

Andrea Fratalocchi
King Abdullah University of Science and Technology
CEMSE
Email: andrea.fratalocchi@kaust.edu.sa

EDUCATION

Roma Tre University, Rome, Italy, 2003-2007

Ph.D. in Electrical Engineering

Dissertation Title: Energy dynamics in nonlinear optical lattices: from fundamentals to applications

Advisor: Prof. Gaetano Assanto

Roma Tre University, Rome, Italy, 1998-2003

MSc in Electrical Engineering

Dissertation Title: Discrete solitons in nonlinear waveguide arrays realized in liquid crystals

Advisor: Prof. Gaetano Assanto

In Italy we do not have a BS program, the University gives a MSc title after the completion of a 5 years program with no intermediate title.

PROFESSIONAL EXPERIENCE

1 Jul 2016 – present	Associate Professor, CEMSE, KAUST University
11-18 Oct 2015	Visiting Professor, Australia National University, Australia
17-24 March 2014	Visiting Professor, Harvard University, USA
4-12 Dec 2013	Visiting Professor, Harvard University, USA
25-31 May 2013	Visiting Professor, Harvard University, USA
24 Oct 2015 – 2 Nov 2012	Visiting Professor, National University of Singapore, Singapore
7-10 July 2012	Visiting Professor, INRS-EMT, Quebec University, Canada
22 May 2011 – 4 June 2011	Visiting Professor, Cambridge University, UK
14-21 May 2011	Visiting Professor, University of St. Andrews, UK
2011-2016	Assistant Professor, CEMSE, KAUST
2010 – Now	Member of the Complex Energy Consortium
2009-2011	Researcher, Sapienza University, Rome, Italy
2007-2009	Junior Researcher at “Enrico Fermi” research center, Rome, Italy, and Post-Doctoral Researcher at Sapienza University, Rome, Italy

RESEARCHER ID NUMBER

ORCID: 0000-0001-6769-4439

Web of Science Researcher ID: F-1056-2015

SCOPUS: 55926483600

HONORS AND SCHOLARLY AWARDS

Fellow of the Institute of Physics (FInstP), 2019

Senior member IEEE, 2019

Electrical Engineer of the Year 2017, 2017 GCC Enterprise Excellence Awards

Journal of Optics Outstanding Referee Award, 2017, - Awarded for the 'exceptional and outstanding referee activity' for the journal

Entered in the Guinness World Record for developing the "Darkest Material Made by Mankind", 2015.

Nature Exceptional Referee Award (2015) - Awarded for the 'exceptional and outstanding referee activity' for the journal Nature

"Nano-Optics gets practical", Early career focus issue on Nature Nanotechnology for 'the outstanding research on chaotic energy harvesting' (Nat. Nanotech. 10,11, 2015)

European Physics Lett. (EPL) Best Presentation Award (2014) - Awarded to PhD Student J. S. T. Gongora for the work 'Superfocusing properties of disordered plasmonic nanolenses'.

KAUST Dean Award (2014) - Awarded to PhD Student M. Bonifazi (coming from Sapienza University, Rome).

KAUST Dean Award (2013) - Awarded to PhD Student Y. Tian (coming from Leicester University, UK).

KAUST Provost Award (2012) - Awarded to PhD Student J. S. T. Gongora (coming from Sapienza University, Rome).

Nature Exceptional Referee Award (2012) - Awarded for the 'exceptional and outstanding referee activity' for the Nature journal Nature Photonics

'Science in the sand', interview on Nature Photonics due to the 'large number of impressive results obtained at KAUST' (Nat. Photon. 6, 277-278, 2012).

KAUST Provost Award (2011) - Awarded to MS Student L. D. Toth (coming from Cambridge University, UK).

KAUST Fellowship Award (2009-2011) - Awarded 100K USD per year for the research project 'SolarPaint', involving the study of new complexity-driven mechanisms for energy harvesting, with emphasis on photovoltaic and thermodynamics solar.

Research Center Enrico Fermi, "New Talent" Award (2007-2009) - Awarded 30K USD per year for conducting "groundbreaking research on complex systems".

PROFESSIONAL AFFILIATIONS

IEEE (Senior), OSA, IOP (Fellow), SPIE, ACS

PATENTS

Patent WO2015097559 A1, Analytic device including nanostructures (US/EU/Asia), inventors: A. Fratalocchi, J.S.T. Gongora, E. Di Fabrizio, M.L. Coluccio, G. Cuda

OPTICAL ENCRYPTION TERMINAL, CRYPTOGRAPHY KEY DISTRIBUTION SYSTEM AND METHOD OF GENERATING CRYPTOGRAPHY KEYS IN A CRYPTOGRAPHY KEY DISTRIBUTION SYSTEM, Inventors: A. Fratalocchi, V. Mazzone, A. Cruz, A. Di Falco (patent USPTO16132017). A cryptosystem that implements the Vernam cipher by using physically unpredictable patterns of light, generated in CMOS compatible silicon chips. Each chip contains a biometric fingerprint of the user. A commercial demo of this system is currently sponsored by WTT (World Transforming Technology, an international foundation aimed at developing breakthrough technology with global impact).

