

FRANCESCO RICCI
Advisor: Prof. Dr. Roman Quidant
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PhD Thesis Defense **FRANCESCO RICCI** 'Levitodynamics toward Force Nano-Sensors in Vacuum'

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February 22, 2019

Friday February 22, 11:00. ICFO Auditorium

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Plasmon Nano-Optics

ICFO-The Institute of Photonic Sciences

Levitodynamics addresses the levitation and manipulation of micro- and nanoresonators with the purpose of studying their dynamics. This emerging field has attracted much attention over the last few years owing to unprecedented performances in terms of mechanical quality factors, cooling rates at room temperature, and ultra-high force sensitivities. In this thesis, I establish the use of an optically levitated and electrically driven charged silica nanoparticle

as a promising and reliable force sensor in vacuum. The first two experiments discussed in this work seek a deeper knowledge and a higher control of the levitated system. Firstly, I suggest and demonstrate a novel protocol to measure the mass of the particle up to 2% accuracy using its electrically driven motion. This method improves by more than one order of magnitude the state-of-the-art mass measurements in standard optical tweezers schemes. Then, leveraging on these results, a second experiment is performed to address important open issues regarding the morphology of the nanoparticles used, with particular interest in their surface chemistry and in the understanding of mass-losses due to water desorption from the silica spheres. Finally, backed up by extensive theoretical background in nonlinear mechanical oscillators, I investigate the stochastic bistable dynamics of a parametrically driven nanoresonator in the nonlinear regime, discussing the potential of noise-activated stochastic switching and stochastic resonance as unconventional force detection schemes.

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Thesis Co-advisor: Prof Raul Rica

