

# Sylvain Gigan

LKB, ENS, Sorbonne U., CNRS, Collège de France

## Wavefront control in disordered media: from imaging to quantum information processing

Scattering of light in heterogeneous media, for instance the skin or a glass of milk, is usually considered an inevitable perturbation or even a nuisance. Through repeated scattering and interferences, this phenomenon seemingly destroys both the spatial and the phase information of any laser illumination and gives rise to the well-known “speckle” interference patterns. At the temporal (or spectral) level, a short pulse entering a scattering medium will see its length greatly extended due to the multiplicity of possible path length light can take before exiting the medium. Multiple scattering is a highly complex but nonetheless deterministic process: it is therefore reversible, in the absence of absorption : speckle is coherent, and can be coherently controlled. By “shaping” or “adapting” the incident light, it is in principle possible to control the propagation and overcome the scattering process. The central tool that we exploit is the ability to measure and exploit the transmission matrix of a complex medium.

I will first show how this concept has opened tremendous prospects for imaging through and in complex media, which is relevant for biomedical imaging. I will then describe our effort towards extending this concept to the quantum regime. More specifically, we implement a quantum walk of indistinguishable photon pairs in a multimode fiber supporting 380 modes. We thereby demonstrate a highly multimode platform for multiphoton interference experiments and provides a powerful method to program a general high-dimensional multiport optical circuit.