TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA

Dipartimento di Scienze e Tecnologie Chimiche
e
Dipartimento di Fisica

Abstract

The possibility of integrating different light-matter interactions to form images and to correlate image data in optical microscopy taking advantage of artificial intelligence developments is the key point for the design and implementation of a multi-messenger optical microscope. The multi-messenger microscope represents a new paradigm in data collection and image formation due to visible light-matter interactions also exploiting the possibility to "tune" the microscope across a large, almost unlimited, range of spatial and temporal resolution ranges. Fluorescence, including FLIM, FRET, FRAP, FCS, super-resolved, and label free approaches, including multiphoton, SHG, Mueller matrix microscopy provide the mechanisms of contrast that can be merged within a liquitopy – liquid tunable microscopy – perspective [1],[2]. It is the melting pot for an effective demonstration of an applied physics approach. For this reason, we will discuss from basic to advanced aspects of confocal and multiphoton microscopy, single molecule localization methods, nanoscopy and label-free approaches. Computational, expansion and light sheet microscopy will be treated as part of the multi-messenger approach that is in tune with the concepts developed by Giuliano Toraldo di Francia in the 50s [3]. Moving to modern times, deep-learning approaches and brand-new detectors are key components for the development of a multi-messenger optical microscope based on an image point-scanning approach [4], [5].

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Via della Ricerca Scientifica, 1
www.stc.uniroma2.it

Tel. 06 72594337
Email: chimica@uniroma2.it