meta materials 2025 amsterdam

19th international congress on
artificial materials
for novel wave phenomena

1 to 6 september

METAMATERIALS CONGRESS

meta morphose

AMOLF

University of Amsterdam
Institute of Physics

TU/e

Metamaterials'2025

19th International Congress on
Artificial Materials for Novel Wave Phenomena

Amsterdam, September 1-6, 2025

METAMATERIALS CONGRESS

AMOLF physics of functional complex matter

University of Amsterdam Institute of Physics

TU/e Eindhoven University of Technology

Contents

Welcome to Metamaterials'25 Amsterdam

On behalf of the local organizing committee, it is a great pleasure to welcome you to the 19th International Congress on Artificial Materials for Novel Wave Phenomena – in short Metamaterials'25. We are very honored to host the conference in Amsterdam. Over its nearly 20 years of tradition, the conference has established itself as the leading forum to discuss the wave and transport properties of a wide class of different materials, with scientists hailing from electromagnetism, optics, acoustics, mechanics, and many other disciplines.

The Technical Program Committee has done an outstanding job this year to embrace the wide scope of disciplines that fall under the common denominator of 'Metamaterials' in the program. Special sessions in the domains of Sustainable Energy, Robotics, and Information Technology highlight the potential impact of metamaterials in various fields. As customary, the Congress is followed by a 2-day Doctoral School, for which we have chosen the emerging theme of "Metamaterials and Information" as a topic – this includes both Metamaterials as hardware physical processors of information and, conversely, information for metamaterials, such as in data-driven design.

The local conference organization has been undertaken by three institutes that reflect this interdisciplinarity: the AMOLF institute with a research program on optical and mechanical metamaterials for information, and for sustainable energy, the University of Amsterdam with research on mechanical metamaterials as well as quantum metamaterials, and the TU Eindhoven, which bridges metamaterials and photonic integration.

We hope that you will very much enjoy the venue that we selected: Felix Meritis was built in 1788 with the very purpose of interdisciplinary discussion, as it was constructed in the age of Enlightenment as a society of learning, to gather in the pursuits of physics, literature, music, drawing, as well as commerce. While it has all the modern amenities for a conference center, it still shows the grandeur and spirit of 1788. Once you are behind the front door, you will find it is an oasis on its own – all the lecture halls and spaces for lunch are tightly integrated, and interspersed with seating areas to work or converse. At the same time, it is located in the hustle and bustle of the Amsterdam canals, just a 10-minute walk from the main cultural highlights in Amsterdam, such as the Rembrandts in the Rijksmuseum, and the famous collection of Van Gogh Paintings.

In closing, we want to express our sincere thanks to the Technical Program Committee Chairs Francesco Monticone and Corentin Coulais for their hard work on an excellent program, and the invaluable work at Metamorpose VI, with much of the hard work behind the scenes for the conference coordinated by the Roma Tre team of Steering Committee Chair Alessio Monti. In addition, we want to express our thanks to all the sponsors, committee members, colleagues, and support staff who make this edition possible.

Femius Koenderink
General Chair

also on behalf of

Esther Alarcón Lladó
Humeyra Caglayan
Jorik van de Groep
Sander Mann
Albert Polman

Past president's farewell message

It is hard to believe that six years have passed since I became President of the Virtual Institute for Artificial Electromagnetic Materials and Metamaterials (METAMORPHOSE VI). It has been a great honor and pleasure for me to serve in this role for our continuously growing community of metamaterials researchers. I am also very happy to welcome you to a new edition of our Metamaterials conference in Amsterdam.

The past six years have been full of events and surprises, we went through a global pandemic and many geo-political challenges across the globe, yet our community has continued to grow and stands strong with a bright future ahead. Our society has grown in institutional members and expanded beyond its traditional boundaries of Europe. Our flagship conference continues to stand as the reference meeting for metamaterials scientists across the world. In these meetings, we can engage in an open way with the leaders in the field and with the young bright scientists that are growing in this highly interdisciplinary field of science. Our community continues to evolve, growing stronger, attracting top scientists, and showcasing impressive new scientific developments. In the past years, we had to cancel three planned meetings, two in the US and one in Israel, due to events beyond our control. I really hope that in the future we will be able to revamp those plans. I am confident that our conference will continue to thrive for many years, together with our Doctoral School program.

I wish to thank the local organizing team of this year's conference for the wonderful leadership and impressive organization, and I would also like to thank the Metamorphose team for the great support across all these past six years. Past Presidents Prof. Tretyakov and Bilotti and all the team in Italy have been particularly supportive and helpful, making my job very easy. I wish the best of luck to our new President, I know we are in great hands and I will do my best to support Metamorphose as Past President in the coming years to the maximum extent. Finally, I wish you an exciting conference and a fun week in Amsterdam, and I look forward to many more years of successes for the metamaterials community at large.

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

President's message

I am honored and humbled to be elected the President of METAMORPHOSE VI for the three-year term (June 2025-May 2028). I am thankful to all the institutional members and their coordinators for their support and vote of confidence in me. I would like to take this opportunity to thank all the previous Presidents, Andrea Alù (2019-2025), Filiberto Bilotti (2013-2019), and Sergei Tretyakov (2007-2013) for their excellent leadership, vision, and service to our scientific community. Also, I thank Sergei Tretyakov and Alex Schuchinsky, who were the founding pillars of METAMORPHOSE, for their foresight in establishing this association. They are all great role models for all of us. I am certain I will consult with them and I will benefit from their experience, vision, and wisdom as I serve in this position. Thank you, Andrea, Filiberto, Sergei, and Alex, for your great work.

It is with great pleasure to welcome all of you to *Metamaterials'2025, the 19th International Congress on Artificial Materials for Novel Wave Phenomena* in the beautiful city of Amsterdam, the Netherlands. Following the excellent tradition of this conference series, we have another exciting technical program organized in four days (Monday-Thursday) and a 2-day doctoral school program on Friday and Saturday. I thank everyone who has contributed significantly to the organization and formation of the events of this week, i.e., the local organizing committee, the technical program committee, the steering committee, the scientific advisory board, and all others who have made this event possible, including the authors who present their work in this conference, the reviewers who evaluated the submissions, the world-renowned scientists as plenary and invited speakers, and the expert instructors in the doctoral school focused on *"Metamaterials and Information,"* which is an active area of research in the community of metamaterials. Their excellent contributions to the field of metamaterials are what make our community so active and strong.

The field of metamaterials continues to grow and expand, achieving exciting frontiers and milestones in science and technology. Our METAMORPHOSE VI promotes and encourages research activities in this field, as evident from this vibrant annual conference and doctoral school. Our association continues to explore ways to expand the metamaterials community and its connections with other scientific and technological fields. It is an honor for me to serve as the President of this association.

I look forward to a great week of exciting presentations, scientific discussions, and informative brainstorming in this field of metamaterials we all love.

Enjoy the conference!

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

Welcome from the Technical Program Committee chairs

On behalf of the technical program committee, we welcome you to Metamaterials' 2025 – the 19th International Congress on Artificial Materials for Novel Wave Phenomena. A quarter of a century after the name "metamaterials" was coined, interest in this field has continued to grow, evolve, and broaden. The concept of engineered metamaterials has instilled a new way of thinking and has introduced a powerful set of design tools across a wide range of disciplines, opening exciting new avenues for scientific discovery and technological innovation in electromagnetism, optics, photonics, acoustics, mechanics, and beyond. These developments are well reflected in the cross-disciplinary scientific program that the technical program committee has assembled.

The technical program spans four full days and is organized into five parallel sessions. We are honored to host five outstanding plenary talks by world-renowned pioneers: Itai Cohen, Rachel Grange, Dragomir Neshev, Mário Silveirinha, and Jelena Vučković. The program also features over 100 invited talks covering a broad and exciting range of topics. This year, we placed particular emphasis on topical, geographical, and gender diversity among plenary and invited speakers, with the aim to better reflect the breadth and inclusivity of our cross-disciplinary international community. The program also includes four special sessions highlighting the role and impact of metamaterials across various areas of science and technology: Metamaterials and Information, Metamaterials and Robotics, Metamaterials and Fluids, and Metamaterials and Sustainable Energy. Each special session will begin with a brief introduction by the session organizer and conclude with an engaging panel discussion. In addition, continuing the tradition of previous editions, a special session organized and sponsored by the American Physical Society (APS) will feature talks by authors whose papers were selected by APS Editors as among the best published in Physical Review journals over the past year. Finally, we have revamped the role of posters to give them greater visibility. Rather than a single session, this year's program includes four dedicated poster sessions, one each day, partially overlapping with a Dutch-style buffet lunch.

We would like to extend our heartfelt thanks to everyone who played a vital role in shaping the technical program of this conference. This includes the authors who submitted their work, the reviewers who carefully evaluated the contributions, the special session organizers, the APS editors, and our sponsors for their generous support. We are also grateful to the steering committee and the scientific advisory board for their guidance, the staff of the METAMORPHOSE Virtual Institute for managing all administrative aspects, and the members of the technical program and program formation committees for the fantastic program they put together. Special mention goes to Mirko Barbuto for his invaluable day-to-day support in all aspects related to the program committee's work, the steering committee Chair, Alessio Monti, the General Chair, Femius Koenderink, and the entire local organizing committee for their dedication, passion, and tireless efforts, which will undoubtedly make this edition of the Metamaterials Congress a memorable and enriching experience.

We all look forward to a wonderful conference in the vibrant setting of Amsterdam. Wij wensen jullie een goede conferentie! Enjoy the conference!

Francesco Monticone and Corentin Coulais, Co-Chairs of the 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)

AMOLF

AMOLF is one of the nine scientific research institutes of the Netherlands Organization for Scientific Research (NWO) and was founded in 1949. The mission of AMOLF is *To understand the fundamental physics and design principles of natural and human-made functional complex matter, and to initiate and develop new research in this field in the Netherlands, in partnership with academia and industry.* Examples of functional complex matter systems studied at AMOLF are metamaterials to control light, sound and motion, nanostructured

solar cells, shape-morphing mechanical metamaterials, and life-like and living adaptive systems. AMOLF is organized along disciplinary strengths, namely Nanophotonics, Chemistry & Spectroscopy, Living Matter, Modern Mechanics, and Light Management in Photovoltaics, and collaborates on interdisciplinary themes, namely Sustainable Energy, Information in Matter, and Autonomous Matter. The institute has a vibrant international community of about 150 scientists (19 principal investigators) and houses state-of-the-art support infrastructure, including a cleanroom facility and an electron microscopy facility. The research program is mainly funded from curiosity-driven research grants (ca. 50% of the grant turnover, in mainly national and ERC talent schemes), combined with mission-driven and industry-cofunded research.

Institute of Physics at University of Amsterdam

The Institute of Physics at the University of Amsterdam is home to over 65 principal investigators and over 250 scientific staff, organized into three world-class units: the Institute for Theoretical Physics, the Institute for High Energy Physics, and the Van der Waals–Zeeman Institute for experimental physics. The Institute hosts multiple metamaterials groups: scientists here develop and characterize novel artificial media, from active and mechanical metamaterials to tunable optical metasurfaces and heat-managing thermal metamaterials, leveraging advanced fabrication, characterization, and simulation facilities. Located on the Science Park in Amsterdam, there are many (interdisciplinary) interactions with AMOLF, ARCNL, Nikhef, and CWI, as well as with other departments within the faculty of natural sciences. The Institute of Physics provides an ideal environment — bringing together theory, experiment, and engineering — to be at the frontier in metamaterials science.

TU Eindhoven

Eindhoven University of Technology (TU/e) is a leading technical university located in the heart of Europe's high-tech innovation hub, Brainport Eindhoven. Founded in 1956, TU/e is renowned for its strong focus on engineering, applied physics, and information sciences, fostering close collaborations between academia, industry, and society. The university's mission is to advance science and technology for the benefit of humanity by driving innovation in areas such as integrated photonics, data science, and sustainable energy.
TU/e is internationally recognized for its photonic integration, electromagnetics, signal processing, and nanoelectronics research. The Center for Integrated Photonics Eindhoven houses state-of-the-art research and cleanroom facilities, supporting interdisciplinary work in areas such as optical communications, quantum photonics, and meta-optics. Researchers at TU/e play a central role in European and national innovation programs, with a strong track record in EU-funded consortia and industry co-funded projects. With over 12,000 students and a vibrant international community, TU/e provides a dynamic environment for cutting-edge research, education, and technological advancement.

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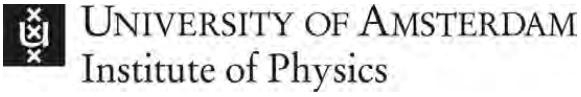
www.tno.nl/en

NWO Dutch Research Organisation
www.nwo.nl/en



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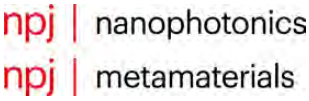	npj Nanophotonics nature.com/npjnanophoton/ npj Metamaterials nature.com/npjmetamat/

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Practical Information

General information — venue and social events

Venue location

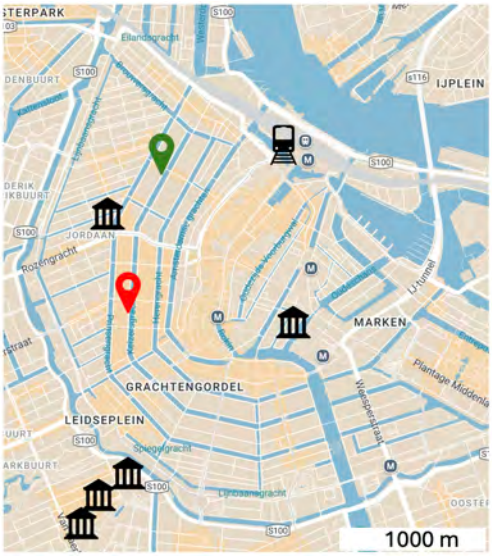
The conference will be organized in the iconic historical building Felix Meritis, located right in the center of Amsterdam, and at one of the most famous and pittoresque canals of the city.

Conference sessions, lunches and welcome drinks:

Felix Meritis
Keizersgracht 324
Amsterdam

Conference banquet
Wednesday at 18:30

Rode Hoed
Keizersgracht 102
Amsterdam



Map attribution: Google My Maps

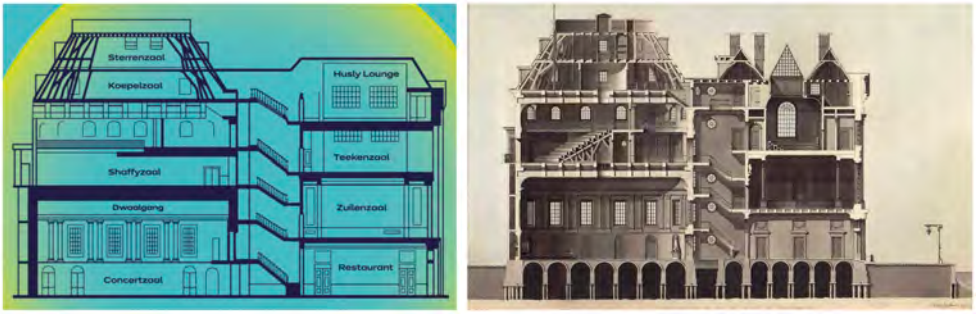
The map indicates Felix Meritis (red pin), the dinner location (green pin), the Amsterdam Central train station, as well as several of the cultural highlights that are at easy walking distance such as the Anne Frank House (just north of the venue), the Rembrandt House (rightmost), and the Rijksmuseum, Van Gogh museum, Stedelijk Museum, and Concertgebouw (bottom of the map).

Felix Meritis

Felix Meritis is an impressive historical building dating from 1788, originally built to house an intellectual society of the same name that was founded in 1776, and that used the building until its dissolution in 1888. This society was founded by affluent citizens of Amsterdam, and was dedicated to Music, Drawing, Physics, Commerce and Literature. The building was realized according to a winning design by Jacob Otten Husly, and the neoclassical design of the building is meant to exemplify the **Enlightenment** period. To encompass the breadth of Arts and Sciences, it was designed to hold a renowned oval Concert hall, a large library (now called Zuilenzaal, after the large columns supporting the ceiling), a hall originally dedicated to performing physical experiments (now called Shaffyzaal), and a hall for the pursuit of drawing and sculpture.

The rooms are connected through a famous grand central staircase, capped by a domed roof that was originally intended for astronomical observations.

After the learned society Felix Meritis was dissolved in 1888, the building had a chequered history. First, it was used by a printing company. After the Second World War, the building was used as the headquarters of the Communist Party of the Netherlands, and until the mid 80's, the newspaper "De Waarheid" (The Truth) was printed in the building. Felix Meritis as a symbol of communism was stormed on 4 November 1956, in response to the Soviet invasion of Hungary which was endorsed by the Dutch communist party. In the late sixties, Felix Meritis became a hot spot for alternative youth, and in 1969 it opened as the Shaffy Theater, which has a Dutch avant-garde reputation, and is named after the Dutch performer Ramses Shaffy. In the late eighties, a new "Felix Meritis" society was founded, a century after the original one dissolved, with the purpose of dedicating the building as a European center for science, art, and culture. The venue has recently been completely renovated, retaining the historical character, yet at the same time implementing all the modern amenities and technical infrastructure for a high-quality conference.



Present day and historical (1788) layout of Felix Meritis.

Plenary sessions

All plenary sessions are held in the large ground-floor oval Concert Hall (**Concertzaal**). As this may be filled to the brim, the session is livestreamed to the **Shaffyzaal**, exactly one floor up.

Parallel sessions and posters

Location

Parallel sessions use the ground floor (**Concertzaal**), first floor **Shaffyzaal**, second floor **Teekenzaal I & II** , and the top floor **Koepelzaal**. Poster sessions will be held daily in the **Husly lounge**, and are co-located with lunch as indicated in the program.

Speaker instructions
Please bring your presentation as Microsoft Powerpoint or as Acrobat PDF file on a USB-A memory stick. Speakers should upload and test their presentation on the presentation laptop in the room where you will be presenting well before your session starts, for instance in the break preceding your session. Also, as presenter please make your presence known to the session chairs well before the session start. Please leave sufficient time for questions after your talk (for invited talks, leave 5 minutes for questions. For contributed talks, leave 3 minutes for questions).

Poster presenters
Posters can be put up in the Husly lounge at the start of the day and should be removed by the end of the last session of the day. Poster boards are 1000×1250 (width × height in mm), 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.

*Top: Impressions of the main hall or **Concertzaal** on the ground floor, and the **Shaffyzaal** on the 1st floor, which was originally built for physical experiments. Bottom: the **Zuilenzaal** was originally the Library, and will be used for lunch. The top room (bottom right, **Koepelzaal**) is under the original dome for astronomical observations.*

Coffee breaks, lunch and lounge areas

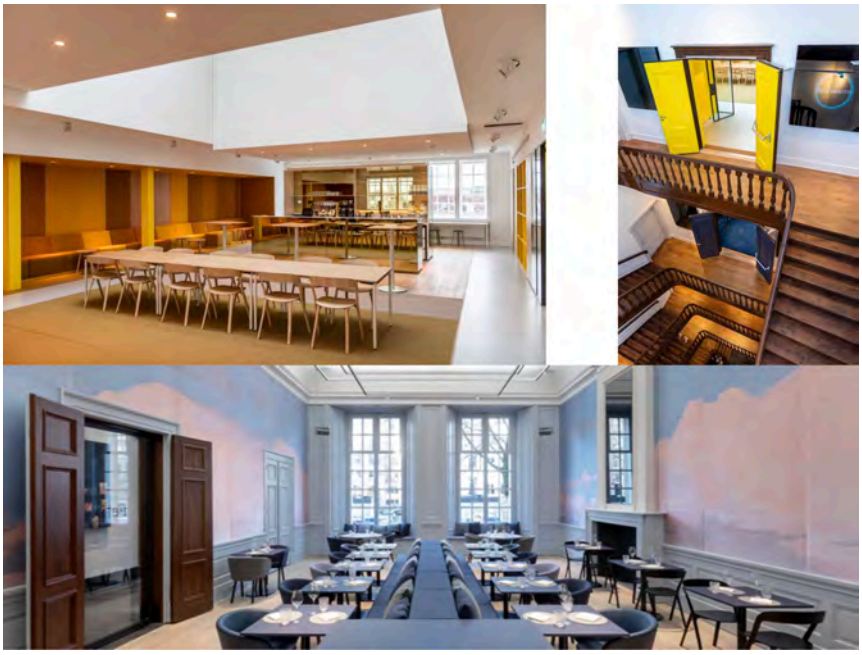
Coffee and lunch are served simultaneously in two locations, namely the ground floor **Restaurant** and 1st floor **Zuilenzaal** in a standing buffet format. The Restaurant area also provides a quiet seating area near the back of the building, suited for individual work or bilateral meetings. Further seating area is provided in the **Husly lounge**.

Registration desk and cloakroom

You find the registration desk immediately upon entering the building, on the right-hand side. Behind the registration desk area, you find an unguarded cloakroom. The registration desk is manned daily from 08:30 till the end of the program as listed in the session matrix.

Sponsor sessions and exhibitions

Sponsor exhibition booths are located in and around the Zuilenzaal. There are two special sessions organized by sponsors: the APS Physical Review Special Session in the Shaffyzaal on Monday at 16:00 and the npj Nanophotonics and npj Metamaterials Special Session on Fabrication and Characterization on Thursday in the Koepelzaal at 10:30. Finally, there are three special sponsor seminars presented by sponsors. They will take place in the Shaffyzaal during lunch breaks, starting at 13:00 and are presented by by COMSOL on Tuesday, Thorlabs on Wednesday, and ASML on Thursday (for details, see page 37).



*The **Husly Lounge** on the 3rd floor will be used for posters and has quiet seating (top left). The restaurant area (bottom) has quiet seating.*

Conference dinner

The Conference Dinner is organized in **de Rode Hoed**, Keizersgracht 102. The building has historical significance as a historical clandestine hidden church — originally built in 1630 it is the largest and oldest remaining example of such a hidden church. Behind a relatively unassuming canal house facade that does not reveal its purpose, it houses a surprisingly large hall that

presents a wide, high-ceilinged ground-level space surrounded by a colonnade that holds several tiers of galleries. The banquet venue is just a 10-minute walk from the conference venue. The banquet includes three courses and a generous selection of drinks. Since the dinner is ticketed, please ensure to wear your badge to the dinner: if you participate this is indicated on your badge with an icon.

*The **Rode Hoed** in atmospheric banquet setting.*

Doctoral School

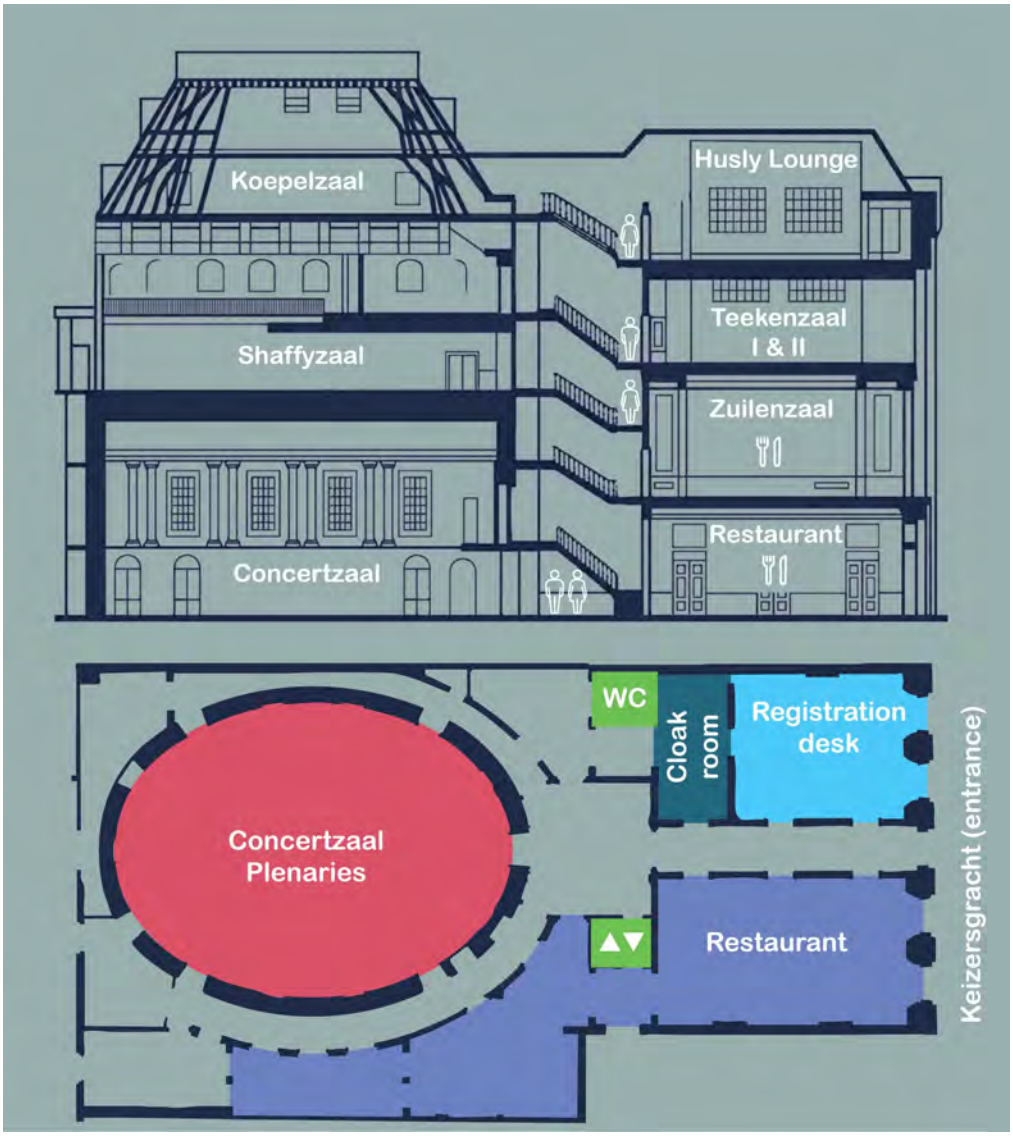
On September 5-6, the conference is followed by the Metamorphose Doctoral School **Metamaterials and Information**. The doctoral school is held in the **Teekenzaal**. If you have not registered but would like to attend, please enquire at the registration desk.

Proceedings

The proceedings of Metamaterials 2025 are uploaded online. Please visit the link:

`https://congress.metamorphose-vi.org/proceedings2025.zip`

Navigating the venue and Wi-Fi



Side view of the building indicating all the lecture halls, the lunch locations (**Restaurant**, **Zuilenzaal**), and the poster space (**Husly lounge**). The ground floor shows the location of the registration desk and the elevator, and ground floor restrooms.

Wireless internet: choose **Felix Meritis** with password **felixmeritis**

Transportation

Getting to Amsterdam

By train: Amsterdam Central Station has direct train connections to Brussels, Paris, London (Thalys/Eurostar), Frankfurt, Berlin, Munich, Prague,Basel, Zurich, Innsbruck and Vienna. International tickets for instance via `www.nsinternational.nl` (QR above), `www.eurostar.com`, `www.bahn.de`, `www.europeansleeper.eu`.
By air: The international airport of Amsterdam is Schiphol `www.schiphol.nl` (QR above), IATA airport code AMS. The arrival hall is directly connected to Schiphol train station, which is a 15-minute train ride away from downtown Amsterdam Central Station. Trains run every 10 minutes from 6:30 till midnight, and at a reduced frequency all through the night. Single fares are ca. 5 euros. The train schedule can be consulted at `www.ns.nl`. To downtown destinations, public transport may be quicker than taxis, which will cost ca. 50 euros.

Public transport in and around Amsterdam

The venue is located a circa 20 minute walk from Amsterdam Central Station. Within the city transport mainly runs by trams, and two metro lines, administered by GVB (`www.gvb.nl`). A transport map can be found at `https://www.gvb.nl/en/gvb-maps` or consult the GVB app. Note that the airport is reached only by train, departing from Central Station.

Public transport apps for smartphones, download links
Train system NS (QR above): `https://www.ns.nl/reisinformatie/ns-app`
Metro/tram/bus (QR above): `https://www.gvb.nl/reisinformatie/gvb-app`

Paying for public transport
The Netherlands has an electronic ticketing system, which requires both "checking in" and "checking out" at electronic terminals. Stations generally have gated access. Schiphol has check-in/check-out posts on the railway plaza before taking the escalators to the platforms. Trams and buses have check-in/check-out machines at the doors. Modes of payment are:

- Contactless credit/debit cards – take out your card, and hold it in front of the reader. Also works with smartphones via Apple Pay / Google Wallet. Check out with the same card. The OVpay app `www.ovpay.nl` (QR above) provides an overview of your trips. If you forgot to check out, fix that in the app afterwards to avoid incurring higher costs.
- Barcoded tickets. Sold separately by NS (train only) and GVB (tram/metro/bus) via their websites and/or apps.
- If you do not wish to use a smartphone, NS ticket machines, kiosks, and supermarkets sell anonymous "OV-chip cards" for EUR 7.50. After charging them with a travel balance at an NS or GVB ticket machine/charging station, they can be used in all public transport.

What to do in Amsterdam

Canal Boat Tour

A boat tour is an excellent way to experience Amsterdam's charming canals and historic buildings from the water. Choose from daytime sightseeing tours or romantic evening cruises with dinner options. Tours depart regularly from areas such as Centraal Station and the Anne Frank House, with tickets starting at around 15 euros for a one-hour tour.

Rijksmuseum

The Rijksmuseum houses Dutch masterpieces, including works by Rembrandt, Frans Hals, and Vermeer. It's located at Museumplein and is open daily from 9:00 to 17:00. Tickets can be booked online to skip the queue via `https://www.rijksmuseum.nl/en`.

Van Gogh Museum

This museum holds the largest collection of Van Gogh's paintings. Located next to the Rijksmuseum, it's open daily from 9:00 to 18:00 (Fridays until 21:00). Tickets must be reserved long in advance online via `https://www.vangoghmuseum.nl/en`.

Anne Frank House

Explore the Secret Annex, where Anne Frank wrote her famous diary during World War II. Located on Prinsengracht, it offers a deeply moving experience. Check availability online via https://www.annefrank.org/en/.

Bicycle Tour

Experience Amsterdam like a local with a guided bike tour through its neighborhoods, parks, and picturesque canal paths. Tours typically last 2–3 hours and start at 30 EUR, including bike rental. Most tours start near Centraal Station or Vondelpark. See, for instance macbike.nl for bike rentals, and yellowbike.nl for guided tours.

Willet-Holthuysen Museum

This lesser-known gem is a beautifully preserved 17th-century canal house with lavish period interiors at Herengracht. Open daily from 10:00 to 17:00. https://www.amsterdammuseum.nl/tentoonstelling/huis-willet-holthuysen/9511

Zandvoort Beach

Zandvoort is a popular seaside escape just 30 minutes by train from Amsterdam Central Station. Enjoy the sandy beach, beach clubs, and nearby dunes.

Albert Cuyp Market

Located in the vibrant De Pijp neighborhood, the Albert Cuyp Market is one of Amsterdam's largest and most diverse street markets. From fresh stroopwafels to local cheese and street art, it offers an authentic taste of Dutch daily life. It is open Monday through Saturday.

Eye Film Museum

A must-see for film enthusiasts, this futuristic building across the IJ River hosts exhibitions on film history, experimental cinema, and regularly screens classic and independent films. Easily accessible by a free ferry from Central Station. https://www.eyefilm.nl/en

NDSM Wharf

This former shipyard, now transformed into a creative hotspot in Amsterdam Noord, is a thriving hub of street art, industrial-chic cafes, artist studios, and waterside hangouts—a great place to explore for an off-the-beaten-track afternoon. https://www.ndsm.nl/en/werf

Artis Zoo and Micropia

For those traveling with family, Artis is the oldest zoo in the Netherlands (founded in 1838), and one of the five oldest in the world. Artis offers a relaxing green escape in the city center.

Next door, Micropia is a one-of-a-kind museum dedicated to microbes, blending science and interactivity. https://www.artis.nl/en

Cultural Nightlife

Amsterdam's nightlife isn't just bars — across town there are club nights, art exhibitions, and live music. For instance, Paradiso, a former church, hosts concerts across all genres. Check their schedules for events during the conference week.

Hortus Botanicus

One of the oldest botanical gardens in the world, the Hortus offers peaceful greenhouses, butterfly rooms, and exotic flora – https://www.dehortus.nl/en/.

Day trip: Haarlem or Utrecht

Both cities are under 30 minutes by train and offer beautiful canals, historical buildings, and fewer crowds. Haarlem has a cozy town center and the famous Teylers Museum, while Utrecht features a unique canal system with wharf-level terraces.

More

See https://www.iamsterdam.com/en/see-and-do for a current list of what is going on in Amsterdam.

Useful contacts

Felix Meritis (Venue)	(+31) 020 627 9477
Public transport	https://9292.nl/en/
Amsterdam Taxi Service	(+31) 020 777 7777
Emergency services	112
Police	(+31) 0900 8844
Fire brigade	(+31) 0900 0904
Medical, after office hours	(+31) 088 00 30 600
Hospital OLVG	(+31) 020 599 91 11
Local organizers	metamaterials25@amolf.nl
AMOLF secretariat	(+31) 020 754 7109

Program

Session matrix, Monday, September 1

	Concertzaal	Shaffyzaal	Teekenzaal I	Teekenzaal II	Koepelzaal
08:00	Registration				
09:00	Opening Ceremony				
09:30	Plenary Session I — Mário G. Silveirinha Chiral Gain Photonics and Beyond				
10:30	Coffee Break				
11:00 - 12:30	Metasurfaces for Antenna Systems I	Physics of Complex EM Media I	Advanced Computational and Deep Learning Approaches in Nanophotonics	Nonlinear, non-Hermitian and Topological Acoustics	Metamaterials for Thermal Radiation
12:30	Lunch break and Poster Session I (Husly lounge)				
14:00 - 15:30	Technologies and Modeling Approaches for Reconfigurable Microwave Metasurfaces	Physics of Complex EM Media II	Metamaterials and Nanophotonics Enabled Novel Metrology	Advanced Analytical Methods in Metamaterials and Metasurfaces	Two-dimensional Materials
15:30	Coffee Break				
16:00 - 18:00		Physical Review Special session	Time-Varying Photonics I	Non-reciprocal and Topological EM Metamaterials	Quantum Materials and Light Emission
18:00	Welcome Reception				

Sponsored session:

APS Physical Review Journals

Physical Review special session, organized by APS
Shaffyzaal at 16:00

The venue opens for registration at 08:00 and closes at 20:00.
All delegates are welcome to the reception, which offers drinks and light snacks

Session matrix, Tuesday, September 2

	Concertzaal	Shaffyzaal	Teekenzaal I	Teekenzaal II	Koepelzaal
09:00	Plenary Session II — Rachel Grange Nonlinear Nanomaterials for Classical and Quantum Photonic Devices				
10:00	Coffee Break				
10:30 - 12:30	Special session: Metamaterials and Robotics I	Metasurface-Enhanced Scattering and Radiation	Time-Varying Media: Resonances and Dispersion	Scattering Particles, Arrays, and Metasurfaces	Electromagnetics of Complex Periodic Structures
12:30	Lunch break and Poster Session II (Husly lounge)				
14:00 - 15:30	Acoustic and Topological Metamaterials	Metasurfaces for Antenna Systems II	Time-Varying Photonics II	Tunable and Reconfigurable Metasurfaces for Imaging, Sensing, and Spectral Control	Nonlinear and Active Metasurfaces for Frequency Generation, Lasing, and Optical Control
15:30	Coffee Break				
16:00 - 17:30	Special session: Metamaterials and Robotics II	Non-linear and Active Microwave Metamaterials	Dynamic Wavefront Control with Tunable and Time-Varying Metasurfaces	Chiral Light-Matter Interaction	Meta-Computing and Processing
17:30	Plenary Session III — Itai Cohen Elastronic Metamaterials				

Special sessions:
Metamaterials and Robotics: Concertzaal at 10:30-12:30 and 16:00-17:30.

Sponsor seminar:

COMSOL

Simulating Electromagnetic Metamaterials using COMSOL Multiphysics: Shaffyzaal at 13:00

The venue opens at 08:30 and closes after the plenary at 18:30

Session matrix, Wednesday, September 3

	Concertzaal	Shaffyzaal	Teekenzaal I	Teekenzaal II	Koepelzaal
09:00	Plenary Session IV — Dragomir Neshev Dielectric metasurfaces for imaging and quantum applications				
10:00	Coffee Break				
10:30 - 12:30	Special session: Metamaterials and Information I	Plasmonics: Observation and Application	Computing and Wave Control in Mechanical Metamaterials	Quantum Metamaterials	Temporal Boundaries and Space-Time Interfaces
12:30	Lunch break and Poster Session III (Husly lounge)				
14:00 - 15:30	Special session: Metamaterials and Information II	Novel Applications in Sensing and Diagnostics	Topological, Nonreciprocal, and Programmable Metamaterials	Quantum Plasmonics and Nanophotonics	Tunable, Dynamic, and Programmable Metasurfaces
15:30	Coffee Break				
16:00 - 17:30	Metasurfaces for Signal Processing and Information Theory	Metamaterials for Novel Microscopy and Photode-tectors	Nonlinear and Multistable Metamaterials	Topological and Nonreciprocal Phenomena in Photonic Resonators	Emerging Applications of Reconfigurable and Topological Metasurfaces
17:30	Break before Social Dinner				
18:30	Social Dinner				

Special sessions:
Metamaterials and Information: Concertzaal at 10:30 and 14:00

Sponsor seminar:

THORLABS

Thorlabs Quantum Optics Kit
Shaffyzaal at 13:00

The venue opens at 08:30 and closes after the sessions end at circa 17:30.
Ticketed dinner guests are welcome at de Rode Hoed at 18:30

Session matrix, Thursday, September 4

	Concertzaal	Shaffyzaal	Teekenzaal I	Teekenzaal II	Koepelzaal
09:00 - 10:00	Metamaterials & Machine Learning	Wave Control in Mechanical Metamaterials	Nonlinear and Tunable Optical Effects in Organic and Inorganic Nanophotonics	Metasurfaces for Antenna Systems III	Novel Sensing and Display Approches in Metamaterials
10:00	Coffee Break				
10:30 - 12:30	Special session: Metamaterials and Sustainable Energy I	Special session: Metamaterials and Fluids	Temporal Metamaterials I	Analysis and Synthesis of Microwave Metastructures	npj Metamaterials and npj Nanophotonics Special Session on Fabrication and Character-ization
12:30	Lunch break and Poster Session IV (Husly lounge)				
14:00 - 15:30	Special session: Metamaterials and Sustainable Energy II	Controlling Shocks and Vibrations & Soft Robotics	Temporal Metamaterials II	Design and Characteriza-ton of Microwave Metadevices	Nanophotonic Sensing and Characteriza-tion
15:30	Coffee Break				
16:00	Plenary Session V — Jelena Vučković Inverse Designed, Densely Integrated Classical and Quantum Photonics				
17:00	Closing Ceremony				

Special sessions:
Metamaterials and Sustainable Energy: Concertzaal at 10:30 and 14:00
Metamaterials and Fluids: Shaffyzaal at 10:30

Sponsored session:

npj | nanophotonics
npj | metamaterials

npj Metamaterials and npj Nanophotonics Special Session on Fabrication and Characterization: Koepelzaal at 10:30

Sponsor seminar:

ASML

Exploring metasurfaces in optical wafer metrology
Shaffyzaal at 13:00

Plenary Session I

Monday 09:30 - 10:30

Chairperson: Francesco Monticone

Chiral Gain Photonics and Beyond

Mário G. Silveirinha

University of Lisbon, Portugal

In most familiar settings, wave dynamics are governed by symmetry principles that enforce reciprocity and conserve energy in closed systems. But what happens when we deliberately step beyond these constraints? Active systems, which can locally supply or remove energy, open a much richer landscape of wave phenomena. In such media, gain and loss can coexist in space, giving rise to a new class of indefinite gain platforms. One striking example is chiral gain, where amplification and dissipation depend on the handedness of wave polarization. Such active responses can be realized, for example, in electrically biased low-symmetry conductors. Similar concepts are emerging in mechanical and acoustic settings, from active metamaterials to elastic media with odd elasticity. In this talk, I will present our recent work on chiral-gain photonic systems, show how the same principles extend to mechanical and other wave platforms, and outline a unified framework for indefinite gain across physics. I will also discuss new opportunities, from unidirectional light amplifiers to novel wave-control strategies, which could reshape the design of active materials.

Location: Concertzaal, and livestreaming to Shaffyzaal

Plenary Session II

Tuesday 09:00 - 10:00

Chairperson: Humeyra Caglayan

Nonlinear Nanomaterials for Classical and Quantum Photonic Devices

Rachel Grange

ETH Zurich, Switzerland

Nonlinear and electro-optic devices are present in our daily life with many applications: light sources for microsurgery or modulators for telecommunication. Most of them use bulk materials such as glass fibres or high-quality crystals, hardly integrable. Even the fast developments of thin film lithium niobate face the challenging etching of metal-oxides. Therefore, the quest for a non-centrosymmetric material, easy to fabricate and to scale up while maintaining its functionality is still ongoing. Here I will present our recent advances in top-down fabrication of lithium niobate devices and bottom-up assemblies of randomly oriented nanocrystals or sol-gel to produce nonlinear classical and quantum signals. Finally, I will also describe how these platforms are suited for random nonlinear optical generators for machine learning.

Location: Concertzaal, and livestreaming to Shaffyzaal

Plenary Session III

Tuesday 17:30 - 18:30

Chairperson: Corentin Coulais

Elastronic Metamaterials

Itai Cohen

Cornell University, USA

What would we be able to do if we could build electronically integrated machines at a scale of 100 microns? At this scale, semiconductor devices are small enough that we could put the computational power of the spaceship Voyager onto a machine component no bigger than the footprint of a single hair. Such robotic components could have on board detectors, power sources, and processors that enable them to sense, interact, and control their local environment. In this talk I will describe a new idea for using this technology to develop a novel materials platform: elastronic metamaterials, which combine electronic circuits at the level of the metamaterial building block. This integration would open the door to making materials with properties that would be impossible to achieve naturally including: response times that approach the speed of light; wave amplification; and materials that can sense and adapt to their environment.

Location: Concertzaal, and livestreaming to Shaffyzaal

Plenary Session IV

Wednesday 09:00 - 10:00

Chairperson: Femius Koenderink

Dielectric metasurfaces for imaging and quantum applications

Dragomir Neshev

Australian National University, Australia

The ability to detect and image hidden properties of light, such as phase, polarization, infrared signals, and quantum entanglement, has crucial applications in surveillance, autonomous navigation, and biological imaging. We review recent progress in imaging these properties using engineered semiconductor metasurfaces. Specifically, we focus on fundamental aspects of such imaging through nonlinear up- and down-conversion. We discuss results in image upconversion from infrared to visible light, enhanced with edge detection for advanced night vision. Additionally, we cover the generation of quantum entanglement by engineered metasurfaces for applications in quantum imaging.

