

BIOGRAPHICAL SKETCH

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NAME: Capitanio, Marco

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Associate Professor, University of Florence, Italy and Associated Researcher and Group Leader, LENS – European Laboratory for Non-linear Spectroscopy, Italy

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of Florence, Florence, Italy	Master	12/2000	Physics
University of Florence, Florence, Italy	Ph.D.	11/2004	Physiology

A. Personal Statement

My current position is Associate Professor at the Dept. of Physics of the University of Florence and Group Leader (Molecular and Cellular Mechanobiology lab) at the European Laboratory for Non-linear Spectroscopy (LENS), a renowned international and interdisciplinary center of excellence of the University of Florence.

My research is focused, on one hand, on the development of techniques for the study of biology at the molecular scale, with a particular interest on optical methods. On the other hand, I am particularly interested in the molecular mechanisms underlying mechanical regulation of biological systems, encompassing the study of molecular motors and mechanotransduction. I developed novel techniques for the imaging and manipulation of single biological molecules, using optical and magnetic tweezers combined with fluorescence and scattering microscopy. Application of these techniques gave new insight into important mechanisms governing the function of molecular motors (Capitanio et al., *PNAS* 2006). In particular, my invention of UFFCS (Capitanio et al., *Nature Methods* 2012), allowed me to uncover the load-dependence of muscle contraction and opened to a series of groundbreaking researches. Among these, I have applied UFFCS to investigate force generation by cardiac myosin (Woody et al., *eLife* 2019), mechanosensitivity of processive molecular motors (Gardini et al., *Nature Communications* 2018), target search by DNA-binding proteins (Tempestini et al., *Nucleic Acids Research* 2018), and the mechanosensitivity of α -catenin in adherens junctions (Arbore et al., *Nature Communications*, 2022). After obtaining a FIR (“Futuro in Ricerca”) funding, an extremely selective grant awarded by the Italian Ministry of Education, University and Research (MIUR) to foster high quality research and support the independence of young researchers, my research also focussed on cellular biophysics, where I combined OT and FRET-based force sensors (Sergides et al., *Eur Phys J Plus* 2021), developed methods for high resolution microscopy in thick samples (Kashchuk et al., *ACS nano* 2023; Gardini et al. *Opt Expr* 2023; Vignolini et al. *Sci Rep* 2024) and, more recently, investigated force propagation in cell membranes ([Lüchtfeld](#) et al, *Nature Methods*, 2024).

B. Positions, Scientific Appointments, and Honors

CURRENT POSITION(S)

2020 - Associate Professor, Dept. of Physics and Astronomy, University of Florence, Italy
2013 – Group Leader, European Laboratory for Non-linear Spectroscopy (LENS), Florence, Italy

PREVIOUS POSITIONS

2017-2020 Senior Researcher (RTDb), Dept. of Physics and Astronomy, University of Florence
2012-2017 Junior Researcher (RTDa), Dept. of Physics and Astronomy, University of Florence
2009-2011 Postdoctoral Researcher, Prof. Francesco S. Pavone's lab, LENS
2008 Marie Curie Experienced Researcher, Dr. James Sellers' lab, NIH, Bethesda, MD (USA)
2005-2008 Postdoctoral Researcher, Prof. Francesco S. Pavone's lab, LENS
2001 Visiting Researcher, Prof. Robert Simmons, Randall Centre, King's College, London (UK)

FELLOWSHIPS & AWARDS

2008 Marie Curie Fellowship, TOK (Transfer of Knowledge) MTKD CT 2004-509761, 2008.
2020 Marie Curie Seal of Excellence, as Supervisor of project proposal 101031634, NO-MeRe-AdJuncts, H2020-MSCA-IF-2020
2016 Marie Curie Seal of Excellence, as Supervisor of project proposal 750192, MechanoMol H2020-MSCA-IF-2016
2008 Gordon Conference Poster Award, "Muscle & Molecular Motors", June 29th – July 4th 2008, Colby-Sawyer College, New London, NH, USA.
2007 EBSA Travel Award 2007, European Biophysical Societies' Association (EBSA).
2004 Biophysical Society Student Travel Award 2004, Biophysical Society.
2001 Poster Award, INFM Meeting 18-22 June 2001.

