UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Giuseppe D'Ambrosio

Student DR number: DR996973

PhD Cycle: XXXVIII
PhD Chairman: Prof. Stefano Russo

PhD program student's start date: 01/01/2023
PhD program student's end date: 31/12/2025

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PhD scholarship funding entity:
Student with UNINA scholarship, Università Federico II, PNRR Partenariato Esteso PE14 RESearch and innovation on future Telecommunications systems and networks (RESTART).

General information

Giuseppe D'Ambrosio received Laurea degree in Telecommunications and Digital Media Engineering in 2022 from Università di Napoli Federico II. He attended a curriculum in applied electromagnetics within the PhD program in Information Technology and Electrical Engineering. He received a grant from Università Federico II under PNRR Partenariato Esteso PE14 RESearch and innovation on future Telecommunications systems and networks (RESTART).

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	How to boost your PhD	Ad hoc course	4	Prof. Antigone Marino - CNR-ISASI – Dipartimento di Fisica, Università degli Studi di Napoli, Federico II	DIETI - ITEE - ICTH - CQB PhD programs
1st	Misure a microonde ed onde millimetriche	MSc course	9	Prof. Claudio Curcio	Università degli Studi di Napoli, Federico II
1st	Academic Entrepreneurship	Ad hoc course	4	Prof. Pierluigi Rippa – Dipartimento di Ingegneria Industriale (DII), Università degli Studi di Napoli, Federico II	DII, Università degli Studi di Napoli, Federico II
1st	Tomografia ed Imaging: Principi, Algoritmi e Metodi Numerici.	MSc course	9	Prof. Angelo Liseno	Università degli Studi di Napoli, Federico II
2nd	Ipertermia e Mezzi di Contrasto per Applicazioni Biomediche a Radiofrequenza	MSc course	9	Prof. Gennaro Bellizzi	Università degli Studi di Napoli, Federico II
2nd	Real and Functional Analysis	MSc course	9	Prof. Anna Mercaldo – Dipartimento di Matematica e Applicazioni, Università degli Studi di Napoli, Federico II	Università degli Studi di Napoli, Federico II

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
2nd	European School of Antennas and Propagation, "Metasurfaces for Antennas"	Siena, Italy	3	20/05/2024 – 24/05/2024	University of Siena
3rd	European School of Antennas and Propagation, "Antenna Synthesis"	Napoli, Italy	3	01/09/2025 – 05/09/2025	Università degli Studi di Napoli, Federico II

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	How to Publish Under the CARE-CRUI Open Access Agreement with IEEE	0.3	Dr. Nino Grizzuti, Eszter Lukacs, Stefano Bianco	CARE-CRUI and IEEE	CARE-CRUI and IEEE
1st	Machine Learning Learning-Enabled Optimization and Synthesis of Metasurface Antenna	0.6	Prof. Zhi Ning Chen, Dr. Peiqin Liu	National University of Singapore	EuCAP
1st	Challenges in Antenna Measurements for Space and Defense Application	0.2	Prof. Manuel Sierra Castañer	Universidad Politecnica de Madrid	Università degli Studi di Napoli, Federico II
1st	Ricerca e Formazione nella Società della Transizione Digitale	1	CINI (Consorzio Interuniversitario Nazionale per l'Informatica)	CINI	CINI
1st	Space-Time Modulated Metasurfaces for Reconfigurable Intelligent Surface Enabled 5G/6G Communications	0.2	Dr. Gangil Byun	Ulsan National Institute of Science and Technology	IEEE AP/ED/MTT North Italy
1st	3D-printing of hybrid structures from Meta-Atoms to dielectrics, metamaterials and antennas	0.4	Prof. Yiannis Vardaxoglou	School of Electronic, Electrical and Systems Engineering, Loughborough University, UK	Università degli Studi di Napoli, Federico II
1st	Simposio Tecnico Scientifico "Una nuova sfida: lo sviluppo della capacità ipersonica" in Accademia Aeronautica di Pozzuoli	2.2	ACCADEMIA AERONAUTICA POZZUOLI	ACCADEMIA AERONAUTICA POZZUOLI	ACCADEMIA AERONAUTICA POZZUOLI
1st	Seminar and visit at the Istituto per il rilevamento elettromagnetico	0.4	Ing. Ilaria Catapano	Istituto per il rilevamento	Università degli Studi di Napoli, Federico II

