the state of the art. The second system, a “needle” , device as thin as a sheet of paper, can be conformally attached to the brain’s surface and operated entirely wirelessly. Together, these technologies provide transformative, minimally invasive tools for mapping and interrogating complex neural circuitry in living and behaving animals.

11:00 - 11:15 **Assembling and Modeling Cascading Disordered Optical Metasurfaces**
Miao Chen[1], Amit Sharma[2], Johann Michler[2], Xavier Maeder[2], Philippe Lalanne[1], Angelos Xomalis[3] — *[1] LP2N, Institut d’Optique Graduate School, CNRS, Université de Bordeaux, France [2] Laboratory for Mechanics of Materials and Nanostructures, Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland [3] Norwegian University of Science and Technology, Norway*
Disordered metasurfaces offer unique properties unattainable with periodic or ordered metasurfaces, notably the absence of deterministic interference effects at specific wavelengths and angles. In this work, we introduce a lithography-free nanofabrication approach to realize cascaded disordered plasmonic metasurfaces with submicrometer total thickness. We experimentally characterize their angle-resolved specular and diffuse reflections using the bidirectional reflection distribution function and develop accurate theoretical models that remain valid even at large incidence angles. These models reveal the intricate interplay between coherent (specular) and incoherent (diffuse) scattering and demonstrate how coherent illumination can strongly influence the perceived color of diffusely scattered light. Exploiting this effect, we realize a centimeter-scale chromo-encryption device whose color changes

depending on whether it is viewed under direct or diffuse illumination. Our results lay the groundwork for advanced nanophotonic platforms based on stacked disordered metasurfaces, offering versatile optical functionalities inaccessible with traditional multilayer thin-film technologies or single-layer metasurfaces.

11:15 - 11:30 **Virtual Absorption and Energy Storage-Release Mechanism in Metasurfaces**
Kaizad Rustomji, Nasim Mohammadi Estakhri, Nooshin M. Estakhri — *Chapman University, USA*
We present successful realization of coherent virtual absorption in metasurfaces-based platforms. Our analysis and results provide new opportunities for engineered optical energy storage, optical memories, and sensing using metasurface-based designs.

11:30 - 12:00 **Nature-Inspired Photonic Surfaces for Next-Generation Imaging and Diagnostics** (Invited talk)
Julia Holland, Paula Kirya, Moises Ibarra Miranda, Georgios Maximos Zipitis, Saaj Chattopadhyay, Nicholas Boechler, Lisa V. Poulikakos — *UC San Diego, USA*
Imaging science is a critical enabler of revolutionary scientific advances across disciplines. However, current imaging technologies face prohibitive trade-offs in resolution, penetration depth and experimental complexity. Here, we introduce new classes of micro- and nanostructured photonic surfaces which scale down and enhance light-matter interactions, to overcome existing challenges in imaging science in a miniaturized, on-chip format.

12:00 - 12:15 **Topology-Optimized Metasurfaces for Distributed 3D Anisotropic Raman Emission**
Ian Hammond[1], Pengning Chao[1], Henry Everitt[2], Rasmus Christiansen[3], Alan Edelman[1], Francesc Verdugo[4], Steven Johnson[1] — *[1] Massachusetts Institute of Technology, USA [2] U.S. Army Research Laboratory-South, Rice University, USA [3] Technical University of Denmark, Denmark [4] Vrije Universiteit Amsterdam, Amsterdam*
We present 3D topology optimization of manufacturable SERS substrates maximizing averaged Raman power from randomly oriented anisotropic molecules in elastic and inelastic scattering. A trace formulation gives closed-form SO(3) averaging and requires one pump plus few reciprocal emission solves. Length-scale constraints prevent singularities; Ag is broadband, Si_3N_4 narrower and Q-limited.

12:15 - 12:30 **Nonlocal 2D Excitonic Metasurfaces for Active Wavefront Manipulation**

Mehmet Atıf Durmuş, Ershad Mohammadi, Jorik Van De Groep — *University of Amsterdam, Netherlands*

Optical metasurfaces enable flat, compact, and lightweight optical components through precise control of the phase and amplitude of scattered light. Among them, nonlocal metasurfaces employ guided mode resonances (GMRs) to achieve high-Q responses with enhanced light-matter interactions, yet most remain static after fabrication. Two-dimensional transition metal dichalcogenides (TMDs) offer a promising route toward active tunability. Here, we integrate monolayer WS_2 with nonlocal metasurfaces to pursue strong exciton-photon coupling and dynamic control of GMRs. To efficiently design and optimize the metasurface geometry, we employ a deep neural network (DNN) surrogate model trained on RCWA simulation results. Fabricated nanogratings exhibit clear GMRs, establishing an experimentally validated platform for actively tunable hybrid excitonic-photonic systems with potential applications in dynamic wavefront shaping, augmented reality, and LiDAR systems.

10:30 - 12:30 Oral Sessions (Thursday Morning 2)
Elebash
Recital Hall

Reconfigurable and Programmable Metasurfaces for Wave Control

Chairperson(s): Agnese Mazzinghi, Eva Rajo-Iglesias

10:30 - 11:00 **Twisted Cascaded Metasurfaces for Vortex Generation and Sensing** (Invited talk)

Mirko Barbuto[1], Alessio Monti[1], Stefano Vellucci[2], Filiberto Bilotti[1], Alessandro Toscano[1] — *[1] Roma Tre University, Italy [2] Niccolò Cusano University, Italy*

In this contribution, we investigate twisted cascaded metasurfaces as an effective approach for vortex beam generation and rotation sensing. The key physical mechanism relies on stacking two phase-engineered metasurfaces and introducing a controllable relative rotation between them, which enables twist-dependent wavefront manipulation. In this way, an incident plane wave can be transformed into an electromagnetic vortex mode whose topological charge can be tuned through the twist angle. Furthermore, since the transmitted field can be engineered to exhibit a strong sensitivity to the relative angular displacement, the same principle can be exploited for rotation detection as well as for vortex mode identification.

11:00 - 11:30 **Generation and Enhancement of Persistent Nanoscale Magnetization in All-Dielectric Metasurfaces by Optically Injected and Localized Free Carriers** (Invited talk)

Gennady Shvets — *Cornell University, USA*

Time varying dielectric metasurfaces supporting sharp optical resonances with a non trivial electromagnetic field distribution represent a unique platform for realizing temporal interfaces for metasurface guided waves. Rapidly changing metasurface resonance enables frequency conversion and temporal scattering of a concurrently propagating waves.We demonstrate that localized free carrier generation can be used to generate large, highly localized quasistatic magnetic fields inside the metasurfaces. The resulting nanoscale magnetization, supported by the residual circulating currents, persists after the departure of the time scattered waves. We further demonstrate that the initial electromagnetic energy of the injected waves is partitioned between the time reflected/refracted waves,residual motion of the free carriers, and a quasi-static magnetic field

11:30 - 11:45 **Programmable Metamaterials via Boundary-Condition Tuning**
Amir Khajevandi, Dimitrios Sounas — *Wayne State University, United States of America*
This paper presents a programmable metamaterial based on printed circuit technology designed through a multi-condition inverse framework. The structure consists of a passive two-dimensional lattice operating at 10 GHz with a fixed internal element distribution. Multiple electromagnetic states are achieved via switch-controlled boundary conditions. Beam steering is demonstrated as a target functionality, where four distinct steering angles are enforced through prescribed power division and progressive phase constraints. The design is formulated as a constrained optimization problem and solved using an adjoint-based gradient method. The final configuration satisfies all steering states simultaneously without structural modification, demonstrating that boundary switching combined with inverse design enables programmable behavior in a fully passive PCB-compatible metamaterial platform.

11:45 - 12:00 **Controlling Wave Propagation with a Minimal Number of Tunable Elements**
Ali Alhulaymi[1], Nazar Pyvovar[1], Philipp Del Hougne[2], Owen Miller[1], Douglas Stone[1] — *[1] Yale University, USA [2] Univ Rennes, CNRS, France*
We determine the minimal number of tunable parameters for coherent control of multichannel wave scattering systems by relating functionality constraints to the codimension, enabling routing, demultiplexing and other target functionalities.

12:00 - 12:15 **Reconfigurable Microwave Metasurfaces For Miniaturized And Tunable Electric Space Propulsion Systems**
Mattia Sartore[1], Elise Bessac[1], Andrea Cester[1], Lorenzo Tonon[2], Luca Schenato[1], Antonio Daniele Capobianco[1], Mirko Magarotto[3], Giorgio Ernesto Bonacchini[1] — *[1] University of Padova, Department of Information Engineering, Italy [2] University of Padova, Center for Studies and Activities for Space "G. Colombo", Italy [3] University of Padova, Department of Information Engineering; University of Padova, Department of Industrial Engineering, Italy*
Electric Propulsion is an emerging space technology enabling efficient, precise control of small satellite constellations. Miniaturizing thruster components is a key challenge. This work presents compact waveguides using a flexible, fully printed metasurface inside a cylindrical structure, achieving over 70% size reduction. Tunable metasurface elements can also enable active control of waveguide mode propagation and thruster operation.

10:30 - 12:30 Oral Sessions (Thursday Morning 2)
Martin E.
Segal Theatre

Breaking Reciprocity: Physics and Technologies of Wave Isolation

Chairperson(s): Younes Radi, Clara Wanjura

10:30 - 11:00 **Spatiotemporal Approaches to Achieving Gyration in Integrated Devices** (Invited talk)
Zhiyin Tu[1], Violet Workman[2], Ogulcan Orsel[2], Alicia Kollar[1], Gaurav Bahl[2] — *[1] University of Maryland, USA [2] University of Illinois at Urbana-Champaign, USA*
The production of gyration, or non-reciprocal phase shifts, is a key enabler for a wide range of non-reciprocal devices. Specifically, gyrators are a universal building block for creating isolators, circulators, and other non-reciprocal transfer functions. In this presentation, we will discuss how gyration responses can be achieved using spatio-temporal modulation. Three distinct approaches will be described – the use of electro-optic material properties to natively induce non-reciprocal rotation of light polarization, the use of electro-optic modulations on discrete resonators to break overall transfer function symmetry, and extending these principles to creating pure gyration with simultaneously symmetric amplitude responses. Our experimental implementations include both photonic integrated circuits and superconducting microwave systems.

11:00 - 11:15 **A Passive Polarization-Independent Microwave Metasurface Isolator**
Shuai S. A. Yuan, Bahman Amrahi, Viktar Asadchy — *Aalto University, Finland*
We present a passive, single-layer, polarization-independent metasurface isolator operating in the microwave regime. The design is based on a meta-atom exhibiting D4h(C4v) symmetry, realized through the hybrid integration of permanent magnets and ferrites. This symmetry enables a pure moving-medium effect without the need for external biasing or time-varying modulation. The proposed metasurface achieves an isolation level of 37 dB at the operating frequency for both orthogonal polarizations.

11:15 - 11:45 **Synthetic Motion: A Path to Passive Bias-Free Optical Non-reciprocity** (Invited talk)
Luis Manuel Máñez-Espina[1], Bahman Amrahi[2], Ihar Faniayeu[3], Rafael Cichelero[3], Alexandre Dmitriev[3], Ana Díaz-Rubio[1], Viktar Asadchy[2] —

[1] Universitat Politecnica de Valencia, Spain [2] Aalto University, Finland [3] University of Gothenburg, Sweden
Bimodal interferometry in photonic integrated waveguides relies on structures supporting at least two modes to connect input and output channels. We present an ultrashort bimodal interferometer integrated into a photonic waveguide by embedding a multilayer hyperbolic metamaterial within a subwavelength gap between two dielectric waveguides. Media link(s): Optics Letters https://doi.org/10.1364/OL.535004.

