POLITECNICO DI MILANO

# PhD in FISICA / PHYSICS - 40th cycle

## PNRR 630 Research Field: BROADBAND HYPERSPECTRAL IMAGING

| Monthly net income of PhDscholarship (max 36 months) |
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| **€ 1300.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | Hyperspectral imaging (HSI) is a novel analytical technique based on spectroscopy, with the aim of measuring the spectrum of the light coming from each point of a scene of interest. While the human eye has only three color receptors, for blue, green and red light, hyperspectral imaging measures the continuous spectrum of the light as a function of the wavelength ¿ for each pixel of the scene at coordinates (x, y) with fine spectral resolution, not only in the visible but also in the infrared range. The collected data form the so-called hyperspectral image: a three-dimensional data cube as a function of x, y and ¿. These data contain an extensive amount of information. Therefore, many numerical methods and algorithms have been developed to enable the extraction of quantitative parameters related to the physicochemical properties of the imaged objects, as well as the clustering into different components, useful for the analysis of congested scenes. For this reason, HSI is an extremely powerful technique, which has been applied to a wide range of fundamental and applied studies in fields as diverse as remote sensing, medical and biological imaging, microscopy, agriculture, coastal and geological prospecting, safety and security, military applications, archaeology and conservation science. In this project, these and similar applications will be explored, in different geometry configurations such as absorbance, transmittance, fluorescence and diffuse reflectance, both in wide-field and microscopy setups. |
| **Methods and techniques that will be developed and used to carry out the research** | The candidate will employ a novel approach to Fourier-Transform spectroscopy, based on a patented ultra-stable |

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| | Transform spectroscopy, based on a patented ultra-stable common-path interferometer, completely insensitive to external vibrations. Unlike a Michelson or a Mach?Zehnder interferometers, this device does not separate the two replicas in space (which would cause mechanical instabilities) but in polarization. To this purpose, it makes use of birefringence. In this class of materials, vertically and horizontally polarized light experience a different index of refraction, and thus it propagates with different speed. It is possible to vary the delay between the two replicas by changing the insertion of a birefringent wedge, thus continuously varying the material thickness. In this way, it is possible to obtain an extremely high delay stability and reproducibility (better than 1 attosecond, i.e. approx. a thousandth of the wavelength). For this reason, it can be used without any active control or position tracking even in harsh environments such as industries in the presence of vibrations.This instrument is already available as a commercial product at NIREOS: see HERA hyperspectral cameras. The candidate will learn how to align the system, use the software and perform absorbance, transmittance and diffuse reflectance measurements in a large set of samples for commercial applications. |
| **Educational objectives** | The candidate will gain specific skills in the design of an innovative hyperspectral camera based on a birefringent interferometer for Fourier-transform spectroscopy, its mechanical and optical design, software for instrument control and data analysis, as well as its application in various fields of practical commercial interest. |
| **Job opportunities** | The skills acquired during this research project will give the opportunity of a career in industrial companies oriented to the R&D in photonics, spectroscopy, materials science, biology, mining, food control and industrial quality control. |
| **Composition of the research group** | 1 Full Professors<br>2 Associated Professors<br>2 Assistant Professors<br>5 PhD Students |
| **Name of the research directors** | Prof. Dario Polli |

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| Contacts |
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| *Prof. Dario Polli*<br><br>*Email: dario.polli@polimi.it*<br>*Webpage:http://polli.faculty.polimi.it*<br>*Tel number: 02.23.99.60.86* |

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

| Scholarship Increase for a period abroad | |
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| **Amount monthly** | 650.0 € |
| **By number of months** | 6 |

| National Operational Program for Research and Innovation | |
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| **Company where the candidate will attend the stage (name and brief description)** | NIREOS SRL Via G. Durando 39 20158 Milano (Italy) www.nireos.com |
| **By number of months at the company** | 18 |
| **Institution or company where the candidate will spend the period abroad (name and brief description)** | The University Hospital Jena - Germany |
| **By number of months abroad** | 6 |

| Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information |
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| ***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 5.300,25 euros per student.<br><br>***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.<br><br>***Computer availability:*** *shared use*<br>***Desk availability:*** *shared use*<br><br>***Other information:*** *See www.vibra.polimi.it* |