

Science Meeting – Scientific Report

Scientific report (one single document in WORD or PDF file) should be submitted online within two months of the event. It should not exceed seven A4 pages.

Proposal Title: Complex Nanophotonics Science Camp

Application Reference N°: 4474

1) Summary (up to one page)

The Complex Nanophotonics Science Camp took place from 27-30th of August 2013. It has brought together a generation of early career scientists (strictly <10 years from Ph.D.) working in this exciting research area, at the boundaries between nanophotonics, biophotonics and complexity science.

Scientific Summary:

The workshop has helped the community that investigates light propagation, localization and its nano-scale interaction with quantum emitters in complex photonic and biological media, which is not represented anymore by a dedicated conference, to come together and discuss the state-of-the-art of the field and the future development. We gathered a new generation of scientists engaging with the topics of complex nanophotonics which is emerging from different fields, from single-molecule nano-optics to biomedical imaging and sensing, from quantum networks to light management for solar cells, from Anderson localization of light to high sensitive biosensing.

The Complex Nanophotonics Science Camp discussed latest progress, future developments and facilitate the formation of a community driven by the next generation of junior scientists linked by the common passion for complexity and nano- and biophotonics, by giving them visibility and building a contact network around them.

We have chosen the format of a “science camp”, mixing traditional presentations with more unconventional format, to break from the traditional conference format, which are often showcases of career-long investigations, to try to engage the creativity of early-stage scientists and create new scientific connections, fostering critical thinking. For this reasons we have chosen a long poster session to prepare for evening debates on science-related topics like science communication, and open access and social media for science.

Scientific program:

Nanophotonics has developed a very strong bottom-up approach by shaping optical fields down to the near-field, which, among many phenomena, allows for very efficient bio-sensing. Plasmonic nanoantennas, dielectric Mie scatterers, oligomers are examples of relatively simple up to increasingly complex systems that are well covered by a range of conferences. Nanostructured dielectrics, plasmonic antennas arrays and photonic networks, just to mention a few, escape this reductionist approach, and can be fully understood only in their collective behavior. Complex nanophotonic systems deal with strong light-matter interaction on a scale that goes beyond these simple devices, bringing emerging properties to macroscopic assemblies and real-life devices. Optics of fractal, chaotic modal statistics, long-range correlation, for example, build on the nanoscopic light-matter interaction to construct phenomena that reach the mesoscopic and macroscopic scale. These systems hold promise in applications such as biosensing, imaging, light management for solar cells, transparent electrodes for LEDs and optoelectronics.

2) Description of the scientific content of and discussions at the event (up to four pages)

In the past years the number of fields influenced by photonics and nanophotonics increased steadily. And the boundaries between what is considered to be nanophotonics and what is not became more and more fuzzy and difficult to define. Nowadays disciplines like biophotonics, plasmonics, bio-sensing, optical imaging, quantum nanophotonics etc. are deeply interconnected with each other. And the tendency is to go in the direction of increasing the interdisciplinary research.

In this novel landscape a new generation of scientists is now emerging, carrying the necessity to rethink the traditional conference format, which are often showcases of career-long investigators. The Complex Nanophotonics Science Camp is meant to break with the conventional schemes to engage the creativity of early-stage scientists and create new scientific connections, fostering critical thinking.

The scientific scope of the meeting was very open and covered various field linked by nanophotonics and complexity [see program in Annex]. We also engaged with companies, directly such as Digital Science (CEO present) and Nature (editor present) as well as indirectly, as for example by sponsoring the best talk and poster prize (Philips) and giving travel grants (nanophotonics4energy.eu). In addition, an artist Nedyalka Panova was also present who enjoyed the inspiration of the meeting and contributed with a renewed enthusiasm.

The keynote speakers discussed quantum coherence, digital holography and forces in complex electromagnetic field that are active research topics.

The invited and contributed presentations engaged on emerging research directions, such as bio-sensing and imaging in complex media, nano-optics of complex media and the interaction of electric and magnetic dipoles, light propagation and localisation in complex media, quantum-optics of complex media for random lasing and photonic chips, complex photonic materials and bio-compatible one.

Every day has been concluded by an evening open debate on science-related topics like science communication, digital tools for science or open access and social media for science. The first on Science & Media, in which Kosmas Tsakmakidis shared his personal experiences as a scientist and editor at Nature Materials and answered questions about scientific publishing. Ad Lagendijk offered his tips on how to survive a

career in science and shared his thoughts on the role of publishers, media, and internet in science. The second debated focused on Digital Tools for Science in the Network Era, when Kostas Repanas talked about collaborative research in the digital era, while Timo Hannay discussed Digital Science and the role of software and applications that change the way science is done.