11:45 - 12:00 **Non-reciprocal Communication With Signal Amplification Through A Compact Acoustic Circulator**
Xinxin Guo[1], Zhenwei Xu[1], Ulrich Kuhl[2], Nicolas Noiray[1] — *[1] ETH Zurich, CAPS laboratory, Switzerland [2] Université Côte d'Azur, CNRS, Institut de Physique de Nice (INPHYNI), France*
In this work, we design and realize a compact, synchronization-based acoustic circulator for the transmission of time-varying information. We demonstrate strong non-reciprocity in both transmitted energy and information accuracy, with directional signal amplification attributed to the energy compensation from the synchronized limit cycle.

12:00 - 12:15 **Nonreciprocity in a Metasurface Formed by Magnetically Biased Plasmonic Cylinders**
Anna Tasolamprou[1], Constantinos Valagiannopoulos[1], Ioannis Katsantonis[2] — *[1] National and Kapodistrian University of Athens [2] Institute of Electronic Structure and Laser, Foundation of Research and Technology Hellas, Greece*
We study a metasurface formed by magnetically biased plasmonic cylinders supporting nonreciprocal magnetoplasmonic modes. Using a magnetized Drude model and cylindrical wave analysis, the electromagnetic response of the structure is investigated. The metasurface exhibits asymmetric dispersion and directional surface plasmon propagation, enabling tunable nonreciprocal behavior.

12:15 - 12:30 **Optimized Metamaterial Multilayers for Faraday Rotation Isolators**
Balázs Bánhelyi, Virág Szünstein, Olivér Ardelán, Ákos Sebők-Pap, Miklós Waldhauser, Dávid Vass, András Szenes, Maria Csete — *University of Szeged, Hungary*
Metamaterials were created by aligning complex nanoresonator miniarrays in periodic patterns using two types of dimerization and stacking them into quadlayers. During optimization asymmetry of constituent Babinet complementary bilayers and distinctly different orientation of ellipsoidal nanorings in the bounding convex layers was allowed. Bianisotropy enabled to achieve simultaneously asymmetric transmission and nonreciprocal rotation, proving isolator

capability.

10:30 - 12:30 Oral Sessions (Thursday Morning 2)
C201

Tunable, Nonlinear, and Temporal Metastructures for Photonics

Chairperson(s): Giampiero Gerini, Yoshiaki Kasahara

10:30 - 11:00 **Coated Scatterers for Tunable Coherent Perfect Absorption** (Extended oral)
Ali Ghorashi, Ali Alhulaymi, Douglas Stone — *Yale University, USA*
We find analytic (closed-form) expressions for the complex surface conductivities required to absorb coherent (subwavelength) spherical and cylindrical wavefronts by coupling to the surface plasmon resonances of isolated nanoparticles. We extend our formalism to the case of periodic arrays of coupled scatterers and find similar closed-form expressions. We show that the complex surface conductivities reported herein may be easily achieved in moderately doped graphene.

11:00 - 11:30 **Soft-Lattice Semiconductors as a Platform for Switchable Photonics** (Invited talk)
Marina Leite — *UC Davis, USA*
We demonstrate reversible and multi-state changes in mid-infrared (MIR) transmission of inorganic halide perovskites with opposite polarity under light and heat. This antithetical response results from a polaron-like lattice distortion under illumination (reducing transmission), and from the material's negative thermo-optic coefficient combined with lattice expansion from heat (increasing transmission). Our results establish halide perovskites for reconfigurable photonic devices based on photostriction.

11:30 - 11:45 **Optical Cavities with Largely Tunable Q-Factors Based on Resonant Metasurfaces**
Felix Wong, Michele Cotrufo — *University of Rochester, USA*
We numerically and experimentally investigate a metasurface-based platform to realize compact free-space optical cavities whose quality (Q) factors can be largely modulated by very small mechanical displacements, while keeping the overall device thickness smaller than 20 μm. The device consists of Fabry-Perot-like cavities where one or both mirrors are replaced by resonant and strongly dispersive metasurfaces. The interplay between the strongly dispersive reflection spectra of the metasurface and the round-trip phase accumulated in the cavity leads to a much sharper dependence of the optical response of the overall device with respect to the cavity length. Experimentally, we demonstrated cavities where only one mirror is replaced by a metasurface,

and that feature a fivefold modulation of Q as the cavity length is changed by less than 100 nm. Simulations suggest that the Q factor modulation can be up to 20x in devices with two resonant metasurfaces. We will discuss these results and prospect of this platform for reconfigurable linear and nonlinear photonics.

11:45 - 12:00 **Dynamic Light Scattering from Dispersive Time-Varying Metasurfaces: A Causal Floquet–Bloch Approach**
Mohammad Mojtaba Sadafi, Omid Poordashtban, Hossein Mosallaei — *Northeastern University, USA*
Dispersive time-varying metasurfaces promise unprecedented scattering phenomena, ranging from Floquet harmonic generation to parametric amplification. Here, we introduce a causal Floquet–Bloch formulation for the scattering analysis of metasurfaces with arbitrary dispersion under temporal modulation. The proposed approach enables efficient calculation of reflected and transmitted harmonics while respecting causality. As a proof of concept, we study a strongly dispersive WS_2 metasurface and demonstrate asymmetric harmonic scattering and signatures of parametric amplification under appropriate modulation conditions

12:00 - 12:15 **Optically Programmed Nonlinear Computing in a Thin Nonlinear Film**
Michael De Oliveira[1], Sedigheh Esfahani[1], Simon Stich[2], Trevor Balikie[3], Zbig Wasiliewski[3], Costantino De Angelis[4], Mikhail Belkin[2], Andrea Alù[1] — *[1] Photonics Initiative, Advanced Science Research Center, City University of New York, USA [2] Walter Schottky Institute, Technical University of Munich, Germany [3] Waterloo Institute for Nanotechnology, University of Waterloo, Canada [4] Department of Information Engineering, University of Brescia, Italy*
We demonstrate a reconfigurable nonlinear optical computing platform in which structured illumination writes a programmable nonlinear source in an unpatterned nonlinear thin film. A single-modulator, common-path architecture enables fast quadratic processing, including tunable focusing, vortex generation, log–polar mapping, and complex-valued kernels for feature extraction.

12:15 - 12:30 **Optical Eigenpulses in Ultra-Fast Time-Modulated ITO as a Temporal Metamaterial**
Joseph Stones, Stefano Vezzoli, Riccardo Sapienza — *Imperial College London, United Kingdom*
We present experimentally constructed optical eigenpulses, the extension of an operator theory produced by S.A.R. Horsley et al. into the optical wave regime. Tailoring a probing pulses to a material modulation eigenvalues enables evolution preserving light pulses with controllable efficiencies for use in

cloaking, communications and filtering. Although the experiments explored are in the near infrared, the application to EM waves can be generalised to visible or telecom frequencies.

10:30 - 12:30 Oral Sessions (Thursday Morning 2)
C203

Special Session New Frontiers of Sound

Chairperson(s): Pierre A Deymier

10:30 - 11:00 **Harnessing Topological Acoustics for Applications: Geometric Phase Computing, Engineering and Sensing** (Invited talk)
Pierre A Deymier — *New Frontiers of Sound, University of Arizona, USA*
The geometric phase associated with an acoustic field is a key concept in topological acoustics. This concept arises from the geometric representation of a field as a vector in a multidimensional complex Hilbert space. The topological characteristics of acoustic waves are revealed as unconventional features in the manifold spanned by the multidimensional acoustic field state vector as it is parametrically rotated.

11:00 - 11:30 **Geometric Phase Sensing on Natural Environments Using Seismic Waves** (Invited talk)
Bingxu Luo[1], Susan Beck[1], Pierre A Deymier[1], Keith Runge[1], Falk Huettmann[2], Samy Missoum[1], Marat Latypov[1] — *[1] New Frontiers of Sound, University of Arizona, USA [2] New Frontiers of Sound, University of Alaska, Fairbanks, USA*
The globally distributed ambient seismic noise has been widely used to monitor near-Earth surface dynamic processes. This is made by reconstructing time-lapse signal response within the medium (i.e., empirical Green's functions, EGF) between seismic sensors.

11:30 - 12:00 **Reconfigurable Non-Volatile Phononic Devices Using Phase-Change Materials** (Invited talk)
Wataru Takeda[1], Tanvir Shuvo[1], Howard Yawit[1], Farrukh Najmi[1], Samajith Biswas[1], Zafer Mutlu[1], Andrea Alu[2], Pierre A Deymier[1], Pierre Lucas[1] — *[1] New Frontiers of Sound, University of Arizona, USA [2] New Frontiers of Sound, Photonics Initiative, ASRC, CUNY, USA*
Acoustic devices such as circuits, sensors, and filters rely on materials with spatial patterns of elastic constants. These patterns must have sufficient contrast to confine and manipulate acoustic waves, and they underpin key wireless technologies such as cell phones.

12:00 - 12:30 **Topological Acoustic Metamaterials Application to Phase Computing with Exponential Scaling** (Invited talk)
Keith Runge[1], Pierre A Deymier[1], Joshua Levine[1], M. Arif Hasan[2] — *[1] New Frontiers of Sound, University of Arizona, USA [2] New Frontiers of Sound, Wayne State University, USA*

A topological acoustic metamaterial comprised of coupled waveguides is used to control geometric phase. The phases in the metamaterial satisfy all of DiVincenzo's criteria for quantum bits and are referred to as phase bits, or phi-bits.

Oral Sessions (Thursday Afternoon)

Metamaterials for Biophysics and Biomedicine

Chairperson(s): Gennady Shvets, Elena Goi

Room: Proshansky Auditorium

Time	1st Author (Presenter)	Title
14:00 - 14:30	Yanyu Xiong	Nanophotonics and AI for Molecular Sequencing and Single-Cell Phenotyping
14:30 - 14:45	Pavel Bezrukov	Silver Bullet – Vaterite-Based Metamaterials for Controllable ROS Generation in Biomedicine
14:45 - 15:00	Qizhe Chen	Interference-Based Structural Color Sensing of Weak Dielectric Perturbations from Tissue Sections
15:00 - 15:15	Torjus Steffensen	Measuring Arterial Stiffness with Skin-interfaced All-optical Metasurfaces
15:15 - 15:30	Jordan Budhu	Quantum Chemistry Modeling, Thin-Film Synthesis, and Measurement of Functionalized Cellulose for Organic Electromagnetic Metamaterials

Physical and Neuromorphic Computing

Chairperson(s): Carlo Forestiere, Gaurav Bahl

Room: Elebash Recital Hall

Time	1st Author (Presenter)	Title
14:00 - 14:30	Clara Wanjura	Physical Learning Machines
14:30 - 15:00	Anthony Grbic	Programmable Transmission-Line Metamaterials as Neuromorphic Computing Systems
15:00 - 15:15	Cheima Hammami	Expressivity Analysis of Multilayer Programmable-Metasurface Physical Neural Network with Structural and Encoding Non-linearities
15:15 - 15:30	M Arif Hasan	Logical Elastic Bits for Quantum-inspired Information Processing

2D, Hyperbolic and Spatiotemporal Nanophotonics

Chairperson(s): Tingyi Gu, Nader Engheta **Martin E. Room: Segal Theatre**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Xiaoqin Elaine Li	Engineering Active Metasurface With Van Der Waals Heterostructures
14:30 - 14:45	Magdalena Furman	Multiplexed Objective-Free Momentum-Space Imaging with 3D-Printed Microlens Arrays
14:45 - 15:00	Emroz Khan	Hyperbolic Grating: Efficient Far-Field Coupler for Hyperbolic Polaritons
15:00 - 15:15	Stéphane Azar	Frozen Surface Modes and Lateral Optical Force Enhancement on Moving Interfaces
15:15 - 15:30	Luca Stefanini	Adiabatic Pulse Reversal In Spatially Symmetric Plasmonic Waveguides

Fabrication and Experimental Characterization of Metastructures II

Chairperson(s): Lukas Jelinek, Juejun Hu **Room: C201**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Otto Muskens	Metasurfaces for Telecommunications and Infrared Technology.
14:30 - 15:00	Juejun Hu	Wafer-Scale Conformal Metasurfaces
15:00 - 15:15	Hyeonseong Yun	High-Index Crystalline TiO_2 Metalenses Fabricated by Sol–Gel Nanoimprint Lithography
15:15 - 15:30	Chanwoong Park	Wafer-Scale Metalens Fabrication via Photolithography and Nanoimprint Lithography for Near-Infrared Applications

Advanced Antenna Architectures and Broadband Radiation Techniques

Chairperson(s): Stefano Vellucci, Ariel Epstein **Room: C203**

Time	1st Author (Presenter)	Title
14:00 - 14:30	Arthur Yaghjian	Combining Bode-Fano and Dispersive Tuning to Increase Antenna Bandwidth
14:30 - 15:00	Eva Rajo-Iglesias	Exploring Dielectric Strip Grating for Leaky Wave Antenna Applications
15:00 - 15:30	Agnese Mazzinghi	Radial Line Slot Array: From the Local to the Non-Local Approach and Back.

