Master 2 Internship

Title: THz vortex beams: generation and macroscopic optical angular manipulation

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PhD funding (if any):

Project: An electromagnetic wave is defined by its amplitude, carrier frequency, wave vector and angular momentum. The latter can be decomposed into two distinct terms: the spin angular momentum (SAM, describing the polarization state of the wave) and the orbital angular momentum (OAM) associated to the spatial distribution of the electric field. Generally, an electromagnetic wave with OAM can be characterized by an azimuthal dependence of its phase like $\exp(-il\theta)$ with l an integer called the topological charge. A beam possessing such a spiral phase distribution is called a vortex beam and carries a $l\hbar$ OAM per photon.

Geometric phase optical elements represent a powerful pathway to generate structured light - especially optical vortex beams - driven by the photon spin. However, the efficiency of current devices is inherently restricted to selective spectral lines due the chromatic nature of the physics at work. We recently initiated THz vortex optics in France by direct beam shaping in the THz domain [1] and by spectral transfer of the topological information from the infrared to the THz domain mediated by nonlinear optical processes [2]. All these advances make it possible the emerging of spin-orbit photonic technologies, e.g. on-demand management of spatiotemporal couplings of light involving frequency-dependent orbital angular moment (OAM) content.

In LOMA, in collaboration between the PULS (E. Abraham) and Singular group (E. Brasselet), the internship will concern the opto-mechanic applications of THz vortex beams. Our idea is to demonstrate, for the time in the THz spectral domain, the mechanical action of both SAM and OAM on a macroscopic object. Namely, a THz-absorbing object will be put into rotation once illuminated by a THz beam carrying SAM and/or OAM. In practice, this will be addressed by considering the levitation of a diamagnetic pyrolytic graphite over a monolithic NdFeB cylinder magnet. With this simple and low cost magnetic levitation (maglev), the student will have to develop the appropriated instrumentation to measure the disk rotation induced by the optical torque of THz radiation (imaging, acquisition and analysis).

[1] A. Minasyan et al., Opt. Lett. 42, 41 (2017).
[2] A. Al Dhaybi, JOSA B 36(1), 12 (2019).