Location: Concertzaal, and livestreaming to Shaffyzaal

Plenary Session V

Thursday 16:00 - 17:00

Chairperson: Jorik Van De Groep

Inverse Designed, Densely Integrated Classical and Quantum Photonics

Jelena Vučković

Stanford University, USA

Recent breakthroughs in photonics design, along with new nanofabrication approaches and heterogeneous integration play crucial roles in building photonics for applications including optical interconnects and quantum technologies. This design breakthrough is named photonic inverse design, and refers to efficiently searching through the space of all possible photonic device geometries, within fabrication constraints, and by employing fast electromagnetic solvers and optimization tools. Additionally, new photonic platforms have been developed which enable functionalities beyond silicon on insulator, including silicon carbide, diamond, and Titanium:sapphire on insulator, as well as ultra-strong electro-optic materials, such as strontium and barium titanate. With these new approaches to design and fabrication, novel optoelectronic devices and systems have been designed and demonstrated, including error-free and fast chip-to-chip and on-chip optical interconnects compatible with commercial foundries, chip scale Ti:sapphire lasers and amplifiers, CMOS compatible isolators and laser frequency stabilizers, and silicon carbide and diamond chip-scale quantum technologies.

Location: Concertzaal, and livestreaming to Shaffyzaal

Sponsored sessions and seminars

Sponsored event

Concertzaal, Monday at 18:00: Nanophotonics, published by de Gruyter, sponsors the welcome reception.

Sponsored sessions

APS Physical Review Journals

Shaffyzaal, Monday at 16:00: APS Physical Review Special Session.

npj | nanophotonics
npj | metamaterials

Koepelzaal, Thursday at 10:30: npj Metamaterials and npj Nanophotonics Special Session on Fabrication and Characterization.

Sponsor seminars

COMSOL

Shaffyzaal, Tuesday 13:00-13:45

Simulating Electromagnetic Metamaterials using COMSOL Multiphysics
Jeroen Roberts, COMSOL

Simulation plays an essential role for developing, analyzing, and optimizing metamaterials. The COMSOL Multiphysics software enables you to couple multiple physics phenomena, and virtually test your design under real-world conditions, before the first prototype is built. In this workshop we will introduce the modeling capabilities of COMSOL Multiphysics for the design of metamaterials. In a live software demo we will build a model of a terahertz perfect absorber. We will focus on the modeling workflow, including geometry, materials, physics, and mesh. Attendees will also see the functionalities for performing a frequency sweep and calculating the scattering parameters. We will conclude by highlighting modeling possibilities such as multiphysics couplings and custom equations.

Sponsor seminars [continued]

Shaffyzaal, Wednesday 13:00-13:45

Thorlabs Quantum Optics Kit
Sam Gavin-Pitt, Thorlabs

Thorlabs' line of educational products aims to promote physics, optics, and photonics by covering many classic experiments as well as emerging fields of research. In this talk, we will introduce our Quantum Optics Educational Kit, which enables students to investigate the quantum properties of single or entangled photons. We will discuss how to characterize a heralded single-photon source and then introduce the Polarization-Entanglement Add-On Kit that extends the Quantum Optics Kit to generate polarization-entangled pairs.

Shaffyzaal, Thursday 13:00-13:45

Exploring metasurfaces in optical wafer metrology
Irwan Setija, ASML

ASML is an innovation leader in the semiconductor industry, and manufacture complex lithography systems critical to the production of microchips. In this talk, I want to give a brief introduction to who ASML is and what we do. The drive to reduce feature size in integrated circuits — given by Moore's law — puts strong requirements on the performance of optical metrology sensors. In collaboration with our academic partners, we are exploring the application of photonic nanostructures and metasurfaces. I will explain how photonic solutions can be used to drive optical metrology forward and what the particular challenges are.

Parallel Sessions

Oral Sessions (Monday Morning)

Metasurfaces for Antenna Systems I
Chairperson(s): Alessio Monti, Antonio Clemente **Room: Concertzaal**

Time	1st author	Title
11:00 - 11:30	Sergei Tretyakov	Fully Reconfigurable, Scanning, and Multifunctional Metasurfaces
11:30 - 11:45	Odysseas Tsilipakos	Controlling the Mode Profile, Dispersion, and End-Fire Radiation in Parallel-Plate Waveguides with Metasurface Boundaries
11:45 - 12:00	Jun Wei Zhang	A Low-Power Smart Millimeter-Wave Beamforming System for Base Station Application Based on Programmable Metasurfaces
12:00 - 12:30	Arthur Yaghjian	A Comparison of Bode-Fano and Dispersive Tuning of Antennas

Physics of Complex EM Media I
Chairperson(s): Alejandro Rodriguez, Emanuele Galiffi **Room: Shaffyzaal**

Time	1st author	Title
11:00 - 11:30	Filippo Capolino	Increased Sensitivity Based on Exceptional Point Degeneracies in Nonlinear Coupled Oscillators
11:30 - 11:45	Sichang Qiu	Octupole Topological Insulating Phase In Brillouin Three-dimensional Real Projective Space
11:45 - 12:00	Carlo Forestiere	First-Principles Nanocircuit Model of Open Electromagnetic Resonators
12:00 - 12:15	Eduardo Barredo -Alamilla	Probing Tellegen response by fast electrons
12:15 - 12:30	Roee Geva	Equivalent Dipolar Moment Array Representations of PTD-Symmetric Screens

Advanced Computational and Deep Learning Approaches in Nanophotonics
Chairperson(s): Philipp Del Hougne, Christopher Stevens **Room: Teekenzaal I**

Time	1st author	Title
11:00 - 11:30	Nasim Mohammadi Estakhri	A Deep Learning Framework for Prediction and Inverse Design of Nanoscale Optical Forces near Gradient Metasurfaces
11:30 - 11:45	Nigar Asadova	Gradient-based Optimization Of Scatterer Arrangements Using T-matrix Approach
11:45 - 12:00	Viktor Aadland Lilja	Informed Deep Learning for Electromagnetic Scattering Using Quasinormal Modes
12:00 - 12:15	Fridtjof Betz	Modal analysis for nanophotonic systems with branch cuts
12:15 - 12:30	Ross Glyn Macdonald	Dielectric Waveguide Networks For Computing The Solutions To Dirichlet Boundary Value Problems

Nonlinear, non-Hermitian and Topological Acoustics
Chairperson(s): Marc Martí Sabaté, Baile Zhang **Room: Teekenzaal II**

Time	1st author	Title
11:00 - 11:15	Alexander K. Stoychev	Nonlinear Scattering at an Array of Self-Excited Meta-Atoms
11:15 - 11:45	Zhenwei Xu	Amplitude Modulated Wave Scattering on a Nonlinear Whistle
11:45 - 12:15	Xinxin Guo	Towards Realization Of A Compact Lossless Acoustic Circulator Based On Synchronization
12:15 - 12:30	Yang Meng	Minimum-phase reflection for passive acoustic absorbers with target absorption spectrum and minimum volume

Metamaterials for Thermal Radiation
Chairperson(s): Andrea Alu, Mark Brongersma **Room: Koepelzaal**

Time	1st author	Title
11:00 - 11:30	Maria Kafesaki	Photonic Strategies for Enhanced Heat Management and Performance in Photovoltaics
11:30 - 11:45	Samira Mehrabi	Exploring Plasmonic MetaSurface: Opportunities in Photothermal Catalysis and Advanced Thermal Emitters.
11:45 - 12:00	Themistoklis Deloudis	Enhancement of the spontaneous emission rate in extreme hybrid nanophotonic cavities.
12:00 - 12:30	Sander Mann	Kirchhoff's laws of thermal radiation for complex, nonreciprocal, and time-varying materials

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

Metasurfaces for Antenna Systems I

Chairperson(s): Alessio Monti, Antonio Clemente

11:00 - 11:30 **Fully Reconfigurable, Scanning, and Multifunctional Metasurfaces** (Invited talk)

Mostafa Movahediqomi[1], Xuchen Wang[2], Grigorii Ptitcyn[3], Yongming Li[4], Viktar Asadchy[1], Sergei Tretyakov[1] — *[1] Aalto University, Finland [2] Harbin Engineering University, China [3] University of Pennsylvania, United States [4] Xi'an Jiaotong University, China*

In this presentation we will discuss our recent research on antenna arrays and metasurfaces formed by aperiodic arrangements of electrically small meta-atoms. The overall objective is to find means for creation of thin layers with an arbitrary engineered response. For example, realize layers that work as all-angle absorbers or leaky-wave antennas or layers that exhibit a desired distribution of near fields in their vicinity. Furthermore, we target arrays that can be configured and reconfigured for various functionalities by changing bulk components (variable capacitors, for example) in their meta-atoms. In contrast to periodical metasurfaces that require different periods for different functionalities, the introduced solutions allow full reconfigurability in geometrically fixed platforms. We will discuss fundamental limitations on the performance of conventional reflectarrays and show how they can be overcome by using arrays with subwavelength geometrical periods. Importantly, we will present solutions that can exhibit even superdirective properties at all scan angles. For example, in the absorbing regime these panels can absorb more power than is incident on their surfaces.

11:30 - 11:45 **Controlling the Mode Profile, Dispersion, and End-Fire Radiation in Parallel-Plate Waveguides with Metasurface Boundaries**

Odysseas Tsilipakos[1], Thomas Koschny[2] — *[1] National Hellenic Research Foundation, Greece [2] Ames National Laboratory, USA*

We study parallel-plate waveguides formed by metasurface boundaries, which are both electrically and magnetically polarizable and exhibit temporal and spatial dispersion. We find novel opportunities for controlling the mode profile and propagation constant. We also show that an asymmetric profile can tilt the radiation from the open waveguide end.

11:45 - 12:00 **A Low-Power Smart Millimeter-Wave Beamforming System for Base Station Application Based on Programmable Metasurfaces**

Jun Wei Zhang[1], Qiang Cheng[2] — *[1] Southeast University, China [2] Southeast University,*

A low-cost, low-power, intelligent millimeter-wave base station based on programmable metasurfaces is proposed. The front-end configuration of the base station includes a disc-cone antenna feed, an ultra-large-scale 2-bit phase modulation metasurface, and a control board with 1,800 output ports. Based on this core architecture, we construct an intelligent millimeter-wave base station capable of wide-angle beamforming in free space while ensuring simultaneous transmission of data streams in the desired direction. Compared to traditional millimeter-wave base stations, the average operating power of this novel system is approximately 12 W, significantly reducing the design cost and power consumption of beamforming millimeter-wave base stations. This advancement provides strong motivation for the development of next-generation intelligent 6G base stations.

12:00 - 12:30 **A Comparison of Bode-Fano and Dispersive Tuning of Antennas** (Invited talk)
Arthur Yaghjian — *Electromagnetics Research, USA*
The derivation and comparison of Bode-Fano and dispersive tuning will be presented.

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

Physics of Complex EM Media I

Chairperson(s): Alejandro Rodriguez, Emanuele Galiffi

11:00 - 11:30 **Increased Sensitivity Based on Exceptional Point Degeneracies in Nonlinear Coupled Oscillators** (Invited talk)
Benjamin Bradshaw, Amin Hakimi, Filippo Capolino — *University of California, Irvine, USA*
Coupled oscillator systems tend to synchronize and oscillate at the same frequency, depending on their individual system's characteristics. The oscillation frequency of the system changes more rapidly when the oscillator's characteristics are varied over the exceptional degenerate solutions to the system's eigenfrequency problem. Introducing nonlinearities in systems with exceptional point degeneracy (EPD) makes the system more complex, but steady-state analysis can reveal the resonant frequency. Applying this analysis to a coupled oscillator system with a nonlinear gain element near the EPD shows that the system's sensitivity to parameters can vary quadratically or cubically, depending on the parameter.

11:30 - 11:45 **Octupole Topological Insulating Phase In Brillouin Three-dimensional Real Projective Space**
Sichang Qiu[1], Shuo Liu[1], Ce Shang[2], Lei Zhang[1] — *[1] Southeast University, China [2] Chinese Academy of Sciences, China*
We propose and experimentally verify an octupole topological insulator in three-dimensional real projective space (RP3) using topological circuits. Corner-localized impedance peaks serve as its signature. Our findings extend the topological framework beyond toroidal Brillouin zones and offer fresh insights into band theory on non-toroidal manifolds.

11:45 - 12:00 **First-Principles Nanocircuit Model of Open Electromagnetic Resonators**
Carlo Forestiere[1], Emanuele Corsaro[2], Giovanni Miano[2], Andrea Alù[3] — *[1] University of Naples Federico II, Italy [2] Department of Electrical Engineering and Information Technology, Universit'a degli Studi di Napoli Federico II, via Claudio 21, Napoli, 80125, Italy, Italy [3] CUNY Advanced Science Research Center, USA*
We derive from first principles a general circuit model representation for open, frequency dispersive electromagnetic resonators in the full-wave regime. This model extends the concepts of input and radiation impedance to scattering modes induced in open resonators by an arbitrary external excitation. We validate the model by reproducing Mie scattering phenomena using an equivalent analog circuit.

12:00 - 12:15 **Probing Tellegen response by fast electrons**
Eduardo Barredo -Alamilla, Maxim A. Gorlach — *ITMO University, Russia*
Recent studies suggest that the Tellegen (axion) response in photonics and condensed matter systems arises from either orbital or spin contributions—two fundamentally distinct mechanisms, distinguishable only in the presence of sources. Here, we propose a Cherenkov radiation method as a novel probe of these contributions, revealing that while the total radiated power remains nearly identical, the emitted polarization differs significantly. These findings offer a direct method to probe the microscopic structure of Tellegen materials, offering new possibilities for testing new material responses.

12:15 - 12:30 **Equivalent Dipolar Moment Array Representations of PTD-Symmetric Screens**

Roee Geva[1], Mário Silveirinha[2], Raphael Kastner[1] — *[1] Tel Aviv University, Israel [2] University of Lisbon, Portugal*

The polarization inversion property of PTD - symmetric systems is linked to an equivalent representations of the system by general polarizability parameters of dipole arrays. These problem-dependent representations allow for homogeneous models that can replace complex PTD structures while preserving their polarization characteristics.

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

Advanced Computational and Deep Learning Approaches in Nanophotonics

Chairperson(s): Philipp Del Hougne, Christopher Stevens

11:00 - 11:30 **A Deep Learning Framework for Prediction and Inverse Design of Nanoscale Optical Forces near Gradient Metasurfaces** (Invited talk)
Ponthea Zahraii, Saman Kashanchi, Nooshin M. Estakhri, Nasim Mohammadi Estakhri — *Chapman University, USA*
Traditional optical tweezers use a focused laser beam to trap and manipulate nano- and micro-scale objects, subject to diffraction limit. For accurate nanoscale optical trapping and manipulation, localized sub-diffractive light management is essential. Here, we propose a dielectric gradient metasurface configuration as a rich platform for creating tailored optical forces with sub-diffractive features. We focus on accurate modeling and inverse design of optical forces in the vicinity of this multi-parameter metasurface, demonstrating the power of data-driven-based approaches for analysis and design of analogous configurations.

11:30 - 11:45 **Gradient-based Optimization Of Scatterer Arrangements Using T-matrix Approach**
Nigar Asadova[1], Renaud Vallée[2], Carsten Rockstuhl[1] — *[1] Karlsruhe Institute of Technology, Germany [2] Centre de Recherche Paul Pascal, France*
This work presents a gradient-based optimization framework for nanophotonic design within the T-matrix formalism. Spheres serve as building blocks, enabling semi-analytical computation. Automatic differentiation allows for optimization over geometric and positional parameters in finite and infinite arrangements. Applying the method to a cluster and a metasurface demonstrates its suitability for inverse design.

11:45 - 12:00 **Informed Deep Learning for Electromagnetic Scattering Using Quasinormal Modes**
Viktor Aadland Lilja, Albin Jonasson Svärdsby, Timo Gahlmann, Philippe Tassin — *Chalmers University of Technology, Sweden*
We present a neural network for electromagnetic scattering with a built-in quasinormal-mode expansion of the scattering matrix. Our approach significantly reduces the required amount of training data compared to standard neural networks by utilizing prior knowledge about the governing physics.

12:00 - 12:15 **Modal analysis for nanophotonic systems with branch cuts**
Fridtjof Betz[1], Felix Binkowski[1], Jan David Fischbach[1], Nick Feldman[2], Lin Zschiedrich[3], Carsten Rockstuhl[4], A. Femius Koenderink[2], Sven Burger[1] — *[1] Zuse Institute Berlin, Germany [2] AMOLF, The Netherlands [3] JCMwave, Germany [4] KIT, Germany*
The scattering response of periodic structures often contains pronounced features resulting from the interplay of resonances and square-root-type singularities at scattering thresholds where diffraction orders appear or vanish. These scattering thresholds correspond to branch points where different Riemann sheets of a multi-valued function meet. We demonstrate that resonances from different Riemann sheets influence the real frequency response in the vicinity of branch points, uncovering hidden resonances. The presented theory contributes to the

physical understanding of metamaterials, sensing devices, and other classes of photonic systems, and enables efficient design of improved functionalities in upcoming technologies. Media link(s): See arXiv preprint arXiv:2503.03549, https://dx.doi.org/10.48550/arXiv.2503.03549

12:15 - 12:30 **Dielectric Waveguide Networks For Computing The Solutions To Dirichlet Boundary Value Problems**
Ross Glyn Macdonald, Victor Pacheco-Peña — *Newcastle University, United Kingdom*
Networks of dielectric waveguides and wave splitters are exploited to produce approximate solutions to partial differential equations (PDEs) in the form of the Helmholtz equation. This is done via an analogy between the behavior of the networks and that of a regularly spaced finite difference grid.

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

Nonlinear, non-Hermitian and Topological Acoustics

Chairperson(s): Marc Martí Sabaté, Baile Zhang

11:00 - 11:15 **Nonlinear Scattering at an Array of Self-Excited Meta-Atoms**
Alexander K. Stoychev[1], Ulrich Kuhl[2], Nicolas Noiray[1] — *[1] ETH Zurich, Switzerland [2] Université Côte d'Azur, France*
This work examines nonlinear scattering in an array of limit cycle oscillators. A model combining a conservative resonator and a saturable gain is used to describe the basic coupled mode dynamics in the weak coupling limit and the results for a single meta-atom are shown to be consistent with experimental data. Furthermore, the derived amplitude dispersion gives a preliminary view of how radiation losses interact with self-excitation in an infinite array.

11:15 - 11:45 **Amplitude Modulated Wave Scattering on a Nonlinear Whistle** (Extended)
Zhenwei Xu[1], Ulrich Kuhl[2], Nicolas Noiray[1] — *[1] ETH Zurich, Switzerland [2] Université Côte d'Azur - CNRS, France*
This work explores synchronization-based acoustic cloaking under amplitude-modulated incident wave. We derive a relation showing how the limit cycle oscillator suppresses the input modulation, and validate experimentally by scattering acoustic waves on a 3D-printed whistle embedded in a 1D waveguide.

11:45 - 12:15 **Towards Realization Of A Compact Lossless Acoustic Circulator Based On Synchronization** (Extended)
Xinxin Guo[1], Kuhl Ulrich[2], Nicolas Noiray[1] — *[1] ETH Zürich, CAPS laboratory, Switzerland [2] Université Côte d'Azur, CNRS, Institut de Physique de Nice (INPHYNI), France*
Current realization of acoustic circulators has often been plagued by their bulky dimensions and unavoidable inherent losses. Here we show a compact 3D-printed design of a self-oscillating acoustic cavity that has great potential to achieve lossless nonreciprocal transmission based on a synchronization mechanism. In the absence of external excitation, we generate self-sustained spinning acoustic modes by injecting swirling airflow into the cavity. An acoustic Zeeman effect is experimentally observed. The control over the flow rate allows the spinning to be adjusted in clockwise and counterclockwise directions, respectively. We then introduce an external acoustic source allowing to control the spinning direction of the mode. Our results hold great promise for the future development of networks of nonlinear acoustic circulators.

12:15 - 12:30 **Minimum-phase reflection for passive acoustic absorbers with target absorption spectrum and minimum volume**
Yang Meng[1], Hao Dong[2], Éric Ballestero[1], Simon Félix[1], Gwénaël Gabard[1], Jean-Philippe Groby[1] — *[1] CNRS, UMR 6613 - LAUM, France [2] CNRS, CNRS 8006 - PIMM, France*
This work shows that, among the possible designs of a 1D system achieving a target absorption spectrum, the one with minimum-phase reflection displays the minimum total volume, making this design optimal for practical use. Minimum-phase reflection implies that all the zeros and poles of the reflection coefficient lie in the same half complex-frequency plane. Based on the magnitude-phase relationship satisfied by a minimum-phase system, a design strategy is proposed to develop passive acoustic absorbers that achieve the theoretical minimum volume for a given target absorption spectrum.

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

Metamaterials for Thermal Radiation

Chairperson(s): Andrea Alu, Mark Brongersma

11:00 - 11:30 **Photonic Strategies for Enhanced Heat Management and Performance in Photovoltaics** (Invited talk)
Maria Kafesaki[1], Anna Tasolamprou[2], George Perrakis[3] — *[1] FORTH and University of Crete, Greece [2] FORTH and University of Athens, Greece [3] FORTH, Greece*
We present our recent research on solar cell passive radiative cooling and other photonic cooling approaches, leading lower temperatures and improved efficiency in different photovoltaic devices, including silicon, organic and perovskite solar cells.

11:30 - 11:45 **Exploring Plasmonic MetaSurface: Opportunities in Photothermal Catalysis and Advanced Thermal Emitters.**
Samira Mehrabi, Richard Zhang, Nazir Kherani — *university of toronto, Canada*
MetaSurfaces enable precise control over electromagnetic and thermal radiation at subwavelength scales. They enhance photothermal heating, concentrate electromagnetic energy for catalytic reactions, while also serving as thermal emitters with tuned emissivity for efficient heat management utilization. These functionalities can advance heterogeneous catalysis, optimizing energy conversion and chemical processes in sustainable applications.

11:45 - 12:00 **Enhancement of the spontaneous emission rate in extreme hybrid nanophotonic cavities.**
Themistoklis Deloudis, Angus Crookes, Angela Demetriadou — *University of Birmingham, United Kingdom*
Optical nanocavities constitute environments that enhance the spontaneous decay rate of emitters placed inside them. Nonetheless, the intrinsic disadvantages that stem from the material of the cavity prevent the emission rate from reaching ultra high values. Recently, high finesse hybrid structures have been proposed to overcome these restrictions. However, the majority of these cavities operate at telecommunication wavelengths. In our work, we design a hybrid nanocavity with dielectric and plasmonic parts, which yields a four fold enhancement of the spontaneous emission decay rate compared with its isolated constituents while operating in the optical spectrum. Furthermore, the size and shape of our hybrid nanocavity are such that a quantum network is easily formable by fabricating a sequence of these cavities that spans a large distance.

12:00 - 12:30 **Kirchhoff's laws of thermal radiation for complex, nonreciprocal, and time-varying materials** (Invited talk)
Sander Mann[1], Dimitrios Sounas[2], Mingze He[3], Andrea Alù[3] — *[1] University of Amsterdam, Netherlands [2] Wayne State University, USA [3] CUNY ASRC, USA*
Absorption and emission of thermal radiation can be manipulated in novel and unintuitive ways in advanced metamaterial environments. We present fundamental relationships between the emission and absorption in complex, nonreciprocal, and time-varying materials, and discuss resulting fundamental bounds.

Oral Sessions (Monday Afternoon 1)

Technologies and Modeling Approaches for Reconfigurable Microwave Metasurfaces
Chairperson(s): Sergei Tretyakov, Arthur Yaghjian **Room: Concertzaal**

Time	1st author	Title
14:00 - 14:30	Alessio Monti	Plasma-Based Metastructures for Reconfigurable Microwave Devices
14:30 - 15:00	Philipp Del Hougne	Mutual Coupling in Reconfigurable Wave Systems
15:00 - 15:30	Antonio Clemente	Wavefront Control using Transmissive Electromagnetic Surfaces: from PIN Diode based Architectures to Advanced Microelectronic Technologies

Physics of Complex EM Media II
Chairperson(s): Che Ting Chan, Maxim Gorkunov **Room: Shaffyzaal**

Time	1st author	Title
14:00 - 14:30	Said Rahimzadeh Kalaleh Rodriguez	Continuous-Wave Nonlinear Polarization Control and Signatures of Criticality in a Perovskite Cavity
14:30 - 14:45	Ioannis Katsantonis	Quantum Metasurfaces for Enhancement of Reverse Saturable Absorption
14:45 - 15:00	Clément Ferise	Optimal matrix-based spatiotemporal wave control in disordered media
15:00 - 15:15	Florin Hemmann	Effect of Disorder in 3D Photonic Networks on their Photonic Band Gaps
15:15 - 15:30	Alex Schuchinsky	Mechanisms of Passive Intermodulation in Contact Junctions of Good Conductors

Metamaterials and Nanophotonics Enabled Novel Metrology
Chairperson(s): Paloma Arroyo Huidobro **Room: Teekenzaal I**

Time	1st author	Title
14:00 - 14:30	Nikolay Zheludev	Harnessing Fisher Information for Optical Metrology with Plasmonics and Topological light
14:30 - 14:45	Falco Bijloo	Deeply Subwavelength Critical Dimension Metrology with Structured Void Metasurfaces
14:45 - 15:00	Nick Feldman	Information Advantage In Sensing Revealed By Fano Resonant Fourier Scatterometry
15:00 - 15:30	Ekaterina Shamonina	Neural Network-Based Conductivity Imaging Using Time-Domain Reflectometry

Advanced Analytical Methods in Metamaterials and Metasurfaces
Chairperson(s): Carlo Forestiere, Sander Mann **Room: Teekenzaal II**

Time	1st author	Title
14:00 - 14:30	Alexander Kildishev	Susceptibility of Time-Variant Metamaterial Systems: Classical Convolution vs. ODEs with Non-local Forcing
14:30 - 14:45	Hossein Allahverdizadeh	GSTCs A Connection To Exact Spherical Multipoles
14:45 - 15:00	Jan David Fischbach	Efficient Description of Meta-Atoms: On the Pole Expansion of the T-matrix
15:00 - 15:15	Luis Manuel Máñez Espina	Revisiting Bianisotropic Photonics with Coupled-Mode Theory
15:15 - 15:30	Rémi Colom	Phase singularies in resonant metasurfaces

Two-dimensional Materials
Chairperson(s): Yohannes Abate, Anna Tasolamprou **Room: Koepelzaal**

Time	1st author	Title
14:00 - 14:30	Su-Hyun Gong	Multilayered Transition Metal Dichalcogenides as Platforms for Nanophotonic Applications
14:30 - 14:45	Cristina Cruciano	Ultrafast Dynamics of Strongly Coupled Bound State in the Continuum in a WS2 Metasurface
14:45 - 15:00	Alvaro Roriguez Echarri	Smith-Purcell Lensing using 2D-nanoribbon Metasurfaces
15:00 - 15:30	Nahid Talebi	Exciton Transfer Mechanisms in Ruddlesden Popper Perovskites Probed by Cathodoluminescence and Photoluminescence Spectroscopy

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

Technologies and Modeling Approaches for Reconfigurable Microwave Metasurfaces

Chairperson(s): Sergei Tretyakov, Arthur Yaghjian

14:00 - 14:30 **Plasma-Based Metastructures for Reconfigurable Microwave Devices** (Invited talk)
Alessio Monti[1], Mohammad G. H. Alijani[1], Mirko Barbuto[1], Stefano Vellucci[2], Alessandro Toscano[1], Filiberto Bilotti[1] — *[1] Roma Tre University, Italy [2] Niccolò Cusano University, Italy*
Reconfigurability is a key requirement for future wireless systems, enabling dynamic control of electromagnetic behavior. Metastructures offer an effective way to embed reconfigurability into conventional components like antennas. Among various tuning methods, the use of plasma discharges is particularly attractive due to their wide tunability, fast response, and high-frequency compatibility. In this talk, we present some examples of plasma-based metastructures for microwave applications: a horn antenna with a reconfigurable plasma superstrate, and a tunable metagrating based on plasma cylinders. We demonstrate how controlling plasma parameters enables beam steering and pattern shaping.

14:30 - 15:00 **Mutual Coupling in Reconfigurable Wave Systems** (Invited talk)
Philipp Del Hougne — *CNRS, IETR - Univ Rennes, France*
Dynamic metasurface antennas (DMAs), reconfigurable intelligent surface (RISs), and wave-based physical neural network (PNNs) are prominent contemporary examples of reconfigurable wave systems. Due to mutual coupling, their transfer functions depend in general non-linearly on the configuration of their tunable elements. Mutual coupling is hence often mitigated to simplify the configuration optimization. However, this reasoning overlooks that mutual coupling boosts the strength of the transfer function dependence on the tunable elements' configurations. First, I will present theoretical, numerical, and experimental evidence to demonstrate that the control over a DMA's radiation pattern substantially increases with the mutual coupling strength. Second, to reap this benefit of mutual coupling, I will pave the way toward in-software model-based optimizations of reconfigurable wave systems. Specifically, I will discuss a universal model-based framework for wave control in reconfigurable wave systems. I will report experimental evidence showing that the Virtual VNA method can unambiguously retrieve the model parameters, even for non-reciprocal systems and under limitations to non-coherent detection.

15:00 - 15:30 **Wavefront Control using Transmissive Electromagnetic Surfaces: from PIN Diode based Architectures to Advanced Microelectronic Technologies** (Invited talk)
Antonio Clemente — *CEA, Leti, France*
Programmable electromagnetic (EM) surfaces and/or metasurfaces offer a highly effective solution for electronically shaping, controlling and manipulating EM waves. This ability opens up a myriad of possibilities across various fields, including telecommunications, radar, imaging, sensing, and even cloaking technology. Unlike traditional phased arrays, which rely on phase shifters and power amplifiers, programmable EM surfaces are typically passive radiative architectures. They integrate components such as varactors, RF-MEMS, p-i-n diodes, varactors, or liquid crystals to electronically control the local surface phase gradient and / or impedance characteristics. Based on the technology used in the unit cell (UC), EM surfaces can be classified

as active or passive. Active EM surfaces amplify reflected or transmitted signals using active elements in the UCs, while passive ones use low-loss reactive components to implement either continuous or quantized phase shifts, resulting in energy-efficient devices.

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

Physics of Complex EM Media II

Chairperson(s): Che Ting Chan, Maxim Gorkunov

14:00 - 14:30 **Continuous-Wave Nonlinear Polarization Control and Signatures of Criticality in a Perovskite Cavity** (Invited talk)
Said Rahimzadeh Kalaleh Rodriguez — *AMOLF, Netherlands*
We present the first observation of continuous wave nonlinear phenomena in a halide perovskite. Using an optical cavity containing a perovskite crystal, we demonstrate optical bistability, nonlinear control over the polarization state of light, and signatures of criticality.

14:30 - 14:45 **Quantum Metasurfaces for Enhancement of Reverse Saturable Absorption**
Ioannis Katsantonis, Maria Kafesaki — *FORTH and University of Crete, Greece*
Reverse saturable absorption (RSA) occurs in nonlinear materials where the excited state exhibits higher absorption than the ground state. This study develops a full-wave spatio-temporal numerical model coupling quantum systems with Maxwell's equations to accurately simulate RSA. By integrating RSA materials with metasurfaces, we achieve over twice the absorption enhancement compared to a bare layer. This approach enables the design of low-power, highly efficient optical absorption devices, with applications in protective optics and photonic components.

14:45 - 15:00 **Optimal matrix-based spatiotemporal wave control in disordered media**
Clément Ferise, Philipp Del Hougne, Matthieu Davy — *University of Rennes, France*
We present and experimentally verify a matrix approach to identifying optimal input wavefront in both space and time domain for arbitrary wave-control functionality, irrespective of the complexity of wave scattering. We leverage a singular value decomposition of a transport matrix that fully captures how both the spatial and temporal degrees of freedom available to shape the input wavefront impact the output wavefront's spatial and temporal form.

15:00 - 15:15 **Effect of Disorder in 3D Photonic Networks on their Photonic Band Gaps**
Florin Hemmann, Vincent Glauser, Ullrich Steiner, Matthias Saba — *Adolphe Merkle Institute, University of Fribourg, Switzerland*
Complete photonic band gaps are frequency domains where light cannot enter a dielectric structure from any angle due to an interference-induced vanishing density of states. Band gaps can be found in binary structures with high dielectric contrast above 4. These phenomena are well understood for periodic systems, so-called photonic crystals, but band gaps are also found in amorphous photonic networks. Here, we investigate how different types of disorder in the network's simplices affect the photonic density of states. Using a Metropolis Monte Carlo algorithm, we generate a large population of 3D random networks with tunable statistics in the bond angle and length distribution. We calculate the photonic density of states of these random networks and correlate it to the statistical variations.

15:15 - 15:30 **Mechanisms of Passive Intermodulation in Contact Junctions of Good Conductors**
Alex Schuchinsky, Yi Huang — *University of Liverpool, United Kingdom*

The concurrent multiphysics effects of charge tunnelling, and contact thermal and mechanical deformations are studied in joints of conductors with rough surfaces. It is shown that the charge tunnelling is dominant in the nonlinear contact resistance whilst the effects of heating and mechanical deformations are weaker.

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

Metamaterials and Nanophotonics Enabled Novel Metrology

Chairperson(s): Paloma Arroyo Huidobro

14:00 - 14:30 **Harnessing Fisher Information for Optical Metrology with Plasmonics and Topological light** (Invited talk)
Cheng-Hung Chi[1], Huanli Zhou[1], Thomas Grant[1], Stefan Rotter[2], Kevin Macdonald[1], Nikolay Zheludev[1] — *[1] University of Southampton, United Kingdom [2] Vienna University of Technology, Austria*
In optical metrology, the limit of precision depends on the total Fisher information accessible in a measurement. We show that the flow of Fisher information can be enhanced by using topologically structured light and resonant plasmonic structures and that the total amount of Fisher information can be resonantly enhanced with plasmonic cavities. Optical metrology with sub-atomic precision (λ/10,000) is demonstrated that traces the positional coordinate of a nanowire exhibiting Brownian motion with a sampling frequency of 1MHz.

14:30 - 14:45 **Deeply Subwavelength Critical Dimension Metrology with Structured Void Metasurfaces**
Falco Bijloo[1], Arie Den Boef[2], Peter Kraus[3], Femius Koenderink[4] — *[1] Center for Nanophotonics, NWO Institute AMOLF, and NWO Institute ARCNL, Netherlands [2] ASML BV and NWO Institute ARCNL, Netherlands [3] NWO Institute ARCNL, Netherlands [4] Center for Nanophotonics, NWO Institute AMOLF, Netherlands*
Fano resonances in dielectric metasurfaces, arising from quasi-bound states in the continuum, show extreme sensitivity to nanoscale geometric perturbations. We exploit this sensitivity to detect minute linewidth variations by structurally infilling the voids of a dielectric disk-hole metasurface. This approach offers high-throughput and sensitivity critical dimension metrology in semiconductor manufacturing.

14:45 - 15:00 **Information Advantage In Sensing Revealed By Fano Resonant Fourier Scatterometry**
Nick Feldman[1], Arie Den Boef[2], Lyuba Amitonova[3], Femius Koenderink[4] — *[1] Center for Nanophotonics, NWO Institute AMOLF, and NWO Institute ARCNL, Netherlands [2] ASML BV and NWO Institute ARCNL, Netherlands [3] NWO Institute ARCNL, Netherlands [4] Center for Nanophotonics, NWO Institute AMOLF, Netherlands*
We experimentally demonstrate that analyzing the scattering of a Fano resonant metasystem in k-space provides quantitatively more information in a sensing context compared to conventional analysis of spectral lineshapes. We thoroughly characterize deeply subwavelength structural perturbations within dielectric Fano resonant metarings using a dark-field spectroscopic approach, and a Fourier scatterometry based approach, and show that perturbations can induce pronounced resonant directional scattering in k-space. Finally, by using information theory, we quantitatively compare these two sensing strategies by evaluating their inherent Fisher information content, and show that an information advantage can be gained from a k-space measurement.

15:00 - 15:30 **Neural Network-Based Conductivity Imaging Using Time-Domain Reflectometry** (Invited talk)

Xinying Li[1], Georgiana Dima[1], Anna Radkovskaya[1], Jiaruo Yan[2], Chris Stevens[1], Laszlo Solymar[1], Ekaterina Shamonina[1] — *[1] University of Oxford, UK [2] FORTH-IESL, Greece*

We present a neural network-based approach for sensing conductive objects using time-domain reflectometry of magnetoinductive (MI) waves in metamaterials with inter-element coupling. Our method significantly improves previously reported accuracy and expands the detection range, enabling simultaneous localisation of multiple conductive objects and paving the way for real-time, contactless imaging of inhomogeneous conductive media, with potential applications ranging from 3D printing quality control to medical imaging.

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

Advanced Analytical Methods in Metamaterials and Metasurfaces

Chairperson(s): Carlo Forestiere, Sander Mann

14:00 - 14:30 **Susceptibility of Time-Variant Metamaterial Systems: Classical Convolution vs. ODEs with Non-local Forcing** (Invited talk)
Alexander Kildishev, Ludmila Prokopeva — *Elmore Family School of Electrical and Computer Engineering, Birck Nanotechnology Center and Purdue Quantum Science and Engineering Institute, Purdue University, West Lafayette, IN 47907, USA, USA*
We investigate the relationship between convolution integral representation and differential equations for disordered and time-variant systems with Gaussian-damped sinusoidal impulse response. While the impulse response satisfies a specific ordinary differential equation (ODE), we demonstrate that the general response does not satisfy this same equation. We derive an alternative ODE formulation that preserves the standard convolution form while adaptively accounting for time-variance through time and input-dependent terms. Numerical validation confirms agreement between the proposed adaptive ODE solutions and exact convolution results for various input signals. This approach enables efficient time-domain numerical schemes with controlled accuracy bounds for modeling susceptibility in metasystems with spatial disorder and external temporal control.

14:30 - 14:45 **GSTCs A Connection To Exact Spherical Multipoles**
Hossein Allahverdizadeh, Karim Achouri — *École Polytechnique Fédérale de Lausanne (EPFL), Switzerland*
Metasurfaces manipulate electromagnetic properties using subwavelength structures. Traditional GSTC methods focus on far-field effects, neglecting near-field distributions. This work extends GSTC via multipolar decomposition, linking near- and far-fields while accommodating oblique incidence and different background media. It provides a systematic approach to analyzing metasurface behavior in complex environments.

14:45 - 15:00 **Efficient Description of Meta-Atoms: On the Pole Expansion of the T-matrix**
Jan David Fischbach[1], Fridtjof Betz[2], Felix Binkowski[2], Sven Burger[3], Martin Hammerschmidt[4], Markus Nyman[1], Carsten Rockstuhl[5] — *[1] Institute of Nanotechnology at Karlsruhe Institute of Technology, Germany [2] Zuse Institute Berlin, Germany [3] Zuse Institute Berlin, JCMwave GmbH, Germany [4] JCMwave GmbH, Germany [5] Institute of Nanotechnology at Karlsruhe Institute of Technology, Institute of Theoretical Solid State Physics at Karlsruhe Institute of Technology, Germany*
The transition matrix (T-matrix) encapsulates the linear scattering properties of meta-atoms. Conventionally one T-matrix is calculated per frequency, resulting in excessive computational costs when treating metamaterials supporting sharp resonances. Instead, we introduce a pole expansion representation of the frequency dependent T-matrix via the AAA algorithm for rational approximation.

15:00 - 15:15 **Revisiting Bianisotropic Photonics with Coupled-Mode Theory**
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*

Metasurfaces have been extensively studied using homogenization techniques, which leverage the subwavelength nature of meta-atoms to model their electromagnetic response. While these approaches are effective in the microwave regime, they face challenges at optical frequencies due to weaker mode confinements and larger sizes of the meta-atoms compared to the wavelength. Coupled-mode theory has emerged as a powerful phenomenological model to describe resonant behavior in photonic structures. In this work, we explore the connection between coupled-mode theory and the bianisotropic homogenization models. By analyzing the interplay between the mode coupling strength and bianisotropic effects, we establish a direct relationship between resonant mode interactions and metasurface scattering properties. Our findings provide new insights into the physics of photonic metastructures and offer a unified perspective for modeling their electromagnetic behavior.

15:15 - 15:30 **Phase singularies in resonant metasurfaces**
Rémi Colom — *Universite Cote d'Azur, CNRS, CRHEA, France*
Metasurfaces are non-Hermitian systems prone to scattering and absorptive losses, leading to resonances with finite lifetimes tied to complex eigenfrequencies. Studying the optical response at complex frequencies provides insights into their behavior. Here, we highlight the role of phase singularities in response functions (like reflection and transmission coefficients) at complex frequencies and their impact on the optical response at real frequencies.

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

Two-dimensional Materials

Chairperson(s): Yohannes Abate, Anna Tasolamprou

14:00 - 14:30 **Multilayered Transition Metal Dichalcogenides as Platforms for Nanophotonic Applications** (Invited talk)
Su-Hyun Gong — *Korea University, Korea (South)*
Multilayered transition metal dichalcogenides (TMDs) offer a versatile platform for nanophotonic applications. With high dielectric constants, they enable exciton-polariton waveguiding and enhanced light control. Recent demonstrations include ultra-thin waveguides, Mach-Zehnder interferometers, and unidirectional radiation from bilayer metasurfaces, showcasing their potential for advanced light manipulation.

14:30 - 14:45 **Ultrafast Dynamics of Strongly Coupled Bound State in the Continuum in a WS2 Metasurface**
Cristina Cruciano[1], Luca Sortino[2], Armando Genco[1], Michele Guizzardi[1], Jonathan O. Tollerud[3], Thomas Weber[2], Francesco Gucci[1], Daniel Timmer[4], Matteo Corti[1], Gianluca Valentini[1], Cristian Manzoni[5], Christoph Lienau[4], Stefano Dal Conte[1], Jeffrey A. Davis[3], Stefan A. Maier[6], Andreas Tittl[2], Giulio Cerullo[1] — *[1] Dipartimento di Fisica, Politecnico di Milano, Piazza Leonardo Da Vinci 32, Milano, 20133, MI, Italy, Italy [2] Ludwig-Maximilians-Universität München, Faculty of Physics, Chair in Hybrid Nanosystems, 80539 Munich, Germany, Germany [3] Optical Sciences Centre, Swinburne University of Technology, Hawthorn, Victoria 3122, Australia, Australia [4] Physics Department and Center for Nanoscale Dynamics (CeNaD), Carl von Ossietzky Universität Oldenburg, D-26129 Oldenburg, Germany, Germany [5] Istituto di Fotonica e Nanotecnologie (IFN), CNR, Piazza Leonardo da Vinci 32, I-20133 Milano, Italy, Italy [6] School of Physics and Astronomy, Monash University, Clayton, Victoria 3800, Australia, Australia*
We study a WS2 metasurface that supports strong coupling between photonic bound state in the continuum and exciton, exploiting k-space and pump-probe spectroscopy to characterize the dispersion and the ultrafast dynamics of the sample.

