Biophotonics (3 hours per week; start: **21.4. at 4 pm**: overview and date determination for lecture)

This lecture deals with the optics of turbid media (also called random or scattering media), such as paints, tablets, leaves, wood, suspensions like fog, emulsions like milk, clouds, textiles, and not least human biological tissue. The light propagation in these media is discussed considering its theoretical description and presenting a plethora of applications. The two main effects involved, elastic scattering and absorption, are regarded as well as further effects such as luminescence, Raman scattering, or laser Doppler scattering. For the comprehension of single scattering, analytical and numerical solutions of Maxwell's equations, and for the insight into multi-scattering, analytical and numerical solutions of the radiative transport equations and its approximations are derived and discussed. Analytical methods such as Fourier or Laplace transforms and numerical methods such as finite differences or Monte Carlo simulations are applied for solving these equations. In addition, the determination of the optical properties, especially the scattering and absorption coefficients, is considered addressing different experimental methods.

Once the optics of turbid media has been discussed, a variety of technical and biological applications are dealt with in the lecture. Examples are optical coherence tomography, diffuse optical tomography, confocal microscopy, and spectroscopy in the ultraviolet, the visible, and in the near-infrared wavelength range. A special emphasis will be put on physics-based rendering of technical and biological media, see figure 1. In principle, knowing the optics of turbid media means understanding the color and the appearance of almost all objects surrounding us.

Generally, a lab with five one-day experiments is included at the end or after the lecture. The topics are

- Numerical solution of Maxwell's equations based on the finite difference method
- Numerical solution of the radiative transport equation based on Monte Carlo simulations
- Experiments on single scattering
- Determination of scattering and absorption with spatially resolved reflectance measurements
- Determination of scattering and absorption with modulate imaging experiments

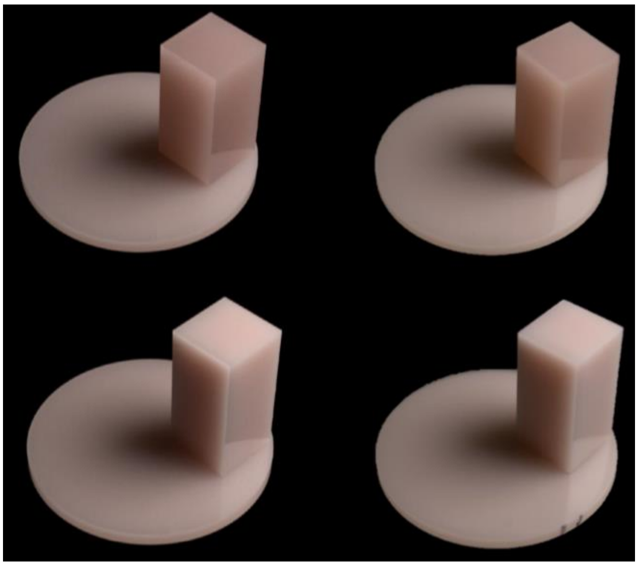

Figure 1: Real (right) and rendered (left; without fitting any parameter) images of cuboids having relatively small scattering (top) and strong scattering (bottom).

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Please write me an email, if you want to participate. I will invite you to the lecture.