Marios Mattheakis (Matthaiakis)

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Current Position

2015– **Postdoctoral Research Fellow, Harvard University**

Advisor: Prof. Efthimios Kaxiras

Education

2014 **Ph.D. in Advanced Physics**

Department of Physics, University of Crete, Greece.

Dissertation: Electromagnetic wave propagation in gradient index metamaterials, plasmonic systems and optical fiber networks.
Advisor: Prof. Giorgos Tsironis

2012 **M. Sc. in Computational Physics**

Department of Physics, University of Crete, Greece.

Thesis: Wave propagation in networks of Luneburg lenses.
Advisor: Prof. Giorgos Tsironis

2010 **B. Sc. in Physics**

Department of Physics, University of Crete, Greece.

Thesis: Numerical Methods in Electromagnetism.
Advisor: Prof. Giorgos Tsironis

Research Experience

2015– **Postdoctoral Research Fellow, Harvard University.**

Advisor: Prof. Efthimios Kaxiras
Research Area: Computational Nano-materials

- Predicted extreme wave events and complex spatiotemporal phenomena by using Machine Learning, utilizing the Deep Learning methods LSTM and Reservoir Computing.
- Studied branched electron flow in graphene and other Dirac solids on substrates with disordered charged impurities.
- Developed an effective model for describing the electronic transport in twisted graphene.
- Predicted power spectrums of nonlinear time series by using Deep Learning approaches.
- Developed a method for designing plasmonic metamaterials consisting of graphene and other two-dimensional materials, to provide epsilon-near-zero behavior.
- Investigated quantum plasmons in graphene multilayers with Lithium intercalation.
- Manipulated light polarization with stacking of two-dimensional Black Phosphorus.
- Designed plasmonic waveguides to subwavelength control electromagnetic waves.

2010–2014 **Graduate Research Assistant, University of Crete.**

Advisor: Prof. Giorgos Tsironis
Research Area: Computational Physics

- Investigated electromagnetic wave branched flow in disordered optical networks.
- Observed linear and nonlinear extreme events (rogue waves) in electromagnetic wave propagation through random strong scattering optical networks.
- Designed electromagnetic waveguides with arrangements of metamaterial lenses.
- Implemented gain materials in non-Hermitian plasmonic systems to satisfy Parity-Time symmetry that leads to real eigenvalues and undamped surface plasmon propagation.
- Studied chaotic behavior of systems consisting of coupled superconducting quantum interference devices (SQUIDs).
- Implemented discrete nonlinear Schroedinger (DNLS) equation and observed sub-diffusive wave propagation in random optical networks of coupled fibers.
- Participated in "MARIE-CURIE Excellence Grant entitled: **ELECTRONCOMPLEXITY**".

2008–2010 **Undergraduate Research Assistant, University of Crete.**

Advisor: Prof. Giorgos Tsironis
Research Area: Computational Physics

- Developed Finite Difference in Time Domain (FDTD) and ray-tracing codes.
- Investigated, numerically, Luneburg lens and cloaking devices.
- Studied, numerically, negative refractive index metamaterials.
- Studied the Duffing and anharmonic oscillator nonlinear differential equations.

Teaching Experience

Summer 2014 **Teaching Assistant for "Computational Labs in** MATHEMATICA"

Special course of Prof. David Campbell on nonlinear dynamics.
Summer School in Athens, Greece.

- Responsible for the Labs sessions.
- Instructed students on MATHEMATICA and computational exercises.

Spring 2014 **Teaching Assistant for "Introduction to Programming (FOTRAN)"**

Department of Physics, University of Crete, Greece.

- Responsible for the Labs sessions.
- Instructed students on FORTRAN labs and computational exercises.
- Assisted in grading of homework and exams.

Summer 2013 **Teaching Assistant for "Computational Labs in** MATHEMATICA"

Special course of Prof. David Campbell on nonlinear dynamics.
Summer School in Heraklion, Greece.

- Responsible for the Labs sessions.
- Instructed students on MATHEMATICA and computational exercises.

Spring 2013 **Teaching Assistant for "Electromagnetism I"**

Department of Physics, University of Crete, Greece.

- Assisted in grading of homework and exams.

- Held weekly office hours.

