Lorenzo Marcucci

- Personal Data:

Born: August 21, 1974
Nationality: Italian

- Academic Education and Position:

2000	Master Degree in **Engineering** at University of Ferrara (Italy), with the mark of **108/110**
2000-2003	Fellowship student at the **Scuola Normale Superiore** of Pisa (Italy), in the program of *Applied Mathematics for Technology and Industry*.
2004	Researcher at **CNR** of Padova (Italy) at the Institute of Institute for Energetics and Interphases (*IENI*)
2005-2008	Ph.D. student at the Laboratoire de Mécanique des Solides (LMS) - **École Polytechnique**, France.

- Scientific Interests

In October 2005 I start a three year grant of the MULTIMAT to perform a Ph.D. research programme at the Laboratoire de Mécanique des Solides of the **École Polytechnique** of France.

The subject of my thesis is the **mechanics of muscle's contraction**, in both the time scales associated with its behaviour in the experiments. The slower time scale, of the order of seconds or tens of seconds, in which we observe the force-velocity curve, and the faster one, of the order of milliseconds, associated to the quick recovery followed by an imposed small length change.

The kinetics of the quick recovery phase can be roughly fitted by an exponential curve, with a recovery faster in contractions than in stretches. The first section of my thesis, deals with this kind of experiments. The second section is focused on the mechanical modelling of the slower processes related to the attachment and detachment kinetics. In the third section I attempt a unified description of the whole cycle of muscle contraction which includes both stages.

The main scope of the thesis is to give a **well defined description of the energy landscape** in order to avoid the unknown ‘’rate constants’’, normally used to fit the experimental data. In the first section, I explore the possibility to give a precise description of the energy introduced in the **Huxley and Simmons** model (1971), whose ‘’infinite steep’’ wells represent a problem in the definition of the rate constants. Actually, I am trying to obtain a **quantitative agreement** with the experiments, for a two wells energy even with the realistic values of all the parameters, that represent the major criticisms to their model. At my knowledge, all the existing models obtain this quantitative agreement only with very particular, and sometimes unrealistic, choice of the rate constants.

In the case of the long-time scale, the central mechanism is related to the attachment and the detachment of the cross bridges. This process is currently mainly described as a chemical reaction linked to the hydrolisation of ATP. The mechanical details of the contractile mechanism remain obscure. The second section, is concentrated on exploring this subject, with the theory of **molecular motors**, that describe the average motion of small particles subjected to a periodic potential and to thermal fluctuation, as is the case of cross-bridge's kinetic. The definitions and the first applications of this theory to the biological problems of the motion of proteins are quite recent ([Magnasco] and [Prost]), but a **rigorous description** of skeletal muscle's mechanics using the molecular motors is still under analysis. The main difference between this type of description and the usual models of cross-bridge cycle, is that in the latter the passage from one state to the other is a "**jump**" governed by a kinetic constant that has to be defined, normally to **fit the data**; in the former this passage is described by diffusion processes, linked to the thermal motion. This aspect gives a **mechanical description** of the transition between states, and the kinetic constant become related to first passage time, described by the Kramer's theory. Now these constant, are firmly related to the potential in which the particles move. During all this analysis, a great importance was given to the physical meaning related to the analytical description. For instance, the actin, one of the two filaments whose sliding generate the contraction, is a polymeric chain of actin-monomer, so its structure is periodic and can well describe the periodic potential acting on the cross-bridge. The analysis is made in *MatLab* using an *Euler* type algorithm for stochastic equations.

Multi-scale modelling and characterisation for phase transformations in advanced materials (Multimat) Meetings:

Midterm meeting, November 22 - 25, 2006, Antwerp, Belgium
Sixth meeting, April 19 - 21, 2007, Prague, Czech Republic
Third annual meeting, September 2 - 5, 2007, Oxford, UK
Eightest meeting, April 2 - 4, 2008, Rome, Italy

Multimat is a great opportunity to make research at an international level.