Dark-hole correction and maintenance in polychromatic light

Location:

- Laboratoire d'Astrophysique de Marseille (LAM), Marseille, France
- Laboratory for Instrumentation and Research in Astrophysics (LIRA), Meudon, France

Funding: AMINO (Advanced Multi-spectral Imaging using Novel wavefront sensors with Optical photon-counting detectors), a target project from the PEPR Origins under France 2030 fundings managed by ANR - **This postdoc position is fully funded.**

Starting date: From October 2026
Duration: 1 + 1 years

Supervisors:

- Arthur Vigan (LAM / CNRS)
- Axel Potier (LIRA / Université Paris-Cité)

Collaborators: Johan Mazoyer, Pierre Baudoz, Moustapha Dekkali, Raphaël Galicher (LIRA/Observatoire de Paris), Faouzi Boussaha, Christine Chaumont (LUX/Observatoire de Paris), Vincent Chambouleyron, Kjetil Dohlen (LAM), Mamadou N'Diaye, Iva Laginja (Lagrange/OCA)

Context: Over the past three decades, the discovery of nearly 6000 exoplanets has revealed an extraordinary diversity in planetary systems. Direct imaging —particularly coronagraphy—has emerged as one of the most promising methods for detecting and characterizing exoplanets in the habitable zone (HZ) of their host star. Such an approach is envisioned in future large facilities, e.g., NASA's **Habitable Worlds Observatory (HWO) in space** and ESO's **Extremely Large Telescope (ELT)** with the Planetary Camera and Spectrograph (PCS) **on the ground**.
The AMINO project (co-PIs: J. Mazoyer and V. Chambouleyron) aims to address some of the challenges associated with direct imaging, particularly for observing exo-Earths with planet/star flux ratios down to 10^{-10}. One of them is the precise control of the incoming light aberrations with deformable optics to maintain areas of high-contrast regions (dark holes) over long periods of time and over a large spectral bandwitdh, which is critical for spectroscopy of faint planets.

The AMINO project focuses on advancing **Focal Plane Wavefront Sensing (FPWFS)** techniques, to estimate aberrations and create or maintain dark-holes. Our team has pioneered some of these techniques, and is currently involved in their integration in both space and ground-based technological demonstrators: **Coronagraph Instrument (CGI) on** NASA's **Roman Space Telescope** and **SPHERE+** on ESO's Very Large Telescope (VLT). But the efficiency of these

FPWFS drops quickly in large spectral broadband: current instruments must rely on slow, sequential measurements in several narrow bands, which limit their performance.

Proposed work: The proposed work will look at two complementary methods for wavefront sensing and control: the Zernike wavefront sensor (ZWFS) and electric field conjugation with pairwise probing (EFC+PWP). These methods have been validated independently but have never been studied and used together to improve their respective performance. In this context, we work will be organised in two sequential parts:

1/ Simulation and design of a polychromatic ZWFS

The selected applicant will conduct simulations to explore the parameter space of the THD2 testbed and find the optimal design for the Zernike mask. Then the mask will be designed, manufactured (by an external company) and verified on the LAM metrology platform. In parallel the postdoc will investigate in simulation how to best combine ZWFS measurements with EFC+PWP for dark hole digging and maintenance.

2/ Implementation on the THD2 testbed at LIRA

The ZWFS component and methods explored in simulation will then be implemented on the THD2 testbed in Paris for broadband dark-hole digging and maintenance. The performance of the different methods or their combination will be investigated and compared in the context for future space missions.

In addition to these two main parts, the selected applicant may have the opportunity to participate in data acquisition at the VLT with the SPHERE/IFS instrument, where ZWFS and EFC+PWP are available. This part of the project will be subject to acceptance of technical time on SPHERE, which cannot be guaranteed now.

Ideally, the selected candidate will spend one year in Marseille and one year in Paris, but this is flexible given the complexity of the logistics involved. Instead of a complete move from one place to the other, long-duration stays could be considered provided that dedicated funding can be secured.

Team & environment: We value diversity of backgrounds and perspectives as essential drivers for innovation and collective success. We are committed to fostering an inclusive environment where everyone feels valued and supported in their professional development.
The postdoc will work between LAM and LIRA, which both have a wide range of expertise in instrumentation and astrophysical exploitation. The selected candidate will also be a member of the broader AMINO project that gathers experts in the field of brown dwarfs and exoplanets, adaptive optics, coronagraphy, wavefront sensors, and detectors at LIRA (Paris), LUX (Paris), LAM (Marseille) and Lagrange (Nice). Additional collaborations include the Makidon Lab at the Space Telescope Science Institute (Baltimore, USA) for space applications towards HWO.

The selected candidate will benefit from a rich national and international scientific environment, and will have the opportunity to share their work with the community through international schools and conferences.

Keywords: instrumentation, adaptive optics, high-contrast imaging and spectroscopy, coronagraphy, wavefront sensing and control, detectors, exoplanets, brown dwarfs.

Applicant's profile: Minimum qualifications include a PhD degree in astrophysics, astronomical instrumentation or a closely related field, but applicants must have a demonstrated track record in wavefront sensing and control, coronagraphy, or related domains. They must also have demonstrated their capacity for independent work and for conducting their own research. The candidates are expected to be enthusiastic, dynamic, autonomous while having teamwork abilities.

Candidates in the process of finishing their PhD by the end of 2026 are highly encouraged to apply and will be given full consideration. Junior and senior applications will be evaluated at the same level. LAM, LIRA and CNRS are actively committed to equal opportunity in employment.

Application

Deadline: **Friday 12 June 2026 (23:59 CET)**

The application is constituted of the following documents:

- Cover letter, up to 3 pages, highlighting your past research and how it relates to the project
- Curriculum vitae, including a full list of publications
- 2 letters of reference to be sent directly to Dr. Arthur Vigan (arthur.vigan@lam.fr) and Dr. Axel Potier (axel.potier@obspm.fr) before the deadline

The CV and research statement must be submitted through the CNRS job portal:

https://emploi.cnrs.fr/Offres/CDD/UMR7326-ANAMEK-129/Default.aspx?lang=EN

Applications not submitted through this portal will not be considered.