Light processing Device based on Multilayer Nano-Elements, Inventors A. Fratalocchi, F. Getman, M. Makarenko and A. B. Lopez (US Patent 62/844,416). A 50 nm thick metasurface technology for wavefront engineering with experimental efficiencies exceeding 90% designed by ALFRED (Autonomous Learning Framework for Rule-based Engineering Design), a proprietary artificially intelligent design platform.

Invited Books

Invited Books

[1] J.S.T. Gongora and A. Fratalocchi, "Ab-initio techniques for light matter interaction at the nanoscale", invited chapter submitted for the book "Computational Chemistry Methodology in Structural Biology and Material Sciences", published by Taylor and Francis (2016) [Refereed].

[2] G. Assanto and A. Fratalocchi, "Nonlinear Optical waves in liquid crystalline lattices", invited chapter in the book "Nonlinearities in periodic structures and Metamaterials", Edited by C. Denz, S. Flach and Y. S. Kivshar (2010, Springer) [Referred].

Publications currently in review

[1] A. Di Falco, V. Mazzone, A. Cruz and A. Fratalocchi, Perfect secrecy cryptography requiring no confidential information on classical channels via silicon photonics chips, Nature (in second review).

[2] Controlling broadband light in 10 nm-thin transparent oxides, G. Favraud, M. Bonifazi, V.

Mazzone, Y. Tian, V. Adamo, A. Adamo, L. Liu, Y. Han, E. H. Sargent and A. Fratalocchi, Nature Nanotech (Second review)

[3] Enhanced photoelectrochemical water-splitting performance and stability by the bifacial design decoupling light harvesting and catalysis, Hui-Chun Fu, Purushothaman Varadhan, Meng-Lin Tsai, Wenjie Li, Qi Ding, Marcella Bonifazi, Andrea Fratalocchi, Song Jin and Jr-Hau He, Nature Energy (First Review)

[4] M. Bonifazi, V. Mazzone, Y. Tian, N. Li and A. Fratalocchi, “Free-electron transparent metasurfaces with controllable losses for broadband light manipulation with nanometer resolution”, Adv. Mat. (Second Review).

[5] Ronghui Lin, Valerio Mazzone, Nasir Alfarij, Xiaohang Li, Andrea Fratalocchi, “Controlling disordered nanolasers via hyperuniform structures”, Laser and Photonics Review (Second Review).

Published Article List

See [here](#) from Scopus database

Research Highlights

[1] A. Fratalocchi, “Mode Locked Lasers: Light Condensation”, Nature Photonics **4**, 502 (2010).

[2] A. Fratalocchi, “Anderson Localization: the role of Quantum symmetries”, Nature Photonics **7**, 271 (2013).

[3] M. Sciamanna, “Chaos aids energy storage”, Nature Photonics **7**, 430–431 (2013). [research news and views on our NPHOT paper on chaotic energy harvesting]

[4] A. Fratalocchi, “Nano-optics gets practical”, Nature Nanotech. **10**, 11 (2015).

[5] A. Moscatelli, “Curved space for fast analysis”, Nature Nanotech. **14**, 100 (2019) [research highlights on our NCOMM paper on warped space materials]

[6] Nature Photonics (2019) [to appear]

CONFERENCE PRESENTATIONS

Invited Speaker

Selected Personal Invited

[1] A. Fratalocchi. Machine learning metamaterials with 98% experimental efficiency and 50 nm thickness for broadband vectorial light control. Invited Talk. Artificial Intelligence in nanophotonics (IWANN workshop), Spain, June 2019.

