DELTA Winter school on Reconfigurable Intelligent Surfaces and Multi-Antenna Backscatter Devices

13-15.2.2023 Ruka Finland

Practical arrangements and how to participate?
See the end of the flyer!

Scope

The general concept of *scattering* may be described as the *redirection of incident electromagnetic energy by an object*. Hence, scattering, diffraction, and reflections are special cases of the same physical process of reradiation of incident electromagnetic energy by a material body. Scattering is traditionally viewed as a natural phenomena of a propagation environment that can be measured, so that the communication protocols can be adapted to it, but not controlled. This traditional view is now becoming obsolete.

A reconfigurable intelligent surface (RIS) is essentially a two-dimensional layer of engineered material whose scattering and absorption properties can be dynamically controlled. An RIS can be *electromagetic metasurface* or it can be an antenna array connected to load modulators. RIS has the potential of revolutionizing the way that wireless communication engineers approach the wireless channel, since it can now be engineered and even real-time controlled to adapt to the needs of communications and sensing applications.

Alternatively, scattering from an object can be dynamically changed to modulate information onto wireless signals. This is the core property of *backscatter devices* that can communicate without a dedicated active transmitter.

This winter school aims at bridging the gap between the antenna and wireless communications communities working in this new exciting area. It first recaps the basics of electromagnetics and communications theory to bring the audience onto the same page, followed by tutorials on metamaterials, anomalous reflectors, and tunable and steerable metasurfaces as well as tutorials on how these systems could be utilized to enhance wireless communications and sensing systems either by shaping the propagation environment or by embedding information to the scattered signals.

Target audience

This winter school is targeted at doctoral students and researchers having background either in electromagnetics (antennas and propagation) or in communications engineering and signal processing. For the participation and learning diary, **2 credit units** (ECTS) are available.

Program

Monday 13.2.2023 (Scandic Rukahovi)

9:00-9:15	Prof. Riku Jäntti: Opening
9:15-10:00	Prof. Ari Sihvola: Basics of electromagnetic waves: propagation, reflection, scattering - Part I
10:00-10:30	Coffee Break
10:30-11:15	Prof. Ari Sihvola: Basics of electromagnetic waves: propagation, reflection, scattering - Part II
11:15-12:00	Prof. Sergei Tretyakov: Metasurfaces and their models - Part I
12:00-16:00	Lunch (12:00 Scandic) + Ski break
16:00-16:45	Prof. Sergei Tretyakov: Metasurfaces and their models - Part II
16:45-17:00	Coffee Break
17:00-18:30	Prof. Ville Viikari: Modelling of single and multi-antenna backscattering systems using scattering parameters and radiation patterns
19:00-21:00	Dinner at Pizzeria Ruka in Ruka village

Tuesday 14.2.2023 (Scandic Rukahovi)

9:15-10:00	Prof. Emil Björnson: RIS: A signal processing perspective with applications - Part I
10:00-10:30	Coffe Break
10:30-11:15	Prof. Emil Björnson: RIS: A signal processing perspective with applications - Part II
11:15-12:00	Prof. Olav Tirkkonen: Coverage area optimized static reflecting surfaces
12:00-16:00	Lunch (12:00 Scandic) + Ski break
16:00-16:45	Prof. Markku Juntti: RIS System Performance and Design
16:45-17:00	Coffee Break
17:00-17:45	Prof. Markku Juntti: RIS Channel estimation
17:45-18:30	Prof. Stephan Sigg: Ambient Intelligence with RIS and backscatter devices
19:30-22:00	Dinner at Royal Ruka (2 km walk)

Wednesday 15.2.2024 (RukaVillage hotel)

9:15-10:00	Prof. Riku Jäntti: Backscatter communications - Part I
10:00-10:15	Coffee Break
10:15-11:00	Prof. Riku Jäntti Jäntti: Backscatter communications - Part II
11:00-12:00	Dr. Dinhtjuy Phanhuy: Orange vision on backscatter communications
12:30	Lunch in restaurant Kuksa

Speakers (in the order of lectures)

Ari Sihvola received the degree of Doctor of Technology in 1987 from the Helsinki University of Technology, Finland (presently Aalto University). Besides working for TKK, Aalto, and the Academy of Finland, he was visiting engineer in the Research Laboratory of Electronics of the Massachusetts Institute of Technology, Cambridge, in 1985–1986. In 1990–1991, he worked as a visiting scientist at the Pennsylvania State University, State College. In 1996, he was visiting scientist at the Lund University, Sweden. He was visiting professor at the Electromagnetics and Acoustics Laboratory of the Swiss Federal Institute of Technology, Lausanne (academic year 2000–01), in the University of Paris 11, in Orsay (June 2008), and in the University of Rome La Sapienza (May–June 2015). His research interests include waves and fields in electromagnetics, modeling of complex media and metamaterials, remote sensing, education in physics and engineering, and history of electrical engineering. He is presently professor in the School of Electrical Engineering at the Aalto University. Ari Sihvola is Vice President of the International Union of Radio Science (URSI), and Life Fellow of IEEE.