14:00 - 15:30 Oral Sessions (Thursday Afternoon)
Proshansky
Auditorium

Metamaterials for Biophysics and Biomedicine

Chairperson(s): Gennady Shvets, Elena Goi

14:00 - 14:30 **Nanophotonics and AI for Molecular Sequencing and Single-Cell Phenotyping** (Invited talk)
Yanyu Xiong, Jennifer Dionne — *Stanford University, USA*
We describe our lab's Si-photonic "Very-large-scale Integrated high-Q Nanophotonic Pixels" (VINPix) for single-cell and single-molecule Raman scattering. First, we show how these resonators enable subcellular differentiation and functional state characterization of cells in the tumor immune microenvironment (TIME). Then, we show how these sensors can be used for peptide and glycoconjugate sequencing. We tether peptides from major histocompatibility complex to each resonator, and use dynamic Raman spectroscopy to monitor the cleavage of each amino acid from the distal terminus. We also show how these resonators, combined with computational metadynamics, can be used to identify previously unseen molecular species.

14:30 - 14:45 **Silver Bullet – Vaterite-Based Metamaterials for Controllable ROS Generation in Biomedicine**
Pavel Bezrukov — *Tel Aviv University, Israel*
Modern biomedicine demands precise, local sources of reactive oxygen species (ROS) for therapies like photodynamic treatment, where excess radicals harm healthy tissues and insufficient yields limit efficacy. Here, we present light-sensitive metamaterials based on biocompatible vaterite spherulites as porous hosts uniformly loaded with silver nanoparticles (AgNPs), leveraging plasmonic enhancement for visible-light-driven ROS generation. The hybrid structure exploits localized surface plasmon resonance (LSPR) of AgNPs to shift absorption into the therapeutic window (400–700 nm), boosting electron transfer to oxygen under low-intensity irradiation, while the vaterite matrix ensures nanoparticle stability, uniform distribution, and controlled dosing without aggregation.

14:45 - 15:00 **Interference-Based Structural Color Sensing of Weak Dielectric Perturbations from Tissue Sections**
Qizhe Chen, Han Gao, Qiaoqiang Gan — *King Abdullah University of Science and Technology, Saudi Arabia*
We demonstrate a planar silicon nanocavity that resolves weak dielectric perturbations from biological tissue sections. Subwavelength variations in refrac-

tive index and thickness are transduced into measurable resonance shifts and structural color contrast. The observed behavior is dictated by interference-induced modulation of effective optical thickness from tissue sections.

15:00 - 15:15 **Measuring Arterial Stiffness with Skin-Interfaced All-Optical Metasurfaces**

Torjus Steffensen[1], Arthur Torvund[2], Vegar Stubberud[3], Julia Lövgren[2], Nils Skjærvold[1], Martin Steinert[3], Angelos Xomalis[2] — *[1] Department of Circulation and Medical Imaging, Norwegian University of Science and Technology, Norway [2] Nanoelectronics and Photonics Group, Norwegian University of Science and Technology, Norway [3] Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Norway*

Continuous cardiovascular monitoring is essential for managing circulatory health and disease, yet most wearable sensors are constrained by reliance on electrical transduction and built-in electronics. We present a circuit-free, all-optical approach using diffraction from a skin-interfaced nanophotonic surface to detect minute skin strains from the arterial pulse. A smartphone camera records the shifting diffraction pattern in real time, removing the need for spectrometers or other optical hardware. In phantom and human studies, we recovered high-fidelity arterial pulse waves and detected benign arrhythmic events in close agreement with a clinical reference. Derived waveforms captured features linked to arterial stiffness, a key cardiovascular risk marker. Our approach uses battery-free, cost-effective, and disposable nanophotonic platforms enabling scalable monitoring for healthcare and broad consumer applications.

15:15 - 15:30 **Quantum Chemistry Modeling, Thin-Film Synthesis, and Measurement of Functionalized Cellulose for Organic Electromagnetic Metamaterials**

Jordan Budhu, Sara Yazdi, Kevin Edgar, Michael Bortner — *Virginia Tech, USA*

In this paper, microcrystalline cellulose is chemically treated to replace the C6 hydroxy group with one of higher polarizability leading to functionalized cellulose with tunable permittivity and ultimately affording graded-index organic metamaterials. Thin films are cast of several samples, each with a different functional group, and measured for their electrical permittivity. Quantum chemistry calculations are used to predict the outcome of the measurement with excellent accuracy.

14:00 - 15:30 Oral Sessions (Thursday Afternoon)
Elebash
Recital Hall

Physical and Neuromorphic Computing

Chairperson(s): Carlo Forestiere, Gaurav Bahl

14:00 - 14:30 **Physical Learning Machines** (Invited talk)
Clara Wanjura — *Max Planck Institute for the Science of Light, Germany*
The growing energy consumption of deep learning applications create a need for efficient neuromorphic hardware. First, I will present a framework for non-linear neuromorphic computing based on purely linear scattering, which is widely applicable across platforms. Second, I will discuss efficient physics-based training methods for classical and quantum neuromorphic systems.

14:30 - 15:00 **Programmable Transmission-Line Metamaterials as Neuromorphic Computing Systems** (Invited talk)
Anthony Grbic, Shrey Thakkar — *University of Michigan, USA*
This talk introduces a class of physical neural networks based on programmable transmission-line metamaterials (2D circuit networks). They consist of a grid of subwavelength unit cells with tunable reactive elements that serve as simple wave-based information processing nodes for learning and inference. Learned associations between input and output signals are stored in the reactive loading elements, and information processing is performed through wave propagation and interference across the grid.

15:00 - 15:15 **Expressivity Analysis of Multilayer Programmable-Metasurface Physical Neural Network with Structural and Encoding Non-linearities**
Cheima Hammami[1], Luc Le Magoarou[2], Christos Monochristou[1], David González-Ovejero[1], Ali Momeni[3], Romain Fleury[3], Philipp Del Hougne[1] — *[1] IETR, University of Rennes, France [2] IETR, INSA Rennes, France [3] Laboratory of Wave Engineering, EPFL, Switzerland*
Non-linearity is a pivotal ingredient to the universal approximation theorem for artificial neural networks, but implementing non-linear transformations in wave-based physical neural networks (WPNNs) is notoriously challenging. Recent work has explored the use of pro- grammable metasurfaces (PMs) in WPNNs to encode and non-linearly transform input data, while the learnable parameters were implemented in subsequent digital layers. In this work, we study a multilayer WPNN whose layers are PM-parametrized chaotic cavities. While the input data is encoded into the configuration of some PM elements, most PM elements are phys- ical learnable parameters. Non-linearity arises in our WPNN due to the encoding of input data into the configuration of PM

elements and because mutual coupling between them results in a non-linear dependence of the transfer function on these PM elements' configuration. Based on a full-wave simulation at 140 GHz of a compact chaotic cavity parametrized by a 100-element PM, we study the ability of our WPNN to approximate non-linear functions. Specifically, we examine the contribution of three factors to our WPNN's expressivity: (i) the encoding function mapping input data to PM element characteristics, (ii) the mutual coupling strength between PM elements, and (iii) the number of WPNN layers.

15:15 - 15:30 **Logical Elastic Bits for Quantum-inspired Information Processing**

M Arif Hasan[1], Pierre A Deymier[2], Keith Runge[2], Josh Levine[2] — *[1] Wayne State University, USA [2] The University of Arizona, USA*

We report a room-temperature mechanical platform that realizes logical elastic bits, namely classical qubit analogues encoded in the nonlinear spectrum of a two-mass oscillator joined by a conical spring. Large-amplitude excitation generates a stable ladder of harmonics with well-defined amplitudes and phases. By projecting the measured two-mass velocity field onto the in-phase and out-of-phase eigenvectors, we obtain complex coefficients that map directly onto a Bloch-sphere representation. Equal-frequency spectral pairings produce time-independent logical states suitable for phase-defined memory, whereas detuned harmonic pairings create deterministic Bloch-vector precession that enables passive gate-like rotations. Because multiple spectral blocks can be assigned to separate logical bits, one resonator can host several qubit analogues without additional hardware. The results establish a compact and experimentally accessible route toward quantum-inspired logic based on nonlinear mechanical vibrations.

14:00 - 15:30 Oral Sessions (Thursday Afternoon)
Martin E.
Segal Theatre

2D, Hyperbolic and Spatiotemporal Nanophotonics

Chairperson(s): Tingyi Gu, Nader Engheta

14:00 - 14:30 **Engineering Active Metasurface With Van Der Waals Heterostructures** (Invited talk)
Xiaoqin Elaine Li — *University of Texas Austin, USA*
We explore a new strategy to seamlessly integrate the ferroelectric (FE) functionality of a twisted-hBN with a light-emitting semiconductor monolayer. The electrostatic potential on the surface of the twisted-hBN confines excitons in an adjacent $MoSe_2$ monolayer or bilayer. Those excitons confined along the domain walls and reside atop the domains are spectrally separated due to the Stark shift induced by an in-plane electric field, strongest at the domain walls. They also exhibit drastically different diffusion and localization behavior, establishing an excitonic analogue of optical metasurfaces.

14:30 - 14:45 **Multiplexed Objective-Free Momentum-Space Imaging with 3D-Printed Microlens Arrays**
Magdalena Furman[1], Marcin Muszynski[1], Przemyslaw Oliwa[1], Lukasz Zinkiewicz[1], Alensander Bogucki[2], Jacek Szczytko[1], Piotr Wasylczyk[1], Wojciech Pacuski[1], Mateusz Krol[1], Barbara Pietka[1] — *[1] Institute of Experimental Physics, Faculty of Physics, University of Warsaw, ul. Pasteura 5, Warsaw, Poland [2] Institute of Experimental Physics, Faculty of Physics, University of Warsaw, ul. Pasteura 5, Warsaw; Center for Quantum Nanoscience, Institute for Basic Science, Seoul, Poland*
We present an objective-free approach to momentum-space imaging based on 3D-printed ellipsoidal microlenses integrated directly on semiconductor microcavities. Such microlens provides high numerical aperture (up to NA ≈ 0.95), enabling wide-angle collection and multiplexed, parallel mapping of dispersion relations from multiple spatial locations without a conventional microscope objective. The microlenses also enhance optical excitation, reducing the polariton condensation threshold by nearly an order of magnitude. This compact, cryo-compatible platform establishes a scalable route toward integrated and multiplexed momentum-space photonics.