	dell'ambiente (IREA-CNR), Napoli.			elettromagnetico dell'ambiente (IREA)	
2nd	Antenna Measurement Challenges and Opportunities – the Next Ten Years	0.2	Prof. Olav Breinbjerg	ElMaReCo, Copenhagen, Denmark	Università degli Studi di Napoli, Federico II
2nd	Antenna Diagnostics - Identifying and Understanding Antenna Diseases	0.2	Prof. Olav Breinbjerg	ElMaReCo, Copenhagen, Denmark	Università degli Studi di Napoli, Federico II
2nd	IA e 5G: Tecnologie Abilitanti per la Manutenzione Predittiva	0.2	Francesco Senatore	Artificial Intelligence Monitoring	5G Accademy, Università degli Studi di Napoli, Federico II
2nd	5G & Digital Transformation: A View from an Unconventional Perspective	0.8	Maurizio Irlando, Gabriele Elia	Noovle, TIM Enterprise	5G Accademy, Università degli Studi di Napoli, Federico II
2nd	Regolazione in Tema di Intelligenza Artificiale alla Luce dell'AI Act	1	Elvira Raviele	Ministero delle Imprese e del Made in Italy	5G Accademy, Università degli Studi di Napoli, Federico II
2nd	Generative AI for Software Engineering: Strategies, Impacts and Practical Applications	0.6	Annalisa Di Leva, Cynthia Cuvi, Giulia Favale, Alessio Zoccoli	Capgemini	5G Accademy, Università degli Studi di Napoli, Federico II
3rd	Multibeam Antennas	0.4	Dr. Giovanni Toso	European Space Agency	Università degli Studi di Napoli, Federico II
3rd	PhD Survival Strategies	0.3	Prof. Gabriele Bavota	Università della Svizzera italiana, Lugano, Switzerland Software Institute	Università degli Studi di Napoli, Federico II
3rd	Sovranità digitale cos'è e quali sono le principali minacce al cyberspazio nazionale	0.4	Prof. Roberto Baldoni	Senior Advisor for Technology and Cybersecurity Policy Embassy of Italy in Washington DC	Università degli Studi di Napoli, Federico II
3rd	RESTART Plenary Dissemination Workshop	2.3	RESTART	RESTART	RESTART
3rd	Near-Field Meta-Steering: a Low-Profile Method for Complete Steering of the Beam of Any Fixed-Beam Antenna	0.4	Prof. Karu Esselle	University of Technology, Sydney	Università degli Studi di Napoli, Federico II

3rd	Radar Cross Section Estimation and Measurements	0.8	Dr. Ivan J. LaHaie, Dr. Alessandro Mori, Dr. Lars Foged	KBR, IDS and MVG	Università degli Studi di Napoli, Federico II

Research activities

Giuseppe D'Ambrosio carried out research on the analysis and design of Reconfigurable Intelligent Surfaces (RISs).
His PhD focused on developing a synthesis methodology and strategy for the design of Reflecting Surfaces (RSs), an emerging technology aimed at enhancing electromagnetic coverage in complex urban environments and enabling reflection patterns that strongly deviate from the specular direction of the incident plane wave, while ensuring Side-Lobe Level (SLL) control and beam shaping. The main objective has been to develop a synthesis tool capable of fully exploiting all degrees of freedom of the scattering structure.
Conventional synthesis techniques, that rely on simplified electromagnetic scattering models, often fail to exploit these degrees of freedom, which are essential for the accurate prediction of the RS behaviour and for enabling functionalities such as SLL control, beam shaping, beam-steering, and reconfigurability.
The synthesis of electrically large structures is further complicated by the high computational burden associated with accurate radiative models and the large number of unknowns.
To overcome these limitations, a multi-stage synthesis strategy has been developed accounting for accuracy, efficiency and effectiveness. The initial stages employ simplified models to minimize computational cost and accelerate convergence. More accurate electromagnetic models are gradually introduced, to refine the solutions of the previous stages, by ensuring accurate prediction and effective RS design.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching	Total per year
1st	26	5.3	30	0	61.3
2nd	21	3	34	0	58
3rd	3	4.6	54	0	61.6
Total	50	12.9	118	0	

The total number of credits acquired during the three-year period is 180.9.

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities

PhD Thesis

The PhD thesis investigates computationally efficient and accurate optimization strategies for the synthesis of Reflecting Surfaces (RSs) based on different electromagnetic radiative models. The proposed methodologies enable the design of RSs capable of manipulating electromagnetic waves to satisfy far-field specifications such as beam shaping, beam steering, and Side Lobe Level (SLL) control.