Prof. Sergei A. Tretyakov (Fellow, IEEE), received the Dipl. Engineer-Physicist, the Candidate of Sciences (PhD), and the Doctor of Sciences degrees (all in radiophysics) from the St. Petersburg State Technical University (Russia), in 1980, 1987, and 1995, respectively. From 1980 to 2000 he was with the Radiophysics Department of the St. Petersburg State Technical University. Presently, he is professor of radio engineering at the Department of Radio Science and Engineering, Aalto University, Finland.

He worked as visiting scientist, CEA-CESTA (French Atomic Energy Commission research centre), also affiliated with the University of Bordeaux, Laboratory of Wave-Material Interactions, in 1994 (6 months); as visiting professor, Abbe Center of Photonics, Friedrich Schiller University Jena, Germany, June – July 2013, and as visiting professor, Department of Photonics Engineering, Technical University of Denmark, Jan. 2013 – April 2013.

From 2007 to 2013 he was the president of the European Virtual Institute for Artificial Electromagnetic Materials and Metamaterials (Metamorphose VI). Prof. Tretyakov served as Chairman of the St. Petersburg IEEE ED/MTT/AP Chapter from 1995 to 1998.

Ville Viikari received the M.Sc. (Tech.) and D.Sc. (Tech.) degrees (Hons.) in electrical engineering from the Helsinki University of Technology (TKK), Espoo, Finland, in 2004 and 2007, respectively. From 2001 to 2007, he was with the Radio Laboratory, TKK, where he studied antenna measurement techniques at submillimeter wavelengths and antenna pattern correction techniques. From 2007 to 2012, he was a Research Scientist and a Senior Scientist with the VTT Technical Research Centre, Espoo. He is currently a Full Professor and the Deputy Head of the Department with the School of Electrical Engineering, Aalto University, Espoo. His research interests include wireless sensors, RFID, radar applications, MEMS, microwave sensors, antennas for mobile networks, RF-powered devices, and antenna measurement techniques.

Emil Björnson Emil Björnson is a Professor of Wireless Communication at the KTH Royal Institute of Technology, Stockholm, Sweden. He is an IEEE Fellow, Digital Futures Fellow, and Wallenberg Academy Fellow. He has a podcast and YouTube channel called Wireless Future. His research focuses on multi-antenna communications and radio resource management, using methods from communication theory, signal processing, and machine learning. He has authored three textbooks and has published a large amount of simulation code. He has received the 2018 and 2022 IEEE Marconi Prize Paper Awards in Wireless Communications, the 2019 EURASIP Early Career Award, the 2019 IEEE Communications Society Fred W. Ellersick Prize, the 2019 IEEE Signal Processing Magazine Best Column Award, the 2020 Pierre-Simon Laplace Early Career Technical Achievement Award, the 2020 CTTC Early Achievement Award, and the 2021 IEEE ComSoc RCC Early Achievement Award. He also received six Best Paper Awards at conferences.

Olav Tirkkonen is full professor in communication theory at Aalto University, Finland, where he has held a faculty position since 2006. He received his M.Sc. and Ph.D. degrees in theoretical physics from Helsinki University of Technology in 1990 and 1994, respectively.
After post-doctoral positions at UBC, Vancouver, Canada, and NORDITA, Copenhagen, Denmark, from 1999 to 2010 he was with Nokia Research Center (NRC), Helsinki, Finland. In 2016-2017 he was Visiting Associate Professor at Cornell University, Ithaca, NY, USA. He has published some 300 papers and is the

inventor of some 85 families of patents and patent applications which include 1% of all patents declared essential for the first standardized version of 4G LTE. His current research interests are in coding for random access and quantization, quantum computation, and machine learning for cellular networks. He is an editor of IEEE Transactions on Wireless Communications.

Markku Juntti (Fellow, IEEE) received his his Dr.Sc. (EE) degree from University of Oulu, Oulu, Finland in 1997. Dr. Juntti was with University of Oulu in 1992–98. In academic year 1994–95, he was a Visiting Scholar at Rice University, Houston, Texas. In 1999–2000, he was a Senior Specialist with Nokia Networks. Dr. Juntti has been a Professor of Communications Engineering since 2000 at University of Oulu, Centre for Wireless Communications (CWC), where he also serves as Leader of CWC – Radio Technologies Research Unit which leads the Finnish 6G Flagship program. His research interests include signal processing for wireless networks as well as communication and information theory. Dr. Juntti is also an Adjunct Professor at Rice University.