14:45 - 15:00 **Smith-Purcell Lensing using 2D-nanoribbon Metasurfaces**
Alvaro Roriguez Echarri[1], Eduardo Dias[2], Joel Cox[2], Albert Polman[1], Javier García De Abajo[3] — *[1] Center for Nanophotonics, NWO Institute AMOLF, Netherlands [2] POLIMA - Center for Polariton-driven Light - Matter Interactions, University of Southern Denmark, Denmark [3] ICFO - Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, Spain*
In this work, we explore the interaction of swift electrons with metasurfaces to create radiation via the so-called Smith-Purcell effect. From a theory viewpoint, we introduce a scheme to actively control the light-matter interaction properties and structure the emitted light using 2D nanoribbons.

15:00 - 15:30 **Exciton Transfer Mechanisms in Ruddlesden Popper Perovskites Probed by Cathodoluminescence and Photoluminescence Spectroscopy** (Invited talk)
Maximilian Black, Paul H. Bittorf, Sara Darbari, Parsa Darman, Masoud Taleb, Yaser Abdi, Nahid Talebi — *Kiel University, Germany*

We explore the underlying mechanisms for the formation of self-hybridized exciton polaritons as well as excitonic diffusion in hybrid perovskites and hexagonal boron nitride heterostructures. Enabled by a newly-developed fiber-based cathodoluminescence detector, we demonstrate an ultra-long diffusion mechanism enabled by exciton-defect coupling in perovskite and hexagonal boron nitride heterostructures.

Oral Sessions (Monday Afternoon 2)

Physical Review Special session
Chairperson(s): Jerry Dadap **Room: Shaffyzaal**

Time	1st author	Title
16:00 - 16:30	Emanuele Galiffi	Steering Loss with Hyperbolic Shear Metasurfaces
16:30 - 17:00	Meera Ramaswamy	Programmable Viscosity Metafluids: Designing fluid properties using temporal superposition of shear and acoustics
17:00 - 17:30	Che Ting Chan	Topological Photonics Without Periodicity: Photonic Alloy
17:30 - 18:00	Alejandro Rodriguez	Approaching the limits of passive bandwidth-integrated optical response: Maximum cloaking and Purcell enhancement in structured media

Time-Varying Photonics I
Chairperson(s): Nikolay Zheludev, Alexander Kildishev **Room: Teekenzaal I**

Time	1st author	Title
16:00 - 16:30	John Pendry	Modulating Optical Properties in Time Using Plasmonic Resonances
16:30 - 17:00	Paloma Arroyo Huidobro	Time-varying nanophotonics
17:00 - 17:15	Matteo Ciabattoni	Temporal Degrees of Freedom, Causality, and Fundamental Limits in Electromagnetics and Photonics
17:15 - 17:30	Marino Coppolaro	Photonic Time Quasicrystals
17:30 - 17:45	Mohamed H. Mostafa	Adiabatic Photonic Time Crystals in an Optical Cavity
17:45 - 18:00	Jinxiang Li	Nonlinear Optical Response in a Time Crystal

Non-reciprocal and Topological EM Metamaterials
Chairperson(s): Nasim Mohammadi Estakhri, Rachel Grange **Room: Teekenzaal II**

Time	1st author	Title
16:00 - 16:15	Zhe Zhang	Renormalization Group of Topological Scattering Networks under Strong Disorder
16:15 - 16:30	João C. Serra	Gain-Momentum Locking in Chiral-Gain Systems
16:30 - 17:00	Anna Tasolamprou	Investigation of THz graphene plasmons with nonlinear effects enhanced by photonic topological surface states
17:00 - 17:15	Guilherme Fonseca	Large Gap Chern Numbers in Electromagnetic Continua
17:15 - 17:30	Rodrigo Câmara	Non-Abelian Geometric Phases for Polarization Control in Metallic Waveguides
17:30 - 18:00	Baile Zhang	Photonic Axion Insulator

Quantum Materials and Light Emission
Chairperson(s): Nahid Talebi, Said Rahimzadeh Kalaleh Rodriguez **Room: Koepelzaal**

Time	1st author	Title
16:00 - 16:30	Mark Brongersma	Light Manipulation with Atomically-thin Metasurfaces
16:30 - 16:45	Matthew Belzer	Designing Quantum Metamaterials in Waveguide QED via Physics-Informed Gradient- Descent Methods
16:45 - 17:00	Carlo Forestiere	Quantum emitter interacting with a dispersive dielectric object: a model based on the modified Langevin noise formalism
17:00 - 17:15	Yinhui Kan	High-Dimensional Arbitrary Spin-Orbital Quantum Light Sources
17:15 - 17:30	Tianshuo Lyu	On-Chip Orbital Angular Momentum Photon Sources via Integration of Quantum Emitters in Metasurface-Decorated Waveguides
17:30 - 18:00	Yohannes Abate	Nanoscale Molecular and Ionic Diffusion for Reconfigurable Quantum Materials

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

Physical Review Special session

Chairperson(s): Jerry Dadap

16:00 - 16:30 **Steering Loss with Hyperbolic Shear Metasurfaces** (Invited talk)
Emanuele Galiffi[1], Simon Yves[2], Enrico Maria Renzi[3], Andrea Alu[3] — *[1] Advanced Science Research Center, City University of New York, USA [2] Institut Langevin, ESPCI, Paris, France [3] Advanced Science Research Center, City University of New York, United States*
Following the recent discovery of hyperbolic shear polaritons in monoclinic materials, we introduce hyperbolic shear metasurfaces, enabling loss mitigation for hyperbolic metamaterials. In these metastructures, thanks to the frequency-dependent rotation of the optical axis caused by the coupling between in-plane polarizability components, dissipative processes are diverted towards one hyperbolic arm, while dramatically reducing the effect of loss of the opposite one, leading to long-lived hyperbolic modes with enhanced tunability and directionality.

16:30 - 17:00 **Programmable Viscosity Metafluids: Designing fluid properties using temporal superposition of shear and acoustics** (Invited talk)
Meera Ramaswamy[1], Prateek Sehgal[2], Edward Y. X Ong[2], Christopher Ness[3], Itai Cohen[2], Brian Kirby[2] — *[1] Princeton University, USA [2] Cornell University, USA [3] University of Edinburgh, United Kingdom*
Metamaterials are composite structures whose extraordinary properties arise from a mesoscale organization of their constituents. Here, we introduce a new material class– viscosity metafluids. Specifically, we demonstrate that we can rapidly drive large viscosity oscillations in shear-thickened fluids using acoustic perturbations with kHz to MHz frequencies. Because the time scale for these oscillations can be orders of magnitude smaller than the timescales associated with the global material flow, we can construct metafluids whose resulting time averaged viscosity is a composite of the thickened, high-viscosity and dethickened, low-viscosity states. We show that viscosity metafluids can be used to engineer a variety of unique properties including zero, infinite and negative viscosities. The high degree of control over the resulting viscosity, the ease with which they can be accessed, and the variety of exotic properties achievable make viscosity metafluids attractive for uses in technologies ranging from coatings to cloaking to 3D printing.

17:00 - 17:30 **Topological Photonics Without Periodicity: Photonic Alloy** (Invited talk)
Che Ting Chan — *HKUST, Hong Kong*
We introduce the notion of photonic alloys, a new class of disordered topological materials realized in 2D magnetic photonic crystals. Photonic alloys exhibit topological characteristics, including chiral edge states, even at low concentrations of magnetized rods. The topology is characterized by the winding of the reflection phase, which remains well-defined without a band structure.

17:30 - 18:00 **Approaching the limits of passive bandwidth-integrated optical response: Maximum cloaking and Purcell enhancement in structured media** (Invited talk)
Alejandro Rodriguez — *Princeton University, USA*
We present recent optimization results relating to the problems of modifying the bandwidth-integrated cloaking and local-density of states, including bounds and scaling laws for finite

bandwidth sources. We also demonstrate the possibility of designing scatterers approaching these limits by introducing a “verlan” method that exploits local and global wave information encoded in performance bounds to guide inverse design towards better-performing structures, highlighting the possibility of accessing significant untapped performance improvements.

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

Time-Varying Photonics I

Chairperson(s): Nikolay Zheludev, Alexander Kildishev

16:00 - 16:30 **Modulating Optical Properties in Time Using Plasmonic Resonances** (Invited talk)
John Pendry — *Imperial College London, United Kingdom*
With the growing interest in extreme time modulation of material properties attention has turned to materials such as Indium Tin Oxide which is commonly doped to give a Fermi energy of around 1eV and plasma frequency,, of similar magnitude. Thin films of ITO are transparent to visible light with frequency well above . It is well known that heating the electrons with a fast laser pump pulse lowers and hence switches between opaque and transparent for near IR radiation. Along with extremely rapid switching times of the order of the few cycles, contrast levels of the order of 50% are commonly observed. Basics of the mechanism are understood: rapid heating of electrons followed by slow equilibration with lattice phonons. Controversy over details remains, but recent experiments shed light on the time scales of the several processes taking place. Experiments in Sapienza's group at Imperial College revealed the existence of extremely fast processes by generating Young's fringes in frequency. It was evident from these experiments that switching happened faster than any of the known time scales: 100fs pulse width for the pump and probe, 300fs electron-electron scattering time. The origin of the fast event will remain a mystery until the excitation process can be probed with single cycle pulse widths.

16:30 - 17:00 **Time-varying nanophotonics** (Invited talk)
Paloma Arroyo Huidobro — *Universidad Autónoma de Madrid, Spain*
The optical response of nanophotonic implementations of photonic time crystals will be discussed. Optical scattering by time-modulated, frequency-dispersive, slabs and nanoparticles is fundamentally different from scattering by their static counterparts. Optical modes sustained by these nanophotonic structures interact through the temporal modulation, giving rise to different instances of complex-frequency band gaps, which host amplifying states.

17:00 - 17:15 **Temporal Degrees of Freedom, Causality, and Fundamental Limits in Electromagnetics and Photonics**
Matteo Ciabattoni, Mohammadreza Salehi, Francesco Monticone — *Cornell University, USA*
Using time as an additional degree of freedom in electromagnetism, photonics, and wave physics is attracting significant research interest, motivated by the possibility of creating efficient electromagnetic and photonic devices, potentially surpassing various well-established performance limits. Many of these physical limits are derived under assumptions of linearity and time-invariance and are deeply related to the principle of causality. We will briefly review these ideas, and will then discuss some of our latest research efforts.

17:15 - 17:30 **Photonic Time Quasicrystals**
Marino Coppolaro, Massimo Moccia, Giuseppe Castaldi, Vincenzo Galdi — *University of Sannio, Italy*
We introduce a framework for analyzing photonic time quasicrystals (PTQCs) using substitutional sequences to model aperiodic temporal modulations. Extending trace map methods to

the time domain, we examine wave transport and spectral properties, focusing on the Thue-Morse sequence. Our findings reveal distinctive PTQC behaviors, including multiscale spectra and localization effects, with potential for advanced photonic applications.

17:30 - 17:45 **Adiabatic Photonic Time Crystals in an Optical Cavity**
Mohamed H. Mostafa[1], Emanuele Galiffi[2], Shixiong Yin[2], Sergei Tretyakov[1], Andrea Alù[2] — *[1] Aalto University, Finland [2] Advanced Science Research Center, City University of New York, United States of America*
Experimental realizations of photonic momentum bandgaps have been constrained to radio frequencies, as the typical slow relaxation times of dispersive optical materials constitute a key bottleneck to their realization at higher frequencies. Here, we demonstrate that to realize a photonic momentum bandgap, it is sufficient that only the rise in the refractive index occurs rapidly, while the relaxation process can proceed adiabatically, without any speed limitations, as long as the phase accumulation during the relaxation time is accounted for. This approach paves the way for the observation and use of momentum bandgaps at near-optical frequencies.

17:45 - 18:00 **Nonlinear Optical Response in a Time Crystal**
Jinxiang Li[1], Giorgio Adamo[1], Nikolay Zheludev[2] — *[1] Nanyang Technological University, Singapore [2] University of Southampton, United Kingdom*
We report on the nonlinear optical properties of a Time Crystal in the mobilized state. In a metamaterial made of nonreciprocally coupled dielectric nanowires, a control light modulates the amplitude and frequency of the mobilized state oscillations leading to nonlinear mixing of the mobilized state and control light frequencies.

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

Non-reciprocal and Topological EM Metamaterials

Chairperson(s): Nasim Mohammadi Estakhri, Rachel Grange

16:00 - 16:15 **Renormalization Group of Topological Scattering Networks under Strong Disorder**
Zhe Zhang, Romain Fleury — *École Polytechnique Fédérale de Lausanne EPFL, Switzerland*
Strong disorder localizes bulk states, and can induce the so-called Anderson insulating phase. The only possibility to escape from this trivialization lies on the anomalous Floquet Anderson insulating phase- a unique phase in Floquet topological systems- where topological chiral edge states survive and fill all the quasienergy spectrum. Exploring such topological phases and phase diagrams in strongly disordered systems is of both theoretically and practically crucial. However, it requires new theoretical tools beyond traditional Hamiltonian-based methods and topological band invariants. Here, we introduce a novel real-space renormalization group (RG) scheme tailored specifically to unitary scattering networks under strong disorder. Our RG approach utilizes iterative block-scattering transformations, preserving crucial topological scattering characteristics. By doing so, we identify robust scattering attractors distinguishing trivial Anderson insulators from anomalous Floquet Anderson insulators, allowing the definition of a topological phase diagram even under strong disorder. Numerical validations through scaling analyses on localization length, along with experimental demonstrations using microwave scattering networks, confirm our findings. This RG framework thus advances understanding and enables efficient prediction and design of topologically resilient systems especially via unique Floquet topological phases.

16:15 - 16:30 **Gain-Momentum Locking in Chiral-Gain Systems**
João C. Serra[1], Nader Engheta[2], Mário G. Silveirinha[1] — *[1] Universidade de Lisboa - Instituto Superior Técnico and Instituto de Telecomunicações, Portugal [2] University of Pennsylvania, USA*
Asymmetric light flows in linear systems are typically achieved by breaking time-reversal symmetry. In this work, we discuss how non-Hermitian effects in time-reversal symmetric platforms can lead to nonreciprocal responses driven by chiral-gain. In particular, we prove that truncated chiral-gain media may exhibit a “gain-momentum locking” effect, where waves are amplified or attenuated depending on the direction of propagation.

16:30 - 17:00 **Investigation of THz graphene plasmons with nonlinear effects enhanced by photonic topological surface states** (Invited talk)
Anna Tasolamprou[1], Spyros Doukas[1], Ioannis Katsantonis[2], Thomas Koschny[3], Elefterios Lidorikis[4] — *[1] National and Kapodistrian University of Athens [2] Institute of Electronic Structure and Laser, Foundation of Research and Technology Hellas, Greece [3] Ames Laboratory and Department of Physics and Astronomy, Iowa State University, USA [4] Department of Materials Science and Engineering, University of Ioannina, Greece*
We investigate third harmonic generation from a graphene-ribbon configuration that supports plasmonic excitations, with efficiency enhanced by a topological cavity. The cavity consists of two adjacent regions of photonic multilayers, with the device operating in both reflection and transmission mode. To explore the nonlinear features, we use a self-consistent multiphysics simulation framework that models graphene’s nonlinear response to THz photoexcitation via the coupled opto-thermal treatment of its thermodynamic response.

17:00 - 17:15 **Large Gap Chern Numbers in Electromagnetic Continua**
Guilherme Fonseca[1], Filipa Prudêncio[2], Paloma Huidobro[3], Mário Silveirinha[1] — *[1] Instituto de Telecomunicações - Instituto Superior Técnico, Portugal [2] Instituto de Telecomunicações and Instituto Universitário de Lisboa, Portugal [3] Departamento de Física Teórica de la Materia Condensada and Condensed Matter Physics Center - Universidad Autónoma de Madrid and Instituto de Telecomunicações, Spain*
In this work, we explore nonreciprocal electromagnetic continua that exhibit large gap Chern numbers. We demonstrate that these topological phases can emerge naturally as a result of competing nonlocal effects. To illustrate this phenomenon, we analyze a two-carrier plasma subjected to a static magnetic field. To accurately model the interaction between the carriers and the electromagnetic field, we consider two distinct nonlocal mechanisms. Using a first-principles approach, we numerically compute these topological invariants and establish a connection between the different topological phases and the emerging Weyl points.

17:15 - 17:30 **Non-Abelian Geometric Phases for Polarization Control in Metallic Waveguides**
Rodrigo Câmara[1], Andrea Alù[2], Mário Silveirinha[1] — *[1] University of Lisbon and Instituto de Telecomunicações, Portugal [2] Advanced Science Research Center and Graduate Center, City University of New York, USA*
We develop a general theory for polarization control in adiabatically-deformed metallic waveguides with a doubly degenerate fundamental mode. Our key finding is that non-Abelian Berry connections enable full polarization control, allowing any input polarization state to be transformed into an arbitrary output polarization state.

17:30 - 18:00 **Photonic Axion Insulator** (Invited talk)
Baile Zhang — *Nanyang Technological University, Singapore*
While still not observed as elementary particles, axions can exist as quasiparticles in topological crystals, whose quantized axion field can induce half Chern numbers on the surfaces of a three-dimensional crystal. We will discuss how to construct an axion insulator in a photonic crystal and demonstrate its unique topological properties.

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

Quantum Materials and Light Emission

Chairperson(s): Nahid Talebi, Said Rahimzadeh Kalaleh Rodriguez

16:00 - 16:30 **Light Manipulation with Atomically-thin Metasurfaces** (Invited talk)
Mark Brongersma — *Stanford University, USA*
In this presentation, I will highlight recent efforts in our group to push the limits in scaling of metasurface optics to the ultimate limit of single monolayers of material. In this extreme limit, it is key to harness optical materials resonances as opposed to the commonly-used geometric plasmon and Mie-type resonances that are supported by metal and semiconductor nanostructures. To enable their effective operation at room temperature, we are on a mission to develop an understanding of the relevant solid-state physics and nanophotonics concepts.

16:30 - 16:45 **Designing Quantum Metamaterials in Waveguide QED via Physics-Informed Gradient- Descent Methods**
Matthew Belzer, Michele Cotrufo — *University of Rochester, USA*
Designing multi-atom quantum metamaterials is challenging due to the exponentially increasing Hilbert space's size. We propose and demonstrate a physics-informed gradient-descent method to optimize 1D quantum metamaterials consisting of N atoms in a waveguide. As an example, we show a system of N=4 atoms optimized to induce few-photon nonreciprocal responses much larger than what previously thought.

16:45 - 17:00 **Quantum emitter interacting with a dispersive dielectric object: a model based on the modified Langevin noise formalism**
Carlo Forestiere, Giovanni Miano, Loris Maria Cangemi — *University of Naples Federico II, Italy*
We model the interaction of a quantum emitter with a finite-size dispersive dielectric object in unbounded space within the framework of macroscopic quantum electrodynamics, using the modified Langevin noise formalism. We show that the emitter couples to two distinct bosonic reservoirs: a medium-assisted reservoir and a scattering-assisted reservoir, each characterized by its own spectral density.

17:00 - 17:15 **High-Dimensional Arbitrary Spin-Orbital Quantum Light Sources**
Yinhui Kan, Xujing Liu, Sergey Bozhevolnyi — *University of Southern Denmark, Denmark*
We propose a general strategy to design high-dimensional spin-orbital single-photon sources by taking full advantage of the spatial freedom to design quantum emitters (QEs) -coupled composite (i.e., Moiré/multipart) metasurfaces. We demonstrate the generation of arbitrary vectorial spin-orbital photon emission in high-dimensional Hilbert spaces, mapping the generated states on hybrid-order Bloch spheres. We further realize single-photon sources of high-dimensional spin-orbital quantum emission and experimentally verify polarization entanglement of high-dimensional superposition states with high fidelity. We believe that the results obtained facilitate further progress in integrated solutions for the deployment of next-generation high-capacity quantum information technologies.

17:15 - 17:30 **On-Chip Orbital Angular Momentum Photon Sources via Integration of Quantum Emitters in Metasurface-Decorated Waveguides**
Tianshuo Lyu[1], Shailesh Kumar[2], Soeren Sande[2], Chao Meng[2], Xujing Liu[2], Yinhui Kan[2], Vladimir Zenin[2], Torgom Yezekyan[2], Maosen Chen[1], Jinhui Shi[1], Chunying Guan[1], Sergey Bozhevolnyi[2], Fei Ding[2] — *[1] Harbin Engineering University, China [2] University of Southern Denmark, Denmark*
We experimentally demonstrate a chip-scale orbital angular momentum (OAM) photon source by embedding a deterministic quantum emitter (QE) within a dielectric waveguide that is integrated with a metasurface grating outcoupler. Upon excitation, the QE's emission propagates along the waveguide to the metasurface grating outcoupler, which efficiently facilitates the generation of high-purity OAM modes across a broadband spectrum between 650 to 690 nm.

17:30 - 18:00 **Nanoscale Molecular and Ionic Diffusion for Reconfigurable Quantum Materials** (Invited talk)
Yohannes Abate — *The University of Georgia, USA*
Interaction with diffusion-driven ions or molecules could enable reconfigurable quantum materials, giving rise to a range of intriguing phenomena, including surface, subsurface, and interface modifications, as well as changes in electronic, optical, and chemical properties. However, understanding the action of molecular and ionic diffusion at the nanoscale presents a formidable challenge in unraveling the fundamental mechanisms involved.

Oral Sessions (Tuesday Morning)

Special session: Metamaterials and Robotics I
Chairperson(s): Benjamin Gorissen **Room: Concertzaal**

Time	1st author	Title
10:30 - 11:00	Benjamin Gorissen	Metafluids: Incorporating Functionality in a Fluid
11:00 - 11:30	Eleonora Tubaldi	Shape and Flow: Waves in Metamaterials induced by Geometric Frustrations and Fluidic Actuation
11:30 - 12:00	Aniket Pal	Mechanical Instabilities in Flexible Mechanical Metamaterials Across Scales
12:00 - 12:30	Anton Souslov	Odd active solids

Metasurface-Enhanced Scattering and Radiation
Chairperson(s): Mirko Barbuto, Giacomo Oliveri **Room: Shaffyzaal**

Time	1st author	Title
10:30 - 11:00	Stefano Maci	Alternating Projections Method for Metasurface Antennas Synthesis
11:00 - 11:15	Joshua Barrass	Equivalent Circuit Analysis Of Position-Dependent Surface Wave Coupling Efficiency In Metasurfaces
11:15 - 11:30	Dmytro Vovchuk	Enhancing Drone Detectability with Genetically Designed Metamaterials
11:30 - 11:45	Jiaruo Yan	Scattering from cylindrical scatterers of time-modulated permittivity
11:45 - 12:00	Giuseppe Labate	Scattering of Cylinders with Surface Impedance Multilayers: The Richmond-Mie Theory
12:00 - 12:15	Yingjuan Lu	Efficient Design of Metasurface with Independent Amplitude and Phase Modulation via Microwave Network Theory
12:15 - 12:30	Roy Nicolas	Beam-steering Solution from Twisted Bilayer Photonic Crystals

Time-Varying Media: Resonances and Dispersion
Chairperson(s): Vladimir Shalaev, Mario Silveirinha **Room: Teekenzaal I**

Time	1st author	Title
10:30 - 11:00	Carsten Rockstuhl	Exploiting Resonances in Spatio-Temporal Metamaterials
11:00 - 11:15	Alessandra Contestabile	Unconventional Phenomena from Space-Time Modulation of Dispersive Media
11:15 - 11:30	Jaime Echave-Sustaeta Osuna	Scattering Of Light From A Dispersive And Time-Varying Slab
11:30 - 11:45	Thomas F. Allard	Dipole Radiation in a Dispersive and Lossy Photonic Time Crystal

Continued from previous page: Time-Varying Media: Resonances and Dispersion
Chairperson(s): Vladimir Shalaev, Mario Silveirinha **Room: Teekenzaal I**

Time	1st author	Title
11:45 - 12:00	Diego Martinez Solis	Dynamics of Surface Plasmon Polaritons with Temporal Interface in Metal
12:00 - 12:30	Simon Horsley	Seeing through a temporally turbid medium

Scattering Particles, Arrays, and Metasurfaces
Chairperson(s): Iñigo Liberal, Uriel Levy **Room: Teekenzaal II**

Time	1st author	Title
10:30 - 11:00	Femius Koenderink	Perfect Absorption, Extinction and Amplification by Resonant Arrays and Single Scatterers
11:00 - 11:15	Mustafa Yucel	Angle-Invariant Scattering in Metasurfaces
11:15 - 11:30	Tom Hoekstra	Impact of Finite Size Effects on the Response of Ultracompact Non-Local Metasurfaces
11:30 - 11:45	Francisco Javier Alfaro Mozaz	Generalized Epsilon-Near-Zero Polaritons in Uniaxial Metasurfaces
11:45 - 12:00	Alexander Lambertz	Exploiting disordered hyperspectral uniformity for nanophotonic light trapping in ultra-thin c-Si solar cells
12:00 - 12:15	Paul-Gregor Nitsch	Plasmonic Mode Coupling in Multilayer Honeycomb Lattices of Ag Nanotriangles and Nanoholes
12:15 - 12:30	Tomas Chlouba	Attosecond Electron Pulse Trains Generated by Transverse Polarized Optical Metasurfaces

Electromagnetics of Complex Periodic Structures
Chairperson(s): Maria Kafesaki, Natalia Litchinitser **Room: Koepelzaal**

Time	1st author	Title
10:30 - 11:00	Nicoletta Granchi	Quasi-normal mode perturbation theory to achieve Q-factor optimization of resonances in ordered and disordered photonic materials
11:00 - 11:15	Shuang Peng	Efficient All-Dielectric Terahertz Metagrating with the Higher-Order Polarizability
11:15 - 11:30	Takayoshi Fujikawa	Reflective metasurfaces for simultaneous control of polarizations and reflection angles based on extended Babinet's relations
11:30 - 11:45	Jamie Somers	Direct Laser Writing of Novel Superimposed Gratings for Structural Colour
11:45 - 12:00	Daniel Muis	Controlling Large-Area Optical Field Enhancement in Photonic Landau Levels by Tailoring Synthetic Strain in Photonic Crystals
12:00 - 12:15	Tommi Isoniemi	Realization of Topological Photonic Structures Made from Multilayer Transition Metal Dichalcogenides
12:15 - 12:30	Stefanos Koufidis	Gravitational Waves: A Paradigm of Luminal Traveling-Wave Modulations

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

Special session: Metamaterials and Robotics I

Chairperson(s): Benjamin Gorissen

10:30 - 11:00 **Metafluids: Incorporating Functionality in a Fluid** (Invited talk)
Benjamin Gorissen — *KU Leuven, Belgium*
Inspired by mechanical metamaterials, liquids can exhibit programmable mechanical properties when embedded with gas-filled elastic capsules. Under compression, the localized buckling of these capsules induces a radically different macroscopic response in the fluid, which can be precisely tuned through the geometrical parameters of the unit cells and their spatial distribution. We demonstrate the fabrication of such fluids using microfluidic techniques and explore their application in robotic systems, where the fluid's material properties inherently encode programmable behavior.

11:00 - 11:30 **Shape and Flow: Waves in Metamaterials induced by Geometric Frustrations and Fluidic Actuation** (Invited talk)
Eleonora Tubaldi — *University of Maryland, College Park, USA*
Mechanical multistable metamaterials (MMMs) will be discussed demonstrating that geometric frustration can be harnessed to trigger and sustain the propagation of transition waves. Moreover, fluidic actuation will be introduced to initiate and control the propagation of wavefronts in MMMs.

11:30 - 12:00 **Mechanical Instabilities in Flexible Mechanical Metamaterials Across Scales** (Invited talk)
Aniket Pal — *University of Stuttgart, Germany*
Mechanical instabilities, in the form of bifurcation buckling and snap-through motion in multistable mechanisms, have attracted a lot of interest as a mode of improving the capabilities and increasing the functionalities of soft systems. Using mechanisms which display mechanical instabilities as the unit cell of a repeating architecture allows us to harness the synergy of periodicity and achieve interesting global responses of the mechanical metamaterial. We look at different mechanical metamaterials, from the centimeter to the micrometer scale, all of which exploit instabilities in their architecture to achieve their functionalities. Starting at the macro scale, we look at how external fields can be used to dynamically program the responses of the instabilities and allows us to achieve reprogrammable devices for mechanical computation. We also look at establishing a rational design strategy for bringing together multiple heterogeneous mechanical computing elements to develop a system level computation architecture. Finally, moving to the micro scale, we utilize the reversible, thermal volumetric shrinking of hydrogels to achieve buckling based transformation of micro-metastructures, and find their use in information encryption.

12:00 - 12:30 **Odd active solids** (Invited talk)
Anton Souslov — *University of Cambridge, United Kingdom*
Active solids consume energy to allow for actuation and shape change not possible in equilibrium. I will focus on novel phenomena and design principles for active materials with so-called

odd elastic moduli, which are composed of non-reciprocal springs. Our results point to the design of novel soft machines at the macroscale, and guide the miniaturization of non-reciprocal metamaterials to the colloidal scale.

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

Metasurface-Enhanced Scattering and Radiation

Chairperson(s): Mirko Barbuto, Giacomo Oliveri

10:30 - 11:00 **Alternating Projections Method for Metasurface Antennas Synthesis** (Invited talk)

Marco Faenzi[1], David Gonzalez-Ovejero[2], Enrica Martini[1], Stefano Maci[3] — *[1] University of Siena, Italy [2] University of Rennes, France [3] University of Siena, Italy*

Metasurface (MTS) antennas play a significant role in a variety of operative contexts and environments. The applications range from space communications systems, to terrestrial wireless links for next generations networks and smart radio environments. Modulated MTS antennas, which rely on the conversion from surface waves (SWs) to leaky waves (LWs), have emerged as particularly attractive due to their low profile, simple feeding mechanism, absence of a beamforming network, independence from application-specific constraints, and their inherent ability to achieve demanding radiation performance. This work addresses the inverse design of metasurface antennas through a physically consistent synthesis of tensorial surface reactance profiles. The method relies on solving the Electric Field Integral Equation (EFIE) via the Method of Moments (MoM), assuming an anti-Hermitian tensor surface reactance to ensure passive and reciprocal implementation. A key challenge in this context is recovering a finite-aperture current distribution that radiates a given far-field pattern, i.e. generates a given spectrum over the visible region, despite the inherent ambiguity due to the unspecified spectral content outside this region. We propose an iterative synthesis strategy inspired by the Gerchberg–Papoulis alternating projection method to reconstruct the missing spectral content of the current, while enforcing both spatial confinement and physical realizability of the impedance. The resulting synthesis process operates directly in the EFIE framework, enabling consistent updates of the current and the impedance profile at each step. The method is implemented using subdomain Gaussian ring basis functions, which provide localized radial resolution and enable efficient analytical evaluation of the MoM matrices entries. The resulting algorithm is therefore extraordinarily fast. Several examples, including single and multiple source configurations, demonstrate the effectiveness of the proposed strategy in producing complex and highly directive far-field patterns.

11:00 - 11:15 **Equivalent Circuit Analysis Of Position-Dependent Surface Wave Coupling Efficiency In Metasurfaces**

Joshua Barrass, Miguel Navarro-Cía, Costas Constantinou — *University of Birmingham, United Kingdom*

Efficient application of metasurfaces as surface waveguides depends on a well-designed launcher to maximise the in- and out-coupling. By considering the case of a square patch unit cell and an aperture surface wave launcher, we build up a procedure to analyse the interactions between a launcher and a metasurface through equivalent circuit models. This analysis identifies that the coupling efficiency depends on the position of the launcher due to the interactions between the launcher and the small-scale structures of the metasurface.

11:15 - 11:30 **Enhancing Drone Detectability with Genetically Designed Metamaterials**

Dmytro Vovchuk[1], Dmitry Dobrykh[2], Konstantin Grotov[2], Anna Mikhailovskaya[2], Vladyslav Tkach[1], Mykola Khobzei[1], Anton Kharchevskii[2], Vjaceslavs Bobrovs[1], Pavel Ginzburg[2] — *[1] Riga Technical University, Latvia [2] Tel Aviv University, Israel*

The rapid expansion of drone applications in areas such as delivery and monitoring has led to increased air traffic, requiring effective navigation and control. A key emerging challenge is the detection of small drones with low radar cross-sections (RCS), comparable to birds, particularly under heavy clutter conditions and low flight altitudes. To address this challenge, we propose equipping drones with superscatterers, dramatically enhancing their RCS. We introduce the concept of evolutionarily designed metamaterials in the form of multilayer stack arrays of strongly coupled electric and magnetic resonators. These structures enable broadband end-fire backscattering, achieving an RCS of approximately 1 m² at 10 GHz, representing a three-order-of-magnitude improvement over a small drone. Despite their compact footprint, the superscatterer provides a fractional bandwidth exceeding 10%, meeting essential radar requirements for high-range resolution. As for the application, we have demonstrated a 1.5- to 5-fold enhancement in detection range using a DJI Mini 2drone tagged with genetically designed volumetric metastructures.

11:30 - 11:45 **Scattering from cylindrical scatterers of time-modulated permittivity**

Jiaruo Yan[1], Ioannis Katsantonis[1], Mohamed Mostafa[2], Viktar Asadchy[2], Maria Kafesaki[1] — *[1] Foundation for Research and Technology-Hellas, Greece [2] Aalto University, Finland*

Dielectric particles of time-varying electromagnetic properties exhibit intriguing scattering phenomena. In this work, employing Floquet-Mie theory, we investigate the scattering properties of an infinitely-long cylinder with periodically time-modulated non-dispersive permittivity. Our results indicate parametric scattering amplification may be realized when the modulation strength and frequency meet certain conditions.

11:45 - 12:00 **Scattering of Cylinders with Surface Impedance Multilayers: The Richmond-Mie Theory**

Giuseppe Labate[1], Cristina Yepes[1], Stefania Monni[1], Bastiaan Florijn[2], Giampiero Gerini[3] — *[1] TNO - Radar Department, Netherlands [2] TNO - Electromagnetic Signature and Propagation Department, Netherlands [3] TNO - Optics Department, Netherlands*

A generalization of the recursive method developed in 1965 by Richmond for dielectric cylindrical multilayer structures is proposed in this paper. Inspired by the mantle cloaking technique, developed in 2009, we extend the Richmond formulation to include multiple boundary conditions with impedance metasurfaces. This method is computationally very efficient and it allows reduced time cost optimizations. All the results presented in the paper have been numerically validated through independent full-wave simulations.

12:00 - 12:15 **Efficient Design of Metasurface with Independent Amplitude and Phase Modulation via Microwave Network Theory**

Yingjuan Lu, Huidong Li, Junyan Dai, Jianan Zhang, Qiang Cheng — *Southeast University, China*

Metasurfaces play a crucial role in wireless communications and radar stealth due to their ability to manipulate electromagnetic (EM) waves. However, achieving independent control of amplitude and phase remains challenging. To address this, multiport microwave network theory and neural networks have been combined to predict multistate EM responses of the RIS unit, accelerating multifunctional unit design. In this work, we extend this approach to design a novel unit operating at 5.57–5.61 GHz with 1-bit amplitude and 2-bit phase modulation, demonstrating

its adaptability for advanced RIS structures.

12:15 - 12:30 **Beam-steering Solution from Twisted Bilayer Photonic Crystals**
Roy Nicolas[1], Beicheng Lou[2], Shanhui Fan[2], Alexandre Mayer[1], Michaëll Lobet[1] — *[1] University of Namur, Belgium [2] Stanford University, USA*
Our study designs twisted bilayer photonic crystals for beam steering. The device efficiently redirects light into a single order, controlled by the twist angle. We derive an analytical model to show that it mainly functions as a blazed diffraction grating. Heuristic optimization achieved over 90% efficiency for twist angles from 0 to 30 degrees.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
Teekenzaal I

Time-Varying Media: Resonances and Dispersion

Chairperson(s): Vladimir Shalaev, Mario Silveirinha

10:30 - 11:00 **Exploiting Resonances in Spatio-Temporal Metamaterials** (Invited talk)
Carsten Rockstuhl[1], Puneet Garg[1], Jan David Fischbach[1], Markus Nyman[1], Mohammad Sajjad Mirmoosa[2], Evangelos Almpanis[3], Nikos Stefanou[4], Nikos Papanikolaou[3], Xuchen Wang[5], Viktar Asadchy[6] — *[1] Karlsruhe Institute of Technology, Germany [2] University of Eastern Finland, Finland [3] NCSR "Demokritos", Greece [4] National and Kapodistrian University of Athens, Greece [5] Harbin Engineering University, China [6] Aalto University, Germany*
Spatio-temporal metamaterials offer unique control over the directional and spectral flow of light. We outline a theoretical and computational framework to study these materials from scattering constituents, highlighting how spatial resonances strongly enhance temporal effects.

11:00 - 11:15 **Unconventional Phenomena from Space-Time Modulation of Dispersive Media**
Alessandra Contestabile[1], Maria Antonietta Vincenti[2], Giuseppe Castaldi[3], Michael Scalora[4], Vincenzo Galdi[3], Carlo Rizza[1] — *[1] University of L'Aquila, Department of Physical and Chemical Sciences, Italy [2] University of Brescia, Department of Information Engineering, Italy [3] University of Sannio, Department of Engineering, Fields & Waves Lab, Italy [4] viation and Missile Center, U.S. Army CCDC, Redstone Arsenal, Alabama, USA*
We investigate wave scattering from a temporally changing interface, which exhibits Lorentz-type dispersion with a sudden shift in its parameters. Our research brings to light a novel mechanism: the unconventional generation of frequencies at the system's natural resonances. This effect facilitates the coupling of traveling waves with evanescent waves, enabling the direct excitation of surface-wave modes in the far field, without the need for spatial structures. These findings propose a new approach for compact, high-speed photonic devices,eliminating the need for spatial patterning or extended temporal modulation.

11:15 - 11:30 **Scattering Of Light From A Dispersive And Time-Varying Slab**
Jaime Echave-Sustaeta Osuna, Thomas Francois Allard, Francisco José García-Vidal, Paloma Arroyo-Huidobro — *Universidad Autónoma de Madrid, Spain*
In a time-varying and dispersive slab, guided modes interact with its negative frequency replicas, which results in band-anticrossing and the opening of gaps. This dramatically enhances the inelastic excitation of frequencies and can make the guided modes radiate to the far-field.

11:30 - 11:45 **Dipole Radiation in a Dispersive and Lossy Photonic Time Crystal**
Thomas F. Allard, Jaime E. Sustaeta-Osuna, Francisco J. García-Vidal, Paloma A. Huidobro — *Universidad Autónoma de Madrid, Spain*
We investigate the dissipated power of a point-dipole embedded in a dispersive and lossy photonic time crystal. We uncover specific effects enabled by such dispersion and losses, such as a large frequency window presenting negative dissipated power only.

11:45 - 12:00 **Dynamics of Surface Plasmon Polaritons with Temporal Interface in Metal**

Diego Martinez Solis[1], Grigorii Ptitcyn[2], Asma Fallah[2], Victor Pacheco Peña[3], Mohammad Mirmoosa[4], Nader Engheta[2] — *[1] University of Vigo, Spain [2] University of Pennsylvania, USA [3] Newcastle University, UK [4] University of Eastern Finland, Finland*
We study, with two different polarization models, the scattered and confined electromagnetic modes at the spatial interface of an air/metal half-space scenario—initially sustaining a surface plasmon polariton (SPP)—when the plasma frequency in metal is temporally switched to zero, thus producing a time interface in the metallic region.

12:00 - 12:30 **Seeing through a temporally turbid medium** (Invited talk)
Simon Horsley, Ian Hooper, David Phillips — *University of Exeter, United Kingdom*
Wavefront shaping to control the transmission and reflection of light incident onto complex media is a well-established field, with applications in biomedical imaging via the ability to focus deep into scattering media. Here, we undertake the temporal equivalent, giving an experimental demonstration of the operator theory of dispersive time varying materials. We experimentally demonstrate enhanced and diminished reflection through sending in the singular vectors of the measured reflection operator of a time varying medium, in addition to the eigenpulses - specially shaped incident waves that maintain the same spectrum after interaction with the medium.

10:30 - 12:30 Oral Sessions (Tuesday Morning)
Teekenzaal II

Scattering Particles, Arrays, and Metasurfaces

Chairperson(s): Iñigo Liberal, Uriel Levy

10:30 - 11:00 **Perfect Absorption, Extinction and Amplification by Resonant Arrays and Single Scatterers** (Invited talk)
Femius Koenderink — *AMOLF, Netherlands*
We discuss singular scattering responses in two scenarios. The first concerns Salisbury screens with gain and loss. We predict that introducing gain in Salisbury screens with loss can induce both perfect absorption and amplification conditions. The second scenario concerns scattering by finite scattering systems down to the single scatterer level. We analyze maximum extinction in experiments by high-NA scatterometry and wavefront shaping.

11:00 - 11:15 **Angle-Invariant Scattering in Metasurfaces**
Mustafa Yucel, Francisco Cuesta, Karim Achouri — *EPFL, Switzerland*
Metasurfaces shape electromagnetic waves but face angular dispersion challenges. Using GSTCs, we derive conditions for angle-invariant scattering, showing how nonlocality and pseudochirality suppress dispersion, enabling stable, angle-independent transmission and reflection — essential for precision, dispersion-sensitive electromagnetic applications.

11:15 - 11:30 **Impact of Finite Size Effects on the Response of Ultracompact Non-Local Metasurfaces**
Tom Hoekstra, Sander Mann, Jorik Van De Groep — *University of Amsterdam, Netherlands*
Finite-size effects prevent achieving high Q-factors in non-local metasurfaces. Here, we experimentally probe the impact of finite size on the Q-factor of a metasurface supporting guided-mode resonances. Additionally, we observe pronounced size-dependent interference patterns in the dispersion and use an analytical model to describe them.

11:30 - 11:45 **Generalized Epsilon-Near-Zero Polaritons in Uniaxial Metasurfaces**
Francisco Javier Alfaro Mozaz, Iñigo Liberal — *Universidad Pública de Navarra, Spain*
We demonstrate epsilon-near-zero (ENZ) polaritons in ultrathin uniaxial SiC metasurfaces, uncovering previously unreported ENZ modes: open isofrequency curves in all-metallic permittivity regions and closed curves in hyperbolic regions. These findings reveal novel topological transitions that redefine anisotropic polaritonics and enhance control of wave propagation.