14:45 - 15:00 **Hyperbolic Grating: Efficient Far-field Coupler for Hyperbolic Polaritons**
Emroz Khan, Mingze He, Lin Jing, Enrico M. Renzi, Andrea Alù — *The City University of New York, USA*

We present the hyperbolic analog of a bullseye grating that allows simultaneous far-field coupling of all polaritonic states with in-plane hyperbolicity, leading to high coupling efficiency with strong spectral and angular selectivity.

15:00 - 15:15 **Frozen Surface Modes and Lateral Optical Force Enhancement on Moving Interfaces**
Stéphane Azar, Joe Bhaseen, Anatoly Zayats, Francisco Rodríguez-Fortuño — *King's College London, United Kingdom*
We revisited light–matter interactions under relative motion, focusing on group-velocity matching between an emitter and electromagnetic modes supported by a medium. This condition gives rise to frozen modes - wavepackets stationary in the emitter frame - resulting in dramatic enhancements of the local density of optical states, and optomechanical forces.

15:15 - 15:30 **Adiabatic Pulse Reversal In Spatially Symmetric Plasmonic Waveguides**
Luca Stefanini[1], Jacob Khurgin[2], Andrea Alù[1] — *[1] CUNY-Advanced Science Research Center, USA [2] John Hopkins University, USA*
In this contribution, we explore an adiabatic process mimicking time-reflection. Traditionally, generating strong time reflections required nearly instantaneous, high-amplitude modulations that are technically difficult to sustain. We propose a more practical alternative by demonstrating that efficient pulse reversal can be achieved through the moderate, adiabatic modulation of a plasmonic waveguide. By utilizing a plasmonic waveguide with tunable carrier concentrations, we show that a relatively slow adjustment of the plasma frequency facilitates temporal reflections driven by the reversal of group velocity rather than phase velocity. Although this specific regime does not time-reverse interference phenomena, we demonstrate that it successfully inverts the pulse's temporal evolution and dispersion. Our theory further clarifies the impact of broken spatial symmetries on momentum evolution, providing a theoretical foundation for implementing exotic temporal scattering processes. Ultimately, by shifting toward adiabatic modulation, we enable sophisticated wave control within realistic optical frameworks, bypassing the stringent requirements of ultrafast material shifts.

14:00 - 15:30 Oral Sessions (Thursday Afternoon)
C201

Fabrication and Experimental Characterization of Metastructures II

Chairperson(s): Lukas Jelinek, Juejun Hu

14:00 - 14:30 **Metasurfaces for Telecommunications and Infrared Technology.** (Invited talk)
Otto Muskens — *University of Southampton, United Kingdom*
I will present our latest progress on how we experimentally achieve new metasurface platforms for free-space and integrated photonics applications. Work includes the development of metaoptics using wafer-scale deep-UV fabrication on silicon and glass substrates, and programmable integrated circuits using complex metasurfaces using laser-written phase change material.

14:30 - 15:00 **Wafer-Scale Conformal Metasurfaces** (Invited talk)
Juejun Hu — *MIT, USA*
Conformal metasurfaces enable enhanced aberration control and wide field-of-view imaging but remain constrained by limited scalability and alignment precision in existing fabrication approaches. We present a wafer-scale thermoforming strategy that reshapes metasurface-embedded thermoplastic substrates into highly curved geometries with micron-level alignment accuracy on large-area platforms. A predictive thermorheological finite element model incorporating measured viscoelastic properties guides deformation-aware design, allowing pre-compensation of strain-induced phase errors and recovery of near-diffraction-limited performance. We demonstrate freestanding curved metalenses, conformal refractive–metasurface hybrid optics, and a wide field-of-view metalens compound eye. This work establishes thermoforming as a scalable and industrially compatible route to high-performance conformal photonic systems.

15:00 - 15:15 **High-Index Crystalline TiO_2 Metalenses Fabricated by Sol–Gel Nanoimprint Lithography**
Hyeonseong Yun — *Korea University, Korea (South)*
Wafer-scale sol–gel nanoimprint lithography enables phase-controlled TiO_2 metasurfaces (amorphous, anatase, and rutile) for high-efficiency, high-NA metalenses with diffraction-limited performance.

15:15 - 15:30 **Wafer-Scale Metalens Fabrication via Photolithography and Nanoimprint Lithography for Near-Infrared Applications**

Chanwoong Park, Seungyeon Lee, Minjeong Lee, Hyunsung Yoon, Heon Lee
— *Korea university, Korea (South)*
Metasurfaces manipulate light using subwavelength meta-atoms, enabling ultrathin optical components such as metalenses. However, conventional fabrication methods like EBL suffer from limited scalability and high cost. Here, we demonstrate two wafer-scale near-infrared metalenses fabricated by photolithography and nanoimprinting, achieving high-resolution imaging and presenting scalable, cost-effective pathways toward metalens mass production.

14:00 - 15:30 Oral Sessions (Thursday Afternoon)
C203

Advanced Antenna Architectures and Broadband Radiation Techniques

Chairperson(s): Stefano Vellucci, Ariel Epstein

14:00 - 14:30 **Combining Bode-Fano and Dispersive Tuning to Increase Antenna Bandwidth** (Invited talk)
Arthur Yaghjian — *Electromagnetics Research, USA*
It is shown that dispersive and Bode-Fano tuning can be combined to significantly increase the antenna bandwidth over that of dispersive tuning or Bode-Fano tuning alone. Although these techniques to increase bandwidth are applied in the present paper to electrically small antennas, they could equally well be applied to increase the bandwidths of the unit-cell inclusions (metamolecules) in metamaterials.

14:30 - 15:00 **Exploring Dielectric Strip Grating for Leaky Wave Antenna Applications** (Invited talk)
Nelson Castro[1], Francisco Pizarro[1], Eva Rajo-Iglesias[2] — *[1] Pontificia Universidad Católica de Valparaíso, Chile [2] Universidad Carlos III de Madrid, Spain*
This work presents an overview of the use of dielectric strip gratings for leaky-wave antenna (LWA) applications, including a comprehensive dispersion analysis of a grounded dielectric slab loaded with periodic dielectric strips. The study examines their potential for mode control and radiation pattern shaping, emphasizing the additional design flexibility enabled by dielectric corrugations, conformal surfaces, shaped strips and anisotropic materials. In particular, anisotropy is highlighted as a powerful parameter for dispersion engineering and enhanced polarization control. The presentation includes representative antenna design examples and a thorough characterization of the structure's dispersive behavior.

15:00 - 15:30 **Radial Line Slot Array: From the Local to the Non-Local Approach and Back.** (Invited talk)
Agnese Mazzinghi, Angelo Freni — *University of Florence, Italy*
The contribution aims to show the evolution in the design of Radial Line Slot Arrays, from the local approach, where the slot length and positions are found using a periodic model, to the non-local approach, where the slots are standalone radiating elements that realize a non-smooth aperture current distribution, and back to a local approach for the brand-new metasurface version of an RLSA. The advantages and drawbacks of the different approaches will be highlighted.

12:30 - 14:00 Poster Session I (Monday)
C198
Chairperson(s): Federico De Luca; Pegah Azizi

1 **Parametric Evaluation of Electrostrictive Regimes in Binary Metamaterials**

Cumali Sabah[1], O. Khakpour[2], R. Rahighi[3], L. Wang[4], F. Rahaman[5], Muharrem Karaaslan[2] — *[1] Middle East Technical University - Northern Cyprus Campus, Türkiye [2] Iskenderun Technical University, Türkiye [3] Bilkent University, Türkiye [4] Reykjavik University, Iceland [5] California State University, USA*

By presenting a comprehensive interaction atlas of 10 prominent optical materials across 90 binary combinations, for the first time we categorize the resulting physical responses into three distinct regimes: Enhancement, Mixing, and Depression. Our results, derived from the Maxwell-Garnett effective medium theory incorporating dispersive corrections, provide a detailed discussion on the influential parameters governing the enhancement, mixing, and reduction of electrostriction. These findings offer a transformative approach to tailoring optoacoustic interactions for high-performance Brillouin lasers and advanced signal processing devices.

2 **Wideband and Wide-Angle Impedance Matching: A Biaxial Metamaterial Approach for Circularly Polarized Antennas**

Dongha Yang, Douglas Werner — *Pennsylvania State University, USA*

We present an interleaved patch-rod structure that creates a low-loss, nearly dispersionless biaxial metamaterial for wide-angle impedance matching (WAIM) in circularly polarized (CP) antenna arrays. By optimizing the multilayer biaxial tensors and the superstrate height, we achieve a remarkable wideband and wide-angle performance for both axial ratio and active S-parameter. The design maintains the axial ratio below 3 dB and the active S-parameter below -10 dB over a wide frequency and angular range, making it ideal for high-performance circularly polarized phased array antenna applications.

3 **Thermo-Mechanical Investigation of Multi-Layer Metamaterial Composites for LEO Satellite Applications**

Garam Kim[1], Byeongjin Park[2], Sangkil Kim[3], Mikyung Lim[4], Yunho Kim[4], Horim Lee[2], Eduardo Barocio[1] — *[1] Assistant Professor, USA [2] Senior Researcher, South Korea [3] Professor, South Korea [4] Assistant Professor, South Korea*

This study investigates the thermo-mechanical behavior of a thin multilayer metamaterial composite for Low Earth Orbit (LEO) satellite applications using finite element analysis. Severe orbital thermal cycling induces deforma-

tion and stresses due to coefficient of thermal expansion (CTE) mismatch between layers. Results show that increased adhesive compliance and bond-line thickness, particularly using a compliant silicone adhesive, significantly reduce interfacial stresses and delamination risk.

4 **A General Framework for Entire-Domain Basis Function Construction in Metasurface Method-of-Moments Analysis**
Federico Giusti, Stefano Maci, Enrica Martini — *University of Siena, Italy*
This paper presents a systematic methodology for synthesizing a compact set of entire-domain basis functions for the analysis of dense metasurfaces (MTSs) within the Method of Moments (MoM) framework. The compact set is extracted via singular value decomposition (SVD) of a data matrix constructed from periodic MoM solutions obtained with Rao–Wilton–Glisson (RWG) basis functions, sampled over frequency and wavevector directions along the dispersion curves. The dominant singular vectors define an optimal set of entire-domain basis functions that preserve edge singularities and accurately reproduce the electromagnetic behavior of the element. These functions represent optimal linear combinations of RWG functions and naturally match the physical degrees of freedom of the structure, reducing the MoM unknowns to only a few per element while maintaining accuracy. Once pre-computed for a reference geometry, the basis functions can be analytically rotated and scaled through spectral-domain transformations, enabling their direct reuse for geometrically transformed elements without repeated full-wave analyses. The method is validated on a two-dimensional array of double-anchor patches printed on a grounded dielectric substrate. The computed dispersion curves are validated against CST Eigenmode Solver results showing excellent agreement.

5 **Regularized Adjoint Inverse Design for High-Fidelity 2D Homogeneous Metasurface Illumination**
Yushi Zhou, Yang Zhao — *University of Illinois Urbana-Champaign (UIUC), USA*
We present an adjoint-based inverse design framework for generating high-fidelity, uniform 2D flat-top beams using TiO_2 metasurfaces. Utilizing variance-based regularization and a Max-Min optimization strategy, our approach suppresses intensity hotspots and enables simultaneous dual-wavelength (700 nm and 759 nm) beam shaping.

6 **Experimental Verification of Broadband-Electromagnetic-Metamaterial Camouflage**
Yongjune Kim — *The University of Suwon, Korea (South)*
A broadband-electromagnetic-metamaterial camouflage is experimentally verified, which can conceal a triangular object on a scattering surface. The proposed camouflage consists of triple or single layer drilled hole acrylic

metamaterials that are matched with isotropic refractive indices designed by transformation electromagnetics. From measurements of the magnitudes of backward scattering ratios, $|mS11|$, it is confirmed that the differences between the scatterings from the triangular-background surface and those from the triangular-target object of which the height is higher than that of the surface are reduced more than 10 dB in the frequency ranges from 8.34 to 9.66 GHz of which the fractional bandwidth is 14.67% and from 8.53 to 9.5 GHz of which the fractional bandwidth is 10.76% for the transverse electric and the transverse magnetic polarizations, respectively, after applying the fabricated-metamaterial camouflage on the target object.

