



**PhD in Information Technology and Electrical Engineering**  
**Università degli Studi di Napoli Federico II**

**PhD Student: Emanuele Corsaro**

---

**Cycle: XXXIX**

**Training and Research Activities Report**

**Academic year: 2024-25 - PhD Year: Second**

**Tutor: prof. Carlo Forestiere**

**Co-Tutor:**

**Date: November 7, 2025**

# Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXIX

Author: Emanuele Corsaro

## 1. Information:

- **PhD student:** Emanuele Corsaro **PhD Cycle:** XXXIX
- **DR number:** DR997186
- **Date of birth:** 02 March 2000
- **Master Science degree:** Electrical Engineering **University:** University of Naples “Federico II”
- **Scholarship type:** DIETI PRIN
- **Tutor:** prof. Carlo Forestiere
- **Co-tutor:** ----
- **Period abroad:** Advanced Science Research Center, *City University of New York* (Feb 2025 – present)

## 2. Study and training activities:

Activity	Type <sup>1</sup>	Hours	Credits	Dates	Organizer	Certificate <sup>2</sup>
Miniaturization of Optical Spectrometer	Seminar	2	0.4	14/11/2024	IEEE Photonics	Y
Dalla Tradizione all’Innovazione: Il Viaggio Digitale – Sfide e opportunità che la trasformazione digitale può offrire	Seminar	4	0.8	22/11/2024	AEIT	Y
Robust Field-Based Antenna Quality Factor	Seminar	1	0.2	07/04/2025	ASRC CUNY	N
Introduzione ai Circuiti Quantistici	Course	72	9	29/08/2025		Y
Tricking Light with Metamaterials	Seminar	2	0.4	22/09/2025	Microsoft Research Lab	Y
2D Semiconductors: a platform for ultrafast photonics	Seminar	1	0.2	25/09/2025	ASRC CUNY	Y
Colloidal Quantum Dot Superlattice: Towards Optoelectronics Materials	Seminar	1	0.2	27/10/2025	ASRC CUNY	Y
Quality of Services	Seminar	4	0.8	28/10/2025	5G Accademy	Y

1) Courses, Seminar, Doctoral School, Research, Tutorship

2) Choose: Y or N

# Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXIX

Author: Emanuele Corsaro

## 2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	1.2	7	0	8.2
Bimonth 2	0	0	9	0	9
Bimonth 3	0	0.2	9	0	9.2
Bimonth 4	0	0	9	0	9
Bimonth 5	0	0	8	0	8
Bimonth 6	9	1,6	9	0	18.6
<b>Total</b>	9	3	51	0	63
<b>Expected</b>	30 - 70	10 - 30	80 - 140	0 - 4.8	

## 3. Research activity:

My research focuses on Theoretical and Computational Electrodynamics, with particular emphasis on metamaterials, metasurfaces, and nano-optics.

During the first year of my PhD, I concentrated on computational electrodynamics, specifically on the efficient simulation of large-area metalenses. Accurate and fast simulations of metasurfaces and metalenses are essential for understanding their fundamental properties and optimizing their performance. However, achieving both accuracy and computational efficiency is challenging due to the large electrical size and multiscale nature of these structures, which pose limitations to general-purpose numerical solvers. To address this issue, we developed a computational method specifically tailored for the electromagnetic scattering of large metasurfaces. This work led to a manuscript published in *IEEE Transactions on Antennas and Propagation* [P1].

In the second year of my PhD, my research has focused on electromagnetic scattering using equivalent circuit models as the main theoretical framework. In this context, I closely collaborate with Prof. Andrea Alù (City University of New York). We introduced and experimentally validated an analog circuit emulator of Mie scattering [P2]. The emulator employs a modular architecture: the excitation conditions are implemented through generators and filters, while distinct networks of resistors, capacitors, and inductors model material dispersion and radiative properties. We demonstrate a one-to-one correspondence between the powers scattered, absorbed, and extinguished by a dispersive sphere and the power exchanged by different stages of the circuit, thereby achieving a circuit-level realization of the optical power conservation law.

I am also investigating Exceptional Points of Degeneracy (EPDs) in scattering resonances, in collaboration with Prof. Filippo Capolino (University of California, Irvine). EPDs are points in the parameter space of a non-Hermitian system where two or more eigenvalues and their corresponding eigenvectors simultaneously coalesce. Specifically, we explore EPDs in the electromagnetic scattering of a spherical dimer, from the electroquasistatic regime to the fully retarded regime. We derive an equivalent circuit model that is formally equivalent to the Coupled Dipole Approximation (CDA). We demonstrate that perturbations of a single parameter yield the characteristic square-root splitting of the eigenvalues, and we quantify the resulting effects on scattering, extinction, and absorption, highlighting potential implications for sensing.

# Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXIX

Author: Emanuele Corsaro

---

## 4. Research products:

[P1] **E. Corsaro**, G. Miano, A. Tamburrino, S. Ventre, and C. Forestiere, "Multilevel fast multipole algorithm for electromagnetic scattering by large metasurfaces using static mode representation," *IEEE Transactions on Antennas and Propagation*, pp. 1-1, 2025.

**Status:** Published

[P2] **E. Corsaro**, M. Balato, G. Miano, C. Petrarca, A. Alù, and C. Forestiere, "Mie Scattering Analog Circuit Emulator"

**Status:** To be submitted

## 5. Conferences and seminars attended

[C1] **ETOPIM13**: 13<sup>o</sup> International Conference on Elastic, Electrical Transport, and Optical Properties of Inhomogeneous Media (16-20 Jun, New York, NY, USA).

[C2] **SIMONS** Collaboration on Extreme Wave Phenomena Based on Symmetries Annual Meeting (22-24 Oct, New York, NY, USA). **Poster Presentation:** *Mie Scattering Analog Circuit Emulator*.

## 6. Periods abroad and/or in international research institutions

**Host Institution:** Advanced Science Research Center, City University of New York

**Host Supervisor:** prof. Andrea Alù

**Period abroad:** 10 Feb 2025 – present

**Brief Description:** Focused on electromagnetic Scattering developing equivalent circuit models as the fundamental approach.

## 7. Tutorship

---

## 8. Plan for year three

- Extending the equivalent circuit model in [P2] to nonlinear dispersive relation
- **Doctoral Research:** Investigating extreme wave phenomena in linear and non-linear scattering