11:45 - 12:00 **Exploiting disordered hyperspectral uniformity for nanophotonic light trapping in ultra-thin c-Si solar cells**
Alexander Lambertz — *AMOLF / UvA Amsterdam, Netherlands*
We develop nanophotonic light-trapping layers for weakly absorbing substrates to enable substantial material reduction by exploiting hyperspectral uniformity. With our method we demonstrated record-breaking 65% sunlight absorption in a single pass through just 1 micron of silicon and a 5-micron-thin c-Si solar cell reaching beyond 16% efficiency.

12:00 - 12:15 **Plasmonic Mode Coupling in Multilayer Honeycomb Lattices of Ag Nanotriangles and Nanoholes**

Paul-Gregor Nitsch[1], Paul Oleynik[1], Markus Ratzke[1], David Stolarek[2], Jon Schlipf[2], Oliver Skibitzki[2], Christian Wenger[2], Inga Anita Fischer[1] — *[1] Brandenburg University of Technology Cottbus-Senftenberg, Germany [2] IHP - Leibniz Institut für innovative Mikroelektronik, Germany*
Coupled lattices of metal nanoparticle and nanohole arrays can support collective plasmonic resonances. Here, we investigate coupled resonances in honeycomb lattices of Ag nanotriangles and nanoholes. Our results indicate that, in these structures, a variation in angle of incidence can be used to tune mode coupling and we discuss implications for applications.

12:15 - 12:30 **Attosecond Electron Pulse Trains Generated by Transverse Polarized Optical Metasurfaces**
Tomas Chlouba, Nika Van Nielen, Matthias Liebtrau, Albert Polman — *NWO AMOLF, Netherlands*
We show a two-stage on-chip metasurface device concept to generate and characterize attosecond electron pulses in the scanning electron microscope. By exploiting transverse components of an optical wave exciting a periodic Si metasurface we spatially filter 10 keV electrons with well-defined phase corresponding to a selected sub-cycle window.

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

Electromagnetics of Complex Periodic Structures

Chairperson(s): Maria Kafesaki, Natalia Litchinitser

10:30 - 11:00 **Quasi-normal mode perturbation theory to achieve Q-factor optimization of resonances in ordered and disordered photonic materials** (Invited talk)
Nicoletta Granchi[1], Matteo Lodde[2], Andrea Fiore[2], Marian Florescu[3], Pedro David Garcia[4], Massimo Gurioli[5], Francesca Intonti[1], Guillermo Arregui[6] — *[1] Department of Physics and Astronomy and LENS, University of Florence, Italy [2] Eindhoven University of Technology, The Netherlands [3] University of Southampton, United Kingdom [4] Instituto de Ciencia de Materiales de Madrid, Spain [5] Department of Physics and Astronomy, University of Florence, Italy [6] Swiss Federal Institute of Technology Lausanne, EPFL, Switzerland*
We propose a gradient-based automated optimization approach to maximize the quality factor of optical resonances in ordered and disordered dielectric slabs which uses first-order non-hermitian perturbation theory. Preliminary experimental results conducted by means of near-field spectroscopy have revealed fascinating and unexpected features of small-footprint photonic cavities optimized with our method.

11:00 - 11:15 **Efficient All-Dielectric Terahertz Metagrating with the Higher-Order Polarizability**
Shuang Peng, Liwei Yan, Jie Ma, Zhanyi Fu, Fei Yang — *State Key Laboratory of Millimeter Wave, Southeast University, China*
In this work, we propose a novel high-resistivity silicon-based all-dielectric metagrating for high-efficiency anomalous refraction of terahertz waves. The scattering characteristics of the metagrating unit are precisely engineered by exciting multipoles up to octupoles. A four-silicon-pillar metagrating achieves a peak diffraction efficiency of 91% by directing terahertz waves into the -1st transmission order. With broadband and wide-angle performance, the design maintains diffraction efficiencies above 60% across a 15% relative bandwidth and over a 63° range of incident angles. Compatible with silicon micromachining processes, this metagrating paves the way for developing compact and efficient terahertz devices for applications in radar, imaging, and communication systems.

11:15 - 11:30 **Reflective metasurfaces for simultaneous control of polarizations and reflection angles based on extended Babinet's relations**
Takayoshi Fujikawa, Toshihiro Nakanishi — *Kyoto University, Japan*
We propose a method to extend Babinet's relations to reflective metasurfaces under specific conditions and demonstrate simultaneous implementation of polarization control and anomalous reflection by the reflective metasurfaces embedding self-complementary structures introducing the phase gradients.

11:30 - 11:45 **Direct Laser Writing of Novel Superimposed Gratings for Structural Colour**
Jamie Somers[1], Jing Qian[1], Colm Delaney[1], Pascal Landais[2], Louise Bradley[1] — *[1] Trinity College Dublin, Ireland [2] Dublin City University, Ireland*
High resolution superimposed gratings for structural colour have been fabricated using direct laser writing via two photon lithography. A single period of the grating consists of five pillars of

three different heights. The superimposed grating design provides a single peak transmittance tunable across the visible spectral range.

11:45 - 12:00 **Controlling Large-Area Optical Field Enhancement in Photonic Landau Levels by Tailoring Synthetic Strain in Photonic Crystals**
Daniel Muis[1], Xiaozhou Wu[2], René Barczyk[2], L. Kuipers[3], Ewold Verhagen[2] — *[1] Delft University of Technology, AMOLF, The Netherlands [2] AMOLF, The Netherlands [3] Delft University of Technology, The Netherlands*
We study the effect of various types of synthetic strain on light confinement in two-dimensional silicon photonic crystals. Applying crystal strain allows generating photonic Landau levels that form flat bands with low loss and high degeneracy. We tailor the properties of optical fields through strain engineering to maximize field enhancement.

12:00 - 12:15 **Realization of Topological Photonic Structures Made from Multilayer Transition Metal Dichalcogenides**
Tommi Isoniemi[1], Paul Bouteyre[1], Xuerong Hu[1], Fedor Benimetskiy[1], Yue Wang[2], Maurice S. Skolnick[1], Dmitry N. Krizhanovskii[1], Alexander I. Tartakovskii[1] — *[1] University of Sheffield, United Kingdom [2] University of York, United Kingdom*
In addition to single and few layer regimes, bulk layers of transition metal dichalcogenides are attractive for high-index and low loss nanophotonic structures. We demonstrate topological spin-Hall lattices in WS2 slab waveguides, with unidirectional photonic interface states in polarization-dependent optical measurements.

12:15 - 12:30 **Gravitational Waves: A Paradigm of Luminal Traveling-Wave Modulations**
Stefanos Koufidis, Martin Mccall — *Imperial College London, United Kingdom*
Co-propagating gravitational and electromagnetic waves can generate sidebands on the forward-scattered light, thereby offering an avenue for detection of gravitational radiation. Employing a covariant coupled-wave approach, we model gravitational waves as dynamic, phase-insensitive “luminal moving gratings.” Derived phase-matching conditions elucidate how these waves interact with electromagnetic fields whilst simultaneously conserving energy and momentum. Although detecting low-frequency gravitational waves is hindered by the requirement for long interaction lengths, advances in laser technology are set to enable high-frequency detection, with the potential of unlocking insights into the primordial fabric of spacetime.

Oral Sessions (Tuesday Afternoon 1)

Acoustic and Topological Metamaterials
Chairperson(s): Romain Fleury **Room: Concertzaal**

Time	1st author	Title
14:00 - 14:15	Tong Guo	Non-Hermitian Topology in Acoustic Su-Schrieffer-Heeger Chains
14:15 - 14:30	Wei Xiong	Long-range coupling induced multiple topological off-site corner states in sonic crystals
14:30 - 14:45	Ziqian Xiao	Performing Complex-Frequency Plane Analysis of Resonant Sound-Absorbing Structures via Real-Frequency Simulations
14:45 - 15:00	Inkyuk Han	Ventilated Sound Absorption Via Porous Material-Integrated Acoustic Metamaterial
15:00 - 15:15	Beomseok Oh	Metasurface-integrated Wide-area Ultrasonic Transducer: A new Platform for Parametric Array Loudspeakers
15:15 - 15:30	Seokho Lee	Ultrasonic Fingerprint Identification via Metasurface-Driven Loop-Diffractive Neural Network

Metasurfaces for Antenna Systems II
Chairperson(s): Giampiero Gerini, Silvio Hrabar **Room: Shaffyzaal**

Time	1st author	Title
14:00 - 14:30	Mirko Barbuto	Recent Advances in the Applications of Composite Vortex Theory to Reconfigurable Radiating Structures and Metasurfaces
14:30 - 14:45	Insang Yoo	Toward Design of Electrically Large Array of Rectangular Waveguide-fed Metasurfaces
14:45 - 15:00	Vinothan Vaheesan	Tunable Topological Metasurface with Leaky-wave Features
15:00 - 15:30	Giacomo Oliveri	Surface Electromagnetics within the Smart EM Environment - Recent Advances and Future Trends

Time-Varying Photonics II
Chairperson(s): Simon Horsley, Carsten Rockstuhl **Room: Teekenzaal I**

Time	1st author	Title
14:00 - 14:30	Vladimir Shalaev	Quantum Meta-Photonics and Extreme Space-Time Optics
14:30 - 14:45	Zeki Hayran	Bridging Guided Waves and Non-Diffractive Free Space Waves
14:45 - 15:00	Alejandro Caballero	Topological Nature of Interface States in Space-Time Modulated Metamaterials
15:00 - 15:15	Michele Guizzardi	Coherent Faraday Effect in Nonlinear Media
15:15 - 15:30	Joseph Stones	Dynamic Temporal Pulse Shaping with ITO

Tunable and Reconfigurable Metasurfaces for Imaging, Sensing, and Spectral Control
Chairperson(s): Femius Koenderink, Odysseas Tsilipakos **Room: Teekenzaal II**

Time	1st author	Title
14:00 - 14:30	Uriel Levy	Controllable and tunable dielectric metasurfaces
14:30 - 15:00	Howard Lee	Tunable “Meta”-Optical Fibers for Advanced Imaging and Endoscopy
15:00 - 15:15	Kim Bui	Reconfigurable Sb2Se3 Metasurface Filter Design for Compressive-Sensing-Enabled Atmospheric Trace-Gas Recognition
15:15 - 15:30	Alexandros Pitilakis	Analysis and Design of a Reconfigurable Metasurface based on Chalcogenide Phase-Change Material for Operation in the Near and Mid Infrared

Nonlinear and Active Metasurfaces for Frequency Generation, Lasing, and Optical Control
Chairperson(s): Owen Miller, Dragomir Neshev **Room: Koepelzaal**

Time	1st author	Title
14:00 - 14:30	Marco Marangi	Perovskite Polariton Condensation with Scalable Silicon Metasurfaces
14:30 - 15:00	Pavel Tonkaev	Generation of High Harmonics from Resonant Metasurfaces
15:00 - 15:30	Natalia Litchinitser	Light Shaping Light via Optical Meta-Structures

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

Acoustic and Topological Metamaterials

Chairperson(s): Romain Fleury

14:00 - 14:15 **Non-Hermitian Topology in Acoustic Su-Schrieffer-Heeger Chains**
Tong Guo, Badreddine Assouar, Brice Vincent, Aurélien Merkel — *Institut Jean Lamour, Université de Lorraine, France*
In this work, we delve into the consequences of non-Hermiticity on the acoustic wave propagation in analog SSH lattices. The Hermiticity of the model is broken by either onsite losses or phase nonreciprocal couplings. Different types of interface states, topological phase transitions and the non-Hermitian skin effect are investigated.

14:15 - 14:30 **Long-range coupling induced multiple topological off-site corner states in sonic crystals**
Wei Xiong, Zhiwang Zhang, Houyou Long, Haixiao Zhang, Ying Cheng, Xiaojun Liu — *Nanjing University, China*
This study focuses on breaking frequency degeneracy constraints of corner states in higher-order topological sonic crystals by introducing long-range couplings. The proposed strategy creates generates an array of unconventional corner-localized states, each with distinct off-site localization positions. Experimental validation of these theoretical predictions is conducted using fabricated sonic crystals.

14:30 - 14:45 **Performing Complex-Frequency Plane Analysis of Resonant Sound-Absorbing Structures via Real-Frequency Simulations**
Ziqian Xiao, Tuo Liu — *Institute of Acoustics, Chinese Academy of Sciences, China*
Complex-frequency plane analysis has been a powerful tool for the investigation of open wave systems but usually relies on the theoretical modeling of the scattering matrices. This paper presents a method, compatible with real-frequency solvers, for acoustic complex-frequency calculation and demonstrates its effectiveness in simulating actual resonant sound-absorbing structures.

14:45 - 15:00 **Ventilated Sound Absorption Via Porous Material-Integrated Acoustic Metamaterial**
Inkyuk Han, Gwanho Yoon — *Seoul National University of Science and Technology, Republic of Korea*
We study numerically and experimentally a ventilated sound absorber that integrates porous material into a metamaterial framework. The design exploits porous cavities as stiffness elements and damping media, achieving absorption coefficients above 0.8 between 384–736 Hz and improved transmission loss, while maintaining effective ventilation.

15:00 - 15:15 **Metasurface-integrated Wide-area Ultrasonic Transducer: A new Platform for Parametric Array Loudspeakers**
Beomseok Oh, Woongji Kim, Wonkyu Moon, Junsuk Rho — *Pohang University of Science and Technology (POSTECH), Korea (South)*
In this work, we propose a new form factor for directional loudspeakers. Our device integrates a wide area piezoelectric transducer with an ultrasonic meatsurface, enabling the generation of

highly efficient directional ultrasonic waves. These are employed to induce a nonlinear acoustic phenomenon known as the parametric acoustic array, which is utilized to produce highly directional audible sound.

15:15 - 15:30 **Ultrasonic Fingerprint Identification via Metasurface-Driven Loop-Diffractive Neural Network**
Seokho Lee — *Pohang university of science and technology(POSTECH), Korea (South)*
We propose a memoryless ultrasonic fingerprint identification (MUFI) system that verifies identity without storing biometric data, mitigating security risks. Using a loop-diffractive neural network, it employs only an ultrasonic transducer, a metasurface, and the fingerprint. Experiments achieved 100% numerical accuracy and 97.92% real-world accuracy, ensuring secure biometric authentication.

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

Metasurfaces for Antenna Systems II

Chairperson(s): Giampiero Gerini, Silvio Hrabar

14:00 - 14:30 **Recent Advances in the Applications of Composite Vortex Theory to Reconfigurable Radiating Structures and Metasurfaces** (Invited talk)
Mirko Barbuto[1], Alessio Monti[1], Stefano Vellucci[2], Andrea Alù[3], Filiberto Bilotti[1], Alessandro Toscano[1] — *[1] Roma Tre University, Italy [2] Niccolò Cusano University, Italy [3] City University of New York, USA*
This contribution presents recent advances in Composite Vortex Theory (CVT) as a unified framework for the synthesis and control of structured electromagnetic fields in reconfigurable systems. By enabling the tailored superposition of multiple vortex modes, CVT supports the design of advanced electromagnetic components (including radiating elements and metasurfaces) with tunable wavefronts, dynamic beam-steering, and self-scanning capabilities. We illustrate how the same principles can be applied to both reflective and transmissive metasurface architectures, as well as to compact antenna systems, enabling consistent and versatile field manipulation across different platforms. Theoretical developments are supported by numerical validations, confirming the potential of CVT in the realization of next-generation reconfigurable electromagnetic devices.

14:30 - 14:45 **Toward Design of Electrically Large Array of Rectangular Waveguide-fed Metasurfaces**
Insang Yoo[1], Michael Boyarsky[2], David Smith[2] — *[1] Yonsei University, Korea (South) [2] Duke University, USA*
We present the design and analysis of waveguide-fed metasurfaces consisting of an array of rectangular waveguides and metamaterial radiators–electrically small irises–inserted into the top wall, with each rectangular waveguide being excited by a slotted waveguide attached to the bottom wall. The metasurface configuration offers advantages for constructing electrically large aperture antenna systems, necessitating an efficient approach for design and analysis. We propose an analytical model for the metasurface using the coupled dipole framework, which approximates individual radiators as polarizable dipoles and models their mutual interactions using the Green's functions. The proposed model is verified through full-wave simulations and thus demonstrated as an effective method for metasurface design and analysis.

14:45 - 15:00 **Tunable Topological Metasurface with Leaky-wave Features**
Vinothan Vaheesan[1], Kevin Mitchell[2], Daniel Trussler[2], Miguel Navarro-Cía[1], Alexandros Feresidis[1] — *[1] University of Birmingham, United Kingdom [2] QinetiQ Group Plc, United Kingdom*
We present a tunable photonic topological metasurface that switches between a guided surface wave and a highly directive leaky wave antenna. Mode shifts in the dispersion diagrams reveal, at 18 GHz, a 5.94% radiation efficiency in guided mode and a 12.42 dB peak directivity in leaky mode.

15:00 - 15:30 **Surface Electromagnetics within the Smart EM Environment - Recent Advances and Future Trends** (Invited talk)

Federico Albi, Giorgio Gottardi, Aaron Angel Salas Sanchez, Francesco Zardi, Giacomo Oliveri — *ELEDIA@UniTN-DICAM, University of Trento, Italy*

The revolutionary Smart Electromagnetic Environment (SEME) concept is transforming wireless system design by enabling control over electromagnetic wave propagation to meet network-defined performance objectives. Among the technologies exploited to implement the SEME vision are Electromagnetic Skins (EMSs), which are passive two-dimensional artificial structures engineered to statically or dynamically manipulate electromagnetic propagation in both indoor and outdoor settings. The enabling feature of EMSs within SEME is related to their advanced wave manipulation functionalities, including anomalous reflection and beam shaping, through meta-atomic adjustments of their electrical properties. Recent advancements have expanded the capabilities of EMSs, introducing innovations such as optically transparent designs for seamless integration into existing infrastructures, and customized design strategies that support inexpensive implementations of EMSs. This work aims to review the recent advancements in EMS engineering for SEME applications, providing insights into cutting-edge design and implementation strategies that are shaping the future of wireless communications.

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

Time-Varying Photonics II

Chairperson(s): Simon Horsley, Carsten Rockstuhl

14:00 - 14:30 **Quantum Meta-Photonics and Extreme Space-Time Optics** (Invited talk)
Vladimir Shalaev — *Purdue University, USA*
In this talk we first discuss the integrated quantum photonic circuitry 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-cycle modulation, enabling novel phenomena in such extreme time-varying media.

14:30 - 14:45 **Bridging Guided Waves and Non-Diffractive Free Space Waves**
Zeki Hayran, John B. Pendry — *Imperial College London, United Kingdom*
Waves propagating in free space are inherently subject to diffraction, which limits performance in applications such as imaging and optical communications. To overcome this, non-diffracting beams that maintain their spatial profile over extended distances have been extensively studied. More recently, there has been growing interest in space-time wave packets, in which spatial and temporal degrees of freedom are intrinsically linked, enabling diffraction-free propagation through tailored spectral correlations. However, these efforts have largely focused on free-space configurations, leaving open the question of how guided waves in integrated photonic platforms can be directly converted into non-diffracting beams. Here we explore this challenge and show that applying temporal and/or spatial modulation to a conventional dielectric waveguide enables the controlled generation of space-time light sheets in free space. These beams propagate in free space but inherit the group velocity of the guided mode, enabling a transition from guided to diffraction-free propagation while maintaining a velocity distinct from that of conventional free-space waves. This approach provides a pathway for practical applications, including high-resolution biomedical imaging, free-space links between integrated photonic circuits, and diffraction-free connections within a photonic chip.

14:45 - 15:00 **Topological Nature of Interface States in Space-Time Modulated Metamaterials**
Alejandro Caballero, Thomas Allard, Paloma Arroyo — *Universidad Autónoma de Madrid, Departamento de Física Teórica de la Materia Condensada (IFIMAC), Spain*
In this work, we discuss the relevant symmetries in one-dimensional spatio-temporal metamaterials that enable their topological classification. In particular, we demonstrate a quantized Zak phase and the existence of interface states that localize at the spatio-temporal boundary and are robust to perturbations of the surface.

15:00 - 15:15 **Coherent Faraday Effect in Nonlinear Media**
Michele Guizzardi, Sedigheh Esfahani, Sriram Guddala, Andrea Alù — *Advanced Science Research Center, City University of New York, USA*
We propose a magnet-free Faraday effect using nonlinearities in a silicon nitride cavity. Two detuned pump beams create a synthetic angular momentum bias, rotating a probe's polarization. This phase-matching-free method enables dynamic control, promising compact, nonreciprocal photonic devices.

15:15 - 15:30 **Dynamic Temporal Pulse Shaping with ITO**

Joseph Stones, Anthony Harwood, Stefano Vezzoli, Riccardo Sapienza — *Imperial College London, United Kingdom*

This contribution presents the experimental advancements in testing and characterising metamaterial based temporal lenses. Metalenses have the potential to enhance our control over diffraction-limited light enabling dynamic aberration correction, zooming lenses and wavelength-dependent polarisers. Indium tin oxide (ITO) nano-films and resonating nano-antennas are modulated at ultrafast timescales driving large index changes or resonant scattering respectively. Using high-energy, ultrashort pulses with tunable wavelength, the characteristics of theoretically modelled metalenses is investigated and applications in communication and light control are highlighted.

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

Tunable and Reconfigurable Metasurfaces for Imaging, Sensing, and Spectral Control

Chairperson(s): Femius Koenderink, Odysseas Tsilipakos

14:00 - 14:30 **Controllable and tunable dielectric metasurfaces** (Invited talk)
Uriel Levy, Zetian Chen, Noa Mazurski, Oren Goldberg, S. Jagan Mohan Rao, Jacob Engelberg, Ronen Mazurski — *HUJI, Israel*
We present our recent work related to controlling the properties of dielectric metasurfaces. Variety of tunability mechanisms are discussed and demonstrated. Different wavelength regimes are explored, from the visible and all the way to the thermal regime.

14:30 - 15:00 **Tunable "Meta"-Optical Fibers for Advanced Imaging and Endoscopy** (Invited talk)
Howard Lee, Andrew Palmer, Yucheng Jin, Beyonce Hu, Harvey Lin, Stuart Love, David Dang — *University of California, Irvine, USA*
I will present our recent development of passive and active "Meta"-optical fiber, an advanced optical fiber integrated with emerging metasurface concepts.

15:00 - 15:15 **Reconfigurable Sb2Se3 Metasurface Filter Design for Compressive-Sensing-Enabled Atmospheric Trace-Gas Recognition**
Kim Bui[1], Sebastian Falckenheiner[2], Pierre Piron[3], Bart Kooi[4], Giampiero Gerini[5] — *[1] Dutch Organization for Applied Scientific Research (TNO) and Delft University of Technology (TU Delft), Netherlands [2] Dutch Organization for Applied Scientific Research (TNO) and Eindhoven University of Technology (TU/e), Netherlands [3] Delft University of Technology (TU Delft), Netherlands [4] University of Groningen, Netherlands [5] Dutch Organization for Applied Scientific Research (TNO) and Eindhoven University of Technology, Netherlands*
In this paper, we propose the design of a reconfigurable metasurface filter incorporating phase change materials (PCMs). This filter is part of a novel spaceborne spectrometer concept for atmospheric monitoring. The metasurface filter consists of PCMs pillars embedded in a diamond matrix. The combination of shape and material properties results in resonances that give rise to specific spectral filtering functions. The optical properties of PCMs, and hence the transmission function, change when stimulated with a pulsed laser. In combination with a compressive sensing (CS) algorithm, a limited number of measurements with a single metasurface results in precise reconstructions of the Earth's atmospheric spectrum.

15:15 - 15:30 **Analysis and Design of a Reconfigurable Metasurface based on Chalcogenide Phase-Change Material for Operation in the Near and Mid Infrared**
Alexandros Pitilakis[1], Alexandros Katsios[2], Alexandros-Apostolos Boulogeorgos[2] — *[1] Aristotle University of Thessaloniki (AUTH), Greece [2] University of Western Macedonia (UoWM), Greece*
We analyze, design and assess the performance of a reconfigurable holographic metasurface architecture for optical wireless communications in the infrared. The device is based on the GST phase-change material. We analytically assess the response using transmission line theory and equivalent circuits, fully incorporating the broadband GST material dispersion.

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

Nonlinear and Active Metasurfaces for Frequency Generation, Lasing, and Optical Control

Chairperson(s): Owen Miller, Dragomir Neshev

14:00 - 14:30 **Perovskite Polariton Condensation with Scalable Silicon Metasurfaces** (Extended)
Marco Marangi, Andrea Zacheo, Alexander M. Dubrovkin, Giorgio Adamo, Cesare Soci — *Centre for Disruptive Photonic Technologies, SPMS, NTU, Singapore*
We report the first experimental demonstration of exciton-polariton condensation in a polycrystalline perovskite film, by hybridizing it with a silicon metasurface, and show polariton lasing. To this end we use bound states in the continuum (BIC) resonances because of their inherently high quality factor. This work establishes a scalable pathway for polaritonic devices compatible with silicon photonics.

14:30 - 15:00 **Generation of High Harmonics from Resonant Metasurfaces** (Extended)
Pavel Tonkaev[1], Felix Richter[2], Ivan Toftul[1], Ivan Sinev[2], Hatice Altug[2], Yuri Kivshar[1] — *[1] The Australian National University, Australia [2] Ecole Polytechnique Federale de Lausanne, Switzerland*
We experimentally demonstrate a high harmonic generation enhancement of at least three orders of magnitude from a free-standing silicon membrane driven by a quasi-bound state in the continuum resonance. The harmonic power dependencies exhibit unconventional behaviour at resonance, while outside the resonance, they follow classical scaling.

15:00 - 15:30 **Light Shaping Light via Optical Meta-Structures** (Invited talk)
Natalia Litchinitser[1], Hooman Barati Sedeh[1], Jiannan Gao[1], Dmitrii Tsvetkov[1], Yuruo Zheng[1], Danilo Gomes Pires[1], Maria Antonietta Vincenti[2], Michael Scalora[3] — *[1] Duke University, United States [2] University of Brescia, Italy [3] Aviation and Missile Center, US Army CCDC, United States*
We introduce a rigorous theoretical approach for sculpting three-dimensional, topological particle-like objects, such as optical knots or links, including precise control of their parts. We also discuss a novel concept called topology imprinting, utilizing judiciously designed all-dielectric nonlinear flat and multi-layered optics to replicate desired waveforms at multiple frequencies, opening new avenues for advanced photonic applications.

Oral Sessions (Tuesday Afternoon 2)

Special session: Metamaterials and Robotics II
Chairperson(s): Benjamin Gorissen **Room: Concertzaal**

Time	1st author	Title
16:00 - 16:30	Daniela Kraft	Colloidal pivots enable Brownian mechanisms, metamaterials, and machines
16:30 - 17:00	Yao Du	Metamaterial that Learns Shape Changes by using Contrastive Learning
17:00 - 17:30		Panel Discussion

Non-linear and Active Microwave Metamaterials
Chairperson(s): Stefano Maci, Filippo Capolino **Room: Shaffyzaal**

Time	1st author	Title
16:00 - 16:30	Silvio Hrabar	A Concept of Generalized Positive/negative Time-varying Capacitor
16:30 - 17:00	Sen Zheng	Broadband Anomalous Refractor Based on Transmission Achromatic Metasurface
17:00 - 17:15	Darin Nozina	Time-Varying Capacitor based on Switching Capacitor Bank

Dynamic Wavefront Control with Tunable and Time-Varying Metasurfaces
Chairperson(s): Victor Pacheco-Peña, Amir Jafargholi **Room: Teekenzaal I**

Time	1st author	Title
16:00 - 16:30	Giampiero Gerini	Metasurfaces For Wave-front Modulation Across The Electromagnetic Spectrum From Microwaves To Optical Frequencies
16:30 - 16:45	Shaojie Wang	Dynamic Surface Plasmonic Polaritons Routing by Dispersion Control of Tunable Metasurface
16:45 - 17:00	Freek Van Gorp	Mechano-Optical Metasurfaces
17:00 - 17:15	Chao Meng	MEMS Tunable Optical Metasurfaces
17:15 - 17:30	Zoltan Sztranyovszky	Extreme Field Enhancement In High-index Tunable Metamaterials

Chiral Light-Matter Interaction
Chairperson(s): Howard Lee, Carsten Rockstuhl **Room: Teekenzaal II**

Time	1st author	Title
16:00 - 16:30	Giuseppe Strangi	The Role of Chirality in Controlling Light-Matter Interactions
16:30 - 16:45	Maxim Gorkunov	Metamirrors and Strong Chirality in the Reflection Geometry
16:45 - 17:00	Debapriya Pal	k-Space Polarimetry of Metasurface Enhanced Chiral Emission: Polarization Singularities and Handedness Reversal
17:00 - 17:15	Ivan Toftul	Chiral Resonant Dielectric Metasurfaces
17:15 - 17:30	Xujing Liu	Arbitrary Polarized Photon Sources With Quantum Emitter Integrated Metasurfaces

Meta- Computing and Processing
Chairperson(s): Nicoletta Granchi **Room: Koepelzaal**

Time	1st author	Title
16:00 - 16:30	Owen Miller	Information Theory of End-to-End Meta-Imagers
16:30 - 17:00	Junsuk Rho	Sustainable Manufacturing of Optical Metasurfaces for Imaging, Sensing and Display
17:00 - 17:15	Bernardo Dias	Excitonic 2D Metasurface for Tunable Image Processing
17:15 - 17:30	Cherry Park	36 channels Spin and Wavelength Co-multiplexed Metasurface Holography by Phase-gradient Inverse Design

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

Special session: Metamaterials and Robotics II

Chairperson(s): Benjamin Gorissen

16:00 - 16:30 **Colloidal pivots enable Brownian mechanisms, metamaterials, and machines** (Invited talk)
Daniela Kraft — *Leiden University, Netherlands*
Biological machines harness targeted deformations that can be actuated by Brownian fluctuations. However, while synthetic micromachines can similarly leverage targeted deformations they are too stiff to be driven by thermal fluctuations and thus require strong forcing. Furthermore, systems that are able to change their conformation by thermal fluctuations do so uncontrollably or require external control. In this talk, I will show how we leverage DNA-based sliding contacts to create colloidal pivots, rigid anisotropic objects that freely fluctuate around their pivot point, and use a hierarchical strategy to assemble these into Brownian metamaterials and machines with targeted deformation modes. I will demonstrate how we realized the archetypical rotating diamond and rotating triangle, or Kagome, geometries, whose auexetic deformations are driven by thermal. Finally, I will present the implementation of magnetic actuation to achieve an elementary Brownian machine with easily actuatable deformations that can harness Brownian fluctuations. Together, our work introduces a strategy for creating thermal mechanical metamaterials and leverages them for functional Brownian devices, paving the way to materialize flexible, actuatable structures for micro-robots, smart materials, and nanomedicine.

16:30 - 17:00 **Metamaterial that Learns Shape Changes by using Contrastive Learning** (Extended)
Yao Du, Corentin Coulais — *University of Amsterdam, Netherlands*
Learning to change shape is a fundamental strategy of adaptation and evolution in crossing scales from cells to animals. Synthetic materials can also exhibit complex shape changing capabilities, but lack the ability to learn. Here, we build metamaterials that can learn complex changes by using a constrastive learning scheme. By progressively updating their local stiffnesses, our metamaterials are able to forget and learn new shape changes in sequence, learn multiple shape changes that break reciprocity, and learn multistable shape changes, which in turn allows them to perform reflex gripping actions and locomotion. Our findings establish metamaterials as an exciting platform for physical learning, which in turn opens avenues for the use of physical learning to design adaptive materials and robots.

17:00 - 17:30 **Panel Discussion**
Benjamin Gorissen[1], Eleonora Tubaldi[2], Aniket Pal[3], Anton Souslov[4], Itai Cohen[5], Daniela Kraft[6], Mingchao Liu[7] — *[1] KU Leuven, Belgium [2] University of Maryland, USA [3] University of Stuttgart, Germany [4] University of Cambridge, UK [5] Cornell University, USA [6] Leiden University, The Netherlands [7] University of Birmingham, UK*
Panel discussion moderated by Benjamin Gorissen

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

Non-linear and Active Microwave Metamaterials

Chairperson(s): Stefano Maci, Filippo Capolino

16:00 - 16:30 **A Concept of Generalized Positive/negative Time-varying Capacitor** (Invited talk)
Silvio Hrabar — *University of Zagreb, Croatia*
Some exotic and potentially very useful EM phenomena have been predicted, which presume the existence of materials with a permittivity whose value varies between negative and positive values. A possible artificial realization of these media would require positive/negative time-varying capacitors, which are currently not available. Here we propose a concept to realize these capacitors, based on the combination of a negative impedance converter terminated with a varactor diode.

16:30 - 17:00 **Broadband Anomalous Refractor Based on Transmission Achromatic Metasurface** (Extended)
Sen Zheng — *Southeast University, China*
In this paper, a broadband anomalous refractor is proposed based on transmission achromatic metasurface achieved by receiver-transmitter integrated (RTI) units with meandering stripline. The transmission phase curves of the RTI unit can be precisely tailored by combining the geometric phase, determined by the rotation angle, with the propagation phase, governed by the length of stripline. Then, a broadband refractor is realized by assembling RTI units. Simulations indicate that the anomalous refractor can achieve stable anomalous refraction at a fixed refraction angle of 16° within the frequency range of 27 to 37 GHz, which verified the effectiveness of our design method.

17:00 - 17:15 **Time-Varying Capacitor based on Switching Capacitor Bank**
Darin Nozina, Srdjan Milic, Igor Krois, Silvio Hrabar — *University of Zagreb, Croatia*
Recent developments in time-varying reactive elements have revealed several new ideas, such as the emulation of a non-Foster element by a commercial time-varying reactance such as a varactor diode. Unfortunately, commercial varactor diodes have limited dynamic range of the generated capacitance and, more importantly, low power consumption. In order to contribute to the solution of this problem, we propose a switched capacitor bank that behaves like a time-varying capacitor.

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

Dynamic Wavefront Control with Tunable and Time-Varying Metasurfaces

Chairperson(s): Victor Pacheco-Peña, Amir Jafargholi

16:00 - 16:30 **Metasurfaces For Wave-front Modulation Across The Electromagnetic Spectrum From Microwaves To Optical Frequencies** (Invited talk)
Giampiero Gerini — *TNO - Optics Department; Technology University of Eindhoven, Netherlands*
In this paper, we present an overview of several research activities on metasurfaces, over a very broad frequency range, from microwaves up to the infrared and visible spectrum, performed at TNO in the last years.

16:30 - 16:45 **Dynamic Surface Plasmonic Polaritons Routing by Dispersion Control of Tunable Metasurface**
Shaojie Wang, Ke Chen, Yijun Feng — *Nanjing University, China*
Topological polaritons in extremely anisotropic materials provide unprecedented control of light-matter interactions and also the energy flow of waves. Developing an active topological platform to provide reconfigurable wave functionalities showcases much potential in device applications, yet remains largely unexplored. Here, we report a metasurface approach to realize electrically reconfigurable elliptical-to-hyperbolic topological transitions of surface plasmonic polaritons by artificial electromagnetic anisotropy incorporating voltage-controlled capacitive components. By exploiting the group velocity of topological transitions, we observe controllable field canalizations facilizing ultra-collimated energy transfer. Furthermore, we conceived a planar reconfigurable polariton circuit that enables on-demand polariton propagation routing. Our findings may offer new opportunities to advance programmable integrated plasmonic devices with potential applications in imaging, sensing, and detection.

16:45 - 17:00 **Mechano-Optical Metasurfaces**
Freek Van Gorp, Wenfeng Liu, Corentin Coulais, Jorik Van De Groep — *University of Amsterdam, Netherlands*
Tunable metasurfaces enable active and on-demand control over optical wavefronts through reconfigurable scattering of resonant nanostructures. Here, we present novel insights inspired by mechanical metamaterials to achieve giant tunability in mechano-optical metasurfaces where the mechanical metamaterial and optical metasurfaces are integrated in a single nanopatterned material. We eliminate the substrate and demonstrate a nanopatterned silicon membrane that simultaneously functions as a mechanical metamaterial and an optical metasurface with large tunability. Our results highlight a promising route toward active metasurfaces, with potential applications in tunable filters, reconfigurable lenses, and dynamic wavefront shaping.

17:00 - 17:15 **MEMS Tunable Optical Metasurfaces**
Chao Meng[1], Paul Thrane[2], Fei Ding[1], Sergey Bozhevolnyi[1] — *[1] University of Southern Denmark, Denmark [2] SINTEF Microsystems and Nanotechnology, Norway*
Electrically tunable metasurfaces offer significant potential for miniaturized and adaptive optoelectronic systems. Here, we present the concept and experimental realization of our MEMS-OMS platform, enabling efficient and fast dynamic light field manipulation. We highlight two

implementations: a tunable waveplate for full-range birefringence control and a tunable bilayer metasurface for dual-state phase control.

17:15 - 17:30 **Extreme Field Enhancement In High-index Tunable Metamaterials**
Zoltan Sztranyovszky[1], Nicolas Spiesshofer[2], Caleb Todd[2], Rakesh Arul[2], Jeremy Baumberg[2], Angela Demetriadou[1] — *[1] University of Birmingham, United Kingdom [2] University of Cambridge, United Kingdom*
We show that metamaterials made from gold nanoparticles self-assembled in layered aggregates with nanometer-sized gaps, exhibit remarkably high refractive index, tuneable by minute changes in the gap size, shape and lattice structure, while exhibiting extreme field enhancement in the gaps, which allows applications in sensing, enhancing non-linearities and up-conversion processes.

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

Chiral Light-Matter Interaction

Chairperson(s): Howard Lee, Carsten Rockstuhl

16:00 - 16:30 **The Role of Chirality in Controlling Light-Matter Interactions** (Invited talk)
Giuseppe Strangi — *Case Western Reserve University, USA*
In this work, we explore the implications of chirality in photonic and plasmonic systems, focusing on the design and implementation of chiral metasurfaces. By leveraging superchiral fields, we demonstrate enhanced optical chirality densities beyond conventional chiral systems, opening new avenues for applications in chiral sensing, enantioselective spectroscopy, and quantum photonics.

16:30 - 16:45 **Metamirrors and Strong Chirality in the Reflection Geometry**
Maxim Gorkunov[1], Alexander Antonov[2], Seongheon Kim[3], Andreas Tittl[2], Young Chul Jun[3], Yuri Kivshar[4] — *[1] Institute of Crystallography, NRC Kurchatov Institute, Russia [2] Ludwig-Maximilians-University of Munich, Germany [3] Ulsan National Institute of Science and Technology, Republic of Korea [4] Australian National University, Australia*
Chiral dielectric metasurfaces interact resonantly with circularly polarized light by virtue of coupling selectivity of photonic eigenstates. Many chiral devices emitting and detecting circularly polarized light require integration with highly reflective mirrors. Here we study advanced designs of chiral metacavities and suggest the strategies to achieve strong chiral optical response in the reflection geometry by combining mirrors and planar achiral metasurfaces.

16:45 - 17:00 **k-Space Polarimetry of Metasurface Enhanced Chiral Emission: Polarization Singularities and Handedness Reversal**
Debapriya Pal, A. Femius Koenderink — *Department of Physics of Information in Matter and Center for Nanophotonics, NWO-I Institute AMOLF, Science Park 104, NL 1098 XG Amsterdam, The Netherlands, The Netherlands*
Chiral light emission is crucial for advanced photonic devices, yet controlling it for both achiral and chiral emitters remains challenging. Metasurfaces can transform incoherent emitters into spatially coherent sources, as studied in thermal sources and solid-state lighting. Using k-space polarimetry and reciprocity-based T-matrix calculations, we unveil the complex topology of far-field polarization in incoherent metasurface-enhanced emission and an unexpected reversal of intrinsic molecular handedness in chiral emitters coupled to metasurfaces.

17:00 - 17:15 **Chiral Resonant Dielectric Metasurfaces**
Ivan Toftul, Yuri Kivshar — *Research School of Physics, Australian National University, Australia*
We summarise our recent studies of chiral effects in linear and nonlinear resonant dielectric metasurfaces. We develop a comprehensive approach for maximising optical chirality in metasurfaces through engineering of lattice and meta-atom symmetries and exploration of the modal strong coupling. By leveraging monoclinic lattice geometries, we demonstrate that even metasurfaces composed of achiral meta-atoms can exhibit pronounced intrinsic chiral response in both linear and nonlinear regimes. We also analyse how chirality can be controlled by meta-atom rotation, and present experimental validations of our theoretical predictions.

17:15 - 17:30 **Arbitrary Polarized Photon Sources With Quantum Emitter Integrated Metasurfaces**

Xujing Liu, Yinhui Kan, Shailesh Kumar, Fei Ding, Sergey Bozhevolnyi — *University of Southern Denmark, Denmark*

We propose a method that enables single-photon emission into arbitrary polarization states with compact chip-scale devices by integrating quantum emitters (QEs) with metasurfaces. Metasurfaces with segmented areas of anisotropic nano-scatterers are employed to efficiently outcouple the QE-excited surface plasmon polaritons, forming free-space radiation consisting of two orthogonally linearly polarized components with completely and independently tailored phases and amplitudes. The design enables single-photon generation encoded with arbitrary polarization states, covering thereby the whole Poincaré sphere.

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

Meta- Computing and Processing

Chairperson(s): Nicoletta Granchi

16:00 - 16:30 **Information Theory of End-to-End Meta-Imagers** (Invited talk)
Owen Miller, Lukas Kienesberger, Zeyu Kuang — *Yale University, USA*
Optical devices frequently no longer need to produce interpretable images and can instead simply encode information. I will describe general information-theoretic considerations for the optics: key factors enabling information extraction, strong constraints on intensity-only measurements, and new metrics enabling data-agnostic optimization of information-encoding optics.

16:30 - 17:00 **Sustainable Manufacturing of Optical Metasurfaces for Imaging, Sensing and Display** (Invited talk)
Junsuk Rho — *POSTECH, Korea (South)*
This talk will discuss the latest progress in metasurface technology, emphasizing its applications, functional advancements, and recent breakthroughs in scalable fabrication techniques.

17:00 - 17:15 **Excitonic 2D Metasurface for Tunable Image Processing**
Bernardo Dias[1], Andrea Cordaro[2], Ludovica Guarneri[1], Albert Polman[2], Jorik Van De Groep[1]
— *[1] University of Amsterdam, Netherlands [2] AMOLF, Netherlands*
Edge detection is a central process in Computer Vision, and low-power operation is achievable using optical metasurfaces. Nevertheless, the operation of these devices is still passive. We propose an active metasurface performing a switchable spatial differentiation by leveraging the coupling between a Fano resonance and an exciton in monolayer WS2.