7 **Experimental Demonstration of Collective Dispersive Behavior in a 3D Copper/PTFE Periodic Bulk Medium at X-Band**

Jose Everardo Juliao Fereira[1], Marcelo B. Perotoni B. Perotoni[2], Sebastien R. M. J. Rondineau3 R. M. J. Rondineau[3], Valéria C. M. N. Leite[4], Hiterson De O. Silva[3] — *[1] IEEE and Optica, Brazil [2] Universidade Federal do ABC - UFABC, Brasil [3] Universidade de Brasília - UnB, Brasil [4] Instituto Tecnologico de Aeronautica - ITA, Brasil*

This paper presents an experimental characterization of a three-dimensional periodic bulk structure in the X-band. Numerical simulations reveal a polarization-dependent response consistent with excitation of a longitudinal plasma mode and free-space measurements confirms this result for horizontal polarization. The first Bragg condition occurs above the measured band, supporting the effective medium approximation. The observed behavior is consistent with an epsilon-negative regime near the artificial plasma frequency.

8 **Dielectric Materials for Metasurface**

Minjeong Lee — *Korea University,Seoul,Republic of Korea, Korea (South)*

Scalable fabrication of dielectric metaholograms requires materials that combine a high refractive index with compatibility for large-area nanofabrication. Although polymer-based or polymer-embedded materials enable scalable fabrication processes, their relatively low refractive indices limit the optical performance of dielectric meta-atoms. In this work, we present sol–gel-derived crystalline TiO_2 as a high-index dielectric material platform for scalable dielectric metaholograms. The sol–gel process enables the formation of nanostructured meta-atoms through the transition from a liquid sol to a solid gel, which can be patterned using nanoimprint lithography. Subsequent thermal calcination induces crystallization of TiO_2 into the anatase phase, leading to a significant increase in refractive index while maintaining a small grain size that minimizes optical scattering. To investigate the structural evolution of the material, sol state TiO_2 films were thermally treated in the temperature range

of 200–600 °C. Structural characterization confirms that crystalline anatase TiO_2 forms at temperatures above 500 °C, corresponding to the transformation from a hydroxylated or hydrated precursor into a crystalline TiO_2. The resulting crystalline TiO_2 exhibits improved optical properties suitable for dielectric meta-atoms and enables the fabrication of high-resolution dielectric metaholograms. These results demonstrate that sol–gel derived crystalline TiO_2 provides a promising material platform for scalable dielectric metasurface devices.

9 **Sb_2S_3 Novel Reconfigurable Filter Architecture Using Semi-Circular Periodic Grating Structures**
Israel Alves Oliveira, Vitaly Felix Rodriguez Esquerre — *Federal University of Bahia, Brazil*
We present a reconfigurable near-infrared optical filter based on a semi-circular periodic silicon grating integrated with phase-change Sb_2S_3. Finite element simulations under TE and TM polarizations demonstrate polarization-dependent transmission and phase-induced spectral shifts, enabling tunable resonance control, compact CMOS compatibility, and promising applications in photonics and infrared sensing.

10 **Tunable Circular Cavity Shaped Electro-Optical Plasmonic Filter**
Adriano Dos Santos Reis[1], Vitaly Felix Rodriguez Esquerre[2] — *[1] Federal University of Bahia and Unime, Brazil [2] Federal University of Bahia, Brazil*
A tunable plasmonic filter, operating in the infrared, based on a metal–insulator–metal (MIM) waveguide laterally coupled to a circular ring resonator filled with an electro-optic material is proposed and numerically investigated. The inner radius of the ring is varied, and electrical tuning is achieved by modifying the refractive index of the electro-optic region under applied voltages of 0–2V.

11 **Harnessing Rigid-Compressible Synergy: A Sea Urchin-Inspired Strategy for Stable Progressive Folding**
Feng-Ling Bao[1], Xiao-Yi Zhou[2] — *[1] Southeast University, China [2] Southeast University, Chian*
Hierarchical auxetic metamaterials often suffer from deformation incompatibility when combined with conventional cores, resulting in unstable buckling and irregular collapse. Inspired by the protective architecture of sea urchins, we propose a multilayer auxetic metamaterial integrating a re-entrant negative Poisson's ratio lattice, a thin-walled tube, and a compressible foam core. The design preserves inward auxetic contraction while enabling coordinated volumetric compaction. Experiments and simulations reveal a transition from localized hinge-controlled folding to stable progressive collapse and distributed densification. The multilayer topology suppresses catastrophic

localization and stabilizes deformation symmetry. The study demonstrates that deformation stability in hierarchical auxetic systems can be achieved through geometric compatibility rather than rigid confinement.

12 **Waveguide Validation of a Low-Cost Dual-Polarized 12-12.5 GHz Reconfigurable Unit Cell with Continuous Phase Control**

Ryan Montoya, Cody Scarborough, Alan Brannon — *University of Colorado Boulder, USA*

The electromagnetic response of a reconfigurable 12-12.5 GHz unit cell design is validated using a test coupon and a custom WR90 waveguide test fixture. The dual-polarized unit cell design uses two low-cost Skyworks SMV2202 varactors and demonstrates up to 180 degrees phase control with low loss.

13 **Observation of Fano Resonance in Self-Assembled Copper Nanoparticles-Blue phase liquid crystal Hybrid Metamaterial**

Vimala Sridurai, Ingo Dierking — *The University of Manchester, UK, United Kingdom*

We report the experimental observation of Fano resonance in a hybrid system of Copper nanoparticles embedded in a 3D Blue Phase Liquid Crystal scaffold. Using hyperspectral imaging, we demonstrate tunable resonant coupling between plasmonic scattering and Bragg reflection. This study provides a pathway for self-assembled and reconfigurable optical metamaterials.

14 **Electro-Optically Tunable Photonic Integrated Meta Circuit For Ultrafast And Precise Waveform Shaping**

Gregorio Beltramo[1], Hamed Nikbakht[2], Robert Horvath[2], Bob Van Somere[2], Femius Koenderink[3], Imran Akca[1] — *[1] Vrije Universiteit Amsterdam, Netherlands [2] Rapid Photonics B.V., Netherlands [3] AMOLF, Netherlands*

Emerging photonic applications, ranging from optical computing and LiDAR to adaptive microscopy and dynamic holography increasingly demand high-speed, high-resolution wavefront control. In this field, metasurfaces have emerged as compact, scalable alternatives, enabling nanoscale control of light's phase, amplitude, and polarization; however, these structures are typically static or only slowly tunable. In this work, we propose an alternative approach merging the fields of metasurfaces with the photonic integrated circuits realized on lithium niobate with an etch-free fabrication approach. In the photonic circuit, the infrared laser light is manipulated in amplitude and phase, at GHz speed, by electro-optic modulators and it is then coupled into free space by the metasurface with precise phase, amplitude, and polarization control. Our device will enable high-speed reconfiguration of complex wavefront while keeping a small, sub-cm², footprint.

15 **Experimental Parallel Plate Test Bench For Grid Oscillator Characterization**

Arunima Singh, Cody Scarborough — *UNIVERSITY OF COLORADO BOULDER, USA*

This paper presents the design and experimental validation of a measurement test bench to characterize the large-signal behavior of finite grid oscillator (GO) arrays. The proposed setup uses a parallel-plate waveguide (PPW) with flared transitions to emulate ideal infinite-array boundary conditions, enforcing perfect electric (PEC) and equivalent perfect magnetic (PMC) boundaries. A one-dimensional rectangular GO array of 13 active E-PHEMT SAV-551 unit cells with sub-wavelength spacing (λ / 15 at 2 GHz) is investigated. The impedance characteristics of each active element are compared with the ideal infinite-array case using a root mean square error (RMSE) metric, which justifies the truncation of the array. The effect of edge padding and termination impedance is investigated. A reflector is placed within the PPW environment 7 cm away from the 1D GO. This enables injection locking and produces a stable oscillation at 2 GHz, as validated through both simulation and measurement.

16 **Nonlinear Transient Robustness of Detuned Helmholtz Resonator Chains**

Filippo Tosato[1], Benoit G. Marinus[1], Kristof Harri[1], Francis Moiny[2] — *[1] Royal military Academy, Belgium [2] UMONS, Belgium*

We study the nonlinear transient response of detuned Helmholtz resonator chains subjected to impulsive excitation. Results demonstrate amplitude-dependent robustness mechanisms that challenge linear predictions, offering new perspectives on wave–metamaterial interaction and the engineering of structured media for extreme transient wave control.

17 **Efficient Adjoint Based Optimization of a Finite, Inhomogenous, Lumped, Nonlinear Transmission Line with Arbitrary Topology**

Cody Oberbeck, Cody Scarborough — *University of Colorado, Boulder, USA*

The submitted work presents an efficient method for optimizing dispersive nonlinear transmission lines (NLTLs) for pulse synthesis with applications in radar, frequency comb generation, sampling, etc. The method identifies an adjoint system associated with a linearized model of the line to efficiently compute the gradient of all parameters which describe the NLTL by solving two problems per iteration. The first step is to solve the nonlinear problem for a given set of parameters, while the second is to calculate a so-called adjoint solution which enables the rapid computation of the gradient. The accuracy of the proposed method as well as the optimization of a representative, varactor-loaded ladder network is reported

12:30 - 14:00 Poster Session II (Tuesday)
C198
Chairperson(s): Debapriya Pal; Lin Jing

1 **Bijective Generation of Second-Harmonic Higher-Order Poincaré Spheres**
Xiaoxue Wang, Guangwei Hu — *Nanyang Technological University, Singapore*
This work demonstrates a compact metasurface–WS_2 platform that generates higher-order Poincaré spheres of arbitrary order by exploiting the full degrees of freedom of photons. In addition, a bijective mapping from the standard to the higher-order Poincaré sphere is theoretically verified. These results enable applications in optical communications, quantum information, and imaging.

2 **Light-Driven Skyrmion Crystal Generation in Plasmonic Metasurfaces Through the Inverse Faraday Effect**
Mathieu Mivelle — *CNRS, Sorbonne université, INSP, France*
We generate a magnetic skyrmion lattice via the Inverse Faraday Effect on a hexagonal plasmonic metasurface. The transfer of spin angular momentum induces drift currents in gold nanodisks, creating stable magnetic textures. This ultrafast, all-optical method paves the way for new architectures in next-gen spintronics and high-density data storage.

3 **Coupled Mode Theory For Scattering From Acoustic Waveguides With Spatiotemporally Modulated Boundaries**
Blaine Gilbert[1], Benjamin Goldsberry[2], Michael Haberman[1] — *[1] The University of Texas at Austin, USA [2] The University of Texas at Austin, Applied Research Laboratories, USA*
Recent research in optical, electromagnetic, and acoustical metamaterials has shown that spatiotemporal modulation of bulk properties and of interfaces between material domains can be used for unprecedented control of wave propagation and scattering. Spatiotemporal modulation of bulk properties has been used to enable nonreciprocal wave propagation in unbounded systems and to couple modes at different frequencies in bounded systems through frequency and wavenumber conversion. This work employs a Fourier series expansion-based coupled mode approach to investigate coupling between guided wave modes in an acoustic waveguide with different frequency-wavenumber pairs using spatiotemporal modulation of a single boundary. Results demonstrate the ability to couple incident plane waves to non-radiating (trapped) modes and to generate radiation from incident evanescent fields.