3) **Assessment of the results and impact of the event on the future directions of the field (up to two pages)**

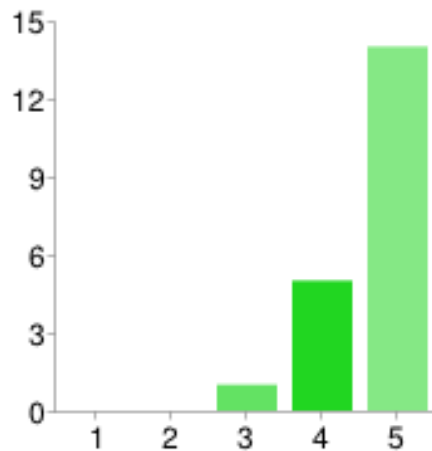


Figure 1. Answers to “Which is your overall rating of the experience?”

From the response of the participants and our own experience as organisers we conclude that the workshop has been a great success. There was something new for everyone, and the enthusiasm generated by the variety of work presented was evident in the vibrant discussions and poster sessions. The evening debates were also a success - discussions on the morality behind scientific integrity, open access and the relationship between art and science were taken to the bar and went on long into the night.

An online questionnaire has been filled by 40% of the participants, which shows that all of them liked the event and the strict limit (<10 years from Ph.D.) for the speakers, with 75% of the participant giving the maximum satisfaction score of 5/5 (see graph Fig 1).

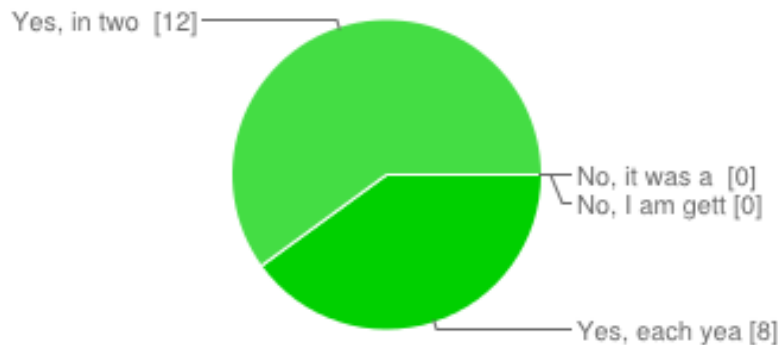


Figure 2. Answer to “Would you like to see another Science Camp?”

At the question “Would you like to see another Science Camp?” we got 100% positive reply, with 60% of the preferences for a bi-annual meeting.

A news article has been written and it will be distributed in the EBN newsletter in King’s College London, as well as in on line blogs and website (sapienzalab.org, <http://phyweb.phys.soton.ac.uk/muskens/>, etc...)

A podcast and a Prezi presentation are almost completed. They gather various interviews that have been done by Ankita Airban, an undergraduate student at King’s College London, to report the outcome of the meeting.

A link to the preliminary podcast is here:

<https://docs.google.com/file/d/0By1gNhhjBsPCMTDdKY3NEY25BLWs/edit?usp=sharing>

In order to foster new ideas and collaborations as a result and to help to build a community in this area a linkedin group has been funded, <http://www.linkedin.com/groups/Complex-Nanophotonics-5159241>, which has already 39 members and active discussions.

Impact of the event on future directions of the field.

The Science Camp has brought together a generation of early career scientists in an informal and constructive atmosphere. The event has given people a sense of community around the theme of complex nanophotonics, a topic that was originally dispersed over different fields. At the workshop several emerging directions have been identified which will expand in coming years, such as in particular: wavefront shaping and imaging in complex biological media, quantum effects in nanophotonic systems, transport through complex environments and the persistence of coherent phenomena in noisy environments, and optical forces and nonlinearity.