Spring 2011 **Teaching Assistant for "Introduction to Programming (FOTRAN)"**
Department of Physics, University of Crete, Greece.

- Responsible for the Labs sessions.
- Instructed students on FORTRAN labs and computational exercises.

Computational Skills

- Fortran, C, C++, Java
- MATLAB, MATHEMATICA, Python, Linux & UNIX shell scripting.
- COMSOL Multiphysics, Simulink, CST microwave studio.
- LaTeX, Microsoft Office, Open & Libre Office.

Language Skills

Greek Native Speaker
English Excellent

Invited Presentations

Mar 2016 **Seminar of Crete Center for Quantum Complexity & Nanotechnology at University of Crete, Greece.**
Title: *Plasmonic periodic structures composed by 2D materials.*

Sep 2015 **Colloquium in Wesleyan University, Connecticut, USA.**
Title: *Surface plasmons in active systems and 2D materials.*

Conference and Summer School participation

Mar 2018 **APS March Meeting**, Los Angeles, California, USA.
Oral presentation: *Electronic Branched Flow in Graphene: Theory and Machine Learning Prediction.*

Mar 2018 **Workshop on Theory and Computation for Transport Properties in 2D Material**, Minneapolis, Minnesota, USA.

May 2017 **Mathematical Modeling of 2D Materials**, Minneapolis, Minnesota, USA.
Poster presentation: *Epsilon-Near-Zero from plasmonic Dirac point: Theory and realization using two-dimensional materials.*

Mar 2017 **APS March Meeting**, New Orleans, Louisiana, USA.
Oral presentation: *Epsilon-Near-Zero from plasmonic Dirac point: Theory and realization using two-dimensional materials.*

Feb 2017 **Boston Photonics Centennial Conference**, Cambridge, Massachusetts, USA.
Poster presentation: *Epsilon-Near-Zero from plasmonic Dirac point: Theory and realization using two-dimensional materials.*

Jul 2016 **Nanosciences & Nanotechnologies (NN16)**, Thessaloniki, Greece.
Oral presentation: *Epsilon-Near-Zero and Plasmonic Dirac Point by using 2D materials.*

Sep 2014 **COMSOL conference**, Cambridge, United Kingdom.
Poster Presentation: *Enhanced surface plasmon polariton propagation induced by active dielectrics.*

Jul 2014 **Fourth International Workshop on Statistical Mechanics and Dynamical Systems**, Athens, Greece.
Poster Presentation: *Linear and nonlinear photonic rogue waves in complex transparent media.*

Jul 2014 **Fourth European Ph.D. Summer School and Workshop on Mathematical Modeling of Complex Systems**, Athens, Greece.
Poster Presentation: *Linear and nonlinear photonic rogue waves in complex transparent media.*

Jul 2014 **International Conference on Statistical Physics**, organized by SigmaPhi Committee, Rhodes, Greece.
Poster Presentation: *Linear and nonlinear photonic rogue waves in complex transparent media.*

Mar 2014 **Dynamics Symposium**, organized by the Max Planck Institute for Dynamics and Self Organization (Goettingen) on Mandarfen in Austria.

Dec 2013 **Light in Disordered Photonic Media**, organized by the Physikzentrum Bad Honnef, Germany.
Poster Presentation: *Observation of photonic rogue waves in strongly scattering random media.*

Jul 2013 **Third European Ph.D. School on Mathematical Modeling of Complex Systems**, organized by the Department of Physics, University of Crete, Greece.
Oral & Poster Presentation: *Linear optical rogue waves in disordered photonic networks.*

Aug 2012 **Third International Workshop on Statistical Mechanics and Dynamical Systems**, organized by ITAP, Turunc, Turkey.
Poster Presentation: *Luneburg lens waveguide networks.*

Sep 2011 **Nanoantennas and Hybrid Quantum Systems**, organized by the Physikzentrum Bad Honnef, Germany.

Aug 2011 **Charged Particle Optics: Theory and Simulations (CPOT)**, organized by the Department of Physics, University of Crete, Greece.

Jul 2011 **First European Ph.D. School on Mathematical Modeling of Complex Systems**, organized by the Department of Mathematics, University of Patras, Greece.