4 **Wave Scattering Theory for Dispersive Space–Time Interfaces**
Alessandra Contestabile[1], Giuseppe Castaldi[2], Maria Antonietta Vincenti[3],

Michael Scalora[3], Marcello Ferrera[4], Vincenzo Galdi[2], Carlo Rizza[1] — *[1] University of L'Aquila, Italy [2] University of Sannio, Italy [3] Università degli Studi di Brescia, Italy [4] Heriot-Watt University SUPA Edinburgh, United Kingdom*

We study the scattering of waves at an interface whose properties vary in time, characterized by Drude-Lorentz dispersion with an abrupt change in its parameters. Our work uncovers an unusual mechanism in which novel frequency components are generated at the system's eigenfrequencies. A space–time interface enables several phenomena, including coupling between propagating and evanescent waves, as well as unexpected optical spin effects induced by phase conjugation.

5 **Shaping the Complex Envelope of Pulses with Paired Phase Shifters**

Nicholas Ventresca, Anthony Grbic — *University of Michigan, USA*

A pulse shaping system is reported that consists of two reconfigurable phase shifters separated in space by a dispersive medium. Each phase shifter acts as a reflectionless, time-varying phase mask, imparting an aperiodic phase delay onto an incident pulse. The system can redistribute the temporal spectrum in transmission to form arbitrary complex envelopes (amplitude and phase). The required time-dependent transmission phase through each mask is determined using a modified Gerchberg-Saxton phase retrieval algorithm. A design example is presented in which an input pulse is both shaped and compressed in time. The results are verified using a commercial circuit solver.

6 **Matched Absorption of Electromagnetic Waves with Temporal Metamaterials under Passive Switching**

Suat Baris Iplikcioglu — *Koç University, Department of Electrical and Electronics Engineering, Turkey*

Building upon the recent re-evaluation of boundary conditions at temporal interfaces, this work demonstrates that temporal metamaterials with passive and periodically impedance-matched modulation absorb electromagnetic waves with minimal reflection, acting analogously to perfectly matched layers. An effective medium model of the effect is provided. Wave absorption is validated through Floquet expansion method and FDTD simulations.

7 **Simulation of Time- and Shape-Varying 3D Metamaterials Using the Finite Element Method**

Ruth Medeiros, Monica Ortega, Clara Iglesias-Tesouro, Valentin De La Rubia — *Universidad Politecnica de Madrid, Spain*

Over the last few years, there has been growing interest in using time- and shape-varying systems to explore new electromagnetic phenomena and develop innovative applications for communications systems. Accurate simulation of 3D electromagnetic structures with time-varying geometries or time-

modulated material properties is a critical point to address proper design of next generation metamaterial-based devices, even though these dynamical systems present unique challenges. This work introduces a full-wave 3D electromagnetic solver based on the finite element method (FEM), to analyze the electromagnetic response of time- and shape varying 3D metamaterials.

8 **A PTD-Symmetric Double Edge Line with a Simplified Feeding Scheme Compatible with Gap Waveguides**
Nelson Castro Salas[1], Enrica Martini[2], Stefano Maci[2], Eva Rajo-Iglesias[3] — *[1] Pontifica Universidad Católica de Valparaíso, Unversity Carlos III de Madrid, Chile [2] University of Siena, Italy [3] University Carlos III de Madrid, Spain*
We propose a novel PTD-symmetric waveguide configuration based on gap-waveguide technology that overcomes key limitations of existing designs while preserving robust propagation. The structure features two edge lines excited by a single feed and incorporates a matching network to ensure proper impedance matching. It is fully compatible with gap waveguides. The design of the metasurface and the required feeding transitions are detailed, along with a simple microwave branching network achieving a 27.5% relative bandwidth with low reflection.

9 **Chiral-Huygens Response in Knot-Particle Scatterers and Metasurfaces via Modal EFIE**
Nadav Goshen, Yarden Mazor — *Tel Aviv University, Israel*
We develop a modal EFIE framework that directly extracts polarizability tensors of toru-knot particles from geometry. The trefoil knot naturally satisfies the chiral-Huygens condition, with a single current harmonic driving both electric and magnetic dipoles. This topology-driven response enables near-optical chirality in metasurface configurations.

10 **Thermalization Beyond Pseudo-Hermiticity: Negative Temperature in General Nonlinear 2D Lattices**
Ahyeon Seo, Heedong Goh — *Seoul National University, Korea (South)*
We analytically establish thermalization in a broad class of interacting second-order oscillator lattices with weak damping and weak nonlinearity. Unlike pseudo-Hermitian frameworks that require a conserved quadratic metric, thermalization here emerges from a variational envelope structure combined with time-scale separation, phase averaging, and kinetic closure, leading to a Rayleigh–Jeans spectrum with an explicit effective temperature determined by mechanical parameters. Because the effective thermodynamic variables depend directly on tunable quantities such as damping, stiffness, and nonlinear coefficients, the present framework provides a general design principle for predicting and controlling collective phenomena in large-scale engineering oscillator networks.

11 **Ultra-Wideband Electromagnetic Metasurface Absorber Optimized by Genetic Algorithm**

Sangwon Baek, Wonnwoo Choi, Taein Choi, Hak Joo Lee, Kichul Kim — *Center for Advanced Meta-Materials, Korea (South)*

This paper presents an ultra-wideband electromagnetic metasurface absorber designed using genetic algorithm optimization. The absorber incorporates three metasurface layers between dielectric layers and glass fiber-reinforced plastic, backed by a perfect electric conductor reflector. The full-wave simulated result shows reflection losses below −10 dB with a fractional bandwidth of 170.4 % and a total thickness of 0.09 times a wavelength at the lowest frequency. This validates the broadband absorption characteristics, confirming the theoretical feasibility of the proposed design methodology.

12 **Space-Time-Coding Conformal Metasurface Antenna**

Shu-Lin Chen — *Academic, Australia*

The manipulation of electromagnetic (EM) waves has attracted increasing attention in recent years as modern wireless communication, sensing and imaging systems demand access to richer physical degrees of freedom for tailoring wave propagation. However, conventional metasurface antennas are usually constrained by their physical configurations and limited modulation mechanisms, which restrict the available degrees of freedom for wave manipulation. In this work, a space-time-coding (STC) conformal metasurface antenna is developed for reconfigurable control of EM waves from guided-wave propagation to free-space radiation.

13 **Toward Topologically Enhanced Polarization-Dependent Metamaterials Using One-Dimensional Photonic Topological Insulators**

Ufuk Kilic[1], Sema Guvenc Kilic[1], Raymond Simith[1], Natale Ianno[1], Christos Argyropoulos[2], Eva Schubert[1], Mathias Schubert[1] — *[1] University of Nebraska-Lincoln, USA [2] The Pennsylvania State University, USA*

The ability to manipulate polarization-dependent light–matter interactions is fundamental to modern photonic technologies, yet achieving strong and spectrally controllable optical responses remains challenging. Here, we investigate a one-dimensional all-dielectric photonic topological insulator (PTI) platform composed of alternating SiO_2-TiO_2 multilayer thin films for strengthening polarization-dependent light–matter interactions through spectrally engineered localized interface states. Through combined theoretical and experimental investigations, we establish the topological characteristics of the dielectric architecture and fabricate the PTI platform by using magnetron sputtering technique. The optical properties are characterized by generalized spectroscopic ellipsometry and correlated with finite-element electromagnetic simulations. In parallel, we present the fabrication and optical charac-

terization of three-dimensional all dielectric nanoboomerang metamaterials prepared by glancing angle deposition, demonstrating pronounced anisotropic and chiroptical optical behavior. Together, these results establish the foundation for future hybrid topological–metamaterial architectures, where localized interface states can be spectrally matched with resonant modes to enhance birefringence, dichroism, optical activity, and other polarization-dependent light–matter interactions.

14 **Vertical Quantization and Band Reindexing in Babinet-Complementary Hexagonal Patch Ring Bilayers**
Arghyadeep Pal, Ravikanth Thanikonda, Stefano Maci — *University of Siena, Italy*
We study how switching the vertical boundaries between electric-wall (PEC/PEC) and magnetic-wall (PMC/PMC) conditions enforces vertical mode quantization and parity selection, which reorders and reindexes Bloch bands in Babinet-complementary hexagonal patch–ring bilayers. We also develop a minimal vertical-quantization model that predicts this band reordering and provides practical guidelines for comparing complementary layers and designing bilayers with controlled Dirac-cone placement and hybridization

15 **Quasi-BIC Metasurfaces for Ultrafast and Reconfigurable Optical Image Processing**
Angela Barreda[1], Shuo Wang[2], Chengjun Zou[2] — *[1] University Carlos III of Madrid, Spain [2] Institute of Microelectronics, Chinese Academy of Sciences, China*
This work presents tunable silicon metasurfaces based on quasi-bound states in the continuum for ultrafast and energy-efficient analog optical image processing. Femtosecond laser pumping enables rapid switching between edge-detection and bright-field imaging functionalities, offering a promising approach for integrated optoelectronic image-processing systems.

12:30 - 14:00 Poster Session III (Wednesday)
C198
Chairperson(s): Michele Guizzardi; Akshaj Arora

1 **Edge-State Optical Switching in Conductive Perovskite Oxide Platforms**
Viktoriia Babicheva[1], Heungsoo Kim[2], Evgeniya Lock[2] — *[1] University of New Mexico, USA [2] Naval Research Laboratory, USA*
We propose an ultrafast optical modulator with lanthanum-doped barium stannate La-BaSnO3, where carrier-induced nonlinear response and tailored photonic band topology enable stable edge-state propagation. This approach provides defect-tolerant light manipulation within the perovskite transparent conductive oxide platforms, offering a promising route toward integrated and resilient nanophotonic devices.

2 **Quantum Dynamics of Multiple Quantum Emitters in Dispersive Electromagnetic Environments Out of Equilibrium**
Carlo Forestiere, Loris Maria Cangemi, Giovanni Miano — *University of Naples, Italy*
The control of interactions among quantum emitters using nanophotonic structures offers significant opportunities for quantum technologies. Here, we introduce an approach based on a modified Langevin noise formalism that enables the description of the quantum dynamics of multiple quantum emitters coupled to complex, dispersive dielectric objects.

3 **Spin-based Microwave Amplitude Demodulation Using Nitrogen-Vacancy Centers**
Henrique Wehrmann De Souza Moscoso[1], Kelvin Evangelista Neiva[2], João Victor Vieira Faria[2], Leonardo Rodrigues Ramos[2], Bruno Cepeda Henriques[3], Vinicius Marrara Pepino[3], Ben-Hur Viana Borges[3], Achiles Fontana Da Mota[2] — *[1] University of Brasília, Brazil [2] University of Brasília, Brazil [3] University of São Paulo, Brazil*
We numerically demodulate an amplified microwave signal using the spin-dependent fluorescence of NV− centers in diamond with on–off keying (OOK) encoding. A Lindblad master-equation model coupled to a two-mode Jaynes–Cummings cavity resonant with the 637 nm ZPL shows Purcell-enhanced emission shortens rise time, boosting the maximum bit rate from 7.73 to 96.15 Mbps.

4 **Dynamic Quantum Radiation Shaping with Time-Modulated Nanoantenna Arrays**
Achiles Da Mota[1], Mohammad Mojtaba Sadafi[2], Hossein Mosallaei[2] — *[1] University of Brasilia, Brazil [2] Northeastern University, USA*

We present a quantum electrodynamics approach to controlling spontaneous emission using time-modulated nanoantenna arrays. Combining a Floquet-harmonic Maxwell solver with Lindblad open-quantum dynamics, we study a barium-titanate (BTO) metal–insulator–metal nanoantenna platform coupled to a nitrogen vacancy center. Temporal modulation enables selective redistribution of emission among Floquet harmonics, yielding Purcell enhancements exceeding 5000. Using a 21-element array, radiation emission is directed to the +1 harmonic, achieving 88% coupling and 70% external quantum efficiency, along with directional beam steering.

