University of Cyprus

Department of Physics
Seminar

Speaker: Prof. Michel Orrit (Leiden University (NL))

Date: Thursday September 15, 2022 - 17:00

Venue: B228 (ΘΕΕ02)

Abstract:
Various optical methods provide signals from single molecules and single nanoparticles: fluorescence or photoluminescence, dark-field or bright-field scattering, absorption through photothermal contrast or nonlinear susceptibilities, refractive effects leading to shifts of plasmon resonances, or plasmon-enhanced optical signals from weak emitters. For more than 30 years, fluorescence has been the workhorse of single-molecule optics. It provides insight into single chemical events, such as the turnovers of single redox proteins [1]. Enhanced by resonant local fields around plasmonic gold nanoparticles, fluorescence reveals very weak emitters with quantum yields as low as 0.0001. Anti-Stokes photoluminescence of gold nanoparticles, enhanced by a plasmon resonance, provides their absolute temperature in a simple and direct way.

In recent years, other optical techniques have reached single-molecule sensitivity. Photothermal microscopy can be made sensitive enough to detect single photostable molecules or even such photosensitive ones as single organic conjugated polymers. The differential absorption of circularly polarized light provides quantitative circular dichroism data of single absorbing chiral nanoparticles, in particular magnetic nanoparticles under applied static magnetic fields [2]. Plasmonic gold nanoparticles are sensitive to refractive index changes in their environment. Non-absorbing protein molecules can thus be detected individually through their optical polarizability only, without need for fluorescent or absorbing labels. The binding and unbinding of single protein molecules from a solution cause sudden absorption steps, opening micro-analytical applications and in-situ sensing. Similar experiments have now been done on-the-fly on single unlabeled and untethered, freely diffusing protein molecules [3].

[1] Pradhan B. et al., Chem. Sci. 11, 763-771 (2020)
[2] Spaeth P. et al., Nanolett. 22, 3645-3650 (2022)
[3] Baaske M. D. et al., Sci. Adv. 8, eabl5776 (2022)

About the speaker:
Prof. Michel Orrit is professor of spectroscopy of molecules in condensed matter at Leiden Institute of Physics (LION) , where he studies the interaction of light with organic condensed matter. He is known for his ground breaking contributions in the development of a highly sensitive technique to light up (fluorescence) molecules by means of laser light with specific wavelengths so that they can be individually detected. Prof. Orrit's research helps to demonstrate and establish optical methods giving access to the nano-world, and to apply them to problems in physical chemistry, materials science, and biomolecular science.