- [2] A. Fratalocchi. Optical neurocomputing with Anapoles. Invited Talk. METANANO. St. Petersburg, Jul, 2019.
- [3] A. Fratalocchi. Complex materials created by warped spaces for energy harvesting, bio-imaging, and broadband light control at the nanoscale. META 2019. Lisbon, Jul, 2019.
- [4] A. Fratalocchi. Controlling light via nanoscale oxides. Keynote Talk. METANANO. Sochi, Aug. 2018.
- [5] A. Fratalocchi. Evolutionary Photonics. Plenary Talk, META 18, Jul 2018.
- [6] A. Fratalocchi. Applications of complex photonics. Invited lecture at ITMO Doctoral school on nanophotonics 2018. June 2018.
- [7] A. Fratalocchi. Evolutionary Photonics and the imitation game of Nature, Honorary presentation at the Schrödinger Colloquium, University of Zurich, Switzerland. Nov. 2018.
- [8] A. Fratalocchi. Towards Photonics "Dark matter": Anapole integrated lasers, SPIE Optics and Photonics Congress, 6-10 Aug. 2017 in San Diego, CA, USA.
- [9] A. Fratalocchi. Epsilon near zero Photonics for Photocatalysis and record efficient Photovoltaics, Discrete, Nonlinear and Disordered Optics (08 - 12 May 2017), Max Plank Institute, Germany.
- [10] A. Fratalocchi. Anapole Nanolasers, META'17, the 8th International Conference on Metamaterials, Photonic Crystals and Plasmonics, Incheon - Seoul, South Korea July 25 – 28, 2017.
- [11] A. Fratalocchi. Complex Epsilon Near Zero metamaterials, The 8th International Conference on Surface Plasmon Photonics, May 22-26, 2017 Taipei, Taiwan
- [12] A. Fratalocchi. Engineering complex nanolasers: from spaser quantum information sources to near-field anapole lasers, Photonics WEST, 28 January - 2 February 2017, San Francisco (US)
- [13] A. Fratalocchi, Dark chameleon nanoparticles for lasing and water purification, META 2016, 25-28 July, Spain.
- [14] A. Fratalocchi, Dark metamaterial lasers, Disorder, Interactions, Turbulence and Wave Dynamics: Fundamentals and Applications, 2-6 May 2016, Turkey.
- [15] A. Fratalocchi, Femtosecond dynamics of the spaser and "dark" metamaterial lasers, Nonlinear waves - Theory and Applications, June 2016, Beijing, China.
- [16] A. Fratalocchi. Evolutionary photonics, CHAOS 2016 (<http://www.cmsim.org>), London, May 23-26 2016.
- [17] A. Fratalocchi, Evolutionary Photonics technologies and nanomaterials for energy harvesting and lasing, Energy, Materials and Nanotechnology workshop on Quantum Technology, April 2016, Thailand.

- [18] A. Fratalocchi, Evolutionary Photonics: a review of recent results. Year-of-light Conference Photonics Middle East, Dec. 2015, Qatar.
- [19] A. Fratalocchi, Disordered black-body lasers and neuromorphic metamaterials, Asia Communications and Photonics Conference 2015 (ACP 2015), Hong-Kong, Nov. 2015.
- [20] A. Fratalocchi, Evolutionary Photonics, NANOMETA15, Seefeld, Austria, 4-8 Jan. 2015.
- [21] A. Fratalocchi, Evolutionary Photonics: from chaotic energy harvesting to black-body lasers, Energy, Material and Nanotechnology on optoelectronics, April 11-14 (2015), Beijing, China.
- [23] A. Fratalocchi, Evolutionary Photonics: dark nanomaterials for energy harvesting, Energy, Material and Nanotechnology on quantum technologies, April 24-27 (2015), Beijing, China.
- [24] A. Fratalocchi, Evolutionary Photonics with a twist, PIERS 2015 Prague, July 6-9 Czech Republic.
- [25] A. Fratalocchi, Dark nanolasers, Nonlinear Photonics: Theory, Materials, Applications, 29 June - 02 July, 2015, St. Petersburg, Russia.
- [26] A. Fratalocchi, Black-body lasers, The Annual Laser Physics Workshop 2015, Shanghai, China, August 21-25, 2015.
- [27] A. Fratalocchi, Dark metamaterials, 5th Annual World Congress of Nano Science and Technology, September 24-26, 2015, Xian, China.
- [28] A. Fratalocchi, Complexity-Driven Photonics, The Nonlinear Meeting 17-22 May 2014, Edimburg, UK (This conference has selected the 50 most famous nonlinear scientists in the world)
- [29] A. Fratalocchi, When disorder is just right, META-14, 20-23 May 2014, Singapore.
- [30] A. Fratalocchi, Complex Optics, Laser Optics 2014, 30 June- 4 July 2014, St. Petersburg.
- [31] A. Fratalocchi, Complexity-Driven architectures for light, IEEE Photonics Conference, 12-16 October 2014, San Diego, CA (USA).
- [32] A. Fratalocchi, A brief lecture on light and complexity, Advances in Nonlinear Photonics, 29 Sep.-3 Oct. 2014, Minsk, Belarus. **[Plenary Talk]**.
- [33] A. Fratalocchi, dispersive shock waves in Schrodinger systems with random and high order nonlinear effects, The Eighth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, March 25-28, 2013 Georgia Center for Continuing Education University of Georgia, Athens, GA, USA.
- [34] A. Fratalocchi, Disordered driven Photonics, Photonics North 2013, Ottawa, June 3-5, Canada.
- [35] A. Fratalocchi, Enlightening complexity, CLEO Europe, 12-16 may 2013, Munich, Germany.
- [36] A. Fratalocchi, Complex Photonics: getting inspiration from Nature, Photonica 2013, 24-28 August, Belgrade, Serbia.

