LABORATOIRE INTERACTIONS, DYNAMIQUES ET LASERS

LIDYL-UMR 9222
CEA, CNRS, Université Paris-Saclay

# SEMINAIRE LIDyL

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**Le Mercredi 25 Janvier 2017 à 11h00**
**- Bâtiment 522 - Salle 138**

## "spatiotemporal control of light in complex media, application to pulse shaping"

Propagation of coherent light through a scattering medium produces a speckle pattern at the output, due to light scrambling by multiple scattering events. Both phase and amplitude information of the light are spatially mixed, thus limiting resolution, depth and contrast of most optical imaging techniques. Wavefront shaping techniques have revolutionized the control of optical waves in disordered media, as the scattering process is deterministic. With more than a million degrees of freedom, spatial light modulators (SLMs) allow to manipulate the propagation of coherent light [1, 2].
With an ultrashort pulse light source, photons exit the scattering medium at different times, giving rise to a broadened pulse at the output. Temporal spreading of the original pulse is characterized by a confinement time of the medium that can be orders of magnitude higher than the initial time-width of the pulse. Therefore, applications that require an ultrashort pulse, such as multiphotonic imaging and non-linear optics are out of reach in the multiply scattering regime. With a single SLM, one can manipulate spatial degrees of freedom to adjust the delay between different optical paths. Therefore spatial and temporal distortions can be both compensated using wavefront shaping techniques, for example to perform spatiotemporal focusing [3, 4, 5].
After a general presentation of light propagation in complex media, and the transmission matrix method, we will discuss the Multi Spectral Transmission Matrix (MSTM), an extension of the Transmission Matrix approach in the spectral domain, to fully control, both spatially and spectrally, the propagation of an ultrashort pulse in a disordered medium. The MSTM coefficients include the relative phase relation between the different frequencies of the output pulse, which is essential for its spectral control. We demonstrate deterministic spatiotemporal focusing and enhanced excitation of a non-linear process, as well as the deterministic achievement of a variety of temporal profiles, that could not be directly reached with the previous techniques [6].

*[1] I. M. Vellekoop and A. P. Mosk, Opt. Lett.* ***32****, 2309-2311 (2007)*
*[2] Popoff, S. M., et al., Physical review letters,* ***104****, 100601 (2010)*
*[3] Aulbach, J., et al., Physical review letters,* ***106****, 103901 (2011)*

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