17:15 - 17:30 **36 channels Spin and Wavelength Co-multiplexed Metasurface Holography by Phase-gradient Inverse Design**
Cherry Park — *POSTECH, Korea (South)*
Metasurface holography enables high-resolution image multiplexing, but scaling channel capacity remains a challenge. This paper presents a high-capacity single-cell metasurface that multiplexes holographic images across spin and wavelength using a single-phase map. Optimized via inverse design and automatic differentiation, the phase profile encodes multiple images without complex meta-atoms, simplifying fabrication while maintaining performance. We demonstrate an 8-channel hologram spanning visible to near-infrared wavelengths and a 36-channel hologram covering the full-visible spectrum with 18 wavelengths at 20-nm intervals. Noise suppression loss functions were integrated to reduce background noise and inter-channel crosstalk, significantly enhancing image quality.

Oral Sessions (Wednesday Morning)

Special session: Metamaterials and Information I
Chairperson(s): Nader Engheta, Romain Fleury **Room: Concertzaal**

Time	1st author	Title
10:30 - 11:00	Nader Engheta	Informatic Metamaterials
11:00 - 11:30	Andrea Alu	Engineered Nonlocalities for Analog Optical Computing
11:30 - 12:00	Humeyra Caglayan	Meta-operators for all-optical image processing
12:00 - 12:30	Jason Valentine	Meta-optics for Edge Computing

Plasmonics: Observation and Application
Chairperson(s): Maryna Meretska, Lisa Poulikakos **Room: Shaffyzaal**

Time	1st author	Title
10:30 - 11:00	Jacob Khurgin	When Plasmon Is Not Really a Plasmon but Just a Photon Confined Near Metal.
11:00 - 11:15	Evelijn Akerboom	Angle-Resolved Cathodoluminescence Interferometry of Plasmonic Scatterers
11:15 - 11:30	Saad Abdullah	Toward Complete Optical Coupling to Confined Surface Polaritons
11:30 - 11:45	Stan De Peinder	Deriving 3D Surface Charge Density in Tapered Plasmonic Nanostructures by Cathodoluminescence Spectroscopy
11:45 - 12:00	Guoqun Li	Plasmonic Trimer-Based Wearable Hydrogel SERS Chip for Uric Acid Detection in Sweat
12:00 - 12:15	Vlastimil Křápek	Composite Gold-Vanadium-Dioxide Reconfigurable Plasmonic Devices
12:15 - 12:30	Dongling Ma	Surface Plasmon Enhanced Photocatalysis

Computing and Wave Control in Mechanical Metamaterials
Chairperson(s): Qingxiang Ji, Siddhant Kumar **Room: Teekenzaal I**

Time	1st author	Title
10:30 - 11:00	Martin Van Hecke	Emergent Computing in Mechanical Metamaterials
11:00 - 11:15	Yuan Zhou	3D Odd Elastic Metamaterials
11:15 - 11:30	Rupesh Mahore	Frustrated Active Metamaterial
11:30 - 12:00	Yi Chen	Nonlocal Metamaterials: Review and Recent Progress
12:00 - 12:30	Guoliang Huang	Theory and Experimental Realization of Temporal Refraction and Reflection in Elastic Beam

Quantum Metamaterials
Chairperson(s): Katja Höflich, Alexander Khanikaev **Room: Teekenzaal II**

Time	1st author	Title
10:30 - 11:00	Angela Vasanelli	Metamaterial Enhanced Unipolar Quantum Optoelectronics
11:00 - 11:15	Artuur Stevens	Simultaneous Single- and Two-Mode Squeezing in Time-Varying Media
11:15 - 11:30	Evgeniy Narimanov	Hyperbolic Quantum Processor.
11:30 - 11:45	Andrei Stepanenko	The Effect Of Disorder On Optimal Quantum State Transfer In Nearest-Neighbor-Coupled Chains
11:45 - 12:00	Max Ehrhardt	Birefringence-induced Topological Effects in Laser-written Quantum Photonics
12:00 - 12:30	Christos Argyropoulos	Quantum Plasmonic Metasurfaces for Efficient Generation and Control of Single Photon Emission

Temporal Boundaries and Space-Time Interfaces
Chairperson(s): Yakir Hadad, Sergey Bozhevolnyi **Room: Koepelzaal**

Time	1st author	Title
10:30 - 10:45	J. Enrique Vázquez-Lozano	Is It Possible To Have Mirrors From Temporal Boundaries?
10:45 - 11:00	Emanuele Galiffi	Coherent Perfect Frequency Conversion and Dynamical Hong-Ou-Mandel Interference at Time-Interfaces
11:00 - 11:15	Furkan Ok	Relativistic Electron Scattering at Uniform-Velocity Space-Time Interfaces
11:15 - 11:30	Mohammad Sajjad Mirmoosa	Evolution of Von Neumann Entropy Across Electromagnetic Time Interfaces
11:30 - 11:45	Amir Bahrami	Retarded Argument Imposition: A Novel Approach for Solving Scattering Problems at Interfaces formed by Space-Time Modulations
11:45 - 12:00	Sahitya Singh	Implementation of Photonic Time-Interfaces in an On-Chip Transmission-Line Metamaterial
12:00 - 12:30	Christophe Caloz	Space-Time Engineered Modulation (STEM) Elements

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

Special session: Metamaterials and Information I

Chairperson(s): Nader Engheta, Romain Fleury

10:30 - 11:00 **Informatic Metamaterials** (Invited talk)
Nader Engheta — *University of Pennsylvania, USA*
In this talk, I will discuss the emerging roles of metamaterials in information science and technology. Metamaterials and metasurfaces have provided a versatile platform for tailoring and manipulating waves, leading to exciting functionalities. One such possibility is the use of metamaterials in wave-based information processing, data handling, and analog computing. As machine learning (ML), artificial intelligence (AI), large language models (LLM), and generative AI such as ChatGPT increasingly become part of our daily lives, it is important to explore how metamaterials can play crucial roles in handling and processing tremendous amounts of data with low energy and high speed. I will give an overview of some of the recent and ongoing developments in this field, discuss some of their advantages and constraints, and forecast future possibilities

11:00 - 11:30 **Engineered Nonlocalities for Analog Optical Computing** (Invited talk)
Andrea Alu — *CUNY Advanced Science Research Center, USA*
Engineered nonlocal responses of meta-structures provide a powerful platform to manipulate and control the information contained in the signals that propagate and interact with them. In this talk, I will discuss our recent progress on nonlocal metasurfaces, meta-structures and metamaterials aimed at processing incoming signals and images to realize fast, efficient and massively parallel wave-based computing.

11:30 - 12:00 **Meta-operators for all-optical image processing** (Invited talk)
Humeyra Caglayan — *Eindhoven University of Technology, Netherlands*
All-optical image processing enables ultrafast, energy-efficient computation by exploiting the parallelism of light. However, existing approaches often rely on bulky optics or are limited to single operations. We present a metasurface-based platform—meta-operators—that performs arbitrary image transformations in a compact, passive format. By integrating double-phase encoding and polarization multiplexing, we realize diverse analog operations, including first- and second-order differentiation, cross-correlation, and high-fidelity 3D holography, all at visible wavelengths. This scalable design establishes a versatile framework for real-time optical computing, intelligent vision systems, and compact volumetric displays. Media link(s): See arxiv preprint https://arxiv.org/abs/2503.12252

12:00 - 12:30 **Meta-optics for Edge Computing** (Invited talk)
Hanyu Zheng[1], Quan Liu[1], Brandon Swartz[1], Xiaomeng Zhang[1], Ivan Kravchenko[2], Yuankai Huo[1], Jason Valentine[1] — *[1] Vanderbilt University, USA [2] Oak Ridge National Laboratory, USA*
This talk will focus on the use of meta-optics for implementing computation for edge sensors, serving to off-load computationally expensive convolutional operations from a digital processing platform, reducing both latency and power consumption.

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

Plasmonics: Observation and Application

Chairperson(s): Maryna Meretska, Lisa Poulikakos

10:30 - 11:00 **When Plasmon Is Not Really a Plasmon but Just a Photon Confined Near Metal.** (Invited talk)
Jacob Khurgin — *Johns Hopkins University, USA*
Metallic structures demonstrate wavelength-dependent loss, with reduced loss at mid-IR to THz wavelengths. This talk distinguishes two regimes: "plasmonic" (high loss, size-independent resonances) and "metal-confined photon" (low loss, size-dependent resonances), emphasizing that non-plasmonic modes at larger structures are better described by conventional RF frameworks than by plasmonics.

11:00 - 11:15 **Angle-Resolved Cathodoluminescence Interferometry of Plasmonic Scatterers**
Evelijn Akerboom[1], Nahid Talebi[2], Javier García De Abajo[3], Albert Polman[1] — *[1] AMOLF, Netherlands [2] Kiel University, Germany [3] ICFO, Barcelona*
High-energy electrons in a SEM excite resonances in plasmonic and dielectric nanostructures that radiate to the far field as cathodoluminescence (CL) emission. Here, we demonstrate CL interferometry, unveiling the coherent characteristics of plasmon excitations at nanometer spatial resolution and femtosecond time scale.

11:15 - 11:30 **Toward Complete Optical Coupling to Confined Surface Polaritons**
Saad Abdullah[1], Eduardo J.C. Dias[1], Jan Krpensky[1], Vahagn Mkhitaryan[2], Javier Garcia De Abajo[3] — *[1] ICFO-Institut de Ciencies Fotoniques, Spain [2] ICFO-Institut de Ciencies Fotoniques, Spain and Purdue University, USA [3] ICFO-Institut de Ciencies Fotoniques, ICREA-Institució Catalana de Recerca i Estudis Avançats, Spain*
We experimentally demonstrate efficient optical coupling of free-space propagating light into surface plasmon polaritons using engineered gold disk scatterers positioned above a gold surface with a controlled silica spacer. Optimizing spacer thickness yields maximal coupling cross sections approaching the incident wavelength squared, providing a versatile framework for enhancing light-polariton interactions.

11:30 - 11:45 **Deriving 3D Surface Charge Density in Tapered Plasmonic Nanostructures by Cathodoluminescence Spectroscopy**
Stan De Peinder[1], Matthias Liebtrau[1], Wiebke Albrecht[1], Javier García De Abajo[2], Albert Polman[1] — *[1] AMOLF, Netherlands [2] ICFO-Institut de Ciencies Fotoniques, ICREA-Institució Catalana de Recerca i Estudis Avançats, Spain*
We derive the surface electric charge density distribution on resonantly excited tapered plasmonic nanostructures at high spatial resolution through cathodoluminescence spectroscopy (CL). From 2D CL maps that represent the electric near-field distribution around Au nanotapers, we derive the surface potential distribution, which in turn allow us to find the surface charge distribution on the nanotips. Comparing measurements and numerical simulation for plasmonic tips with a radius of curvature < 5 nm, we find that the absolute charge density distributions depend strongly on the nanoscale tip geometry. Insights into the nanoscale distribution

of electrical charges should allow for the optimization of plasmon-driven sustainable chemical reactions.

11:45 - 12:00 **Plasmonic Trimer-Based Wearable Hydrogel SERS Chip for Uric Acid Detection in Sweat**
Guoqun Li, Teng Qiu, Qi Hao — *Southeast University, China*
This study introduces a wearable SERS chip with a hydrogel membrane and plasmonic trimers for non-invasive uric acid detection in sweat. It enables real-time monitoring, correlates well with blood tests, and reveals exercise-induced metabolic changes, offering potential for hyperuricemia management.

12:00 - 12:15 **Composite Gold-Vanadium-Dioxide Reconfigurable Plasmonic Devices**
Vlastimil Křápek, Rostislav Řepa, Jiří Liška, Peter Kepič, Jiří Kabát, Michal Horák, Tomáš Šikola — *Brno University of Technology, Czech Republic*
The lateral arrangement of self-assembled VO2 nanoparticles and gold nanostructures fabricated by electron beam lithography is presented as a suitable platform for composite reconfigurable plasmonic devices. Two specific reconfigurable devices are demonstrated: Electric-magnetic switches and resonance-energy switches.

12:15 - 12:30 **Surface Plasmon Enhanced Photocatalysis**
Dongling Ma — *Institut national de la recherche scientifique (INRS), Canada*
With unique surface plasmon resonance properties, plasmonic nanostructures are able to enhance photon harvesting of semiconductor materials via hot carrier injection, near-field effects and/or enhanced light scattering, which has significant implications for the realization of cost-effective high-performance solar utilization technologies. In this talk, I will overview some of our recent progress on the development of plasmonic nanostructures and their beneficial role in solar fuel production, photocatalytic degradation of pollutants and solar cells.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
Teekenzaal I

Computing and Wave Control in Mechanical Metamaterials

Chairperson(s): Qingxiang Ji, Siddhant Kumar

10:30 - 11:00 **Emergent Computing in Mechanical Metamaterials** (Invited talk)
Martin Van Hecke — *Amolf and University Leiden, Netherlands*
The state of a multistable material can often be described by a collection of material bits. Here we leverage buckling and snapping to realize metamaterials with precisely controlled mechanical bits. In particular, we realized metamaterials that count how often they are compressed [1], rewritable shapeshifting metamaterials [2], and more generally, materials that act as finite state machines [3] - a paradigm of computing. Our strategy can be extended to other material bits, such as spins, and opens the door to in-materia computing.

11:00 - 11:15 **3D Odd Elastic Metamaterials**
Yuan Zhou, Rupesh Mahore, Corentin Coulais — *University of Amsterdam, Netherlands*
Metamaterials with engineered microstructures exhibit exotic mechanical properties, but passive solids are limited by energy conservation. Introducing active, non-conservative interactions enables odd elastic moduli, which are absent in passive systems. Here, we design and characterize 3D odd elastic metamaterials using non-reciprocal interactions. By integrating Hookean and feedback-controlled non-pairwise springs, we establish the link between microscopic stiffness and macroscopic moduli through a coarse-grained model. Our results reveal multiple odd moduli in 3D active solids, coupling distinct deformation modes and highlighting the potential for programmable, multi-modal robotic materials.

11:15 - 11:30 **Frustrated Active Metamaterial**
Rupesh Mahore[1], Xiafei Guo[1], Corentin Coulais[1], Oleksandr Gamayun[2] — *[1] University of Amsterdam, Netherlands [2] London Institute of Mathematical Sciences, United Kingdom*
The principle of reciprocity is ubiquitous in most of the physical systems and is of- ten violated in out-of-equilibrium systems, extensively studied in past few decades. While most of the studies typically describe a mono-stable non equilibrium steady state, here we induced topological non orient-ability in robotic metamaterial interacting non reciprocally to get multi- ple steady states. Through numerical simulations, experiments and theory we demonstrate that these states can be isolated within a region in parameter space and non orientability further enhances the robustness and control over these states.

11:30 - 12:00 **Nonlocal Metamaterials: Review and Recent Progress** (Invited talk)
Yi Chen, Martin Wegener — *Karlsruhe Institute of Technology, Germany*
After a brief review of the field of static and dynamic nonlocal metamaterials in mechanics, electromagnetism, and transport, we focus on effective-medium descriptions of recent experiments on nonlocal versions of Ohm's law and Hooke's law.

12:00 - 12:30 **Theory and Experimental Realization of Temporal Refraction and Reflection in Elastic Beam** (Invited talk)
Shaoyun Wang[1], Guoliang Huang[2] — *[1] University of Missouri, USA [2] Peking University, China*

This study presents theory and experimental demonstration of refraction and reflection of flexural waves across a temporal boundary in a continuum-based mechanical metabeam, and unveils opportunities that emerge by tailoring temporal scattering phenomena for phononic applications. We observe these phenomena in an elastic beam attached to an array of piezoelectric patches that can vary in time the effective elastic properties of the beam. Frequency conversion and phase conjugation are observed upon a single temporal interface. These results are consistent with the temporal Snell's law and Fresnel equations for temporal interfaces. Further, we illustrate the manipulation of amplitude and frequency spectra of flexural wave temporal refraction and reflection through multi-stepped temporal interfaces. Our findings enable precise control over wave amplitude and frequency through temporally modulated mechanical systems, providing a concrete framework for designing time-mechanical metamaterials and time-phononic crystals.

10:30 - 12:30 Oral Sessions (Wednesday Morning)
Teekenzaal II

Quantum Metamaterials

Chairperson(s): Katja Höflich, Alexander Khanikaev

10:30 - 11:00 **Metamaterial Enhanced Unipolar Quantum Optoelectronics** (Invited talk)
Angela Vasanelli[1], Jihye Baik[1], Livia Del Balzo[1], Thomas Bonazzi[1], Hamza Dely[1], Marta Mastrangelo[1], Baptiste Chomet[1], Konstantinos Pantzas[2], Grégoire Beaudoin[2], Isabelle Sagnes[2], Carlo Sirtori[1] — *[1] Laboratoire de Physique de l'ENS, École Normale Supérieure, Université PSL, Sorbonne Université, Université Paris Cité, CNRS, 75005 Paris, France [2] Université Paris-Saclay, CNRS, Centre de Nanosciences et de Nanotechnologies, Palaiseau, France*
Metamaterials play an important role in the development of optoelectronic devices due to their ability to enhance the coupling between free-space radiation and the absorbing or emitting medium. In this work, we present unipolar quantum devices operating in the mid-infrared wavelength range and discuss how their implementation into metamaterial architectures can improve their performances and leverage new degrees of freedom for their design.

11:00 - 11:15 **Simultaneous Single- and Two-Mode Squeezing in Time-Varying Media**
Artuur Stevens, Christophe Caloz — *KU Leuven, Belgium*
We study the squeezing of light beams in a system combining beam splitters and time-varying media. First, we derive the input-output operator transformations for time-varying media. Integrating these with the input-output operator transformations of beam splitters allows describing arbitrary sequences of beam splitters and time-varying media. We show that a specific configuration—beam splitter, time-varying medium, beam splitter, time-varying medium—enables simultaneous single- and two-mode squeezing. This dual squeezing mechanism leverages the benefits of both types of squeezing, offering potential advantages for highprecision, non-demolition measurements.

11:15 - 11:30 **Hyperbolic Quantum Processor.**
Evgeniy Narimanov[1], Eugene Demler[2] — *[1] Purdue University, USA [2] ETH Zurich, Switzerland*
Long-range qubit entanglement can be readily achieved when interactions are mediated by optical polariton waves in a hyperbolic material, due to the phenomenon of the Hyperbolic Super-Resonance. With the corresponding quantum gate operations defined by the optical time scale, the proposed Hyperbolic Quantum Processor does not require dilution refrigeration and offers a pathway to bring quantum computation to the realm of conventional engineering.

11:30 - 11:45 **The Effect Of Disorder On Optimal Quantum State Transfer In Nearest-Neighbor-Coupled Chains**
Andrei Stepanenko[1], Kseniia Chernova[2], Maxim Gorlach[2] — *[1] London Institute for Mathematical Sciences, Royal Institution, 21 Albemarle St, London W1S 4BS, UK, United Kingdom [2] School of Physics and Engineering, ITMO University, Saint Petersburg 197101, Russia, Russia*
Our recent results [arXiv:2501.11933] present a model example of time-optimal quantum state transfer in long chains of qubits. Here, we study the robustness of the optimal protocol against random fluctuations in the qubit eigenfrequencies and coupling control function. We show that fluctuations reduce fidelity, necessitating trajectory adjustments or alternative strategies.

11:45 - 12:00 **Birefringence-induced Topological Effects in Laser-written Quantum Photonics**

Max Ehrhardt[1], Matthias Heinrich[2], Kai Wang[1], Alexander Szameit[2] — *[1] McGill University, Canada [2] University of Rostock, Germany*

We experimentally observe effects of topological origin imposed on quantum states of light in laser-written waveguide arrays. In particular, we demonstrate birefringence of waveguides as a powerful tool in the development of quantum photonic circuits with built-in topological protection. We find propagation-invariant quantum interference and entanglement conversion from polarization to orbital angular momentum as effects enabled and protected via tailored birefringence. Our findings may pave the way towards photonic quantum circuitry and scalable quantum computing protected and enabled by virtue of a next-generation of topological photonic devices.

12:00 - 12:30 **Quantum Plasmonic Metasurfaces for Efficient Generation and Control of Single Photon Emission** (Invited talk)

Christos Argyropoulos — *The Pennsylvania State University, USA*

We demonstrate compact quantum metasurfaces to efficiently generate and control single photon emission. Quasi-bound state in the continuum (q-BIC) plasmonic metasurfaces are realized to accomplish chiral single-photon emission. Efficient manipulation and control of non-classical two-photon interference is achieved with asymmetric composite metasurface designs operating in transmission mode. Spontaneous Parametric Down-Conversion (SPDC) and defects in solid-state ultrathin materials are utilized in combination with plasmonic metasurfaces to realize new quantum nanophotonic emitter configurations.

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

Temporal Boundaries and Space-Time Interfaces

Chairperson(s): Yakir Hadad, Sergey Bozhevolnyi

10:30 - 10:45 **Is It Possible To Have Mirrors From Temporal Boundaries?**
J. Enrique Vázquez-Lozano[1], Victor Pacheco-Peña[2], Iñigo Liberal[1] — *[1] Universidad Pública de Navarra, Spain [2] Newcastle University, UK*
We investigate the feasibility of mirrors without spatial boundaries. Due to Minkowski momentum conservation, conventional temporal boundaries prevent the realization of temporal mirrors. However, we show that non-Foster left-handed temporal boundaries, switching the medium's handedness and yielding anti-parallel momentum and energy flow, allows for temporal mirrors.

10:45 - 11:00 **Coherent Perfect Frequency Conversion and Dynamical Hong-Ou-Mandel Interference at Time-Interfaces**
Emanuele Galiffi[1], Nikita Nefedkin[2], Sahitya Singh[3], Andrea Alu[3] — *[1] Advanced Science Research Center, City University of New York, USA [2] Advanced Science Research Center, Graduate Center, CUNY, United States [3] Advanced Science Research Center, City University of New York, United States*
We demonstrate how coherent illumination of a metamaterial undergoing a time-interface (i.e. an abrupt temporal variation of its constitutive properties) can be leveraged to realize frequency conversion with virtually unit efficiency, and how a similar strategy enables, at the quantum mechanical level, a dynamical analogue of the Hong-Ou-Mandel effect.

11:00 - 11:15 **Relativistic Electron Scattering at Uniform-Velocity Space-Time Interfaces**
Furkan Ok, Christophe Caloz — *Katholieke Universiteit Leuven, Belgium*
We present relativistic electron scattering at uniform-velocity space-time interfaces in the subluminal regime. By applying Noether's theorem and Lorentz transformations, we derive closed-form expressions for the reflected and transmitted energies and momenta. The resulting energy–momentum transition diversity offers opportunities for manipulating electron waves, surpassing pure-space or pure-time scattering processes. Our approach explores how adjustable modulation velocities and potentials can drive quantum electronic transport behaviors. This work paves the way for advanced space-time modulation strategies in electron systems.

11:15 - 11:30 **Evolution of Von Neumann Entropy Across Electromagnetic Time Interfaces**
Mohammad Sajjad Mirmoosa — *University of Eastern Finland, Finland*
Temporal modulation of materials offers unprecedented control over light, sparking recent interest in the quantum theory of light interaction with time-varying materials. In this presentation, through the lens of quantum optics, we evaluate the von Neumann entropy transformation induced by an electromagnetic time interface, in which the refractive index of an isotropic, homogeneous, nondispersive dielectric medium uniformly undergoes an abrupt change in time. We demonstrate that the entropy increases across such an interface, with the magnitude of the increase correlating positively with the refractive index contrast. Additionally, we analyze how photon population in the incident modes governs entropy evolution. We hope that our study

advances both the fundamental physics of time interfaces and their potential applications in quantum information technology.

11:30 - 11:45 **Retarded Argument Imposition: A Novel Approach for Solving Scattering Problems at Interfaces formed by Space-Time Modulations**
Amir Bahrami, Christophe Caloz — *KU Leuven, Belgium*
We introduce a simple yet powerful method for solving scattering problems at nonuniform spacetime interfaces, slabs and wedges with complete generality. We explicitly derive and apply this approach to analyze moving perfect electric conductors. Additionally, we present illustrative scattering examples for penetrable interfaces, slabs and spacetime wedges, with their detailed mathematical treatment provided elsewhere. Finally, we extend the method to the inverse problem of arbitrary pulse shaping.

11:45 - 12:00 **Implementation of Photonic Time-Interfaces in an On-Chip Transmission-Line Metamaterial**
Sahitya Singh, Andrea Alu — *ASRC, City University of New York, USA*
We design an on-chip switched transmission-line-metamaterial in 65nm CMOS technology to realize time-interfaces operating at higher frequencies up to 2 GHz. CMOS technology offers transistor-based switches providing rise/ fall times of the order of 20 pico-seconds, enabling operation in the GHz range, hence paving a path for exploring other spatiotemporal wave phenomena.

12:00 - 12:30 **Space-Time Engineered Modulation (STEM) Elements** (Invited talk)
Christophe Caloz[1], Amir Bahrami[1], Klaas De Kinder[1], Zhiyu Li[2] — *[1] KU Leuven, Belgium [2] Xi'an Jiaotong University,, China*
Space-time systems can be classified into elements and media. This paper focuses on the former, describing the corresponding configurations—uniform or nonuniform—and presenting two application examples.

Oral Sessions (Wednesday Afternoon 1)

Special session: Metamaterials and Information II
Chairperson(s): Nader Engheta, Romain Fleury **Room: Concertzaal**

Time	1st author	Title
14:00 - 14:30	Romain Fleury	Analog neural networks with waves
14:30 - 15:00	Marc Serra-Garcia	Physical computing in elastic metamaterials
15:00 - 15:30		Panel Discussion

Novel Applications in Sensing and Diagnostics
Chairperson(s): Jacob Khurgin, Giuseppe Strangi **Room: Shaffyzaal**

Time	1st author	Title
14:00 - 14:15	Georgiana Dima	Inductive Sensing of Lung Conductivity for Fluid Accumulation Detection
14:15 - 14:30	Alireza Nikzamir	A Robust Miniaturized Multi-Chip Module with Wireless Data and Power Transfer for Precise and Safe Tinnitus Therapy
14:30 - 14:45	Pradeep Tiwari	The Optimal Design of Terahertz Metasurface for Ultrasensitive Biosensor
14:45 - 15:00	Paolo Han Beoletto	Bio-inspired meta-sensor for speech recognition
15:00 - 15:30	Siying Peng	Metasurface-Enhanced Photothermal Imaging and High-Sensitivity Biomolecular Detection

Topological, Nonreciprocal, and Programmable Metamaterials
Chairperson(s): Christos Argyropoulos, Filiberto Bilotti **Room: Teekenzaal I**

Time	1st author	Title
14:00 - 14:30	Marc Martí Sabaté	Complex spectrum analysis of QVHE phononic waveguides using QNM expansion
14:30 - 14:45	Qingxiang Ji	3D Metamaterials with Elastic Non-reciprocity
14:45 - 15:00	Bertin Many Manda	Steering Nonreciprocity using Nonlinear Waves
15:00 - 15:15	Xiaofei Guo	Programmable Optomechanical Logic Circuits
15:15 - 15:30	Valeria Cavanni	Experimental Design of Bistable Meta-panel for Dynamic Investigation

Quantum Plasmonics and Nanophotonics
Chairperson(s): Ewold Verhagen, Angela Vasanelli **Room: Teekenzaal II**

Time	1st author	Title
14:00 - 14:30	P. André Gonçalves	Quantum Effects in Nanophotonic Light–Matter Interactions
14:30 - 14:45	Jakub Skorka	Canonical Quantisation Of Electromagnetic Fields Around Dispersive Dielectric Structures
14:45 - 15:00	Luke Hands	Causality and the Second Quantisation of Open Nanophotonic Systems
15:00 - 15:15	Ishita Jena	Quantum Dynamics in Coupled Plasmonic Nanocavities
15:15 - 15:30	Aleksei Tsarapkin	Double Helical Antennas for Direct Coupling to Quantum Emitters or Plasmonic Waveguides

Tunable, Dynamic, and Programmable Metasurfaces
Chairperson(s): Christophe Caloz, Tsampikos Kottos **Room: Koepelzaal**

Time	1st author	Title
14:00 - 14:30	Laura Na Liu	The promise of programmable optical metasurfaces
14:30 - 14:45	Jared Erb	Creation and Manipulation of Scattering Singularities with Tunable Metasurfaces
14:45 - 15:00	Jaekyung Kim	Electro-active Metasurfaces Controlling Exceptional Topological Phase through Low-voltage Operation on Conductive Polymer
15:00 - 15:30	Sergey Bozhevolnyi	Electro-Optic Spatiotemporal Nonlocal Metasurfaces

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

Special session: Metamaterials and Information II

Chairperson(s): Nader Engheta, Romain Fleury

14:00 - 14:30 **Analog neural networks with waves** (Invited talk)
Romain Fleury, Ali Momeni — *EPFL, Switzerland*
Rethinking training and inference in artificial neural networks within the constraints of the underlying hardware physics may enable the development of power-efficient and scalable neural-like architectures, known as physical or analog neural networks. These networks leverage analog physical systems—such as optical platforms—to perform computation. Here, we discuss the advantages of using alternative substrates beyond conventional electronic hardware and examine the trade-offs between various training strategies for analog neural networks, including both backpropagation-based methods and backpropagation-free, local learning approaches.

14:30 - 15:00 **Physical computing in elastic metamaterials** (Invited talk)
Marc Serra-Garcia — *AMOLF, Netherlands*
The talk will provide an overview of our recent progress in information processing in metamaterials, including the physical realization of machine learning models for speech recognition, elastic information storage, digital computation and self-learning systems.

15:00 - 15:30 **Panel Discussion**
Nader Engheta[1], Andrea Alù[2], Humeyra Caglayan[3], Jason Valentine[4], Romain Fleury[5], Marc Serra Garcia[6] — *[1] University of Pennsylvania, USA [2] City University of New York, USA [3] Eindhoven University of Technology, The Netherlands [4] Vanderbilt University, USA [5] EPFL, Switzerland [6] AMOLF, The Netherlands*
panel discussion chaired by Nader Engheta and Romain Fleury

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

Novel Applications in Sensing and Diagnostics

Chairperson(s): Jacob Khurgin, Giuseppe Strangi

14:00 - 14:15 **Inductive Sensing of Lung Conductivity for Fluid Accumulation Detection**
Georgiana Dima, Anna Radkovskaya, Laszlo Solymar, Ekaterina Shamonina — *University of Oxford, United Kingdom*
This study explores a non-invasive inductive sensing method for detecting lung conductivity variations due to the presence of water. Using CST Microwave Studio, the resonant frequency and the quality factor changes of a single resonant element are monitored as lung conductivity is varied to simulate fluid infiltration. The resolution of a standard Vector Network Analyzer (VNA) is compared to the range of changes detected. Noticeable changes are recorded, which support the inductive sensing technique for non-invasive lung fluid monitoring.

14:15 - 14:30 **A Robust Miniaturized Multi-Chip Module with Wireless Data and Power Transfer for Precise and Safe Tinnitus Therapy**
Alireza Nikzamir, Yaoyu Cao, Behnam Moradi, Pooya Khosravi, Hamid Djalilian, Michael Green — *University of California Irvine, USA*
A miniaturized multi-chip module (MCM), designed for safe and efficient electrical stimulation of the inner ear, is proposed to treat tinnitus. The system features advanced circuit designs, including a novel charge-balance mechanism, that enables precise, customizable current waveforms alongside wireless power and data transfer (WPDT). To meet the stringent size requirements for implantation in the ear, the system was fabricated using the TSMC 180 nm BCD technology and incorporates small-form-factor coils, each with a radius of 2.5 mm. This compact design ensures reliability, minimal invasiveness, and compatibility with the anatomy of the inner ear. Performance testing using both biological and circuit models under various conditions validates the WPDT effectiveness, highlighting its potential as an innovative solution for tinnitus therapy.

14:30 - 14:45 **The Optimal Design of Terahertz Metasurface for Ultrasensitive Biosensor**
Pradeep Tiwari — *Institute of High Pressure Physics PAS, Poland*
We present a novel H-split terahertz metasurface with 800 GHz/RIU sensitivity on a PMP substrate, surpassing Fano sensors. The reason for the enhanced sensitivity is the smaller mode volume and stronger field confinement. Experimental BSA detection confirms superior light–matter interaction, establishing an optimal design and substrate for ultrasensitive terahertz biosensing.

14:45 - 15:00 **Bio-inspired meta-sensor for speech recognition**
Paolo Han Beoletto[1], Gianluca Milano[2], Carlo Ricciardi[1], Federico Bosia[1], Antonio Stefano Gliozzi[1] — *[1] Politecnico di Torino, Department of Applied Science and Technology, C.so Duca degli Abruzzi, 24 - 10129, Torino, Italy, Italy [2] INRiM (Istituto Nazionale di Ricerca Metrologica), Advanced Materials Metrology and Life Science Division, Strada delle Cacce 91 - 10135, Torino, Italy, Italy*
We propose a bioinspired metasensor for speech recognition, mimicking the human cochlea with a spiral-shaped elastic metamaterial resonator. The device extracts speech features for

classification, acting both as sensor and computing unit. Processing auditory signals in-sensor ensures reduced power consumption, with significant potential for IoT and edge AI applications.

15:00 - 15:30 **Metasurface-Enhanced Photothermal Imaging and High-Sensitivity Biomolecular Detection** (Invited talk)
Siying Peng — *School of Engineering, Westlake University, China*
Photothermal heterodyne imaging (PHI) is a widely used label-free imaging technique for visualizing chemical bonds. It offers advantages such as high resolution, non-cytotoxicity and imaging in the water environment. However, the inherently low absorption cross-section of molecules limits photothermal signal strength, thereby constraining sensitivity. To address this challenge, we introduce a metasurface-integrated photothermal heterodyne imaging system (M-PHI). By leveraging the near-field enhancement effect of metasurface, the system significantly enhances the absorption cross-section and photothermal signals of molecules. The M-PHI system achieves over 12-fold enhancement in imaging intensity, enabling the detection of biomolecules at concentrations below 400 nM without any surface functionalization. The M-PHI system opens new avenues for ultrasensitive imaging of molecules, with potential applications in biology, clinical medicine, and materials science.

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

Topological, Nonreciprocal, and Programmable Metamaterials

Chairperson(s): Christos Argyropoulos, Filiberto Bilotti

14:00 - 14:30 **Complex spectrum analysis of QVHE phononic waveguides using QNM expansion** (Invited talk)
Marc Martí Sabaté, Richard Wiltshaw, Benjamin Vial, Sébastien Guenneau, Richard Craster — *Imperial College London, United Kingdom*
QVHE edge states emerge at the boundary between two infinite topologically nontrivial media with chiral properties. However, in practical applications, the designed metastructures are finite and exist in an open domain, causing deviations in the device's spectral properties from the ideal infinite band structure. In this talk, we will characterize the distribution of quasinormal modes (QNMs) that play a key role in the emergence of interface states within these finite waveguided structures.

14:30 - 14:45 **3D Metamaterials with Elastic Non-reciprocity**
Qingxiang Ji[1], Jinliang Wang[2], Brahim Lemkalli[3], Gwenn Ulliac[3], Muamer Kadic[3] — *[1] FEMTO-ST, CNRS, Université Marie et Louis Pasteur, France [2] Harbin Institute of Technology, China [3] Université Marie et Louis Pasteur, Institut FEMTO-ST, CNRS, France*
Elastic metamaterials have recently driven significant advancements in static mechanics and wave propagation. In this study, we demonstrate an unusual nonreciprocal elastic behavior for both static states and dynamic elastic waves in elastic metamaterials. The non-reciprocity is validated by simulations and experiments. This peculiar behavior enables unidirectional elasticity and wave transmission within a solid structure, e.g., nonlinear and nonreciprocal elastic modulus, and tunable response amplitudes in elastic waves.

14:45 - 15:00 **Steering Nonreciprocity using Nonlinear Waves**
Bertin Many Manda[1], Sayan Jana[1], Vassos Achilleos[2], Dimitri Frantzeskakis[3], Lea Sirota[4] — *[1] School of Mechanical Engineering, Tel Aviv University, Israel [2] Acoustics Laboratory, Le Mans University, France [3] Department of Physics, National and Kapodistrian University of Athens, Greece [4] School of Mechanical Engineering, Tel Aviv University, Isreal*
Non-Hermitian systems with nonreciprocal couplings are currently attracting considerable attention due to their ability to exhibit exotic wave phenomena like the unidirectional wave amplification, known as the non-Hermitian skin effect (NHSE). I will investigate the effects of nonlinearity in the wave dynamics of nonreciprocal systems. I will first extend the NHSE into the nonlinear regime. Then, considering more realistic scenarios where dissipative effects are non-negligible, I will showcase a novel control mechanism in which nonlinearity mediates the interplay between nonreciprocity and dissipation as well as dispersion. As a result, we can generate long-lived nonlinear pulses (i.e., solitons) that propagate unidirectionally within an otherwise NHSE-dominated phase. Finally, I will present experimental results that support these theoretical predictions, offering a practical realization of nonlinearity-controlled nonreciprocal wave dynamics.

15:00 - 15:15 **Programmable Optomechanical Logic Circuits**

Xiaofei Guo[1], Jonne Drost[1], Jesse Slim[2], Fons Van Der Laan[1], Marc Serra Garcia[1], Ewold Verhagen[1] — *[1] AMOLF, Netherlands [2] The University of Queensland, Australia*
In this paper, we explore information processing functionalities in optomechanical systems using laser-induced mechanical nonlinearities. We demonstrate programmable logic gates in a single nanomechanical resonator, where different logic operations can be dynamically selected by adjusting laser parameters. Additionally, by coupling multiple mechanical modes within one resonator structure, we achieve cascadable logic gates, paving the way to programmable optomechanical computing networks.

15:15 - 15:30 **Experimental Design of Bistable Meta-panel for Dynamic Investigation**
Valeria Cavanni, Gaetano Miraglia, Linda Scussolini, Andrea De Marchi, Luca Caneparo, Rosario Ceravolo — *Politecnico di Torino, Italy*
Bistable metamaterials offer a promising solution for vibration mitigation in structural systems. This research presents the conceptualization of the experiments for a bistable meta-panel, which uses geometric nonlinearity and snap-through instability to enhance energy absorption and dissipation. A scaled prototype, produced via additive manufacturing, undergoes static and dynamic testing to assess its response. This work provides a foundation for further development of meta-material-based seismic protection systems.

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

Quantum Plasmonics and Nanophotonics

Chairperson(s): Ewold Verhagen, Angela Vasanelli

14:00 - 14:30 **Quantum Effects in Nanophotonic Light–Matter Interactions** (Invited talk)
P. André Gonçalves — *University of Southern Denmark, Denmark*
Advances in fabrication and spectromicroscopy techniques have enabled unprecedented access to quantum mechanical effects underlying various nanophotonic phenomena, challenging their description solely within classical electrodynamics. Here, I will present a suite of quantum-informed theoretical frameworks for accurately describing light–matter interactions in nanophotonics and discuss how these approaches provide new insights and unlock new capabilities. Topics will include quantum corrections to plasmon spectra and plasmon-enhanced light–matter interactions, as well as the exploration of quantum effects governing electron–light–matter interactions in various electron-beam-based spectroscopies of current interest.

14:30 - 14:45 **Canonical Quantisation Of Electromagnetic Fields Around Dispersive Dielectric Structures**
Jakub Skorka, Zoltan Sztranyovszky, Ben Yuen, Angela Demetriadou — *University of Birmingham, United Kingdom*
Coupling quantum emitters to plasmonic nanostructures is of increasing interest, motivated by possible applications. However, its theoretical description is challenging due to material dispersion, Ohmic losses, and radiation. We present a modes-of-the-universe quantisation of electromagnetic fields in the presence of structures made of dispersive, lossless media.

14:45 - 15:00 **Causality and the Second Quantisation of Open Nanophotonic Systems**
Luke Hands[1], Ben Yuen[2], Angela Demetriadou[2] — *[1] University Of Birmingham, United Kingdom [2] University of Birmingham, United Kingdom*
Describing systems consisting of quantum emitters coupled to complex radiative nanophotonic geometries is challenging. We present a method that provides an exact and complete second quantisation scheme through the use of complex pseudomodes, and discuss the emergence of causality and non-Markovian dynamics in the spectrum of the quantum dynamics obtained.

15:00 - 15:15 **Quantum Dynamics in Coupled Plasmonic Nanocavities**
Ishita Jena, Angus Crookes, Ben Yuen, Angela Demetriadou — *University of Birmingham, United Kingdom*
Plasmonic nanocavities facilitate strong coupling with few or even a single quantum emitter (QE) at room temperature. We introduce a new design with two coupled nanocavities, placed several micrometers apart and each hosting a QE. This allows for separate excitation and control of each QE. We report that the nanocavity coupling leads to different plasmonic interaction regimes that directly impact the quantum dynamics. Such systems pave the way for the generation of quantum states using nanoplasmonic cavities.

15:15 - 15:30 **Double Helical Antennas for Direct Coupling to Quantum Emitters or Plasmonic Waveguides**

Aleksei Tsarapkin[1], Luka Zurak[2], Krzysztof Maćkosz[3], Lorenz Löffler[2], Victor Deinhart[1], Ivo Utke[3], Thorsten Feichtner[2], Katja Höflich[1] — *[1] Ferdinand-Braun-Institut, Germany [2] University of Würzburg, Germany [3] Empa, Switzerland*

Plasmonic double helix antennas combine large chiroptical interaction strength with highly directional light emission at the nanoscale. Here, such antennas are designed with a semi-analytical design tool and fabricated by direct electron beam writing. The realized antennas exhibit a large and broadband dissymmetry factor in the visible range.

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

Tunable, Dynamic, and Programmable Metasurfaces

Chairperson(s): Christophe Caloz, Tsampikos Kottos

14:00 - 14:30 **The promise of programmable optical metasurfaces** (Invited talk)
Laura Na Liu — *University of Stuttgart, Germany*
In this talk, we will explore the forefront of metasurface-based display systems, focusing on programmable metasurfaces designed for dynamic holographic displays.

14:30 - 14:45 **Creation and Manipulation of Scattering Singularities with Tunable Metasurfaces**
Jared Erb[1], Isabella Giovannelli[2], Nadav Shaibe[2], Tsampikos Kottos[3], Steven Anlage[2] — *[1] University of Maryland, USA [2] University of Maryland, United States [3] Wesleyan University, United States*
We utilize metasurfaces to take parametric control of the scattering properties of a variety of complex and over-moded scattering systems, and discover rich topological structure and dynamics of a wide variety of scattering singularities. These singularities have topological stability, can all be associated with diverging time delays, and obey conservation laws.

14:45 - 15:00 **Electro-active Metasurfaces Controlling Exceptional Topological Phase through Low-voltage Operation on Conductive Polymer**
Jaekyung Kim — *POSTECH, Korea (South)*
We investigate an electro-active chiral optical response-driven dual-channel metasurfaces with fast electrical switching rates of 52 ms, and a low operating voltage of 0.5 V. The combination of polyaniline thin film and the exceptional topological phase of chiral gold meta-atoms modulate holographic images through the applied voltage and the polarization of the incident light simultaneously.

