Waves for life sciences: Characterization of biomedical structures with a focus on X-ray imaging

Marina Eckermann[1]

[1] *Institute of Applied Physics, University of Bern, Switzerland*

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Disease and development mechanisms in the field of biomedical sciences emerge in complex patterns. As different experimental methods are sensitive for different contrast mechanisms, their entity is required to unfold this complexity. In the group of Biomedical Photonics at the Institute of Applied Physics (IAP), we develops tool for the characterization of biomedical samples, including laser-based system such as polarimetric imaging or fluorescence lifetime imaging, optoacoustic microscopy, and - since recently - also X-ray based techniques.

With their short wavelength, hard X-rays can penetrate matter such as biological tissues deeply, and provide information about its interior architecture: going below the diffraction limit of visible light, and not necessarily relying on specific stains, but assessing samples based on their electron density. Here, different X-ray techniques such as X-ray fluorescence, X-ray diffraction, or X-ray phase-contrast tomography are used more and more to address biomedical questions. In the case of X-ray phase-contrast tomography, it could be shown to give access to the chromatin packing in cellular nuclei, or also to cells for which no histological stain exists. To further exploit and develop this, we build on the joint exploitation of synchrotron-facility setups and a home-built device for X-ray phase-contrast nanoCT, together with other (established) experimental tools, in close collaborations with biomedical researchers.

This presentation provides an overview of the techniques developed at the BP-IAP, with a focus on the newly introduced X-ray methods: this comprises an introduction into the physical concepts of the methods, followed by examples of their elaboration and applications in biomedical research.