PhD position at the Lagrange Laboratory, Nice
– In the framework of the SPEED project –

Optimization and development of complex diffractive focal plane masks

*The aim of the research project is to carry out a comprehensive analysis and design optimization of two optical systems – a coronagraph and a cophasing sensor – in order to meet the extreme challenges for the direct imaging of exoplanets with segmented telescopes. The research will focus on advancements in optical cophasing performance with the **S**elf-**C**oherent **C**amera-**P**hasing **S**ensor (**SCC-PS**, Janin-Potiron et al. 2016), and in high-contrast imaging at very small angular separation with the **P**hase **I**nduced **A**mplitude **A**podization **C**omplex **M**ask **C**oronagraph (**PIAACMC**, Guyon et al. 2014). These systems are expected to play a key role in achieving the required performance improvement leading to a significant step forward in planet-star contrast and angular separation of future exoplanet hunters with segmented telescopes. The research is a part of a larger effort in instrumentation for the direct detection and characterization of exoplanets initiated at the Lagrange laboratory since mid-2013 with the development of the **S**egmented **P**upil **E**xperiment for **E**xoplanet **D**etection facility (SPEED, Martinez et al. 2015 , 2016).*

PhD main objectives

The PhD research seeks at developing novel and innovative complex focal plane mask solutions with two complementary focuses : (1) the correction of phase discontinuities introduced by the segmented nature of the telescope primary mirror (segment alignment) using the SCC-PS, and (2) the correction of amplitude discontinuities introduced by the telescope primary mirror (inter-segments spacing), and secondary mirror/supports (central obscuration and spiders) using the PIAACMC. The more general and long term ambition is to participate in two critical areas : guaranty the telescope full optical capacity to deliver sharp and coherent PSF near to diffraction-limit by improving the performance of a fine cophasing sensor (SCC-PS), and guaranty the instrument high-contrast imaging efficiency by accessing deep contrast levels at the telescope diffraction limit with a very small inner working angular coronagraph (PIAACMC) coping with complex telescope apertures.

Both focal plane mask developments listed above are of equal complexity, and will thus require in-depth numerical modeling optimization (geometry, structure, material, etc.), and fabrication process investigations (e.g., electron beam lithography, etc.), as well as mastering metrological aspects.

The ambition of the PhD project is thus threefold :
objectif (1) concentrates on the development of diffractive focal plane mask (phase *or* amplitude) with innovative geometry and structure to precisely control the spatial localization of the complex amplitude diffracted by the focal plane mask in the relayed pupil plane (SCC-PS) ;
objectif (2) concentrates on the development of complex diffractive focal plane mask (phase *and* amplitude) with innovative geometry and structure to deliver high-contrast imaging at $1\lambda/D$ accommodating complex telescope apertures (PIAACMC) ;
objectif (3) concerns the integration, tests, and exploitation of the SCC-PS and PIAACMC on the SPEED testbed through the laboratory comparison of the SCC-PS to other cophasing sensors (ZELDA N'Diaye et al. 2016 & Janin-Potiron et al. in prep., APF-WS Pope et al. 2014) in optical wavelengths, and the experimental validation and performance assessment of the PIAACMC in the near infrared wavelengths combined with two continuous face-sheet deformable mirrors made of 952 actuators to create a deep contrast zone in the field of interest.

Working environment and collaborations

The PhD project will be held at the Lagrange laboratory. The successful candidate will evolves within the SPEED project, with collaborations with the LESIA (P. Baudoz) for objective (1), and the Subaru telescope (O. Guyon) for objective (2). The SPEED project includes researchers, engineers, and students from various expertise fields. The PhD position is co-funded by the CNES (French national space agency) and industries have been solicited for the additional co-funding part. The PIAACMC development is supported by a CNES R&T program.

Additional information and timeline

Prior to the PhD position, we offer a five months Master 2 training (funded) from March 2016 to August 2017 (application for the training must be sent before February 25th), and PhD applications sent before 1st June 2017 will be given full consideration. Past this date applications will be considered depending on availability.

Candidate profile

The successful candidate must have a Master degree (or equivalent) with good records by the starting date of the PhD, with interest in physics, optics, astrophysics, numerical modeling, engineering or other relevant fields.

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