15:00 - 15:30 **Electro-Optic Spatiotemporal Nonlocal Metasurfaces** (Invited talk)
Sergey Bozhevolnyi — *University of Southern Denmark, Denmark*
Spatiotemporal light control with dynamic optical metasurfaces has been high on the research agenda, promising attractive solutions and new avenues for modern highly integrated optics and nanophotonics. Here, several promising electro-optic metasurface configurations are presented that exploit nonlocal interactions between incident radiation and grating-excited waveguide modes propagating inside nm-thin electro-optic films. Challenges and opportunities for spatiotemporal light control with electro-optic nonlocal metasurfaces are discussed, outlining also future developments towards tackling the most serious challenges and exploiting the most exciting opportunities.

Oral Sessions (Wednesday Afternoon 2)

Metasurfaces for Signal Processing and Information Theory
Chairperson(s): Jason Valentine, Marc Serra Garcia **Room: Concertzaal**

Time	1st author	Title
16:00 - 16:30	Filiberto Bilotti	Application of the metasurface aided signal processing concept in wireless communications and radar systems
16:30 - 16:45	Qun Yan Zhou	Meta-atom Phase Extraction Based on Frequency-Manipulating Metasurface
16:45 - 17:00	Xiao Qing Chen	Integrated Sensing and Communication via Space-Time-Coding Metasurfaces
17:00 - 17:30	Tie Jun Cui	Recent Advances in Collaborative Information and Power Metasurfaces

Metamaterials for Novel Microscopy and Photodetectors
Chairperson(s): Siying Peng, Giuseppe Strangi **Room: Shaffyzaal**

Time	1st author	Title
16:00 - 16:30	Maryna Meretska	Optical Metagrating for Light Sheet Microscopy
16:30 - 16:45	Benquan Wang	Building a high-resolution image from super-pixels
16:45 - 17:00	Lion Augel	CMOS-Oriented Concept For A Metasurface Enhanced Back-Side Illuminated SWIR Photodetector
17:00 - 17:30	Lisa Poulikakos	Nature-Inspired Photonic Surfaces for Next-Generation Imaging and Diagnostics

Nonlinear and Multistable Metamaterials
Chairperson(s): Martin Van Hecke, Yi Chen **Room: Teekenzaal I**

Time	1st author	Title
16:00 - 16:30	Siddhant Kumar	Unifying The Design Space And Optimizing Linear And Nonlinear Truss Metamaterials By Generative Modeling
16:30 - 16:45	Simon Preston	Effects of Negative Poisson's Ratio on the Viscoelastic Behaviour of Sandwich Beams
16:45 - 17:00	Valeria Cavanni	Simulation and Identification of a Seismic Bistable Device with Hysteresis
17:00 - 17:15	Cetin Yilmaz	Inertially Amplified Elastic Metametarial with Quasi-Zero Stiffness
17:15 - 17:30	Sidharth Beniwal	Analysing Wave Dynamics in Additively Manufactured Viscoelastic Metamaterials

Topological and Nonreciprocal Phenomena in Photonic Resonators
Chairperson(s): P. André Gonçalves, Mohammad Sajjad Mirmoosa **Room: Teekenzaal II**

Time	1st author	Title
16:00 - 16:30	Alexander Khanikaev	Geometrical phase resonators
16:30 - 17:00	Ewold Verhagen	Topology-inspired Routes to Optical Field Confinement and Enhancement in Two-dimensional Photonic Crystals
17:00 - 17:30	Yakir Hadad	Loss Threshold Phenomenon in Cavity-Enhanced Lorentz Nonreciprocity

Emerging Applications of Reconfigurable and Topological Metasurfaces
Chairperson(s): Laura Na Liu, Steven Anlage **Room: Koepelzaal**

Time	1st author	Title
16:00 - 16:15	Filippo Pepe	A Study of Cylindrical Reconfigurable Intelligent Surfaces
16:15 - 16:45	Tsampikos Kottos	Harnessing multiple scattering electromagnetic environments for wave control via in situ adjoint optimization
16:45 - 17:00	Jim Alexander Enriquez	Manipulating the Electromagnetic Field in Wire Media Resonators for Enhanced Axion Detection
17:00 - 17:30	Tie Jun Cui	Topological Metasurface for Intelligent Applications

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

Metasurfaces for Signal Processing and Information Theory

Chairperson(s): Jason Valentine, Marc Serra Garcia

16:00 - 16:30 **Application of the metasurface aided signal processing concept in wireless communications and radar systems** (Invited talk)
Filiberto Bilotti[1], Mirko Barbuto[1], Michela Longhi[2], Alessio Monti[1], Davide Ramaccia[1], Alessandro Toscano[1], Stefano Vellucci[2] — *[1] Roma Tre University, Italy [2] Niccolò Cusano University, Italy*
We review our recent work on applying the metasurface-aided signal processing concept to wireless, short-range, and satellite communication, as well as radar systems. The ability to control in real time the properties of metasurfaces operating at microwave and millimeter-wave frequencies – using PIN or varactor diodes driven by a programmable FPGA – unlocks unprecedented performances in terms of reduced complexity, lower costs, decreased computation time, and minimized latency, which are key aspects for transforming and revolutionizing next-generation communication and radar systems. Specifically, we demonstrate how the integration of conventional antennas with intelligent metasurfaces enables the development of innovative smart antennas, leading to enhanced coverage and multi-channel operation in wireless communications, ultra-low latency and near-zero power consumption in short-range IoT systems, and improved beam shaping and steering in satellite communications. Regarding radar systems, we show how time- or/and frequency-modulated metasurfaces can execute a variety of advanced functions – including direction-of-arrival estimation, Doppler effect compensation, deceptive jamming with false targets, radar cross-section manipulation, and pseudo-random coded electronic counter-countermeasures – without relying on complex and time-consuming digital signal processing algorithms. This enables electronic countermeasures and counter-countermeasures at the speed of light through the direct manipulation of electromagnetic waves.

16:30 - 16:45 **Meta-atom Phase Extraction Based on Frequency-Manipulating Metasurface**
Qun Yan Zhou, Jia Chen Wang, Jun Wei Wu, Shuo Liu, Huidong Li, Jun Yan Dai, Qiang Cheng — *southeast university, China*
Generally, metasurfaces' passive structure couples meta - atom phase info, hampering independent extraction. We propose a frequency-manipulating metasurface method for decoupling and rapid extraction. Verified by theory and simulation.

16:45 - 17:00 **Integrated Sensing and Communication via Space-Time-Coding Metasurfaces**
Xiao Qing Chen[1], Lei Zhang[1], Yi Ning Zheng[1], Shuo Liu[1], Zhuo Ran Huang[1], Jing Cheng Liang[1], Marco Di Renzo[2], Vincenzo Galdi[3], Tie Jun Cui[1] — *[1] Southeast University, China [2] Université Paris-Saclay, CNRS, CentraleSupélec, France [3] University of Sannio, Italy*
This study explores integrated sensing and communication using space-time-coding metasurfaces to control electromagnetic waves for both wireless communication and sensing, eliminating the need for extra sensors. A 2-bit prototype at microwave frequencies demonstrated real-time reconfigurability, ensuring stable communication even with a moving transmitter.

17:00 - 17:30 **Recent Advances in Collaborative Information and Power Metasurfaces** (Invited talk)

Long Li[1], Dexiao Xia[1], Yicen Li[1], Xiangjin Ma[1], Xin Wang[2], Yajie Mu[1], Hao Xue[1], Haixia Liu[1], Jiaqi Han[1], Lianlin Li[3], Qiang Cheng[4], Tie Jun Cui[4] — *[1] Xidian University, China [2] Xi'an University of Posts and Telecommunications, China [3] Peking University, China [4] Southeast University, China*

The rapid development of metasurface has revolutionized the way we approach wireless communication and power transfer. This paper introduces the concept of collaborative information and power metasurfaces, which represents a significant advancement over traditional simultaneous wireless information and power transmission systems.

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

Metamaterials for Novel Microscopy and Photodetectors

Chairperson(s): Siying Peng, Giuseppe Strangi

16:00 - 16:30 **Optical Metagrating for Light Sheet Microscopy** (Invited talk)
Maryna Meretska — *Karlsruhe Institute of Technology, Germany*
Oblique Plane Microscopy (OPM) is notable for its fast scanning capabilities. It relies on conventional gratings, which suffer from low deflection efficiency at steep angles. We designed and optimized a metagrating that achieved a more than 40% increase in light deflection efficiency compared to conventional gratings for OPM setup.

16:30 - 16:45 **Building a high-resolution image from super-pixels**
Benquan Wang[1], Jin-Kyu So[1], Eng Aik Chan[1], Ruyi An[1], Yewen Li[1], Zexiang Shen[1], Bo An[1], Giorgio Adamo[1], Nikolay I. Zheludev[2] — *[1] Nanyang Technological University, Singapore [2] University of Southampton, UK*
We provide the first demonstration of a label-free far-field optical microscopy with resolution of λ/11. Using the prior knowledge of light diffraction patterns from super-pixels of subwavelength size we build the image by scanning a focused beam of light across the object and reconstructing it from the diffraction patterns.

16:45 - 17:00 **CMOS-Oriented Concept For A Metasurface Enhanced Back-Side Illuminated SWIR Photodetector**
Lion Augel[1], Jens Knobbe[2] — *[1] Brandenburg University of Technology, Germany [2] Fraunhofer Institute for Photonic Microsystems IPMS, Germany*
Detection of short-wave infrared radiation by Schottky photodetectors offers compatibility to complementary metal-oxide-semiconductor technology but suffers from low detection efficiency. The presented concept aims at combining the current knowledge in the field of plasmonic “hot carrier” enhanced Schottky photodetectors using a buried metallic metastructure with a cavity enhanced detector principle. It will be shown that by applying a backside illuminated detector design compatibility to standard technology even with thin metal films is in general achievable.

17:00 - 17:30 **Nature-Inspired Photonic Surfaces for Next-Generation Imaging and Diagnostics** (Invited talk)
Lisa Poulikakos — *UC San Diego, USA*
Imaging science is a critical enabler of revolutionary scientific advances. 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.

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

Nonlinear and Multistable Metamaterials

Chairperson(s): Martin Van Hecke, Yi Chen

16:00 - 16:30 **Unifying The Design Space And Optimizing Linear And Nonlinear Truss Metamaterials By Generative Modeling** (Invited talk)
Li Zheng[1], Dennis Kochmann[1], Siddhant Kumar[2] — *[1] ETH Zurich, Switzerland [2] TU Delft, Netherlands*
The rise of machine learning has fueled the discovery of new materials and, especially, metamaterials—truss lattices being their most prominent class. While their tailorable properties have been explored extensively, the design of truss-based metamaterials has remained highly limited and often heuristic, due to the vast, discrete design space and the lack of a comprehensive parameterization. We here present a graph-based deep learning generative framework, which combines a variational autoencoder and a property predictor, to construct a reduced, continuous latent representation covering an enormous range of trusses. This unified latent space allows for the fast generation of new designs through simple operations (e.g., traversing the latent space or interpolating between structures). We further demonstrate an optimization framework for the inverse design of trusses with customized mechanical properties in both the linear and nonlinear regimes, including designs exhibiting exceptionally stiff, auxetic, pentamode-like, and tailored nonlinear behaviors. This generative model can predict manufacturable (and counter-intuitive) designs with extreme target properties beyond the training domain. Media link(s): Published paper: Zheng, L., Karapiperis, K., Kumar, S. et al. Unifying the design space and optimizing linear and nonlinear truss metamaterials by generative modeling. Nat Commun 14, 7563. https://doi.org/10.1038/s41467-023-42068-x

16:30 - 16:45 **Effects of Negative Poisson's Ratio on the Viscoelastic Behaviour of Sandwich Beams**
Simon Preston, Julain Londoño-Monsalve, Ken. E. Evans — *Univerversity of Exeter, United Kingdom*
Auxetic viscoelastic materials enhance energy dissipation and damping in structural applications, their impact on sandwich beams remains underexplored. This study examines how auxeticity affects stress–strain response and stiffness in single-, three-, and five-layer beams. A Prony series models the time-dependent modulus, with analytical predictions compared to finite element analysis (FEA). Results show that greater auxeticity improves energy dissipation and reduces stress in multi-layered beams, though extreme values introduce modelling discrepancies. These findings aid in optimising auxetic viscoelastic materials for vibration damping and structural applications.

16:45 - 17:00 **Simulation and Identification of a Seismic Bistable Device with Hysteresis**
Valeria Cavanni[1], Linda Scussolini[1], Oreste S. Bursi[2], Corentin Coulais[3], Rosario Ceravolo[1] — *[1] Politecnico di Torino, Italy [2] Università di Trento, Italy [3] Universiteit van Amsterdam, The Netherlands*
Mechanical metamaterials with bistable configurations offer a promising solution for enhancing energy dissipation in existing structures subjected to dynamic excitations. This research focuses on a pre-buckled steel bistable device engineered for energy dissipation, examining the critical interplay between geometric nonlinearity and hysteretic behaviour. The classical

Bouc-Wen model is here modified to incorporate the effects of bistability. The study includes parametric simulations and instantaneous identification of the proposed model parameters. Finally, an equivalent damping factor that considers both viscous and hysteretic dissipation is calculated.

17:00 - 17:15 **Inertially Amplified Elastic Metametarial with Quasi-Zero Stiffness**
Cetin Yilmaz — *Bogazici University, Turkey*
A lever-type inertially amplified elastic metamaterial with quasi-zero stiffness is investigated. By varying amplification ratio of the levers and pre-compressing the springs that generate negative stiffness, dispersion diagram of this structure is varied and low frequency band gaps are obtained.

17:15 - 17:30 **Analysing Wave Dynamics in Additively Manufactured Viscoelastic Metamaterials**
Sidharth Beniwal[1], Ranjita Bose[2], Anastasiia Krushynska[2] — *[1] Engineering and Technology Institute Groningen (ENTEG), Faculty of Science and Engineering, University of Groningen, Netherlands [2] Engineering and Technology Institute Groningen (ENTEG), Faculty of Science and Engineering, University of Groningen, Netherlands*
Elastic metamaterials hold potential for advanced wave manipulation, yet their proper characterization remains underexplored due to challenges in predicting the frequency-dependent behavior of constituent polymer. This study presents a comprehensive framework to model the viscoelastic behavior of additively manufactured polymers, focusing on dynamic conditions rather than traditional static settings, using a quasi-1D acrylonitrile butadiene styrene (ABS) metamaterial as a representative system. The methodology combines material characterization through dynamic mechanical analysis (DMA) and tensile testing, and finite-element simulations incorporating frequency-dependent viscoelastic properties (from DMA) combined with ultrasonic transmission experiments. This mix provides a proper tool for precise prediction of wave dynamics in additively manufactured polymer metamaterials and hence a step faciliating functional applications like waveguiding, vibration isolation, energy harvesting, and others.

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

Topological and Nonreciprocal Phenomena in Photonic Resonators

Chairperson(s): P. André Gonçalves, Mohammad Sajjad Mirmoosa

16:00 - 16:30 **Geometrical phase resonators** (Invited talk)
Alexander Khanikaev — *CREOL, College of Optics and Photonics, UCF, USA*
Geometrical phases play a central role in numerous phenomena across physical fields and systems, from optical waveguides and metasurfaces to quantum systems and topological materials. Acquired during the adiabatic evolution of the multimodal system, it can add up to the conventional propagation phase and alter interference phenomena and resonance conditions of the system. Here we introduce a new type of resonator whose resonant condition is defined solely by the geometrical phase – a geometrical phase resonator. In such a resonator, based on photonic topological metasurfaces, topological boundary modes are designed to undergo an adiabatic evolution that gives rise to the net geometrical phase of 2π, rendering resonance without any propagation phase. This renders the resonance condition invariant with respect to its shape and length, which we confirmed both using first-principles simulations and in experiments. Specifically, we show that a set of samples with completely different geometries exhibit an extremely stable "geometrical resonance" pinned to a specific frequency. Therefore, we believe that geometrical resonators can be of profound importance for applications where such spectral stability of resonances is needed, including arrays of precisely tuned lasers, sensors, geometrical cavities coupled to quantum emitters.

16:30 - 17:00 **Topology-inspired Routes to Optical Field Confinement and Enhancement in Two-dimensional Photonic Crystals** (Invited talk)
René Barczyk[1], Daniël Muis[2], Yandong Li[3], Xiaozhou Wu[1], Sonakshi Arora[2], Gennady Shvets[3], Laurens Kuipers[2], Ewold Verhagen[1] — *[1] AMOLF, Netherlands [2] Delft University of Technology, Netherlands [3] Cornell University, United States*
We explore the use of topological channels and symmetry breaking in two-dimensional silicon photonic crystals for the confinement and enhancement of light fields at the nanoscale. This includes highly degenerate Landau level flat bands in strained photonic crystals, and broadband light localization due to suppressed backscattering in terminated topological waveguides.

17:00 - 17:30 **Loss Threshold Phenomenon in Cavity-Enhanced Lorentz Nonreciprocity** (Invited talk)
Yakir Hadad, Koffi Emanuel Sadzi — *Tel-Aviv University, Israel*
This work explores the interplay between loss and Lorentz nonreciprocity in gyrotropic systems embedded within electromagnetic cavities. We demonstrate that cavity-enhanced interactions can modify the loss threshold required to maintain nonreciprocity, leading to a robust and tunable nonreciprocal response. Using a rigorous analytical framework, we reveal the fundamental conditions under which a gyrotropic particle sustains nonreciprocity in the presence of dissipation. Our findings provide new insights into cavity-modified wave dynamics, with potential applications in nonreciprocal photonic devices, waveguides, and electromagnetic sensing. The results highlight the crucial role of system losses and cavity effects in controlling and optimizing nonreciprocal behavior.

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

Emerging Applications of Reconfigurable and Topological Metasurfaces

Chairperson(s): Laura Na Liu, Steven Anlage

16:00 - 16:15 **A Study of Cylindrical Reconfigurable Intelligent Surfaces**
Filippo Pepe[1], Ivan Iudice[2], Giuseppe Castaldi[1], Marco Di Renzo[3], Vincenzo Galdi[1] — *[1] University of Sannio, Italy [2] Italian Aerospace Research Centre (CIRA), Italy [3] Universite Paris-Saclay, CNRS, CentraleSupelec, France*
This study focuses on modeling and designing cylindrical reconfigurable intelligent surfaces for efficient beam steering, particularly in unmanned aerial vehicle networks. Starting from a rigorous electromagnetic model, an approximate formulation is developed along with an optimization framework suited for practical, low-complexity reconfigurable elements. Various optimization techniques are assessed to evaluate their effectiveness and suitability for these scenarios.

16:15 - 16:45 **Harnessing multiple scattering electromagnetic environments for wave control via in situ adjoint optimization** (Invited talk)
Tsampikos Kottos[1], John Guillamon[1], Cheng-Zhen Wang[1], Zin Lin[2] — *[1] Wesleyan University, USA [2] Virginia Tech, USA*
We develop an in-situ time- and energy-efficient adjoint optimization (AO) methodology for the manipulation of wave scattering in multiple scattering systems and demonstrate wave-driven functionalities like targeted channel emission, coherent perfect absorption and camouflage. Our paradigm leverages these highly multi-path complex environments which dramatically amplify small local system AO-informed variations.

16:45 - 17:00 **Manipulating the Electromagnetic Field in Wire Media Resonators for Enhanced Axion Detection**
Jim Alexander Enriquez, Pavel A. Belov — *ITMO university, Russia*
Microwave cavities aid in axion detection, where key parameters include quality factor, volume, and field homogeneity. We present a simple method to control field homogeneity in wire medium-filled cavities using an air gap. When its thickness is a quarter of the plasma wavelength, the field becomes uniform, enhancing axion detection.

17:00 - 17:30 **Topological Metasurface for Intelligent Applications** (Invited talk)
Jian Wei You, Tie Jun Cui — *Southeast University, China*
Recent advancements in topological metasurfaces have unveiled unprecedented opportunities for intelligent electromagnetic systems. Here, we present our breakthroughs in reprogrammable plasmonic topological insulators, flexible valley-Hall systems, phase-transition photonic bricks, and multifunctional topological metasurface to establish a unified framework for intelligent applications such as intelligent gesture recognition. Specifically, the integration of topological metasurfaces with machine-learning-driven design and control highlights their promising applications in smart healthcare, smart homes, next-generation wireless communication, and electromagnetic intelligence agents. These contributions position topological metasurfaces as a fundamental cornerstone for the emerging era of cognitive electromagnetic intelligence.

Oral Sessions (Thursday Morning 1)

Metamaterials & Machine Learning
Chairperson(s): Georgia Theano Papadakis, Harry Atwater **Room: Concertzaal**

Time	1st author	Title
09:00 - 09:30	Lianlin Li	Recent Results of Metamaterial Agent (MetaAgent)
09:30 - 09:45	Vlad Medvedev	Generative Inverse Design of Metamaterials Enhanced by Physics-Informed Neural Network
09:45 - 10:00	Raúl Candás	Self-Learning Active Metamaterials: A Local Learning Framework For Non-reciprocal Linear Flow Networks

Wave Control in Mechanical Metamaterials
Chairperson(s): Ying Wu, Lucia Stein-Montalvo **Room: Shaffyzaal**

Time	1st author	Title
09:00 - 09:30	Varvara Kouznetsova	A Computational Homogenization Methodology for the Analysis and Design of Subwavelength Mechanical and Acoustic Metamaterials on Finite Size Domains
09:30 - 09:45	Michael Haberman	Acousto-electromagnetic media: Homogenization and constraints
09:45 - 10:00	Geon Lee	Ultrabroadband Achromatic Elastic Metasurface Via Synthesized Dispersion Engineering

Nonlinear and Tunable Optical Effects in Organic and Inorganic Nanophotonics
Chairperson(s): Dorota A. Pawlak, Giulia Tagliabue **Room: Teekenzaal I**

Time	1st author	Title
09:00 - 09:30	Maria Antonietta Vincenti	Tailoring Optical Properties in Organic Polymers: from Ion-Injected GRIN Materials to Nonlinear Optical Tuning
09:30 - 09:45	Andrea Zacheo	Rashba Polariton Lasing from Perovskite Metasurfaces
09:45 - 10:00	Radoslaw Kolkowski	Nonlinear Nanophotonics with Mie-Resonant Nanostructures Based on Wafer-Bonded Crystalline AlInP – a Low-Loss χ(2) Material

Metasurfaces for Antenna Systems III
Chairperson(s): Hiroki Wakatsuchi, Enrica Martini **Room: Teekenzaal II**

Time	1st author	Title
09:00 - 09:15	Stefano Vellucci	Reconfigurable Transmissive Huygens Metasurfaces for Antenna Wavefront Manipulation via Locally Optimized Design
09:15 - 09:30	Mikhail Tsukerman	Adaptive Metasurface for Complex Inverse-design Scattering Control
09:30 - 10:00	George Eleftheriades	Nonreciprocal Magnetless Phased-Array Antenna with Decoupled Beam Scanning

Novel Sensing and Display Approches in Metamaterials
Chairperson(s): Yang Zhao, Abdoulaye Ndao **Room: Koepelzaal**

Time	1st author	Title
09:00 - 09:30	Walter Gubinelli	Digital Twin of Metamaterial-based Micro-Acoustic Resonator for Sensing Applications
09:30 - 09:45	Minseok Chou	Roll-to-plate Printable RGB Achromatic Metalens For Wide-field-of-view Holographic Near-eye Display
09:45 - 10:00	Christopher Stevens	A Proprioceptive Metamaterial

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

Metamaterials & Machine Learning

Chairperson(s): Georgia Theano Papadakis, Harry Atwater

09:00 - 09:30 **Recent Results of Metamaterial Agent (MetaAgent)** (Invited talk)
Lianlin Li — *State Key Laboratory of Photonic and Communications, School of Electronics, Peking University, Beijing 100871, China, China*
Metamaterials have revolutionized wave control; in the last two decades, they evolved from passive devices via programmable devices to sensor-endowed self-adaptive devices realizing a user-specified functionality. Although deep-learning techniques play an increasingly important role in metamaterial inverse design, measurement post-processing and end-to-end optimization, their role is ultimately still limited to approximating specific mathematical relations; the metamaterial is still limited to serving as proxy of a human operator, realizing a predefined functionality. Here, we propose and experimentally prototype a paradigm shift toward a metamaterial agent (coined metaAgent) endowed with reasoning and cognitive capabilities enabling the autonomous planning and successful execution of diverse long-horizon tasks, including electromagnetic (EM) field manipulations and interactions with robots and humans. Leveraging recently released foundation models, metaAgent reasons in high-level natural language, acting upon diverse prompts from an evolving complex environment. Specifically, metaAgent's cerebrum performs high-level task planning in natural language via a multi-agent discussion mechanism, where agents are domain experts in sensing, planning, grounding, and coding. In response to live environmental feedback within a real-world setting emulating an ambient-assisted living context (including human requests in natural language), our metaAgent prototype self-organizes a hierarchy of EM manipulation tasks in conjunction with commanding a robot. metaAgent masters foundational EM manipulation skills related to wireless communications and sensing, and it memorizes and learns from past experience based on human feedback.

09:30 - 09:45 **Generative Inverse Design of Metamaterials Enhanced by Physics-Informed Neural Network**
Vlad Medvedev, Andreas Rosskopf, Andreas Erdmann — *Fraunhofer IISB, Germany*
We introduce a data-free deep learning framework that combines a Conditional Deep Convolutional Generative Adversarial Network (cDCGAN) with a Physics-Informed Neural Network (PINN) for inverse metamaterial design. The cDCGAN generates flexible meta-atom shapes, while the PINN acts as a fast, physics-based simulator, enforcing Maxwell's equations and rapidly generating training data. Media link(s): A video preview can be downloaded from: https://owncloud.fraunhofer.de/index.php/s/mQsXjgk2UVjQrQs

09:45 - 10:00 **Self-Learning Active Metamaterials: A Local Learning Framework For Non-reciprocal Linear Flow Networks**
Raúl Candás, Menachem Stern — *AMOLF, Netherlands*
We present a framework for physical local learning in metamaterials based on a linear flow network with symmetric and antisymmetric components. This model extends previous work on steady-state networks, incorporating asymmetric interactions to broaden the scope and potential applications of local learning procedures.

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

Wave Control in Mechanical Metamaterials

Chairperson(s): Ying Wu, Lucia Stein-Montalvo

09:00 - 09:30 **A Computational Homogenization Methodology for the Analysis and Design of Subwavelength Mechanical and Acoustic Metamaterials on Finite Size Domains** (Invited talk)
Varvara Kouznetsova, Renan Liupekevicius, Xhorxha Kuci, Johannes Van Dommelen, Marc Geers — *Eindhoven University of Technology, Netherlands*
This talk will present the recent advancements in the computational homogenization techniques for modelling elastic and acoustic wave propagation in locally resonant metamaterials on finite size domain in both frequency and time domains, including transient regimes.

09:30 - 09:45 **Acousto-electromagnetic media: Homogenization and constraints**
Michael Haberman — *The University of Texas at Austin, USA*
Ensembles of asymmetric piezoelectric scatterers embedded in a background medium have been predicted to couple acceleration to electric displacement. Previous models of this so-called electromomentum coupling are based on electrostatics. However, energy conservation involving time-varying electric fields requires considering the magnetic field. This work employs an acousto-electromagnetic polarizability matrix to calculate the fields scattered by a one-dimensional lattice of asymmetric piezoelectric scatterers. The effective constitutive relations couple acoustics and electromagnetism and satisfy passivity and reciprocity.

09:45 - 10:00 **Ultrabroadband Achromatic Elastic Metasurface Via Synthesized Dispersion Engineering**
Geon Lee, Junsuk Rho — *Pohang University of Science and Technology, Korea (South)*
We introduce a synthesized dispersion-engineering approach that compensates for both diffraction and refraction effects, enabling ultra-broadband achromatic focusing from audible to ultrasonic frequencies. Using Kirchhoff–Love plate theory, we achieve a quasi-continuous phase profile, eliminating the need for complex meta-atom designs. Furthermore, we integrate piezoelectric energy harvesting, demonstrating significantly amplified electrical output.

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

Nonlinear and Tunable Optical Effects in Organic and Inorganic Nanophotonics

Chairperson(s): Dorota A. Pawlak, Giulia Tagliabue

09:00 - 09:30 **Tailoring Optical Properties in Organic Polymers: from Ion-Injected GRIN Materials to Nonlinear Optical Tuning** (Invited talk)
P. Franceschini[1], W. Jaffray[2], A. Tognazzi[3], S. Stengel[4], V. M. Demartis[5], D. De Ceglia[5], L. Carletti[5], E. Menshikov[5], L. Alessandri[5], A. C. Cino[4], M. Scalora[6], C. De Angelis[5], F. Torricelli[5], M. Ferrera[4], Maria Antonietta Vincenti[5] — *[1] University of Brescia, Iatly [2] SUPA Edinburgh, United Kingdom [3] Università degli studi di Palermo, Iatly [4] SUPA Edinburgh, United Kingdom [5] University of Brescia, Italy [6] Charles M. Bowden Research Center, USA*
Tunable optical devices enable dynamic control of optical properties, essential for advanced photonic applications. PEDOT:PSS, a flexible organic conductor, offers significant potential for achieving spatially tunable optics and ultrafast nonlinear modulation. These results pave the way for next-generation adaptive photonic technologies in communications, imaging, and ultrafast photonics.

09:30 - 09:45 **Rashba Polariton Lasing from Perovskite Metasurfaces**
Andrea Zacheo[1], Yutao Wang[1], Dario Gerace[2], Giorgio Adamo[1], Cesare Soci[1] — *[1] Nanyang Technological University, Singapore [2] Università di Pavia, Italy*
We demonstrate the first spin-polarized exciton-polariton condensate in a monolithic perovskite metasurface that supports bound states in the continuum (BIC). The resulting coherent emission displays spin-split, momentum-entangled dispersion, highlighting the potential of these active metasurfaces to tailor the dispersion/polarization of polaritonic devices.

09:45 - 10:00 **Nonlinear Nanophotonics with Mie-Resonant Nanostructures Based on Wafer-Bonded Crystalline AlInP – a Low-Loss χ(2) Material**
Radoslaw Kolkowski[1], Seyed Ahmad Shahahmadi[2], Serguei Novikov[2], Jani Oksanen[2], Andreas C. Liapis[3], Huayu Bai[1], Timo Stolt[1], Matti Kaivola[1], Andriy Shevchenko[1] — *[1] Department of Applied Physics, Aalto University, Finland [2] Engineered Nanosystems Group, Aalto University, Finland [3] Department of Electronics and Nanoengineering, Aalto University, Finland*
We use wafer-bonded crystalline aluminum indium phosphide (AlInP) to fabricate Mie-resonant nanostructures with strongly enhanced second-order nonlinear optical response. In particular, we experimentally demonstrate the resonant enhancement of second harmonic generation in AlInP nanodisks operating close to the anapole condition. Our results showcase AlInP as an attractive material for nonlinear nanophotonic applications.

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

Metasurfaces for Antenna Systems III

Chairperson(s): Hiroki Wakatsuchi, Enrica Martini

09:00 - 09:15 **Reconfigurable Transmissive Huygens Metasurfaces for Antenna Wavefront Manipulation via Locally Optimized Design**
Stefano Vellucci[1], Alessio Monti[2], Mirko Barbuto[2], Alessandro Toscano[2], Filiberto Bilotti[2] *— [1] Niccolò Cusano University, Italy [2] Roma Tre University, Italy*
This work presents a two-state reconfigurable Huygens metasurface that dynamically switches between beam-steering and transparent operation. Reconfigurability is achieved by modulating only the outermost layer of a cascaded unit-cell architecture, leveraging a multi-objective local optimization of surface impedances to minimize active components while ensuring full 2π phase coverage. The HMS is evaluated as a planar meta-dome integrated with PIN diodes in an antenna array, demonstrating its potential for dynamic wavefront control.

09:15 - 09:30 **Adaptive Metasurface for Complex Inverse-design Scattering Control**
Mikhail Tsukerman[1], Konstantin Grotov[2], Ildar Yusupov[1], Pavel Ginzburg[2] *— [1] ITMO University, Russia [2] Tel Aviv University, Israel*
The angle-dependent electromagnetic response of a structure is determined by the complex interplay between its geometry and material properties. Solving the inverse scattering problem – designing a structure that reproduces a specified scattering signature over a range of observation angles – is a fundamental challenge in computational electromagnetism. While theoretical results such as Love's equivalence principle establish that a surface impedance distribution can replicate any far-field pattern at a single frequency, they do not offer a constructive path toward realizable implementations. In this work, we address the practical inverse scattering problem by designing arrays of subwavelength spherical scatterers whose collective response emulates a user-defined angular scattering behavior. We formulate the task as a large-scale optimization problem and employ a parallelized evolutionary optimization strategy interfaced with a fast T-matrix-based forward solver to explore the vast design space efficiently. This approach enables the design of passive structures that can approximate angular scattering profiles. The framework opens new possibilities for metasurface engineering and scattering control phenomena.

09:30 - 10:00 **Nonreciprocal Magnetless Phased-Array Antenna with Decoupled Beam Scanning** (Invited talk)
Alexander Mackay, George Eleftheriades *— University of Toronto, Canada*
Time-modulated materials have emerged as a means to realize microwave nonreciprocity and are therefore an enabling technology for future antenna applications. Here, we show how such materials, when implemented as nonreciprocal phase shifters, can realize an element-level in-band full-duplex phased-array antenna with decoupled beam scanning. Specifically, each element of the array can support simultaneous transmit and receive beam signals; therefore transmit and receive beams can scan to independent directions, with independent transmit and receive feed ports. Transmit and receive signal isolation depends on the implementation of a microwave coupler but requires no active cancellation. The phased-array feed itself is modular with respect to the antenna elements.

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

Novel Sensing and Display Approches in Metamaterials

Chairperson(s): Yang Zhao, Abdoulaye Ndao

09:00 - 09:30 **Digital Twin of Metamaterial-based Micro-Acoustic Resonator for Sensing Applications** (Extended)
Walter Gubinelli, Lorenzo Cantù, Matteo Rinaldi, Luca Colombo — *Northeastern University, USA*
In this work we explore the optimization of a bi-layer Gold-Tungsten Leaky Surface Acoustic Wave Resonator by means of an equivalent digital twin of the metamaterial structure intended for harsh environment sensing applications. Through the hybrid modeling framework, the resonator's geometry and stacking are optimized, balancing mechanical and electrical losses to push performance beyond previously reported results.

09:30 - 09:45 **Roll-to-plate Printable RGB Achromatic Metalens For Wide-field-of-view Holographic Near-eye Display**
Minseok Chou[1], Joohoon Kim[1], Junsuk Rho[2] — *[1] Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang, Republic of Korea, Korea (South) [2] Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Republic of Korea, Korea (South)*
We introduce a centimeter-scale RGB achromatic metalens fabricated using a roll-to-plate technique and explore its potential for practical applications in NEDs. Furthermore, the integration of scalable large-area RGB achromatic metalens with CGH advances practical applications in NEDs.

09:45 - 10:00 **A Proprioceptive Metamaterial**
Christopher Stevens, Huirrui Dai, Georgiana Dima — *University of Oxford, United Kingdom*
Soft robot systems have a [particular problem in terms of proprioception and the detection of pose. We have developed a metamaterial-based sensor that can continuously determine the pose of a robot limb or digit. This paper describes the sensor's physics, engineering and its performance.

Oral Sessions (Thursday Morning 2)

Special session: Metamaterials and Sustainable Energy I
Chairperson(s): Albert Polman, Esther Alarcon-Llado **Room: Concertzaal**

Time	1st author	Title
10:30 - 11:00	Esther Alarcon-Llado	Power Spectral Density Control With Metasurfaces Enabling New Solar Cell Designs
11:00 - 11:30	Georgia Theano Papadakis	Active near-IR and mid-IR materials for temperature regulation in building
11:30 - 12:00	Harry Atwater	Tailoring Incoherent Coherent Radiation with Guided-Mode Metastructures for Energy Applications
12:00 - 12:30	Giulia Tagliabue	Unraveling Hot Carrier Processes for Advancing Plasmonic Energy Devices

Special session: Metamaterials and Fluids
Chairperson(s): Anastasiia Krushynska **Room: Shaffyzaal**

Time	1st author	Title
10:30 - 11:00	Anastasiia Krushynska	Near-Wall Pressure Power Spectral Density Content in High-Speed Internal Flows
11:00 - 11:30	Lucia Stein-Montalvo	Kirigami for Urban Ventilation
11:30 - 12:00	José Bico	Inflating To Shape: From Planar Sheets To 3D Structures
12:00 - 12:30		Panel Discussion

Temporal Metamaterials I
Chairperson(s): Dimitrios Sounas **Room: Teekenzaal I**

Time	1st author	Title
10:30 - 11:00	Vincenzo Galdi	Engineering Wave Propagation with Temporal Metamaterials
11:00 - 11:30	Amir Shlivinski	Modeling and Analysis of the Wave Dynamics by Temporal Switching in Optical Guiding Structures
11:30 - 11:45	Victor Pacheco-Peña	Adiabatic temporal media and their potential to mimic time refraction
11:45 - 12:00	Iñigo Liberal	Noether's Theorem in Spatiotemporal Metamaterials
12:00 - 12:15	Klaas De Kinder	Amplifying Optical Pulses with Space-Time Wedges
12:15 - 12:30	Benjamin Apffel	Dynamic of Phase Dislocation in a Controlled Array of Parametric Oscillators

Analysis and Synthesis of Microwave Metastructures
Chairperson(s): Stefano Vellucci, Jordan Budhu **Room: Teekenzaal II**

Time	1st author	Title
10:30 - 10:45	Denis Sakhno	Anisotropy in a Wire Medium due to the Rectangularity of a Unit Cell
10:45 - 11:00	Vasileios Salonikios	Perpendicular Incidence on Complementary Split-Ring Resonator Composite Media
11:00 - 11:15	John Le	Impedance Based Synthesis of Circular Modulated Metasurface Antennas with Entire Domain Basis Functions
11:15 - 11:30	Davorin Mikulic	Synthesis of Cylindrical Metasurfaces through Tailoring the Propagation Characteristics of Electromagnetic Waves
11:30 - 12:00	Enrica Martini	Rigorous Solution for the Canonical Problem of Anomalous Reflection from a Modulated Impedance Boundary
12:00 - 12:15	Damián Rodríguez-Trujillo	Multifunctional Metasurfaces at Millimeter-Waves and Terahertz for Next-Generation Wireless Systems
12:15 - 12:30	Thomas Delplace	Asymmetric Smith-Purcell Radiation Via Coupled High-Index Gratings

npj Metamaterials and npj Nanophotonics Special Session on Fabrication and Characterization
Chairperson(s): Humeyra Caglayan **Room: Koepelzaal**

Time	1st author	Title
10:30 - 11:00	Dorota A. Pawlak	Enabling Optical And Functional Composites
11:00 - 11:30	Maria Farsari	Multiphoton Lithography for Metamaterials Fabrication
11:30 - 11:45	Harald Giessen	Discovery of Phonon-Polaritonic Skyrmions: Transition from Néel to Bubble Type
11:45 - 12:00	Jinkyu So	Optical Metrology of 3D Nanoscale Objects Challenges Precision of Scanning Electron Microscopy
12:00 - 12:15	Beáta Idesová	All-Dielectric Metasurface Supporting Quasi-Bound States in the Continuum for Ultraviolet Light
12:15 - 12:30	Shadi Safaei Jazi	Experimental Realization of the Optical Tellegen Effect in Nonreciprocal Metasurfaces

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

Special session: Metamaterials and Sustainable Energy I

Chairperson(s): Albert Polman, Esther Alarcon-Llado

10:30 - 11:00 **Power Spectral Density Control With Metasurfaces Enabling New Solar Cell Designs** (Invited talk)
Esther Alarcon-Llado — *AMOLF, Netherlands*
For the large-scale deployment of solar energy conversion technologies, whether to electrical or chemical energy, we must master broadband control of light-scattering. Designing the spatial frequencies in metasurfaces allows for distributing light in directions at will. Solar energy conversion devices greatly benefit from the light scattering control of metasurfaces, from extreme absorption to colorful aesthetics.

11:00 - 11:30 **Active near-IR and mid-IR materials for temperature regulation in building** (Invited talk)
Georgia Theano Papadakis — *ICFO, Spain*
Tailoring of thermal radiation is critical for applications like daytime radiative cooling, thermophotovoltaic energy conversion, solar hearing, spectroscopy and sensing. In this talk, I will discuss design rules and available materials for near-unity change in the thermal emissivity of planar structures. Based on these design rules, I will present experimental results of switchable diffuse thermal emission with In3SbTe2. I will also discuss how In3SbTe2 and other relevant near-infrared and mid-infrared materials can play a crucial role in developing robust temperature regulation platforms for macroscopic temperature regulation in buildings. I will present predictions and initial results on actively tunable smart windows that modulate both the near- and mid-infrared influx and outflux of radiation, thereby controlling cooling and heating functionalities and yielding a prediction of up to 30% energy savings in buildings in urban environments.

11:30 - 12:00 **Tailoring Incoherent Coherent Radiation with Guided-Mode Metastructures for Energy Applications** (Invited talk)
Harry Atwater, Komron Shayega, Yae-Chan Lim, Arun Nagpal, Nimisha Ramprasad, Lior Michael — *California Institute of Technology, USA*
Thermal emission is usually thought to be incoherent and reciprocal, with balanced absorption and emission for a given wavelength and angular channel. However, metastructures that support surface waves allow for design of the relationship between in-plane wave vector and radiation wavelength, enabling self-focused thermal emission via a collective resonance. We report simulations and experiments that demonstrate focusing of both thermal radiation and luminescence radiation, where, in-plane spatial coherence combined with local resonances can be used to realize emission with controlled spatial phase profile.

12:00 - 12:30 **Unraveling Hot Carrier Processes for Advancing Plasmonic Energy Devices** (Invited talk)
Giulia Tagliabue — *LNET - IGM - STI - EPFL, Switzerland*

Hot carriers and photoluminescence in metals have opened new pathways for controlling photo(electro)chemical processes and monitoring temperatures. In this talk I will present reuslt unravelling fundamental aspects of these processes.

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

Special session: Metamaterials and Fluids

Chairperson(s): Anastasiia Krushynska

10:30 - 11:00 **Near-Wall Pressure Power Spectral Density Content in High-Speed Internal Flows** (Invited talk)
Quentin Hopman, Kamiel Politiek, Bastiaan Piest, Anastasiia Krushynska — *University of Groningen, Netherlands*
Geometric-dependent turbulence in pipes causes fluid-induced vibrations. This study explores the groundwork for turbulence mitigation through externally mounted phononic structures by characterizing the flow. Large Eddy Simulations (LES) of sudden expansions and 90-degree bends reveal dominant turbulence frequencies around 100 Hz. These findings inform the first step in the design of phononic structures to disrupt turbulence-induced vibrations. Future work includes fluid-structure interaction (FSI) simulations and experimental validation.