5 **Controlling Quantum Radiation via Resonant Confinement with Collective Multipolar Nanoantennas**
Julien Werzowa, Li Liu, Viktoriia Babicheva — *University of New Mexico, USA*
We investigate the interaction between quantum emitters and multipolar antennas to explore light–matter dynamics at the nanoscale. Upon the weak-coupling regime, emission enhancement is quantified via the Purcell effect, strong coupling is investigated through emitter–nanoantenna interactions, and entanglement is evaluated using negativity, thereby demonstrating controllable radiation and potential for integrated quantum photonic applications.

6 **Metapinhole: Abrupt Angular Filtering with Metagratings**
Mahmoud A. A. Abouelatta, Karim Achouri — *EPFL, Switzerland*
Traditional 4f systems are indispensable for Fourier optics but their bulk poses a barrier to on-chip integration. We present a metapinhole architecture using metagratings to replicate angular filtering within a sub-wavelength footprint, reducing device volume by five orders of magnitude. By engineering two-dimensional dipolar resonances and Rayleigh anomalies, we realize high-efficiency transmissive low-pass, high-pass, and reflective band-pass filtering. This alignment-insensitive, lens-free platform could enable robust optical signal processing across the infrared, terahertz, and X-ray regimes.

7 **Analysis of Stacked Intelligent Metasurface Assisted MIMO Communication Systems using Electromagnetic-compliant Models**
Insang Yoo — *Yonsei University, Korea (South)*
We present an analysis of multi-user uplink MIMO communication systems employing stacked intelligent metasurfaces (SIM) as the transceiver at a base station. The SIM transceiver consists of cascaded metasurfaces, each with an array of subwavelength metamaterial elements that can be reconfigured individually. Conventional methods for analyzing SIM-MIMO systems rely on simplified electromagnetic models of metasurfaces to enable tractable system-level performance evaluations; however, such models lack the ability to accurately capture the electromagnetic responses of metasurfaces, potentially leading to inaccuracies in performance metrics. To address this limitation, we

propose a systematic analysis framework for SIM-MIMO systems using a coupled dipole model of the SIM transceiver. Numerical simulations demonstrate the importance of incorporating electromagnetic-compliant characterization of metasurfaces in analyzing the system-level performance of SIM-MIMO systems.

8 **Frequency-Selective Hybrid Metacomposites for Thermally Stable EM Absorption in Space Applications**

Byeongjin Park[1], Sangkil Kim[2], Mikyung Lim[3], Yunho Kim[4], Garam Kim[5], Horim Kim[1] — *[1] Korea Institute of Materials Science, Korea (South) [2] Pusan National Univeristy, Korea (South) [3] Chung-Ang Univeristy, Korea (South) [4] Seoul National University, Korea (South) [5] Purdue University, USA*

This study proposes a hybrid metacomposite enabling simultaneous electromagnetic absorption and thermal radiation control. A magnetic composite layer provides impedance-matched microwave absorption, while a high-emissivity radiative layer enhances infrared emission within the atmospheric window. Preliminary electromagnetic and thermal characterizations demonstrate functional feasibility, and integrated multifunctional validation is currently underway.

9 **RF-Transparent Thermal Metamaterials for Thermal Regulation of LEO Communication Platforms**

Mikyung Lim[1], Suwan Jeon[2], Byeongjin Park[3], Sangkil Kim[4], Yunho Kim[5], Garam Kim[6] — *[1] Chung-Ang University, Korea (South) [2] Korea Institute of Machinery and Materials, Korea (South) [3] Korea Institute of Materials Science, Korea (South) [4] Pusan National University, Korea (South) [5] Seoul National University, Korea (South) [6] Purdue University, USA*

In Low Earth Orbit (LEO), satellites exchange heat exclusively through radiation, requiring wavelength-selective control of solar absorption and infrared emission to maintain thermal stability. Conventional radiative coatings rely on metallic layers that inherently reflect microwave signals, limiting their direct integration with communication antennas. Here, we present an RF-transparent thermal metamaterial that enables simultaneous solar reflectance, mid-infrared emission, and microwave transmission within a single platform. By combining a spectrally selective metal–dielectric architecture with subwavelength slit patterning, the proposed structure achieves independent thermal and RF functionality. This multifunctional design provides a scalable pathway toward thermally robust metamaterial coatings for next-generation spaceborne communication systems.

10 **Spatial Kramers–Kronig Metamaterial Based on Tuned Plasmonic Nanorod Arrays for Perfect Optical Absorption**

András Szenes, Dávid Vass, Balázs Bánhelyi, Maria Csete — *University of*

Szeged, Hungary
Plasmonic metamaterial realization of a spatial Kramers–Kronig (KK) permittivity profile enabling near-perfect optical absorption was demonstrated. By tuning the major axis length of gold nanorods during numerical optimizations appropriately, the effective permittivity exhibits spatial Lorentzian dispersion and approximates a spatial KK-consistent distribution. The optimized multilayer achieves near-unity absorptance around 800 nm over a broad band. Time-domain simulations with 12 fs pulses confirm strong broadband absorption.

11 **Metamaterial-Assisted Log-Periodic Toothed Antenna on Flexible Substrate for Broadband Applications**

Md Abdur Rashid[1], Yihong Maggie Chen[2] — *[1] Texas State University, USA [2] Texas State University, United States*

A log-periodic toothed antenna with localized metamaterial loading is presented. Implemented on Kapton, two symmetric rectangular copper cells are placed near the tapered balun backside. This loading alters near fields, reducing VSWR and extending −10 dB S_{11} bandwidth, while preserving low profile, flexibility, and suitability for wearable systems.

12 **High Power Ka-Band Locally Resonant Metamaterials Waveguide Filter for Space Application**

Karim Kouny, Zhechen Zhang, Amir Jafargholi, Romain Fleury — *Laboratory of Wave Engineering Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland*

This work presents the high-power behaviour of a fourth-order Ka-band bandpass (wideband) filter based on a locally resonant metamaterial (LRM) waveguide. The structure is a rectangular waveguide periodically loaded with metallic pins (resonators), operating below the cutoff frequency of the empty guide and supporting a TE_{10}-like hybrid mode. A relative bandwidth of about 22 %, for an operating frequency f_0 = 27.5 GHz, is obtained around Ka band with a four-pole response, and the power-handling (PH) capability is evaluated at the center frequency f_0 and at the lower and upper group-delay frequencies peaks fTPG1 and fTPG2 . Using SPARK3D simulations with European Cooperation for Space Standardization (ECSS)- compliant total electron emission yield models for gold, silver, copper, and aluminum, we show that, in this under-cutoff LRM regime, the MP thresholds follow PMP(fTPG1) < PMP(f0) < PMP(fTPG2), in contrast with the behaviour usually expected in conventional filters. The MP avalanche region is also identified and discussed. The results provide new insight into the interplay between dispersion, stored energy, and MP in subwavelength meta-waveguide filters, and highlight the potential of LRM topologies for high-power Ka-band front ends. Experimental results will be presented during

the conference.

13 **Degradation of Bisphenol-A_DETDA Epoxy Under Vacuum and Proton Radiation in a Simulated LEO Environmen**

Jinhyeok Seok[1], Byeongjin Park[2], Horim Lee[2], Sangkil Kim[3], Mikyung Lim[4], Garam Kim[5], Eduardo Barocio[6], Yunho Kim[1] — *[1] Seoul National University, Korea (South) [2] Korea Institute of Materials Science, Korea (South) [3] Pusan National University, Korea (South) [4] Chung-Ang University, Korea (South) [5] Purdue University, Korea (South) [6] Purdue University, United States*

Epoxy-based polymers are widely used in space structures due to their mechanical reliability and processing versatility. Under low Earth orbit (LEO) conditions, these materials are simultaneously exposed to high vacuum and ionizing radiation, which may alter their long- term performance. In this study, bisphenol-A epoxy(YD-128) cured with DETDA was experimentally evaluated under simulated LEO conditions combining ASTM E595-compliant high-vacuum exposure and proton irradiation. Vacuum testing performed at pressures down to 5×10^{-5} Torr revealed a systematic increase in total mass loss with increasing surface-to-volume ratio, reaching a variation of approximately 0.35% across the tested range. Proton irradiation at 20 MeV produced fluence-dependent discoloration, indicating radiation-induced modification of the material. The results demonstrate that geometric parameters and charged-particle exposure influence the environmental stability of epoxy polymers in LEO-relevant environments.

14 **A Simplified 2-Bit Energy-Efficient Reconfigurable Intelligent Surface Architecture**

Muhammad Rizwan Akram, Douglas H. Werner — *The Pennsylvania State University, USA*

Electronically reconfigurable intelligent surfaces (RIS) offer a power-efficient solution for enhancing coverage, reducing latency, and enabling programmable propagation in emerging 6G wireless systems. This work presents a compact RIS unit-cell operating under circular polarization, formed by integrating four PIN diodes within a circular slot to realize a complementary split-ring resonator. The design achieves high reflection efficiency over 4.42–5.06 GHz (13.5% bandwidth) while providing 2-bit discrete phase control through diode state switching. The proposed approach enables low-loss, wideband, and fast reconfigurable beamforming suitable for scalable RIS deployments.

15 **Elimination of Alignment and Manufacturing Tolerances Using an Antisymmetric Metamaterial Approach**

Michael Töfferl — *University of Technology Graz, Austria*

In this work we propose an antisymmetric dual-layer metamaterial approach for mmWaves to compensate for material thickness variations which have a

parasitic influence on an in-plane shift-based sensor effect. We propose an antisymmetric alignment of broadside-coupled split ring resonators that compensates variations caused by manufacturing tolerances.

12:30 - 14:00 Poster Session IV (Thursday)
C198
Chairperson(s): Federico De Luca; Pegah Azizi

1 **Novel Sensing Technique for Non-destructive Composites Monitoring at microwaves**

Valentina Zhukova[1], Paula Corte-León[2], Aleksandra Allue[3], Koldo Gondra[3], Mihail Ipatov[4], Juan Maria Blanco[5], Julian Gonzalez[6], Arcady Zhukov[7] — *[1] Dept. Polym. and Adv. Mater., University of the Basque Country, EHU, 20018 San Sebastian, Spain, Spain [2] Dept. Mater. Science & Metallurgy, Univ. Cambridge, Cambridge CB3 0FS, UK [3] Gaiker Technological Centre, 48170, Zamudio,, Spain [4] General Magnetic Measurement Service of Advanced Research Facilities (SGIker), University of the Basque Country, EHU, Planta -1, Avda. Tolosa 72, 20018 Donostia-San Sebastián,, Spain [5] Dept. Appl. Phys., University of the Basque Country, EIG, EHU, 20018 San Sebastian, Spain [6] Dept. Polym. and Adv. Mater., University of the Basque Country, EHU, 20018 San Sebastian,, Spain [7] Dept. Appl. Phys., University of the Basque Country, EIG, EHU, and Ikerbasque, Spain*

We measured the transmission and reflection parameters of the composites containing magnetic microwire inclusions during the composite matrix polymerization. A remarkable change of the reflection and transmission in the range of 4-7 GHz upon the matrix polymerization is observed. The obtained results can be considered as a basis for a novel sensor technique for non-destructive and contactless monitoring of composites using ferromagnetic glass-coated microwires inclusions.

