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Selected Topics in Biophotonics: Photoacoustic Tomography and Fiber-Based Lasers and Supercontinuum Sources

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The present special section entitled "Selected Topics in Biophotonics: Photoacoustic Tomography and Fiber-Based Lasers and Supercontinuum Sources" comprises two invited papers and several contributed papers from the summer school Biophotonics '15, as well as contributed papers within this general scope.

1 Motivation and Purpose of Biophotonics Graduate Schools

Over the past decade, lasers, optical methods, and instruments based on light interaction with tissues have emerged as powerful techniques for medical diagnostics, monitoring a wide spectra of tissue function, and pathology. In biophysics and biology, optical sensing and manipulation of cells have strengthened understanding of basic cell function. Together with improved laser therapeutic techniques, optical sensing and cell manipulation form the basis for the increased interest in biophotonics. Throughout Europe, the United States, and the rest of the world, major research centers are highly active in this field that in a broad sense may be labeled biophotonics. Therefore, education within this area is becoming increasingly important.

The main purpose with the biennial graduate summer school is to provide education within biophotonics for students and young scientists at the highest international level. Our aim is to attract internationally renowned researchers as lecturers who would in turn attract the most talented young researchers worldwide in the field of biophotonics.

2 Format of the Biophotonics Graduate Summer School

The school mainly targets graduate students and postdoctoral fellows from around the world. The format of the school is a combination of lectures and student poster presentations, with time between lectures for discussions and exchange of scientific ideas. The lecturers cover one topic in a full session comprised of four lectures, which thoroughly covers the basics and state of the art of each topic. On one hand, this choice limits the number of topics taught at each school. On the other hand, the topics selected for the schools are covered in detail. Therefore, the range of topics taught will change from year to year.

An important feature of the school format is that students and lecturers spend the entire week together, which provides excellent opportunities for the exchange of scientific ideas, networking, and socializing.

The 7th International Graduate Summer School Biophotonics '15 covered the basics of lasers as well as supercontinuum sources and their application in medicine, tissue optics, photodynamic therapy, optical tweezers and their applications in biophotonics, optical biosensors, diffuse optical and molecular imaging, fluorescence nanoscopy, optical coherence tomography, and coherent Raman scattering microscopy.[1] In addition, the topic of entrepreneurship and translating ideas into applications that eventually become products was included.

3 Special Section in the *Journal of Biomedical Optics*

We are pleased to introduce the contributions to this special section on "Selected Topics in Biophotonics: Photoacoustic Tomography and Fiber-Based Lasers and Supercontinuum Sources" comprised of two invited tutorial papers and seven contributed papers, mainly from the participants of the school but also from other researchers in the field. Not all the contributions are strictly covered by the title of the special section, but all of the contributions reflect the core topics of the school and span the fields of biomedical optics and biophotonics. The invited papers are:

- Y. Zhou, J. Yao, and L. V. Wang, "Tutorial on photoacoustic tomography"
- J. R. Taylor, "Tutorial on fiber-based sources for biophotonic applications"

These two papers from lecturers at the school are tutorial in character and provide an excellent background to the fields of photoacoustic tomography, while also pointing to future challenges and fiber-based supercontinuum sources that have a plethora of applications within our field. These invited papers provide a natural continuation to previous tutorial papers on the foundation of diffuse optics,[2] imaging thick tissues with diffuse optics,[3] molecular imaging,[4] optical micromanipulation,[5]

photodynamic therapy,[6] optical coherence tomography,[7] and biological imaging with coherent Raman scattering microscopy[8] published in similar special sections from previous schools. These papers all belong to a planned series of tutorial review papers from each biennial school that provide high-level, open-access educational material for the benefit of the scientific community and, in addition, fulfill our own motivation for creating the school in the first place. With this special section, there are in total nine excellent tutorials that provide profound introduction into the basics of our field.

Following the invited review papers, we will discuss the contributed papers according to their main topic, starting with papers on the same general theme as one of the tutorial papers. Related to the topic of photoacoustics, Lin et al. describe tomography of myoglobin oxygen saturation and demonstrate its potential *in vivo* in mice. Deng and Li demonstrate *in vivo* measurements of oxygen saturation in human subjects (fingers). Related to supercontinuum sources (and photoacoustics), Bondu et al. describe a new realization of a fiber-based supercontinuum source that can be applied within photoacoustic microscopy. Given the source specifications, it is interesting for other applications as well; hence it might be useful for multimodal approaches.

Another general area covered at the school and in past special sections is Raman spectroscopy.[8] Tamosaityte et al. investigate inflammation-related alterations of lipids after spinal cord injury by combining several methods, including Raman spectroscopy, coherent anti-Stokes Raman scattering, and two-photon fluorescence microscopy. Alfonso-García et al. investigate D38-cholesterol as a Raman probe using hyperspectral stimulated Raman scattering and multivariate analysis. Their results might lead to new understanding of cholesterol movement and distribution in cells.

In biophotonics, reflectance measurements[2] and fluorescence measurement both play a major role. Fluorescein sodium and aminolevulinic acid–induced protoporphyrin IX can be used for contrasting malign and benign tissues. Bravo et al. develop a mathematical model for correcting reflectance spectral measurements obtained in the presence of strong fluorescence, demonstrated experimentally in phantoms. Their investigation represents a first step toward using quantitative optical spectroscopy to guide surgeries through simultaneous assessment of two contrast agents.

Finally, linking OCT[7] and the present tutorial on supercontinnum sources, Yao et al. demonstrate an ultrahigh-resolution spectral domain OCT system and apply it for myocardial imaging. Their investigation reveals detailed structures that might become important disease biomarkers.

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