RSs, and especially Reconfigurable Intelligent Surfaces (RISs), have recently attracted significant attention for their potential to improve wireless communication systems by controlling the electromagnetic propagation environment. However, conventional synthesis approaches are generally based on simplified electromagnetic models and limited optimization strategies, often focusing only on beam steering and providing reduced control over the radiated field. Furthermore, the synthesis of electrically large RSs typically involves a high computational burden due to the large number of unknowns and the complexity of accurate electromagnetic models.

To address these limitations, a multi-step optimization strategy is proposed, aiming to achieve a trade-off between computational efficiency and electromagnetic accuracy. The synthesis process starts from simplified radiative models with a reduced number of unknowns, allowing the computation of an initial low-cost solution. Subsequently, the model is progressively refined by introducing more accurate electromagnetic representations and additional degrees of freedom. At each stage, the solution obtained from the previous optimization step is exploited as the initial guess for the following one, improving convergence properties and reducing the risk of local minima. The synthesis strategy is based on a power pattern optimization technique employing mask functions to enforce far-field constraints.

The effectiveness of the methodology is demonstrated through different application scenarios. First, the approach is applied to RSs operating in realistic urban environments, where electromagnetic propagation is affected by obstacles, shadowing, and multipath effects. In this context, the RS is illuminated by a Base Station (BS) through a plane wave, while the reflected field is synthesized to improve coverage in shadowed areas. The designed far-field patterns include flat-top and cosecant-shaped beams to ensure more uniform user coverage.

The initial optimization stages rely on a Phase-Only radiative model, where only the phase distribution is optimized while the amplitude remains fixed, significantly reducing computational complexity. Full-wave electromagnetic simulations confirm the validity of the approach and show satisfactory performance for the co-polarized field components.

The methodology is further extended to anomalous reflection configurations, where the reflected beam is steered toward directions strongly deviating from the specular one. Both one-dimensional and two-dimensional configurations are investigated. In particular, challenging cases involving reflections directed 60 degrees away from the specular direction are considered. While the initial

single-cell Phase-Only model shows limitations in accurately predicting the radiated field, the introduction of macro-cell-based radiative models including multiple Floquet harmonics significantly improves the agreement with full-wave simulations, especially regarding undesired reflections and non-specular contributions.
Comparisons with approaches available in the literature confirm the robustness, effectiveness, and implementation simplicity of the proposed synthesis methodology, even when employing simplified unit-cell geometries with reduced phase ranges.
The activities have been developed in collaboration with the University of Florence and the Polytechnic of Turin.
Future developments will focus on the fabrication and experimental validation of the synthesized layouts, the adoption of more accurate radiative models, and the improvement of the computational efficiency of the optimization procedure.
Additional research activities will investigate the integration of subwavelength elements and electronically controlled components to further enhance the flexibility and reconfigurability of the proposed structures.

Research products

Research results appear in 3 contributions to international conferences and 1 contribution published in international journals.

List of scientific publications

International journal papers

A. Capozzoli, I. Catapano, C. Curcio, G. D'Ambrosio, G. Esposito, G. Gennarelli, A. Liseno, G. Ludeno, F. Soldovieri

Resolution-Enhanced Electromagnetic Inverse Source: a Deep Learning Approach
IEEE Antennas and Wireless Propagation Letters
vol. 22 (12), pp. 2812-2816, 2023, DOI: 10.1109/LAWP.2023.3299224.

International conference papers

A. Capozzoli, I. Catapano, C. Curcio, G. D'Ambrosio, G. Esposito, G. Gennarelli, A. Liseno, G. Ludeno, F. Soldovieri

A Deep Learning Approach to Electromagnetic Inverse Source

24th International Conference on Applied Electromagnetics and Communications (ICECOM)
Dubrovnik (Croatia), September 2023.

International conference papers

S. Ayaz, M. Beccaria, A. Capozzoli, C. Curcio, G. D'Ambrosio, A. Freni, A. Liseno, P. Pirinoli
Phase-Only Synthesis of a Reflecting Surface for Enhancing Coverages in Urban Scenarios
19th European Conference on Antennas and Propagation (EuCAP)
Stockholm (Sweden), April 2025, pp. 1-4, IEEE, DOI: 10.23919/EuCAP63536.2025.10999437.

International conference papers

M. Beccaria, A. Capozzoli, C. Curcio, G. D'Ambrosio, A. Freni, A. Liseno, P. Pirinoli
Phase-Only Synthesis of a Reflecting Surface for Enhancing Coverages in Urban Scenarios
Applied Computational Electromagnetics Society Conference (ACES)
Greece (Thessaloniki), May 2026, pp. 1-2.

Date 06/06/2026

PhD student signature Giuseppe D'Ambrosio

Supervisor signature