2 **Free Space Microwave Stress Monitoring Using Amorphous Glass-coated Co-rich Microwire**

Valenitna Zhukova[1], Mihail Ipatov[2], Arcady Zhukov[3] — *[1] Dept. Polym. and Adv. Mater., University of the Basque Country, EHU, 20018 San Sebastian,, Spain [2] General Magnetic Measurement Service of Advanced Research Facilities (SGIker), University of the Basque Country, EHU, Planta -1, Avda. Tolosa 72, 20018 Donostia-San Sebastián, Spain [3] Dept. Appl. Phys., University of the Basque Country, EIG, EHU, 20018 San Sebastian and Ikerbasque, Spain*

We provide our xperimental results on studies on effect of applied stress on Reflection coefficient (S_{22} parameter) of Co-rich glass-coated ferromagnetic amorphous microwire measured using free space microwave spectroscopy at 2.45 GHz. The experimentally observed stress dependence of the reflection coefficient allows for contactless stresses and damage monitoring of composites with such magnetic microwire inclusions

3 **Near-Field Engineering for Enhanced Sensitive Performance in Resonant**

Metasurfaces

Jose Antonio Álvarez-Sanchis, Rubén Prieto-Molina, Luis Manuel Máñez-Espina, Amadeu Griol, Teresa Mengual-Chulia, Ana Díaz-Rubio — *Universitat Politècnica de València, Spain*

We demonstrate a near-field engineering approach to enhance the sensitivity of resonant metasurfaces through selective mode excitation and controlled modal coupling that allows redistribution of the electromagnetic field toward regions of stronger analyte interaction. This strategy enables improved sensing performance in both high- and low-Q resonant structures without relying solely on bandwidth narrowing. Our results show both numerically and experimentally that modal engineering of the near field provides a robust pathway to optimize sensitivity.

4 **Modeling Floquet Dynamics In Parametrically Modulated Metamaterials**

Junda Wang, Romain Fleury — *École polytechnique fédérale de Lausanne, Switzerland*

A surge of publications on space-time modulated metamaterials has appeared in recent years. Although related theories and experiments have been developed, methodologies connecting idealized models with realistic implementations remain limited. In this paper, we present a systematic workflow for the design and modeling of RF metamaterials under relatively high-frequency modulation.

5 **Thermally Addressable Au/PDLC Multilayer metamaterial: A Platform for Tunable Epsilon-Near-Zero Response**

Vimala Sridurai[1], Geetha Nair[2] — *[1] The University of Manchester, UK, United Kingdom [2] Centre for Nano and Soft Matter Sciences, Bangalore, India*

We report a five- layer gold and polymer dispersed liquid crystal multilayer metamaterial exhibiting sub unity permittivity in the optical regime. Using spectroscopic ellipsometry and effective medium theory, we characterize this Epsilon near zero phenomenon. This architecture serves as a foundational platform for thermally switching the system towards hyperbolic dispersion.

6 **Inverse-Designed Metasurface Couplers for Optical-See-Through AR Waveguides**

Seunghyun Lee[1], Kyungmin Kim[2], Chanik Kang[3], Haejun Chung[1] — *[1] Department of Electronic Engineering, Hanyang University, Korea (South) [2] Department of AI Semiconductor Engineering, Hanyang University, Korea (South) [3] Department of Artificial Intelligence, Hanyang University, Korea (South)*

We present inverse-designed metasurface in- and out-couplers for optical see-through AR waveguides, optimized in the diffraction-order domain. The approach aligns RGB propagation, enables guided-power recycling, and

preserves zeroth-order transmission of external light, suppressing parasitic diffraction while maintaining high see-through image quality.

7 **Thermal Tuning of Hyperbolic Surface Waves on Non-hyperbolic Crystals**
Yihua Bai, Guangwei Hu — *Nanyang Technological University, Singapore*
We reveal hyperbolic surface phonon polaritons in non-hyperbolic YVO_4 crystals and show that in-plane dispersion can be thermally reconfigured by varying the temperature. By using cryo-SNOM, we directly visualized an in-situ dynamic control of topological transitions via modulation, expanding the operational spectral range and providing unprecedented control over polaritonic properties.

8 **Topology-Optimized, Inverse-Designed Silicon Nitride Coupler for Integrated Quantum Emitters**
Henna Farheen[1], Yuheng Chen[2], Peigang Chen[2], Samuel Peana[2], Alexander Senichev[2], Vladimir M. Shalaev[2], Alexandra Boltasseva[2], Jens Foerstner[1], Alexander V. Kildishev[2] — *[1] Paderborn University, Germany [2] Purdue University, USA*
We demonstrate a topology-optimized hybrid photonic–plasmonic coupler combining a gold nanodisk with an inverse-designed SiN coupler, achieving strong Purcell-enhancement and nearly 80% waveguide coupling efficiency, enabling scalable integration of classical and quantum light sources.

9 **Synthesized Dispersion-Engineered Elastic Metasurfaces for Ultrabroadband Achromatic Focusing and Confocal Energy Harvesting**
Geon Lee, Junsuk Rho — *Pohang University of Science and Technology, Korea (South)*
Dispersion-engineered elastic metasurface on an aluminum plate enables broadband achromatic focusing of antisymmetric flexural waves through continuous thickness grading and coupling correction, enhancing confocal piezoelectric energy harvesting.

10 **Design of Two-Dimensional Underwater Luneburg Lens with Circular Meta-atoms**
Sea-Moon Kim[1], Beomseok Oh[2], Junsuk Rho[2], Sung-Hoon Byun[1] — *[1] KRISO, Korea (South) [2] POSTECH, Korea (South)*
tThis paper investigates the design of a two-dimensional underwater Luneburg lens based on circular meta-atoms. To realize the required refractive index profile, the relationship between the radius of the circular cylinders and the phase delay was numerically derived. While the initial design utilized rigid cylinders, it was observed that using solid steel cylinders—commonly used for actual fabrication—resulted in degraded focusing performance due to the reduction in impedance mismatch. To address this, the phase delay relationship

was reevaluated considering the material properties of the solid cylinders. Numerical simulations verify that the modified design achieves significantly enhanced focusing performance compared to the initial solid model. here

11 **Metamaterial-based Solar Absorber and Selective Thermal Emitter for Solar Thermophotovoltaic Systems**

Senlu Zhou, Amir Jafargholi, Romain Fleury — *EPFL STI IEM LWE, Switzerland*

Efficient solar thermophotovoltaic (STPV) systems require photonic structures that can tailor both solar absorption and thermal emission spectra. In this work, we study two structures, a metal-insulator-metal (MIM) design and a multilayer architecture, for use as absorbers and emitters in STPV systems. The study mainly focuses on spectral reshaping for broadband absorption and selective thermal emission. Simulation results show that both designs can modify the spectrum effectively, although with different spectral features and tuning behavior. The MIM structure offers flexible control of resonant features, while the multilayer design provides another practical route for selective spectral tailoring. This work provides a basis for the design and fabrication of solar absorbers and emitters for STPV device.

12 **Flexible Metasurface-Enhanced Wireless Power Transfer for Biomedical Implant Applications**

Shaghayegh Roshanghiyas[1], Danilo Brizi[2], Gianluca Lazzi[1] — *[1] University of Southern California, USA [2] University of Pisa, Italy*

Reliable energy delivery remains a major challenge for implantable medical devices, particularly in applications requiring device miniaturization and long-term operation. Wireless power transfer (WPT) offers a promising alternative to battery-based solutions, but its performance is often limited by transmitter–receiver misalignment, separation distance, and strict size constraints on implanted components. In this work, we present a flexible metasurface-enhanced wireless power transfer system designed for biomedical implant applications. The proposed metasurface patch improves magnetic near-field coupling while maintaining mechanical flexibility. Experimental results demonstrate improved power transfer efficiency and robust performance under different curvature and separation conditions compared to a conventional two-coil configuration.

13 **Quantum Čerenkov Effect in Graphene Waveguides**

Michela Longhi[1], Davide Mencarelli[2], Alessandro Toscano[3], Luca Pierantoni[2] — *[1] Niccolò Cusano University, Italy [2] Marche Polytechnic University, Italy [3] Roma Tre University, Italy*

We present a rigorous electromagnetic model of a waveguide inside which a graphene sheet is contained. Rigorous dispersion equations for all mode families transverse electromagnetic (TEM), transverse electric (TE), and trans-

verse magnetic (TM) are systematically derived from Maxwell's equations with complete boundary conditions. We demonstrate that only the plasmonic TM0 mode satisfies the quantum Čerenkov condition at Thz regime.

14 **Impact Of The Substrate Thickness On The Spatial Positions Of The PMC/PEC Behavior Around A Conformable AMC**
Chloé Scotti[1], Nicolas Malléjac[1], Stefan Enoch[2] — *[1] CEA Le Ripault, France [2] Aix-Marseille Université, CNRS, Centrale Méditerranée, Institut Fresnel, France*
The impact of the dielectric thickness composing a MS AMC is studied here. Although the dual PEC/PMC behavior is achieved with this design when observed in the far field, it is shown here that the spatial position of the field antinodes is not strictly on the surface of the MS when the latter is composed of a sufficiently thick dielectric substrate.

15 **Multishell Spherical Nanoresonator Layers To Promote Large Near-Field Enhancement**
Dávid Vass, Balázs Bánhelyi, Maria Csete — *University of Szeged, Hungary*
Silica-gold and silica-silver multishell spherial nanoresonators were tuned to achieve large near-field enhancement. Based on the optical cross-section and near-field characteristics of the individual multishells, the material of the metal shell was selected. Then, 3D passive and active periodic multishell-patterns were studied considering their optical response, near-field and effective optical properties. ENZ and ENP regions appear in the effective permittivity spectra of the inspected targets.

16 **Second-Harmonic Wavefront Shaping with Lithium Niobate Metasurfaces**
Fei Ding — *University of Southern Denmark; Eastern Institute of Technology, Ningbo, Denmark*
Nonlinear metasurfaces enable compact manipulation of light at the nanoscale. Here, we demonstrate dynamic control of second-harmonic chirality using a nonlocal lithium-niobate (LN) metasurface. By engineering metasurfaces on LN thin films, the SH polarization is continuously tuned from right- to left-handed circular states, enabling spin-decoupled second-harmonic holography.

17 **High-Gain Circularly Polarized Antenna with Optimized Feed Efficiency**
Ravi Kanth Thanikonda[1], Vydehi Nitta[2], Stefano Maci[3] — *[1] university of siena, italy, Italy [2] UNIVERISTY OF SIENA, ITALY [3] university of siena, italy*
This work presents a compact framework for evaluating and optimizing the feed efficiency of metasurface (MTS) antennas using a double-path wave arrangement. A circular metasurface aperture of radius 10λ is designed at 29

GHz on a grounded dielectric substrate with relative permittivity $\varepsilon_r = 6.3$ and thickness $h = 0.635$ mm, characterized by an average transparent reactance $X_0 = -300\ \Omega$. A triaxial feeding structure excites a radially propagating surface wave (SW), enabling separation of surface-wave, space-wave, and collected power contributions, as illustrated in Fig.1. The optimized configuration achieves a feed efficiency of approximately 88%, as shown in Fig. 2. By applying a tapered leakage profile, efficient conversion of the guided SW into leaky-wave radiation is obtained, resulting in a total radiation efficiency of about 70% and a simulated gain of 35 dBi with dominant right-handed circular polarization, as confirmed by the far-field patterns in Fig.13. The results demonstrate that proper engineering of the average reactance and feed geometry enables highly efficient millimeter-wave metasurface antennas.

18 **Om-Electromagnetism in Isotropy-Broken, Non-Reciprocal, and Non-Hermitian Media**

Maxim Durach, David Keene — *Georgia Southern University, USA*

The ॐ-potential framework unifies sources and fields in anisotropic, non-reciprocal, and non-Hermitian media, extending electromagnetism to near-fields, linking hidden momentum, Beer-Lambert attenuation, photonic density of states, and structured-light formation within a single analytical foundation.

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