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

Supervisor name:	Paolo Biagioni
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Department Name: Research topic: (https://www.polimi.it/en/scientific-research/research-structures/departments/)	Physics Departments Chiral and nonlinear nanophotonics for molecular sensing
MSCA-IF Research Area Panels	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ ENG_Information Science and Engineering ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics **X** PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Territorial Fragilities **X** Health ☐ Industry 4.0
Brief description of the Department and Research Group:	The Physics Department (www.fisi.polimi.it) comprises five main research lines that together represent a very collaborative and stimulating environment covering all aspects of photonics and nanoscience: (i) Ultrashort light pulse generation and applications to the study of ultrafast phenomena in the matter; (ii) Solid state lasers and photonic devices; (iii) Photonics for health, food and cultural heritage; (iv) Epitaxial growth and nanostructure fabrication; (v) Electronic, optical and magnetic properties of low-dimensional systems. The nano-optics group, where the activities of the supervisor are located, focuses on nanoscale optics and molecular sensing with metal and dielectric nanostructures, covering the whole spectral range from the visible to the mid infrared.

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Brief project description:	Over the last two decades nano-optics (the study of light-matter interactions at the nanoscale) has enriched the realm of molecular sensing with novel strategies devised to boost our ability to detect small amounts of specific molecular species. Dielectric nanocavities and nanoparticles, plasmonic antennas, photonic crystals, are just some of the solutions that nano-optics adopts to locally engineer the electromagnetic fields and achieve a specific enhanced sensitivity. Among the many aspects of light-matter interactions, nonlinear optics [1-2] and chiroptical spectroscopies [3-4] are emerging as two specific fields in which the use of nanostructured systems can potentially pave the way to novel enhanced photonic platforms for molecular detection, also with sensitivity to the specific chiral configuration of the molecules. However, both the concept of nonlinear nanoscale sensing and that of the so-called 'superchiral' sensing are still in their infancy and the mechanisms behind their specific sensitivity still need to be investigated and optimized. This requires the combination of theoretical, numerical, and experimental efforts capable to address the physical principles behind the sensing mechanisms, numerically optimize the response of the sensing platform, fabricate it, and test it after integration in a suitable device that comprises a microfluidic network for the controlled delivery of molecules. The activity will be aimed at developing novel strategies for nonlinear and chiroptical nanoscale spectroscopies. In doing this, the candidate will benefit from the whole infrastructure available at the Physics Department and also from the already existing synergies with other Departments at the Politecnico di Milano, specifically the Department of Chemistry, Materials and Chemical Engineering (quantum numerical simulations of the molecular response to electromagnetic fields, synthesis and characterization of chiral molecules) and with the Department of Mathematics (statistical analysis of complex spectroscopic data). [1] M. Celebrano *et al.*, Nature Nanotechnology **10**, 412 (2015) [2] L. Ghirardini *et al.*, arXiv:1711.05584 [3] M. Finazzi *et al.*, Phys. Rev. B **91**, 195427 (2015) [4] G. Pellegrini *et al.*, Phys. Rev. B **95**, 241402(R) (2017)