

Optimal selective focusing of light on moving targets

PhD proposal, 2024-2027 (funding already secured)

Laboratory: Laboratoire Interdisciplinaire de Physique (LIPhy), Grenoble, France

Supervisors: Dr. Dorian Bouchet and Prof. Emmanuel Bossy

Project description

Light propagates in a simple way in homogeneous media such as vacuum and air, which allows our brain to easily interpret visible information captured with our eyes. However, **it remains extremely challenging to perform optical imaging when light propagate through complex media**. For instance, it is very difficult to monitor biological processes such as viral infections in living organisms, because light is scattered by surrounding biological tissues in an uncontrolled way. **This challenge motivates us to get a better fundamental understanding of how light waves propagate in complex media.**

In the last decades, the possibility to generate shaped light waves has been widely employed to focus light onto target objects hidden behind complex scattering media. However, these techniques typically require to label the targets using fluorescent molecules to be used as guidestars, which is often not possible to achieve in practical applications. This PhD project will now tackle the following question: **how can we shape light in order to optimally detect unlabeled moving targets, and selectively focus light on these objects?** On the conceptual side, the project associates tools from wave theory and information theory in order to understand how to optimally extract information from the measured scattered waves, as needed to focus light on moving targets without the need of fluorescent molecules. On the experimental side, the project involves the development of a proof-of-principle system based on red blood cells flowing through a microfluidic network, that will be hidden behind a complex scattering medium. The goal of this experiment will be first to detect the presence of a nanoparticle among red blood cells, and then to selectively focus onto this particle.

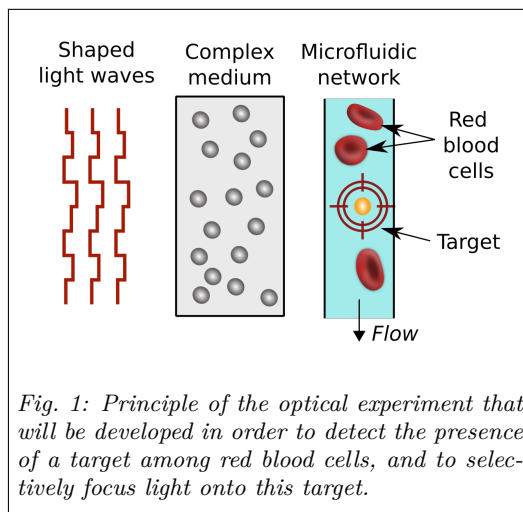


Fig. 1: Principle of the optical experiment that will be developed in order to detect the presence of a target among red blood cells, and to selectively focus light onto this target.

Profile of the candidate

The candidate must have a Master's degree in Physics or Engineering. He/she needs to be motivated in (i) learning new concepts in physics and (ii) applying them for the experimental development of a new kind of optical microscope.

For further information

Contact: Dorian Bouchet (dorian.bouchet@univ-grenoble-alpes.fr)

Personal webpage: <https://sites.google.com/view/dorianbouchet>

Laboratory website: <https://liphy.univ-grenoble-alpes.fr>

References:

- D. Bouchet *et al.*, *Phys. Rev. Lett.* 127, 253902 (2021)
- S. Gigan *et al.*, *J. Phys. Photonics* 4, 042501 (2022)