Liquid crystal particle-like structure driven by light

Emma Furlanetto[1,*], Delphine Coursault[1] & Etienne Brasselet[1]

1) LOMA, CNRS, University of Bordeaux, Talence, France

** Contact : emma.furlanetto@u-bordeaux.fr*

Optical trapping is a well-known phenomenon in the case of solid objects, where the center of mass—the positional degrees of freedom—can be manipulated. In liquid crystals, which belong to the family of ordered fluids, one usually deals with orientational rather than positional degrees of freedom. Here we report on the optical manipulation of particle-like orientational structures existing in liquid crystals endowed with intrinsic helical orientational order. These structures are elastic in nature and it is known that they can be manipulate under the action of light, making such elastic particle-like structures to move on demand.

In this work we unveil a surprising optical manipulation phenomenon of elastic particle-like structures, namely, a polarization-controlled optomechanical push-pull effect, Fig.1(up). Liquid crystals being birefringent materials, one expects that their manipulation depends on the polarization state of light, however, our unpredicted observations raise new questions. Indeed, we demonstrate that the effect is generic, being neither nonspecific to a given material, sample preparation, nor to light-matter interaction geometry. Therefore, what drives such a behavior ?

In order to elucidate the process of light-matter interaction at work, we have explored two avenues. The first option is to consider that elastic particle-like structures behave as a rigid-body optically anisotropic scatterers subject to radiation pressure effects. In fact, for solid objects, it is known that polarization-dependent push-pull effects can occur in bespoke situations. The second option is to take into account of light-induced changes of the internal orientational order of elastic particle-like structures, a process that is expected to depend on polarization. So far, our experimental investigations, supported by modelling, tend to confirm that the latter option is at work, Fig.1(down).

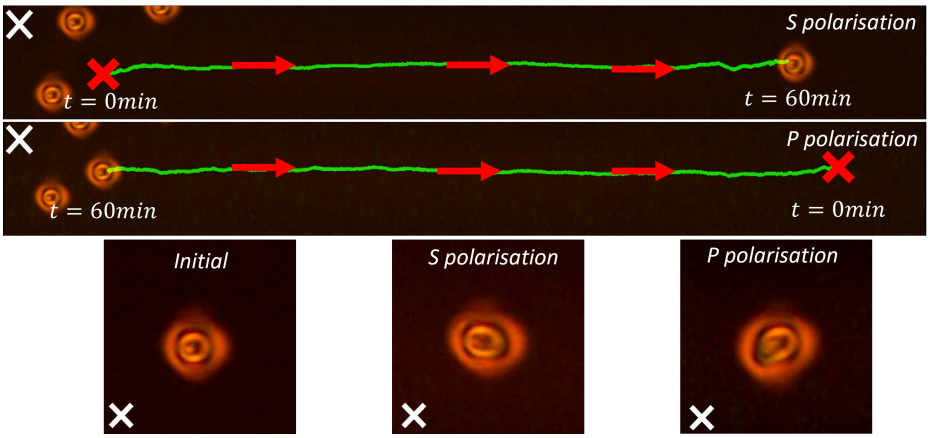

FIGURE 1 – (up) Evolution of particle-like structures positions over time for two incident laser polarizations. Red arrow refers to direction of displacement. (down) Deformation of particle-like structures in case of high power laser for both polarization.