Professional Activities and Memberships

Reviewer

- Nano Letters.
- Nature Communication.
- ACS Applied Nano-Materials.
- Journal of the Optical Society of America A.
- Journal of Applied Physics.
- Chaos Solitons & Fractals.
- IEEE Journal of Selected Topics in Quantum Electronics.
- International Conference on New Material and Chemical Industry.
- The Scientific Pages of Photonics and Optics.
- European Physical Journal B.
- Optical Material Express.
- Wave Motion, Elsevier.
- Applied Optics.

Memberships

- American Physical Society (APS)

Publications

Published

1. **M. Mattheakis**, G. P. Tsironis, and E. Kaxiras: *Emergence and dynamical properties of stochastic branching in the electronic flows of disordered Dirac solids*. EPL **122**, 27003 (2018). [Link]
2. S. N. Shirodkar, **M. Mattheakis**, P. Cazeaux, P. Narang, M. Soljačić, and E. Kaxiras: *Quantum plasmons with optical-range frequencies in doped few-layer graphene.* Phys. Rev. B **97**, 195435 (2018). [Link]
3. M. Maier, **M. Mattheakis**, E. Kaxiras, M. Luskin, and D. Margetis: *Universal behavior of dispersive Dirac cone in gradient-index plasmonic metamaterials*. Phys. Rev. B **97**, 035307 (2018). [Link]
4. **M. Mattheakis**, G. P. Tsironis, and E. Kaxiras: *Graphene and Active Metamaterials: Theoretical Methods and Physical Properties*, Nanoplasmonics - Fundamentals and Applications, edited by Gregory Barbillon, InTech (2017). [Link]
5. C. A. Valagiannopoulos, **M. Mattheakis**, S. N. Shirodkar, and E. Kaxiras: *Manipulating polarized light with a planar slab of Black Phosphorus* J. Phys. Commum. **1**, 045003 (2017). [Link]
6. O. V. Shramkova, **M. Mattheakis**, G. P. Tsironis: *Amplification of surface plasmons in active nonlinear hyperbolic systems* Proceedings of the 47th European Microwave Conference, 488-491 (2017). [Link]
7. **M. Mattheakis**, C. A. Valagiannopoulos, and E. Kaxiras: *Epsilon-Near-Zero behavior from Plasmonic Dirac Point: theory and realization using two-dimensional materials*, Phys. Rev. B **94**, 201404(R) (2016). [Link]
8. **M. Mattheakis**, I. J. Pitsios, G. P. Tsironis, and S. Tzortzakis: *Extreme events in complex linear and nonlinear photonic media*, Chaos, Solitons & Fractals **84**, 73-80 (2016). [Link]
9. **M. Mattheakis**, T. Oikonomou, M. I. Molina, and G. P. Tsironis: *Phase transition in $\mathcal{PT}$ symmetric active plasmonic systems*, IEEE Journal of Selected Topics in Quantum Electronics **22**, Vol.5 (2015). [Link]
10. **M. Mattheakis**, and G. P. Tsironis: *Extreme waves and branching flows in optical media*, In: J.F.R. Archilla, N. Jimènez, V.J. Sànchez-Morcillo, L.M. Garcìa-Raffi (eds.). Quodons in mica: nonlinear localized travelling excitations in crystals, Springer series in materials science, pp 425-454 (2015). [Link]
11. F. Perakis, **M. Mattheakis**, and G. P. Tsironis: *Small-world networks of optical fiber lattices*, J. Opt. **16**, 102003 (2014). [Link]
12. C. Athanasopoulos, **M. Mattheakis**, and G. P. Tsironis: *Enhanced surface plasmon polariton propagation induced by active dielectrics*, Expert from the Proceedings of the 2014 COMSOL conference in Cambridge (2014). [Link]
13. **M. Mattheakis**, G. P Tsironis, and V. I. Kovanis: *Luneburg lens waveguide networks*, J. Opt. **14**, 114005 (2012). [Link]

Forthcoming/In Preparation

14. M. Maier, **M. Mattheakis**, E. Kaxiras, M. Luskin, and D. Margetis: *Homogenization of plasmonic crystals: Seeking the epsilon-near-zero behavior*. In preparation.
15. G. Neofotistos, **M. Mattheakis**, G. Barbaris, J. Hitzanidi, G. P. Tsironis, E. Kaxiras: *Predicting complex spatiotemporal phenomena with machine learning techniques*. In preparation.