Complete list of conferences

See attached file from scopus

RESEARCH FUNDS

Multifunctional floating water desalination device for solar energy harvesting and carbon negative technologies. Funding Agency: Avina Foundation and PERA Complexity. PI: Andrea Fratolocchi. Co-Pi: C. Aegerter (University of Zurich, Switzerland). 1 June 2019-30 May 2022. Awarded 750000 USD.

Photonics of Chiral Nanostructures. Funding Agency: KAUST. Principal Investigator: Andrea Fratolocchi; Co-Investigator: F. Capasso (Harvard University, USA). 1 Apr 2017 - 31 March 2020. (Awarded 1.05M USD, 3 years, my portion 630000 USD).

Multipurpose nano spectroscopies with spatial and temporal control through adiabatic compression and localization of surface plasmon polaritons. Funding Agency: Kaust. Principal Investigator: Enzo di Fabrizio; Co-Investigators: A. Fratolocchi, Matthias F. Kling (Ludwig Maximilians Universität München (LMU), Germany). 1-March-2015/28-Feb-2018 (Awarded \$1.5M, my portion 200000 USD).

Optics and Plasmonics for efficient energy harvesting. Funding Agency: Kaust. Principal Investigator: Andrea Fratolocchi; Co-Investigators: Osman Bakr, Federico Capasso (Harvard University, USA). 1-Sep-2012/31-Aug-2015 (Awarded \$1.5M, my portion 350000 USD).

Dispersive shock waves in complex systems. Funding Agency: Italian Government PRIN project No. 2009P3K72Z. Principal Investigator: Stefano Trillo (Ferrara University, Italy); Co-Investigators: A. Fratolocchi, F. Baronio (Brescia University, Italy), C. Conti (Sapienza University, Italy). 2011-2013 (Awarded \$350K).

TEACHING EXPERIENCE (2011-Now)

Instructor. EE 391D Advanced Concepts in Photonics, Spring, KAUST University. The course introduces the field of Photonics, from discrete to integrated structures. Courses details and lecture notes are found at <http://www.primallight.org>.

Instructor. EE 231 Optics, Fall, KAUST University. The course introduces the field of Optics, from diffraction to waveguides and resonators. Courses details and lecture notes are found at <http://www.primallight.org>.

Instructor. EE 233 Photonics, Spring, KAUST University. The course introduces the field of Photonics, from discrete to integrated structures. Courses details and lecture notes are found at <http://www.primallight.org>.

PROFESSIONAL SERVICE

Editorial Activity

Editor of Nature Scientific Reports, the online Journal of Nature Publishing Group.

REVIEWER FOR JOURNALS

1. Nature Photonics
2. Nature Physics
3. Nature Comm.
4. Nature Materials
5. Science
6. Science Advances
7. Joule
8. Light Science and Applications
9. Advanced Materials
10. Physical Review Letters/X/A/B/E
11. ACS Photonics
12. NanoLetters
13. Optics Letters/Optics Express
14. Journal of Optics A/B
15. Europhysics Letters
16. Evaluator expert of the European Commission for ERC Grants, the Velux Stiftung Science Foundation (Switzerland), the Marie Curie EU Fellowship.
17. Evaluation expert under contract for the Project Agency at the German Aerospace Center (DLR).

RESEARCH SUPERVISED

Supervision at KAUST		
Primary Supervision - Masters	Primary Supervision – PhD	Post Doc Supervision
Completed: 7 In Progress: 1	Completed: 5 In Progress: 7	Completed: 1

ALUMNI

PhDs

C. Liu. Research Fellow at Metamaterial Center, Birmingham University, UK. Now LMU Fellow/Humboldt Fellow (Prof. Stefan Maier), LMU University, Munich, Germany.

J. S. T. Gongora. Helena Normaton research Fellow at Sussex University UK.

M. Bonifazi. Post Doctoral Researcher at University of Zurich, Switzerland.

V. Mazzone. Post Doctoral Researcher at University of Zurich, Switzerland.

Y. Tian. Research Fellows at Sussex University, UK.

MSs

L. D. Toth. PhD at EPFL (Switzerland).

E. D. Morales. PhD at EPFL (Switzerland).

A. M. V. Faez. ARAMCO (Saudi Arabia).

D. Brambila. PhD at Max-Borne Institute (Germany).

Yi Tian. PhD at KAUST.

A.Mirigaldi. PhD at Politecnico di Torino (Italy).

D. di Stefano. PhD at Fraunhofer Institute (Germany).

A.Marruzzo. PhD at Sapienza University (Italy)

Y. Khan. PhD UC Berkley (US).

Postdocs

G. Favraud. Research Fellow at Harvard University (US).