Application of He-Ne Zeeman Laser in polarization-based characterization of chiral structures

Fabio Callegari[1,2*], Aymeric Le Gratiet[2], Alessandro Zunino[1,2], Ali Mohebi[1,2], Paolo Bianchini[2], Alberto Diaspro[1,2]

1 - Nanoscopy and NIC @ Italian Institute of Technology (IIT), Center for Human Technologies, Genova, Italy

2 - Department of Physics, University of Genova, Italy

***E-mail: fabio.callegari@iit.it**

Polarization-based microscopy techniques are an excellent investigation tool widely used in biological research. Thanks to their sensitivity to morphological parameters of the structure of the samples, they can be used as a label-free approach in microscopy imaging. Particularly, the Circular Intensity Differential Scattering (CIDS) has been demonstrated to be a quantity strongly sensitive to spirally-shaped molecules: so it is particularly suited to applications as the study chromatin in DNA [1] or identification of different cells and microorganisms.

The vast majority of traditional CIDS architectures can be divided into three main parts: the illumination stage, the Polarization State Generator (PSG) and the Polarization State Analyzer (PSA). Depending upon the approach encoding strategy of the polarization information, these techniques may have the need of complex setup, e.g. based on a Photo Elastic Modulator as PSG. [2]

In this work, we show our attempt to introduce a Zeeman Laser (ZL) as a key element to reduce the complexity of the setup: this is possible since that the ZL allows to merge the encoding of the polarization and the illumination source in a single stage. The simultaneous emission of two orthogonal circular polarization states owning slightly different wavelengths of a ZL [3] are exploited to perform spectroscopic measurements on reference chiral samples, by using the setup shown in Figure 1. Our technology has been modeled with both Jones and Mueller formalisms and it is experimentally validated using reference chiral samples such as optical active molecules or biopolymers.

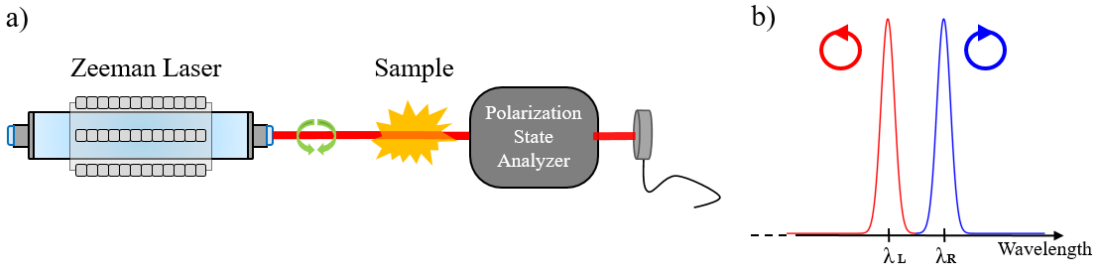

Figure 1 – (a) A scheme representing the setup used to analyze the response of chiral samples to circularly polarized Light using a Zeeman laser. (b) The typical emission spectrum of Zeeman laser with the associated Polarization states.

References

[1] A. Diaspro et al. - Polarized Light Scattering of Nucleosomes and Polynucleosomes-In Situ and In Vitro Studies –*IEEE Transactions On Biomedical Engineering* (1991)

[2] A. Le Gratiet Et al. - Circular intensity differential scattering (CIDS) scanning microscopy to image chromatin-DNA nuclear organization - *OSA Continuum* (2018)

[3] T. Shigeoka et al. - Development of a beat frequency tunable stabilized axial Zeeman laser - *Jpn. J. Appl. Phys.* (1997)