Stephan Sigg is an associate professor at Aalto University in the Department of Communications and Networking. From October 2013 to September 2015, he was with the Computer Networks of Georg-August-University Goettingen, Germany. Before, he was a researcher at TU-Braunschweig, Germany and an academic guest in the Wearable Computing Lab at ETH Zurich. From December 2010 to March 2013, Stephan was with the National Institute of Informatics (NII), Japan, in the Information systems architecture division and a part-time lecturer at Waseda University, Japan. He was a visiting Professor for Distributed Ubiquitous Systems at TU Braunschweig, Germany in the winter term 2010, a PostDoc researcher at the chair for Pervasive Computing Systems of the Karlsruhe Institute of Technology, Germany in 2010 and a PostDoc researcher at the chair for Distributed and Ubiquitous Systems at the TU Braunschweig , Germany from 2008 to 2010. He obtained his PhD (Dr. rer. nat.; 2008) from University of Kassel, Germany where he was with the chair for Communications Technology from 2005 to 2007.

Riku Jäntti is a Full Professor of Communications Engineering and the head of the department of Communications and Networking at Aalto University School of Electrical Engineering, Finland. He received his M.Sc (with distinction) in Electrical Engineering in 1997 and D.Sc (with distinction) in Automation and Systems Technology in 2001, both from Helsinki University of Technology (TKK). Prior to joining Aalto in August 2006, he was professor pro tem at the Department of Computer Science, University of Vaasa. Prof. Jäntti is a senior member of IEEE and member of the editorial board of the IEEE Transactions on Cognitive Communications and Networking. He has also been IEEE VTS Distinguished Lecturer (Class 2016). The research interests of Prof. Jäntti include machine type communications, disaggregated radio access networks, backscatter communications, *quantum communications,* and radio frequency inference.

Dr. Dinh-Thuy PHAN HUY is currently a research project manager in Orange Innovation/Networks entity. She received the degree in engineering from Supelec, in 2001, and the Ph.D. degree in electronics and telecommunications from the National Institute of Applied Sciences of Rennes, France, in 2015. In 2001, she joined France Telecom R&D (now Orange Innovation), Châtillon, France. She led the national French collaborative research projects TRIMARAN (2011-2014) and SpatialModulation (2016-2019). She participated to the following 5G PPP projects: METIS, Fantastic 5G, mmMAGIC and 5GCAR. She is co-inventor of more than 40 patents and the co-author of more than 50 papers. She is the recipient of several awards in France: "Prix Impact Economique des Rencontres du Numérique 2016" from the French National Research Agency, "Grand Prix de l'Electronique du General Ferrié 2018" from the French Society of Electricity, Electronics and Information and Communication Technologies and the "Prix Irène Joliot Curie 2018 – catégorie Femme-Recherche-Entreprise" from the French Ministry of Education and Research. Her research interests include wireless communications and beamforming, time reversal, spatial modulation, backscattering and intelligent reconfigurable surfaces. She is involved in the EU Flagship project on 6G Hexa-x and leads the work package on sustainability and security in RISE-6G EU project on reconfigurable intelligent surfaces for 6G. She is an IEEE senior member. She is a member of the Future Networks community of Orange Experts since 2012, and an Orange Senior Expert since 2022.

Practical arrangements

There is a bulk of hotel rooms and apartments that the organizers have to confirm by Christmas 2022. All rooms/apartments are with a sauna, and capacity of 1 to 3-4 persons (in apartments). Breakfasts will be included, as well as coffee breaks, three lunches and two dinners. ***All the organization costs will be charged from the participating universities*** (and possible other organizations attending) in proportion to the headcounts, as well as their delegates' accommodation costs. All travel costs are directly on the sending organization.

Any possible freetime activities during the lunch-and-ski breaks are on the participant's personal account and up to them.

Because of the costs to your organization, we recommend the potential participants to apply the following procedure:

1) ***Discuss with your supervisor*** to find out if they support your participation both topic-wise and by funding the trip and course arrangements
2) If yes, try to find out if any of your colleagues are going to participate, too, to see if apartment sharing is possible, see the room options below (if not, the organizers will try to fill the apartments, even with students from different universities if necessary)
3) Make a plan for the travel and double-check that you are allowed to execute that. ***It is recommended that you arrive on Sunday Feb. 12 and depart on Feb 15 afternoon.***
4) Register to the winter school at https://forms.office.com/e/D3pWs5gC1a **at latest on December 22, 2022** and make the necessary travel arrangements according to your organization's policies
5) You will be informed on the apartment sharing arrangements in January, and will get the room access code a few days before the event by email

Room rates per person (breakfast included) for three nights (default):
Single room (for lecturers): 333,50€
Double room (very limited!): 187€
Apartment shared by two: 211,50€
Apartment shared by three: 154,50€
Apartment shared by four: 126€

Travel to Ruka

Finnair flies from Helsinki-Vantaa to Kuusamo airport. There are synchronized airport buses from the airport to Ruka after the flight arrival, and from Ruka leaving two hours before the flight departure, price 10€ per direction.

From Oulu and Jyväskylä there are buses to Ruka.

It is also possible to take a train to Oulu, Rovaniemi or Kemijärvi and continue by bus.