Project 3.9 Use of dynamic light scatterers to improve resolution in OCT imaging

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Background:

Modern optical imaging methods range from optical microscopy, in which the attenuation of ballistic light produces a diffraction-limited image of a sample, to diffusion techniques that analyze multiple scattered light to determine the optical properties of a medium. On the one hand, imaging techniques seek to maximize the imaging range, which decreases exponentially with increasing optical thickness of the sample in order to overcome the optical thickness barrier below which multi-scattered light (which does not provide imaging information) dominates. On the other hand, diffusion techniques seek to increase their range of applicability to objects of intermediate optical thickness. However, the boundary between these regimes is very arbitrary. Many objects manifest properties that are partly strictly diffusive as well as weakly diffusive. In particular, the human eye is such a "hybrid" object - some tissues have high transmission for visible and near-infrared light, but there are also tissues such as pigment epithelium, sclera, iris or choroid that strongly scatter light.

In this research project, we will use dynamic light scattering to improve the resolution of coherent imaging systems by minimizing distortion from spatially coherent illumination. This non-intuitive reduction in spatial coherence allows for improved imaging by more efficiently rejecting photons that do not carry imaging information.

Aim:

The goal of this project is to improve the quality of tomographic imaging of the retina. To this end, we plan to use dynamic light scatterers, which will be applied to the eye as droplets with dynamic scatterers. Alternatively, a layer of scatterers will be placed in front of the eye or we will use an additional transmission optical field phase modulator. One of the goals of the project is to see which solution will be the most optimal. One of the research hypotheses of this project is that removing speckle noise based on dynamic light scattering will allow us to increase the sensitivity of the method.

Requirements:

- Master's degree in physics or chemistry,
- experience in experimental work in optics with particular emphasis on phase and microscopic methods