11:00 - 11:30 **Kirigami for Urban Ventilation** (Invited talk)
Lucia Stein-Montalvo[1], Chealen Berry[1], Liuyang Ding[2], Marcus Hultmark[2], Sigrid Adriaenssens[2], Elie Bou-Zeid[2] — *[1] Northwestern University, USA [2] Princeton University, USA*
With simulations and wind tunnel experiments, we explore how kirigami-based mechanical metamaterials can improve ventilation in urban spaces with stagnant air. We study how geometry affects air exchange and local flow features in the presence of oncoming wind, and implement an interactive meter-scale demonstrator, showcasing kirigami's potential for adaptive architecture.

11:30 - 12:00 **Inflating To Shape: From Planar Sheets To 3D Structures** (Invited talk)
José Bico[1], Tian Gao[2], Emmanuel Siéfert[3], Nathan Vani[1], Joo-Won Hong[4], Maïka Saint-Jean[4], Satyanu Bhadra[4], Alejandro Ibarra[5], Étienne Reyssat[4], Benoît Roman[4] — *[1] PMMH-ESPCI, Paris Sciences et Lettres, Sorbonne U, Paris Sciences et Lettres U., CNRS, France [2] LadHyx, École Polytehcnique, CNRS, France [3] LiPHY, Université Grenoble Alpes, CNRS, France [4] ESPCI, Paris Sciences et Lettres, Sorbonne U, Paris Sciences et Lettres U., CNRS, France [5] Luxembourg University, Luxembourg*
Inflating channels embedded in a patch of elastomer or a piece of air-tight fabric induces in-plane distortions leading to 3D shapes. How can we program the deployed shape? Is controlling in-plane distortion enough to dictate the actual shape of the inflated structure?

12:00 - 12:30 **Panel Discussion**
Anastasiia Krushynska[1], Lucia Stein-Montalvo[2], José Bico[3] — *[1] University of Groningen, The Netherlands [2] Princeton University, USA [3] ESPCI, France*
Panel discussion chaired by Anastasiia Krushynska

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

Temporal Metamaterials I

Chairperson(s): Dimitrios Sounas

10:30 - 11:00 **Engineering Wave Propagation with Temporal Metamaterials** (Invited talk)
Vincenzo Galdi — *University of Sannio, Italy*
This presentation explores recent advancements in temporal metamaterials, which feature time-dependent properties for dynamic wave manipulation. Topics include temporal multi-steps, short-pulsed metamaterials, and aperiodic time modulation, highlighting novel wave phenomena and applications. We also discuss inverse design methods tailored for these emerging materials.

11:00 - 11:30 **Modeling and Analysis of the Wave Dynamics by Temporal Switching in Optical Guiding Structures** (Invited talk)
Amir Shlivinski[1], Yakir Hadad[2] — *[1] Ben Gurion University of the Negev, School of Electrical and Computer Engineering, Israel [2] Tel-Aviv University, Schools of Electrical Engineering, Israel*
Wave dynamics in time-varying, lossy, dispersive waveguides offer intriguing physical phenomena and applications. Using a Laplace-transform-based model, we analyze a hollow lossy, dispersive dielectric fiber, revealing mode coupling, focusing, and radiation effects upon temporal switching with a precise control over their characteristics.

11:30 - 11:45 **Adiabatic temporal media and their potential to mimic time refraction**
Victor Pacheco-Peña[1], Mariya Antyufeyeva[2] — *[1] Newcastle University, United Kingdom [2] Newcastle University and V. N. Karazin Kharkiv National University, United Kingdom*
We study adiabatic modulations of the refractive index of the material where a wave propagates and demonstrate both theoretically and numerically that it is possible to mimic time refraction when carefully engineering the rising/falling time of a smoothly varying refractive index. In this way, it will be shown how the rapid temporal modulation required for time interfaces can be relaxed.

11:45 - 12:00 **Noether's Theorem in Spatiotemporal Metamaterials**
Iñigo Liberal — *Universidad Publica de Navarra, Spain*
Noether's theorem is one of the most influential theorems in physics. However, its usage in nanophotonics is rather limited. In our talk, we will discussed how composite symmetries enable the applicability of Noether's theorem in a wide range of configurations. We will pay special attention to spatiotemporal translation symmetries and spatiotemporal rotations due to the recent interest in time-varying media.

12:00 - 12:15 **Amplifying Optical Pulses with Space-Time Wedges**
Klaas De Kinder, Christophe Caloz — *KU Leuven, Belgium*
We propose Doppler pulse amplification (DPA), an alternative to chirped pulse amplification (CPA) that uses moving space-time impenetrable interfaces instead of dispersive elements to amplify optical pulses. DPA stretches and compresses optical pulses via Doppler frequency shifts in space-time wedges, avoiding higher-order dispersion and potentially mitigating gain narrowing. This approach enables compact, high-intensity pulse amplification, with the same applications as CPA.

12:15 - 12:30 **Dynamic of Phase Dislocation in a Controlled Array of Parametric Oscillators**
Benjamin Apffel — *Laboratory of Wave Engineering, STI, EPFL, Switzerland*
We investigate topological features in a chain of parametric oscillators where we leverage the external forcing of each oscillator independently. We show the existence of traveling phase dislocations due to half-phase winding and investigate the impact of non-linearities. An experimental realization using Faraday instability in a vibrated fluid is proposed

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

Analysis and Synthesis of Microwave Metastructures

Chairperson(s): Stefano Vellucci, Jordan Budhu

10:30 - 10:45 **Anisotropy in a Wire Medium due to the Rectangularity of a Unit Cell**
Denis Sakhno, Pavel Belov — *ITMO University, Russia*
This study explores the dispersion characteristics of a wire medium composed of a rectangular lattice of parallel wires near its plasma frequency. Although effective medium theory suggests isotropic behavior for transverse magnetic waves, numerical simulations indicate significant anisotropy. This finding is supported by the line-of-current approximation theory. The anisotropic effect emerges when the plasma wavelength is comparable to the lattice period and disappears for extremely thin wires. The degree of anisotropy was revealed at the level of 6% along the wires and more than 75% across them.

10:45 - 11:00 **Perpendicular Incidence on Complementary Split-Ring Resonator Composite Media**
Vasileios Salonikios[1], Michalis Nitas[2] — *[1] Aristotle University of Thessaloniki, Greece [2] Independent Researcher, Denmark*
We investigate the behavior of the recently proposed simplified complementary split- ring resonator composite medium under perpendicular wave incidence. Utilizing the solutions of wave excitation problems, we compare the behavior of the novel medium with the one consisting of ordinary complementary resonators. Simulated results exhibit a very similar behavior, with respect to the passband frequency zones and the preservation of the supported modes.

11:00 - 11:15 **Impedance Based Synthesis of Circular Modulated Metasurface Antennas with Entire Domain Basis Functions**
John Le[1], Jorge Ruiz-García[2], Anthony Grbic[1] — *[1] University of Michigan - Ann Arbor, USA [2] Université de Rennes, INSA Rennes, CNRS, IETR, France*
This paper presents a numerical technique for the synthesis of circular modu lated metasurface antennas through impedance optimization of a metasurface using a Method of Moments (MoM) formulation. The metasurface is modeled as an inhomogeneous, transparent sheet impedance boundary condition (IBC) layer atop a grounded dielectric substrate. Both the current density over the aperture and the sheet impedance are expanded into orthogonal sets of entire-domain Fourier-Bessel basis functions (FBBFs). The optimization procedure tunes the expansion coefficients of the sheet impedance to achieve a desired far-field radiation pattern while ensuring a purely reactive IBC. An isotropic, azimuthally invariant metasurface antenna is designed that radiates a radial Gaussian beam to verify the proposed approach.

11:15 - 11:30 **Synthesis of Cylindrical Metasurfaces through Tailoring the Propagation Characteristics of Electromagnetic Waves**
Davorin Mikulic, Marko Bosiljevac, Zvonimir Šipuš — *University of Zagreb, Croatia*
This paper presents a fast and efficient approach for designing metasurfaces that conform to curved geometries. We introduce analytical tools that allow for the efficient extraction of parameters related to electromagnetic wave propagation along cylindrical metasurfaces, enabling the design of diverse components with minimal curvature-induced effects.

11:30 - 12:00 **Rigorous Solution for the Canonical Problem of Anomalous Reflection from a Modulated Impedance Boundary** (Invited talk)
Federico Giusti[1], Enrica Martini[1], Stefano Maci[2], Matteo Albani[2] — *[1] University of Siena, Italy [2] University of Siena, Italia*
We rigorously study the canonical problem of an anomalous reflector constituted by an infinite periodic reactance surface designed based on the generalized reflection law. For this canonical problem, the amplitude of the scattered field is derived in closed form for all the diffraction orders. The derived results are numerically validated.

12:00 - 12:15 **Multifunctional Metasurfaces at Millimeter-Waves and Terahertz for Next-Generation Wireless Systems**
Damián Rodríguez-Trujillo, Alicia E. Torres-García, Mikel Aldea, Jorge Teniente, Asier Marzo-Pérez, Miguel Beruete — *Public University of Navarra, Spain*
Multifunctional metasurfaces offer promising solutions for high-frequency wireless systems. This work proposes a metasurface optimized via neural networks, capable of delivering distinct electromagnetic responses under varying illumination. By combining the Huygens-Fresnel principle with AI optimization, the design achieves high efficiency, adaptability, and scalability.

12:15 - 12:30 **Asymmetric Smith-Purcell Radiation Via Coupled High-Index Gratings**
Thomas Delplace, Ilyes Bouanati, Gilles Rosolen, Bjorn Maes — *University of Mons, Belgium*
In this work, we present a structure consisting of a double photonic crystal with a high-refractive-index substrate. By shifting the two crystals, we induce an asymmetry in the Smith-Purcell radiation between the upper and lower directions. This asymmetry is explained using a semi-analytical model based on Coupled Mode Theory.

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

npj Metamaterials and npj Nanophotonics Special Session on Fabrication and Characterization

Chairperson(s): Humeyra Caglayan

10:30 - 11:00 **Enabling Optical And Functional Composites** (Invited talk)
Dorota A. Pawlak, Kingshuk Bandopadhay, Nada Aghad, Ali Abbas, Piotr Piotrowski, Monika Tomczyk, Katarzyna Sadecka, Krzysztof Markus, Andrzej Materna, Hamid Reza-Darabian — *Ensemble3 Centre of Excellence, Poland*
We report on developments in the composite materials based on crystalline and glass phases, and including various dopants including quantum dots and plasmonic particles. We report on their properties and potential applications in the optoelectronics, photonics and energy applications.

11:00 - 11:30 **Multiphoton Lithography for Metamaterials Fabrication** (Invited talk)
Maria Farsari — *FORTH, Greece*
Multiphoton Lithography (MPL) uses laser-based nonlinear optical absorption for high-resolution additive manufacturing, achieving feature sizes in nanometers. It enables precise 3D fabrication within photosensitive materials, advancing fields like photonics, biomedical engineering, and metamaterials for novel applications in optics and mechanics.

11:30 - 11:45 **Discovery of Phonon-Polaritonic Skyrmions: Transition from Néel to Bubble Type**
Harald Giessen — *University of Stuttgart, Germany*
We introduce the concept of phonon-polaritonic skyrmions in thin SiC films, which are known for their extreme k-tuning over a narrow excitation wavelength range due to its strong dispersion within the Reststrahlen band. We utilize the strong sublinear dispersion of SiC to measure and characterize the transition from bubble- to Néel-type skyrmions through minute changes in excitation wavelength.

11:45 - 12:00 **Optical Metrology of 3D Nanoscale Objects Challenges Precision of Scanning Electron Microscopy**
Jinkyu So[1], Eng Aik Chan[1], Giorgio Adamo[1], Nikolay I. Zheludev[2] — *[1] Nanyang Technological University, Singapore [2] University of Southampton, United Kingdom*
We present the first experimental demonstration of all-optical label free metrology of 3D nanoscale objects with precision of λ/467 and λ/96 for the in-plane and out-of-plane object dimensions. The deeply subwavelength precision is facilitated by gathering the a posteriori information on the diffraction patterns from similar objects. The metrology challenges precision of scanning electron microscopy and is suitable for characterization of plasmonic and metamaterial samples.

12:00 - 12:15 **All-Dielectric Metasurface Supporting Quasi-Bound States in the Continuum for Ultraviolet Light**
Beáta Idesová[1], Filip Ligmajer[2], Alexander Berestennikov[3], Leonardo De Souza Menezes[4], Andreas Tittl[3], Tomáš Šikola[5] — *[1] Brno University of Technology, Central European Institute*

of Technology, Czech Republic [2] Brno University of Technology, Central European Institute of Technology; Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Czech Republic [3] Ludwig Maximilians University Munich, Faculty of Physics, Nanoinstitute Munich, Chair in Hybrid Nanosystems, Germany [4] Ludwig Maximilians University Munich, Faculty of Physics, Nanoinstitute Munich, Chair in Hybrid Nanosystems; Departamento de Física, Universidade Federal de Pernambuco, Germany; Brazil [5] Brno University of Technology, Central European Institute of Technology; Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Czech Republic

Label-free optical sensing provides a non-invasive approach to detecting biomolecular interactions. Nanophotonics offers a novel approach in the form of metasurfaces that support quasi-bound states in the continuum (qBICs). In our work, we propose a metasurface supporting qBICs in the UV region, that could be used for next-generation biosensing technologies.

12:15 - 12:30 **Experimental Realization of the Optical Tellegen Effect in Nonreciprocal Metasurfaces**

Shadi Safaei Jazi[1], Ihar Faniayeu[2], Rafael Cichelero[2], Nikolai Kuznetsov[1], Sebastiaan Van Dijken[1], Shanhui Fan[3], Alexandre Dmitriev[2], Viktar Asadchy[1] — *[1] Aalto University, Finland [2] University of Gothenburg, Sweden [3] Stanford University, USA*

We present the first experimental demonstration of an optical Tellegen metasurface, composed of cobalt-silicon nanocones with shape anisotropy. Leveraging spontaneous magnetization, it exhibits a strong Tellegen response, enabling nonreciprocal light reflection.

Oral Sessions (Thursday Afternoon)

Special session: Metamaterials and Sustainable Energy II
Chairperson(s): Albert Polman, Esther Alarcon-Llado **Room: Concertzaal**

Time	1st author	Title
14:00 - 14:30	Albert Polman	Controlling Optical Near Fields for Sustainable Energy Generation
14:30 - 15:00	Rebecca Saive	Fundamentals And Applications Of Free Space Diffuse Irradiance Collimation For Enhancing Photovoltaic Yield
15:00 - 15:30		Panel Discussion

Controlling Shocks and Vibrations & Soft Robotics
Chairperson(s): Varvara Kouznetsova, José Bico **Room: Shaffyzaal**

Time	1st author	Title
14:00 - 14:30	Ying Wu	Zero-space Waveguide Arrays for Flexural Waves
14:30 - 15:00	Hasan N. Olmez	Mechanically and Thermally Robust Metastructures for Optimized Reflective Metasurfaces in Urban Wireless Networks
15:00 - 15:15	Ioannis Spanos	Metamaterial-based Soft Grippers for Handling Delicate Objects
15:15 - 15:30	Jakob Mildenberger	Analysis of Acoustic Excitation Effects on Vibroacoustic Metamaterial Plates

Temporal Metamaterials II
Chairperson(s): Vincenzo Galdi, Amir Shlivinski **Room: Teekenzaal I**

Time	1st author	Title
14:00 - 14:30	Hiroki Wakatsuchi	Circuit-Based Metasurfaces Varying in Time and Space without Additional Power Supply
14:30 - 15:00	Dimitrios Sounas	Negative Capacitors through Floquet Engineering
15:00 - 15:30	Gennady Shvets	Wave Propagation in Time-Varying Media: The First 35 Years

Design and Characterizaton of Microwave Metadevices
Chairperson(s): Alex Schuchinsky, Zvonimir Šipuš **Room: Teekenzaal II**

Time	1st author	Title
14:00 - 14:15	Giacomo Oliveri	An Inverse Source Approach to Inexpensive Static Passive EMS Design
14:15 - 14:30	Boris Okorn	Parity Time Epsilon-Near-Zero systems: a preliminary stability analysis
14:30 - 14:45	Alessandra Contestabile	Radio-Frequency Mie Scattering from High-Permittivity Dielectric Spheres
14:45 - 15:00	Afshin Abbaszadeh	An Analytic Design Approach for Conformal Leaky Wave Antennas
15:00 - 15:15	Savvas Papamakarios	Multi-Photon Lithography On Thin Films For Efficient Fabrication Of 2D And 2.5D Meta-Atoms
15:15 - 15:30	Rossano Albatici	Postgraduate Teaching in Metamaterial Engineering: the M3 Program

Nanophotonic Sensing and Characterization
Chairperson(s): Maria Farsari, Nasim Mohammadi Estakhri **Room: Koepelzaal**

Time	1st author	Title
14:00 - 14:30	Yang Zhao	Imaging, Sensing, and Wearable Devices Using Nanophotonic Platforms
14:30 - 14:45	Sam Borman	Towards Using Angle-resolved Cathodoluminescence Interferometry For 3D Reconstruction Of Nanoscale Geometries
14:45 - 15:00	Saskia Fiedler	Pump-probe Cathodoluminescence Of Resonant Silicon Nanospheres For Nanothermometry
15:00 - 15:30	Abdoulaye Ndao	Breaking the limit of exception point generation in a single chip

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

Special session: Metamaterials and Sustainable Energy II

Chairperson(s): Albert Polman, Esther Alarcon-Llado

14:00 - 14:30 **Controlling Optical Near Fields for Sustainable Energy Generation** (Invited talk)
Albert Polman — *AMOLF, Netherlands*
We present novel advances in the design and fabrication of optical metamaterials to realize ultra-high-efficiency photovoltaics and light-driven sustainable chemical reactions.

14:30 - 15:00 **Fundamentals And Applications Of Free Space Diffuse Irradiance Collimation For Enhancing Photovoltaic Yield** (Invited talk)
Rebecca Saive — *University of Twente, Netherlands*
This work explores an optical metamaterial for redirecting diffuse sunlight to PV panels. Using free-space luminescent solar concentrators (FSLSCs), the system employs polymer waveguides, photon recycling, and a spectro-angular notch filter to produce collimated 'cold photons,' enhancing PV efficiency, particularly in winter conditions.

15:00 - 15:30 **Panel Discussion**
Albert Polman[1], Esther Alarcon-Llado[1], Georgia Theano Papadakis[2], Harry Atwater[3], Giulia Tagliabue[4], Rebecca Saive[5] — *[1] AMOLF, The Netherlands [2] ICFO, Spain [3] California Institute of Technology, USA [4] EPFL, Switzerland [5] University of Twente, The Netherlands*
Panel chaired by Albert Polman and Esther Alarcon-Llado.

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

Controlling Shocks and Vibrations & Soft Robotics

Chairperson(s): Varvara Kouznetsova, José Bico

14:00 - 14:30 **Zero-space Waveguide Arrays for Flexural Waves** (Invited talk)
Ying Wu — *KAUST, Saudi Arabia*
Zero-space waveguide arrays (ZSWAs) enable ultra-compact waveguides without bulky cladding. We extend ZSWA principles to flexural waves, overcoming evanescent-to-propagating conversion limitations by altering obstacles. This approach advances elastic waveguide design, optimizing confinement and guiding efficiency in thin elastic plates.

14:30 - 15:00 **Mechanically and Thermally Robust Metastructures for Optimized Reflective Metasurfaces in Urban Wireless Networks** (Extended)
Hasan N. Olmez, Tugberk Guner, Oreste S. Bursi, Giacomo Oliveri — *University of Trento, Italy*
The smart electromagnetic environment (SEME) paradigm enhances wireless systems using reconfigurable intelligent surfaces (RISs). However, their performance is sensitive to mechanical and thermal deformations. We propose an auxetic metastructure with near-zero Poisson ratio and thermal expansion, ensuring dimensional stability. This improves signal redirection and network robustness in smart cities.

15:00 - 15:15 **Metamaterial-based Soft Grippers for Handling Delicate Objects**
Ioannis Spanos, Ajay Kottapalli, Anastasiia Krushynska — *University of Groningen, Netherlands*
In this work, soft grippers with integrated mechanical metamaterials is investigated. Currently there is no established methodology for quantitatively assessing their performance. The contact area between the gripper and a test object is proposed as a potential metric to address this gap. Numerical analysis is conducted on two meta-grippers.

15:15 - 15:30 **Analysis of Acoustic Excitation Effects on Vibroacoustic Metamaterial Plates**
Jakob Mildenberger, Davide Esposito — *Technical University of Darmstadt, Department System Reliability, Adaptive Structures, and Machine Acoustics SAM, Germany*
This study investigates the impact of acoustic excitation on the structural response of a vibroacoustic metamaterial using a finite element model. A synthetic acoustic pressure field is generated by an array of monopole sound sources, with phase shifts between the sources systematically varied. Results show that while in-phase excitation produces a response similar to that of a two-mass oscillating system, introducing phase shifts between excitation sources from 90° to 135° results in a defined stopband and improved vibration attenuation, with the maximum vibration reduction observed close to 90° phase shift. These findings indicate that the spatial distribution of the excitation highly influences the efficacy of vibration attenuation in VAMM plates.

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

Temporal Metamaterials II

Chairperson(s): Vincenzo Galdi, Amir Shlivinski

14:00 - 14:30 **Circuit-Based Metasurfaces Varying in Time and Space without Additional Power Supply** (Invited talk)
Hiroki Wakatsuchi — *Nagoya Institute of Technology, Japan*
We present circuit-based metasurfaces varying in the time domain even at the same frequency according to the incoming pulse width. Importantly, our metasurfaces break classic LTI nature and attain unique properties and phenomena, e.g., passive yet reconfigurable radiation patterns, spatially interlocked multipath filters, pulse division multiplexing, and frequency-hopping wave engineering.

14:30 - 15:00 **Negative Capacitors through Floquet Engineering** (Invited talk)
Dimitrios Sounas — *Wayne State University, USA*
We present an approach to realize negative capacitor by using time periodic modulation. The proposed approach leads to the same response as one would expect from a negative capacitor, is scalable in frequency, and applicable in various scenarios where negative capacitors could be needed.

15:00 - 15:30 **Wave Propagation in Time-Varying Media: The First 35 Years** (Extended)
Gennady Shvets — *Cornell University, USA*
Some of the early history of time-varying media plasmas will be reviewed, with the emphasis on the underlying microscopic description of the media and the resulting conservation laws. I will then discuss how dielectric metasurfaces can be used to produce a wide range of optical phenomena, including: time-steps, negative refraction, and phase front reversal.

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

Design and Characterizaton of Microwave Metadevices

Chairperson(s): Alex Schuchinsky, Zvonimir Šipuš

14:00 - 14:15 **An Inverse Source Approach to Inexpensive Static Passive EMS Design**
Giacomo Oliveri, Francesco Zardi, Aaron Angel Salas Sanchez, Giorgio Gottardi, Andrea Massa — *ELEDIA@UniTN-DICAM, University of Trento, Italy*
Electromagnetic Skins (EMSs) are key enablers in the development of Smart Electromagnetic Environments (SEMEs), offering reconfigurable and energy-efficient solutions for wave manipulation. This work presents a novel methodology to enhance the performance of low-cost, static passive EMSs (SP-EMSs). The proposed approach exploits the decomposition of the surface currents as a combination of pre-image (PI) and null-space (NS) components. The resulting optimization process aims to minimize the mismatch between the ideal surface current, which radiates the desired target field, and the actual current distribution on the EMS. A proof-of-concept experiment is shown to demonstrate the feasibility and effectiveness of the method in synthesizing SP-EMSs realized using conductive ink on a standard paper substrate.

14:15 - 14:30 **Parity Time Epsilon-Near-Zero systems: a preliminary stability analysis**
Boris Okorn[1], Victor Pacheco-Peña[2], Silvio Hrabar[1] — *[1] University of Zagreb, Croatia [2] Newcastle University, United Kingdom*
We report on the stability analysis of a parity-time (PT) symmetric system where gain and loss layers are separated by a section of epsilon-near-zero (ENZ) waveguide. In this PT-ENZ system, gain and loss layers are modelled as lumped elements (i.e. as having zero thickness). Stability analysis is performed using the normalized determinant function (NDF). Our analysis demonstrates stable behavior, proving a feasibility of practical PT-ENZ based systems.

14:30 - 14:45 **Radio-Frequency Mie Scattering from High-Permittivity Dielectric Spheres**
Alessandra Contestabile[1], Angelo Galante[2], Angela Capocefalo[1], Vincenzo Galdi[3], Marcello Alecci[2], Carlo Rizza[1] — *[1] University of L'Aquila, Department of Physical and Chemical Sciences, Italy [2] University of L'Aquila, Department of Life, Health and Environmental Sciences, Italy [3] University of Sannio, Department of Engineering, Fields & Waves Lab, Italy*
We experimentally investigate Mie resonances in a high-permittivity dielectric sphere operating in the radio-frequency (RF) regime. By measuring S-parameters, we clearly identify RF Mie resonances in a high-index ceramic sphere exhibiting small electromagnetic loss. Our findings provide valuable insights for developing new techniques to manipulate RF waves, which could have potential applications in magnetic resonance imaging.

14:45 - 15:00 **An Analytic Design Approach for Conformal Leaky Wave Antennas**
Afshin Abbaszadeh, Jordan Budhu — *Virginia Tech, USA*
A fully analytic approach is presented for the design of a sinusoidally shaped conformal Leaky Wave Antenna (LWA). The approach is based on differential geometry formulations of arc-lengths and ray tangents for conformal rays emanating from a central feed pin. A Voronoi patterning technique is used to realize the necessary surface impedance to generate a far-field beam in a desired direction as obtained from the holography approach. Full-wave simulations validate the design. The analytic design approach presented paves the way for conformal LWA designs without the need to incorporate costly full-wave simulations into the design stage.

15:00 - 15:15 **Multi-Photon Lithography On Thin Films For Efficient Fabrication Of 2D And 2.5D Meta-Atoms**

Savvas Papamakarios[1], Gordon Zyla[1], Dimitrios Zografopoulos[2], Anna Christoforidou[3], George Kenanakis[1], Maria Farsari[1], Odysseas Tsilipakos[4] — *[1] IESL/FORTH, N. Plastira 100, 70013, Heraklion, Greece, Greece [2] Consiglio Nazionale delle Ricerche, Istituto per la Microelettronica e Microsistemi, Rome, Italy [3] Lund University, Faculty of Engineering, Lund, Sweden [4] Theoretical and Physical Chemistry Institute, National Hellenic Research Foundation, Athens, Greece*

Fabrication of metasurfaces using film-assisted Multi-photon Lithography for high quality 2D and 2.5D structures using a fast, cheap and novel approach. High resolution structures are demonstrated and the process is supported by THz and mid-IR applications.

15:15 - 15:30 **Postgraduate Teaching in Metamaterial Engineering: the M3 Program**

Rossano Albatici[1], Oreste Bursi[1], Giacomo Oliveri[2], Alessandro Pegoretti[1], Paolo Rocca[3], Andrea Massa[2] — *[1] University of Trento, Italy [2] ELEDIA@UniTN-DICAM, University of Trento, Italy [3] ELEDIA@UniTN-DICAM, University of Trento, University of Trento*

With the growing research and industrial applications of Metamaterials (MTM), interest in MTM education is steadily increasing across multiple disciplines. Unlike conventional subjects, MTM education demands a multidisciplinary approach, integrating fundamental and advanced concepts from electromagnetics, mechanics, acoustics, electronics, materials science, and structural engineering. This talk presents the approach and the learning process introduced in the Postgraduate Program in Multifunctional Metamaterials and Metastructures, a recently introduced didactic initiative at the University of Trento.

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

Nanophotonic Sensing and Characterization

Chairperson(s): Maria Farsari, Nasim Mohammadi Estakhri

14:00 - 14:30 **Imaging, Sensing, and Wearable Devices Using Nanophotonic Platforms** (Invited talk)
Yang Zhao — *University of Illinois Urbana Champaign, USA*
We develop nanophotonic instruments and devices for early diagnosis and health monitoring. These platforms enable nanomaterial characterization, chiral molecular sensing, and wearable physiological monitoring. I will discuss ultrafast optical force nanoscopy for nanometer-scale, nanosecond-resolved thermal imaging of nanodevices, as well as wearable metasurface-enabled implantable sensors for tracking brain activity.

14:30 - 14:45 **Towards Using Angle-resolved Cathodoluminescence Interferometry For 3D Reconstruction Of Nanoscale Geometries**
Sam Borman, Evelijn Akerboom, Daphne Dekker, Matthias Liebtrau, Albert Polman — *AMOLF, Netherlands*
We present a novel method to reconstruct the 3D geometry of nanoscale objects in a SEM. We do this by analyzing the interference pattern generated when coherent cathodoluminescence scatters of a nanostructure. This provides a fast, high-resolution tomography method with potential applications in the field of semiconductor device inspection.

14:45 - 15:00 **Pump-probe Cathodoluminescence Of Resonant Silicon Nanospheres For Nanothermometry**
Saskia Fiedler[1], Loriane Monin[1], Hiroshi Sugimoto[2], Minoru Fujii[2], Wiebke Albrecht[1], Albert Polman[1] — *[1] NWO-Institute AMOLF, Netherlands [2] Kobe University, Japan*
We control and probe optical Mie resonances in 200-nm-diameter single Si nanospheres using a novel pump-probe cathodoluminescence (CL) spectroscopy technique. We couple a 442 nm laser into the SEM-CL system to locally heat individual NPs and observe a thermally driven spectral shift of Mie modes in CL.

15:00 - 15:30 **Breaking the limit of exception point generation in a single chip** (Invited talk)
Abdoulaye Ndao — *University of California, San Diego, USA*
We propose a new paradigm for implementing non-Hermitian transformations in a programmable scheme that breaks the limit of Exceptional Points generation in a single chip.

12:30 - 14:00 Poster Session I (Monday)
Husly lounge
Chairperson(s): Masha Ogienko

1 **Protein Detection Based on Infrared Metamaterial Absorber Inducing Strong Coupling**
Joo-Yun Jung[1], Do Hyun Kang[1], Doo-Sun Choi[1], Taewon Park[2], Yeonkyeong Park[2], Eun-Chae Jeon[2] — *[1] Korea Institute of Machinery and Materials, Korea (South) [2] University of Ulsan, Korea (South)*
A mid-infrared label-free immunoassay biosensor utilizing surface-enhanced infrared absorption spectroscopy enables sensitive biomolecule detection. This study developed a biosensor with a metamaterial absorber to achieve strong coupling effects. Maximizing coupling requires enhancing near-field intensity and ensuring spatial and spectral overlap between the optical cavity resonance and the analyte's vibrational mode. Conventional baseline correction fails due to significant peak splitting. Thus, a coupled harmonic oscillation model was used to analyze spectral distortion caused by strong coupling-induced peak splitting.

2 **Hyperband Multi-functional Metadevice based on Double-walled Carbon Nanotubes**
Jin Zhang, Zhipei Sun — *Aalto University, Finland*
In the past decade, metasurfaces have become a paradigm for engineering electromagnetic space due to their strong interaction with light or wave. However, mastering the cross- wavelength modulation of spatial light over the entire electromagnetic spectrum remains a challenging task. Here, we experimentally demonstrate an avenue towards hyperband multifunctionality in a single metadevice based on double-walled carbon nanotubes (DWCNTs). As a proof of concept, the proposed DWCNT-based metadevice integrates three typical functionalities including microwave selectivity, terahertz diffusion, and optical transparency.

3 **Chiral Optical Forces In A Slot Waveguide For Separating [6]-Helicenes Enantiomers**
Josep Martinez-Romeu, Daniel Arenas-Ortega, Iago Diez, Alejandro Martínez — *Universitat Politecnica Valencia, Spain*
Chiral optical forces present an exciting avenue to separate enantiomers using light, which could be exploited in numerous industries. In this work, we calculate the chiral optical forces exerted by light guided in a dielectric slot waveguide in air and study the possible separation of hexahelicene in air.

4 **Asymmetric optical responses and polarization rotation via optimized metamaterials**
Emese Tóth, Olivér Fekete, Dávid Takács, Miklós Waldhauser, Dániel Megyeri, Dávid Vass, András Szenes, Balázs Bánhelyi, Mária Csete — *University of Szeged, Hungary*
Tri-layer metamaterial constructed with Babinet complementary miniarray patterns in convex-concave-convex succession was optimized to maximize asymmetric optical responses and accompanying polarization rotation. Better meeting of the generalized Faraday criterion was achieved via optimized configuration exhibiting more predominantly Tellegen coupling than playing with the artificial moving characteristic, compared to a dual counterpart configuration.

5 **Electrostatic Field-Driven Cation Effects in Electrocatalytic CO2 Reduction: Insights from *CO Adsorption Configurations Analysis**
Dexiang Cheng — *Southeast University, China*
This work employs a plasmonic Cu nanoarray with controlled curvature to regulate local K+ concentration, stabilizing *COb and lowering the C-C coupling barrier. In situ SERS and DFT

calculations reveal charge redistribution at the Cu-K+-*CO interface, enhancing C2+ selectivity in CO2RR.

6 **Integrated Subwavelength Bimodal Interferometer via Multilayer Hyperbolic Metamaterials**
Luis Manuel Máñez-Espina, Alejandro Martínez — *Universitat Politècnica de València, Spain*
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.

7 **Hybrid High-Index Composite Meta-structures with Atomic Layer-Coated Nanoparticle-Embedded Resin**
Minseok Choi, Hyunjung Kang, Dohyun Kang, Junsuk Rho — *Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang, Republic of Korea, Korea (South)*
We introduce a hybrid nanoparticle-embedded resin (nano-PER) structure that reduces meta-atom height and aspect ratio. By utilizing TiO2 nano-PER as the core material with thin TiO2 coatings, we can implement the optical properties of high refractive index with printable material, achieving height and aspect ratio reduction.

8 **Reverse Design of Correlated Disorder Meta-Surfaces for Light Trapping in (Ultra-)Thin Film Solar Cells**
Anja Tiede[1], Nick Feldman[2], Alexander Lambertz[2], Femius Koenderink[2], Anna Fontcuberta I Morral[1], Esther Alarcon-Lladó[2] — *[1] École Polytechnique Fédérale de Lausanne, Switzerland [2] AMOLF, The Netherlands*
We present a method to create correlated disordered metasurfaces with independent angular and spectral scattering response control. It is founded on reverse-engineering the Fourier space and blob detection, incorporating a decoration step to leverage individual resonances in nano-scatterers. We demonstrate its effectiveness as light trapping in thin film solar cells using earth-abundant zinc phosphide.

9 **Inverse Design of Photonic Metasurfaces through Physics-informed Deep Learning using a Rigorous Point-dipole Scattering Model**
Timo Gahlmann, Femius Koenderink, Ewold Verhagen — *Amolf, Netherlands*
We present a physics-informed deep-learning approach for the inverse design [1–6] of photonic metasurfaces. By embedding an analytic multiple-scattering model employing Ewald summation of dipolar lattices into the network, it is infused with a rigorous theory of scattering and diffraction, enforcing symmetries and conservation laws in each forward pass. This leads to better resonance prediction and enables rapid design generation once trained.

10 **Design And Development Of Metaoptics For Vortex Beam Generation In The Infrared**
Philippe Clouet, Patrick Bouchon, Julien Jaeck — *DOTA, ONERA, Université Paris-Saclay, France*
2-dimensionnal arrays made of sub-wavelength nanostructures can manipulate electromagnetic waves. Here we conceive an optical vortex generator working in the near-infrared. The component can be used into a Coherent Beam Combining (CBC) system.

11 **Large-area Nanophotonic Scintillators for X-ray Imaging**
Louis Martin-Monier[1], Simo Pajovic[2], Muluneh G. Abebe[2], Joshua Chen[2], Sachin Vaidya[2], Seokhwan Min[3], Seou Choi[2], Steven E. Kooi[2], Bjorn Maes[2], Juejun Hu[2], Marin Soljačić[2], Charles Roques-Carmes[2] — *[1] Massachusetts Institute of Technology, USA [2] Massachusetts Institute of Technology, USA [3] Korea Advanced Institute of Science and Technology, South Korea*
Nanophotonic scintillators, which feature nanostructures at the scale of their emission wavelength, provide a promising approach to enhancing light yield with a substantially reduced thickness. Here, we demonstrate a six-fold emission enhancement over a wafer scale area of 4 cm x 4 cm and 0.5 mm thickness. This facilitates the development of brighter and thinner X-ray scintillators, which could lead to low-dose and high-resolution X-ray imaging with promising applications in medical imaging and nondestructive inspection.

12 **Periodic Via Hole Loaded Transmission Line for Harmonic Suppression**
Jie Ma[1], Liwei Yan[1], Zhanyi Fu[1], Han Zhang[1], Yang Kuai[1], Yang Fei[2] — *[1] Southeast University, China [2] Southeast University, China*
This paper investigates a non-planar transmission line periodically loaded with via holes, which is modeled and validated through full-wave electromagnetic simulations. The transmission characteristics and calculated characteristic impedance are reported. A parametric analysis of the unit cell is conducted to predict the stopband behavior of the transmission line. Due to its compact structure, the artificial transmission line is particularly useful for optimizing circuit size and suppressing spurious signals, making it highly suitable for miniaturization and performance enhancement.

13 **Achieving Glide-Like Dispersion Properties in Broken-Glide Symmetric Structures**
Dubravko Tomić, Zvonimir Šipuš — *University of Zagreb, Croatia*
This paper explores the propagation properties of glide-symmetric and broken-glide symmetric dielectric periodic structures, focusing on tailoring the dispersion characteristics in asymmetric configurations. Using the Frobenius norm to quantify the similarity of the broken-glide symmetric submatrix to the glide-symmetric submatrix, we demonstrate that careful parameter optimization can enable broken-glide structures to mimic glide-like behavior. This approach provides a pathway for achieving glide-like dispersion in structurally asymmetric systems, expanding the design flexibility for applications in microwave and optical devices.

14 **Plasmonic multipod clusters as emitters of magnetic light**
Joshua Davis[1], Sébastien Bidault[2], Mathieu Mivelle[3], Mona Tréguer-Delapierre[4], Alexandre Baron[5] — *[1] University of Bordeaux, CRPP, France [2] Institut Langevin, ESPCI, France [3] Sorbonne Université, INSP, France [4] University of Bordeaux, ICMCB, France [5] University of Bordeaux, CRPP, Institut Universitaire de France, France*
We design magnetic optical emitters based on plasmonic multipod structures. By employing quasinormal modes we are able vastly decrease the optimization parameter space and successfully achieve isotropic magnetic Purcell factors larger than 180. Additionally, we show the relationship between symmetries of the emitter and its use as an isotropic emitter.

15 **Plasmonic Smith-Purcell Metagratings Generate Polarization-Tunable Free-Electron Radiation**
Hollie Marks, Matthias Liebtrau, Albert Polman — *NWO-Institute AMOLF, Netherlands*
Merging plasmonic metasurface design concepts with free-electron radiation phenomena presents a powerful approach to investigate and shape the interaction between light, plas-

mons, and electrons. Here, we demonstrate a metasurface that generates polarization-tunable free-electron-driven photon emission, based on spatially-selective excitation of plasmonic modes within gold nanostructures.

16 **Optical Tomography- Reconstructing Plasmonic Structures Below The Diffraction Limit**
Ethan Kensett, Wiebke Albrecht — *AMOLF, Netherlands*
This project aims to resolve (sub-)nanometer nanoparticle morphologies by optical tomography. Polarization dependent scattering patterns enable the reconstruction of 3D nanoparticle shapes via deep neural networks, offering an optical-only approach analogous to electron tomography, without the associated limitations of electron microscopy.

17 **Graviton-Polaritons in FQH Systems Coupled to Optical Cavities**
Daniele Battesimo Provenzano[1], Zeno Bacciconi[2], Marcello Dalmonte[3], Iacopo Carusotto[4], Giuseppe La Rocca[5] — *[1] Scuola Normale Superiore, Italy [2] International School for Advances Studies and The Abdus Salam International Centre for Theoretical Physics, Italy [3] The Abdus Salam International Centre for Theoretical Physics, Italy [4] INO-CNR Pitaevskii BEC Center University of Trento, Italy [5] Scuola Normale Superiore and National Enterprise for nanoScience and nanoTechnology, Italy*
We investigate the coupling of a fractional quantum Hall (FQH) layer with the electromagnetic field of a high-Q optical cavity. By deriving the response function of the FQH layer, we reveal anisotropic behavior similar to gyrotropic media and propose an experiment to detect graviton-polariton excitations through cavity mode shifts.

18 **Strong light-matter coupling in a Graphene-Cube-Micro-Cavity**
Julieta Olivo[1], Hernán Ferrari[2], Mauro Cuevas[2] — *[1] CONICET, Universidad Austral, Universidad de Buenos Aires, Argentina [2] CONICET, Universidad Austral, Argentina*
The present work deals with the study of a 3D-graphene-cube cavity, designed to strengthen the interaction between a quantum emitter (QE) and surface plasmon (SP) fields. This setup generates two distinct plasmonic modes: a high-frequency mode associated with SPs on the graphene sheet, and a low-frequency mode resulting from the reflection of SP fields between the graphene sheet and the micro-cube base. When coupled to these modes, the QE relaxation rate increases significantly compared to free-space conditions, while its population dynamics can display oscillatory, reversible patterns. We show that, for specific values of the system parameters, the population of the quantum emitter can become trapped in the excited state, leading to the formation of a bound state within the environment. This finding opens up new possibilities for designing chip-scale quantum plasmonic devices, offering a unique approach to controlling light-matter interactions at the nanoscale.

12:30 - 14:00 Poster Session II (Tuesday)
Husly lounge
Chairperson(s): Xiaofei Guo

1 **Design of Broadband Radar Absorbing Structure using Two Bitmap-type Frequency Selective Surfaces**
Jinbong Kim, Hong-Kyu Jang, Jaecheol Oh — *Korea Institute of Materials Science, Korea (South)*
This study presents an optimized design of a radar absorbing composite structure using two frequency-selective surfaces to achieve a broadband absorption performance in the S, C, X, and Ku-bands. Each frequency-selective surface is coded as a 20 × 20 bitmap matrix.

2 **300-GHz-band metamaterial-based phase shifting integrated circuit in high-resolution 3D printed waveguide packaging for future wireless communication**
Adam Pander[1], Kentaro Soeda[2], Daisuke Kitayama[1], Hibiki Kagami[1], Hiroshi Hamada[1], Yoshinori Yamaguchi[2], Kuniaki Konishi[2], Junji Yumoto[2], Hiroyuki Takahashi[1] — *[1] NTT Device Technology Laboratories, NTT Corporation, Japan [2] The University of Tokyo, Japan*
This study presents the first-ever phase shifter metamaterial-based devices at 300-GHz-band with continuous 2π phase controllability for future beamforming in wireless networks. To cope with the demand for high-density packaging, fabricated metamaterial chips were mounted in hollow waveguides fabricated using a high-resolution 3D printer (RECILS). The fabricated devices showed over 360° phase control in the response to the applied bias.