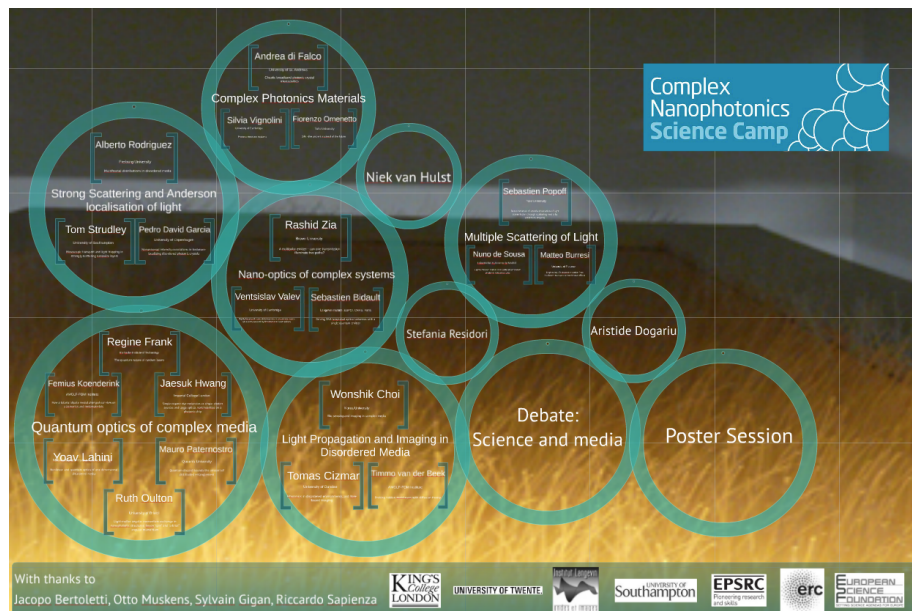


Figure 3. Preliminary Prezi presentation of the workshop

Many of the early career participants at the Science Camp will be shaping the field in years to come; already the Science Camp has helped in generating new links and collaborations between individuals and research teams that will lead to increased activity and visibility of the field. It is expected that the active community will help the complex nanophotonics theme to gain recognition at other conferences. In particular we expect that this may be given form through new sessions at leading conferences introduced by participants of the Science Camp.



Figure 4. Group photo at the workshop

4) Annexes 4a) and 4b): Programme of the meeting and full list of speakers and participants

Annex 4a: Programme of the meeting

Programme of the meeting

Tuesday 27 August

14.30 - 15.30 Keynote talk: Niek van Hulst (ICFO, The Institute of Photonic Science)

15.30 - 16.00 Nano-optics of complex systems

15.30 Rashid Zia (Brown University) - A Multipolar Emitter: Can 1 Transition Illuminate 2 Paths?

16.00 Coffee break

16.30 Sebastien Bidault (Institut Langevin) - Driving DNA templated optical antennas with a single quantum emitter

16.50 Ventsislav Valev (University of Cambridge) - Highly localized nano-deformations in plasmonic nano-structures caused by femtosecond laser pulses

20.45 - 22.00 Evening debate Everything you always wanted to know about scientific publishing, but were afraid to ask. With Kosmas Tsakmakidis (editor of Nature Materials) and Ad Lagendijk (AMOLF)

Wednesday 28 August

09.00 - 10.20 Light propagation and imaging in disordered media

09.00 Tomas Cizmar (University of St. Andrews) - Photonics in disordered environments and fibre based imaging

09.30 Wonshik Choi (Korea University) - Bio-sensing and imaging in complex media

10.00 Timmo van der Beek (AMOLF) - Probing hidden multilayers with diffusion theory

10.20 Coffee break

11.00 - 12.10 Strong scattering and Anderson localization of light

11.00 Alberto Rodriguez (Freiburg University) - Multifractal distributions in disordered media

11.30 Tom Strudley (University of Southampton) - Mesoscopic transport and light trapping in strongly scattering nanowire layers

11.50 Pedro David Garcia (University of Copenhagen) - Nonuniversal intensity correlations in Anderson-localizing disordered photonic crystals

14.30 - 15.30 Keynote talk: Stefania Residori (Institut Non Lineaire de Nice)

15.30 - 16.15 Poster pitches (~1 min. each)

16.15 - 16.45 Coffee break

16.45 - 19.15 Poster session (with drinks and refreshments)

20.45 - 22.00 Evening debate Open session/ Dj session

Thursday 29 August

09.00 - 12.00 Quantum optics of complex media

09.00 Femius Koenderink (AMOLF) - How a tutorial dipole model changed our view on plasmonics and metamaterials

- 09.30 Regine Frank (Karlsruhe Institute of Technology) - The Quantum Nature of Random Lasers
- 10.00 Jaesuk Hwang (Imperial College) - Single organic dye molecules as single photon sources and large optical nonlinearities on a photonic chip
- 10.30 - 11.00 Coffee break
- 11.00 Mauro Paternostro (Queen's University Belfast) - Quantum discord bounds the amount of distributed entanglement
- 11.20 Ruth Oulton (University of Bristol) - Light-matter angular momentum exchange in nanophotonic structures: beyond "spin" and "orbital" angular momentum
- 11.40 Yoav Lahini (MIT) - Nonlinear and quantum optics of one dimensional disordered media

