Meso- and nanoscale photonics
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Spectacular technological progress in miniaturization has led in the course of a couple of decades to the realization of subwavelength devices. The physical understanding of the operation of such ultrasmall sources and their characterization has, however, been left lagging behind due to substantial instrumental and modeling obstacles.

In the past five years, we have been contributing to both aspects through an approach aimed at describing nanoscale optical sources through mesoscopic photonics, which in turn can be seen as an extension of the physics of macroscopic, well understood devices. Our specialty, reinforced by strong experience in dynamical properties of lasers and optical systems, has been the identification of fundamental properties of meso- and nanolasers in particular concerning the definition of threshold and the transition towards coherent emission. The experimental work concentrates on the mesoscale, while modeling covers all devices. A good summary of our current expertise can be found in [1], available from the following web site [2]. Work on these topics includes collaborations on different aspects (experimental or theoretical) with colleagues in China, Denmark, France, Germany, Italy and the UK.

On the basis of this experience, we are open to collaborations involving the characterization of optical sources, in particular small and novel ones. On the experimental side we have facilities covering mostly the near IR optics, fast detection at very low light levels and data sampling and storing with high performance. Spectral information can also be acquired with high resolution and a specialized home-built instrument allows us to obtain information on the intensity profiles (near or far field) coupled to spectral and/or polarization analysis [3, 4] of lasers, LEDs, etc. In collaboration with the Quantum Information group of INPHYNI, we perform photon counting experiments for the characterization of very weak sources and model them with stochastic techniques we have developed [5].

A different branch of the investigations in small-sized systems has more recently developed, where we look towards applications of photonics to biological systems. One recently started project involves the characterization of cellular elasticity with non-invasive optical techniques, while another one is centered around the amplification of weak fluorescence signals through the use of multiple scattering induced by high-index, biologically compatible nanoparticles introduced in the sample. This work is done in collaboration with biologists (IPMC, Sophia Antipolis) and the Istituto di Biofisica (CNR, Genoa, Italy).

References


[2] A free copy of this contribution can be downloaded from this author’s web site: https://sites.google.com/site/gianlucalippi (navigate to the publications page).