3 **Reconfigurable Polarization Deflector in PTD-Symmetric Geometry**
Roee Geva[1], Mário Silveirinha[2], Rapahel Kastner[1] — *[1] Tel Aviv University, Israel [2] University of Lisbon, Portugal*
We describe a reconfigurable polarization deflecting device based on the recently reported capability of PTD symmetric structures to achieve polarization inversion. The device can rotate dynamically the mirror plane using controlled capacitors as short or open circuits for allocating near-PEC and near-PMC regions. Simulations verify the viability of the device.

4 **Electromagnetic Wave-Based Quasi-Digital Linear Logic Operations**
Ross Glyn Macdonald, Alex Yakovlev, Victor Pacheco-Peña — *Newcastle University, United Kingdom*
The superposition of electromagnetic (EM) waves is exploited to implement quasi-digital logic operations. Different than true digital operations, quasi-digital operations are implemented using entirely linear structures by tailoring the encoding scheme of the input signals and the geometry of the structure.

5 **Broadband multilayer metasurface absorbers with MXene resonators and topology optimized substrates**
Maria-Thaleia Passia, Yilin Zhao, Haozhe Wang, Steven Cummer — *Duke University, USA*
We present the synthesis of broadband multilayer metamaterial absorbers (MMA) based on MXenes, which are novel two-dimensional conductive materials with higher ohmic losses than copper. We examine the possibility of utilizing topology-optimized stereolithography (SLA) 3D-printed substrates as a complementary means for enhancing absorption.

6 **3D-Printed Optically Transparent Metasurface for Automotive Radar Applications**

Sergey Geyman[1], Dmytro Vovchuk[2], Denis Kolchanov[1], Mykola Khobzei[2], Vladyslav Tkach[2], Vjaceslavs Bobrovs[2], Hagit Gilon[3], Eyal Cohen[3], Eran Yungar[3], Pavel Ginzburg[1] — *[1] School of Electrical Engineering, Tel Aviv University, Tel Aviv, Israel [2] Institute of Telecommunications, Riga Technical University, Riga, Latvia [3] DR Utilight Ltd., Yavne, Israel*

Radar enhances automotive safety by enabling reliable object detection, crucial for advanced driver assistance systems (ADAS) and autonomous driving. A vehicle's radar cross-section (RCS) determines its visibility, yet modern cars lack embedded radar reflectors due to design constraints. Rear windshields, offering unused space, could host a retroreflective surface designed for the interrogation geometry. We propose a metasurface of thin conductive wires, patterned to satisfy the first Bragg condition. Fabricated using silver-nanoparticle inks, our 10×10 cm² sample achieves 90% optical transparency and an RCS of 8 m², exceeding typical vehicle RCS. Scaling to a full windshield could yield an RCS of 1,000 m², improving detectability nearly hundredfold. Smart transparent surfaces integrating electromagnetic functions open avenues in automotive radar, wireless communication, and IoT.

7 **Dual-frequency cofocus microwave metasurface**

Quansheng Zhang, Di Guo, Changsheng Shen, Zhaofu Chen, Hehong Fan, Ningfeng Bai — *Southeast University, China*

This paper introduces a dual-frequency microwave metasurface. The operating frequencies of this metasurface are 110 GHz and 150 GHz. Based on the PB phase, an achromatic metasurface is constructed using a simple and easy-to-process rectangular perforated unit structure. In general, the unit structure of a microwave metasurface is complex and large, and there will be phase differences between metasurfaces of different frequencies. This paper uses an anisotropic dielectric perforated unit structure to construct an achromatic metasurface. The simulation results show that the focus shift of this metasurface can be less than 1 wavelength at dual frequency.

8 **Tunable Antenna Integrating Highly-Conductive Nanocrystalline Graphite and Meta-atoms for Advanced and Miniaturized Millimetre-wave Radar Applications**

Martino Aldrigo[1], Hardly Joseph Christopher[1], Catalin Parvulescu[1], Octavian-Gabriel Simionescu[1], Sergiu Iordanescu[1], Stephane Xavier[2], Afshin Ziaei[2] — *[1] IMT Bucharest, Romania [2] Thales Research and Technology France, Campus Polytechnique, France*

This paper proposed the wafer-scale integration of highly-conductive nanocrystalline graphite (NCG) and meta-atoms into 60-GHz antennas fabricated on a 4-in high-resistivity silicon substrate. At the end, a 4-element antenna array is proposed for a practical 60-GHz radar application. Preliminary measurements of both reflection coefficient and transmission prove the advantages of such a solution with respect to the same antenna without meta-atoms, especially in terms of bandwidth. Furthermore, the high fabrication yield and repeatability of the measurement results ensure the future upgrade to mass production.

9 **Designing Isotropic Dark Modes**

Kieran Cowan[1], Simon Berry[2], Alastair Hibbins[1], Alex Powell[1] — *[1] University of Exeter, United Kingdom [2] QinetiQ, United Kingdom*

Dark modes do not radiatively couple to the far field at specific incident wave angles. This work explores designing a resonant dimer with a mode that is observed in the near field but not the far field, regardless of incident angle.

10 **Application of H∞ Approximation Method in Design of Negative Inductance**

Dominik Zanic, Silvio Hrabar — *University of Zagreb, Croatia*
This paper presents a frequency-based method for determining the loading impedance of a two-port dispersive NIC network such that the NIC approximates arbitrary predetermined impedance.

11 **Design of an Intelligent Metasurface with Independently and Precisely Tunable Amplitude-Phase Control**
Jia Chen Wang, Zhen Jie Qi, Qun Yan Zhou, Jun Wei Wu, Shuo Liu, Hui Dong Li, Jun Yan Dai, Qiang Cheng — *Southeast University, China*
This paper proposes a metasurface with precise independent amplitude and phase control in the 2–2.5 GHz band, achieving over 10 dB amplitude tuning and 0–360° phase tuning. Full-wave simulations confirm its superior performance for complex electromagnetic wave manipulation.

12 **A 1-bit Amplifying Space-Time-Coding Metasurface**
Lijie Wu, Zheng Xing Wang, Jun Yan Dai, Qiang Cheng, Tie Jun Cui — *Southeast University, China*
To compensate the energy loss of traditional passive space-time-coding metasurface, an amplifying space-time-coding metasurface (ASTCM) is proposed in this work. The ASTCM can achieve more than 5 dB energy enhancement and over 20 dB dynamic amplitude manipulation with different control voltages of the amplifier chip. Furthermore, a stable 1-bit phase modulation is also realized through two oppositely arranged PIN diodes. For verification, a 6*6 metasurface array is constructed to realize flexible beam control by using different space-time-coding strategies. The proposed ASTCM exhibits amplifying capability and great beamforming performance, which may find critical applications in the field of wireless communication and radar systems.

13 **Reconfigurable Dual-polarized Waveguide-fed Metasurface for 5G Millimeter-wave Communication**
Han Zhang, Shuang Peng, Qian Yu, Xiaoyue Shen, Zhanyi Fu, Fei Yang — *Southeast University, China*
A reconfigurable dual-polarized waveguide-fed metasurface (RDWM) for 5G mmWave systems integrates ±45° slotted SIW and PIN diodes, enabling independent ±45° beam steering (<3° error). Experiments validate decoupled control (e.g., +45° at 0° & -45° at 20°), offering a low-profile solution for 5G/6G multi-functional antennas.

14 **Packing a Wire Metamaterial Haloscope into a Cylindrical Footprint Using Spiral Geometry**
Rustam Balafendiev[1], Junu Jeong[2], Gagandeep Kaur[2], Gaganpreet Singh[2], Pavel Belov[3], Jon Gudmundsson[1] — *[1] University of Iceland, Iceland [2] Stockholm University, Sweden [3] ITMO University, Russia*
In this work we describe a way to arrange a wire medium inside a plasma haloscope which insures that the boundary of the metamaterial closely follows the walls of a cylindrical microwave cavity, optimizing it for use with a cylindrical-bore magnet. A way of tuning the cavity's resonant frequency by utilizing static and rotating spiral arms is investigated numerically, demonstrating 33% of tuning and 17% of change to the figure of merit throughout the process.

15 **A Frequency Beam-Scanning TMA Without Utilizing Phase Shifters or Complex Feeds**

Alireza Ghaneizadeh[1], Sören F. Peik[2], Martin Schneider[3], Mojtaba Joodaki[1] — *[1] Constructor University Bremen, Germany [2] Hochschule Bremen, Germany [3] University of Bremen, Germany*

True metasurface antennas (TMAs) have already been introduced as a novel concept for the development of ultra-thin superdense antenna arrays. A shortcoming of the existing TMAs is that they have not been able to provide a passive reconfigurable TMA. In this paper, we design, simulate, and measure a new reconfigurable passive TMA, inspired by dynamic traveling-wave metasurface antenna arrays for beam steering. Such compact passive reconfigurable TMAs are in great demand in 6G networks and other terrestrial communication applications and in today's spacecraft or space satellites.

16 **Metamaterial-Based Micro-Doppler Enhancement via High-Order Multipole Scattering**

Sergey Geyman[1], Dmytro Vovchuk[2], Konstantin Grotov[1], Dmitry Dobrykh[1], Anton Kharchevskii[1], Vjaceslavs Bobrovs[2], Pavel Ginzburg[1] — *[1] School of Electrical Engineering, Tel Aviv University, Tel Aviv, Israel [2] Institute of Telecommunications, Riga Technical University, Riga, Latvia*

In electromagnetic wave interactions, rotating objects typically induce micro-Doppler frequency shifts governed by the symmetry of their scattering response. Traditional dipolar scattering results in a shift at 2Ω, while higher-order rotational harmonics require engineered scatterers. Here, we introduce a metamaterial-based approach for artificial micro-Doppler enhancement via strongly interacting magneto-electric resonators. These GHz-range structures, optimized through a covariance matrix adaptation genetic algorithm, support high-order multipoles, generating frequency shifts exceeding the dipolar limit by two orders of magnitude. Our designed array effectively maps slow (Hz-range) rotations to the kHz range, significantly boosting micro-Doppler visibility. This enhancement not only advances fundamental studies of wave-matter interactions but also improves radar-based motion detection by elevating micro-Doppler signatures above clutter.

17 **Huygens Metasurfaces Array Synthesis for Azimuth and Elevation Beam Tilt**

Michela Longhi — *Niccolò Cusano University, Italy*

In this contribution, we present a model of a cylindrical Huygens metasurface designed to modify the radiation pattern of an omnidirectional antenna over a wide range of angles. Thanks to the accurate synthesis of the metasurface, it is possible to achieve an advanced control of the electromagnetic properties of the radiation beam, acting simultaneously on both the E-plane and the H-plane. This approach allows to improve the directivity and the configuration of the radiation, making the solution particularly useful in advanced communication, beamforming and interference reduction applications.

18 **Large-scale Programmable Metasurface for Terahertz Beam Scanning**

Biao-Bing Jin — *Nanjing University, China*

In this talk, we presented a large-scale programmable metasurface for terahertz (THz) beam scanning. A pixelated liquid crystal THz metasurface with a crossbar structure arranged in two layers is designed to avoid the complexity of feedline in one layer, and decreased the control lines from N2 to 2N, N is the array number. This made us easily to increase the scale of array number more than 3000. We also demonstrated experimentally the programmable metasurface capable of active beam deflection in the upper half space with theta< 45 degree and 0 < phi<360 degrees. This large-scale metasurface device opens exciting opportunities in pencil beamforming, high-speed information processing, and optical computing.

19 **A Complementary Split Ring Resonator (CSRR) Based Metamaterial Structure for Antenna and Size Reduction Applications**

Mohammad Fairouz — *PAAET, Kuwait*

This paper presents the design and simulation of a Complementary Split Ring Resonator (CSRR)-based metamaterial structure aimed at enhancing antenna performance for wireless communication applications. The CSRR is integrated into a microstrip patch antenna to optimize impedance matching, bandwidth, size and efficiency. Utilizing Rogers RT/duroid 5870 as the substrate, the proposed design ensures low dielectric loss and improved radiation characteristics. The extracted material parameters confirm negative permittivity at resonance, validating the metamaterial behavior. The results indicate that CSRR structures can effectively contribute to antenna miniaturization while maintaining high radiation efficiency, reduce size, making them suitable for modern wireless communication and RF applications.

20 **Characterizing 3D Printed Polymers At Telecommunications Wavelengths For Use In Photonics**

Joseph Arnold Riley, Christian Johnson-Richards, Ross Glyn Macdonald, Noel Healy, Victor Pacheco-Peña — *Newcastle University, United Kingdom*

In this work we experimentally, theoretically and numerically study the possibility to use 3D printable plastics in photonics. The complex refractive index of the selected plastics is retrieved in the wavelength range of 1520 - 1630 nm. Demonstrating that the chosen materials may have potential uses at Telecom wavelengths.

12:30 - 14:00 Poster Session III (Wednesday)
Husly lounge
Chairperson(s): Timo Gahlmann

1 **Wave Scattering by Isorefractive Bodies and γ-Type Meta-Shells**
Gregory Samelsohn — *Shamoon College of Engineering, Israel*
In this contribution, both direct and inverse scattering by isorefractive obstacles is addressed. Linear acoustics is chosen as an illustrative example, but the results are equally applicable to electromagnetic waves, at least for 2D setups with TM- or TE-polarized incident waves. Using the Bergmann substitution, it is shown that any homogeneous isorefractive body can be described by a delta-prime scattering potential, i.e., can emulate a pure γ-type meta-shell. The strength of the potential depends on the density contrast. Numerical proof-of-principle simulations aimed at shape recovery of isorefractive scatterers confirm the expected double-ring pattern observed in the tomograms.

2 **Three-dimensional locally-resonant underwater lens for low-frequency sound focusing**
Beomseok Oh[1], Dongwoo Lee[1], Yeon-Seong Choo[2], Sung-Hoon Byun[2], Sea-Moon Kim[2], Junsuk Rho[1] — *[1] Pohang University of Science and Technology (POSTECH), Korea (South) [2] Ocean and Maritime Digital Technology Research Division, Korea Research Institute of Ships & Ocean Engine ering (KRISO), Korea (South)*
Broadband underwater sound focusing in the low-frequency range is crucial for a wide array of applications, such as battery-free environmental monitoring and sensing. However, achieving low-frequency underwater focusing typically necessitates bulky, heavy structures that hinder practical deployment. In this work, we present a three-dimensional lens composed of cavity-based asymmetric scatterers, enabling a highly efficient design for manipulating low frequency waterborne sound through densely packed lattice configuration. We experimentally validate its broadband focusing performance over the 20-35 kHz range.

3 **Ventilated Sound Barrier based on Fano-like Interference with Central Discrete Paths**
Seohyun Kim — *Seoul National University of Science and Technology, Korea (South)*
We propose a novel acoustic metamaterial based on Fano resonance, featuring a central double-helix discrete path surrounded by a continuous path for enhanced manufacturability and noise attenuation. The design is validated through theoretical analysis, numerical simulation, and experimental measurement, demonstrating effective noise reduction and practical applicability.

4 **Reconfigurable Wavefront Engineering Based On Timoshenko Beam Theory**
Geon Lee, Junsuk Rho — *Pohang University of Science and Technology, Korea (South)*
This study presents a Timoshenko–Ehrenfest beam-based reconfigurable elastic metasurface, which enables multifunctional manipulation of elastic waves on a single substrate. This system allows easy reconfiguration to achieve various wave phenomena. The Timoshenko–Ehrenfest beam theory is employed for accurate analytical modeling. Both numerical simulations and experimental results validate this analytical approach, demonstrating its significant superiority.

5 **A Novel Model Order Reduction Approach Based on Maximized Localization in Nonlinear Resonator Networks**
Sima Zahedi Fard[1], Paolo Tiso[2], Marc Serra Garcia[1] — *[1] AMOLF, Netherlands [2] ETH Zurich, Switzerland*

Elastic metamaterials show promise for applications in processing information in matter with near-zero energy consumption. The very low energy dissipation in elastic materials has attracted scientists to design diverse microstructured devices. A large network of resonators serves as an excellent platform for designing devices such as information processors, logic gates, and sensors. However, designing highly sophisticated devices requires the development of complex geometries. Traditional finite element methods (FEM) become impractical due to the high number of degrees of freedom involved, especially when capturing the essential nonlinearities that enable device functionality. Linearizing these systems would eliminate their crucial nonlinear behavior, thereby making the devices nonfunctional. Consequently, an efficient and suitable nonlinear dynamic method is essential for effective device design. This research introduces a novel approach for designing heterogeneous nonlinear metamaterials based on maximally-localized basis functions (Wannier functions) combined with a nonlinear coordinate transformation. This method provides an efficient reduced-order modeling technique that facilitates the development of complex elastic microstructured networks.

6 **Dispersion Characteristics and Vibroacoustic Performance Analysis of Nonlinear Locally Resonant Metamaterials**

Régis Boukadia, Wim Desmet, Elke Deckers — *KU Leuven, Belgium*

This contribution proposes a novel method for computing the dispersion curves and band diagrams of nonlinear metamaterials featuring analytical nonlinearities. The proposed method is applied to locally resonant metamaterials with geometrically nonlinear resonators, and their vibroacoustic performance is assessed.

7 **Microlattices with tailored properties as thermoplastic composite sandwich cores**

Camill De Vos[1], Ingmar Pragt[2], David Bal[2], Wessel W. Wits[2], Ruud P.G. Veul[2] — *[1] NLR – Netherlands Aerospace Centre, Netherlands [2] NLR – Netherlands Aerospace Centre, Netherlands*

Carbon microlattices demonstrate potential as substitutes for traditional honeycomb cores in aerospace applications due to their exceptional combination of ultra-low weight, high compression strength and stiffness. Integrating them into thermoplastic composite structures could be one of their first industrial applications. This study demonstrates that composites with carbon core materials can be realised and that carbon microlattices can be produced at a larger scale using commercially available stereolithography and sintering equipment.

8 **Wave propagation in an elastic lattice with nonreciprocal stiffness and damping**

Harshit Kumar Sandhu, Saurav Dutta, Rajesh Chaunsali — *Indian Institute of Science, Bengaluru, India*

Wave control through non-reciprocity enables directional energy localization and asymmetric wave propagation, offering new possibilities for manipulating mechanical waves. This study investigates the combined effects of non-reciprocal stiffness and damping in one-dimensional elastic lattices. While non-reciprocal damping governs wave-number-dependent asymmetry in frequency and attenuation, its combination with stiffness asymmetry leads to remarkable phenomena such as unidirectional amplification accompanied by asymmetric group velocities. Our findings offer new strategies for designing elastic metamaterials with tunable wave propagation and applications in topological mechanics and wave-based technologies.

9 **Electrostriction Control in Metamaterials: Enhancement and Suppression in a Silicon-Based System**

Cumali Sabah[1], Omid Khakpour[2], B. Yang[2], R. Rahighi[2] — *[1] METU NCC, Turkey [2] ,*
Electrostriction in metamaterials is a crucial phenomenon influencing their electromechanical properties. This study investigates the enhancement and suppression of electrostriction in a metamaterial system where silicon (Si) serves as the background medium, and 35 different inclusions are considered. The results indicate that specific inclusions, such as As_2S_3, CuCl, and KI, enhance electrostriction, whereas others like diamond, MgO, and YAG suppress it. Furthermore, we performed the analysis at different frequencies and found that both enhancement and suppression of electrostriction are frequency independent. The findings provide insights into designing tunable metamaterials for advanced applications in optics and photonics.

10 **Time-varying Aubry–André Model: FDTD Simulations**

Takamichi Terao — *Gifu university, Japan*
This study introduces a time-domain model analogous to the localized-delocalized transition in one-dimensional systems. Using the finite-difference time-domain (FDTD) method, the study found no corresponding transition, highlighting that spatial and time-domain correspondences are not always valid.

11 **Temporal Metamaterials In The Space-Harmonic Approach**

Mariana Dalarsson[1], Balwan Rana[1], Victor Pacheco-Pẽna[2] — *[1] KTH Royal Institute of Technology, Sweden [2] Newcastle University, United Kingdom*
In this work, we propose the space-harmonic method to study graded temporal multistepped metamaterials, described using periodic mathematical functions. Exact analytical solutions for the fields are obtained and analyzed. The space-harmonic analysis of temporally periodic metamaterials is the dual of the time-harmonic analysis of spatially periodic metamaterials, previously studied by one of the present authors.

12 **Large Complete Momentum Gaps in Dispersive Media with Temporal Modulation**

Yao-Ting Wang, Yu-Huei Chen — *National Sun Yat-sen University, Taiwan*
This study investigates the formation of large complete k-gaps in Lorentzian media with time-periodic plasma frequency modulation. We identify a substantial k-gap whose width remains nearly unchanged with increasing resonance frequency. Numerical analyses indicate that the k-gap emerges when the modulation frequency approaches the unmodulated plasma frequency. This phenomenon suggests applications in non-Hermitian physics and gain mechanisms.

13 **Topological Temporal Boundary States In A Non-Hermitian Spatial Crystal**

Wenjie Chen — *Sun Yat-sen University, China*
We find that the presence of TTBS is not limited to the temporally periodic systems. A crystal with spatially periodic non-Hermiticity is another mechanism to achieve momentum gaps. Intriguingly, a sudden sign flip of the non-Hermiticity triggers a topological transition for the momentum gap, resulting in the emergence of a TTBS that peaks at the flipping instance. Unlike the traditional TTBS, this phenomenon does not require constantly modulating to material properties, instead it is achieved with a single time-dependent operation: a single flip in non-Hermiticity. Its robustness against perturbation and disorder is demonstrated in both simulations and experiments.

14 **Optical Response By Time-Varying Plasmonic Nanoparticles**

Miguel Verde Ruiz, Paloma Arroyo Huidobro — *Universidad Autónoma de Madrid, Spain*

We study the optical response of plasmonic nanoparticles whose frequency-dispersive permittivity is periodically modulated in time. We show that the modulation gives rise to Floquet replicas of the localized surface plasmon resonance, whose behavior can be described using a two-band model that captures the observed phenomenology while providing analytical insight.

15 **Cross-Phase Modulation via Time-varying epsilon-near-zero metasurface**
Rakesh Dhama, Imran Hossain, Jesse Pietila, Humeyra Caglayan — *Tampere University, Finland*
We demonstrate the cross-phase modulation (XPM) in the time-varying ENZ metasurface for the first time by exciting beyond epsilon near zero region. Our designed metasurface comprised of gold nanostructures designed on ITO film with specific size, shape, and periodicity has been designed to enhance the absorption towards both side of the ENZ window. Our degenerate and non-degenerate ultrafast pump-probe experiments compare the frequency shift via XPM with AFC and report the large tunable and broadband frequency shift up to 65 nm via cross-phase modulation.

16 **Extreme acoustic wave guiding using time varying non-local media**
Fabio Nistri[1], Paolo Beoletto[1], Gregory Chaplain[2], Timothy Starkey[2], Simon Horsley[2] — *[1] Politecnico di Torino, Italy [2] University of Exeter, United Kingdom*
As already demonstrated in acoustics, media with time-varying impedance can enable novel wave manipulation phenomena, such as frequency conversion and temporal scattering. In this work, we show that introducing time-varying non-local couplings in a medium can produce similar wave manipulation effects. By exploiting roton-like dispersion relations resulting from non-local coupling, we achieve extreme wave steering phenomena, including total temporal reflection for wavelengths associated with negative group velocity. In this study, we provide numerical evidence of these phenomena and demonstrate their applicability to non-local systems that support surface acoustic wave propagation.

17 **Shock Waves in Nonlinear Transmission Lines**
Eugene Kogan — *Bar-Ilan University, Israel*
In the first half of the paper we consider interaction between the small amplitude travelling waves (”sound”) and the shock waves in the transmission line containing both nonlinear capacitors and nonlinear inductors. We calculate the ”sound” wave coefficient of reflection from (coefficient of transmission through) the shock wave. These coefficients are expressed in terms of the speeds of the ”sound” waves relative to the shock and the wave impedances. In the second half of the paper we explicitly include into consideration the dissipation in the system, introducing ohmic resistors shunting the inductors and also in series with the capacitors. This allows us to justify the conditions on the shocks, postulated in the first half of the paper. This also allows us to describe the shocks as physical objects of finite width and study their profiles, same as the profiles of the waves closely connected with the shocks - the kinks. The profiles of the latter, and in some particular cases the profiles of the former, were obtained in terms of elementary functions.

18 **Kinetic Inductance Tuning of Superconducting Wire: Towards Tunable ENZ Metamaterial for Dark Matter Search**
Jingan Cai[1], Steven Anlage[2] — *[1] University of Maryland, USA [2] University of Maryland, United States*
We measure and model the kinetic inductance and microwave loss of a thin superconducting

wire for use in a current-tunable ENZ plasmonic metamaterial for dark matter search. A dc current is found to tune the kinetic inductance of a superconducting wire, which enables electronic variation of the plasma frequency of a wire array.

19 **Tailored States of RF SQUID Metamaterials Through Controlled Counter-Disorder**
Jingnan Cai[1], Steven Anlage[2] — *[1] University of Maryland, USA [2] University of Maryland, United States*
We explore the use of artificially-imposed counter-disorder in an attempt to overcome the effects of quenched-disorder and modify the behavior of an rf-SQUID superconducting-metamaterial in a controlled manner. The measurements are performed in a laser scanning microscope to both image the currents in the SQUIDs and perturb the Josephson junctions.

20 **Speeding Up Quantum State Transfer In A Three-Qubit Chain**
Kseniia Chernova[1], Andrei Stepanenko[2], Maxim Gorlach[1] — *[1] School of Physics and Engineering, ITMO University, Saint Petersburg 197101, Russia [2] London Institute for Mathematical Sciences, Royal Institution, 21 Albemarle St, London W1S 4BS, UK*
Efficient state transfer in quantum systems is crucial for advancing quantum communication. We apply the quantum brachistochrone method to find a time-optimal state transfer in a fully connected array of three qubits. By leveraging multi-path interference, we demonstrate that multi-path evolution reduces transfer time compared to the single-path protocols.

21 **Roadmap for focused ion beam technologies**
Katja Höflich[1], Gerhard Hobler[2], Frances Allen[3], Tom Wirtz[4], Gemma Rius[5], Gregor Hlawacek[6] — *[1] Ferdinand-Braun-Institut, Germany [2] TU Wien, Austria [3] University of California, Berkley, USA [4] Advanced Instrumentation for Nano-Analytics (AINA), Luxembourg [5] Institut de Microelectrònica de Barcelona, Spain [6] Institute of Ion Beam Physics and Materials Research, Germany*
Focused ion beams are key to cutting-edge research! They drive analysis, optimize materials or devices and enable sophisticated nanoscale structuring without the need for a mask. This poster presents the roadmap for focused ion beam technologies, combining a comprehensive survey of the field with a future perspective for research and development.

12:30 - 14:00 Poster Session IV (Thursday)
Husly lounge
Chairperson(s): Debapriya Pal

1 **Design Of A Soft Porous Metamaterial For Passive Daytime Radiative Cooling**
Nigar Namazzade, Alexandre Baron — *Université de Bordeaux, France*
Passive daytime radiative cooling occurs when a body cools through thermal radiation without electricity, by backscattering solar radiation and emitting in the atmospheric transparency window. We characterize this using FEM simulations and effective medium parameter retrieval, comparing results with the extended Maxwell-Garnett theory.

2 **Optimization of imaging systems containing metasurfaces using a ray-wave model**
Enzo Isnard[1], Sébastien Héron[1], Mahmoud Elsawy[2], Stéphane Lanteri[2] — *[1] Thales Research & Technology, France [2] Centre Inria d'Université Côte d'Azur, France*
We describe a methodology for optimizing imaging performances of optical imaging systems containing both refractive optical elements and metasurfaces. The modelling of systems is done with a combination of geometrical and Fourier optics to take into account diffraction effects in the computation of the imaging performances. A surrogate model based on the local periodicity approximation is used to calculate the optical response of meta-atoms. System optimization is performed using an evolutionary strategy that takes into account both the distribution of meta-atoms on the metasurface and the geometry of refractive lenses.

3 **Fast Forward Prediction of Metasurface Transmission Spectra Using Deep Learning**
Md Imran Hossain[1], Linzhi Yu[1], Humeyra Caglayan[2] — *[1] Faculty of Engineering and Natural Science, Tampere University, Finland [2] Institute for Photonic Integration, Eindhoven University of Technology, Netherlands*
A neural network miming a conventional numerical simulator like Ansys Lumerical FDTD is presented in this work. The neural network capable of predicting the transmission spectra of gold metasurfaces within the 1200 to 1700 nm region within a couple of milliseconds with 85.27% accuracy. The model is trained with 10,000 simulated data of metasurfaces with varied geometries. The model aims to present a time-efficient method for investigating polarization conversion and vector holography through gradient metasurfaces.

4 **Core-shell nanoresonator arrays to achieve epsilon-near-zero metamaterials**
Dávid Vass, András Szenes, Emese Tóth, Balázs Bánhelyi, Mária Csete — *University of Szeged, Hungary*
Targets seeded with multilayers of periodic passive and active core-shell nanoresonator patterns were studied to create epsilon-near-zero materials. First, the material of the shell was selected in order to achieve near-zero permittivity at the selected wavelength in the passive target. Then, the active material around the core-shell was optimized considering the optical response, near-field enhancement and the effective parameters.

5 **Simple characterization of complex stacking of semiconductors through near field imaging and spectroscopy**
Laure Tailpied[1], Clément Gureghian[2], Frédéric Fossard[3], Jean-Sébastien Mérot[3], Grégory Vincent[1], Thierry Talierco[4], Baptiste Fix[1] — *[1] DOTA, ONERA, Université Paris Saclay, France [2] 1Sorbonne Universit´e, CNRS, Institut des NanoSciences de Paris, France [3] LEM, UMR 104*

CNRS-ONERA, Universit´e Paris Saclay, France [4] IES UMR 5214, Universit´e de Montpellier, France
Here, SNOM imaging and spectroscopy on a mechanically cleaved facet is used to characterize the different layers of a complex epitaxial heterostructures composed of a type II superlattice and heavily doped semiconductor

6 **Photoluminescence Enhancement in a Hybrid Al/Si/Ge Metasurface: Impact of Illumination Spot Size**
Paul Oleynik[1], Diana Ryzhak[2], Jon Schlipf[2], Carlos Alvarado Chavarin[2], Yuji Yamamoto[2], Fritz Berkmann[1], Inga Anita Fischer[1] — *[1] Brandenburgische Technische Universität Cottbus-Senftenberg, Germany [2] IHP–Leibniz Institut für Innovative Mikroelektronik, Germany*
We investigate the µ-photoluminescence signal of a metasurface, using varying illumination spot sizes. Our results indicate that changing the number of illuminated meta-atoms can enable the investigation of finite size effects in one single metasurface as well as provide an additional degree of freedom to engineer the photoluminescence response.

7 **Dielectric Metasurfaces for Generation and Detection of Light Beams Carrying Orbital-Angular-Momentum**
Arttu Nieminen[1], Rizwana Ahmad[2], Harald Haas[2], Humeyra Caglayan[3] — *[1] Tampere University, Finland [2] University of Cambridge, UK [3] Eindhoven University of Technology, The Netherlands*
The work presents the use of orbital angular momentum (OAM) multiplexing to enhance data bandwidth for high-speed data communication. Dielectric metasurfaces are proposed to generate and detect OAM beams, addressing challenges in integrated photonics and facilitating the development of free-space optical communication.

8 **Imprinted Nanocrystalline Lithium Niobate Metasurfaces**
Ulle-Linda Talts, Helena Weigand, Irene Occhiodori, Eleni Prountzou, Elise Bailley, Virginia Falcone, Rachel Grange — *ETH Zurich, Switzerland*
Lithium niobate is a widely used material platform in nonlinear nanophotonics but nanofabrication in this inert material is challenging. Here we present solution-derived lithium niobate for scalable bottom-up nanofabrication with imprint lithography to demonstrate nonlinear resonant and wavefront shaping metasurfaces.

9 **Second Harmonic Generation In GaAs Metasurfaces**
Hugo Pitot-Belin, Baptiste Fix, Patrick Bouchon — *ONERA, France*
Nonlinear effects are useful for the generation light sources in infrared and terahertz . However, these effects are inherently weak. One method of amplifying them is to exalt the electric field in a restricted volume using metasurfaces. This article shows how second harmonic generation efficiency can be increased to 1.3.10-6 W-1 in a thin GaAs metasurface.

10 **High-Quality Silica-Glass 3D-Metamaterials by Two-Photon Grayscale Lithography (2GL)**
Jonathan L. G. Schneider, Jiajie Liang, Mirhan Özdemir, Yi Chen, Alexander Berkes, Jens Bauer, Martin Wegener — *Karlsruhe Institute of Technology, Germany*
We manufacture complex 3D metamaterials and microstructures composed of silica glass using a polyhedral oligomeric silsesquioxane (POSS)-based resist and two-photon grayscale lithography (2GL). The results exhibit optical-grade surfaces and mechanical damping much lower

than polymer structures.

11 **Sharpening Conducting Polymer Plasmonics through Nonlocal Coupling**
Dongqing Lin[1], Yulong Duan[2], Pravallika Bandaru[1], Mohammad Shaad Ansari[1], Alexander Polyakov[1], Janna Wilhelmsen[1], Magnus Jonsson[1] — *[1] Linkoping University, Sweden [2] Linkoping University, Sweden*
Conducting polymers can enable active plasmonics and metasurfaces but typically suffer from large losses. I will show how we address this through nonlocal coupling, leading to dramatically improved quality factor and modulation during redox-switching. I will also discuss the choice of polymers including possibilities with strained polymers with hyperbolic permittivity.

12 **A Low-Cost and Low-Profile 2-bit Metasurface Antenna**
Ge Fan, Hui Dong Li, Jun Yan Dai, Shuo Liu, Jun Wei Wu, Qiang Cheng — *Southeast University, China*
A low-cost and low-profile 2-bit metasurface antenna with attractive beam scanning capability is presented in this work. The antenna element is implemented with four PIN diodes, so as to realize the 2-bit phase shifting. Specifically, by controlling the working states of the PIN diodes, the antenna element obtains four transmission phase states (0°, 90°, 180°, and 270°). Additionally, thanks to the careful design, the metasurface antenna has a profile with only one wavelength. For verification, a metasurface antenna with 10×10 elements is designed and simulated, obtaining a 29.3% aperture efficiency, a 3dB gain bandwidth of 10%, and a beam scanning range up to 60°. The 2-bit metasurface antenna proposed in this paper is potentially competitive in the field of satellite communication and radar systems.

13 **Tunable VO_2 Films for Hyperbolic Metamaterials via In-Situ Reactive Magnetron Sputtering**
Katarína Rovenská[1], Tereza Bačová[2], Filip Ligmajer[3], Thomas Possmayer[4], Manobina Karmakar[4], Leonardo De Souza Menezes[5], Tomáš Šikola[3] — *[1] Brno University of Technology, Central European Institute of Technology, Czech Republic [2] Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Czech Republic [3] Brno University of Technology, Central European Institute of Technology; Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Czech Republic [4] Ludwig-Maximilians Universität München, Faculty of Physics, Nanoinstitute Munich, Chair in Hybrid Nanosystems, Germany [5] Ludwig-Maximilians Universität München, Faculty of Physics, Nanoinstitute Munich, Chair in Hybrid Nanosystems; Universidade Federal de Pernambuco, Departamento de Física, Germany; Brazil*
Hyperbolic metamaterials (HMMs) require tunability for advanced applications. Ag/VO_2 multilayers, fabricated via reactive magnetron sputtering with in-situ heating, achieve reconfigurable optical behavior via the phase transition of VO_2. This transition-driven tunability paves the way for actively controlled HMMs, expanding their application potential in nanophotonics.

14 **Investigating The Potential Of Electro-Optical Tuning Of Circular Aperture-Based Extraordinary Optical Transmission Multilayers**
Hanan Alhesseny, Christian Johnson-Richards, Ross Glyn Macdonald, Noel Healy, Toby Hallam, Victor Pacheco-Peña — *Newcastle University, United Kingdom*
This study examines the design of a multilayered structure made of alternating silver and SiO2 layers having perforated subwavelength holes. In so doing, Extraordinary Optical Transmission peaks are excited. It is then placed on top of Lithium Niobate to explore the tunable properties

of the structure working at telecom wavelengths.

15 **A Flexible Metasurface for MRI Enhancement Based on Flexible Electronic Printing Technology**
Qingdong Cai, Xiaojian Fu — *southeast university, china*
Conventional metasurfaces frequently employ rigid structures, which impede their ability to achieve exceptional conformality and render them more susceptible to damage during bending. We have delved into flexible electronic printing technology for fabrication of flexible metasurface. The flexible metasurface can be adapted to the MRI coil to enhance the SNR.

16 **On the Use of Reconfigurable Metasurfaces in Compressive Sensing Applied to Atmospheric Trace Gas Recognition**
Sebastian Falckenheiner[1], Kim Bui[2], Giampiero Gerini[1] — *[1] Dutch Organization for Applied Scientific Research (TNO) and Eindhoven University of Technology (TU/e), Netherlands [2] Dutch Organization for Applied Scientific Research (TNO) and Delft University of Technology (TU Delft), Netherlands*
In this paper, we propose a reconfigurable metasurface filter in the short-wave infrared band, as an enabling component of a space instrument for atmospheric trace gases detection, based on a compressive sensing approach. Its performance is analysed considering the effect of noise in a typical space instrument configuration. The final results show that the reconstruction possesses de-noising capabilities.

17 **3D printed THz Aplanatic Metalens for Achromatic focusing with High-Resolution**
Jin Chen, Geng-Bo Wu, Chi-Hou Chan — *City University of Hong Kong, Hong Kong*
Inspired by optical metalens, terahertz (THz) metalenses have been developed rapidly in the last decade. Numerous functionalities, such as achromatic focusing and super-resolution imaging, were realized. However, previous works have concentrated on eliminating chromatic aberrations, while accomplishing aberration-free THz metalens in both chromatic and spherical aberration is still a big challenge. In this paper, an aplanatic achromatic THz metalens with a large numerical aperture (NA) of 0.61 is achieved by gradient metamaterials and fabricated by 3D printing. Measured results demonstrate that spherical aberration-free achromatic focusing with a full width at half maximum (FWHM) of about 0.82λ is fulfilled in the range of 0.1THz to 0.6THz.

18 **Distorted OAM Mode Sorting by Diffractive Neural Network**
Cherry Park — *POSTECH, Korea (South)*
Orbital Angular Momentum (OAM) has emerged as a promising candidate for high-capacity optical communication, yet practical OAM demultiplexing remains challenging due to beam misalignment and the complexity of conventional methods relying on bulky diffractive optical elements. To address these limitations, we propose a metasurface-based OAM demultiplexer optimized using Diffractive Neural Networks (DNN). This approach enables the simultaneous demultiplexing of 8 OAM modes while maintaining high accuracy even under beam misalignment and rotation. The proposed method offers a compact and efficient solution, advancing the practical deployment of OAM-based communication systems.

19 **Learning-Based Meta-Optics for Computational Microscopy**
Ipek Anil Atalay Appak[1], Erdem Sahin[1], Christine Guillemot[2], Humeyra Caglayan[3] — *[1] Tampere University, Finland [2] INRIA, France [3] Eindhoven University of Technology, The*

Netherlands
Multi-spectral fluorescence microscopy is crucial for sub-cellular analysis but is limited by chromatic aberration and shallow depth of field (DOF). This work introduces a 4f microscopy-based, end-to-end optimized meta-optics framework that integrates a learning-based reconstruction algorithm to correct aberrations and extend DOF across a broad spectral range.

20 **Light field Microscopy for Snapshot Volumetric Imaging**
Haobijam Johnson Singh[1], Jani Makinen[1], Anil Appak[1], Erdem Sahin[1], Atanas Gotchev[1], Teemu Ihalainen[1], Humeyra Caglayan[2] — *[1] Tampere University, Finland [2] Eindhoven University of Technology, Netherlands*
Light field microscopy offers a scanning-free imaging technique capable of recording volumetric images in a single snapshot with a low light dose making it ideal for capturing dynamics of live biological specimens Integrating with novel meta-optics could potentially enhanced the spatial resolution with extended depth of field.

21 **Dual-Band Angle Insensitive Metamaterial Absorber for Microwave Sensor Applications**
Bahar Ila[1], Ercan Yaldiz[1], Emin Unal[2] — *[1] Konya Technical University, Turkey [2] Necmettin Erbakan University, Turkey*
This work presents an angle-insensitive dual-band metamaterial absorber for microwave sensor applications. The percentage of absorption rates for the proposed MMA at 3.06 GHz and 5.8 GHz are 93.62% and 99.01%, respectively. Also, MMA has been investigated for sensor applications by changing permittivity between 1 and 10. Frequency sensitivity have been obtained 550 MHz at the first resonance and 1 GHz at the second resonance.

22 **Direction-of-Arrival Estimation Based On Radiative Space-Time-Coding Digital Metasurface**
Xiaoyue Shen, Shuang Peng, Qian Yu, Han Zhang, Fei Yang — *Southeast University, China*
A direction-of-arrival (DOA) estimation method based on radiative space-time-coding digital metasurfaces is proposed. Experimental results demonstrate that the proposed method achieves accurate DOA estimation with an error margin of less than 1°, validating its high precision and feasibility, and paving the way for future integrated communication and sensing systems.

23 **Neural Network Based Remote Localiser for Two Objects**
Georgiana Dima, Christopher J. Stevens, Huirui Dai — *University of Oxford, Department of Engineering Science, United Kingdom*
This work presents a neural network-based method for localising two identical objects on a 2D metamaterial array using single-port S11 measurements. A robotic arm was used to automate data collection across all object combinations. Three tasks were demonstrated: single-object localisation, two-object localisation, and classification of the number of objects on the array. The network achieved 100% accuracy for single-object localisation, 99.9% for two-object localisation, and 99.6% for classifying surface states. These results confirm the feasibility of scalable, single-port localisation for multiple objects using machine learning.

24 **Plasmonic structure integrated superconducting BSCCO nanowire single-photon detector compatible with He-ion lithography**

András Szenes, László Pothorcki, Balázs Bánhelyi, Mária Csete — *University of Szeged, Hungary*

Single-photon detection is essential for quantum communication and computing. Superconducting nanowire single-photon detectors (SNSPDs) offer high efficiency and fast response but require cryogenic temperatures, limiting their practical use. This study focuses on BSCCO-based SNSPDs integrated with plasmonic structures to enhance its absorption and improve detection efficiency. By integrating one-dimensional wavelength-scaled periodic plasmonic patterns high detection efficiency is achieved, making these detectors more suitable for real-world applications.

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