14.30 - 15.30 Keynote talk: Aristide Dogariu (CREOL)

16.00 - 17.00 Multiple scattering of light

- 16.00 Nuno de Sousa (Universidad Autónoma de Madrid) - Light emission statistics in correlated random photonic nanostructures
- 16.20 Sebastien Popoff (Yale University) - Demonstration of a tenfold variation of light transmission through scattering media by wavefront shaping
- 16.40 Matteo Burrelli (European Laboratory for Non-linear Spectroscopy) - Engineering 2D photonic disorder: from incoherent transport to interference effects

20.45 - 22.00 Evening debate Digital tools for science in the network era. With Kostas Repanas (Project Manager & Managing Editor, Joint Council Office, A*STAR Singapore) and Timo Hannay, (Managing Director, Digital Science, Macmillan Publishers Ltd.)

Friday 30 August

09.00 - 10.30 Complex photonics materials

- 09.00 Andrea Di Falco (University of St. Andrews) - Chaotic broadband photonic crystal microcavities
- 09.30 Silvia Vignolini (Cambridge University) - Photonic Structures in Plants
- 10.00 Fiorenzo Omenetto (Tufts University) - Silk –the ancient material of the future

11.00 - 12.00 Closing remarks and prize awarding

Annex 4b: Full list of speakers and participants

Prof. CHOI Wonshik Korea University
Dr. DI FALCO Andrea University of St. Andrews
Prof. DOGARIU Aristide University of Central Florida, CREOL
Dr. FRANK Regine Karlsruhe *Institute of Technology*
Dr. HANNAY Timo Digital Science
Dr. HWANG Jaesuk Imperial College
Prof. KOENDERINK Femius AMOLF
Prof. LAGENDIJK Ad AMOLF / University of Twente
Prof. OMENETTO Fiorenzo Tufts University
Dr.. REPANAS Kostas A*Star
Dr. RESIDORI Stefania INLN, CNRS
Dr. RODRIQUEZ Alberto Freiburg University
Dr. TOMAS Cizmar University of St. Andrews / University of Dundee
Dr. TSAKMAKIDIS Kosmas Nature Materials
Prof. VAN HULST Niek ICFO
Dr. VIGNOLINI Silvia University of Cambridge
Prof. ZIA Rashid Brown University
Dr. ABB Martina University of Southampton
Ms. AINRBAN Ankita King's College London
Dr. BIDAULT Sebastien Institut Langevin ESPCI / CNRS
Dr. BOWMAN Richard University of Cambridge
Dr. BRUCK Roman University of Southampton
Dr. Garcia Pedro David Niels Bohr Institute, University of Copenhagen
Mrs. DE MEDOZA Adriana Universidad de los Andes
Dr. DE SOUSA Nuno Universidad Autonoma de Madrid
Dr. DEVARAPU Chinna University fo Exeter
Mr. GAIO Michele King's college
Dr. KARADEMIR Ertugrul Bilkent University
Dr. LOPEZ-GARCIA Martin University of Bristol
Mr. DE ROQUE Pablo ICFO
Dr. MAHDAVI Ali University of Erlangen
Dr. MATTEO Burrese LENS / University of Florence
Ms. NEDYALKA Panova
Dr. NUNEZ-SANCHEZ Sara University of Exeter
Dr. OSORIO Clara AMOLF
Dr. OULTON Ruth University of Bristol
Mr. PASTORELLI Francesco ICFO
Dr. PATERNOSTRO Mauro Queen's University Belfast
Dr. POPOF Sebastien Yale University
Dr. SAVO Romolo LENS
Dr. SCULLION Mark University of York
Dr. STELLINGA Daan University of York
Dr. STRUDLEY To University of Southampton
Dr. THYRRESTRUP Henri University of Twente
Dr. TONINELLI Costanza INO / CNR
Mr. UPPU Ravitej TATA Institute
Mr. VAN DER BEEK Timmo AMOLF
Dr. VENTSISLAV Valev University of Cambridge
Dr. VIDAL Xavier Macquarie University
Dr. VYNCK Kevin Institute Langevin ESPCI
Dr. YOAV Lahini MIT