Read & Win: Super-Resolution Microscopy - A Practical Guide

Super-resolution microscopy is based on light microscopy and encompasses several techniques that enable an enhanced structural resolution in biological and other specimens down to 10 nm. It is the achievement of a truly interdisciplinary research community as it requires the expertise of chemists, biologists, physicists and engineers: Suitable probes such as chemical fluorophores and fluorescent proteins had to be designed, sample preparation optimized, and adequate hard- and software had to be developed for single-molecule detection and analysis. Udo Birk gives a practical introduction to the field of super-resolution microscopy. Written for the non-expert user who is new to the field and wishes to use recently commercialized instruments, this book provides information on practical requirements, e.g. on sample preparation, as well as hard- and software considerations. The book depicts the four major techniques of super-resolution microscopy: structured illumination microscopy (SIM), multi-scale imaging, single-molecule localization (SML) and stimulated emission depletion (STED) microscopy. For each individual technique the experimental setup is introduced, imaging protocols are provided and applications are shown. The author concludes with a discussion of future challenges addressing issues of routine applications and further commercialization of the available techniques.

Win the book!
To have a chance of winning the book read Issue 1, 2018 of Imaging & Microscopy (page 12). As a subscriber you could read the issue already online or order you own copy (as a free trial copy). Take part in our competition and send your answer to contact@imaging-git.com with the subject line Read & Win. All correct answers will be entered in a prize draw and the lucky winner will receive a copy of "Super-Resolution Microscopy".
Closing date: June 17, 2018.

Dr. Udo J. Birk
is a Lecturer for Image Processing at the HTW Chur and at Mainz University, where he holds a post-doctoral teaching degree (Habilitation) in Experimental Physics.
his research, he focuses on the development of novel quantitative imaging and visualization approaches. He obtained his PhD for the co-development of a structured illumination, super-resolution fluorescence microscope. His work has also included quantitative optical tomography, photo-acoustics, and single molecule localization microscopy.

**Interview with Udo Birk:**

**What is your main focus in research, what is your main scientific interest?**

*Birk:* In the past I have contributed to the development of novel imaging approaches, be it setting up new hardware devices such as developing structured illumination or single molecule localization microscopes or new software tools e.g. for advanced 3D reconstructions or for the correction of artifacts. Additionally, I use modelling approaches to corroborate experimental data. My main scientific interest is the quantitative analysis of image data.

**What was the reason to write the book?**

*Birk:* At the time of writing, there was a lack of guidance for users new to the field of super-resolution microscopy. I found that the microscopy community at the time was divided into several groups resulting in a sometimes biased view of the respective topics covered in the books available. Consequently, a comparative approach, which my book provides, was required.

**What is the target audience for the book?**

*Birk:* The book is suitable for researchers new to the field as well as for experts. It helps users to get the most out of their super-resolution experiments. It introduces first the physicochemical and microscopy background, then dedicates special chapters to a variety of different techniques, and gives practical tips e.g. for calibration samples, alignment procedures, image acquisition protocols, and how to avoid common pitfalls.

**What knowledge is prerequisite for the book?**

*Birk:* Although I recommend previous practical experience in microscopy, all the details required to get the microscope to work are covered in the book.

**What is the structure of the book?**

*Birk:* First, the reader is introduced to the field of super-resolution microscopy, including some milestones in the development of the field. The chapter on physicochemical background covers labeling techniques as well as the question of
how to boost performance of your fluorophores. The chapter on hard- and software covers choices for e.g. objective lens, detector, PC architecture; it highlights the software requirements for a successful application of super-resolution microscopy, and discusses best practice for the use of such software. Then specialized chapters dedicated to specific super-resolution microscopy approaches are presented: Structured Illumination Microscopy, Localization Microscopy, Stimulated Emission Depletion Microscopy, and Multiscale Imaging with Light-Sheet Fluorescence Microscopy (LSFM), Optical Projection Tomography (OPT), Expansion Microscopy (ExM) and Sample Clearing. All chapters include highly useful illustrations.

**Which field will benefit most from super-resolution microscopy?**

*Birk:* Presently, medical centers advertise the most academic positions in the field of super-resolution microscopy, with a focus on cardiovascular and neuro-imaging. I believe that in the end, and with the development of non-fluorescence based super-resolution microscopy, the material sciences will benefit the most.

**How important are imaging analysis algorithms?**

*Birk:* Super-resolution microscopy has been developed at the crossroads of multiple disciplines, such as engineering (lasers, detectors), chemistry (fluorophores), computer sciences (quantitative image analysis), biology and medicine (applications), and many more. Image analysis algorithms play an essential part in understanding hitherto unknown experimental image data, but sample preparation, illumination, and detection are equally important. Together with the implementation of advanced image analysis algorithms, it is essential to distill best practice for the application of these algorithms.

**What will, in your opinion, be the “next big thing” in microscopy?**

*Birk:* Probably, several super-resolution microscopy techniques not restricted to fluorescence microscopy will be developed. These super-resolution microscopy approaches will be further advanced to allow imaging with large working distances and without the need for immersion of the sample. Together this will form a solid basis for automated super-resolution microscopy as favored by e.g. pharmaceutical companies, and for correlative electron/light microscopy.

**More information:**
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