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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/)	Physics Department **Controlling electronic properties of advanced materials on attosecond time scale** PE2_11 Lasers, ultra-short lasers and laser physics PE3_9 Condensed matter beam interactions (photons, electrons, etc.) PE3_4 Electronic properties of materials, surfaces, interfaces, nanostructures, etc.
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 of the Physics Department focus on two broad areas: photonics and nanotechnologies. In particular, the Department has gained wide recognition in the field of ultrafast phenomena. Indeed, the group and the attosecond research center where the project will be hosted (http://www.attosecond.fisi.polimi.it/) occupy a leading position in attosecond science. Many first pioneering experiments in this new branch of ultrafast spectroscopy have been performed in this group. It is composed by three staff members, an average of two postdocs, four PhD students and several Master's students.

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Brief project description: **(max 1 page)**	**Controlling electronic properties of advanced materials on attosecond time scale** An increasing understanding of the static and dynamical electro-optical properties of solids is the prerequisite for the development of many key technological areas like electronics, optoelectronics, spintronics, information processing and photovoltaics. In a word constantly seeking for more efficient and powerful devices, all these technological areas are moving towards smaller time and spatial scales. As those scales are not accessible with conventional spectroscopic tools, the scientific community is currently placing great effort in investigating new experimental and theoretical tools which could allow to enter unexplored areas of knowledge, setting the basis for the development of the next generation technology. In this framework, the candidate proposes to combine the most advanced spectroscopical techniques with unconventional materials to go beyond the state of the art and study ultrafast electron, spin and exciton dynamics happening on few femtoseconds (1 fs = 10^{-15} s) to tens of attoseconds (1 as = 10^{-18} s). The project focuses on the realization of innovative schemes for attosecond all-optical pump-probe spectroscopy as transient absorption spectroscopy or transient reflection spectroscopy with advance control over the optical characteristics (energy, time duration, polarization state) of pump and probe pulses in order to make them suitable for solid state samples. Investigating for the first time the possibility to manipulate the electron-optical properties of unconventional materials (such as 2D materials, topological insulators, etc.) on sub-fs time scales, the outcome of the project will shed a new light on important and fundamental physical problems at the basis of light matter interaction, such as ultrafast electron screening, transport, exciton formation, electron correlation and coherent demagnetization. As a result, many open questions like: "Which are the mechanisms that dominate the coherent response during light-matter interaction?", "Is it possible to manipulate carriers on a sub-femtosecond regime (PHz domain)?", may find an answer with consequent great impact in key technological areas like optoelectronics, spintronics, valleytronics, photovoltaics and signal processing.