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Supervisor Expression of Interest
MSCA-IF Marie Sklodowska Curie Action-Individual Fellowship 2020

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Department Name: Research topic: (https://www.polimi.it/en/scientific-research/research-at-the-politecnico/departments/)	Department of Physics **Ultrafast light-driven processes in bio-relevant molecules** PE2_11 Lasers, ultra-short lasers and laser physics PE2_7 Atomic, molecular physic
MSCA-IF Research Area Panels	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ ENG_Information Science and Engineering ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics ✖ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Territorial Fragilities ☐ Health ✖ Industry 4.0
Brief description of the Department and Research Group (including URL if applicable):	The research activities will be performed in the Attosecond Research Centre (www.attosecond.fisi.polimi.it). The Centre is equipped with state-of- the-art instrumentation and it is internationally recognised in the field of attosecond science. The research activity is based on the application of ultrashort EUV pulses to the investigation of ultrafast phenomena in atoms, molecules and solids on timescales ranging from a few femtoseconds to a few tens of attoseconds. The current research is highly interdisciplinary, since it combines challenging achievements in various fields: laser technology, extreme nonlinear optics, XUV optics, atomic, molecular and solid-state physics, molecular modelling, inorganic and organic chemistry, biophysics. The research group is composed by three staff members, an average of two postdocs, four PhD students and several Master students.

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Brief project description: **(max 1 page)**	**Ultrafast light-driven processes in bio-relevant molecules** The processes of electron transfer and charge transfer in organic materials are of crucial importance for technologies aiming at the conversion of solar energy into electrical energy and at its efficient transport. On the other hand, the interaction of light with bio-relevant molecules is of crucial importance since it triggers ultrafast physical/chemical phenomena, which drive several biological processes. Ultrafast photo-induced electron dynamics plays a crucial role in the early stages of radiation damage of bio-molecules and in any process where electron transfer occurs. Ultrashort pulses can be generated in the 20–40 eV energy range, which is highly relevant for the biological context. This is indeed the typical energy of the secondary electrons that, by interacting with DNA, represent the main source of indirect damage following tissue irradiation. A complete picture of the physical/chemical processes initiated by ionization is still far from being achieved. The target of the project is the investigation, with extreme temporal resolution, of the molecular processes initiated by the interaction of ionizing radiation with biologically relevant molecules. ***We expect that the project will have strong impact in bio-technological applications such as sensing and molecular electronics and, more in general, in organic opto-electronics.*** The main objective is to identify and control at molecular level the early steps of light-driven processes of primary importance in photochemistry and photobiology, which typically evolve on timescales ranging from the attosecond domain of purely electron dynamics, to the hundreds of femtosecond domain of nuclear dynamics. *Objective 1*: Development of the experimental setup for the generation of femtosecond pulses in the ultraviolet (UV) spectral region (around 260 nm). Femtosecond UV pulses will be used as pump pulses in pump-probe measurements. Probe pulses are produced by the process of high-order harmonic generation in gases. The individual harmonics are spectrally selected by a time-delay compensated monochromator, which preserves their duration (<15 fs). The use of UV-pump pulses is particularly useful since biologically-relevant molecules often present resonances in this spectral region. *Objective 2*: Pump-probe measurements in the gas phase, to understand the path followed by the molecules after excitation. The target is to shed light on the ultrafast coupling between the electronic and nuclear degrees of freedom. *Objective 3*: Development of ultrathin liquid jets and application of ultrafast XUV spectroscopy techniques to liquid sheets for the investigation of ultrafast electron dynamics in molecules in the natural aqueous environment. This is particularly crucial for the investigation of photo-chemical reactions in biologically relevant processes.