POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 39th cycle

PNRR 118 INTERDISC Research Field: MULTIMODAL HYPERSPECTRAL IMAGING TO MAP CONTAMINANTS AND MICRO-PLASTICS IN WATER THROUGH A NOVEL MULTIMODAL MICROSCOPY PLATFORM AND OBJECT-ORIENTED DATA ANALYSIS OF MULTIMODAL DATASETS

Monthly net income of PhDscholarship (max 36 months)
€ 1195.5
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	This PhD research project originates from an important environmental problem: the ubiquitous prevalence of microplastics in the ecosystem that contaminates the food chain and put at risk human health. Since the end of the second World War, the manufacturing of plastic has exponentially grown on a global scale, leading to an increase in environmental plastic waste. Microplastics are created because of the gradual fragmentation of plastics caused by weathering and biological processes. Additionally, microplastics are purposefully produced as components of consumer goods.Over the last decade, microplastics pollution has been identified as a growing global threat that might affect ecosystems, biodiversity, and human health. The persistent contaminants of microplastics in ecosystems have also been recognized as an emerging global issue and the contemporary period has been defined as "a new historical epoch, *the Plasticene*", due to the extensive deposits of microplastics. In this context, scientific research works in designing instrumentation capable of detecting the presence of microplastics at a trace level in terrestrial and marine environments. The present PhD project aims to develop new methods and computational tools to detect, map, and classify microplastics with sensitivity and accuracy superior to state-of-the-art methods currently used for this purpose.

Methods and techniques that will be developed and used to carry out the research	Within this framework, the PhD research project will pursue the aforementioned objective based on two pillars: (i) the design and development of **a new class of hyperspectral microscopes for the multimodal imaging of samples of interest in the environmental field**; the innovative microscope will be able of recording hyperspectral datasets related to three different phenomena of optical radiation interaction with the sample: diffuse reflectance, Raman scattering and fluorescence emission. (ii) the study of **object-oriented statistics-based data analysis methods to enhance mapping and identification of microplastics** in terrestrial and marine environments. Indeed, the use of a multimodal approach to detect contaminants in terrestrial and water samples requires data analysis methods capable of exploiting complementarity and correlations among datasets. In this context, the expertise of MOXstat's group in Statistical Learning will provide the needed knowhow to define and optimize data analysis algorithms derived from Object Oriented Spatial Statistics. By designing and introducing this hyperspectral multimodal approach, innovative at both the instrumental and data analysis level, we expect to be able to identify and classify micrometric and sub-micrometric size microplastic materials that are now undetectable by current methods, making it easier to comprehend how microplastics affect the environment and public health. Further the developed approach will be of considerable interest not only for microplastic detection, but also in other application areas, such as biology, biomedicine, material science, and conservation science.
Educational objectives	The PhD project will bring the candidate to the frontiers of research in the two following topics: - design and application of multimodal hyperspectral imaging. - development and optimization of cutting-edge data analysis techniques, based on object-oriented, deep learning and artificial intelligence methods. He/she will also become an expert of the design of design of optical micro-imaging set-ups and will become familiar with

	different optical spectroscopy techniques for material science analysis, as Raman, optical fluorescence and diffuse reflectance spectroscopy. He/she will have the opportunity to be part of two dynamic and international research groups located at the Physics department and the Mathematics Department of Politecnico di Milano.
Job opportunities	Due to the multidisciplinary training in optics, photonics and object-oriented data analysis methods, the scholar will have excellent job opportunities in different types of industries, including those developing analytical instruments and spectroscopic systems and those developing innovative methods for data and big data analysis. Innovative companies and start-ups in green economy will also offer employment opportunities. In addition, he/she will be well positioned for a possible career in university or research center.
Composition of the research group	2 Full Professors 2 Associated Professors 2 Assistant Professors 4 PhD Students
Name of the research directors	Daniela Comelli; Piercesare Secchi

Contacts
Daniela.comelli@polimi.it; piercesare.secchi@polimi.it.

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	597.75 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	non definito
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	He/she will carry out a 6-months minimum secondment activity in an EU-located research group active in the design and application of hyperspectral and multimodal imaging devices.

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By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
*Educational activities***:** Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences). Financial aid per PhD student per 3 years: max 4.872,90 euros per student. *Teaching assistantship***:** There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations. *Computer availability:* individual use *Desk availability:* individual use