Photonics Meets Biology: From Nanoscale Imaging to Winning the War on Cancer

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In the past few decades, advances in optics have been translated into vital applications in biology and medicine. Nanoscale imaging is one of these emerging applications. Cellular life is fundamentally governed by physical processes at a macromolecular scale (i.e. ten to hundreds of nanometers), but observation of these scales is challenging. In particular, most of what biologists know about genome regulation comes from the view of the cell as a molecular machine. Although powerful, this prevailing approach omits an important facet: the regulatory role of nuclear nanoscale structure. Molecular processes in the cell do not happen in an empty space but in a highly complex and dense nanoscale environment, which has profound effects on many aspects of these processes. Yet, the ramifications of nanoarchitecture with regard to macromolecular interactions have been largely unexplored to a large extent due to the limitations of optical microscopy to image nanoscale cell structure. This talk discusses a suite of spectroscopic imaging techniques based on the analysis of the interference of elastically scattered light, which have been recently developed to quantify the statistical properties of intra- and extracellular structure at the nanoscale. The talk also discusses the physical principles linking the nanoarchitecture with the regulation of molecular processes. Alterations in the nuclear nanoarchitecture are some of the earliest events in carcinogenesis, and optical nanoscale imaging has the potential to provide key insights into fundamental cell biology as well as lead to cancer screening.