

InsLight – Experimental Quantum Optics and Biophysics

InsLight is an experimental group led by Dr. Maria Bondani, Researcher of the Institute of Photonics and Nanotechnologies of CNR, operating at the University of Insubria.

The group is involved in two main research activities, taking place in the laboratories of Quantum Optics and Photophysics and Biomolecules. Moreover, it is strongly involved in Physics Outreach and Education.

At present, other five people enrolled at the University of Insubria belong to the group, Dr. Alessia Allevi, tenure-track Researcher, Dr. Luca Nardo, PostDoc, Giovanni Chesi, Guglielmo Vesco and Filippo Pallotta, PhD students.

The group has several national and international collaborators, among which the group of Prof. Matteo Paris at the University of Milan, the group of Prof. Jan Perina and Prof. Ondrej Haderka at the Joint Laboratory of Optics of the Palacky University in Olomouc (Czech Republic) and the group of Prof. Francesco Mantegazza at the University of Milano Bicocca.

The research activity in the Quantum Optics laboratory includes some relevant topics in light-matter interaction, such as nonlinear optics, quantum optics, quantum information and characterization of different classes of photodetectors. Thanks to the availability of different kinds of laser systems and detection chains, the experimental investigations are performed in different intensity regimes, ranging from the single-photon level up to the macroscopic domain, passing through the so-called mesoscopic photon-number domain, in which pulsed optical states with sizeable numbers of photons per pulse are produced and photon-number resolving detectors are employed. In particular, the research focuses on:

- generation and characterization of both classical and nonclassical states useful for applications in the field of Quantum Information and Quantum Communication
- correlated imaging protocols for fundamentals of Quantum Mechanics and applications to Quantum Information
- new detection schemes based on photon-number-resolving detectors aimed at investigating both the particle-like and wave-like properties of light are being developed.

The research activity in the Photophysics and Biomolecules Lab is aimed at:

- characterizing the structure of biomolecules, particularly non-double-stranded DNA, and their relationships with metabolic regulation
- studying at the single molecule the level of aggregation of amyloidogenic proteins, whose deposition in brain tissue is responsible for the onset of neurodegenerative diseases such as Alzheimer and Parkinson
- Exploiting the spectroscopic properties of metal-organic complexes for technological applications including sensing and controlled drug release
- Investigating the quantum features of the fluorescence emitted by single molecules.

The experimental investigations are based on advanced fluorescence techniques, such as time-correlated single-photon counting, fluorescence-resonance energy transfer, and fluorescence fluctuation spectroscopy.

For what concerns Physics Outreach and Education, the research activities aim at finding new

educational strategies and, in particular, at encouraging and supporting the experimental activity in high schools, devoted to both students and teachers.

Among the other initiatives, we mention:

- the project “LuNa – La natura della Luce nella luce della Natura”,
- the annual “Joint International Physics Summer School – Optics”, organized in Como and in Olomouc (Czech Republic),
- the Workshop “Officina di didattica e divulgazione della Fisica” on different aspects of Physics and devoted to high-school students and teachers,
- the organization of PLS (Progetto Lauree Scientifiche) laboratories,
- the interdisciplinary introduction to Forensic Science, also in collaboration with the RIS Laboratories in Parma.

Publications

[1] G. Chesi, L. Malinverno, A. Allevi, R. Santoro, M. Caccia, and M. Bondani, “Measuring nonclassicality with silicon photomultipliers,” *Opt. Lett.* **44**, 1371-1374 (2019).

[2] A. Allevi and M. Bondani, “Antibunching-like behavior of mesoscopic light,” *Sci. Rep.* **7**, 16787(1-10) (2017).

[3] M. Bina, A. Allevi, M. Bondani, and S. Olivares, “Homodyne-like detection for coherent state-discrimination in the presence of phase noise,” *Opt. Express* **25**, 10685-10692 (2017).

[4] L. Nardo, F. Re, S. Brioschi, E. Cazzaniga, A. Orlando, S. Minniti, M. Lamperti, M. Gregori, V. Cassina, D. Brogioli, D. Salerno, F. Mantegazza, “Fluorimetric detection of active liposomes,” *Biochim. Biophys. Acta Gen. Subj.* **1860**, 746-756 (2016).

[5] L. Nardo, M. Lamperti, D. Salerno, V. Cassina, N. Missana, M. Bondani, A. Tempestini, and F. Mantegazza, “Effects of non-CpG site methylation on DNA thermal stability: a fluorescence study,” *Nucl. Acids Res.* **43**, 10722-10733 (2015).

Reference person: Maria Bondani maria.bondani@uninsubria.it

Website: <https://inslight.it>