Measuring optical forces using single beam optical tweezers

T. Giannakis [1, 2] and M. Kandyla [*,1]

[1] *National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, 48 Vasileos Constantinou Avenue, 11635 Athens, Greece*
[2] *National and Kapodistrian University of Athens, Department of Physics, University Campus, Zografou, 15784 Athens, Greece*

**kandyla@eie.gr*

Optical trapping, performed by optical tweezers (OT), is an innovative and highly sensitive method, which has the ability of measuring forces in the femto-Newton range, consequently, it can probe very small variations in biological properties. Using this method, we can capture at the focus of a laser beam microscopic objects like living cells, bacteria viruses, etc.[1], without physical contact and study their basic physical properties such as shear elastic constant and membrane viscosity.[2]

The most known way of calibration in an optical tweezer setup for spherical shaped-like specimens is based on the comparison between the trapping force and the Stokes' dragging force [3]. According to Stokes' law: $F_{drag} = 6\pi\eta r u$, where η is the medium viscosity coefficient, r is the radius of the specimen and u is the dragging velocity. In the equilibrium position the two forces are equals, so significant results such as trapping efficiency can be derived.

In this work, we build a single beam OT equipped with a homemade inverted microscope for biological and technological applications (Figure 1). We measure the optical forces exerted in the specimens from the optical trapping setup using the calibration method mentioned above for different specimen radii and different media viscosity coefficients.

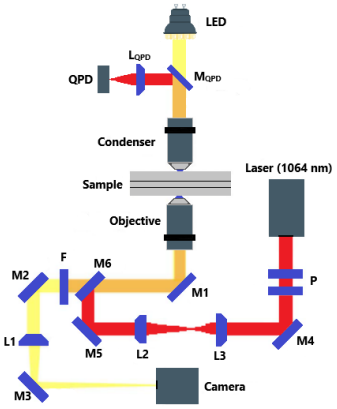

Figure 1: Schematic representation of the optical trapping setup

References

[1] I. A. Favre-Bulle, A. B. Stilgoe, E. K. Scott, and H. Rubinsztein-Dunlop, "Optical trapping in vivo: Theory, practice, and applications," *Nanophotonics*, vol. 8, no. 6. De Gruyter, pp. 1023–1040, 2019. doi: 10.1515/nanoph-2019-0055.

[2] C. N. Lima *et al.*, "Evaluating viscoelastic properties and membrane electrical charges of red blood cells with optical tweezers and cationic quantum dots – applications to β-thalassemia intermedia hemoglobinopathy," *Colloids and Surfaces B: Biointerfaces*, vol. 186, no. November, p. 110671, 2020, doi: 10.1016/j.colsurfb.2019.110671.

[3] R. Zhu, T. Avsievich, A. Popov, and I. Meglinski, "Optical Tweezers in Studies of Red Blood Cells," *Cells*, vol. 9, no. 3, p. 545, 2020, doi: 10.3390/cells9030545.