C. Contributions to Science

Innovation in Single-Molecule Force Spectroscopy:

Developed ultrafast force-clamp spectroscopy to measure biomechanical interactions with microsecond resolution, providing new insights into the load-dependence of the myosin working stroke.

Pioneered methods combining optical tweezers with high-precision fluorescence imaging to analyze the dynamics of force generation and mechanosensitive signal transduction.

1. **Capitanio, M.**, Canepari, M., Maffei, M., Beneventi, D., Monico, C., Vanzi, F., Bottinelli, R. and Pavone F.S. "Ultrafast force-clamp spectroscopy of single molecules reveals load dependence of myosin working stroke", *Nature Methods*, **9**, 1013–1019 (2012).
2. Woody, M.S., Winkelmann, D. A., **Capitanio, M.**, Ostap, M.E., and Y.E. Goldman, "Single molecule mechanics resolves the earliest events in force generation by cardiac myosin", *eLife* **8**, e49266 (2019)
3. **Capitanio, M.**, Canepari, M., Cacciafesta, P., Lombardi, V., Cicchi, R., Maffei, M., Pavone, F.S. and Bottinelli, R. *Two independent mechanical events in the interaction cycle of skeletal muscle myosin with actin. Proc. Natl. Acad. Sci. USA* **103**, 87-92 (2006).

Advances in Mechanobiology:

Applied engineered optical traps and FRET-based force sensors to study cellular mechanotransduction and the interplay between mechanical forces and biochemical signals in muscle contraction and cell adhesion.

Explored the mechanosensitivity of various molecular motors and DNA-binding proteins, elucidating mechanisms relevant to gene regulation and cell fate.

4. Arbore, C., Sergides, M., Gardini, L., Bianco, G., Kashchuk, A., Pertici, I., Bianco, P., Pavone, F.S., and **M. Capitanio**, “ α -catenin switches between a slip and an asymmetric catch bond with F-actin to cooperatively regulate cell junction fluidity”, *Nature Communications* **13**, 1146 (2022).
5. Sergides, M., Perego, L., Galgani, T., Pavone F.S., and **M. Capitanio**. “Probing mechanotransduction in living cells by optical tweezers and FRET-based molecular force microscopy”. *Eur. Phys. J. Plus* **136**, 316 (2021).
6. Gardini, L., Heissler, S., Arbore, C., Yang, Y., Sellers, J., Pavone, F. S. and **M. Capitanio**, “Dissecting myosin-5B mechanosensitivity and calcium regulation at the single molecule level”, *Nature Communications* **9**, 2844 (2018).
7. Tempestini, A., Monico, C., Gardini, L., Vanzi, F., Pavone F. S., and **M. Capitanio**, “Sliding of a single *lac* repressor protein along DNA is tuned by DNA sequence and molecular switching”, *Nucleic Acids Research* **46**, 5001-5011 (2018), doi: 10.1093/nar/gky208

Instrumentation and Methodological Developments:

Designed and implemented integrated platforms that merge optical manipulation with advanced imaging modalities, greatly enhancing the temporal and spatial resolution available for single-molecule studies.

Contributed key methodologies that have been adopted internationally, as demonstrated by numerous citations and invited presentations.

8. Luchtefeld, I., Pivkin, I.V., Gardini, L., Zare-Eelanjegh, E., Gäbelein, C., Ihle, S.J., Reichmuth, A.M., **Capitanio, M.**, Martinac, B., Zambelli, T., and Vassalli, M. “Dissecting Cell Membrane Tension Dynamics and its Effect on Piezo1-Mediated Cellular Mechanosensitivity Using Force-Controlled Nanopipettes”, *Nature Methods* **21**, 1063–1073. <https://doi.org/10.1038/s41592-024-02277-8> (2024)
9. Kashchuk, A. V., Perederiy, O., Caldini, C., Gardini, L., Pavone, F.S., Negriyko, A. M. and **M. Capitanio**, “Particle Localization Using Local Gradients and Its Application to Nanometer Stabilization of a Microscope”, *ACS Nano*, **17** (2), 1344-1354; DOI: 10.1021/acsnano.2c09787 (2023)
10. Gardini, L., Vignolini, T., Curcio, V., P., Pavone, F.S., and **M. Capitanio**, “Optimization of highly inclined Illumination for diffraction-limited and super-resolution microscopy”, *Optics Express* **31**, 26208-26225 (2023)